SUSE Edge Documentation

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SUSE Edge 3.7 Documentation

Welcome to the SUSE Edge documentation. You will find the high level architectural overview, quick start guides, validated designs, guidance on using components, third-party integrations, and best practices for managing your edge computing infrastructure and workloads.

1 What is SUSE Edge?

SUSE Edge is a purpose-built, tightly integrated, and comprehensively validated end-to-end solution for addressing the unique challenges of the deployment of infrastructure and cloud-native applications at the edge. Its driving focus is to provide an opinionated, yet highly flexible, highly scalable, and secure platform that spans initial deployment image building, node provisioning and onboarding, application deployment, observability, and complete lifecycle operations. The platform is built on best-of-breed open source software from the ground up, consistent with both our 30-year+ history in delivering secure, stable, and certified SUSE Linux platforms and our experience in providing highly scalable and feature-rich Kubernetes management with our Rancher portfolio. SUSE Edge builds on-top of these capabilities to deliver functionality that can address a wide number of market segments, including retail, medical, transportation, logistics, telecommunications, smart manufacturing, and Industrial IoT.

2 Design Philosophy

The solution is designed with the notion that there is no "one-size-fits-all" edge platform due to customers' widely varying requirements and expectations. Edge deployments push us to solve, and continually evolve, some of the most challenging problems, including massive scalability, restricted network availability, physical space constraints, new security threats and attack vectors, variations in hardware architecture and system resources, the requirement to deploy and interface with legacy infrastructure and applications, and customer solutions that have extended lifespans. Since many of these challenges are different from traditional ways of thinking, e.g. deployment of infrastructure and applications within data centers or in the public cloud, we have to look into the design in much more granular detail, and rethinking many common assumptions.

For example, we find value in minimalism, modularity, and ease of operations. Minimalism is important for edge environments since the more complex a system is, the more likely it is to break. When looking at hundreds of locations, up to hundreds of thousands, complex systems will break in complex ways. Modularity in our solution allows for more user choice while removing unneeded complexity in the deployed

platform. We also need to balance these with the ease of operations. Humans may make mistakes when repeating a process thousands of times, so the platform should make sure any potential mistakes are recoverable, eliminating the need for on-site technician visits, but also strive for consistency and standardization.

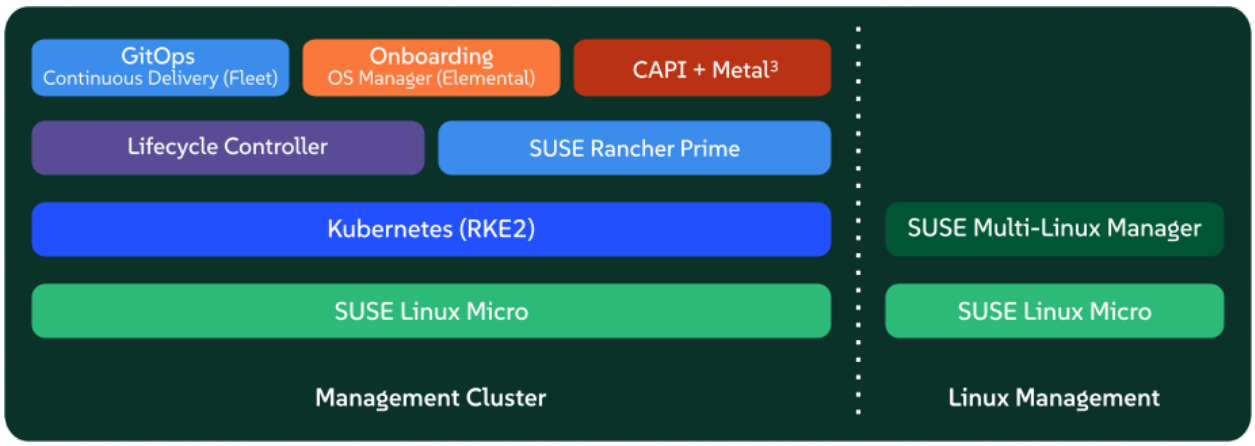
3 High Level Architecture

The high level system architecture of SUSE Edge is broken into two core categories, namely "management" and "downstream" clusters. The management cluster is responsible for remote management of one or more downstream clusters, although it's recognized that in certain circumstances, downstream clusters need to operate without remote management, e.g. in situations where an edge site has no external connectivity and needs to operate independently. In SUSE Edge, the technical components that are utilized for the operation of both the management and downstream clusters are largely common, although likely differentiate in both the system specifications and the applications that reside on-top, i.e. the management cluster would run applications that enable systems management and lifecycle operations, whereas the downstream clusters fulfil the requirements for serving user applications.

3.1 Components used in SUSE Edge

SUSE Edge is comprised of both existing SUSE and Rancher components along with additional features and components built by the Edge team to enable us to address the constraints and intricacies required in edge computing. The components used within both the management and downstream clusters are explained below, with a simplified high-level architecture diagram, noting that this isn't an exhaustive list:

3.1.1 Management Cluster



- **Management**: This is the centralized part of SUSE Edge that is used to manage the provisioning and lifecycle of connected downstream clusters. The management cluster typically includes the following components:

  - Multi-cluster management with Rancher Prime (*Chapter 4, Rancher*), enabling a common dashboard for downstream cluster onboarding and ongoing lifecycle management of infrastructure and applications, also providing comprehensive tenant isolation and `IDP` (Identity Provider) integrations, a large marketplace of third-party integrations and extensions, and a vendor-neutral API.

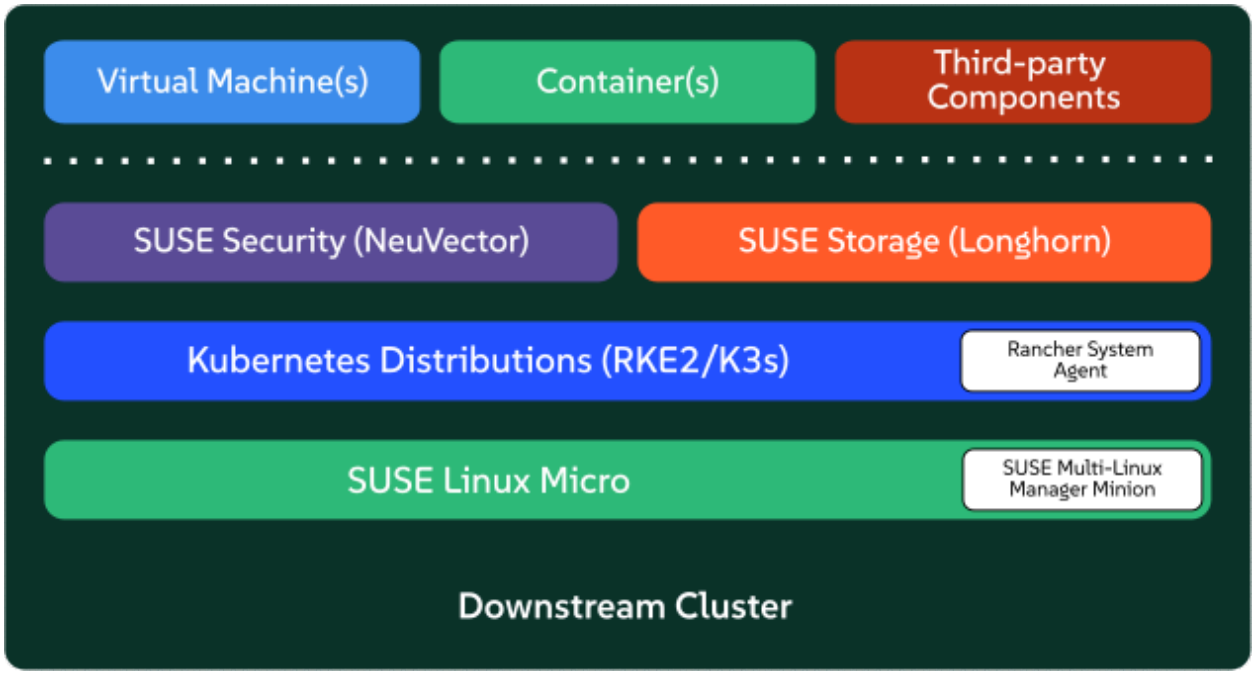
  - Linux systems management with SUSE Multi-Linux Manager, enabling automated Linux patch and configuration management of the underlying Linux operating system (*SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*)) that runs on the downstream clusters. Note that while this component is containerized, it currently needs to run on a separate system to the rest of the management components, hence labelled as "Linux Management" in the diagram above.

  - A dedicated Lifecycle Management (*Chapter 19, Upgrade Controller*) controller that handles management cluster component upgrades to a given SUSE Edge release.

  - Remote system on-boarding into Rancher Prime with Elemental (*Chapter 10, Elemental*), enabling late binding of connected edge nodes to desired Kubernetes clusters and application deployment, e.g. via GitOps.

- An optional GitOps engine called Fleet (*Chapter 6, Fleet*) for managing the provisioning and lifecycle of downstream clusters and applications that reside on them.
- Underpinning the management cluster itself is SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*) as the base operating system and RKE2 (*Chapter 12, RKE2*) as the Kubernetes distribution supporting the management cluster applications.

3.1.2 Downstream Clusters

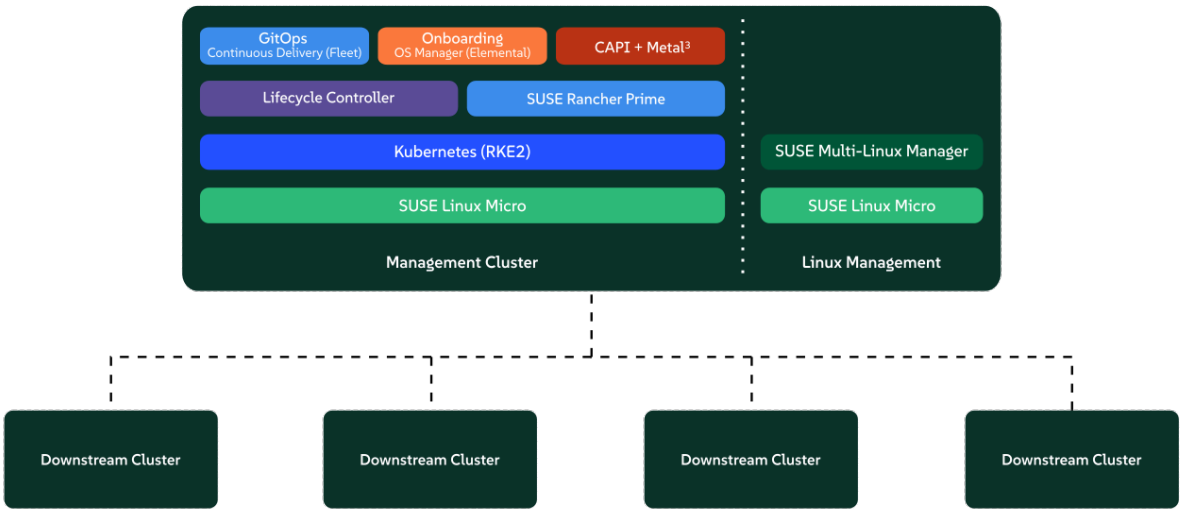


- **Downstream**: This is the distributed part of SUSE Edge that is used to run the user workloads at the Edge, i.e. the software that is running at the edge location itself, and is typically comprised of the following components:
  - A choice of Kubernetes distributions, with secure and lightweight distributions like K3s (*Chapter 11, K3s*) and RKE2 (*Chapter 12, RKE2*) (RKE2 is hardened, certified and optimized for usage in government and regulated industries).
  - SUSE Security (*Chapter 14, SUSE Security*) to enable security features like image vulnerability scanning, deep packet inspection, and real-time threat and vulnerability protection.
  - Software block storage with SUSE Storage (*Chapter 13, SUSE Storage*) to enable lightweight persistent, resilient, and scalable block-storage.

- A lightweight, container-optimized, hardened Linux operating system with SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*), providing an immutable and highly resilient OS for running containers and virtual machines at the edge. SUSE Linux Micro is available for both AArch64 and AMD64/Intel 64 architectures, and it also supports `Real-Time Kernel` for latency sensitive applications (e.g. telco use-cases).

- For connected clusters (i.e. those that do have connectivity to the management cluster) two agents are deployed, namely Rancher System Agent for managing the connectivity to Rancher Prime, and venv-salt-minion for taking instructions from SUSE Multi-Linux Manager for applying Linux software updates. These agents are not required for management of disconnected clusters.

3.2 Connectivity



The above image provides a high-level architectural overview for **connected** downstream clusters and their attachment to the management cluster. The management cluster can be deployed on a wide variety of underlying infrastructure platforms, in both on-premises and cloud capacities, depending on networking availability between the downstream clusters and the target management cluster. The only requirement for this to function are API and callback URL's to be accessible over the network that connects downstream cluster nodes to the management infrastructure.

It’s important to recognize that there are distinct mechanisms in which this connectivity is established relative to the mechanism of downstream cluster deployment. The details of this are explained in much more depth in the next section, but to set a baseline understanding, there are three primary mechanisms for connected downstream clusters to be established as a "managed" cluster:

1. The downstream clusters are deployed in a "disconnected" capacity at first (e.g. via Edge Image Builder (*Chapter 8, Edge Image Builder*)), and are then imported into the management cluster if/when connectivity allows.

2. The downstream clusters are configured to use the built-in onboarding mechanism (e.g. via Elemental (*Chapter 10, Elemental*)), and they automatically register into the management cluster at first-boot, allowing for late-binding of the cluster configuration.

3. The downstream clusters have been provisioned with the baremetal management capabilities (CAPI + Metal[3]), and they’re automatically imported into the management cluster once the cluster has been deployed and configured (via the Rancher Turtles operator).

Note

It’s recommended that multiple management clusters are implemented to accommodate the scale of large deployments, optimize for bandwidth and latency concerns in geographically dispersed environments, and to minimize the disruption in the event of an outage or management cluster upgrade. You can find the current management cluster scalability limits and system requirements here (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/installation-requirements).

4 Common Edge Deployment Patterns

Due to the varying set of operating environments and lifecycle requirements, we’ve implemented support for a number of distinct deployment patterns that loosely align to the market segments and use-cases that SUSE Edge operates in. We have documented a quickstart guide for each of these deployment patterns to help you get familiar with the SUSE Edge platform based around your needs. The three deployment patterns that we support today are described below, with a link to the respective quickstart page.

4.1 "Phone Home" network provisioning

Sometimes you are operating in an environment where the central management cluster cannot manage the hardware directly (for example, your remote network is behind a firewall or there is no out-of-band management interface; common in "PC" type hardware often found at the edge). In this scenario, we provide tooling to remotely provision clusters and their workloads with no need to know where hardware is being shipped when it is bootstrapped. This is what most people think of when they think about edge computing; it's the thousands or tens of thousands of somewhat unknown systems booting up at edge locations and securely phoning home, validating who they are, and receiving their instructions on what they're supposed to do. Our requirements here expect provisioning and lifecycle management with very little user-intervention other than either pre-imaging the machine at the factory, or simply attaching a boot image, e.g. via USB, and switching the system on. The primary challenges in this space are addressing scale, consistency, security, and lifecycle of these devices in the wild.

This solution provides a great deal of flexibility and consistency in the way that systems are provisioned and on-boarded, regardless of their location, system type or specification, or when they're powered on for the first time. SUSE Edge enables full flexibility and customization of the system via Edge Image Builder, and leverages the registration capabilities Rancher's Elemental offering for node on-boarding and Kubernetes provisioning, along with SUSE Multi-Linux Manager for operating system patching. The quick start for this solution can be found in *Chapter 1, Remote host onboarding with Elemental*.

4.2 Image-based provisioning

For customers that need to operate in standalone, air-gapped, or network limited environments, SUSE Edge provides a solution that enables customers to generate fully customized installation media that contains all of the required deployment artifacts to enable both single-node and multi-node highly-available Kubernetes clusters at the edge, including any workloads or additional layered components required, all without any network connectivity to the outside world, and without the intervention of a centralized management platform. The user-experience follows closely to the "phone home" solution in that installation media is provided to the target systems, but the solution will "bootstrap in-place". In this scenario, it's possible to attach the resulting clusters into Rancher for ongoing management (i.e. going from a "disconnected" to "connected" mode of operation without major reconfiguration or redeployment), or can continue to operate in isolation. Note that in both cases the same consistent mechanism for automating lifecycle operations can be applied.

Furthermore, this solution can be used to quickly create management clusters that may host the centralized infrastructure that supports both the "directed network provisioning" and "phone home network provisioning" models as it can be the quickest and most simple way to provision all types of Edge infrastructure.

This solution heavily utilizes the capabilities of SUSE Edge Image Builder to create fully customized and unattended installation media; the quickstart can be found in *Chapter 2, Standalone clusters with Edge Image Builder*.

5 SUSE Edge Stack Validation

All SUSE Edge releases comprise of tightly integrated and thoroughly validated components that are versioned as one. As part of the continuous integration and stack validation efforts that not only test the integration between components but ensure that the system performs as expected under forced failure scenarios, the SUSE Edge team publishes all of the test runs and the results to the public. The results along with all input parameters can be found at ci.edge.suse.com (https://ci.edge.suse.com).

6 Full Component List

The full list of components, along with a link to a high-level description of each and how it's used in SUSE Edge can be found below:

- Rancher (*Chapter 4, Rancher*)
- Rancher Dashboard Extensions (*Chapter 5, Rancher Dashboard Extensions*)
- SUSE Multi-Linux Manager
- Fleet (*Chapter 6, Fleet*)
- SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*)
- Edge Image Builder (*Chapter 8, Edge Image Builder*)
- NetworkManager Configurator (*Chapter 9, Edge Networking*)
- Elemental (*Chapter 10, Elemental*)
- K3s (*Chapter 11, K3s*)
- RKE2 (*Chapter 12, RKE2*)
- SUSE Storage (*Chapter 13, SUSE Storage*)
- SUSE Security (*Chapter 14, SUSE Security*)

- MetalLB (*Chapter 15, MetalLB*)
- KubeVirt (*Chapter 17, Edge Virtualization*)
- System Upgrade Controller (*Chapter 18, System Upgrade Controller*)
- Upgrade Controller (*Chapter 19, Upgrade Controller*)

I Quick Starts

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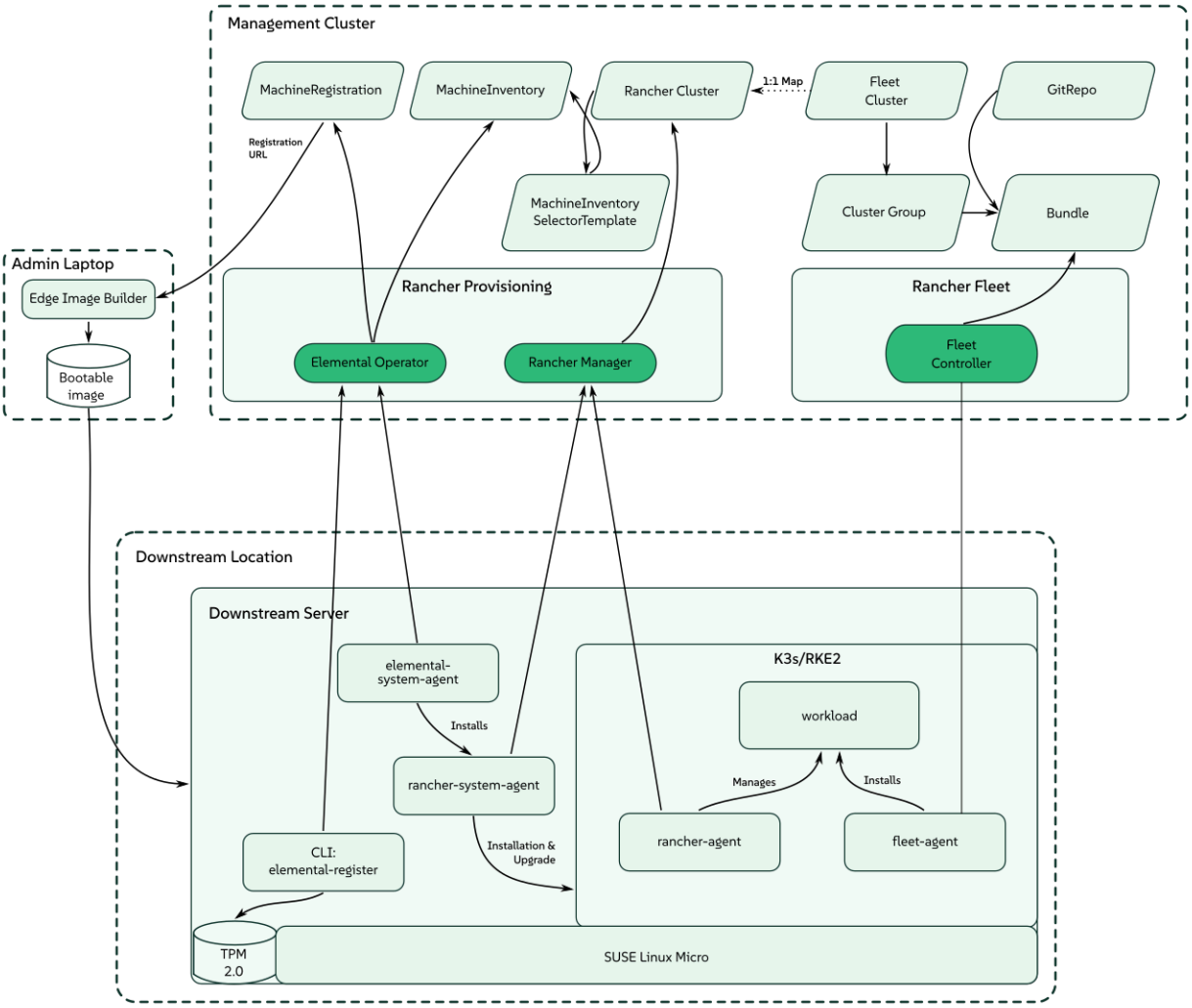
Quick Starts here

1 Remote host onboarding with Elemental

This section documents the "phone home network provisioning" solution as part of SUSE Edge, where we use Elemental to assist with node onboarding. Elemental is a software stack enabling remote host registration and centralized full cloud-native OS management with Kubernetes. In the SUSE Edge stack we use the registration feature of Elemental to enable remote host onboarding into Rancher so that hosts can be integrated into a centralized management platform and from there, deploy and manage Kubernetes clusters along with layered components, applications, and their lifecycle, all from a common place.

This approach can be useful in scenarios where the devices that you want to control are not on the same network as the management cluster or do not have a out-of-band management controller onboard to allow more direct control, and where you’re booting many different "unknown" systems at the edge, and need to securely onboard and manage them at scale. This is a common scenario for use cases in retail, industrial IoT, or other spaces where you have little control over the network your devices are being installed in.

1.1 High-level architecture



1.2 Resources needed

The following describes the minimum system and environmental requirements to run through this quick-start:

- A host for the centralized management cluster (the one hosting Rancher and Elemental):
  - Minimum 8 GB RAM and 20 GB disk space for development or testing (see here (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/installation-requirements#hardware-requirements) for production use)
- A target node to be provisioned, i.e. the edge device (a virtual machine can be used for demoing or testing purposes)
  - Minimum 4GB RAM, 2 CPU cores, and 20 GB disk
- A resolvable host name for the management cluster or a static IP address to use with a service like sslip.io
- A host to build the installation media via Edge Image Builder
  - Running SLES 15 SP6, openSUSE Leap 15.6, or another compatible operating system that supports Podman.
  - With Kubectl (https://kubernetes.io/docs/reference/kubectl/kubectl/), Podman (https://podman.io), and Helm (https://helm.sh) installed
- A USB flash drive to boot from (if using physical hardware)
- A downloaded copy of the latest SUSE Linux Micro 6.2 SelfInstall ISO image found here (https://www.suse.com/download/sle-micro/).

Note

Existing data found on target machines will be overwritten as part of the process, please make sure you backup any data on any USB storage devices and disks attached to target deployment nodes.

This guide is created using a Digital Ocean droplet to host the upstream cluster and an Intel NUC as the downstream device. For building the installation media, SUSE Linux Enterprise Server is used.

1.3 Build bootstrap cluster

Start by creating a cluster capable of hosting Rancher and Elemental. This cluster needs to be routable from the network that the downstream nodes are connected to.

1.3.1 Create Kubernetes cluster

If you are using a hyperscaler (such as Azure, AWS or Google Cloud), the easiest way to set up a cluster is using their built-in tools. For the sake of conciseness in this guide, we do not detail the process of each of these options.

If you are installing onto bare-metal or another hosting service where you need to also provide the Kubernetes distribution itself, we recommend using RKE2 (https://docs.rke2.io/install/quickstart).

1.3.2 Set up DNS

Before continuing, you need to set up access to your cluster. As with the setup of the cluster itself, how you configure DNS will be different depending on where it is being hosted.

Tip

If you do not want to handle setting up DNS records (for example, this is just an ephemeral test server), you can use a service like sslip.io (https://sslip.io) instead. With this service, you can resolve any IP address with `<address>.sslip.io`.

1.4 Install Rancher

To install Rancher, you need to get access to the Kubernetes API of the cluster you just created. This looks different depending on what distribution of Kubernetes is being used.

For RKE2, the kubeconfig file will have been written to `/etc/rancher/rke2/rke2.yaml`. Save this file as `~/.kube/config` on your local system. You may need to edit the file to include the correct externally routable IP address or host name.

Install Rancher easily with the commands from the Rancher Documentation (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/install-upgrade-on-a-kubernetes-cluster):

Install cert-manager (https://cert-manager.io):

```
helm repo add jetstack https://charts.jetstack.io
helm repo update
helm install cert-manager jetstack/cert-manager \
 --namespace cert-manager \
 --create-namespace \
 --set crds.enabled=true
```

Then install Rancher itself:

```
helm repo add rancher-prime https://charts.rancher.com/server-charts/prime
helm repo update
helm install rancher rancher-prime/rancher \
  --namespace cattle-system \
  --create-namespace \
  --set hostname=<DNS or sslip from above> \
  --set replicas=1 \
  --set bootstrapPassword=<PASSWORD_FOR_RANCHER_ADMIN> \
  --version 2.15.1
```

Note

If this is intended to be a production system, please use cert-manager to configure a real certificate (such as one from Let's Encrypt).

Browse to the host name you set up and log in to Rancher with the `bootstrapPassword` you used. You will be guided through a short setup process.

1.5 Install Elemental

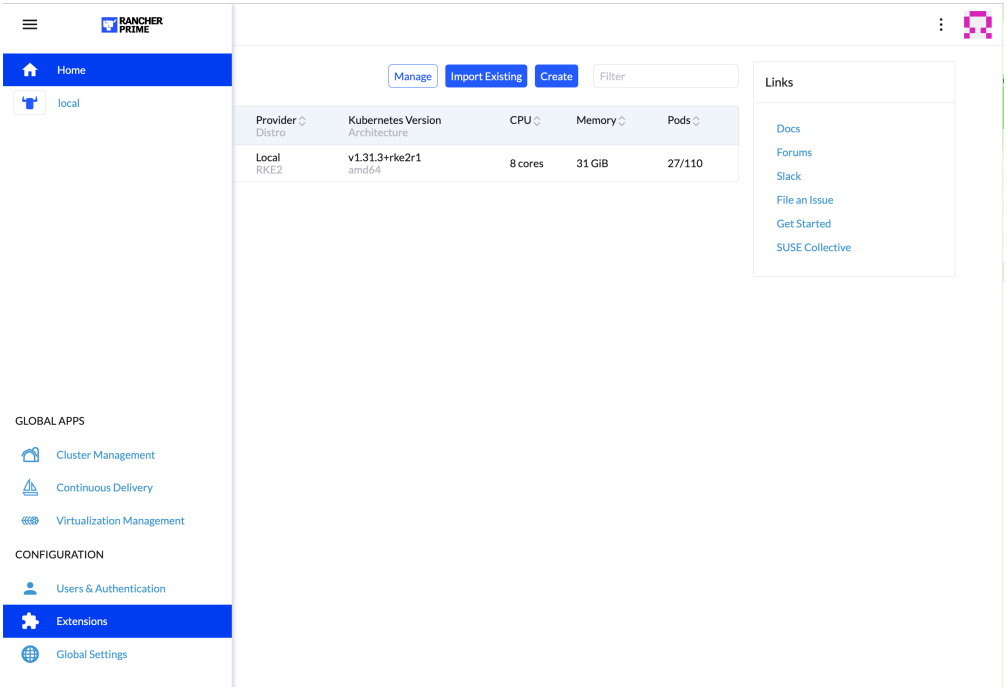
With Rancher installed, you can now install the Elemental operator and required CRD's. The Helm chart for Elemental is published as an OCI artifact so the installation is a little simpler than other charts. It can be installed from either the same shell you used to install Rancher or in the browser from within Rancher's shell.

```
helm install --create-namespace -n cattle-elemental-system \
 elemental-operator-crds \
```

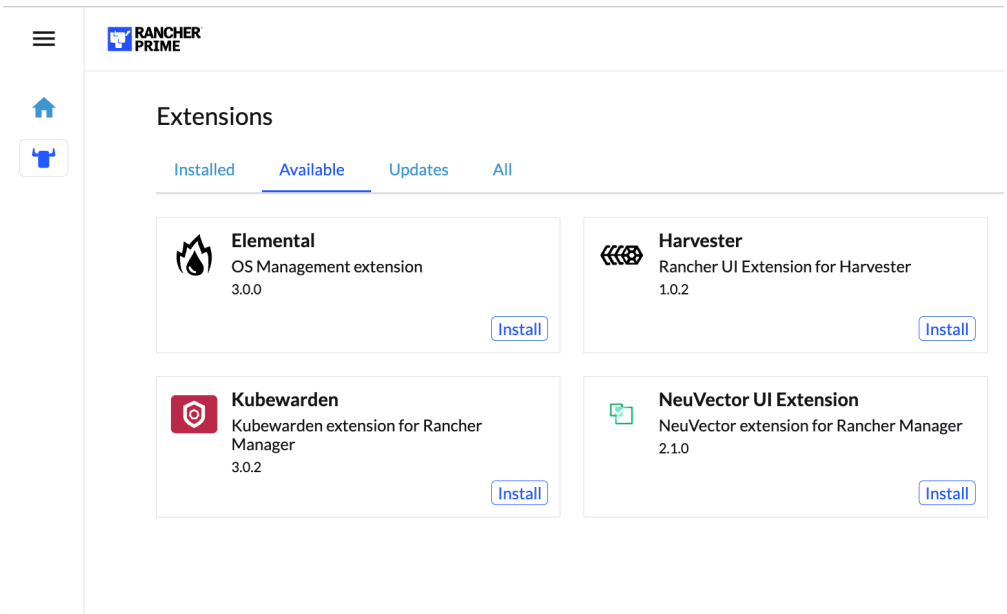
```
 oci://registry.suse.com/rancher/elemental-operator-crds-chart \
 --version 1.9.2

helm install -n cattle-elemental-system \
 elemental-operator \
 oci://registry.suse.com/rancher/elemental-operator-chart \
 --version 1.9.2
```

1.5.1 (Optionally) Install the Elemental UI extension

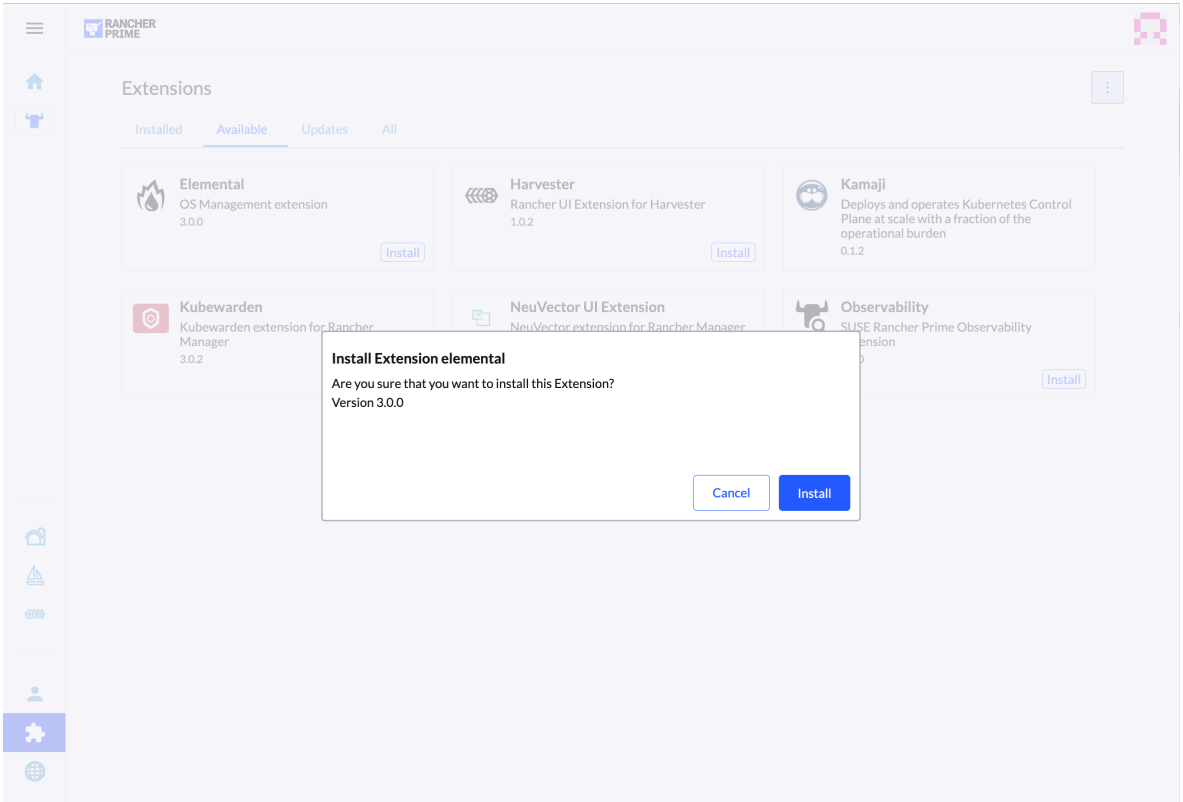
1. To use the Elemental UI, log in to your Rancher instance, click the three-line menu in the upper left:



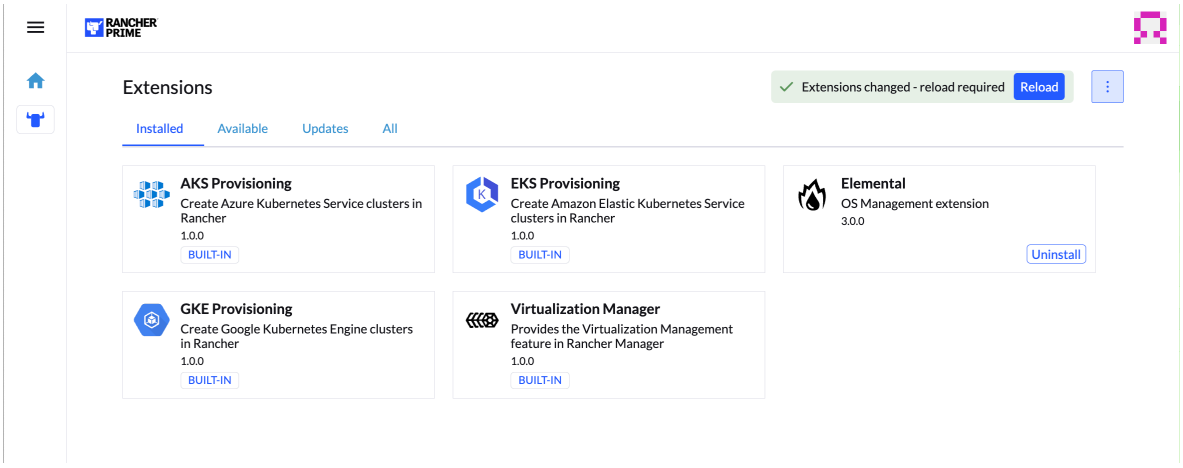
2. From the "Available" tab on this page, click "Install" on the Elemental card:



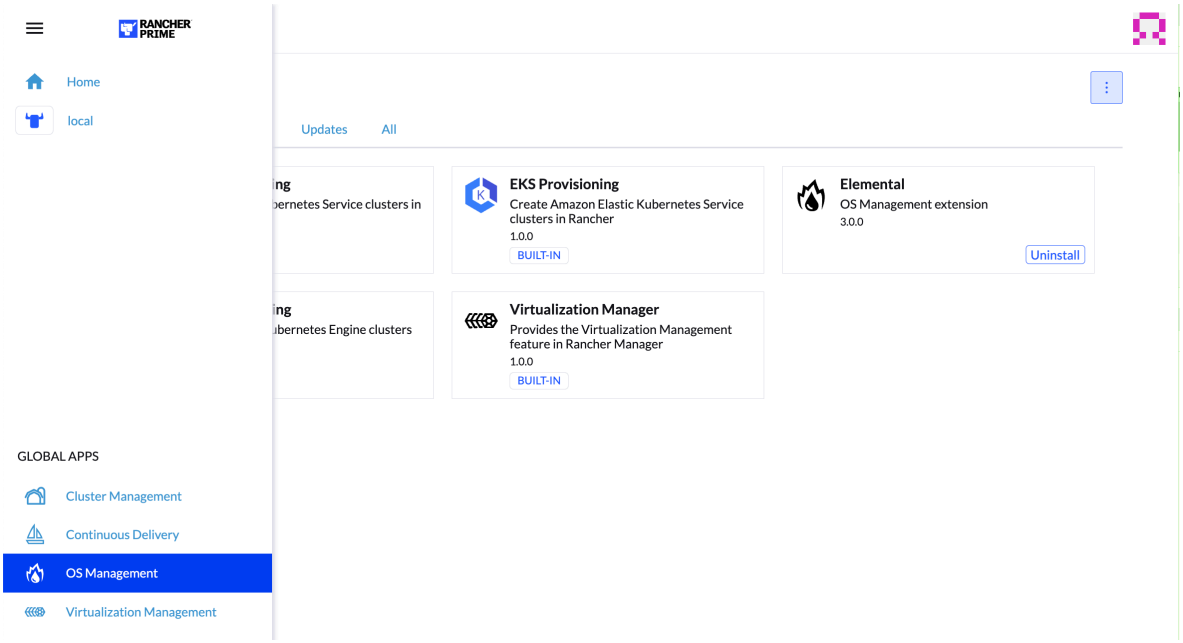
3. Confirm that you want to install the extension:



4. After it installs, you will be prompted to reload the page.



5. Once you reload, you can access the Elemental extension through the "OS Management" global app.



1.6 Configure Elemental

For simplicity, we recommend setting the variable `$ELEM` to the full path of where you want the configuration directory:

```
export ELEM=$HOME/elemental
mkdir -p $ELEM
```

To allow machines to register to Elemental, we need to create a `MachineRegistration` object in the `fleet-default` namespace.

Let us create a basic version of this object:

```
cat << EOF > $ELEM/registration.yaml
apiVersion: elemental.cattle.io/v1beta1
kind: MachineRegistration
metadata:
  name: ele-quickstart-nodes
  namespace: fleet-default
spec:
  machineName: "\${System Information/Manufacturer}-\${System Information/UUID}"
  machineInventoryLabels:
    manufacturer: "\${System Information/Manufacturer}"
    productName: "\${System Information/Product Name}"
EOF
```

```
kubectl apply -f $ELEM/registration.yaml
```

Note

The `cat` command escapes each `$` with a backslash (\) so that Bash does not template them. Remove the backslashes if copying manually.

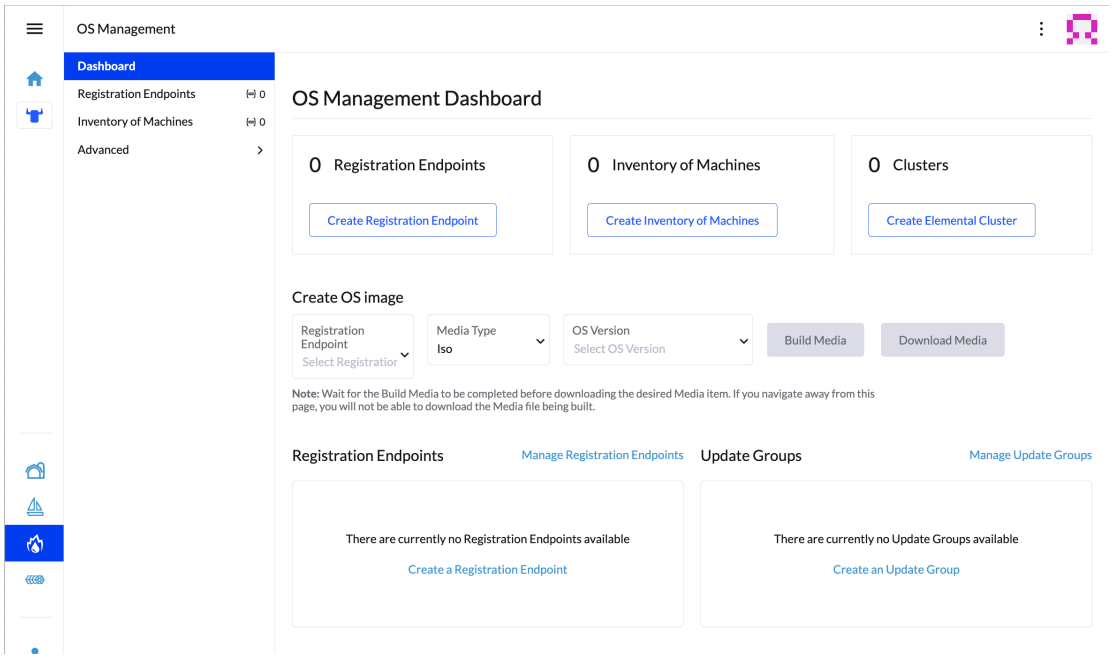
Once the object is created, find and note the endpoint that gets assigned:

```
REGISURL=$(kubectl get machineregistration ele-quickstart-nodes -n fleet-default -o
 jsonpath='{.status.registrationURL}')
```

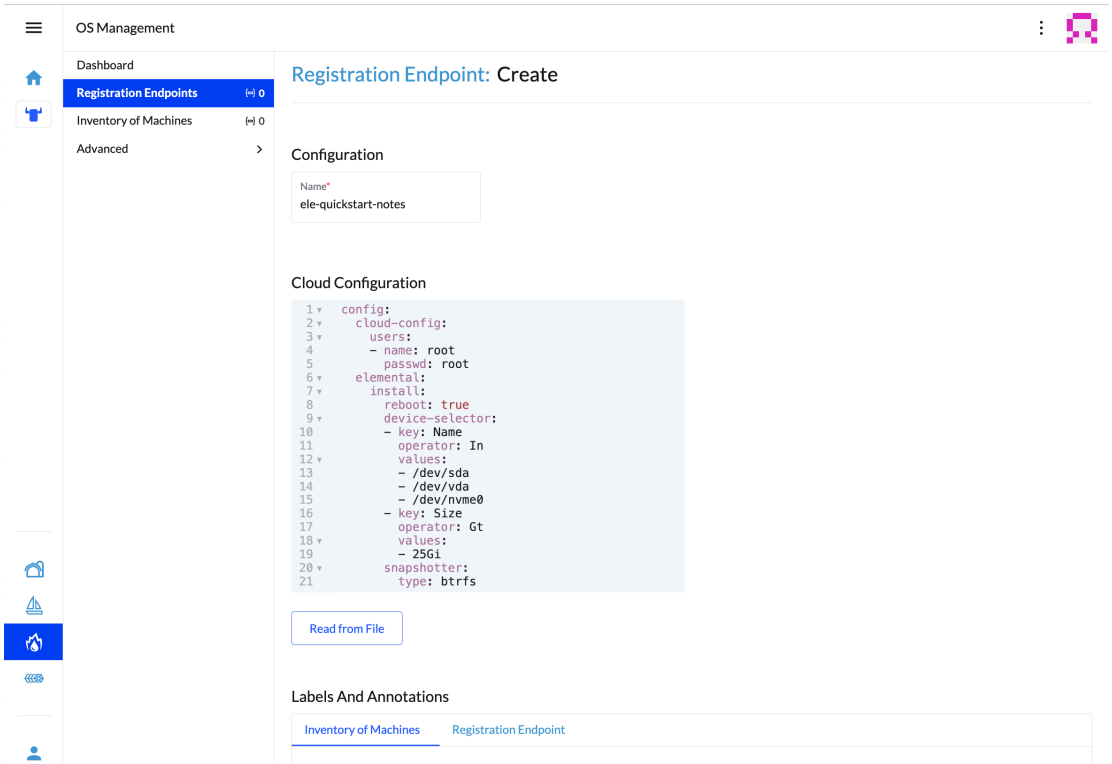
Alternatively, this can also be done from the UI.

UI Extension

1. From the OS Management extension, click "Create Registration Endpoint":



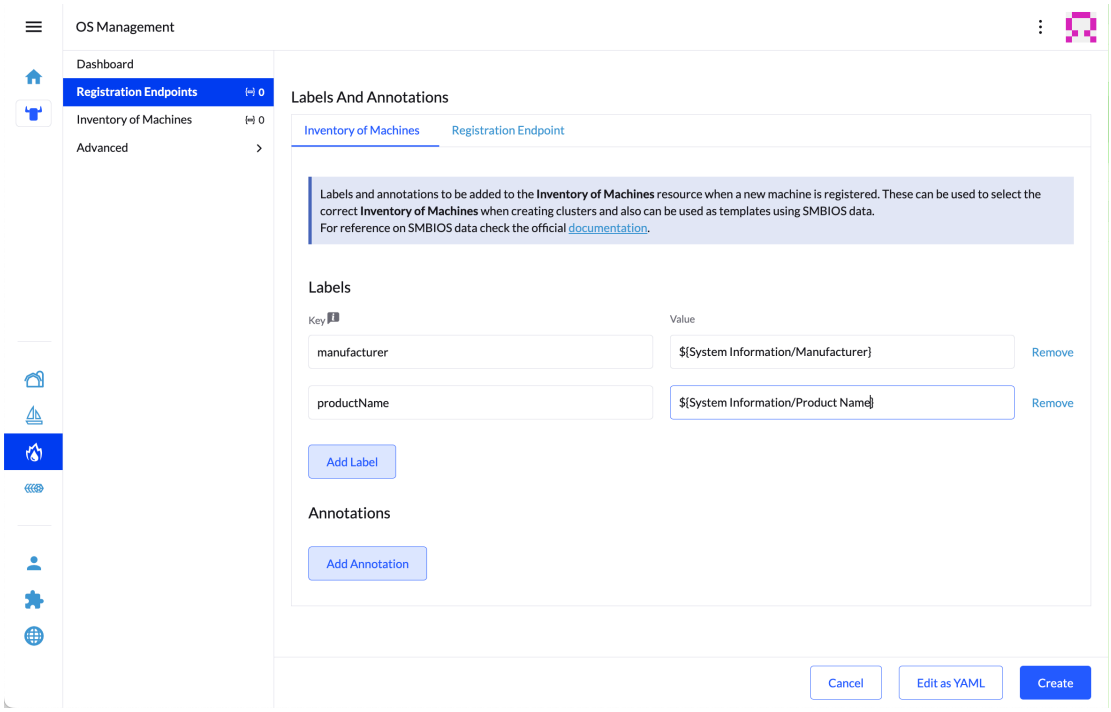
2. Give this configuration a name.



Note

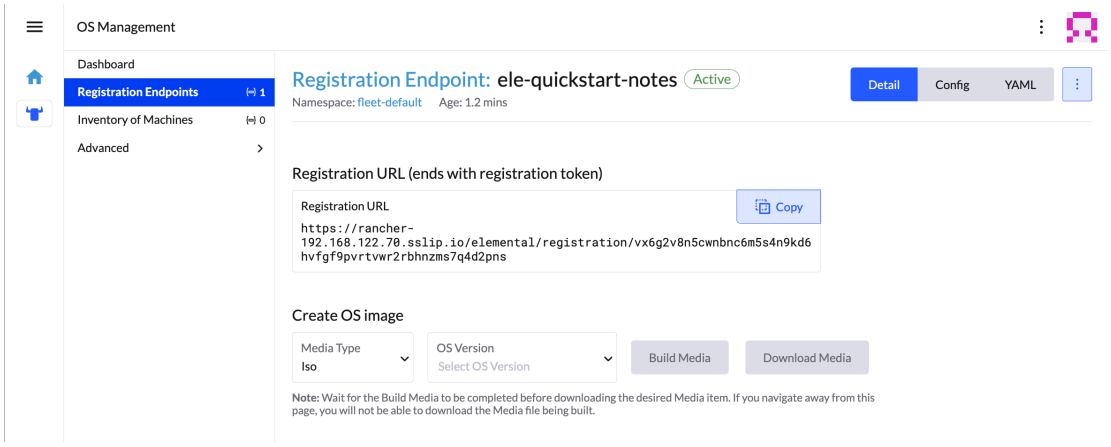
You can ignore the Cloud Configuration field as the data here is overridden by the following steps with Edge Image Builder.

3. Next, scroll down and click "Add Label" for each label you want to be on the resource that gets created when a machine registers. This is useful for distinguishing machines.



4. Click "Create" to save the configuration.

5. Once the registration is created, you should see the Registration URL listed and can click "Copy" to copy the address:



Tip

If you clicked away from that screen, you can click "Registration Endpoints" in the left menu, then click the name of the endpoint you just created.

This URL is used in the next step.

1.7 Build the image

While the current version of Elemental has a way to build its own installation media, in SUSE Edge 3.7 we do this with Kiwi and Edge Image Builder instead, so the resulting system is built with SUSE Linux Micro (https://www.suse.com/products/micro/) as the base Operating System.

Tip

For more details on Kiwi, please follow Kiwi Image Builder process (*Chapter 26, Building Updated SUSE Linux Micro Images with Kiwi*) to build fresh images first and for Edge Image Builder, check out the Edge Image Builder Getting Started Guide (*Chapter 2, Standalone clusters with Edge Image Builder*) and also the Component Documentation (*Chapter 8, Edge Image Builder*).

From a Linux system with Podman installed, create the directories and place the base image being built by Kiwi:

```
mkdir -p $ELEM/eib_quickstart/base-images
cp /path/to/{micro-base-image-iso} $ELEM/eib_quickstart/base-images/
mkdir -p $ELEM/eib_quickstart/elemental
```

```
curl $REGISURL -o $ELEM/eib_quickstart/elemental/elemental_config.yaml
```

```
cat << EOF > $ELEM/eib_quickstart/eib-config.yaml
apiVersion: 1.3
image:
    imageType: iso
    arch: x86_64
    baseImage: SL-Micro.x86_64-6.2-Base-SelfInstall-GM.install.iso
    outputImageName: elemental-image.iso
operatingSystem:
  time:
    timezone: Europe/London
    ntp:
      forceWait: true
      pools:
        - 2.suse.pool.ntp.org
      servers:
        - 10.0.0.1
```

```
        - 10.0.0.2
  isoConfiguration:
    installDevice: /dev/vda
  users:
    - username: root
      encryptedPassword: \$6\$jHugJNNd3HElGsUZ\
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
  packages:
    sccRegistrationCode: XXX
EOF
```

Note

- The `time` section is optional but it is highly recommended to be configured to avoid potential issues with certificates and clock skew. The values provided in this example are for illustrative purposes only. Please adjust them to fit your specific requirements.
- The unencoded password is `eib`.
- The `sccRegistrationCode` is needed to download and install the necessary RPMs from the official sources (alternatively, the `elemental-register` and `elemental-system-agent` RPMs can be manually side-loaded instead)
- The `cat` command escapes each `$` with a backslash (`\`) so that Bash does not template them. Remove the backslashes if copying manually.
- The installation device will be wiped during the installation.

```
podman run --privileged --rm -it -v $ELEM/eib_quickstart/:/eib \
 registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
 build --definition-file eib-config.yaml
```

If you are booting a physical device, we need to burn the image to a USB flash drive. This can be done with:

```
sudo dd if=/eib_quickstart/elemental-image.iso of=/dev/<PATH_TO_DISK_DEVICE>
 status=progress
```

1.8 Boot the downstream nodes

Now that we have created the installation media, we can boot our downstream nodes with it.

For each of the systems that you want to control with Elemental, add the installation media and boot the device. After installation, it will reboot and register itself.

If you are using the UI extension, you should see your node appear in the "Inventory of Machines."

Note

Do not remove the installation medium until you've seen the login prompt; during first-boot files are still accessed on the USB stick.

1.9 Create downstream clusters

There are two objects we need to create when provisioning a new cluster using Elemental.

Linux

The first is the `MachineInventorySelectorTemplate`. This object allows us to specify a mapping between clusters and the machines in the inventory.

1. Create a selector which will match any machine in the inventory with a label:

```
cat << EOF > $ELEM/selector.yaml
apiVersion: elemental.cattle.io/v1beta1
kind: MachineInventorySelectorTemplate
metadata:
  name: location-123-selector
  namespace: fleet-default
spec:
  template:
    spec:
      selector:
        matchLabels:
          locationID: '123'
EOF
```

2. Apply the resource to the cluster:

```
kubectl apply -f $ELEM/selector.yaml
```

3. Obtain the name of the machine and add the matching label:

```
MACHINENAME=$(kubectl get MachineInventory -n fleet-default | awk 'NR>1 {print
 $1}')
```

```
kubectl label MachineInventory -n fleet-default \
 $MACHINENAME locationID=123
```

4. Create a simple single-node K3s cluster resource and apply it to the cluster:

```
cat << EOF > $ELEM/cluster.yaml
apiVersion: provisioning.cattle.io/v1
kind: Cluster
metadata:
  name: location-123
  namespace: fleet-default
spec:
  kubernetesVersion: v1.36.3+k3s1
  rkeConfig:
    machinePools:
      - name: pool1
        quantity: 1
        etcdRole: true
        controlPlaneRole: true
        workerRole: true
        machineConfigRef:
          kind: MachineInventorySelectorTemplate
          name: location-123-selector
          apiVersion: elemental.cattle.io/v1beta1
EOF

kubectl apply -f $ELEM/cluster.yaml
```

UI Extension

The UI extension allows for a few shortcuts to be taken. Note that managing multiple locations may involve too much manual work.

1. As before, open the left three-line menu and select "OS Management." This brings you back to the main screen for managing your Elemental systems.

2. On the left sidebar, click "Inventory of Machines." This opens the inventory of machines that have registered.

3. To create a cluster from these machines, select the systems you want, click the "Actions" drop-down list, then "Create Elemental Cluster." This opens the Cluster Creation dialog while also creating a MachineSelectorTemplate to use in the background.

4. On this screen, configure the cluster you want to be built. For this quick start, K3s v1.30.5+k3s1 is selected and the rest of the options are left as is.

> **Tip**
> You may need to scroll down to see more options.

After creating these objects, you should see a new Kubernetes cluster spin up using the new node you just installed with.

1.10 Node Reset (Optional)

SUSE Rancher Elemental supports the ability to perform a "node reset" which can optionally trigger when either a whole cluster is deleted from Rancher, a single node is deleted from a cluster, or a node is manually deleted from the machine inventory. This is useful when you want to reset and clean-up any orphaned resources and want to automatically bring the cleaned node back into the machine inventory so it can be reused. This is not enabled by default, and thus any system that is removed, will not be cleaned up (i.e. data will not be removed, and any Kubernetes cluster resources will continue to operate on the downstream clusters) and it will require manual intervention to wipe data and re-register the machine to Rancher via Elemental.

If you wish for this functionality to be enabled by default, you need to make sure that your `MachineRegistration` explicitly enables this by adding `config.elemental.reset.enabled: true`, for example:

```
config:
  elemental:
    registration:
      auth: tpm
    reset:
      enabled: true
```

Then, all systems registered with this `MachineRegistration` will automatically receive the `elemental.cattle.io/resettable: 'true'` annotation in their configuration. If you wish to do this manually on individual nodes, e.g. because you've got an existing `MachineInventory` that doesn't have this annotation, or you have already deployed nodes, you can modify the `MachineInventory` and add the `resettable` configuration, for example:

```
apiVersion: elemental.cattle.io/v1beta1
kind: MachineInventory
metadata:
  annotations:
```

```
    elemental.cattle.io/os.unmanaged: 'true'
    elemental.cattle.io/resettable: 'true'
```

In SUSE Edge 3.1, the Elemental Operator puts down a marker on the operating system that will trigger the cleanup process automatically; it will stop all Kubernetes services, remove all persistent data, uninstall all Kubernetes services, cleanup any remaining Kubernetes/Rancher directories, and force a re-registration to Rancher via the original Elemental `MachineRegistration` configuration. This happens automatically, there is no need for any manual intervention. The script that gets called can be found in `/opt/edge/elemental_node_cleanup.sh` and is triggered via `systemd.path` upon the placement of the marker, so its execution is immediate.

Warning

Using the `resettable` functionality assumes that the desired behavior when removing a node/cluster from Rancher is to wipe data and force a re-registration. Data loss is guaranteed in this situation, so only use this if you're sure that you want automatic reset to be performed.

1.11 Next steps

Here are some recommended resources to research after using this guide:

- End-to-end automation in *Chapter 6, Fleet*
- Additional network configuration options in *Chapter 9, Edge Networking*

2 Standalone clusters with Edge Image Builder

Edge Image Builder (EIB) is a tool that streamlines the process of generating Customized, Ready-to-Boot (CRB) disk images for bootstrapping machines, even in fully air-gapped scenarios. EIB is used to create deployment images for use in all three of the SUSE Edge deployment footprints, as it's flexible enough to offer the smallest customizations, e.g. adding a user or setting the timezone, through offering a comprehensively configured image that sets up, for example, complex networking configurations, deploys multi-node Kubernetes clusters, deploys customer workloads, and registers to the centralized management platform via Rancher/Elemental and SUSE Multi-Linux Manager. EIB runs as in a container image, making it incredibly portable across platforms and ensuring that all of the required dependencies are self-contained, having a very minimal impact on the installed packages of the system that's being used to operate the tool.

Note

For multi-node scenarios, EIB automatically deploys MetalLB and Endpoint Copier Operator in order for hosts provisioned using the same built image to automatically join a Kubernetes cluster.

For more information, read the Edge Image Builder Introduction (*Chapter 8, Edge Image Builder*).

Warning

Edge Image Builder 1.3.4 supports customizing SUSE Linux Micro 6.2 images. Older versions, such as SUSE Linux Enterprise Micro 5.5, or 6.0 are not supported.

2.1 Prerequisites

- An AMD64/Intel 64 build host machine (physical or virtual) running SLES 15 SP6.
- The Podman container engine
- A SUSE Linux Micro 6.2 SelfInstall ISO image created using the Kiwi Builder procedure (*Chapter 26, Building Updated SUSE Linux Micro Images with Kiwi*)

Note

For non-production purposes, openSUSE Leap 15.6, or openSUSE Tumbleweed may be used as a build host machine. Other operating systems may function, so long as a compatible container runtime is available.

2.1.1 Getting the EIB Image

The EIB container image is publicly available and can be downloaded from the SUSE Edge registry by running the following command on your image build host:

```
podman pull registry.suse.com/edge/3.7/edge-image-builder:1.3.4
```

2.2 Creating the image configuration directory

As EIB runs within a container, we need to mount a configuration directory from the host, enabling you to specify your desired configuration, and during the build process EIB has access to any required input files and supporting artifacts. This directory must follow a specific structure. Let’s create it, assuming that this directory will exist in your home directory, and called "eib":

```
export CONFIG_DIR=$HOME/eib
mkdir -p $CONFIG_DIR/base-images
```

In the previous step we created a "base-images" directory that will host the SUSE Linux Micro 6.2 input image, let’s ensure that the image is copied over to the configuration directory:

```
cp /path/to/SL-Micro.x86_64-6.2-Base-SelfInstall-GM.install.iso $CONFIG_DIR/base-images/
slemicro.iso
```

Note

During the EIB run, the original base image is **not** modified; a new and customized version is created with the desired configuration in the root of the EIB config directory.

The configuration directory at this point should look like the following:

```
└── base-images/
    └── slemicro.iso
```

2.3 Creating the image definition file

The definition file describes the majority of configurable options that the Edge Image Builder supports, a full example of options can be found here (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/pkg/image/testdata/full-valid-example.yaml), and we would recommend that you take a look at the upstream building images guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/building-images.md) for more comprehensive examples than the one we're going to run through below. Let's start with a very basic definition file for our OS image:

```
cat << EOF > $CONFIG_DIR/iso-definition.yaml
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
EOF
```

This definition specifies that we are generating an output image for an AMD64/Intel 64 based system. The image that will be used as the base for further modification is an `iso` image named `slemicro.iso`, expected to be located at `$CONFIG_DIR/base-images/slemicro.iso`. It also outlines that after EIB finishes modifying the image, the output image will be named `eib-image.iso`, and by default will reside in `$CONFIG_DIR`.

Now our directory structure should look like:

```
├── iso-definition.yaml
└── base-images/
    └── slemicro.iso
```

In the following sections we'll walk through a few examples of common operations:

2.3.1 Configuring Operating System (OS)

The EIB `operatingSystem` section is intended to configure where the operating system is going to be installed, the image size, etc. It is an optional section and should not be included unless one or more customizations are being applied.

```
apiVersion: 1.3
image:
  imageType: iso
```

```
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-Base-RT-SelfInstall.iso
operatingSystem:
  isoConfiguration:
    installDevice: /dev/disk/by-id/ata-QEMU_HARDDISK_111-disk1 # first defined disk
```

Type-specific Configuration. Depending on the type of image being customized, one of the following optional sections may be included.

- `isoConfiguration` - Optional; configuration in this section only applies to ISO images.
- `installDevice` - Optional; specifies the disk that should be used as the install device. This needs to be a block device, and will default to automatically wipe any data found on the disk. Additionally, specifying this attribute triggers a GRUB override to automatically install the operating system rather than prompting user to begin the installation, allowing for a fully unattended and automated installation. If omitted, the user is prompted to select the "Install" option from the GRUB menu, as well as having to select the installation disk and confirm that the device will be wiped in the process.

> **Note**
>
> The device being used on the `installDevice` section can be specified as `/dev/sda` or using the `/dev/disk/by-id`, `/dev/disk/by-path` naming to ensure the proper device is being used. If using libvirt VMs, the `serial` attribute value can be specified when creating a disk for the VM (e.g., `serial=111-disk1`) so it can be used on the `installDevice` value with the `by-id` naming as for example `/dev/disk/by-id/ata-QEMU_HARDDISK_111-disk1` if using ATA devices (`libvirt` automatically prefixes the ID with `ata-QEMU_HARDDISK_` for ATA devices, or `virtio-` for virtio devices, see #17670 virtio issue (https://github.com/systemd/systemd/issues/17670#issuecomment-731261739) for more information).

- `rawConfiguration` - Optional; configuration in this section only applies to RAW images.
- `diskSize` - Optional; sets the desired raw disk image size that EIB will resize the resulting image to. This is important to ensure that your disk image is large enough to accommodate any artifacts being embedded in the image. It is advised to set this to slightly smaller than your SD card size (or block device if writing directly to a disk) as the system will automatically expand at boot time to fill the size of the block device. This is optional, but highly recommended. Specify as an integer with either "M" (Megabyte), "G" (Gigabyte), or "T" (Terabyte) as a suffix (e.g. "32G").

- `luksKey` - Required for encrypted images; the given LUKS key for an encrypted raw image which is necessary for EIB to be able to complete the build process.
- `expandEncryptedPartition` - Optional; disabled by default, when enabled, automatically expands the encrypted partition to its maximum size. E.g. if `diskSize` is `25G` and this field is `true`, EIB will expand the encrypted partition to `25G` during the build process.

2.3.2 Configuring OS Users

EIB allows you to preconfigure users with login information, such as passwords or SSH keys, including setting a fixed root password. As part of this example we're going to fix the root password, and the first step is to use `OpenSSL` to create a one-way encrypted password:

```
openssl passwd -6 SecurePassword
```

This will output something similar to:

```
$6$G392FCbxVgn[...]Y7zTXnC1
```

We can then add a section in the definition file called `operatingSystem` with a `users` array inside it. The resulting file should look like:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$G392FCbxVgn[...]Y7zTXnC1
```

Note

It's also possible to add additional users, create the home directories, set user-id's, add ssh-key authentication, and modify group information. Please refer to the upstream building images guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/building-images.md) for further examples.

2.3.3 Configuring OS time

The `time` section is optional but it is highly recommended to be configured to avoid potential issues with certificates and clock skew. EIB will configure chronyd and `/etc/localtime` depending on the parameters here.

```
operatingSystem:
  time:
    timezone: Europe/London
    ntp:
      forceWait: true
      pools:
        - 2.suse.pool.ntp.org
      servers:
        - 10.0.0.1
        - 10.0.0.2
```

- The `timezone` specifies the timezone in the format of "Region/Locality" (e.g. "Europe/London"). The full list may be found by running `timedatectl list-timezones` on a Linux system.
- ntp - Defines attributes related to configuring NTP (using chronyd):
- forceWait - Requests that chronyd attempts to synchronize timesources before starting other services, with a 180s timeout.
- pools - Specifies a list of pools that chronyd will use as data sources (using `iburst` to improve the time taken for initial synchronization).
- servers - Specifies a list of servers that chronyd will use as data sources (using `iburst` to improve the time taken for initial synchronization).

Note

The values provided in this example are for illustrative purposes only. Please adjust them to fit your specific requirements.

2.3.4 Adding certificates

Certificate files with the extension ".pem" or ".crt" stored in the `certificates` directory will be installed in the node system-wide certificate store:

```
.
```

```
├── definition.yaml
└── certificates
    ├── my-ca.pem
    └── my-ca.crt
```

See the "Securing Communication with TLS Certificate" guide (https://documentation.suse.com/smart/security/html/tls-certificates/index.html#tls-adding-new-certificates) for more information.

2.3.5 Adding Operating System Files

The files placed in the `os-files` directory in the image configuration directory are automatically copied into the filesystem of the built image. The exact directory will be retained when they are copied. For example, if a file exists in a subdirectory named `os-files/etc`, it is placed in the `/etc` directory of the built image.

Note

If the `os-files` directory exists, it cannot be empty.

```
.
├── definition.yaml
└── os-files
    └── etc
        └── ssh
            └── sshd_config
```

2.3.6 Configuring RPM packages

One of the major features of EIB is to provide a mechanism to add additional software packages to the image, so when the installation completes the system is able to leverage the installed packages right away. EIB permits users to specify the following:

- Packages by their name within a list in the image definition
- Network repositories to search for these packages in
- SUSE Customer Center (SCC) credentials to search official SUSE repositories for the listed packages

- Via an `$CONFIG_DIR/rpms` directory, side-load custom RPM's that don't exist in network repositories
- Via the same directory (`$CONFIG_DIR/rpms/gpg-keys`), GPG-keys to enable validation of third party packages

EIB will then run through a package resolution process at image build time, taking the base image as the input, and attempts to pull and install all supplied packages, either specified via the list or provided locally. EIB downloads all of the packages, including any dependencies into a repository that exists within the output image and instructs the system to install these during the first boot process. Doing this process during the image build guarantees that the packages will successfully install during first-boot on the desired platform, e.g. the node at the edge. This is also advantageous in environments where you want to bake the additional packages into the image rather than pull them over the network when in operation, e.g. for air-gapped or restricted network environments.

As a simple example to demonstrate this, we are going to install the `nvidia-container-toolkit` RPM package found in the third party vendor-supported NVIDIA repository:

```
  packages:
    packageList:
      - nvidia-container-toolkit
    additionalRepos:
      - url: https://nvidia.github.io/libnvidia-container/stable/rpm/x86_64
```

The resulting definition file looks like the following:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$G392FCbxVgn[...]Y7zTXnC1
  packages:
    packageList:
      - nvidia-container-toolkit
    additionalRepos:
      - url: https://nvidia.github.io/libnvidia-container/stable/rpm/x86_64
```

The above is a simple example, but for completeness, download the NVIDIA package signing key before running the image generation:

```
$ mkdir -p $CONFIG_DIR/rpms/gpg-keys
$ curl -fsSL https://nvidia.github.io/libnvidia-container/gpgkey > $CONFIG_DIR/rpms/gpg-keys/nvidia.gpg
```

Warning

Adding in additional RPM's via this method is meant for the addition of supported third party components or user-supplied (and maintained) packages; this mechanism should not be used to add packages that would not usually be supported on SUSE Linux Micro. If this mechanism is used to add components from openSUSE repositories (which are not supported), including from newer releases or service packs, you may end up with an unsupported configuration, especially when dependency resolution results in core parts of the operating system being replaced, even though the resulting system may appear to function as expected. If you're unsure, contact your SUSE representative for assistance in determining the supportability of your desired configuration.

Note

A more comprehensive guide with additional examples can be found in the upstream installing packages guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/installing-packages.md).

2.3.7 Configuring Kubernetes cluster and user workloads

Another feature of EIB is the ability to use it to automate the deployment of both single-node and multi-node highly-available Kubernetes clusters that "bootstrap in place" (i.e. don't require any form of centralized management infrastructure to coordinate). The primary driver behind this approach is for air-gapped deployments, or network restricted environments, but it also serves as a way of quickly bootstrapping standalone clusters, even if full and unrestricted network access is available.

This method enables not only the deployment of the customized operating system, but also the ability to specify Kubernetes configuration, any additional layered components via Helm charts, and any user workloads via supplied Kubernetes manifests. However, the design principle behind using this method is that we default to assuming that the user is wanting to air-gap. Therefore, any items specified in the

image definition will be pulled into the image, which includes user-supplied workloads. EIB ensures that any discovered images that are required by definitions are copied locally and are served by the embedded image registry in the resulting deployed system.

In this next example, we're going to take our existing image definition and will specify a Kubernetes configuration (in this example it doesn't list the systems and their roles, so we default to assuming single-node), which will instruct EIB to provision a single-node RKE2 Kubernetes cluster. To show the automation of both the deployment of both user-supplied workloads (via manifest) and layered components (via Helm), we are going to install KubeVirt via the SUSE Edge Helm chart, as well as NGINX via a Kubernetes manifest. The additional configuration we need to append to the existing image definition is as follows:

```
kubernetes:
  version: v1.36.3+rke2r1
  manifests:
    urls:
      - https://k8s.io/examples/application/nginx-app.yaml
  helm:
    charts:
      - name: kubevirt
        version: 307.0.3+up0.8.0
        repositoryName: suse-edge
    repositories:
      - name: suse-edge
        url: oci://registry.suse.com/edge/charts
```

The resulting full definition file should now look like:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$G392FCbxVgn[...]Y7zTXnC1
  packages:
    packageList:
      - nvidia-container-toolkit
    additionalRepos:
      - url: https://nvidia.github.io/libnvidia-container/stable/rpm/x86_64
kubernetes:
  version: v1.36.3+k3s1
  manifests:
    urls:
```

```
      - https://k8s.io/examples/application/nginx-app.yaml
  helm:
    charts:
      - name: kubevirt
        version: 307.0.3+up0.8.0
        repositoryName: suse-edge
    repositories:
      - name: suse-edge
        url: oci://registry.suse.com/edge/charts
```

Note

Further examples of options such as multi-node deployments, custom networking, and Helm chart options/values can be found in the upstream documentation (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/building-images.md).

2.3.8 Configuring the network

In the last example in this quickstart, let's configure the network that will be brought up when a system is provisioned with the image generated by EIB. It's important to understand that unless a network configuration is supplied, the default model is that DHCP will be used on all interfaces discovered at boot time. However, this is not always a desirable configuration, especially if DHCP is not available and you need to provide static configurations, or you need to set up more complex networking constructs, e.g. bonds, LACP, and VLAN's, or need to override certain parameters, e.g. hostnames, DNS servers, and routes.

EIB provides the ability to provide either per-node configurations (where the system in question is uniquely identified by its MAC address), or an override for supplying an identical configuration to each machine, which is more useful when the system MAC addresses aren't known. An additional tool is used by EIB called Network Manager Configurator, or `nmc` for short, which is a tool built by the SUSE Edge team to allow custom networking configurations to be applied based on the nmstate.io (https://nmstate.io/) declarative network schema, and at boot time will identify the node it's booting on and will apply the desired network configuration prior to any services coming up.

We'll now apply a static network configuration for a system with a single interface by describing the desired network state in a node-specific file (based on the desired hostname) in the required `network` directory:

```
mkdir $CONFIG_DIR/network

cat << EOF > $CONFIG_DIR/network/host1.local.yaml
```

```
routes:
  config:
  - destination: 0.0.0.0/0
    metric: 100
    next-hop-address: 192.168.122.1
    next-hop-interface: eth0
    table-id: 254
  - destination: 192.168.122.0/24
    metric: 100
    next-hop-address: 192.168.122.1
    next-hop-interface: eth0
    table-id: 254
dns-resolver:
  config:
    server:
    - 192.168.122.1
    - 8.8.8.8
interfaces:
- name: eth0
  type: ethernet
  state: up
  mac-address: 34:8A:B1:4B:16:E7
  ipv4:
    address:
    - ip: 192.168.122.50
      prefix-length: 24
    dhcp: false
    enabled: true
  ipv6:
    enabled: false
EOF
```

Warning

The above example is set up for the default `192.168.122.0/24` subnet assuming that testing is being executed on a virtual machine, please adapt to suit your environment, not forgetting the MAC address. As the same image can be used to provision multiple nodes, networking configured by EIB (via `nmc`) is dependent on it being able to uniquely identify the node by its MAC address, and hence during boot `nmc` will apply the correct networking configuration to each machine. This means that you'll need to know the MAC addresses of the systems you want to install onto. Alternatively, the default behavior is to rely on DHCP, but you can utilize the `configure-network.sh` hook to apply a common configuration to all nodes - see the networking guide (*Chapter 9, Edge Networking*) for further details.

The resulting file structure should look like:

```
├── iso-definition.yaml
├── base-images/
│   └── slemicro.iso
└── network/
    └── host1.local.yaml
```

The network configuration we just created will be parsed and the necessary NetworkManager connection files will be automatically generated and inserted into the new installation image that EIB will create. These files will be applied during the provisioning of the host, resulting in a complete network configuration.

Note

Please refer to the Edge Networking component (*Chapter 9, Edge Networking*) for a more comprehensive explanation of the above configuration and examples of this feature.

2.4 Building the image

Now that we've got a base image and an image definition for EIB to consume, let's go ahead and build the image. For this, we simply use `podman` to call the EIB container with the "build" command, specifying the definition file:

```
podman run --rm -it --privileged -v $CONFIG_DIR:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file iso-definition.yaml
```

The output of the command should be similar to:

```
Setting up Podman API listener...
Downloading file: dl-manifest-1.yaml 100% (498/498 B, 9.5 MB/s)
Pulling selected Helm charts... 100% (1/1, 43 it/min)
Generating image customization components...
Identifier ................... [SUCCESS]
Custom Files ................. [SKIPPED]
Time ......................... [SKIPPED]
Network ...................... [SUCCESS]
Groups ....................... [SKIPPED]
Users ........................ [SUCCESS]
Proxy ........................ [SKIPPED]
Resolving package dependencies...
Rpm .......................... [SUCCESS]
Os Files ..................... [SKIPPED]
```

```
Systemd ..................... [SKIPPED]
Fips ........................ [SKIPPED]
Elemental ................... [SKIPPED]
Suma ........................ [SKIPPED]
Populating Embedded Artifact Registry... 100% (3/3, 10 it/min)
Embedded Artifact Registry ... [SUCCESS]
Keymap ...................... [SUCCESS]
Configuring Kubernetes component...
The Kubernetes CNI is not explicitly set, defaulting to 'cilium'.
Downloading file: rke2_installer.sh
Downloading file: rke2-images-core.linux-amd64.tar.zst 100% (657/657 MB, 48 MB/s)
Downloading file: rke2-images-cilium.linux-amd64.tar.zst 100% (368/368 MB, 48 MB/s)
Downloading file: rke2.linux-amd64.tar.gz 100% (35/35 MB, 50 MB/s)
Downloading file: sha256sum-amd64.txt 100% (4.3/4.3 kB, 6.2 MB/s)
Kubernetes .................. [SUCCESS]
Certificates ................ [SKIPPED]
Cleanup ..................... [SKIPPED]
Building ISO image...
Kernel Params ............... [SKIPPED]
Build complete, the image can be found at: eib-image.iso
```

The built ISO image is stored at `$CONFIG_DIR/eib-image.iso`:

```
├── iso-definition.yaml
├── eib-image.iso
├── _build
│   └── cache/
│       └── ...
│   └── build-<timestamp>/
│       └── ...
├── base-images/
│   └── slemicro.iso
└── network/
    └── host1.local.yaml
```

Each build creates a time-stamped folder in `$CONFIG_DIR/_build/` that includes the logs of the build, the artifacts used during the build, and the `combustion` and `artefacts` directories which contain all the scripts and artifacts that are added to the CRB image.

The contents of this directory should look like:

```
├── build-<timestamp>/
│   │── combustion/
│   │   ├── 05-configure-network.sh
│   │   ├── 10-rpm-install.sh
│   │   ├── 12-keymap-setup.sh
│   │   ├── 13b-add-users.sh
│   │   ├── 20-k8s-install.sh
```

```
│   │   ├── 26-embedded-registry.sh
│   │   ├── 48-message.sh
│   │   ├── network/
│   │   │   ├── host1.local/
│   │   │   │   └── eth0.nmconnection
│   │   │   └── host_config.yaml
│   │   ├── nmc
│   │   └── script
│   ├── artefacts/
│   │   ├── registry/
│   │   │   ├── hauler
│   │   │   ├── nginx:<version>-registry.tar.zst
│   │   │   ├── rancher_kubectl:<version>-registry.tar.zst
│   │   │   └── registry.suse.com_suse_sles_15.6_virt-operator:<version>-registry.tar.zst
│   │   ├── rpms/
│   │   │   └── rpm-repo
│   │   │       ├── addrepo0
│   │   │       │   ├── nvidia-container-toolkit-<version>.rpm
│   │   │       │   ├── nvidia-container-toolkit-base-<version>.rpm
│   │   │       │   ├── libnvidia-container1-<version>.rpm
│   │   │       │   └── libnvidia-container-tools-<version>.rpm
│   │   │       ├── repodata
│   │   │       │   ├── ...
│   │   │       └── zypper-success
│   │   └── kubernetes/
│   │       ├── rke2_installer.sh
│   │       ├── registries.yaml
│   │       ├── server.yaml
│   │       ├── images/
│   │       │   ├── rke2-images-cilium.linux-amd64.tar.zst
│   │       │   └── rke2-images-core.linux-amd64.tar.zst
│   │       ├── install/
│   │       │   ├── rke2.linux-amd64.tar.gz
│   │       │   └── sha256sum-amd64.txt
│   │       └── manifests/
│   │           ├── dl-manifest-1.yaml
│   │           └── kubevirt.yaml
│   ├── createrepo.log
│   ├── eib-build.log
│   ├── embedded-registry.log
│   ├── helm
│   │   └── kubevirt
│   │       └── kubevirt-0.4.0.tgz
│   ├── helm-pull.log
│   ├── helm-template.log
│   ├── iso-build.log
│   ├── iso-build.sh
```

```
│   ├── iso-extract
│   │   └── ...
│   ├── iso-extract.log
│   ├── iso-extract.sh
│   ├── modify-raw-image.sh
│   ├── network-config.log
│   ├── podman-image-build.log
│   ├── podman-system-service.log
│   ├── prepare-resolver-base-tarball-image.log
│   ├── prepare-resolver-base-tarball-image.sh
│   ├── raw-build.log
│   ├── raw-extract
│   │   └── ...
│   └── resolver-image-build
│       └──...
└── cache
    └── ...
```

If the build fails, `eib-build.log` is the first log that contains information. From there, it will direct you to the component that failed for debugging.

At this point, you should have a ready-to-use image that will:

1. Deploy SUSE Linux Micro 6.2
2. Configure the root password
3. Install the `nvidia-container-toolkit` package
4. Configure an embedded container registry to serve content locally
5. Install single-node RKE2
6. Configure static networking
7. Install KubeVirt
8. Deploy a user-supplied manifest

2.5 Debugging the image build process

If the image build process fails, refer to the upstream debugging guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/debugging.md).

2.6 Testing your newly built image

For instructions on how to test the newly built CRB image, refer to the upstream image testing guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/testing-guide.md).

3 SUSE Multi-Linux Manager

Warning

The SUSE Multi-Linux Manager version included with SUSE Edge 3.7 (5.1) doesn't support SUSE Linux Micro 6.2 yet. It will be updated and supported in future SUSE Edge 3.7 releases.

SUSE Multi-Linux Manager is included in SUSE Edge to provide automation and control for keeping SUSE Linux Micro as the underlying operating system consistently up-to-date on all nodes of your edge deployment. It can also be used to manage Kubernetes and applications deployed on Kubernetes on your edge nodes.

This quickstart guide is intended to get you up to speed with SUSE Multi-Linux Manager as quickly as possible, with the goal of providing operating system updates to your edge nodes. The quickstart guide doesn't discuss topics like sizing your storage, creating and managing additional software channels for staging purposes, or managing users, system groups, and organizations for larger deployments. For production use, we strongly recommend to get familiar with the comprehensive SUSE Multi-Linux Manager Documentation (https://documentation.suse.com/multi-linux-manager/5.1/en/docs/index.html).

The following steps are required to prepare SUSE Edge for using SUSE Multi-Linux Manager effectively:

- Deploy and configure SUSE Multi-Linux Manager Server.
- Sync the SUSE Linux Micro package repositories.
- Create system groups.
- Create activation keys.
- Use Edge Image Builder to prepare installation media for SUSE Multi-Linux Manager registration

3.1 Deploy SUSE Multi-Linux Manager Server

If you already have an instance of SUSE Multi-Linux Manager 5.2 running, you can skip this step.

You can run SUSE Multi-Linux Manager Server on a dedicated physical server, as a virtual machine on your own hardware, or in the cloud. Pre-configured virtual machine images for SUSE Multi-Linux Server are provided for supported public clouds.

In this quick start we're using the "qcow2" image `SUSE-Multi-Linux-Manager-Server.x86_64-5.1.5-Qcow-5.1-2026-08.qcow2` for AMD64/Intel 64 that you can find at https://www.suse.com/download/suse-manager/ or in the SUSE Customer Center. This image will work as a virtual machine on hypervisors like KVM. Please always check for the newest version of the image and use it for new installations.

You can also install SUSE Multi-Linux Manager Server on any of the other supported hardware architectures. In that case pick the image that matches your hardware architecture.

Once you have downloaded the image, create a virtual machine that meets at least the following minimal hardware specifications:

- 16 GB RAM
- 4 physical or virtual cores
- an additional block device that has at least 100 GB

With the qcow2 image, there is no need to install the operating system. You can directly attach the image as your root partition.

You need to set up the network so that your edge nodes can later access SUSE Multi-Linux Manager Server with a hostname that contains the fully qualified domain name ("FQDN")!

When you boot SUSE Multi-Linux Manager for the first time you need to perform some initial configuration:

- Select your keyboard layout
- Accept the license agreement
- Select your time zone
- Enter the root password for the operating system

The next steps need to be done as the "root" user:

For the next step you need the registration code for the SUSE Multi-Linux Manager Extension that you can find in the SUSE Customer Center. The same code can be used for both registering SUSE Linux Micro and SUSE Multi-Linux Manager:

Register SUSE Linux Micro:

```
transactional-update register -r <REGCODE> -e <your_email>
```

Register SUSE Multi-Linux Manager:

```
transactional-update register -p Multi-Linux-Manager-Server/5.1/x86_64 -r <REGCODE>
```

The product string depends on your hardware architecture! For example, if you are using SUSE Multi-Linux Manager on a 64-bit Arm system, the string is "Multi-Linux-Manager-Server/5.1/aarch64".

Reboot

Update the system:

```
transactional-update
```

Unless there were no changes, reboot to apply the updates.

SUSE Multi-Linux Manager is provided via a container that is managed by Podman. The `mgradm` command handles the setup and configuration for you.

Warning

It is very important that your SUSE Multi-Linux Manager Server has the hostname configured with a fully qualified domain name ("FQDN") that the edge nodes you want to manage can properly resolve in your network!

Before you install and configure the SUSE Multi-Linux Manager Server container, you need to prepare the additional block device that you have previously added. For that, you need to know the name the virtual machine has given to the device. For example, if the block device is `/dev/vdb`, you can configure it to be used for SUSE Multi-Linux Manager using the following command:

```
mgr-storage-server /dev/vdb
```

Deploy SUSE Multi-Linux Manager:

```
mgradm install podman <FQDN>
```

Provide the password for the CA certificate. This password should be different from your login passwords. You usually don’t need to enter it later, but you should note it down.

Provide the password for the "admin" user. This is the initial user for logging into SUSE Multi-Linux Manager. You can create additional users with full or restricted rights later.

3.2 Configure SUSE Multi-Linux Manager

Once the deployment has finished, you can log into the SUSE Multi-Linux Manager web UI using the host name you provided earlier. The initial user is "admin". Use the password you provided in the previous step.

For the next step you need your Organization Credentials that you can find on the 2nd sub-tab of the "Users" tab of your organization in SUSE Customer Center. With those credentials, SUSE Multi-Linux Manager can synchronize all the products that you have subscriptions for.

Select `Admin > Setup Wizard`.

On the `Organization Credentials` tab create a new credential with your `Username` and `Password` that you found in the SUSE Customer Center.

Go to the next tab `SUSE Products`. You need to wait until the first data synchronization with SUSE Customer Center has finished.

Once the list is populated, you use the filter to only show "Micro 6.2". Check the box for SUSE Linux Micro 6.2 for the hardware architecture your edge nodes will run on (`x86_64` or `aarch64`).

Click `Add Products`. This will add the main package repository ("channel") for SUSE Linux Micro and automatically add the channel for the SUSE Manager client tools as a sub-channel.

Depending on your Internet connection, the first synchronization will take a while. You can already start with the next steps:

Under `Systems > System Groups`, create at least one group that your systems will automatically join when they are onboarded. Groups are an important way of categorizing systems, so you can apply configuration or actions to a whole set of systems at once. They are conceptually similar to labels in Kubernetes.

Click `+ Create Group`

Provide a short name, e.g., "Edge Nodes", and long description.

Under `Systems > Activation Keys`, create at least one activation key. Activation keys can be thought of as a configuration profile that is automatically applied to systems when they are onboarded to SUSE Multi-Linux Manager. If you want certain edge nodes to be added to different groups or use different configuration, you can create separate activation keys for them and use them later in Edge Image Builder to create customized installation media.

A typical advanced use case for activation keys would be to assign your test clusters to the software channels with the latest updates and your production clusters to software channels that only get those latest updates once you've tested them in the test cluster.

Click `+ Create Key`

Choose a short description, e.g., "Edge Nodes". Provide a unique name that identifies the key, e.g., "edge-x86_64" for your edge nodes with AMD64/Intel 64 hardware architecture. A number prefix is automatically added to the key. For the default organization, the number is always "1". If you create additional organizations in SUSE Multi-Linux Manager and create keys for them, that number may differ.

If you haven't created any cloned software channels, you can keep the setting for the Base Channel to "SUSE Manager Default". This will automatically assign the correct SUSE update repository for your edge nodes.

As "Child Channel", select the "include recommended" slider for the hardware architecture your activation key is used for. This will add the "SUSE-Manager-Tools-For-SL-Micro-6.2" channel.

On the "Groups" tab, add the group you've created before. All nodes that are onboarded using this activation key will automatically be added to that group.

3.3 Create a customized installation image with Edge Image Builder

To use Edge Image Builder, you only need an environment where you can start a Linux-based container with podman.

For a minimal lab setup, we can actually use the same virtual machine SUSE Multi-Linux Manager Server is running on. Please make sure that you have enough disk space in the virtual machine! This is not a recommended setup for production use. See *Section 2.1, "Prerequisites"* for host operating systems we have tested Edge Image Builder with.

Log into your SUSE Multi-Linux Manager Server host as root.

Pull the Edge Image Builder container:

```
podman pull registry.suse.com/edge/3.7/edge-image-builder:1.3.4
```

Create the directory `/opt/eib` and a sub-directory `base-images`:

```
mkdir -p /opt/eib/base-images
```

In this quickstart we're using the "self-install" flavor of the SUSE Linux Micro image. That image can later be written to a physical USB thumb drive that you can use to install on physical servers. If your server has the option of remote attachment of installation ISOs via a BMC (Baseboard Management Controller), you can also use that approach. Finally that image can also be used with most virtualization tools.

If you either want to preload the image directly to a physical node or directly start it from a VM, you can also use the "raw" image flavor.

You can find those images in the SUSE Customer Center or on https://www.suse.com/download/sle-micro/

Download or copy the image `SL-Micro.x86_64-6.2-Default-SelfInstall-GM.install.iso` to the `base-images` directory and name it "slemicro.iso".

Building AArch64 images on an Arm-based build host is a technology preview in SUSE Edge 3.7. It will most likely work, but isn't supported yet. If you want to try it out, you need to be running Podman on a 64-bit Arm machine, and you need to replace "x86_64" in all the examples and code snippets with "aarch64".

In `/opt/eib`, create a file called `iso-definition.yaml`. This is your build definition for Edge Image Builder.

Here is a simple example that installs SL Micro 6.2, sets a root password, an additional user and the keymap, starts the Cockpit graphical UI and registers your node to SUSE Multi-Linux Manager:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
  - username: root
    createHomeDir: true
    encryptedPassword: $6$aaBTHyqDRUMY1HAp$pmBY7.qLtoVlCGj32XR/Ogei4cngc3f4OX7fwBD/
gw7HWyuNBOKYbBWnJ4pvrYwH2WUtJLKMbinVtBhMDHQIY0
  - username: admin
    createHomeDir: true
    encryptedPassword: $6$8EGZXU1iFcLiHHxk$Hs3nVtzO.yZhApT.YBHaNvLRZvXG3Iv/
km92BtiNiGXhSSUG0ZbNHxlm7c//ROFj3W9M5xIkB.RLQpPKOFxP91
  keymap: de
  systemd:
    enable:
      - cockpit.socket
  packages:
    noGPGCheck: true
  suma:
    host: ${fully qualified hostname of your SUSE Multi-Linux Manager Server}
    activationKey: 1-edge-x86_64
```

Edge Image Builder can also configure the network, automatically install Kubernetes on the node, and even deploy applications via Helm charts. See *Chapter 2, Standalone clusters with Edge Image Builder* for more comprehensive examples.

For `baseImage`, specify the actual name of the ISO in the `base-images` directory that you want to use.

In this example, the root password would be "root". See *Section 2.3.2, "Configuring OS Users"* for creating password hashes for the secure password you want to use.

As Cockpit forbids connection as root user, an additional user is needed. In this example that user is "admin" with password "admin".

Set the keymap to the actual keyboard layout you want the system to have after installation.

Note

We use the option `noGPGCheck: true` because we aren't going to provide a GPG key to check RPM packages. A comprehensive guide with a more secure setup that we recommend for production use can be found in the upstream installing packages guide (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/installing-packages.md).

As mentioned several times, your SUSE Multi-Linux Manager host requires a fully qualified hostname that can be resolved in the network your edge nodes will boot into.

The value for `activationKey` needs to match the key you created in SUSE Multi-Linux Manager.

To build an installation image that automatically registers your edge nodes to SUSE Multi-Linux Manager after installation, you also need to prepare two artifacts:

- the Salt minion package that installs the management agent for SUSE Multi-Linux Manager
- the CA certificate of your SUSE Multi-Linux Manager server

3.3.1 Download the venv-salt-minion package

In `/opt/eib`, create a subdirectory `rpms`.

Download the package `venv-salt-minion` from your SUSE Multi-Linux Manager server into that directory. You can either get it via the web UI by finding the package under `Software > Channel List` and downloading it from the SUSE-Manager-Tools … channel or download it from the SUSE Multi-Linux Manager "bootstrap repo" with a tool like curl:

```
curl -O http://${HOSTNAME_OF_SUSE_MANAGER}/pub/repositories/slmicro/6/1/bootstrap/x86_64/
venv-salt-minion-3006.0-8.1.x86_64.rpm
```

The actual package name may differ if a newer release has already been released. If there are multiple packages to choose from, always pick the latest.

To work around an issue documented in the release notes (https://www.suse.com/releasenotes/x86_64/multi-linux-manager/5.1/index.html#_bootstrapping_sl_micro_6_1_clients) for SUSE Multi-Linux Manager, you also need to put the latest version of the build key package into the `rpms` directory (`suse-build-key-12.0-slfo.1.1_3.1.noarch.rpm` at the time this documentation was created). You can find it in the `Software` section of SUSE Multi-Linux Manager via the `Packages` tab of the Pool channel of SL Micro. There is a `Download` button in the `Details` view.

3.4 Download the SUSE Multi-Linux Manager CA certificate

In `/opt/eib`, create a subdirectory `certificates`

Download the CA certificate from SUSE Multi-Linux Manager into that directory:

```
curl -O http://${HOSTNAME_OF_SUSE_MANAGER}/pub/RHN-ORG-TRUSTED-SSL-CERT
```

Warning

You have to rename the certificate to `RHN-ORG-TRUSTED-SSL-CERT.crt`. Edge Image Builder will then make sure that the certificate is installed and activated on the edge node during installation.

Now you can run Edge Image Builder:

```
cd /opt/eib
podman run --rm -it --privileged -v /opt/eib:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file iso-definition.yaml
```

If you have used a different name for your YAML definition file or want to use a different version of Edge Image Builder, you need to adapt the command accordingly.

After the build is finished, you'll find the installation ISO in the `/opt/eib` directory as `eib-image.iso`.

That image can now be used to deploy nodes that will try to register with SUSE Multi-Linux Manager.

After the node has fully installed, you will see its key listed as `pending` in the `Salt/Keys` section of SUSE Multi-Linux Manager. Once you have accepted the key, the node will automatically be onboarded to SUSE Multi-Liux Manager and show up in the `Systems` list after that process is finished. It will have the system group(s) assigned that you provided in the activation key.

You should then schedule a reboot before applying any additional configuration.

Note that accepting the key can be fully automated using whitelists as described here (https://docs.salt-project.io/en/latest/topics/tutorials/autoaccept_grains.html).

II Components

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List of components for Edge

4 Rancher

See Rancher documentation at https://ranchermanager.docs.rancher.com/v2.15.

> Rancher is a powerful open-source Kubernetes management platform that streamlines the deployment, operations and monitoring of Kubernetes clusters across multiple environments. Whether you manage clusters on premises, in the cloud, or at the edge, Rancher provides a unified and centralized platform for all your Kubernetes needs.

4.1 Key Features of Rancher

- **Multi-cluster management:** Rancher's intuitive interface lets you manage Kubernetes clusters from anywhere—public clouds, private data centers and edge locations.
- **Security and compliance:** Rancher enforces security policies, role-based access control (RBAC), and compliance standards across your Kubernetes landscape.
- **Simplified cluster operations:** Rancher automates cluster provisioning, upgrades and troubleshooting, simplifying Kubernetes operations for teams of all sizes.
- **Centralized application catalog:** The Rancher application catalog offers a diverse range of Helm charts and Kubernetes Operators, making it easy to deploy and manage containerized applications.
- **Continuous delivery:** Rancher supports GitOps and CI/CD pipelines, enabling automated and streamlined application delivery processes.

4.2 Rancher's use in SUSE Edge

Rancher provides several core functionalities to the SUSE Edge stack:

4.2.1 Centralized Kubernetes management

In typical edge deployments with numerous distributed clusters, Rancher acts as a central control plane for managing these Kubernetes clusters. It offers a unified interface for provisioning, upgrading, monitoring, and troubleshooting, simplifying operations, and ensuring consistency.

4.2.2 Simplified cluster deployment

Rancher streamlines Kubernetes cluster creation on the lightweight SUSE Linux Micro operating system, easing the rollout of edge infrastructure with robust Kubernetes capabilities.

4.2.3 Application deployment and management

The integrated Rancher application catalog can simplify deploying and managing containerized applications across SUSE Edge clusters, enabling seamless edge workload deployment.

4.2.4 Security and policy enforcement

Rancher provides policy-based governance tools, role-based access control (RBAC), and integration with external authentication providers. This helps SUSE Edge deployments maintain security and compliance, critical in distributed environments.

4.3 Best practices

4.3.1 GitOps

Rancher includes Fleet as a built-in component to allow manage cluster configurations and application deployments with code stored in git.

4.3.2 Observability

Rancher includes built-in monitoring and logging tools like Prometheus and Grafana for comprehensive insights into your cluster health and performance.

4.4 Installing with Edge Image Builder

SUSE Edge is using *Chapter 8, Edge Image Builder* in order to customize base SUSE Linux Micro OS images. Follow *Section 25.6, "Rancher Installation"* for an air-gapped installation of Rancher on top of Kubernetes clusters provisioned by EIB.

4.5 Additional Resources

- Rancher Documentation (https://rancher.com/docs/)
- Rancher Academy (https://www.rancher.academy/)
- Rancher Community (https://rancher.com/community/)
- Helm Charts (https://helm.sh/)
- Kubernetes Operators (https://operatorhub.io/)

5 Rancher Dashboard Extensions

Extensions allow users, developers, partners, and customers to extend and enhance the Rancher UI. SUSE Edge provides KubeVirt dashboard extensions.

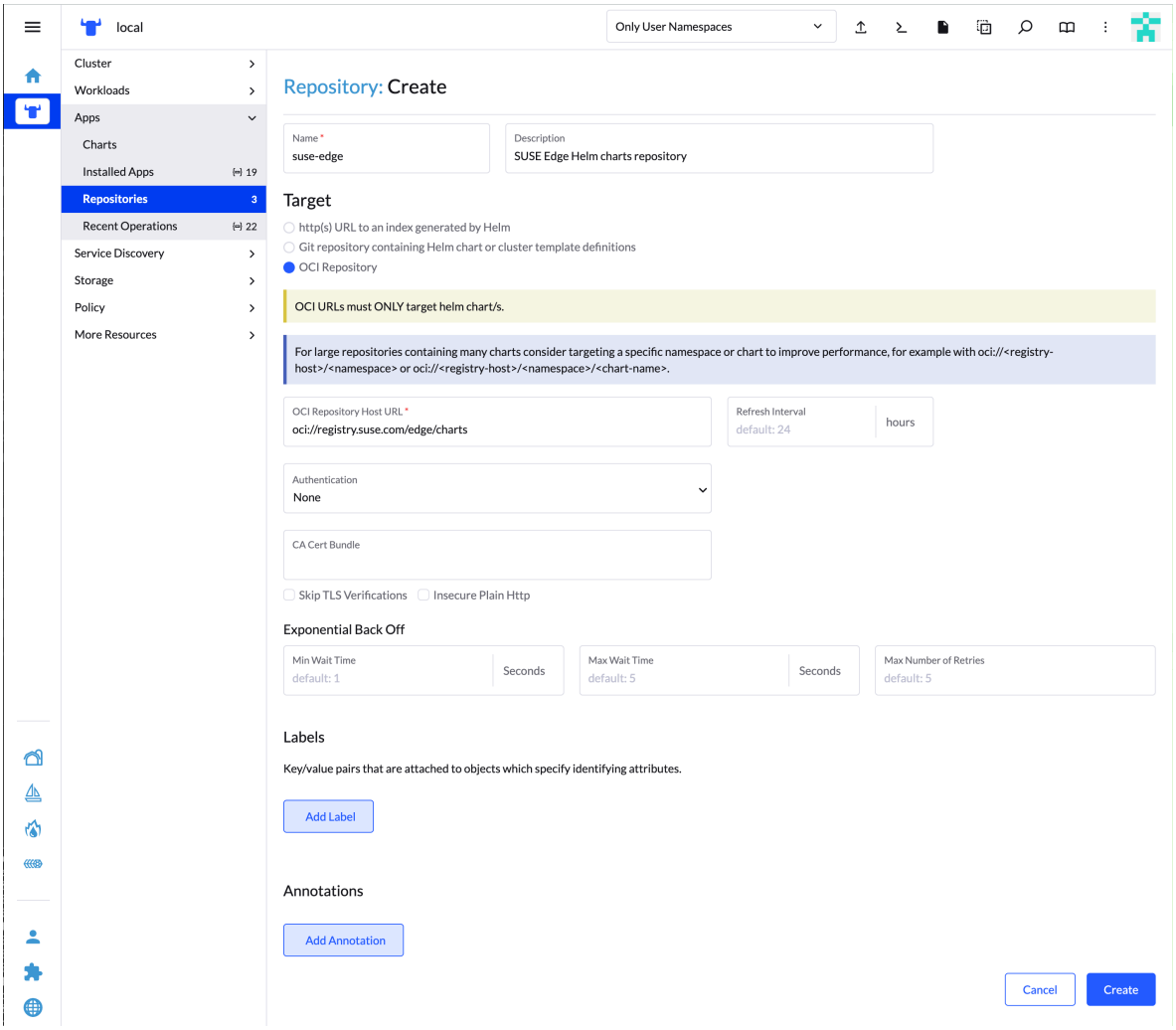
See `Rancher documentation` for general information about Rancher Dashboard Extensions.

5.1 Installation

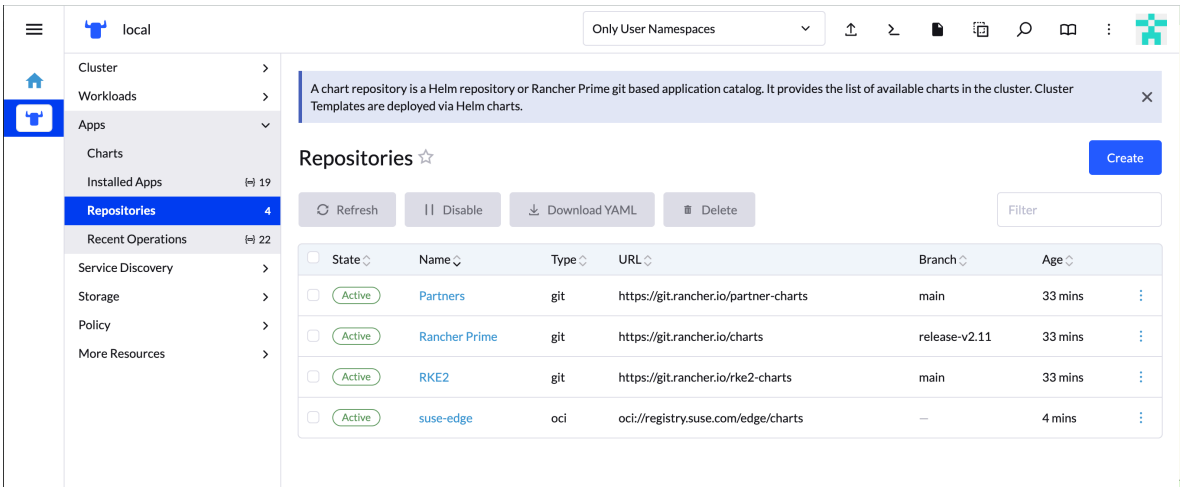
All of the SUSE Edge 3.7 components, including dashboard extensions, are distributed as OCI artifacts. To install SUSE Edge Extensions you can use Rancher Dashboard UI, Helm or Fleet:

5.1.1 Installing with Rancher Dashboard UI

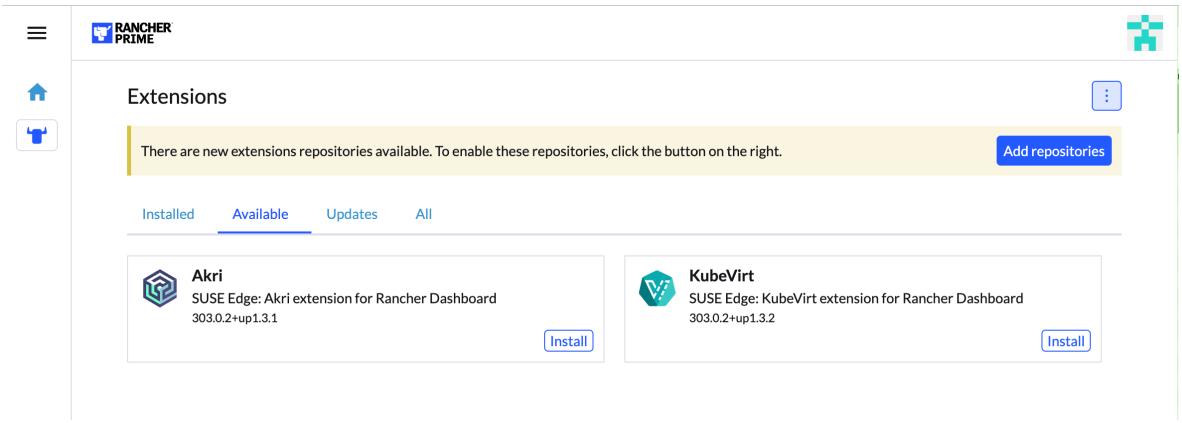
1. Click **Extensions** in the **Configuration** section of the navigation sidebar.
2. On the Extensions page, click the three dot menu at the top right and select **Manage Repositories**. Each extension is distributed via its own OCI artifact. They are available from the SUSE Edge Helm charts repository.
3. On the **Repositories page**, click `Create`.
4. In the form, specify the repository name and URL, and click `Create`.
   SUSE Edge Helm charts repository URL: `oci://registry.suse.com/edge/charts`



5. You can see that the extension repository is added to the list and is in `Active` state.



6. Navigate back to the **Extensions** in the **Configuration** section of the navigation sidebar.
   In the **Available** tab you can see the extensions available for installation.



7. On the extension card click `Install` and confirm the installation.
   Once the extension is installed Rancher UI prompts to reload the page as described in the `Installing Extensions Rancher documentation page`.

5.1.2 Installing with Helm

```
# KubeVirt extension
helm install kubevirt-dashboard-extension oci://registry.suse.com/edge/charts/kubevirt-
dashboard-extension --version 307.0.5+up1.4.2 --namespace cattle-ui-plugin-system
```

Note

The extensions need to be installed in `cattle-ui-plugin-system` namespace.

Note

After an extension is installed, Rancher Dashboard UI needs to be reloaded.

5.1.3 Installing with Fleet

Installing Dashboard Extensions with Fleet requires defining a `gitRepo` resource which points to a Git repository with custom `fleet.yaml` bundle configuration file(s).

```
# KubeVirt extension fleet.yaml
```

```
defaultNamespace: cattle-ui-plugin-system
helm:
  releaseName: kubevirt-dashboard-extension
  chart: oci://registry.suse.com/edge/charts/kubevirt-dashboard-extension
  version: "307.0.5+up1.4.2"
```

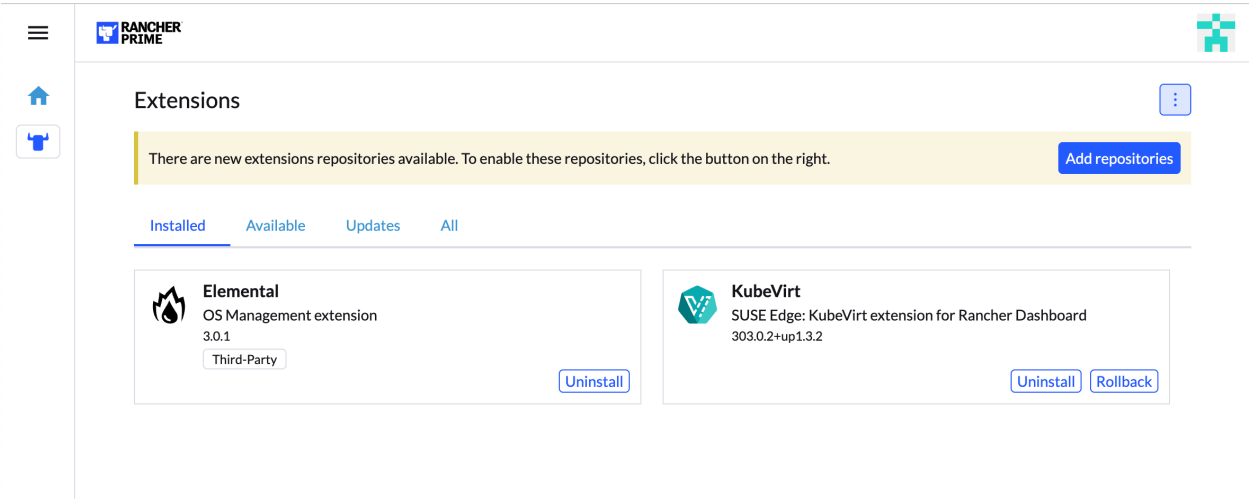
Note

The `releaseName` property is required and needs to match the extension name to get the extension correctly installed.

```
cat <<- EOF | kubectl apply -f -
apiVersion: fleet.cattle.io/v1alpha1
metadata:
  name: edge-dashboard-extensions
  namespace: fleet-local
spec:
  repo: https://github.com/suse-edge/fleet-examples.git
  branch: main
  paths:
  - fleets/kubevirt-dashboard-extension/
EOF
```

For more information, see *Chapter 6, Fleet* and the `fleet-examples` repository.

Once the Extensions are installed they are listed in **Extensions** section under **Installed** tabs. Since they are not installed via Apps/Marketplace, they are marked with `Third-Party` label.



5.2 KubeVirt Dashboard Extension

KubeVirt Extension provides basic virtual machine management for Rancher dashboard UI. Its capabilities are described in *Section 17.7.2, "Using KubeVirt Rancher Dashboard Extension"*.

6 Fleet

Fleet (https://fleet.rancher.io) is a container management and deployment engine designed to offer users more control on the local cluster and constant monitoring through GitOps. Fleet focuses not only on the ability to scale, but it also gives users a high degree of control and visibility to monitor exactly what is installed on the cluster.

Fleet can manage deployments from Git of raw Kubernetes YAML, Helm charts, Kustomize, or any combination of the three. Regardless of the source, all resources are dynamically turned into Helm charts, and Helm is used as the engine to deploy all resources in the cluster. As a result, users can enjoy a high degree of control, consistency and auditability of their clusters.

For information about how Fleet works, see Fleet Architecture (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/architecture).

6.1 Installing Fleet with Helm

Fleet comes built-in to Rancher, but it can be also installed (https://fleet.rancher.io/installation) as a standalone application on any Kubernetes cluster using Helm.

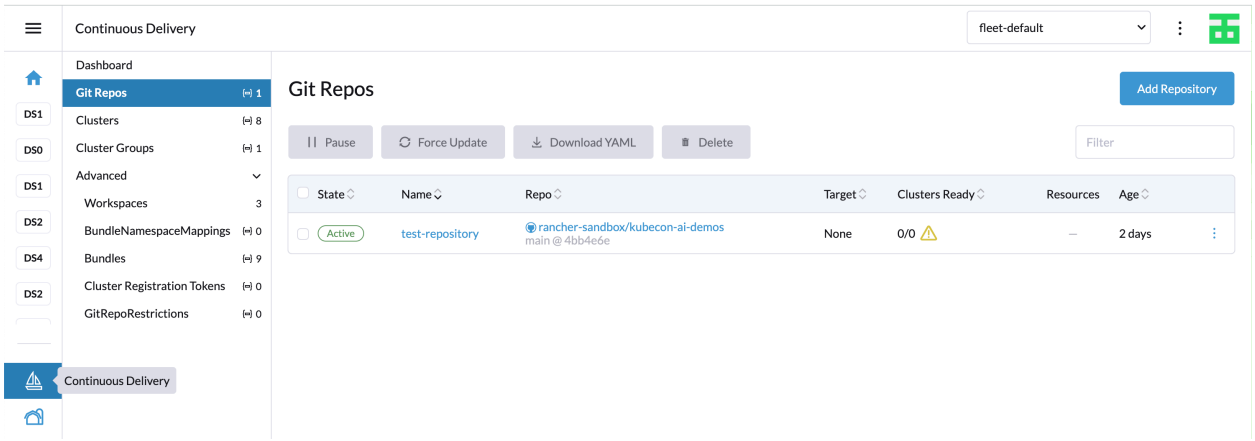
6.2 Using Fleet with Rancher

Rancher uses Fleet to deploy applications across managed clusters. Continuous delivery with Fleet introduces GitOps at scale, designed to manage applications running on large numbers of clusters.

Fleet shines as an integrated part of Rancher. Clusters managed with Rancher automatically get the Fleet agent deployed as part of the installation/import process and the cluster is immediately available to be managed by Fleet.

6.3 Accessing Fleet in the Rancher UI

Fleet comes preinstalled in Rancher and is managed by the **Continuous Delivery** option in the Rancher UI.



Continuous Delivery section consists of following items:

6.3.1 Dashboard

An overview page of all GitOps repositories across all workspaces. Only the workspaces with repositories are displayed.

6.3.2 Git repos

A list of GitOps repositories in the selected workspace. Select the active workspace using the dropdown list at the top of the page.

6.3.3 Clusters

A list of managed clusters. By default, all Rancher-managed clusters are added to the `fleet-default` workspace. `fleet-local` workspace includes the local (management) cluster. From here, it is possible to `Pause` or `Force update` the clusters or move the cluster into another workspace. Editing the cluster allows to update labels and annotations used for grouping the clusters.

6.3.4 Cluster groups

This section allows custom grouping of the clusters within the workspace using selectors.

6.3.5 Advanced

The "Advanced" section allows to manage workspaces and other related Fleet resources.

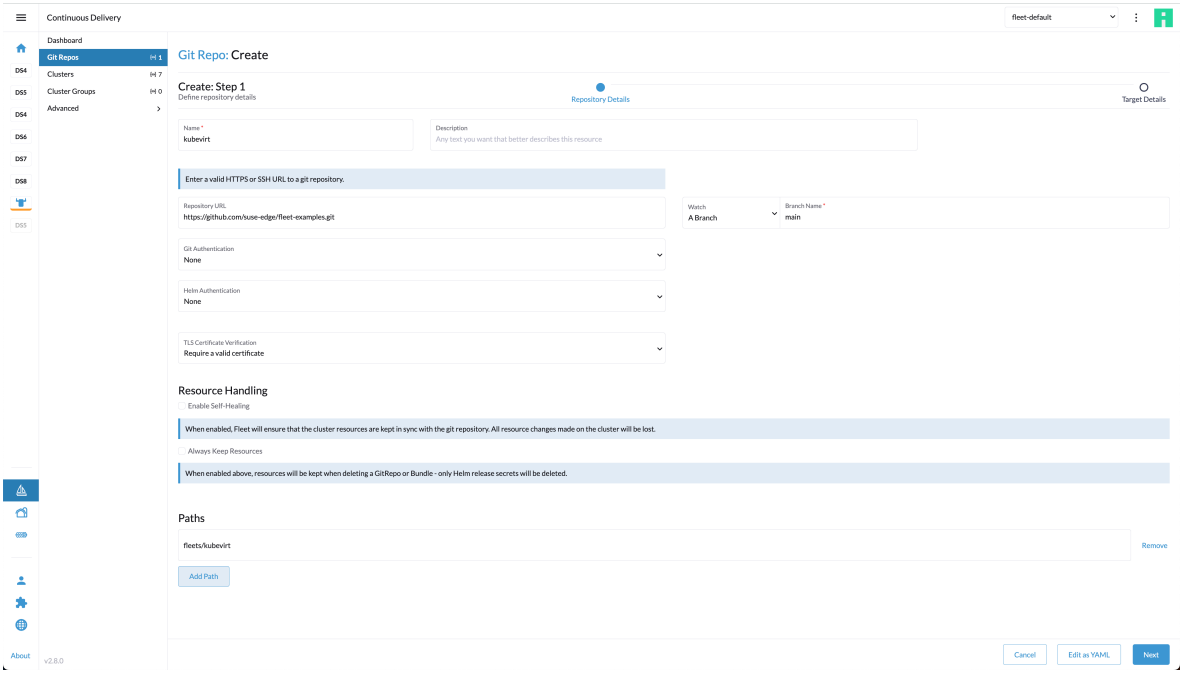
6.4 Example of installing KubeVirt with Rancher and Fleet using Rancher dashboard

1. Create a Git repository containing the `fleet.yaml` file:

```
defaultNamespace: kubevirt
helm:
  chart: "oci://registry.suse.com/edge/charts/kubevirt"
  version: "307.0.3+up0.8.0"
  # kubevirt namespace is created by kubevirt as well, we need to take ownership of
 it
  takeOwnership: true
```

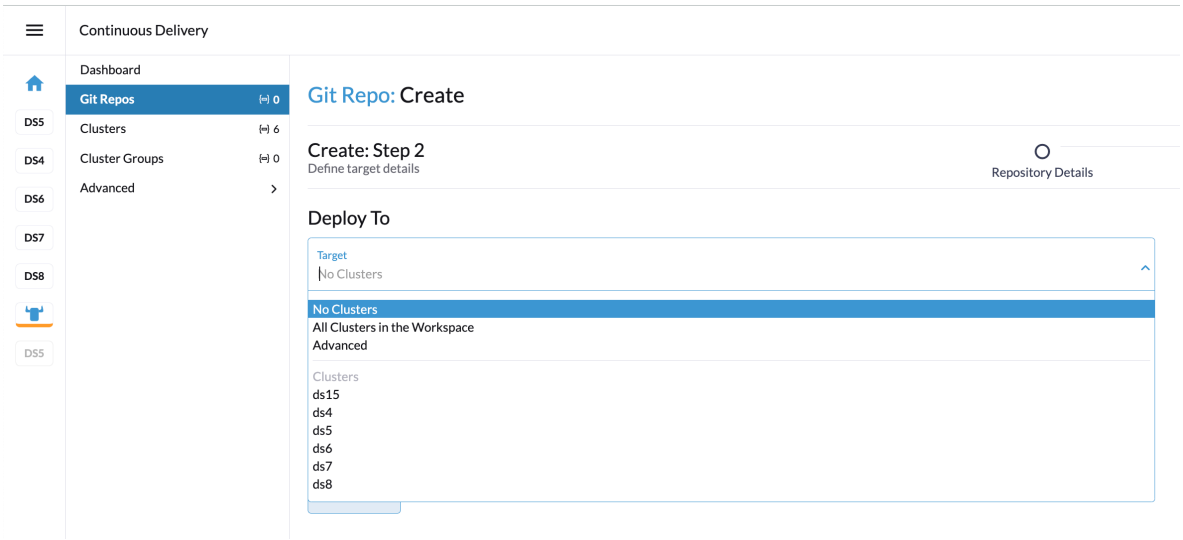
2. In the Rancher dashboard, navigate to # > **Continuous Delivery** > **Git Repos** and click `Add Repository`.

3. The Repository creation wizard guides through creation of the Git repo. Provide **Name**, **Repository URL** (referencing the Git repository created in the previous step) and select the appropriate branch or revision. In the case of a more complex repository, specify **Paths** to use multiple directories in a single repository.



4. Click `Next`.

5. In the next step, you can define where the workloads will get deployed. Cluster selection offers several basic options: you can select no clusters, all clusters, or directly choose a specific managed cluster or cluster group (if defined). The "Advanced" option allows to directly edit the selectors via YAML.

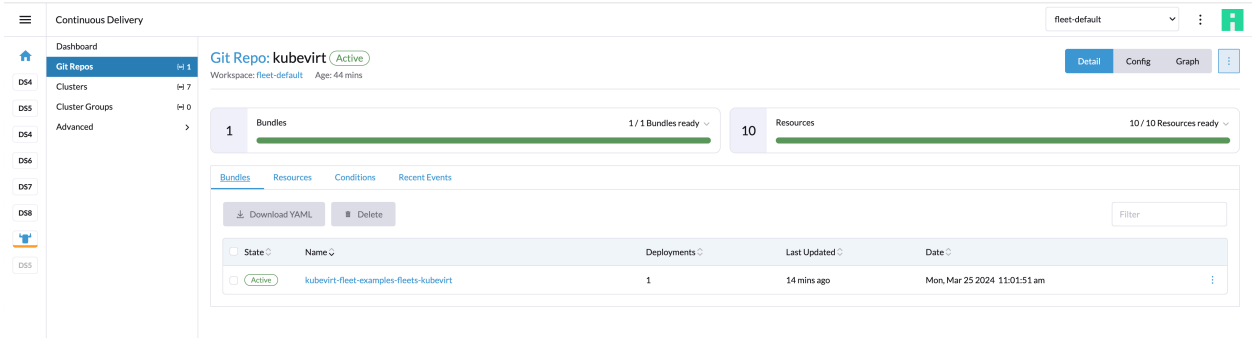


6. Click `Create`. The repository gets created. From now on, the workloads are installed and kept in sync on the clusters matching the repository definition.

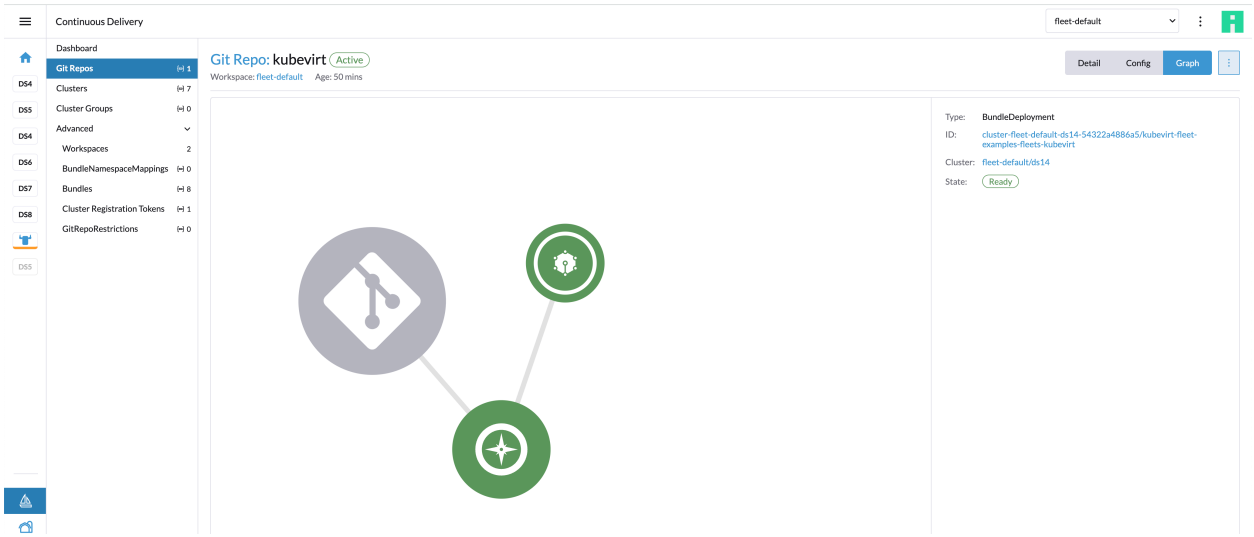
6.5 Debugging and troubleshooting

The "Advanced" navigation section provides overviews of lower-level Fleet resources. A bundle (https://fleet.rancher.io/ref-bundle-stages) is an internal resource used for the orchestration of resources from Git. When a Git repo is scanned, it produces one or more bundles.

To find bundles relevant to a specific repository, go to the Git repo detail page and click the `Bundles` tab.



For each cluster, the bundle is applied to a BundleDeployment resource that is created. To view BundleDeployment details, click the `Graph` button in the upper right of the Git repo detail page. A graph of **Repo > Bundles > BundleDeployments** is loaded. Click the BundleDeployment in the graph to see its details and click the `Id` to view the BundleDeployment YAML.



For additional information on Fleet troubleshooting tips, refer here (https://fleet.rancher.io/troubleshooting).

6.6 Fleet examples

The Edge team maintains a repository (https://github.com/suse-edge/fleet-examples) with examples of installing Edge projects with Fleet.

The Fleet project includes a fleet-examples (https://github.com/rancher/fleet-examples) repository that covers all use cases for Git repository structure (https://fleet.rancher.io/gitrepo-content).

7 SUSE Linux Micro

See SUSE Linux Micro official documentation (https://documentation.suse.com/sle-micro/6.2/)

> SUSE Linux Micro is a lightweight and secure operating system for the edge. It merges the enterprise-hardened components of SUSE Linux Enterprise with the features that developers want in a modern, immutable operating system. As a result, you get a reliable infrastructure platform with best-in-class compliance that is also simple to use.

7.1 How does SUSE Edge use SUSE Linux Micro?

We use SUSE Linux Micro as the base operating system for our platform stack. This provides us with a secure, stable and minimal base for building upon.

SUSE Linux Micro is unique in its use of file system (Btrfs) snapshots to allow for easy rollbacks in case something goes wrong with an upgrade. This allows for secure remote upgrades for the entire platform even without physical access in case of issues.

7.2 Best practices

7.2.1 Installation media

SUSE Edge uses the Edge Image Builder (*Chapter 8, Edge Image Builder*) to preconfigure the SUSE Linux Micro self-install installation image.

7.2.2 Local administration

SUSE Linux Micro comes with Cockpit to allow the local management of the host through a Web application.

This service is disabled by default but can be started by enabling the systemd service `cockpit.socket`. As cockpit forbids root login by default, the creation of a user with administrative privileges is recommended, refer to the SUSE Linux Micro official documentation (https://documentation.suse.com/sle-micro/6.2/) for more information.

7.3 Known issues

- There is no desktop environment available in SUSE Linux Micro at the moment but a containerized solution is in development.

8 Edge Image Builder

See the Official Repository (https://github.com/suse-edge/edge-image-builder).

Edge Image Builder (EIB) is a tool that streamlines the generation of Customized, Ready-to-Boot (CRB) disk images for bootstrapping machines. These images enable the end-to-end deployment of the entire SUSE software stack with a single image.

Whilst EIB can create CRB images for all provisioning scenarios, EIB demonstrates a tremendous value in air-gapped deployments with limited or completely isolated networks.

8.1 How does SUSE Edge use Edge Image Builder?

SUSE Edge uses EIB for the simplified and quick configuration of customized SUSE Linux Micro images for a variety of scenarios. These scenarios include the bootstrapping of virtual and bare-metal machines with:

- Fully air-gapped deployments of K3s/RKE2 Kubernetes (single & multi-node)
- Fully air-gapped Helm chart and Kubernetes manifest deployments
- Registration to Rancher via Elemental API
- Metal[3]
- Customized networking (for example, static IP, host name, VLAN's, bonding, etc.)
- Customized operating system configurations (for example, users, groups, passwords, SSH keys, proxies, NTP, custom SSL certificates, etc.)
- Air-gapped installation of host-level and side-loaded RPM packages (including dependency resolution)
- Registration to SUSE Multi-Linux Manager for OS management
- Embedded container images
- Kernel command-line arguments
- Systemd units to be enabled/disabled at boot time
- Custom scripts and files for any manual tasks

8.2 Getting started

Comprehensive documentation for the usage and testing of Edge Image Builder can be found here (https://github.com/suse-edge/edge-image-builder/tree/release-1.3/docs).

Additionally, see *Chapter 2, Standalone clusters with Edge Image Builder* covering a basic deployment scenario.

Once you are familiar with this tool, please find some more useful information on our EIB Tips and Tricks section (*Part IV, "Tips and Tricks"*) page.

8.3 Known issues

- EIB air-gaps Helm charts through templating the Helm charts and parsing all the images within the template. If a Helm chart does not keep all of its images within the template and instead side-loads the images, EIB will not be able to air-gap those images automatically. The solution to this is to manually add any undetected images to the `embeddedArtifactRegistry` section of the definition file.

9 Edge Networking

This section describes the approach to network configuration in the SUSE Edge solution. We will show how to configure NetworkManager on SUSE Linux Micro in a declarative manner, and explain how the related tools are integrated.

9.1 Overview of NetworkManager

NetworkManager is a tool that manages the primary network connection and other connection interfaces.

NetworkManager stores network configurations as connection files that contain the desired state. These connections are stored as files in the `/etc/NetworkManager/system-connections/` directory.

Details about NetworkManager can be found in the SUSE Linux Micro documentation (https://documentation.suse.com/sle-micro/6.2/html/Micro-network-configuration/index.html).

9.2 Overview of nmstate

nmstate is a widely adopted library (with an accompanying CLI tool) which offers a declarative API for network configurations via a predefined schema.

Details about nmstate can be found in the upstream documentation (https://nmstate.io/).

9.3 Enter: NetworkManager Configurator (nmc)

The network customization options available in SUSE Edge are achieved via a CLI tool called NetworkManager Configurator or *nmc* for short. It is leveraging the functionality provided by the nmstate library and, as such, it is fully capable of configuring static IP addresses, DNS servers, VLANs, bonding, bridges, etc. This tool allows us to generate network configurations from predefined desired states and to apply those across many different nodes in an automated fashion.

Details about the NetworkManager Configurator (nmc) can be found in the upstream repository (https://github.com/suse-edge/nm-configurator).

9.4 How does SUSE Edge use NetworkManager Configurator?

SUSE Edge utilizes *nmc* for the network customizations in the various different provisioning models: * Declarative static configurations in the Image Based Provisioning scenarios (*Chapter 2, Standalone clusters with Edge Image Builder*)

9.5 Configuring with Edge Image Builder

Edge Image Builder (EIB) is a tool which enables configuring multiple hosts with a single OS image. In this section we'll show how you can use a declarative approach to describe the desired network states, how those are converted to the respective NetworkManager connections, and are then applied during the provisioning process.

9.5.1 Prerequisites

If you're following this guide, it's assumed that you've got the following already available:

- An AMD64/Intel 64 physical host (or virtual machine) running SLES 15 SP6 or openSUSE Leap 15.6
- An available container runtime (e.g. Podman)
- A copy of the SUSE Linux Micro 6.2 RAW image found here (https://www.suse.com/download/sle-micro/)

9.5.2 Getting the Edge Image Builder container image

The EIB container image is publicly available and can be downloaded from the SUSE Edge registry by running:

```
podman pull registry.suse.com/edge/3.7/edge-image-builder:1.3.4
```

9.5.3 Creating the image configuration directory

Let's start with creating the configuration directory:

```
export CONFIG_DIR=$HOME/eib
mkdir -p $CONFIG_DIR/base-images
```

We will now ensure that the downloaded base image copy is moved over to the configuration directory:

```
mv /path/to/downloads/SL-Micro.x86_64-6.2-Base-GM.raw $CONFIG_DIR/base-images/
```

> **Note**
>
> EIB is never going to modify the base image input. It will create a new image with its modifications.

The configuration directory at this point should look like the following:

```
└── base-images/
    └── SL-Micro.x86_64-6.2-Base-GM.raw
```

9.5.4 Creating the image definition file

The definition file describes the majority of configurable options that the Edge Image Builder supports.

Let's start with a very basic definition file for our OS image:

```
cat << EOF > $CONFIG_DIR/definition.yaml
apiVersion: 1.3
image:
  arch: x86_64
  imageType: raw
  baseImage: SL-Micro.x86_64-6.2-Base-GM.raw
  outputImageName: modified-image.raw
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
EOF
```

The `image` section is required, and it specifies the input image, its architecture and type, as well as what the output image will be called. The `operatingSystem` section is optional, and contains configuration to enable login on the provisioned systems with the `root/eib` username/password.

Note

Feel free to use your own encrypted password by running `openssl passwd -6 <password>`.

The configuration directory at this point should look like the following:

```
├── definition.yaml
└── base-images/
    └── SL-Micro.x86_64-6.2-Base-GM.raw
```

9.5.5 Defining the network configurations

The desired network configurations are not part of the image definition file that we just created. We'll now populate those under the special `network/` directory. Let's create it:

```
mkdir -p $CONFIG_DIR/network
```

As previously mentioned, the NetworkManager Configurator (*nmc*) tool expects an input in the form of predefined schema. You can find how to set up a wide variety of different networking options in the upstream NMState examples documentation (https://nmstate.io/examples.html).

This guide will explain how to configure the networking on three different nodes:

- A node which uses two Ethernet interfaces
- A node which uses network bonding
- A node which uses a network bridge

Warning

Using completely different network setups is not recommended in production builds, especially if configuring Kubernetes clusters. Networking configurations should generally be homogeneous amongst nodes or at least amongst roles within a given cluster. This guide is including various different options only to serve as an example reference.

Note

The following assumes a default `libvirt` network with an IP address range `192.168.122.1/24`. Adjust accordingly if this differs in your environment.

Let’s create the desired states for the first node which we will call `node1.suse.com`:

```
cat << EOF > $CONFIG_DIR/network/node1.suse.com.yaml
routes:
  config:
    - destination: 0.0.0.0/0
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: eth0
      table-id: 254
    - destination: 192.168.122.0/24
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: eth0
      table-id: 254
dns-resolver:
  config:
    server:
      - 192.168.122.1
      - 8.8.8.8
interfaces:
  - name: eth0
    type: ethernet
    state: up
    mac-address: 34:8A:B1:4B:16:E1
    ipv4:
      address:
        - ip: 192.168.122.50
          prefix-length: 24
      dhcp: false
      enabled: true
    ipv6:
      enabled: false
  - name: eth3
    type: ethernet
    state: down
    mac-address: 34:8A:B1:4B:16:E2
    ipv4:
      address:
        - ip: 192.168.122.55
          prefix-length: 24
      dhcp: false
      enabled: true
    ipv6:
      enabled: false
EOF
```

In this example we define a desired state of two Ethernet interfaces (eth0 and eth3), their requested IP addresses, routing, and DNS resolution.

Warning

You must ensure that the MAC addresses of all Ethernet interfaces are listed. Those are used during the provisioning process as the identifiers of the nodes and serve to determine which configurations should be applied. This is how we are able to configure multiple nodes using a single ISO or RAW image.

Next up is the second node which we will call `node2.suse.com` and which will use network bonding:

```
cat << EOF > $CONFIG_DIR/network/node2.suse.com.yaml
routes:
  config:
    - destination: 0.0.0.0/0
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: bond99
      table-id: 254
    - destination: 192.168.122.0/24
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: bond99
      table-id: 254
dns-resolver:
  config:
    server:
      - 192.168.122.1
      - 8.8.8.8
interfaces:
  - name: bond99
    type: bond
    state: up
    ipv4:
      address:
        - ip: 192.168.122.60
          prefix-length: 24
      enabled: true
    link-aggregation:
      mode: balance-rr
      options:
        miimon: '140'
      port:
```

```
        - eth0
        - eth1
  - name: eth0
    type: ethernet
    state: up
    mac-address: 34:8A:B1:4B:16:E3
    ipv4:
      enabled: false
    ipv6:
      enabled: false
  - name: eth1
    type: ethernet
    state: up
    mac-address: 34:8A:B1:4B:16:E4
    ipv4:
      enabled: false
    ipv6:
      enabled: false
EOF
```

In this example we define a desired state of two Ethernet interfaces (eth0 and eth1) which are not enabling IP addressing, as well as a bond with a round-robin policy and its respective address which is going to be used to forward the network traffic.

Lastly, we'll create the third and final desired state file which will be utilizing a network bridge and which we'll call `node3.suse.com`:

```
cat << EOF > $CONFIG_DIR/network/node3.suse.com.yaml
routes:
  config:
    - destination: 0.0.0.0/0
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: linux-br0
      table-id: 254
    - destination: 192.168.122.0/24
      metric: 100
      next-hop-address: 192.168.122.1
      next-hop-interface: linux-br0
      table-id: 254
dns-resolver:
  config:
    server:
      - 192.168.122.1
      - 8.8.8.8
interfaces:
  - name: eth0
```

```
    type: ethernet
    state: up
    mac-address: 34:8A:B1:4B:16:E5
    ipv4:
      enabled: false
    ipv6:
      enabled: false
  - name: linux-br0
    type: linux-bridge
    state: up
    ipv4:
      address:
        - ip: 192.168.122.70
          prefix-length: 24
      dhcp: false
      enabled: true
    bridge:
      options:
        group-forward-mask: 0
        mac-ageing-time: 300
        multicast-snooping: true
        stp:
          enabled: true
          forward-delay: 15
          hello-time: 2
          max-age: 20
          priority: 32768
      port:
        - name: eth0
          stp-hairpin-mode: false
          stp-path-cost: 100
          stp-priority: 32
EOF
```

The configuration directory at this point should look like the following:

```
├── definition.yaml
├── network/
│   │── node1.suse.com.yaml
│   │── node2.suse.com.yaml
│   └── node3.suse.com.yaml
└── base-images/
    └── SL-Micro.x86_64-6.2-Base-GM.raw
```

> **Note**
>
> The names of the files under the `network/` directory are intentional. They correspond to the hostnames which will be set during the provisioning process.

9.5.6 Building the OS image

Now that all the necessary configurations are in place, we can build the image by simply running:

```
podman run --rm -it -v $CONFIG_DIR:/eib registry.suse.com/edge/3.7/edge-image-
builder:1.3.4 build --definition-file definition.yaml
```

The output should be similar to the following:

```
Generating image customization components...
Identifier ................... [SUCCESS]
Custom Files ................. [SKIPPED]
Time ......................... [SKIPPED]
Network ...................... [SUCCESS]
Groups ....................... [SKIPPED]
Users ........................ [SUCCESS]
Proxy ........................ [SKIPPED]
Rpm .......................... [SKIPPED]
Systemd ...................... [SKIPPED]
Elemental .................... [SKIPPED]
Suma ......................... [SKIPPED]
Embedded Artifact Registry ... [SKIPPED]
Keymap ....................... [SUCCESS]
Kubernetes ................... [SKIPPED]
Certificates ................. [SKIPPED]
Building RAW image...
Kernel Params ................ [SKIPPED]
Image build complete!
```

The snippet above tells us that the `Network` component has successfully been configured, and we can proceed with provisioning our edge nodes.

> **Note**
>
> A log file (`network-config.log`) and the respective NetworkManager connection files can be inspected in the resulting `_build` directory under a timestamped directory for the image run.

9.5.7 Provisioning the edge nodes

Let's copy the resulting RAW image:

```
mkdir edge-nodes && cd edge-nodes
for i in {1..4}; do cp $CONFIG_DIR/modified-image.raw node$i.raw; done
```

You will notice that we copied the built image four times but only specified the network configurations for three nodes. This is because we also want to showcase what will happen if we provision a node which does not match any of the desired configurations.

> **Note**
>
> This guide will use virtualization for the node provisioning examples. Ensure the necessary extensions are enabled in the BIOS (see here (https://documentation.suse.com/sles/15-SP6/html/SLES-all/cha-virt-support.html#sec-kvm-requires-hardware) for details).

We will be using `virt-install` to create virtual machines using the copied raw disks. Each virtual machine will be using 10 GB of RAM and 6 vCPUs.

9.5.7.1 Provisioning the first node

Let's create the virtual machine:

```
virt-install --name node1 --ram 10000 --vcpus 6 --disk path=node1.raw,format=raw --osinfo
 detect=on,name=sle-unknown --graphics none --console pty,target_type=serial --network
 default,mac=34:8A:B1:4B:16:E1 --network default,mac=34:8A:B1:4B:16:E2 --virt-type kvm --
import
```

> **Note**
>
> It is important that we create the network interfaces with the same MAC addresses as the ones in the desired state we described above.

Once the operation is complete, we will see something similar to the following:

```
Starting install...
Creating domain...
```

```
Running text console command: virsh --connect qemu:///system console node1
Connected to domain 'node1'
Escape character is ^] (Ctrl + ])


Welcome to SUSE Linux Micro 6.0 (x86_64) - Kernel 6.4.0-18-default (tty1).

SSH host key: SHA256:XN/R5Tw43reG+QsOw480LxCnhkc/1uqMdwlI6KUBY70 (RSA)
SSH host key: SHA256:/96yGrPGKlhn04f1rb9cXv/2WJt4TtrIN5yEcN66r3s (DSA)
SSH host key: SHA256:Dy/YjBQ7LwjZGaaVcMhTWZNSOstxXBsPsvgJTJq5t00 (ECDSA)
SSH host key: SHA256:TNGqY1LRddpxD/jn/8dkT/9YmVl9hiwulqmayP+wOWQ (ED25519)
eth0: 192.168.122.50
eth1:


Configured with the Edge Image Builder
Activate the web console with: systemctl enable --now cockpit.socket

node1 login:
```

We're now able to log in with the `root:eib` credentials pair. We're also able to SSH into the host if we prefer that over the `virsh console` we're presented with here.

Once logged in, let's confirm that all the settings are in place.

Verify that the hostname is properly set:

```
node1:~ # hostnamectl
 Static hostname: node1.suse.com
 ...
```

Verify that the routing is properly configured:

```
node1:~ # ip r
default via 192.168.122.1 dev eth0 proto static metric 100
192.168.122.0/24 dev eth0 proto static scope link metric 100
192.168.122.0/24 dev eth0 proto kernel scope link src 192.168.122.50 metric 100
```

Verify that Internet connection is available:

```
node1:~ # ping google.com
PING google.com (142.250.72.78) 56(84) bytes of data.
64 bytes from den16s09-in-f14.1e100.net (142.250.72.78): icmp_seq=1 ttl=56 time=13.2 ms
64 bytes from den16s09-in-f14.1e100.net (142.250.72.78): icmp_seq=2 ttl=56 time=13.4 ms
^C
--- google.com ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
```

```
rtt min/avg/max/mdev = 13.248/13.304/13.361/0.056 ms
```

Verify that exactly two Ethernet interfaces are configured and only one of those is active:

```
node1:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 34:8a:b1:4b:16:e1 brd ff:ff:ff:ff:ff:ff
    altname enp0s2
    altname ens2
    inet 192.168.122.50/24 brd 192.168.122.255 scope global noprefixroute eth0
       valid_lft forever preferred_lft forever
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 34:8a:b1:4b:16:e2 brd ff:ff:ff:ff:ff:ff
    altname enp0s3
    altname ens3

node1:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME  UUID                                  TYPE      DEVICE  FILENAME
eth0  dfd202f5-562f-5f07-8f2a-a7717756fb70  ethernet  eth0    /etc/NetworkManager/system-
connections/eth0.nmconnection
eth1  7e211aea-3d14-59cf-a4fa-be91dac5dbba  ethernet  --      /etc/NetworkManager/system-
connections/eth1.nmconnection
```

You'll notice that the second interface is `eth1` instead of the predefined `eth3` in our desired networking state. This is the case because the NetworkManager Configurator (*nmc*) is able to detect that the OS has given a different name for the NIC with MAC address `34:8a:b1:4b:16:e2` and it adjusts its settings accordingly.

Verify this has indeed happened by inspecting the Combustion phase of the provisioning:

```
node1:~ # journalctl -u combustion | grep nmc
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO
 nmc::apply_conf] Identified host: node1.suse.com
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO
 nmc::apply_conf] Set hostname: node1.suse.com
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO
 nmc::apply_conf] Processing interface 'eth0'...
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO
 nmc::apply_conf] Processing interface 'eth3'...
```

```
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO
 nmc::apply_conf] Using interface name 'eth1' instead of the preconfigured 'eth3'
Apr 23 09:20:19 localhost.localdomain combustion[1360]: [2024-04-23T09:20:19Z INFO  nmc]
 Successfully applied config
```

We will now provision the rest of the nodes, but we will only show the differences in the final configuration. Feel free to apply any or all of the above checks for all nodes you are about to provision.

9.5.7.2 Provisioning the second node

Let's create the virtual machine:

```
virt-install --name node2 --ram 10000 --vcpus 6 --disk path=node2.raw,format=raw --osinfo
 detect=on,name=sle-unknown --graphics none --console pty,target_type=serial --network
 default,mac=34:8A:B1:4B:16:E3 --network default,mac=34:8A:B1:4B:16:E4 --virt-type kvm --
import
```

Once the virtual machine is up and running, we can confirm that this node is using bonded interfaces:

```
node2:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,SLAVE,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast master bond99
 state UP group default qlen 1000
    link/ether 34:8a:b1:4b:16:e3 brd ff:ff:ff:ff:ff:ff
    altname enp0s2
    altname ens2
3: eth1: <BROADCAST,MULTICAST,SLAVE,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast master bond99
 state UP group default qlen 1000
    link/ether 34:8a:b1:4b:16:e3 brd ff:ff:ff:ff:ff:ff permaddr 34:8a:b1:4b:16:e4
    altname enp0s3
    altname ens3
4: bond99: <BROADCAST,MULTICAST,MASTER,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group
 default qlen 1000
    link/ether 34:8a:b1:4b:16:e3 brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.60/24 brd 192.168.122.255 scope global noprefixroute bond99
       valid_lft forever preferred_lft forever
```

Confirm that the routing is using the bond:

```
node2:~ # ip r
default via 192.168.122.1 dev bond99 proto static metric 100
```

```
192.168.122.0/24 dev bond99 proto static scope link metric 100
192.168.122.0/24 dev bond99 proto kernel scope link src 192.168.122.60 metric 300
```

Ensure that the static connection files are properly utilized:

```
node2:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME    UUID                                  TYPE      DEVICE  FILENAME
bond99  4a920503-4862-5505-80fd-4738d07f44c6  bond      bond99  /etc/NetworkManager/
system-connections/bond99.nmconnection
eth0    dfd202f5-562f-5f07-8f2a-a7717756fb70  ethernet  eth0    /etc/NetworkManager/
system-connections/eth0.nmconnection
eth1    0523c0a1-5f5e-5603-bcf2-68155d5d322e  ethernet  eth1    /etc/NetworkManager/
system-connections/eth1.nmconnection
```

9.5.7.3 Provisioning the third node

Let’s create the virtual machine:

```
virt-install --name node3 --ram 10000 --vcpus 6 --disk path=node3.raw,format=raw --osinfo
 detect=on,name=sle-unknown --graphics none --console pty,target_type=serial --network
 default,mac=34:8A:B1:4B:16:E5 --virt-type kvm --import
```

Once the virtual machine is up and running, we can confirm that this node is using a network bridge:

```
node3:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast master linux-br0
 state UP group default qlen 1000
    link/ether 34:8a:b1:4b:16:e5 brd ff:ff:ff:ff:ff:ff
    altname enp0s2
    altname ens2
3: linux-br0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc noqueue state UP group
 default qlen 1000
    link/ether 34:8a:b1:4b:16:e5 brd ff:ff:ff:ff:ff:ff
    inet 192.168.122.70/24 brd 192.168.122.255 scope global noprefixroute linux-br0
       valid_lft forever preferred_lft forever
```

Confirm that the routing is using the bridge:

```
node3:~ # ip r
default via 192.168.122.1 dev linux-br0 proto static metric 100
```

```
192.168.122.0/24 dev linux-br0 proto static scope link metric 100
192.168.122.0/24 dev linux-br0 proto kernel scope link src 192.168.122.70 metric 425
```

Ensure that the static connection files are properly utilized:

```
node3:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME       UUID                                  TYPE      DEVICE     FILENAME
linux-br0  1f8f1469-ed20-5f2c-bacb-a6767bee9bc0  bridge    linux-br0  /etc/
NetworkManager/system-connections/linux-br0.nmconnection
eth0       dfd202f5-562f-5f07-8f2a-a7717756fb70  ethernet  eth0       /etc/
NetworkManager/system-connections/eth0.nmconnection
```

9.5.7.4 Provisioning the fourth node

Lastly, we will provision a node which will not match any of the predefined configurations by a MAC address. In these cases, we will default to DHCP to configure the network interfaces.

Let's create the virtual machine:

```
virt-install --name node4 --ram 10000 --vcpus 6 --disk path=node4.raw,format=raw --osinfo
 detect=on,name=sle-unknown --graphics none --console pty,target_type=serial --network
 default --virt-type kvm --import
```

Once the virtual machine is up and running, we can confirm that this node is using a random IP address for its network interface:

```
localhost:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 52:54:00:56:63:71 brd ff:ff:ff:ff:ff:ff
    altname enp0s2
    altname ens2
    inet 192.168.122.86/24 brd 192.168.122.255 scope global dynamic noprefixroute eth0
       valid_lft 3542sec preferred_lft 3542sec
    inet6 fe80::5054:ff:fe56:6371/64 scope link noprefixroute
       valid_lft forever preferred_lft forever
```

Verify that nmc failed to apply static configurations for this node:

```
localhost:~ # journalctl -u combustion | grep nmc
```

```
Apr 23 12:15:45 localhost.localdomain combustion[1357]: [2024-04-23T12:15:45Z ERROR nmc]
 Applying config failed: None of the preconfigured hosts match local NICs
```

Verify that the Ethernet interface was configured via DHCP:

```
localhost:~ # journalctl | grep eth0
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7801]
 manager: (eth0): new Ethernet device (/org/freedesktop/NetworkManager/Devices/2)
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7802]
 device (eth0): state change: unmanaged -> unavailable (reason 'managed', sys-iface-
state: 'external')
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7929]
 device (eth0): carrier: link connected
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7931]
 device (eth0): state change: unavailable -> disconnected (reason 'carrier-changed', sys-
iface-state: 'managed')
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>
 [1713874529.7944] device (eth0): Activation: starting connection 'Wired
 Connection' (300ed658-08d4-4281-9f8c-d1b8882d29b9)
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7945]
 device (eth0): state change: disconnected -> prepare (reason 'none', sys-iface-state:
 'managed')
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7947]
 device (eth0): state change: prepare -> config (reason 'none', sys-iface-state:
 'managed')
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7953]
 device (eth0): state change: config -> ip-config (reason 'none', sys-iface-state:
 'managed')
Apr 23 12:15:29 localhost.localdomain NetworkManager[704]: <info>  [1713874529.7964]
 dhcp4 (eth0): activation: beginning transaction (timeout in 90 seconds)
Apr 23 12:15:33 localhost.localdomain NetworkManager[704]: <info>  [1713874533.1272]
 dhcp4 (eth0): state changed new lease, address=192.168.122.86

localhost:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME              UUID                                  TYPE      DEVICE  FILENAME
Wired Connection  300ed658-08d4-4281-9f8c-d1b8882d29b9  ethernet  eth0    /var/run/
NetworkManager/system-connections/default_connection.nmconnection
```

9.5.8 Unified node configurations

There are occasions where relying on known MAC addresses is not an option. In these cases we can opt for the so-called *unified configuration* which allows us to specify settings in an `_all.yaml` file which will then be applied across all provisioned nodes.

We will build and provision an edge node using different configuration structure. Follow all steps starting from *Section 9.5.3, "Creating the image configuration directory"* up until *Section 9.5.5, "Defining the network configurations"*.

In this example we define a desired state of two Ethernet interfaces (eth0 and eth1) - one using DHCP, and one assigned a static IP address.

```
mkdir -p $CONFIG_DIR/network

cat <<- EOF > $CONFIG_DIR/network/_all.yaml
interfaces:
- name: eth0
  type: ethernet
  state: up
  ipv4:
    dhcp: true
    enabled: true
  ipv6:
    enabled: false
- name: eth1
  type: ethernet
  state: up
  ipv4:
    address:
    - ip: 10.0.0.1
      prefix-length: 24
    enabled: true
    dhcp: false
  ipv6:
    enabled: false
EOF
```

Let's build the image:

```
podman run --rm -it -v $CONFIG_DIR:/eib registry.suse.com/edge/3.7/edge-image-
builder:1.3.4 build --definition-file definition.yaml
```

Once the image is successfully built, let's create a virtual machine using it:

```
virt-install --name node1 --ram 10000 --vcpus 6 --disk path=$CONFIG_DIR/modified-
image.raw,format=raw --osinfo detect=on,name=sle-unknown --graphics none --console
 pty,target_type=serial --network default --network default --virt-type kvm --import
```

The provisioning process might take a few minutes. Once it's finished, log in to the system with the provided credentials.

Verify that the routing is properly configured:

```
localhost:~ # ip r
default via 192.168.122.1 dev eth0 proto dhcp src 192.168.122.100 metric 100
10.0.0.0/24 dev eth1 proto kernel scope link src 10.0.0.1 metric 101
192.168.122.0/24 dev eth0 proto kernel scope link src 192.168.122.100 metric 100
```

Verify that Internet connection is available:

```
localhost:~ # ping google.com
PING google.com (142.250.72.46) 56(84) bytes of data.
64 bytes from den16s08-in-f14.1e100.net (142.250.72.46): icmp_seq=1 ttl=56 time=14.3 ms
64 bytes from den16s08-in-f14.1e100.net (142.250.72.46): icmp_seq=2 ttl=56 time=14.2 ms
^C
--- google.com ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 14.196/14.260/14.324/0.064 ms
```

Verify that the Ethernet interfaces are configured and active:

```
localhost:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 52:54:00:26:44:7a brd ff:ff:ff:ff:ff:ff
    altname enp1s0
    inet 192.168.122.100/24 brd 192.168.122.255 scope global dynamic noprefixroute eth0
       valid_lft 3505sec preferred_lft 3505sec
3: eth1: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 52:54:00:ec:57:9e brd ff:ff:ff:ff:ff:ff
    altname enp7s0
    inet 10.0.0.1/24 brd 10.0.0.255 scope global noprefixroute eth1
       valid_lft forever preferred_lft forever

localhost:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME  UUID                                  TYPE      DEVICE  FILENAME
eth0  dfd202f5-562f-5f07-8f2a-a7717756fb70  ethernet  eth0    /etc/NetworkManager/system-
connections/eth0.nmconnection
eth1  0523c0a1-5f5e-5603-bcf2-68155d5d322e  ethernet  eth1    /etc/NetworkManager/system-
connections/eth1.nmconnection
```

```
localhost:~ # cat /etc/NetworkManager/system-connections/eth0.nmconnection
[connection]
autoconnect=true
autoconnect-slaves=-1
id=eth0
interface-name=eth0
type=802-3-ethernet
uuid=dfd202f5-562f-5f07-8f2a-a7717756fb70

[ipv4]
dhcp-client-id=mac
dhcp-send-hostname=true
dhcp-timeout=2147483647
ignore-auto-dns=false
ignore-auto-routes=false
method=auto
never-default=false

[ipv6]
addr-gen-mode=0
dhcp-timeout=2147483647
method=disabled

localhost:~ # cat /etc/NetworkManager/system-connections/eth1.nmconnection
[connection]
autoconnect=true
autoconnect-slaves=-1
id=eth1
interface-name=eth1
type=802-3-ethernet
uuid=0523c0a1-5f5e-5603-bcf2-68155d5d322e

[ipv4]
address0=10.0.0.1/24
dhcp-timeout=2147483647
method=manual

[ipv6]
addr-gen-mode=0
dhcp-timeout=2147483647
method=disabled
```

9.5.9 Custom network configurations

We have already covered the default network configuration for Edge Image Builder which relies on the NetworkManager Configurator. However, there is also the option to modify it via a custom script. Whilst this option is very flexible and is also not MAC address dependant, its limitation stems from the fact that using it is much less convenient when bootstrapping multiple nodes with a single image.

> **Note**
>
> It is recommended to use the default network configuration via files describing the desired network states under the `/network` directory. Only opt for custom scripting when that behaviour is not applicable to your use case.

We will build and provision an edge node using different configuration structure. Follow all steps starting from *Section 9.5.3, "Creating the image configuration directory"* up until *Section 9.5.5, "Defining the network configurations"*.

In this example, we will create a custom script which applies static configuration for the `eth0` interface on all provisioned nodes, as well as removing and disabling the automatically created wired connections by NetworkManager. This is beneficial in situations where you want to make sure that every node in your cluster has an identical networking configuration, and as such you do not need to be concerned with the MAC address of each node prior to image creation.

Let's start by storing the connection file in the `/custom/files` directory:

```
mkdir -p $CONFIG_DIR/custom/files

cat << EOF > $CONFIG_DIR/custom/files/eth0.nmconnection
[connection]
autoconnect=true
autoconnect-slaves=-1
autoconnect-retries=1
id=eth0
interface-name=eth0
type=802-3-ethernet
uuid=dfd202f5-562f-5f07-8f2a-a7717756fb70
wait-device-timeout=60000

[ipv4]
dhcp-timeout=2147483647
method=auto

[ipv6]
```

```
addr-gen-mode=eui64
dhcp-timeout=2147483647
method=disabled
EOF
```

Now that the static configuration is created, we will also create our custom network script:

```
mkdir -p $CONFIG_DIR/network

cat << EOF > $CONFIG_DIR/network/configure-network.sh
#!/bin/bash
set -eux

# Remove and disable wired connections
mkdir -p /etc/NetworkManager/conf.d/
printf "[main]\nno-auto-default=*\n" > /etc/NetworkManager/conf.d/no-auto-default.conf
rm -f /var/run/NetworkManager/system-connections/* || true

# Copy pre-configured network configuration files into NetworkManager
mkdir -p /etc/NetworkManager/system-connections/
cp eth0.nmconnection /etc/NetworkManager/system-connections/
chmod 600 /etc/NetworkManager/system-connections/*.nmconnection
EOF

chmod a+x $CONFIG_DIR/network/configure-network.sh
```

Note

The nmc binary will still be included by default, so it can also be used in the `configure-network.sh` script if necessary.

Warning

The custom script must always be provided under `/network/configure-network.sh` in the configuration directory. If present, all other files will be ignored. It is NOT possible to configure a network by working with both static configurations in YAML format and a custom script simultaneously.

The configuration directory at this point should look like the following:

```
├── definition.yaml
├── custom/
│   └── files/
```

```
│       └── eth0.nmconnection
├── network/
│   └── configure-network.sh
└── base-images/
    └── SL-Micro.x86_64-6.2-Base-GM.raw
```

Let’s build the image:

```
podman run --rm -it -v $CONFIG_DIR:/eib registry.suse.com/edge/3.7/edge-image-
builder:1.3.4 build --definition-file definition.yaml
```

Once the image is successfully built, let’s create a virtual machine using it:

```
virt-install --name node1 --ram 10000 --vcpus 6 --disk path=$CONFIG_DIR/modified-
image.raw,format=raw --osinfo detect=on,name=sle-unknown --graphics none --console
 pty,target_type=serial --network default --virt-type kvm --import
```

The provisioning process might take a few minutes. Once it’s finished, log in to the system with the provided credentials.

Verify that the routing is properly configured:

```
localhost:~ # ip r
default via 192.168.122.1 dev eth0 proto dhcp src 192.168.122.185 metric 100
192.168.122.0/24 dev eth0 proto kernel scope link src 192.168.122.185 metric 100
```

Verify that Internet connection is available:

```
localhost:~ # ping google.com
PING google.com (142.250.72.78) 56(84) bytes of data.
64 bytes from den16s09-in-f14.1e100.net (142.250.72.78): icmp_seq=1 ttl=56 time=13.6 ms
64 bytes from den16s09-in-f14.1e100.net (142.250.72.78): icmp_seq=2 ttl=56 time=13.6 ms
^C
--- google.com ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1001ms
rtt min/avg/max/mdev = 13.592/13.599/13.606/0.007 ms
```

Verify that an Ethernet interface is statically configured using our connection file and is active:

```
localhost:~ # ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen
 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
```

```
2: eth0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UP group
 default qlen 1000
    link/ether 52:54:00:31:d0:1b brd ff:ff:ff:ff:ff:ff
    altname enp0s2
    altname ens2
    inet 192.168.122.185/24 brd 192.168.122.255 scope global dynamic noprefixroute eth0

localhost:~ # nmcli -f NAME,UUID,TYPE,DEVICE,FILENAME con show
NAME  UUID                                  TYPE      DEVICE  FILENAME
eth0  dfd202f5-562f-5f07-8f2a-a7717756fb70  ethernet  eth0    /etc/NetworkManager/system-
connections/eth0.nmconnection

localhost:~ # cat  /etc/NetworkManager/system-connections/eth0.nmconnection
[connection]
autoconnect=true
autoconnect-slaves=-1
autoconnect-retries=1
id=eth0
interface-name=eth0
type=802-3-ethernet
uuid=dfd202f5-562f-5f07-8f2a-a7717756fb70
wait-device-timeout=60000

[ipv4]
dhcp-timeout=2147483647
method=auto

[ipv6]
addr-gen-mode=eui64
dhcp-timeout=2147483647
method=disabled
```

10 Elemental

Elemental is a software stack enabling centralized and full cloud-native OS management with Kubernetes. The Elemental stack consists of a number of components that either reside on Rancher itself, or on the edge nodes. The core components are:

- **elemental-operator** - The core operator that resides on Rancher and handles registration requests from clients.
- **elemental-register** - The client that runs on the edge nodes allowing registration via the `elemental-operator`.
- **elemental-system-agent** - An agent that resides on the edge nodes; its configuration is fed from `elemental-register` and it receives a `plan` for configuring the `rancher-system-agent`
- **rancher-system-agent** - Once the edge node has fully registered, this takes over from `elemental-system-agent` and waits for further `plans` from Rancher Manager (e.g. for Kubernetes installation).

See Elemental upstream documentation (https://elemental.docs.rancher.com/) for full information about Elemental and its relationship to Rancher.

10.1 How does SUSE Edge use Elemental?

We use portions of Elemental for managing remote devices where Metal[3] is not an option (for example, there is no BMC, or the device is behind a NAT gateway). This tooling allows for an operator to bootstrap their devices in a lab before knowing when or where they will be shipped to. Namely, we leverage the `elemental-register` and `elemental-system-agent` components to enable the onboarding of SUSE Linux Micro hosts to Rancher for "phone home" network provisioning use-cases. When using Edge Image Builder (EIB) to create deployment images, the automatic registration through Rancher via Elemental can be achieved by specifying the registration configuration in the configuration directory for EIB.

Note

In SUSE Edge 3.7 we do **not** leverage the operating system management aspects of Elemental, and therefore it’s not possible to manage your operating system patching via Rancher. Instead of using the Elemental tools to build deployment images, SUSE Edge uses the Edge Image Builder tooling, which consumes the registration configuration.

10.2 Best practices

10.2.1 Installation media

The SUSE Edge recommended way of building deployments image that can leverage Elemental for registration to Rancher in the "phone home network provisioning" deployment footprint is to follow the instructions detailed in the remote host onboarding with Elemental (*Chapter 1, Remote host onboarding with Elemental*) quickstart.

10.2.2 Labels

Elemental tracks its inventory with the `MachineInventory` CRD and provides a way to select inventory, e.g. for selecting machines to deploy Kubernetes clusters to, based on labels. This provides a way for users to predefine most (if not all) of their infrastructure needs prior to hardware even being purchased. Also, since nodes can add/remove labels on their respective inventory object (by re-running `elemental-register` with the additional flag `--label "FOO=BAR"`), we can write scripts that will discover and let Rancher know where a node is booted.

10.3 Known issues

- The Elemental UI does not currently know how to build installation media or update non-"Elemental Teal" operating systems. This should be addressed in future releases.

11 K3s

K3s (https://k3s.io/) is a highly available, certified Kubernetes distribution designed for production workloads in unattended, resource-constrained, remote locations or inside IoT appliances.

It is packaged as a single and small binary, so installations and updates are fast and easy.

11.1 How does SUSE Edge use K3s

K3s can be used as the Kubernetes distribution backing the SUSE Edge stack. It is meant to be installed on a SUSE Linux Micro operating system.

Using K3s as the SUSE Edge stack Kubernetes distribution is only recommended when etcd as a backend does not fit your constraints. If etcd as a backend is possible, it is better to use RKE2 (*Chapter 12, RKE2*).

11.2 Best practices

11.2.1 Installation

The recommended way of installing K3s as part of the SUSE Edge stack is by using Edge Image Builder (EIB). See its documentation (*Chapter 8, Edge Image Builder*) for more details on how to configure it to deploy K3s.

It automatically supports HA setup, as well as Elemental setup.

11.2.2 Fleet for GitOps workflow

The SUSE Edge stack uses Fleet as its preferred GitOps tool. For more information around its installation and use, refer to the Fleet section (*Chapter 6, Fleet*) in this documentation.

11.2.3 Storage management

K3s comes with local-path storage preconfigured, which is suitable for single-node clusters. For clusters spanning over multiple nodes, we recommend using SUSE Storage (*Chapter 13, SUSE Storage*).

11.2.4 Load balancing and HA

If you installed K3s using EIB, this part is already covered by the EIB documentation in the HA section.

Otherwise, you need to install and configure MetalLB as per our MetalLB documentation (*Chapter 21, MetalLB on K3s (using Layer 2 Mode)*).

12 RKE2

See RKE2 official documentation (https://docs.rke2.io/).

RKE2 is a fully conformant Kubernetes distribution that focuses on security and compliance by:

- Providing defaults and configuration options that allow clusters to pass the CIS Kubernetes Benchmark v1.6 or v1.23 with minimal operator intervention
- Enabling FIPS 140-2 compliance
- Regularly scanning components for CVEs using trivy (https://trivy.dev) in the RKE2 build pipeline

RKE2 launches control plane components as static pods, managed by kubelet. The embedded container runtime is containerd.

Note: RKE2 is also known as RKE Government in order to convey another use case and sector it currently targets.

12.1 RKE2 vs K3s

K3s is a fully compliant and lightweight Kubernetes distribution focused on Edge, IoT, ARM - optimized for ease of use and resource constrained environments.

RKE2 combines the best of both worlds from the 1.x version of RKE (hereafter referred to as RKE1) and K3s.

From K3s, it inherits the usability, ease of operation and deployment model.

From RKE1, it inherits close alignment with upstream Kubernetes. In places, K3s has diverged from upstream Kubernetes in order to optimize for edge deployments, but RKE1 and RKE2 can stay closely aligned with upstream.

12.2 How does SUSE Edge use RKE2?

RKE2 is a fundamental piece of the SUSE Edge stack. It sits on top of SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*), providing a standard Kubernetes interface required to deploy Edge workloads.

12.3 Best practices

12.3.1 Installation

The recommended way of installing RKE2 as part of the SUSE Edge stack is by using Edge Image Builder (EIB). See the EIB documentation (*Chapter 8, Edge Image Builder*) for more details on how to configure it to deploy RKE2.

EIB is flexible enough to support any parameter required by RKE2, such as specifying the RKE2 version, the servers (https://docs.rke2.io/reference/server_config) or the agents (https://docs.rke2.io/reference/linux_agent_config) configuration, covering all the Edge use cases.

12.3.2 High availability

For HA deployments, EIB automatically deploys and configures MetalLB (*Chapter 15, MetalLB*) and the Endpoint Copier Operator (*Chapter 16, Endpoint Copier Operator*) to expose the RKE2 API endpoint externally.

12.3.3 Networking

SUSE Edge Stack supports Cilium (https://docs.cilium.io/en/stable/), Calico (https://docs.tigera.io/calico/latest/about/), with Cilium as its default CNI. Multus (https://github.com/k8snetworkplumbingwg/multus-cni) meta-plugin can also be used when pods require multiple network interfaces. RKE2 standalone supports a wider range of CNI options (https://docs.rke2.io/install/network_options).

12.3.4 Storage

RKE2 does not provide any kind of persistent storage class or operators. For clusters spanning over multiple nodes, it is recommended to use SUSE Storage (*Chapter 13, SUSE Storage*).

13 SUSE Storage

SUSE Storage is a lightweight, reliable, and user-friendly distributed block storage system designed for Kubernetes. It is a product based on Longhorn, an open-source project initially developed by Rancher Labs and currently incubated under the CNCF.

13.1 Prerequisites

If you are following this guide, it assumes that you have the following already available:

- At least one host with SUSE Linux Micro 6.2 installed; this can be physical or virtual
- A Kubernetes cluster installed; either K3s or RKE2
- Helm

13.2 Manual installation of SUSE Storage

13.2.1 Installing Open-iSCSI

A core requirement of deploying and using SUSE Storage is the installation of the `open-iscsi` package and the `iscsid` daemon running on all Kubernetes nodes. This is necessary, since Longhorn relies on `iscsiadm` on the host to provide persistent volumes to Kubernetes.

Let's install it:

```
transactional-update pkg install open-iscsi
```

It is important to note that once the operation is completed, the package is only installed into a new snapshot as SUSE Linux Micro is an immutable operating system. In order to load it and for the `iscsid` daemon to start running, we must reboot into that new snapshot that we just created. Issue the reboot command when you are ready:

```
reboot
```

> **Tip**
>
> For additional help installing open-iscsi, refer to the official Longhorn documentation (https://longhorn.io/docs/1.12.1/deploy/install/#installing-open-iscsi).

13.2.2 Installing SUSE Storage

There are several ways to install SUSE Storage on your Kubernetes clusters. This guide will follow through the Helm installation, however feel free to follow the official documentation (https://longhorn.io/docs/1.12.1/deploy/install/) if another approach is desired.

Starting with SUSE Edge 3.7, the V2 Data Engine is recommended for new volumes. Before enabling it, prepare the required block devices and review *Chapter 27, SUSE Storage V2 Data Engine*.

1. Log into the Rancher Application Collection:

```
helm registry login dp.apps.rancher.io --username $APPS.RANCHER.IO_USERNAME --
password $APPS.RANCHER.IO_ACCESS_TOKEN
```

2. Install SUSE Storage in the `longhorn-system` namespace and add your container registry credentials:

```
helm install longhorn oci://dp.apps.rancher.io/charts/suse-storage \
  --version 1.12.1 \
  --namespace longhorn-system \
  --create-namespace \
  --set privateRegistry.createSecret=true \
  --set privateRegistry.registryUrl=dp.apps.rancher.io \
  --set privateRegistry.registryUser=$APPS.RANCHER.IO_USERNAME \
  --set privateRegistry.registryPasswd=$APPS.RANCHER.IO_ACCESS_TOKEN \
  --set privateRegistry.registrySecret=application-collection \
  --set defaultSettings.v1DataEngine=false \
  --set defaultSettings.v2DataEngine=true \
  --set persistence.dataEngine=v2
```

3. Confirm that the deployment succeeded:

```
kubectl -n longhorn-system get pods
```

```
localhost:~ # kubectl -n longhorn-system get pods
NAME                                                READY   STATUS    RESTARTS
  AGE
```

```
csi-attacher-7656559cf4-pkhh6                       1/1     Running   0
  103s
csi-attacher-7656559cf4-pnzw5                       1/1     Running   0
  103s
csi-attacher-7656559cf4-z94mm                       1/1     Running   0
  103s
csi-provisioner-6d9cf6456d-kcwtq                    1/1     Running   0
  103s
csi-provisioner-6d9cf6456d-mvvml                    1/1     Running   0
  103s
csi-provisioner-6d9cf6456d-q4f88                    1/1     Running   0
  103s
csi-resizer-f587cd467-clr2n                         1/1     Running   0
  103s
csi-resizer-f587cd467-z28v4                         1/1     Running   0
  103s
csi-resizer-f587cd467-zxmtx                         1/1     Running   0
  103s
csi-snapshotter-6dcdf78684-757mg                    1/1     Running   0
  103s
csi-snapshotter-6dcdf78684-8ktgc                    1/1     Running   0
  103s
csi-snapshotter-6dcdf78684-ffsqr                    1/1     Running   0
  103s
engine-image-ei-099f845a-lvdtr                      1/1     Running   0
  2m21s
instance-manager-4adffddaffe02374cd5635b8a6113de7   1/1     Running   0
  111s
longhorn-csi-plugin-w7pwr                           3/3     Running   0
  103s
longhorn-driver-deployer-6886fb84bc-wm9h6           1/1     Running   2 (2m32s ago)
  2m45s
longhorn-manager-zblbl                              2/2     Running   0
  2m45s
longhorn-ui-6bcc65d4bd-mcn6r                        1/1     Running   0
  2m45s
longhorn-ui-6bcc65d4bd-rwf97                        1/1     Running   0
  2m45s
```

13.3 Creating SUSE Storage volumes

SUSE Storage utilizes Kubernetes resources called `StorageClass` in order to automatically provision `PersistentVolume` objects for pods. Think of `StorageClass` as a way for administrators to describe the *classes* or *profiles* of storage they offer.

The following example creates a V2 `StorageClass`. The V2 Data Engine and a schedulable block disk must already be configured as described in *Chapter 27, SUSE Storage V2 Data Engine*.

```
kubectl apply -f - <<EOF
kind: StorageClass
apiVersion: storage.k8s.io/v1
metadata:
  name: longhorn-v2-example
provisioner: driver.longhorn.io
allowVolumeExpansion: true
parameters:
  dataEngine: "v2"
  numberOfReplicas: "3"
  staleReplicaTimeout: "2880" # 48 hours in minutes
  fromBackup: ""
  fsType: "ext4"
EOF
```

Now that we have our `StorageClass` in place, we need a `PersistentVolumeClaim` referencing it. A `PersistentVolumeClaim` (PVC) is a request for storage by a user. PVCs consume `PersistentVolume` resources. Claims can request specific sizes and access modes (e.g., they can be mounted once read/write or many times read-only).

Let's create a `PersistentVolumeClaim`:

```
kubectl apply -f - <<EOF
apiVersion: v1
kind: PersistentVolumeClaim
metadata:
  name: longhorn-volv-pvc
  namespace: longhorn-system
spec:
  accessModes:
    - ReadWriteOnce
  storageClassName: longhorn-v2-example
  resources:
    requests:
      storage: 2Gi
EOF
```

That's it! Once we have the `PersistentVolumeClaim` created, we can proceed with attaching it to a `Pod`. When the `Pod` is deployed, Kubernetes creates the Longhorn volume and binds it to the `Pod` if storage is available.

```
kubectl apply -f - <<EOF
```

```
apiVersion: v1
kind: Pod
metadata:
  name: volume-test
  namespace: longhorn-system
spec:
  containers:
  - name: volume-test
    image: nginx:stable-alpine
    imagePullPolicy: IfNotPresent
    volumeMounts:
    - name: volv
      mountPath: /data
    ports:
    - containerPort: 80
  volumes:
  - name: volv
    persistentVolumeClaim:
      claimName: longhorn-volv-pvc
EOF
```

Tip

The concept of storage in Kubernetes is a complex, but important topic. We briefly mentioned some of the most common Kubernetes resources, however, we suggest to familiarize yourself with the terminology documentation (https://longhorn.io/docs/1.12.1/terminology/) that Longhorn offers.

In this example, the result should look something like this:

```
localhost:~ # kubectl get storageclass
NAME                 PROVISIONER          RECLAIMPOLICY   VOLUMEBINDINGMODE
 ALLOWVOLUMEEXPANSION   AGE
longhorn (default)   driver.longhorn.io   Delete          Immediate           true
            12m
longhorn-v2-example  driver.longhorn.io   Delete          Immediate           true
            24s

localhost:~ # kubectl get pvc -n longhorn-system
NAME                STATUS   VOLUME                                     CAPACITY   ACCESS
 MODES   STORAGECLASS       AGE
longhorn-volv-pvc   Bound    pvc-f663a92e-ac32-49ae-b8e5-8a6cc29a7d1e   2Gi        RWO
         longhorn-v2-example   54s

localhost:~ # kubectl get pods -n longhorn-system
```

```
NAME                                                READY   STATUS    RESTARTS      AGE
csi-attacher-5c4bfdcf59-qmjtz                       1/1     Running   0             14m
csi-attacher-5c4bfdcf59-s7n65                       1/1     Running   0             14m
csi-attacher-5c4bfdcf59-w9xgs                       1/1     Running   0             14m
csi-provisioner-667796df57-fmz2d                    1/1     Running   0             14m
csi-provisioner-667796df57-p7rjr                    1/1     Running   0             14m
csi-provisioner-667796df57-w9fdq                    1/1     Running   0             14m
csi-resizer-694f8f5f64-2rb8v                        1/1     Running   0             14m
csi-resizer-694f8f5f64-z9v9x                        1/1     Running   0             14m
csi-resizer-694f8f5f64-zlncz                        1/1     Running   0             14m
csi-snapshotter-959b69d4b-5dpvj                     1/1     Running   0             14m
csi-snapshotter-959b69d4b-lwwkv                     1/1     Running   0             14m
csi-snapshotter-959b69d4b-tzhwc                     1/1     Running   0             14m
engine-image-ei-5cefaf2b-hvdv5                      1/1     Running   0             14m
instance-manager-0ee452a2e9583753e35ad00602250c5b   1/1     Running   0             14m
longhorn-csi-plugin-gd2jx                           3/3     Running   0             14m
longhorn-driver-deployer-9f4fc86-j6h2b              1/1     Running   0             15m
longhorn-manager-z4lnl                              1/1     Running   0             15m
longhorn-ui-5f4b7bbf69-bln7h                        1/1     Running   3 (14m ago)   15m
longhorn-ui-5f4b7bbf69-lh97n                        1/1     Running   3 (14m ago)   15m
volume-test                                         1/1     Running   0             26s
```

13.4 Accessing the UI

If you installed SUSE Storage with kubectl or Helm, you need to set up an Ingress controller to allow external traffic into the cluster. Authentication is not enabled by default. If the Rancher catalog app was used, Rancher automatically created an Ingress controller with access control (the rancher-proxy).

1. Get the Longhorn's external service IP address:

   ```
   kubectl -n longhorn-system get svc
   ```

2. Once you have retrieved the `longhorn-frontend` IP address, you can start using the UI by navigating to it in your browser.

13.5 Installing with Edge Image Builder

SUSE Edge is using *Chapter 8, Edge Image Builder* in order to customize base SUSE Linux Micro OS images. We are going to demonstrate how to do so for provisioning an RKE2 cluster with SUSE Storage on top of it.

Let’s create the definition file:

```
export CONFIG_DIR=$HOME/eib
mkdir -p $CONFIG_DIR

cat << EOF > $CONFIG_DIR/iso-definition.yaml
apiVersion: 1.3
image:
  imageType: iso
  baseImage: SL-Micro.x86_64-6.2-Base-SelfInstall-GM.install.iso
  arch: x86_64
  outputImageName: eib-image.iso
kubernetes:
  version: v1.36.3+rke2r1
  helm:
    charts:
      - name: suse-storage
        releaseName: longhorn
        version: 1.12.1
        repositoryName: rancher-application-collection
        targetNamespace: longhorn-system
        createNamespace: true
        installationNamespace: kube-system
    repositories:
      - name: rancher-application-collection
        url: oci://dp.apps.rancher.io/charts
        authentication:
          username: $APPS.RANCHER.IO_USERNAME
          password: $APPS.RANCHER.IO_ACCESS_TOKEN
embeddedArtifactRegistry:
  registries:
    - uri: dp.apps.rancher.io
      authentication:
        username: $APPS.RANCHER.IO_USERNAME
        password: $APPS.RANCHER.IO_ACCESS_TOKEN
  images:
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-attacher:4.12.0-17.6
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-provisioner:5.3.0-17.8
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-resizer:2.2.1-10.8
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-snapshotter:8.6.0-17.6
    - name: dp.apps.rancher.io/containers/kubernetes-csi-livenessprobe:2.19.0-17.6
    - name: dp.apps.rancher.io/containers/kubernetes-csi-node-driver-
registrar:2.17.0-17.6
    - name: dp.apps.rancher.io/containers/longhorn-backing-image-manager:1.12.1-1.5
    - name: dp.apps.rancher.io/containers/longhorn-engine:1.12.1-1.6
    - name: dp.apps.rancher.io/containers/longhorn-instance-manager:1.12.1-1.7
    - name: dp.apps.rancher.io/containers/longhorn-manager:1.12.1-1.5
```

```
    - name: dp.apps.rancher.io/containers/longhorn-share-manager:1.12.1-1.5
    - name: dp.apps.rancher.io/containers/longhorn-ui:1.12.1-1.3
    - name: dp.apps.rancher.io/containers/rancher-support-bundle-kit:0.0.92-13.12
operatingSystem:
  packages:
    sccRegistrationCode: <reg-code>
    packageList:
      - open-iscsi
  users:
  - username: root
    encryptedPassword: \$6\$jHugJNNd3HElGsUZ\
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
EOF
```

Note

Customizing any of the Helm chart values is possible via a separate file provided under `helm.charts[].valuesFile`. Refer to the upstream documentation (https://github.com/suse-edge/edge-image-builder/blob/release-1.3/docs/building-images.md#kubernetes) for details. To use the V2 Data Engine, include the V2 values and ensure that the required raw block devices are prepared and registered as described in *Chapter 27, SUSE Storage V2 Data Engine*.

Let's build the image:

```
podman run --rm --privileged -it -v $CONFIG_DIR:/eib registry.suse.com/edge/3.7/edge-
image-builder:1.3.4 build --definition-file $CONFIG_DIR/iso-definition.yaml
```

After the image is built, you can use it to install your OS on a physical or virtual host. Once the provisioning is complete, you are able to log in to the system using the `root:eib` credentials pair.

Ensure that SUSE Storage has been successfully deployed:

```
localhost:~ # /var/lib/rancher/rke2/bin/kubectl --kubeconfig /etc/rancher/rke2/rke2.yaml
 -n longhorn-system get pods
NAME                                                READY   STATUS    RESTARTS        AGE
csi-attacher-5c4bfdcf59-qmjtz                       1/1     Running   0
 103s
csi-attacher-5c4bfdcf59-s7n65                       1/1     Running   0
 103s
csi-attacher-5c4bfdcf59-w9xgs                       1/1     Running   0
 103s
csi-provisioner-667796df57-fmz2d                    1/1     Running   0
 103s
```

```
csi-provisioner-667796df57-p7rjr                    1/1     Running   0
 103s
csi-provisioner-667796df57-w9fdq                    1/1     Running   0
 103s
csi-resizer-694f8f5f64-2rb8v                        1/1     Running   0
 103s
csi-resizer-694f8f5f64-z9v9x                        1/1     Running   0
 103s
csi-resizer-694f8f5f64-zlncz                        1/1     Running   0
 103s
csi-snapshotter-959b69d4b-5dpvj                     1/1     Running   0
 103s
csi-snapshotter-959b69d4b-lwwkv                     1/1     Running   0
 103s
csi-snapshotter-959b69d4b-tzhwc                     1/1     Running   0
 103s
engine-image-ei-5cefaf2b-hvdv5                      1/1     Running   0
 109s
instance-manager-0ee452a2e9583753e35ad00602250c5b   1/1     Running   0
 109s
longhorn-csi-plugin-gd2jx                           3/3     Running   0
 103s
longhorn-driver-deployer-9f4fc86-j6h2b              1/1     Running   0
 2m28s
longhorn-manager-z4lnl                              1/1     Running   0
 2m28s
longhorn-ui-5f4b7bbf69-bln7h                        1/1     Running   3 (2m7s ago)
 2m28s
longhorn-ui-5f4b7bbf69-lh97n                        1/1     Running   3 (2m10s ago)
 2m28s
```

Note

This installation will not work for completely air-gapped environments. In those cases, please refer to *Section 25.8, "SUSE Storage Installation"*.

14 SUSE Security

SUSE Security is a security solution for Kubernetes that provides L7 network security, runtime security, supply chain security, and compliance checks in a cohesive package.

SUSE Security is a product that is deployed as a platform of multiple containers, each communicating over various ports and interfaces. Under the hood, it uses NeuVector as its underlying container security component. The following containers make up the SUSE Security platform:

- Manager. A stateless container which presents the Web-based console. Typically, only one is needed and this can run anywhere. Failure of the Manager does not affect any of the operations of the controller or enforcer. However, certain notifications (events) and recent connection data are cached in memory by the Manager so viewing of these would be affected.
- Controller. The 'control plane' for SUSE Security must be deployed in an HA configuration, so configuration is not lost in a node failure. These can run anywhere, although customers often choose to place these on 'management', master or infra nodes because of their criticality.
- Enforcer. This container is deployed as a DaemonSet so one Enforcer is on every node to be protected. Typically deploys to every worker node but scheduling can be enabled for master and infra nodes to deploy there as well. Note: If the Enforcer is not on a cluster node and connections come from a pod on that node, SUSE Security labels them as 'unmanaged' workloads.
- Scanner. Performs the vulnerability scanning using the built-in CVE database, as directed by the Controller. Multiple scanners can be deployed to increase scanning capacity. Scanners can run anywhere but are often run on the nodes where the controllers run. See below for sizing considerations of scanner nodes. A scanner can also be invoked independently when used for build-phase scanning, for example, within a pipeline that triggers a scan, retrieves the results, and stops the scanner. The scanner contains the latest CVE database so should be updated daily.
- Updater. The updater triggers an update of the scanner through a Kubernetes cron job when an update of the CVE database is desired. Please be sure to configure this for your environment.

A more in-depth SUSE Security onboarding and best practices documentation can be found here (https://open-docs.neuvector.com/).

14.1 How does SUSE Edge use SUSE Security?

SUSE Edge provides a leaner configuration of SUSE Security as a starting point for edge deployments.

14.2 Important notes

- The `Scanner` container must have enough memory to pull the image to be scanned into memory and expand it. To scan images exceeding 1 GB, increase the scanner's memory to slightly above the largest expected image size.
- High network connections expected in Protect mode. The `Enforcer` requires CPU and memory when in Protect (inline firewall blocking) mode to hold and inspect connections and possible payload (DLP). Increasing memory and dedicating a CPU core to the `Enforcer` can ensure adequate packet filtering capacity.

14.3 Installing with Edge Image Builder

SUSE Edge is using *Chapter 8, Edge Image Builder* in order to customize base SUSE Linux Micro OS images. Follow *Section 25.7, "SUSE Security Installation"* for an air-gapped installation of SUSE Security on top of Kubernetes clusters provisioned by EIB.

15 MetalLB

See MetalLB official documentation (https://metallb.universe.tf/).

MetalLB is a load-balancer implementation for bare-metal Kubernetes clusters, using standard routing protocols.

In bare-metal environments, setting up network load balancers is notably more complex than in cloud environments. Unlike the straightforward API calls in cloud setups, bare-metal requires either dedicated network appliances or a combination of load balancers and Virtual IP (VIP) configurations to manage High Availability (HA) or address the potential Single Point of Failure (SPOF) inherent in a single node load balancer. These configurations are not easily automated, posing challenges in Kubernetes deployments where components dynamically scale up and down.

MetalLB addresses these challenges by harnessing the Kubernetes model to create Load-Balancer type services as if they were operating in a cloud environment, even on bare-metal setups.

There are two different approaches, via L2 mode (https://metallb.universe.tf/concepts/layer2/) (using ARP *tricks*) or via BGP (https://metallb.universe.tf/concepts/bgp/). Mainly L2 does not need any special network gear but BGP is in general better. It depends on the use cases.

15.1 How does SUSE Edge use MetalLB?

SUSE Edge uses MetalLB in three key ways:

- As a Load Balancer Solution: MetalLB serves as the Load Balancer solution for bare-metal machines.
- For an HA K3s/RKE2 Setup: MetalLB allows for load balancing the Kubernetes API using a Virtual IP address.
- As an L3 BGP solution where MetalLB advertises routes to the service IPs to nearby routers.

Note

In order to be able to expose the API, the Endpoint Copier Operator (*Chapter 16, Endpoint Copier Operator*) is used to keep in sync the K8s API endpoints from the `kubernetes` service to a `kubernetes-vip` LoadBalancer service.

15.2 Best practices

Installation of MetalLB in L2 mode is described in *Chapter 21, MetalLB on K3s (using Layer 2 Mode)* and for L3 mode in *Chapter 22, MetalLB on K3s (using Layer 3 Mode)*.

A guide on installing MetalLB in front of the `kube-api-server` to achieve high-availability topology can be found in *Chapter 24, MetalLB in front of the Kubernetes API server*.

15.3 Known issues

- K3s comes with its Load Balancer solution called `Klipper`. To use MetalLB, `Klipper` must be disabled. This can be done by starting the K3s server with the `--disable servicelb` option, as described in the K3s documentation (https://docs.k3s.io/networking).

16 Endpoint Copier Operator

Endpoint Copier Operator (https://github.com/suse-edge/endpoint-copier-operator) is a Kubernetes operator whose purpose is to create a copy of a Kubernetes Service and Endpoint and to keep them synced.

16.1 How does SUSE Edge use Endpoint Copier Operator?

At SUSE Edge, the Endpoint Copier Operator plays a crucial role in achieving High Availability (HA) setup for K3s/RKE2 clusters. This is accomplished by creating a `kubernetes-vip` service of type `LoadBalancer`, ensuring its Endpoint remains in constant synchronization with the kubernetes Endpoint. MetalLB (*Chapter 15, MetalLB*) is leveraged to manage the `kubernetes-vip` service, as the exposed IP address is used from other nodes to join the cluster.

16.2 Best Practices

Comprehensive documentation for using the Endpoint Copier Operator can be found here (https://github.com/suse-edge/endpoint-copier-operator/blob/main/README.md).

Additionally, refer to our guide (*Chapter 21, MetalLB on K3s (using Layer 2 Mode)*) on achieving a K3s/RKE2 HA setup using the Endpoint Copier Operator and MetalLB.

16.3 Known issues

Presently, the Endpoint Copier Operator is limited to working with only one Service/Endpoint. Enhancements to support multiple Services/Endpoints are planned for the future.

17 Edge Virtualization

This section describes how you can use Edge Virtualization to run virtual machines on your edge nodes. Edge Virtualization is designed for lightweight virtualization use-cases, where it is expected that a common workflow for the deployment and management of both virtualized and containerized applications will be utilized.

SUSE Edge Virtualization supports two methods of running virtual machines:

1. Deploying the virtual machines manually via libvirt+qemu-kvm at the host level (where Kubernetes is not involved)
2. Deploying the KubeVirt operator for Kubernetes-based management of virtual machines

Both options are valid, but only the second one is covered below. If you want to use the standard out-of-the box virtualization mechanisms provided by SUSE Linux Micro, a comprehensive guide can be found here (https://documentation.suse.com/sles/15-SP6/html/SLES-all/chap-virtualization-introduction.html), and whilst it was primarily written for SUSE Linux Enterprise Server, the concepts are almost identical.

This guide initially explains how to deploy the additional virtualization components onto a system that has already been pre-deployed, but follows with a section that describes how to embed this configuration in the initial deployment via Edge Image Builder. If you do not want to run through the basics and set things up manually, skip right ahead to that section.

17.1 KubeVirt overview

KubeVirt allows for managing Virtual Machines with Kubernetes alongside the rest of your containerized workloads. It does this by running the user space portion of the Linux virtualization stack in a container. This minimizes the requirements on the host system, allowing for easier setup and management.

Details about KubeVirt's architecture can be found in the upstream documentation. (https://kubevirt.io/user-guide/architecture/)

17.2 Prerequisites

If you are following this guide, we assume you have the following already available:

- At least one physical host with SUSE Linux Micro 6.2 installed, and with virtualization extensions enabled in the BIOS (see here (https://documentation.suse.com/sles/15-SP6/html/SLES-all/cha-virt-support.html#sec-kvm-requires-hardware) for details).
- Across your nodes, a K3s/RKE2 Kubernetes cluster already deployed and with an appropriate `kubeconfig` that enables superuser access to the cluster.
- Access to the root user — these instructions assume you are the root user, and *not* escalating your privileges via `sudo`.
- You have Helm (https://helm.sh/docs/intro/install/) available locally with an adequate network connection to be able to push configurations to your Kubernetes cluster and download the required images.

17.3 Manual installation of Edge Virtualization

This guide will not walk you through the deployment of Kubernetes, but it assumes that you have either installed the SUSE Edge-appropriate version of K3s (https://k3s.io/) or RKE2 (https://docs.rke2.io/install/quickstart) and that you have your kubeconfig configured accordingly so that standard `kubectl` commands can be executed as the superuser. We assume your node forms a single-node cluster, although there are no significant differences expected for multi-node deployments.

SUSE Edge Virtualization is deployed via three separate Helm charts, specifically:

- **KubeVirt**: The core virtualization components, that is, Kubernetes CRDs, operators and other components required for enabling Kubernetes to deploy and manage virtual machines.
- **KubeVirt Dashboard Extension**: An optional Rancher UI extension that allows basic virtual machine management, for example, starting/stopping of virtual machines as well as accessing the console.
- **Containerized Data Importer (CDI)**: An additional component that enables persistent-storage integration for KubeVirt, providing capabilities for virtual machines to use existing Kubernetes storage back-ends for data, but also allowing users to import or clone data volumes for virtual machines.

Each of these Helm charts is versioned according to the SUSE Edge release you are currently using. For production/supported usage, employ the artifacts that can be found in the SUSE Registry.

First, ensure that your `kubectl` access is working:

```
$ kubectl get nodes
```

This should show something similar to the following:

```
NAME                    STATUS   ROLES                       AGE     VERSION
node1.edge.rdo.wales    Ready    control-plane,etcd,master   4h20m   v1.30.5+rke2r1
node2.edge.rdo.wales    Ready    control-plane,etcd,master   4h15m   v1.30.5+rke2r1
node3.edge.rdo.wales    Ready    control-plane,etcd,master   4h15m   v1.30.5+rke2r1
```

Now you can proceed to install the **KubeVirt** and **Containerized Data Importer (CDI)** Helm charts:

```
$ helm install kubevirt oci://registry.suse.com/edge/charts/kubevirt --namespace
 kubevirt-system --create-namespace
$ helm install cdi oci://registry.suse.com/edge/charts/cdi --namespace cdi-system --
create-namespace
```

In a few minutes, you should have all KubeVirt and CDI components deployed. You can validate this by checking all the deployed resources in the `kubevirt-system` and `cdi-system` namespace.

Verify KubeVirt resources:

```
$ kubectl get all -n kubevirt-system
```

This should show something similar to the following:

```
NAME                                  READY   STATUS    RESTARTS      AGE
pod/virt-operator-5fbcf48d58-p7xpm    1/1     Running   0             2m24s
pod/virt-operator-5fbcf48d58-wnf6s    1/1     Running   0             2m24s
pod/virt-handler-t594x                1/1     Running   0             93s
pod/virt-controller-5f84c69884-cwjvd  1/1     Running   1 (64s ago)   93s
pod/virt-controller-5f84c69884-xxw6q  1/1     Running   1 (64s ago)   93s
pod/virt-api-7dfc54cf95-v8kcl         1/1     Running   1 (59s ago)   118s

NAME                                 TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)
 AGE
service/kubevirt-prometheus-metrics  ClusterIP   None            <none>        443/TCP
 2m1s
service/virt-api                     ClusterIP   10.43.56.140    <none>        443/TCP
 2m1s
service/kubevirt-operator-webhook    ClusterIP   10.43.201.121   <none>        443/TCP
 2m1s
service/virt-exportproxy             ClusterIP   10.43.83.23     <none>        443/TCP
 2m1s
```

```
NAME                          DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE
 SELECTOR            AGE
daemonset.apps/virt-handler   1         1         1       1            1
 kubernetes.io/os=linux   93s

NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/virt-operator       2/2     2            2           2m24s
deployment.apps/virt-controller     2/2     2            2           93s
deployment.apps/virt-api            1/1     1            1           118s

NAME                                          DESIRED   CURRENT   READY   AGE
replicaset.apps/virt-operator-5fbcf48d58      2         2         2       2m24s
replicaset.apps/virt-controller-5f84c69884    2         2         2       93s
replicaset.apps/virt-api-7dfc54cf95           1         1         1       118s

NAME                              AGE     PHASE
kubevirt.kubevirt.io/kubevirt     2m24s   Deployed
```

Verify CDI resources:

```
$ kubectl get all -n cdi-system
```

This should show something similar to the following:

```
NAME                                    READY   STATUS    RESTARTS   AGE
pod/cdi-operator-55c74f4b86-692xb       1/1     Running   0          2m24s
pod/cdi-apiserver-db465b888-62lvr       1/1     Running   0          2m21s
pod/cdi-deployment-56c7d74995-mgkfn     1/1     Running   0          2m21s
pod/cdi-uploadproxy-7d7b94b968-6kxc2    1/1     Running   0          2m22s

NAME                              TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)    AGE
service/cdi-uploadproxy           ClusterIP   10.43.117.7    <none>        443/TCP
 2m22s
service/cdi-api                   ClusterIP   10.43.20.101   <none>        443/TCP
 2m22s
service/cdi-prometheus-metrics    ClusterIP   10.43.39.153   <none>        8080/TCP
 2m21s

NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/cdi-operator        1/1     1            1           2m24s
deployment.apps/cdi-apiserver       1/1     1            1           2m22s
deployment.apps/cdi-deployment      1/1     1            1           2m21s
deployment.apps/cdi-uploadproxy     1/1     1            1           2m22s

NAME                                          DESIRED   CURRENT   READY   AGE
replicaset.apps/cdi-operator-55c74f4b86       1         1         1       2m24s
replicaset.apps/cdi-apiserver-db465b888       1         1         1       2m21s
replicaset.apps/cdi-deployment-56c7d74995     1         1         1       2m21s
```

```
replicaset.apps/cdi-uploadproxy-7d7b94b968   1         1         1       2m22s
```

To verify that the `VirtualMachine` custom resource definitions (CRDs) are deployed, you can validate with:

```
$ kubectl explain virtualmachine
```

This should print out the definition of the `VirtualMachine` object, which should print as follows:

```
GROUP:      kubevirt.io
KIND:       VirtualMachine
VERSION:    v1

DESCRIPTION:
    VirtualMachine handles the VirtualMachines that are not running or are in a
    stopped state The VirtualMachine contains the template to create the
    VirtualMachineInstance. It also mirrors the running state of the created
    VirtualMachineInstance in its status.
(snip)
```

17.4 Deploying virtual machines

Now that KubeVirt and CDI are deployed, let us define a simple virtual machine based on openSUSE Tumbleweed (https://get.opensuse.org/tumbleweed/). This virtual machine has the most simple of configurations, using standard "pod networking" for a networking configuration identical to any other pod. It also employs non-persistent storage, ensuring the storage is ephemeral, just like in any container that does not have a PVC (https://kubernetes.io/docs/concepts/storage/persistent-volumes/).

```
$ cat <<EOF > user-data.yaml
#cloud-config
disable_root: false
ssh_pwauth: True
users:
  - default
  - name: suse
    groups: sudo
    shell: /bin/bash
    sudo:  ALL=(ALL) NOPASSWD:ALL
    lock_passwd: False
    plain_text_passwd: 'suse'
EOF
$ kubectl apply -f - <<EOF
apiVersion: kubevirt.io/v1
kind: VirtualMachine
```

```
metadata:
  name: tumbleweed
  namespace: default
spec:
  runStrategy: Always
  template:
    spec:
      domain:
        devices: {}
        machine:
          type: q35
        memory:
          guest: 2Gi
        resources: {}
      volumes:
      - containerDisk:
          image: quay.io/containerdisks/opensuse-tumbleweed:1.0.0
        name: tumbleweed-containerdisk-0
      - cloudInitNoCloud:
          userDataBase64: $(cat user-data.yaml | base64 -w 0)
        name: cloudinitdisk
EOF
```

This should print that a `VirtualMachine` was created:

```
virtualmachine.kubevirt.io/tumbleweed created
```

This `VirtualMachine` definition is minimal, specifying little about the configuration. It simply outlines that it is a machine type "q35 (https://wiki.qemu.org/Features/Q35)" with 2 GB of memory that uses a disk image based on an ephemeral `containerDisk` (that is, a disk image that is stored in a container image from a remote image repository), and specifies a base64 encoded cloudInit disk, which we only use for user creation and password enforcement at boot time (use `base64 -d` to decode it).

Note

This virtual machine image is only for testing. The image is not officially supported and is only meant as a documentation example.

This machine takes a few minutes to boot as it needs to download the openSUSE Tumbleweed disk image, but once it has done so, you can view further details about the virtual machine by checking the virtual machine information:

```
$ kubectl get vmi
```

This should print the node that the virtual machine was started on, and the IP address of the virtual machine. Remember, since it uses pod networking, the reported IP address will be just like any other pod, and routable as such:

```
NAME          AGE     PHASE     IP           NODENAME                READY
tumbleweed    4m24s   Running   10.42.2.98   node3.edge.rdo.wales    True
```

When running these commands on the Kubernetes cluster nodes themselves, with a CNI that routes traffic directly to pods (for example, Cilium), you should be able to `ssh` directly to the machine itself. Substitute the following IP address with the one that was assigned to your virtual machine:

```
$ ssh suse@10.42.2.98
(password is "suse")
```

Once you are in this virtual machine, you can play around, but remember that it is limited in terms of resources, and only has 1 GB disk space. When you are finished, `Ctrl-D` or `exit` to disconnect from the SSH session.

The virtual machine process is still wrapped in a standard Kubernetes pod. The `VirtualMachine` CRD is a representation of the desired virtual machine, but the process in which the virtual machine is actually started is via the `virt-launcher` pod, a standard Kubernetes pod, just like any other application. For every virtual machine started, you can see there is a `virt-launcher` pod:

```
$ kubectl get pods
```

This should then show the one `virt-launcher` pod for the Tumbleweed machine that we have defined:

```
NAME                             READY   STATUS    RESTARTS   AGE
virt-launcher-tumbleweed-8gcn4   3/3     Running   0          10m
```

If we take a look into this `virt-launcher` pod, you see it is executing `libvirt` and `qemu-kvm` processes. We can enter the pod itself and have a look under the covers, noting that you need to adapt the following command for your pod name:

```
$ kubectl exec -it virt-launcher-tumbleweed-8gcn4 -- bash
```

Once you are in the pod, try running `virsh` commands along with looking at the processes. You will see the `qemu-system-x86_64` binary running, along with certain processes for monitoring the virtual machine. You will also see the location of the disk image and how the networking is plugged (as a tap device):

```
qemu@tumbleweed:/> ps ax
  PID TTY      STAT   TIME COMMAND
    1 ?        Ssl    0:00 /usr/bin/virt-launcher-monitor --qemu-timeout 269s --name
 tumbleweed --uid b9655c11-38f7-4fa8-8f5d-bfe987dab42c --namespace default --kubevirt-
share-dir /var/run/kubevirt --ephemeral-disk-dir /var/run/kubevirt-ephemeral-disks --
container-disk-dir /var/run/kube
```

```
   12 ?        Sl     0:01 /usr/bin/virt-launcher --qemu-timeout 269s --name tumbleweed
 --uid b9655c11-38f7-4fa8-8f5d-bfe987dab42c --namespace default --kubevirt-share-dir /
var/run/kubevirt --ephemeral-disk-dir /var/run/kubevirt-ephemeral-disks --container-disk-
dir /var/run/kubevirt/con
   24 ?        Sl     0:00 /usr/sbin/virtlogd -f /etc/libvirt/virtlogd.conf
   25 ?        Sl     0:01 /usr/sbin/virtqemud -f /var/run/libvirt/virtqemud.conf
   83 ?        Sl     0:31 /usr/bin/qemu-system-x86_64 -name
 guest=default_tumbleweed,debug-threads=on -S -object {"qom-
type":"secret","id":"masterKey0","format":"raw","file":"/var/run/kubevirt-private/
libvirt/qemu/lib/domain-1-default_tumbleweed/master-key.aes"} -machine pc-q35-7.1,usb
  286 pts/0    Ss     0:00 bash
  320 pts/0    R+     0:00 ps ax

qemu@tumbleweed:/> virsh list --all
 Id   Name                 State
-----------------------------------
 1    default_tumbleweed   running

qemu@tumbleweed:/> virsh domblklist 1
 Target   Source
-------------------------------------------------------------------------------------------
 sda      /var/run/kubevirt-ephemeral-disks/disk-data/tumbleweed-containerdisk-0/
disk.qcow2
 sdb      /var/run/kubevirt-ephemeral-disks/cloud-init-data/default/tumbleweed/
noCloud.iso

qemu@tumbleweed:/> virsh domiflist 1
 Interface   Type       Source   Model                     MAC
-----------------------------------------------------------------------------
 tap0        ethernet   -        virtio-non-transitional   e6:e9:1a:05:c0:92

qemu@tumbleweed:/> exit
exit
```

Finally, let us delete this virtual machine to clean up:

```
$ kubectl delete vm/tumbleweed
virtualmachine.kubevirt.io "tumbleweed" deleted
```

17.5 Using virtctl

Along with the standard Kubernetes CLI tooling, that is, `kubectl`, KubeVirt comes with an accompanying CLI utility that allows you to interface with your cluster in a way that bridges some gaps between the virtualization world and the world that Kubernetes was designed for. For example, the `virtctl` tool

provides the capability of managing the lifecycle of virtual machines (starting, stopping, restarting, etc.), providing access to the virtual consoles, uploading virtual machine images, as well as interfacing with Kubernetes constructs such as services, without using the API or CRDs directly.

Let us download the latest stable version of the `virtctl` tool:

```
$ export VERSION=v1.8.3
$ wget https://github.com/kubevirt/kubevirt/releases/download/$VERSION/virtctl-$VERSION-
linux-amd64
```

If you are using a different architecture or a non-Linux machine, you can find other releases here (https://github.com/kubevirt/kubevirt/releases). You need to make this executable before proceeding, and it may be useful to move it to a location within your `$PATH`:

```
$ mv virtctl-$VERSION-linux-amd64 /usr/local/bin/virtctl
$ chmod a+x /usr/local/bin/virtctl
```

You can then use the `virtctl` command-line tool to create virtual machines. Let us replicate our previous virtual machine, noting that we are piping the output directly into `kubectl apply`:

```
$ cat <<EOF >  user-data.yaml
#cloud-config
disable_root: false
ssh_pwauth: True
users:
  - default
  - name: suse
    groups: sudo
    shell: /bin/bash
    sudo:  ALL=(ALL) NOPASSWD:ALL
    lock_passwd: False
    plain_text_passwd: 'suse'
EOF
$ alias virtctl=echo
$ virtctl create vm --name virtctl-example --memory=1Gi \
    --volume-containerdisk=src:quay.io/containerdisks/opensuse-tumbleweed:1.0.0 \
    --cloud-init-user-data "$(cat user-data.yaml | base64 -w 0)"
```

This should then show the virtual machine running (it should start a lot quicker this time given that the container image will be cached):

```
$ kubectl get vmi
NAME              AGE   PHASE     IP           NODENAME               READY
virtctl-example   52s   Running   10.42.2.29   node3.edge.rdo.wales   True
```

Now we can use `virtctl` to connect directly to the virtual machine:

```
$ virtctl ssh suse@virtctl-example
```

```
(password is "suse" - Ctrl-D to exit)
```

There are plenty of other commands that can be used by `virtctl`. For example, `virtctl console` can give you access to the serial console if networking is not working, and you can use `virtctl guestosinfo` to get comprehensive OS information, subject to the guest having the `qemu-guest-agent` installed and running.

Finally, let us pause and resume the virtual machine:

```
$ virtctl pause vm virtctl-example
VMI virtctl-example was scheduled to pause
```

You find that the `VirtualMachine` object shows as **Paused** and the `VirtualMachineInstance` object shows as **Running** but **READY=False**:

```
$ kubectl get vm
NAME              AGE     STATUS   READY
virtctl-example   8m14s   Paused   False

$ kubectl get vmi
NAME              AGE     PHASE     IP           NODENAME               READY
virtctl-example   8m15s   Running   10.42.2.29   node3.edge.rdo.wales   False
```

You also find that you can no longer connect to the virtual machine:

```
$ virtctl ssh suse@virtctl-example
can't access VMI virtctl-example: Operation cannot be fulfilled on
 virtualmachineinstance.kubevirt.io "virtctl-example": VMI is paused
```

Let us resume the virtual machine and try again:

```
$ virtctl unpause vm virtctl-example
VMI virtctl-example was scheduled to unpause
```

Now we should be able to re-establish a connection:

```
$ virtctl ssh suse@virtctl-example
suse@vmi/virtctl-example.default's password:
suse@virtctl-example:~> exit
logout
```

Finally, let us remove the virtual machine:

```
$ kubectl delete vm/virtctl-example
virtualmachine.kubevirt.io "virtctl-example" deleted
```

17.6 Simple ingress networking

In this section, we show how you can expose virtual machines as standard Kubernetes services and make them available via the Kubernetes ingress service, for example, Traefik with RKE2 (https://docs.rke2.io/networking/networking_services#ingress-controller) or Traefik with K3s (https://docs.k3s.io/networking/networking-services#traefik-ingress-controller). This document assumes that these components are already configured appropriately and that you have an appropriate DNS pointer, for example, via a wild card, to point at your Kubernetes server nodes or your ingress virtual IP for proper ingress resolution.

Note

In SUSE Edge 3.1+, if you are using K3s in a multi-server node configuration, you might have needed to configure a MetalLB-based VIP for Ingress; this is not required for RKE2.

In the example environment, another openSUSE Tumbleweed virtual machine is deployed, cloud-init is used to install NGINX as a simple Web server at boot time, and a simple message is configured to be returned to verify that it works as expected when a call is made. To see how this is done, simply `base64 -d` the cloud-init section in the output below.

Let us create this virtual machine now:

```
$ cat <<EOF > user-data.yaml
#cloud-config
disable_root: false
ssh_pwauth: True
users:
  - default
  - name: suse
    groups: sudo
    shell: /bin/bash
    sudo:  ALL=(ALL) NOPASSWD:ALL
    lock_passwd: False
    plain_text_passwd: 'suse'
EOF
$ kubectl apply -f - <<EOF
apiVersion: kubevirt.io/v1
kind: VirtualMachine
metadata:
  name: ingress-example
  namespace: default
```

```
spec:
  runStrategy: Always
  template:
    metadata:
      labels:
        app: nginx
    spec:
      domain:
        devices: {}
        machine:
          type: q35
        memory:
          guest: 2Gi
        resources: {}
      volumes:
      - containerDisk:
          image: quay.io/containerdisks/opensuse-tumbleweed:1.0.0
        name: tumbleweed-containerdisk-0
      - cloudInitNoCloud:
          userDataBase64: $(cat user-data.yaml | base64 -w 0)
        name: cloudinitdisk
EOF
```

When this virtual machine has successfully started, we can use the `virtctl` command to expose the `VirtualMachineInstance` with an external port of `8080` and a target port of `80` (where NGINX listens by default). We use the `virtctl` command here as it understands the mapping between the virtual machine object and the pod. This creates a new service for us:

```
$ virtctl expose vmi ingress-example --port=8080 --target-port=80 --name=ingress-example
Service ingress-example successfully exposed for vmi ingress-example
```

We will then have an appropriate service automatically created:

```
$ kubectl get svc/ingress-example
NAME              TYPE           CLUSTER-IP      EXTERNAL-IP       PORT(S)
          AGE
ingress-example   ClusterIP      10.43.217.19    <none>            8080/TCP
          9s
```

Next, if you then use `kubectl create ingress`, we can create an ingress object that points to this service. Adapt the URL (known as the "host" in the ingress (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_create/kubectl_create_ingress/) object) here to match your DNS configuration and ensure that you point it to port `8080`:

```
$ kubectl create ingress ingress-example --rule=ingress-example.suse.local/=ingress-
example:8080
```

With DNS being configured correctly, you should be able to curl the URL immediately:

```
$ curl ingress-example.suse.local
It works!
```

Let us clean up by removing this virtual machine and its service and ingress resources:

```
$ kubectl delete vm/ingress-example svc/ingress-example ingress/ingress-example
virtualmachine.kubevirt.io "ingress-example" deleted
service "ingress-example" deleted
ingress.networking.k8s.io "ingress-example" deleted
```

17.7 Using the Rancher UI extension

SUSE Edge Virtualization provides a UI extension for Rancher Manager, enabling basic virtual machine management using the Rancher dashboard UI.

17.7.1 Installation

See Rancher Dashboard Extensions (*Chapter 5, Rancher Dashboard Extensions*) for installation guidance.

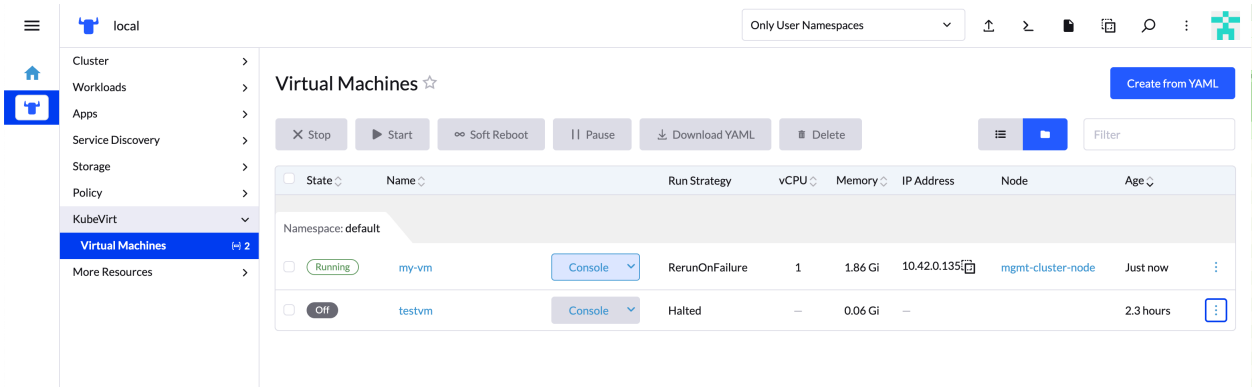
17.7.2 Using KubeVirt Rancher Dashboard Extension

The extension introduces a new **KubeVirt** section to the Cluster Explorer. This section is added to any managed cluster which has KubeVirt installed.

The extension allows you to directly interact with KubeVirt Virtual Machine resources to manage Virtual Machines lifecycle.

17.7.2.1 Creating a virtual machine

1. Navigate to **Cluster Explorer** clicking KubeVirt-enabled managed cluster in the left navigation.
2. Navigate to **KubeVirt** > **Virtual Machines** page and click `Create from YAML` in the upper right of the screen.
3. Fill in or paste a virtual machine definition and press `Create`. Use virtual machine definition from Deploying Virtual Machines section as an inspiration.



17.7.2.2 Virtual Machine Actions

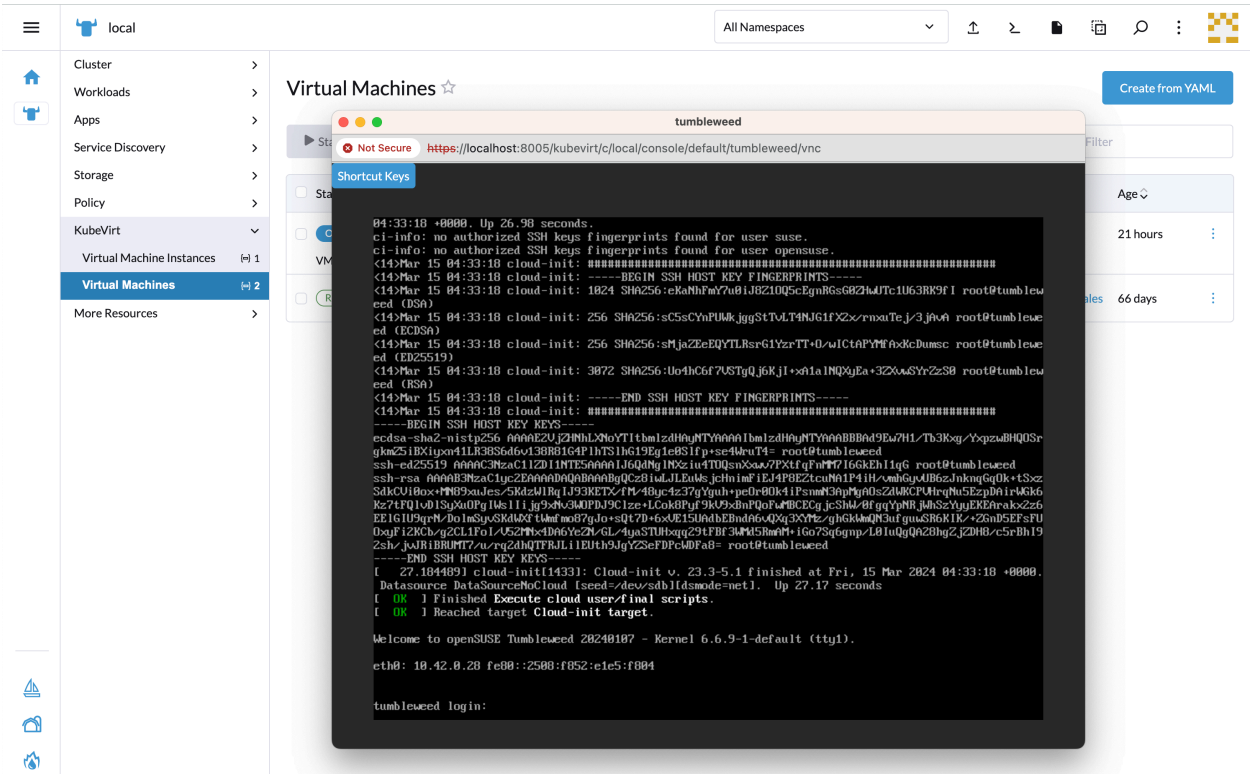
You can use the action menu accessed from the # drop-down list to the right of each virtual machine to perform start, stop, pause or soft reboot actions. Alternatively you can also use group actions at the top of the list by selecting virtual machines to perform the action on.

Performing the actions may have an effect on Virtual Machine Run Strategy. See the table in KubeVirt documentation (https://kubevirt.io/user-guide/compute/run_strategies/#virtctl) for more details.

17.7.2.3 Accessing virtual machine console

The "Virtual machines" list provides a `Console` drop-down list that allows to connect to the machine using **VNC or Serial Console**. This action is only available to running machines.

In some cases, it takes a short while before the console is accessible on a freshly started virtual machine.



17.8 Installing with Edge Image Builder

SUSE Edge is using *Chapter 8, Edge Image Builder* in order to customize base SUSE Linux Micro OS images. Follow *Section 25.9, "KubeVirt and CDI Installation"* for an air-gapped installation of both KubeVirt and CDI on top of Kubernetes clusters provisioned by EIB.

18 System Upgrade Controller

See the System Upgrade Controller documentation (https://github.com/rancher/system-upgrade-controller).

> The System Upgrade Controller (SUC) aims to provide a general-purpose, Kubernetes-native upgrade controller (for nodes). It introduces a new CRD, the Plan, for defining any and all of your upgrade policies/requirements. A Plan is an outstanding intent to mutate nodes in your cluster.

18.1 How does SUSE Edge use System Upgrade Controller?

SUSE Edge uses `SUC` to facilitate various "Day 2" operations related to OS and Kubernetes version upgrades on management and downstream clusters.

"Day 2" operations are defined through `SUC Plans`. Based on these plans, `SUC` deploys workloads on each node to execute the respective "Day 2" operation.

`SUC` is also used within the *Chapter 19, Upgrade Controller*. To learn more about the key differences between SUC and the Upgrade Controller, see *Section 19.2, "Upgrade Controller vs System Upgrade Controller"*.

18.2 Installing the System Upgrade Controller

Important

Starting with Rancher v2.10.0 (https://github.com/rancher/rancher/releases/tag/v2.10.0), the `System Upgrade Controller` is installed automatically.

Follow the steps below **only** if your environment is **not** managed by Rancher, or if your Rancher version is lesser than `v2.10.0`.

We recommend that you install SUC through Fleet (*Chapter 6, Fleet*) located in the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository.

Note

The resources offered by the `suse-edge/fleet-examples` repository **must** always be used from a valid fleet-examples release (https://github.com/suse-edge/fleet-examples/releases). To determine which release you need to use, refer to the Release Notes (*Chapter 40, Release Notes*).

If you are unable to use Fleet for the installation of SUC, you can install it through Rancher's Helm chart repository, or incorporate the Rancher's Helm chart in your own third-party GitOps workflow.

This section covers:

- Fleet installation (*Section 18.2.1, "System Upgrade Controller Fleet installation"*)
- Helm installation (*Section 18.2.2, "System Upgrade Controller Helm installation"*)

18.2.1 System Upgrade Controller Fleet installation

Using Fleet, there are two possible resources that can be used to deploy SUC:

- GitRepo (https://fleet.rancher.io/ref-gitrepo) resource - for use cases where an external/local Git server is available. For installation instructions, see System Upgrade Controller installation - GitRepo (*Section 18.2.1.1, "System Upgrade Controller installation - GitRepo"*).
- Bundle (https://fleet.rancher.io/bundle-add) resource - for air-gapped use cases that do not support a local Git server option. For installation instructions, see System Upgrade Controller installation - Bundle (*Section 18.2.1.2, "System Upgrade Controller installation - Bundle"*).

18.2.1.1 System Upgrade Controller installation - GitRepo

Note

This process can also be done through the Rancher UI, if such is available. For more information, see Accessing Fleet in the Rancher UI (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

In your **management** cluster:

1. Determine on which clusters you want to deploy SUC. This is done by deploying a SUC `GitRepo` resource in the correct Fleet workspace on your **management** cluster. By default, Fleet has two workspaces:

   - `fleet-local` - for resources that need to be deployed on the **management** cluster.
   - `fleet-default` - for resources that need to be deployed on **downstream** clusters.

     For more information on Fleet workspaces, see the upstream (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups) documentation.

2. Deploy the `GitRepo` resource:

   - To deploy SUC on your management cluster:

     ```
     kubectl apply -n fleet-local -f - <<EOF
     apiVersion: fleet.cattle.io/v1alpha1
     kind: GitRepo
     metadata:
       name: system-upgrade-controller
     spec:
       revision: release-3.7.0
       paths:
       - fleets/day2/system-upgrade-controller
       repo: https://github.com/suse-edge/fleet-examples.git
     EOF
     ```

   - To deploy SUC on your downstream clusters:

     Note

     Before deploying the resource below, you **must** provide a valid `targets` configuration, so that Fleet knows on which downstream clusters to deploy your resource. For information on how to map to downstream clusters, see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets).

     ```
     kubectl apply -n fleet-default -f - <<EOF
     apiVersion: fleet.cattle.io/v1alpha1
     kind: GitRepo
     metadata:
       name: system-upgrade-controller
     ```

```
spec:
  revision: release-3.7.0
  paths:
  - fleets/day2/system-upgrade-controller
  repo: https://github.com/suse-edge/fleet-examples.git
  targets:
  - clusterSelector: CHANGEME
  # Example matching all clusters:
  # targets:
  # - clusterSelector: {}
EOF
```

3. Validate that the `GitRepo` resource is deployed:

```
# Namespace will vary based on where you want to deploy SUC
kubectl get gitrepo system-upgrade-controller -n <fleet-local/fleet-default>

NAME                        REPO                                                COMMIT
          BUNDLEDEPLOYMENTS-READY   STATUS
system-upgrade-controller   https://github.com/suse-edge/fleet-examples.git
 release-3.7.0   1/1
```

4. Validate the System Upgrade Controller deployment:

```
kubectl get deployment system-upgrade-controller -n cattle-system
NAME                        READY   UP-TO-DATE   AVAILABLE   AGE
system-upgrade-controller   1/1     1            1           2m20s
```

18.2.1.2 System Upgrade Controller installation - Bundle

This section illustrates how to build and deploy a `Bundle` resource from a standard Fleet configuration using the fleet-cli (https://fleet.rancher.io/cli/fleet-cli/fleet).

1. On a machine with network access download the `fleet-cli`:

> **Note**
>
> Make sure that the version of the fleet-cli you download matches the version of Fleet that has been deployed on your cluster.

- For Mac users there is a fleet-cli (https://formulae.brew.sh/formula/fleet-cli) Homebrew Formulae.
- For Linux and Windows users the binaries are present as **assets** to each Fleet release (https://github.com/rancher/fleet/releases).
  - Linux AMD:

    ```
    curl -L -o fleet-cli https://github.com/rancher/fleet/releases/download/v0.16.1/fleet-linux-amd64
    ```

  - Linux ARM:

    ```
    curl -L -o fleet-cli https://github.com/rancher/fleet/releases/download/v0.16.1/fleet-linux-arm64
    ```

2. Make `fleet-cli` executable:

   ```
   chmod +x fleet-cli
   ```

3. Clone the `suse-edge/fleet-examples` release (https://github.com/suse-edge/fleet-examples/releases) that you wish to use:

   ```
   git clone -b release-3.7.0 https://github.com/suse-edge/fleet-examples.git
   ```

4. Navigate to the SUC fleet, located in the `fleet-examples` repo:

   ```
   cd fleet-examples/fleets/day2/system-upgrade-controller
   ```

5. Determine on which clusters you want to deploy SUC. This is done by deploying the SUC Bundle in the correct Fleet workspace inside your management cluster. By default, Fleet has two workspaces:
   - `fleet-local` - for resources that need to be deployed on the **management** cluster.
   - `fleet-default` - for resources that need to be deployed on **downstream** clusters.
     For more information on Fleet workspaces, see the upstream (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups) documentation.

6. If you intend to deploy SUC only on downstream clusters, create a `targets.yaml` file that matches the specific clusters:

   ```
   cat > targets.yaml <<EOF
   ```

```
targets:
- clusterSelector: CHANGEME
EOF
```

For information on how to map to downstream clusters, see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets)

7. Proceed to building the Bundle:

> **Note**
>
> Make sure you did **not** download the fleet-cli in the `fleet-examples/fleets/day2/system-upgrade-controller` directory, otherwise it will be packaged with the Bundle, which is not advised.

- To deploy SUC on your management cluster, execute:

```
fleet-cli apply --compress -n fleet-local -o - system-upgrade-controller . >
 system-upgrade-controller-bundle.yaml
```

- To deploy SUC on your downstream clusters, execute:

```
fleet-cli apply --compress --targets-file=targets.yaml -n fleet-default -o -
 system-upgrade-controller . > system-upgrade-controller-bundle.yaml
```

For more information about this process, see Convert a Helm Chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle).
For more information about the `fleet-cli apply` command, see fleet apply (https://fleet.rancher.io/cli/fleet-cli/fleet_apply).

8. Transfer the `system-upgrade-controller-bundle.yaml` bundle to your management cluster machine:

```
scp system-upgrade-controller-bundle.yaml <machine-address>:<filesystem-path>
```

9. On your management cluster, deploy the `system-upgrade-controller-bundle.yaml` Bundle:

```
kubectl apply -f system-upgrade-controller-bundle.yaml
```

10. On your management cluster, validate that the Bundle is deployed:

```
# Namespace will vary based on where you want to deploy SUC
```

```
kubectl get bundle system-upgrade-controller -n <fleet-local/fleet-default>

NAME                        BUNDLEDEPLOYMENTS-READY   STATUS
system-upgrade-controller   1/1
```

11. Based on the Fleet workspace that you deployed your Bundle to, navigate to the cluster and validate the SUC deployment:

> **Note**
>
> SUC is always deployed in the **cattle-system** namespace.

```
kubectl get deployment system-upgrade-controller -n cattle-system
NAME                        READY   UP-TO-DATE   AVAILABLE   AGE
system-upgrade-controller   1/1     1            1           111s
```

18.2.2 System Upgrade Controller Helm installation

1. Add the Rancher chart repository:

```
helm repo add rancher-charts https://charts.rancher.io/
```

2. Deploy the SUC chart:

```
helm install system-upgrade-controller rancher-charts/system-upgrade-controller --
version 110.0.0 --set global.cattle.psp.enabled=false -n cattle-system --create-
namespace
```

This will install SUC version v0.20.1 which is needed by the Edge 3.7 platform.

3. Validate the SUC deployment:

```
kubectl get deployment system-upgrade-controller -n cattle-system
NAME                        READY   UP-TO-DATE   AVAILABLE   AGE
system-upgrade-controller   1/1     1            1           37s
```

18.3 Monitoring System Upgrade Controller Plans

SUC Plans can be viewed in the following ways:

- Through the Rancher UI (*Section 18.3.1, "Monitoring System Upgrade Controller Plans - Rancher UI"*).
- Through manual monitoring (*Section 18.3.2, "Monitoring System Upgrade Controller Plans - Manual"*) inside of the cluster.

Important

Pods deployed for SUC Plans are kept alive **15** minutes after a successful execution. After that they are removed by the corresponding Job that created them. To have access to the Pod's logs after this time period, you should enable logging for your cluster. For information on how to do this in Rancher, see Rancher Integration with Logging Services (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/logging).

18.3.1 Monitoring System Upgrade Controller Plans - Rancher UI

To check Pod logs for the specific SUC plan:

1. In the upper left corner, **#** → **<your-cluster-name>**
2. Select Workloads → Pods
3. Select the `Only User Namespaces` drop down menu and add the `cattle-system` namespace
4. In the Pod filter bar, write the name for your SUC Plan Pod. The name will be in the following template format: `apply-<plan_name>-on-<node_name>`

   #### Note

   There may be both `Completed` and `Unknown` Pods for a specific SUC Plan. This is expected and happens due to the nature of some of the upgrades.

5. Select the pod that you want to review the logs of and navigate to **#** → **View Logs**

18.3.2 Monitoring System Upgrade Controller Plans - Manual

> **Note**
>
> The below steps assume that `kubectl` has been configured to connect to the cluster where the **SUC Plans** have been deployed to.

1. List deployed **SUC** Plans:

```
kubectl get plans -n cattle-system
```

2. Get Pod for **SUC** Plan:

```
kubectl get pods -l upgrade.cattle.io/plan=<plan_name> -n cattle-system
```

> **Note**
>
> There may be both `Completed` and `Unknown` Pods for a specific SUC Plan. This is expected and happens due to the nature of some of the upgrades.

3. Get logs for the Pod:

```
kubectl logs <pod_name> -n cattle-system
```

19 Upgrade Controller

A Kubernetes controller capable of performing upgrades over the following SUSE Edge platform components:

- Operating System (SUSE Linux Micro)
- Kubernetes (K3s & RKE2)
- Additional components (Rancher, Elemental, SUSE Security, etc.)

The Upgrade Controller (https://github.com/suse-edge/upgrade-controller) streamlines the upgrade process for the components mentioned above by encapsulating their complexities within a single `user-facing` resource that serves as a **trigger** for the upgrade. Users only need to configure this resource and the `Upgrade Controller` takes care of the rest.

Note

The `Upgrade Controller` currently supports SUSE Edge platform upgrades only for **non air-gapped management** clusters. Refer to the *Section 19.8, "Known Limitations"* section for more information.

19.1 How does SUSE Edge use Upgrade Controller?

The **Upgrade Controller** is essential in automating the (formerly manual) "Day 2" operations required to upgrade management clusters from one SUSE Edge release version to the next.

To achieve this automation, the Upgrade Controller utilizes tools such as the System Upgrade Controller (*Chapter 18, System Upgrade Controller*) and the Helm Controller (https://github.com/k3s-io/helm-controller/).

For further details on how the Upgrade Controller works, see *Section 19.5, "How does the Upgrade Controller work?"*.

For known limitations that the Upgrade Controller has, see *Section 19.8, "Known Limitations"*.

For information on the difference between the Upgrade Controller and the System Upgrade Controller, see *Section 19.2, "Upgrade Controller vs System Upgrade Controller"*.

19.2 Upgrade Controller vs System Upgrade Controller

The System Upgrade Controller (SUC) (*Chapter 18, System Upgrade Controller*) is a general-purpose tool that propagates upgrade instructions to specific Kubernetes nodes.

While it supports some "Day 2" operations for the SUSE Edge platform, it **does not** cover all of them. Moreover, even for supported operations, users have to manually configure, maintain, and deploy multiple `SUC Plans` — an error-prone process that can lead to unexpected issues.

This led to the need for a tool that **automates** and **abstracts** the complexity of managing various "Day 2" operations for the SUSE Edge platform. Thus, the `Upgrade Controller` was developed. It simplifies the upgrade process by introducing a single `user-facing resource` that drives the upgrade. Users only need to manage this resource, while the `Upgrade Controller` takes care of the rest.

19.3 Installing the Upgrade Controller

19.3.1 Prerequisites

- Helm (https://helm.sh/docs/intro/install/)
- cert-manager (https://cert-manager.io/docs/installation/helm/)
- System Upgrade Controller (*Section 18.2, "Installing the System Upgrade Controller"*)
- A Kubernetes cluster; either K3s or RKE2

19.3.2 Steps

1. Install the Upgrade Controller Helm chart on your management cluster:

```
helm install upgrade-controller oci://registry.suse.com/edge/charts/upgrade-
controller --version 307.0.4+up0.1.3 --create-namespace --namespace upgrade-
controller-system
```

2. Validate the Upgrade Controller deployment:

```
kubectl get deployment -n upgrade-controller-system
```

3. Validate the Upgrade Controller pod:

```
kubectl get pods -n upgrade-controller-system
```

4. Validate the Upgrade Controller pod logs:

```
kubectl logs <pod_name> -n upgrade-controller-system
```

19.4 Installing the Upgrade Controller via Edge Image Builder

As an alternative to the manual installation described above, it is possible to install the upgrade controller as part of the initial deployment orchestrated by Edge Image Builder (*Chapter 8, Edge Image Builder*).

In this case it is necessary to add the following helm chart configuration to the EIB configuration file:

```
kubernetes:
  helm:
    charts:
      - name: cert-manager
        repositoryName: jetstack
        version: {version-cert-manager}
        targetNamespace: cert-manager
        valuesFile: certmanager-values.yaml
        createNamespace: true
        installationNamespace: kube-system
      - name: upgrade-controller
        version: {version-upgrade-controller-chart}
        repositoryName: suse-edge-charts
        targetNamespace: upgrade-controller-system
        createNamespace: true
        installationNamespace: kube-system
```

19.5 How does the Upgrade Controller work?

In order to perform an Edge release upgrade, the Upgrade Controller introduces two new Kubernetes custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/):

- UpgradePlan (*Section 19.6.1, "UpgradePlan"*) - created by the user; holds configurations regarding an Edge release upgrade.
- ReleaseManifest (*Section 19.6.2, "ReleaseManifest"*) - created by the Upgrade Controller; holds component versions specific to a particular Edge release version. **This file must not be edited by users.**

The Upgrade Controller proceeds to create a `ReleaseManifest` resource that holds the component data for the Edge release version specified by the user under the `releaseVersion` property in the `UpgradePlan` resource.

Using the component data from the `ReleaseManifest`, the Upgrade Controller proceeds to upgrade the Edge release components in the following order:

1. Operating System (OS) (*Section 19.5.1, "Operating System upgrade"*).
2. Kubernetes (*Section 19.5.2, "Kubernetes upgrade"*).
3. Additional components (*Section 19.5.3, "Additional components upgrades"*).

Note

During the upgrade process, the Upgrade Controller continually outputs upgrade information to the created `UpgradePlan`. For more information on how to track the upgrade process, see Tracking the upgrade process (*Section 19.7, "Tracking the upgrade process"*).

19.5.1 Operating System upgrade

To upgrade the operating system, the Upgrade Controller creates SUC (*Chapter 18, System Upgrade Controller*) Plans that have the following naming template:

- For SUC Plans related to control plane node OS upgrades - `control-plane-<os-name>-<os-version>-<suffix>`.
- For SUC Plans related to worker node OS upgrades - `workers-<os-name>-<os-version>-<suffix>`.

Based on these plans, SUC proceeds to create workloads on each node of the cluster that perform the actual OS upgrade.

Depending on the `ReleaseManifest`, the OS upgrade may include:

- Package only updates - for use-cases where the OS version does not change between Edge releases.
- Full OS migration - for use-cases where the OS version changes between Edge releases.

The upgrade is executed **one** node at a time starting with the control plane nodes first. Only if the control-plane node upgrade finishes will the worker nodes begin to be upgraded.

Note

The Upgrade Controller configures the OS SUC Plans to do perform a drain (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_drain/) of the cluster nodes if the cluster has more than **one** node of the specified type.

For clusters where the control plane nodes are **greater than** one and there is **only one** worker node, a drain will be performed only for the control plane nodes and vice versa.

For information on how to disable node drains altogether, see the UpgradePlan (*Section 19.6.1, "UpgradePlan"*) section.

19.5.2 Kubernetes upgrade

To upgrade the Kubernetes distribution of a cluster, the Upgrade Controller creates SUC (*Chapter 18, System Upgrade Controller*) Plans that have the following naming template:

- For SUC Plans related to control plane node Kubernetes upgrades - `control-plane-<k8s-version>-<suffix>`.
- For SUC Plans related to worker node Kubernetes upgrades - `workers-<k8s-version>-<suffix>`.

Based on these plans, SUC proceeds to create workloads on each node of the cluster that perform the actual Kubernetes upgrade.

The Kubernetes upgrade will happen **one** node at a time starting with the control plane nodes first. Only if the control plane node upgrade finishes will the worker nodes begin to be upgraded.

Note

The Upgrade Controller configures the Kubernetes SUC Plans to perform a drain (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_drain/) of the cluster nodes if the cluster has more than **one** node of the specified type.

For clusters where the control plane nodes are **greater than** one and there is **only one** worker node, a drain will be performed only for the control plane nodes and vice versa.

For information on how to disable node drains altogether, see *Section 19.6.1, "UpgradePlan"*.

19.5.3 Additional components upgrades

Currently, all additional components are installed via Helm charts. For a full list of the components for a specific release, refer to the Release Notes (*Chapter 40, Release Notes*).

For Helm charts deployed through EIB (*Chapter 8, Edge Image Builder*), the Upgrade Controller updates the existing HelmChart CR (https://docs.rke2.io/helm#using-the-helm-crd) of each component.

For Helm charts deployed outside of EIB, the Upgrade Controller creates a `HelmChart` resource for each component.

After the creation/update of the `HelmChart` resource, the Upgrade Controller relies on the helm-controller (https://github.com/k3s-io/helm-controller/) to pick up this change and proceed with the actual component upgrade.

Charts will be upgraded sequentially based on their order in the `ReleaseManifest`. Additional values can also be passed through the `UpgradePlan`. If a chart's version remains unchanged in the new SUSE Edge release, it will not be upgraded. For more information about this, refer to *Section 19.6.1, "UpgradePlan"*.

19.6 Kubernetes API extensions

Extensions to the Kubernetes API introduced by the Upgrade Controller.

19.6.1 UpgradePlan

The Upgrade Controller introduces a new Kubernetes custom resource (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) called an `UpgradePlan`.

The `UpgradePlan` serves as an instruction mechanism for the Upgrade Controller and it supports the following configurations:

- `releaseVersion` - Edge release version to which the cluster should be upgraded to. The release version must follow semantic (https://semver.org) versioning and should be retrieved from the Release Notes (*Chapter 40, Release Notes*).
- `disableDrain` - **Optional**; instructs the Upgrade Controller on whether to disable node drains (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_drain/). Useful for when you have workloads with Disruption Budgets (https://kubernetes.io/docs/tasks/run-application/configure-pdb/).
  - Example for control plane node drain disablement:

    ```
    spec:
      disableDrain:
        controlPlane: true
    ```

  - Example for control plane and worker node drain disablement:

    ```
    spec:
      disableDrain:
        controlPlane: true
        worker: true
    ```

- `helm` - **Optional**; specifies additional values for components installed via Helm.

> **Warning**
>
> It is only advised to use this field for values that are critical for upgrades. Standard chart value updates should be performed after the respective charts have been upgraded to the next version.

  - Example:

    ```
    spec:
      helm:
      - chart: foo
        values:
    ```

```
      bar: baz
```

19.6.2 ReleaseManifest

The Upgrade Controller introduces a new Kubernetes custom resource (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) called a `ReleaseManifest`.

The `ReleaseManifest` resource is created by the Upgrade Controller and holds component data for **one** specific Edge release version. This means that each Edge release version upgrade will be represented by a different `ReleaseManifest` resource.

> **Warning**
>
> The Release Manifest should always be created by the Upgrade Controller.
>
> It is not advisable to manually create or edit the `ReleaseManifest` resources. Users that decide to do so should do this **at their own risk**.

Component data that the Release Manifest ships include, but is not limited to:

- Operating System data - version, supported architectures, additional upgrade data, etc.
- Kubernetes distribution data - RKE2 (https://docs.rke2.io)/K3s (https://k3s.io) supported versions
- Additional components data - SUSE Helm chart data (location, version, name, etc.)

For an example of how a Release Manifest can look, refer to the upstream (https://github.com/suse-edge/upgrade-controller/blob/main/config/samples/lifecycle_v1alpha1_releasemanifest.yaml) documentation. *Please note that this is just an example and it is not intended to be created as a valid* `ReleaseManifest` *resource.*

19.7 Tracking the upgrade process

This section serves as means to track and debug the upgrade process that the Upgrade Controller initiates once the user creates an `UpgradePlan` resource.

19.7.1 General

General information about the state of the upgrade process can be viewed in the Upgrade Plan's status conditions.

The Upgrade Plan resource's status can be viewed in the following way:

```
kubectl get upgradeplan <upgradeplan_name> -n upgrade-controller-system -o yaml
```

EXAMPLE 19.1: RUNNING UPGRADE PLAN EXAMPLE:

```
apiVersion: lifecycle.suse.com/v1alpha1
kind: UpgradePlan
metadata:
  name: upgrade-plan-mgmt
  namespace: upgrade-controller-system
spec:
  releaseVersion: 3.7
status:
  conditions:
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Control plane nodes are being upgraded
    reason: InProgress
    status: "False"
    type: OSUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Kubernetes upgrade is not yet started
    reason: Pending
    status: Unknown
    type: KubernetesUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Rancher upgrade is not yet started
    reason: Pending
    status: Unknown
    type: RancherUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Longhorn upgrade is not yet started
    reason: Pending
    status: Unknown
    type: LonghornUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: MetalLB upgrade is not yet started
    reason: Pending
    status: Unknown
    type: MetalLBUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: CDI upgrade is not yet started
    reason: Pending
```

```
    status: Unknown
    type: CDIUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: KubeVirt upgrade is not yet started
    reason: Pending
    status: Unknown
    type: KubeVirtUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: NeuVector upgrade is not yet started
    reason: Pending
    status: Unknown
    type: NeuVectorUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: EndpointCopierOperator upgrade is not yet started
    reason: Pending
    status: Unknown
    type: EndpointCopierOperatorUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Elemental upgrade is not yet started
    reason: Pending
    status: Unknown
    type: ElementalUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: SRIOV upgrade is not yet started
    reason: Pending
    status: Unknown
    type: SRIOVUpgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: Metal3 upgrade is not yet started
    reason: Pending
    status: Unknown
    type: Metal3Upgraded
  - lastTransitionTime: "2024-10-01T06:26:27Z"
    message: RancherTurtles upgrade is not yet started
    reason: Pending
    status: Unknown
    type: RancherTurtlesUpgraded
  observedGeneration: 1
  sucNameSuffix: 90315a2b6d
```

Here you can view every component that the Upgrade Controller will try to schedule an upgrade for. Each condition follows the below template:

- `lastTransitionTime` - the last time that this component condition has transitioned from one status to another.
- `message` - message that indicates the current upgrade state of the specific component condition.

- `reason` - the current upgrade state of the specific component condition. Possible `reasons` include:
  - `Succeeded` - upgrade of the specific component is successful.
  - `Failed` - upgrade of the specific component has failed.
  - `InProgress` - upgrade of the specific component is currently in progress.
  - `Pending` - upgrade of the specific component is not yet scheduled.
  - `Skipped` - specific component is not found on the cluster, so its upgrade will be skipped.
  - `Error` - specific component has encountered a transient error.
- `status` - status of the current condition `type`, one of `True`, `False`, `Unknown`.
- `type` - indicator for the currently upgraded component.

The Upgrade Controller creates SUC Plans for component conditions of type `OSUpgraded` and `KubernetesUpgraded`. To further track the SUC Plans created for these components, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

All other component condition types can be further tracked by viewing the resources created for them by the helm-controller (https://github.com/k3s-io/helm-controller/). For more information, see *Section 19.7.2, "Helm Controller"*.

An Upgrade Plan scheduled by the Upgrade Controller can be marked as `successful` once:

1. There are no `Pending` or `InProgress` component conditions.
2. The `lastSuccessfulReleaseVersion` property points to the `releaseVersion` that is specified in the Upgrade Plan's configuration. *This property is added to the Upgrade Plan's status by the Upgrade Controller once the upgrade process is successful.*

EXAMPLE 19.2: SUCCESSFUL `UpgradePlan` EXAMPLE:

```
apiVersion: lifecycle.suse.com/v1alpha1
kind: UpgradePlan
metadata:
  name: upgrade-plan-mgmt
  namespace: upgrade-controller-system
spec:
  releaseVersion: 3.7
status:
  conditions:
  - lastTransitionTime: "2024-10-01T06:26:48Z"
    message: All cluster nodes are upgraded
```

```
    reason: Succeeded
    status: "True"
    type: OSUpgraded
  - lastTransitionTime: "2024-10-01T06:26:59Z"
    message: All cluster nodes are upgraded
    reason: Succeeded
    status: "True"
    type: KubernetesUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Chart rancher upgrade succeeded
    reason: Succeeded
    status: "True"
    type: RancherUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Chart longhorn is not installed
    reason: Skipped
    status: "False"
    type: LonghornUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Specified version of chart metallb is already installed
    reason: Skipped
    status: "False"
    type: MetalLBUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Chart cdi is not installed
    reason: Skipped
    status: "False"
    type: CDIUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Chart kubevirt is not installed
    reason: Skipped
    status: "False"
    type: KubeVirtUpgraded
  - lastTransitionTime: "2024-10-01T06:27:13Z"
    message: Chart neuvector-crd is not installed
    reason: Skipped
    status: "False"
    type: NeuVectorUpgraded
  - lastTransitionTime: "2024-10-01T06:27:14Z"
    message: Specified version of chart endpoint-copier-operator is already installed
    reason: Skipped
    status: "False"
    type: EndpointCopierOperatorUpgraded
  - lastTransitionTime: "2024-10-01T06:27:14Z"
    message: Chart elemental-operator upgrade succeeded
    reason: Succeeded
    status: "True"
```

```
    type: ElementalUpgraded
  - lastTransitionTime: "2024-10-01T06:27:15Z"
    message: Chart sriov-crd is not installed
    reason: Skipped
    status: "False"
    type: SRIOVUpgraded
  - lastTransitionTime: "2024-10-01T06:27:19Z"
    message: Chart metal3 is not installed
    reason: Skipped
    status: "False"
    type: Metal3Upgraded
  - lastTransitionTime: "2024-10-01T06:27:27Z"
    message: Chart rancher-turtles is not installed
    reason: Skipped
    status: "False"
    type: RancherTurtlesUpgraded
  lastSuccessfulReleaseVersion: 3.7
  observedGeneration: 1
  sucNameSuffix: 90315a2b6d
```

19.7.2 Helm Controller

This section covers how to track resources created by the helm-controller (https://github.com/k3s-io/helm-controller/).

Note

The below steps assume that `kubectl` has been configured to connect to the cluster where the Upgrade Controller has been deployed to.

1. Locate the `HelmChart` resource for the specific component:

```
kubectl get helmcharts -n kube-system
```

2. Using the name of the `HelmChart` resource, locate the upgrade Pod that was created by the `helm-controller`:

```
kubectl get pods -l helmcharts.helm.cattle.io/chart=<helmchart_name> -n kube-system

# Example for Rancher
kubectl get pods -l helmcharts.helm.cattle.io/chart=rancher -n kube-system
NAME                          READY   STATUS      RESTARTS   AGE
```

```
helm-install-rancher-tv9wn   0/1     Completed   0          16m
```

3. View the logs of the component specific pod:

```
kubectl logs <pod_name> -n kube-system
```

19.8 Known Limitations

- Downstream cluster upgrades are not yet managed by the Upgrade Controller. For information on how to upgrade downstream clusters, refer to *Chapter 32, Downstream clusters*.
- The Upgrade Controller expects any additional SUSE Edge Helm charts that are deployed through EIB (*Chapter 8, Edge Image Builder*) to have their HelmChart CR (https://docs.rke2.io/helm#using-the-helm-crd) deployed in the `kube-system` namespace. To do this, configure the `installationNamespace` property in your EIB definition file. For more information, see the upstream (https://github.com/suse-edge/edge-image-builder/blob/main/docs/building-images.md#kubernetes) documentation.
- Currently the Upgrade Controller has no way to determine the current running Edge release version on the management cluster. Ensure to provide an Edge release version that is greater than the currently running Edge release version on the cluster.
- Currently the Upgrade Controller supports **non air-gapped** environment upgrades only. **Air-gapped** upgrades are not yet possible.

20 SUSE Multi-Linux Manager

SUSE Multi-Linux Manager is included in SUSE Edge to provide automation and control for keeping SUSE Linux Micro as the underlying operating system consistently up-to-date on all nodes of your edge deployment.

For more information please refer to the *Chapter 3, SUSE Multi-Linux Manager* and the SUSE Multi-Linux Manager Documentation (https://documentation.suse.com/multi-linux-manager/5.1/en/docs/index.html).

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How-to guides and best practices

21 MetalLB on K3s (using Layer 2 Mode)

MetalLB is a load-balancer implementation for bare-metal Kubernetes clusters, using standard routing protocols.

In this guide, we demonstrate how to deploy MetalLB in layer 2 (L2) mode.

21.1 Why use MetalLB

MetalLB is a compelling choice for load balancing in bare-metal Kubernetes clusters for several reasons:

1. Native Integration with Kubernetes: MetalLB seamlessly integrates with Kubernetes, making it easy to deploy and manage using familiar Kubernetes tools and practices.
2. Bare-Metal Compatibility: Unlike cloud-based load balancers, MetalLB is designed specifically for on-premises deployments where traditional load balancers might not be available or feasible.
3. Supports Multiple Protocols: MetalLB supports both Layer 2 and BGP (Border Gateway Protocol) modes, providing flexibility for different network architectures and requirements.
4. High Availability: By distributing load-balancing responsibilities across multiple nodes, MetalLB ensures high availability and reliability for your services.
5. Scalability: MetalLB can handle large-scale deployments, scaling alongside your Kubernetes cluster to meet increasing demand.

In layer 2 mode, one node assumes the responsibility of advertising a service to the local network. From the network's perspective, it simply looks like that machine has multiple IP addresses assigned to its network interface.

The major advantage of the layer 2 mode is its universality: it works on any Ethernet network, with no special hardware required, not even fancy routers.

21.2 MetalLB on K3s (using L2)

In this quick start, L2 mode will be used. This means we do not need any special network equipment but three free IPs within the network range.

21.3 Prerequisites

- A K3s cluster where MetalLB is going to be deployed.

Warning

K3S comes with its own service load balancer named Klipper. You need to disable it to run MetalLB (https://metallb.universe.tf/configuration/k3s/). To disable Klipper, K3s needs to be installed using the `--disable=servicelb` flag.

- Helm
- Three free IP adressess within the network range. In this example `192.168.122.10-192.168.122.12`

Important

You must make sure these IP addresses are unassigned. In a DHCP environment these addresses must not be part of the DHCP pool to avoid dual assignments.

21.4 Deployment

We will be using the MetalLB Helm chart published as part of the SUSE Edge solution:

```
helm install \
  metallb oci://registry.suse.com/edge/charts/metallb \
  --namespace metallb-system \
  --create-namespace

while ! kubectl wait --for condition=ready -n metallb-system $(kubectl get\
 pods -n metallb-system -l app.kubernetes.io/component=controller -o name)\
 --timeout=10s; do
 sleep 2
done
```

21.5 Configuration

At this point, the installation is completed. Now it is time to configure (https://metallb.universe.tf/configuration/) using our example values:

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: ip-pool
  namespace: metallb-system
spec:
  addresses:
  - 192.168.122.10/32
  - 192.168.122.11/32
  - 192.168.122.12/32
EOF
```

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
kind: L2Advertisement
metadata:
  name: ip-pool-l2-adv
  namespace: metallb-system
spec:
  ipAddressPools:
  - ip-pool
EOF
```

Now, it is ready to be used. You can customize many things for L2 mode, such as:

- IPv6 And Dual Stack Services (https://metallb.universe.tf/usage/#ipv6-and-dual-stack-services)
- Control automatic address allocation (https://metallb.universe.tf/configuration/_advanced_ipaddresspool_configuration/#controlling-automatic-address-allocation)
- Reduce the scope of address allocation to specific namespaces and services (https://metallb.universe.tf/configuration/_advanced_ipaddresspool_configuration/#reduce-scope-of-address-allocation-to-specific-namespace-and-service)

- Limiting the set of nodes where the service can be announced from (https://metallb.universe.tf/configuration/_advanced_l2_configuration/#limiting-the-set-of-nodes-where-the-service-can-be-announced-from)
- Specify network interfaces that LB IP can be announced from (https://metallb.universe.tf/configuration/_advanced_l2_configuration/#specify-network-interfaces-that-lb-ip-can-be-announced-from)

And a lot more for BGP (https://metallb.universe.tf/configuration/_advanced_bgp_configuration/).

21.5.1 Traefik and MetalLB

Traefik is deployed by default with K3s (it can be disabled (https://docs.k3s.io/networking#traefik-ingress-controller) with `--disable=traefik`) and it is by default exposed as `LoadBalancer` (to be used with Klipper). However, as Klipper needs to be disabled, Traefik service for ingress is still a `LoadBalancer` type. So at the moment of deploying MetalLB, the first IP will be assigned automatically to Traefik Ingress.

```
# Before deploying MetalLB
kubectl get svc -n kube-system traefik
NAME      TYPE           CLUSTER-IP     EXTERNAL-IP   PORT(S)                      AGE
traefik   LoadBalancer   10.43.44.113   <pending>     80:31093/TCP,443:32095/TCP   28s
# After deploying MetalLB
kubectl get svc -n kube-system traefik
NAME      TYPE           CLUSTER-IP     EXTERNAL-IP      PORT(S)                      AGE
traefik   LoadBalancer   10.43.44.113   192.168.122.10   80:31093/TCP,443:32095/TCP
 3m10s
```

This will be applied later (*Section 21.6.1, "Ingress with MetalLB"*) in the process.

21.6 Usage

Let us create an example deployment:

```
cat <<- EOF | kubectl apply -f -
---
apiVersion: v1
kind: Namespace
metadata:
  name: hello-kubernetes
---
apiVersion: v1
```

```yaml
kind: ServiceAccount
metadata:
  name: hello-kubernetes
  namespace: hello-kubernetes
  labels:
    app.kubernetes.io/name: hello-kubernetes
---
apiVersion: apps/v1
kind: Deployment
metadata:
  name: hello-kubernetes
  namespace: hello-kubernetes
  labels:
    app.kubernetes.io/name: hello-kubernetes
spec:
  replicas: 2
  selector:
    matchLabels:
      app.kubernetes.io/name: hello-kubernetes
  template:
    metadata:
      labels:
        app.kubernetes.io/name: hello-kubernetes
    spec:
      serviceAccountName: hello-kubernetes
      containers:
        - name: hello-kubernetes
          image: "paulbouwer/hello-kubernetes:1.10"
          imagePullPolicy: IfNotPresent
          ports:
            - name: http
              containerPort: 8080
              protocol: TCP
          livenessProbe:
            httpGet:
              path: /
              port: http
          readinessProbe:
            httpGet:
              path: /
              port: http
          env:
          - name: HANDLER_PATH_PREFIX
            value: ""
          - name: RENDER_PATH_PREFIX
            value: ""
          - name: KUBERNETES_NAMESPACE
```

```
            valueFrom:
              fieldRef:
                fieldPath: metadata.namespace
          - name: KUBERNETES_POD_NAME
            valueFrom:
              fieldRef:
                fieldPath: metadata.name
          - name: KUBERNETES_NODE_NAME
            valueFrom:
              fieldRef:
                fieldPath: spec.nodeName
          - name: CONTAINER_IMAGE
            value: "paulbouwer/hello-kubernetes:1.10"
EOF
```

And finally, the service:

```
cat <<- EOF | kubectl apply -f -
apiVersion: v1
kind: Service
metadata:
  name: hello-kubernetes
  namespace: hello-kubernetes
  labels:
    app.kubernetes.io/name: hello-kubernetes
spec:
  type: LoadBalancer
  ports:
    - port: 80
      targetPort: http
      protocol: TCP
      name: http
  selector:
    app.kubernetes.io/name: hello-kubernetes
EOF
```

Let us see it in action:

```
kubectl get svc -n hello-kubernetes
NAME               TYPE           CLUSTER-IP     EXTERNAL-IP      PORT(S)        AGE
hello-kubernetes   LoadBalancer   10.43.127.75   192.168.122.11   80:31461/TCP   8s

curl http://192.168.122.11
<!DOCTYPE html>
<html>
<head>
    <title>Hello Kubernetes!</title>
    <link rel="stylesheet" type="text/css" href="/css/main.css">
```

```
    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Ubuntu:300" >
</head>
<body>

  <div class="main">
    <img src="/images/kubernetes.png"/>
    <div class="content">
      <div id="message">
  Hello world!
</div>
<div id="info">
  <table>
    <tr>
      <th>namespace:</th>
      <td>hello-kubernetes</td>
    </tr>
    <tr>
      <th>pod:</th>
      <td>hello-kubernetes-7c8575c848-2c6ps</td>
    </tr>
    <tr>
      <th>node:</th>
      <td>allinone (Linux 5.14.21-150400.24.46-default)</td>
    </tr>
  </table>
</div>
<div id="footer">
  paulbouwer/hello-kubernetes:1.10 (linux/amd64)
</div>
    </div>
  </div>

</body>
</html>
```

21.6.1 Ingress with MetalLB

As Traefik is already serving as an ingress controller, we can expose any HTTP/HTTPS traffic via an `Ingress` object such as:

```
IP=$(kubectl get svc -n kube-system traefik -o
 jsonpath="{.status.loadBalancer.ingress[0].ip}")
cat <<- EOF | kubectl apply -f -
apiVersion: networking.k8s.io/v1
kind: Ingress
```

```
metadata:
  name: hello-kubernetes-ingress
  namespace: hello-kubernetes
spec:
  rules:
  - host: hellok3s.${IP}.sslip.io
    http:
      paths:
        - path: "/"
          pathType: Prefix
          backend:
            service:
              name: hello-kubernetes
              port:
                name: http
EOF
```

And then:

```
curl http://hellok3s.${IP}.sslip.io
<!DOCTYPE html>
<html>
<head>
    <title>Hello Kubernetes!</title>
    <link rel="stylesheet" type="text/css" href="/css/main.css">
    <link rel="stylesheet" href="https://fonts.googleapis.com/css?family=Ubuntu:300" >
</head>
<body>

  <div class="main">
    <img src="/images/kubernetes.png"/>
    <div class="content">
      <div id="message">
  Hello world!
</div>
<div id="info">
  <table>
    <tr>
      <th>namespace:</th>
      <td>hello-kubernetes</td>
    </tr>
    <tr>
      <th>pod:</th>
      <td>hello-kubernetes-7c8575c848-fvqm2</td>
    </tr>
    <tr>
      <th>node:</th>
      <td>allinone (Linux 5.14.21-150400.24.46-default)</td>
```

```
    </tr>
  </table>
</div>
<div id="footer">
  paulbouwer/hello-kubernetes:1.10 (linux/amd64)
</div>
    </div>
  </div>

</body>
</html>
```

Verify that MetalLB works correctly:

```
% arping hellok3s.${IP}.sslip.io

ARPING 192.168.64.210
60 bytes from 92:12:36:00:d3:58 (192.168.64.210): index=0 time=1.169 msec
60 bytes from 92:12:36:00:d3:58 (192.168.64.210): index=1 time=2.992 msec
60 bytes from 92:12:36:00:d3:58 (192.168.64.210): index=2 time=2.884 msec
```

In the example above, the traffic flows as follows:

1. `hellok3s.${IP}.sslip.io` is resolved to the actual IP.
2. Then the traffic is handled by the `metallb-speaker` pod.
3. `metallb-speaker` redirects the traffic to the `traefik` controller.
4. Finally, Traefik forwards the request to the `hello-kubernetes` service.

22 MetalLB on K3s (using Layer 3 Mode)

MetalLB is a load-balancer implementation for bare-metal Kubernetes clusters, using standard routing protocols.

In this guide, we demonstrate how to deploy MetalLB in layer 3 (L3) BGP mode.

22.1 Why use MetalLB

MetalLB is a compelling choice for load balancing in bare-metal Kubernetes clusters for several reasons:

1. Native Integration with Kubernetes: MetalLB seamlessly integrates with Kubernetes, making it easy to deploy and manage using familiar Kubernetes tools and practices.
2. Bare-Metal Compatibility: Unlike cloud-based load balancers, MetalLB is designed specifically for on-premises deployments where traditional load balancers might not be available or feasible.
3. Supports Multiple Protocols: MetalLB supports both Layer 2 and Layer 3 BGP (Border Gateway Protocol) modes, providing flexibility for different network architectures and requirements.
4. High Availability: By distributing load-balancing responsibilities across multiple nodes, MetalLB ensures high availability and reliability for your services.
5. Scalability: MetalLB can handle large-scale deployments, scaling alongside your Kubernetes cluster to meet increasing demand.

In layer 2 mode, one node assumes the responsibility of advertising a service to the local network. From the network's perspective, it simply looks like that machine has multiple IP addresses assigned to its network interface.

The major advantage of the layer 2 mode is its universality: it works on any Ethernet network, with no special hardware required, not even fancy routers.

22.2 MetalLB on K3s (using L3)

In this quick start, L3 mode is used. This means that we need to have neighboring router(s) with BGP capabilities within the network range.

Note

From version 0.16.0, `frr-k8s` is the default backend for BGP. The FRR mode will be deprecated with the ultimate goal of removing it in the future.

22.3 Prerequisites

- A K3s cluster where MetalLB is deployed.
- Router(s) on the network that support the BGP protocol.
- A free IP address within the network range for the service. In this example `192.168.10.100`

Important

You must make sure this IP address is unassigned. In a DHCP environment this address must not be part of the DHCP pool to avoid dual assignments.

22.4 Configuration to Advertise Service IP Addresses

Out of the box BGP advertises a Service IP address to all the peers that are configured. These peers, which are usually routers, will receive a route for each Service IP address with a 32 bit network mask. In this examlple we will use an FRR based router and is on the same network as our cluster. We will then use MetalLB's BGP capability to advertise a service to that FRR based router.

22.5 Deployment

MetalLB is deployed by default for L2 VIP functionality, so there is no need to install it separately.

Verify that you have 4 pods in the `metallb-system` namespace and that they are all running without a problem:

```
k get pods -n metallb-system
NAME                                                    READY   STATUS    RESTARTS
 AGE
metallb-controller-7fbfd8977d-m2q9t                     1/1     Running   0
 46s
```

```
metallb-metallb-frr-k8s-9w7wl                                6/6     Running   0
 46s
metallb-metallb-frr-k8s-webhook-server-5d9d67ffd6-8jqnc   1/1     Running   1 (6s ago)
 46s
metallb-speaker-qx8bl                                        1/1     Running   0
 46s
```

22.6 Configuration

1. Create an `IPAddressPool`:

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: bgp-pool
  namespace: metallb-system
  labels:
    app: httpd
spec:
  addresses:
  - 192.168.10.100/32
  autoAssign: true
  avoidBuggyIPs: false
  serviceAllocation:
    namespaces:
    - metallb-system
    priority: 100
    serviceSelectors:
    - matchExpressions:
      - key: serviceType
        operator: In
        values:
        - httpd
EOF
```

2. Configure a `BGPPeer`.

Note

The FRR router has ASN 1000 while our `BGPPeer` will have 1001. We can also see that the FRR Router has an IP address that is 192.168.3.140.

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta2
kind: BGPPeer
metadata:
  namespace: metallb-system
  name: mypeertest
spec:
  peerAddress: 192.168.3.140
  peerASN: 1000
  myASN: 1001
  routerID: 4.4.4.4
EOF
```

3. Create the BGPAdvertisement (L3):

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
kind: BGPAdvertisement
metadata:
  name: bgpadvertisement-test
  namespace: metallb-system
spec:
  ipAddressPools:
  - bgp-pool
EOF
```

22.7 Usage

1. Create an example application with a service. In this case, IP address from the `IPAddressPool` is `192.168.10.100` for that service.

```
cat <<- EOF | kubectl apply -f -
apiVersion: apps/v1
kind: Deployment
metadata:
  name: httpd-deployment
  namespace: metallb-system
  labels:
    app: httpd
spec:
  replicas: 3
  selector:
    matchLabels:
```

```
      pod-label: httpd
  template:
    metadata:
      labels:
        pod-label: httpd
    spec:
      containers:
      - name: httpdcontainer
        image: image: docker.io/library/httpd:2.4
        ports:
          - containerPort: 80
            protocol: TCP
      restartPolicy: Always

---
apiVersion: v1
kind: Service
metadata:
  name: http-service
  namespace: metallb-system
  labels:
    serviceType: httpd
spec:
  selector:
    pod-label: httpd
  type: LoadBalancer
  ports:
  - protocol: TCP
    port: 8080
    name: 8080-tcp
    targetPort: 80
EOF
```

2. To verify, log onto the FRR Router to can see the routes created from the BGP advertisement.

```
42178089cba5# show ip bgp all

For address family: IPv4 Unicast
BGP table version is 3, local router ID is 2.2.2.2, vrf id 0
Default local pref 100, local AS 1000
Status codes:  s suppressed, d damped, h history, * valid, > best, = multipath,
               i internal, r RIB-failure, S Stale, R Removed
Nexthop codes: @NNN nexthop's vrf id, < announce-nh-self
Origin codes:  i - IGP, e - EGP, ? - incomplete
RPKI validation codes: V valid, I invalid, N Not found

   Network          Next Hop            Metric LocPrf Weight Path
```

```
* i172.16.0.0/24    1.1.1.1                  0    100      0 i
*>                  0.0.0.0                  0         32768 i
* i172.17.0.0/24    3.3.3.3                  0    100      0 i
*>                  0.0.0.0                  0         32768 i
*= 192.168.10.100/32
                    192.168.3.162                          0 1001 i
*=                  192.168.3.163                          0 1001 i
*>                  192.168.3.161                          0 1001 i

Displayed  3 routes and 7 total paths
kubectl get svc -n hello-kubernetes
NAME               TYPE           CLUSTER-IP     EXTERNAL-IP      PORT(S)        AGE
hello-kubernetes   LoadBalancer   10.43.127.75   192.168.122.11   80:31461/TCP   8s
```

3. If this router is the default gateway for your network, you can run the `curl` command from a box on that network to verify that they can reach the httpd sample app

```
# curl http://192.168.10.100:8080
<html><body><h1>It works!</h1></body></html>
#
```

23 Learning External Routes with MetalLB BGP

MetalLB is a load-balancer implementation for bare-metal Kubernetes clusters, using standard routing protocols.

In this guide, we demonstrate how to use MetalLB to learn routes from external routers via BGP.

23.1 Learning External Routes with MetalLB BGP

Note

FRR-K8s is now the default backend for BGP. Community documentation of FRR-K8s is here (https://github.com/metallb/frr-k8s/).

23.2 Prerequisites

- All prerequisites here are the same as for *Chapter 22, MetalLB on K3s (using Layer 3 Mode)* apart from the need for a free IP address.

  ### Note

  The example here does not include setting up a service so there is no need for an IP address.

- A K3s cluster with MetalLB already deployed.
- Router(s) on the network that support the BGP protocol.

23.3 Configuration to Accept Incoming Routes

Out of the box MetalLB BGP advertises a Service IP address to all the BGP peers that are configured. These peers, which are usually routers, will receive a route for each Service IP address with a 32 bit network mask. When using FRR-K8s with the FRRConfiguration CR, it is also possible to receive routes from external routers. These external routes will show up in each node's routing table. There are multiple

benefits from this, but the main one is that it eliminates the need to manually update Linux routing tables on nodes when the external network changes, specifically in cases where it is desirable to avoid sending traffic through the default gateway.

23.4 Deployment

MetalLB is deployed by default for L2 VIP functionality, so there is no need to install it separately.

Verify that you have 4 pods in the `metallb-system` namespace and that they are all running without a problem:

```
k get pods -n metallb-system
NAME                                                      READY   STATUS    RESTARTS
 AGE
metallb-controller-7fbfd8977d-m2q9t                       1/1     Running   0
 46s
metallb-metallb-frr-k8s-9w7wl                             6/6     Running   0
 46s
metallb-metallb-frr-k8s-webhook-server-5d9d67ffd6-8jqnc   1/1     Running   1 (6s ago)
 46s
metallb-speaker-qx8bl                                     1/1     Running   0
 46s
```

23.5 Configuration

1. Create an `FRRConfiguration` for the FRR-K8s based BGP backend:

```
cat <<-EOF | kubectl apply -f -
apiVersion: frrk8s.metallb.io/v1beta1
kind: FRRConfiguration
metadata:
  name: frrdemo
  namespace: metallb-system
spec:
  bgp:
    routers:
    - asn: 64513
      neighbors:
        - address: 192.168.20.154
          asn: 64512
          port: 179
          toAdvertise:
```

```
            allowed:
              mode: all
          toReceive:
            allowed:
              mode: all
EOF
```

The external BGP router has ASN 64512 while our `BGPPeer` will have 64513. We can also see that the external BGP Router has an IP address that is 192.168.20.154.

2. Verify that the FRRConfiguration has been deployed:

```
k get FRRConfiguration -A
NAMESPACE        NAME      AGE
metallb-system   frrdemo   4s
```

Note

The `toReceive` settings above will make your cluster accept all incoming routes. This might not be advisable in a production environment as, depending on your external routers, it can cause your nodes' routing tables to fill up. See documentation on how to filter toReceive further. (https://github.com/metallb/frr-k8s/)

With FRR-K8s these are all the settings needed. Any route that your external BGP router is receiving will be shared with your cluster and all the nodes will have their routing tables updated.

The setup can be tested with what is described in *Chapter 22, MetalLB on K3s (using Layer 3 Mode)*. In order to combine these setups there are some requirements:

- The FRR-K8s configuration is done on a separate cluster. This is required to avoid cluster internal routing.
- Changes to ASN IDs and to the Router IP address are required to match both setups.

With both these setups in place the following can be observed:

- Once the Deployment and Service have been applied on the cluster described in *Chapter 22, MetalLB on K3s (using Layer 3 Mode)*, the route to the service will be visible on the external FRR Router.
- The route will be added to all nodes on the FRR-K8s cluster.

Note

In standard configurations of FRR Routing routes are shared with the next-hop set to the IP Address of the FRR Router. To achieve a next-hop without the FRR Router IP Address, one can add a line "neighbor BGPPG next-hop-unchanged" and a line "neighbor BGPPG as-override" to the `/etc/frr/frr.conf` file on the FRR Router. With this in place, the nodes on the FRR-K8s cluster will get a direct route to the service.

24 MetalLB in front of the Kubernetes API server

This guide demonstrates using a MetalLB service to expose the RKE2/K3s API externally on an HA cluster with three control-plane nodes. To achieve this, a Kubernetes Service of type `LoadBalancer` will be manually created. Then an `EndpointSlices` object will be automatically created which keeps the IPs of all control plane nodes available in the cluster. For the EndpointSlices to be continuously synchronized with the events occurring in the cluster (adding/removing a node or a node goes offline), the Endpoint Copier Operator (*Chapter 16, Endpoint Copier Operator*) will be deployed. The operator monitors the events happening in the default `kubernetes` EndpointSlices and updates the managed one automatically to keep them in sync. Since the managed Service is of type `LoadBalancer`, MetalLB assigns it a static `ExternalIP`. This `ExternalIP` will be used to communicate with the API Server.

24.1 Prerequisites

- Three hosts to deploy RKE2/K3s on top.
  - Ensure the hosts have different host names.
  - For testing, these could be virtual machines
- At least 2 available IPs in the network (one for the Traefik ingress-controller exposed service and one for the managed service).
- Helm

24.2 Installing RKE2/K3s

Note

If you do not want to use a fresh cluster but want to use an existing one, skip this step and proceed to the next one.

First, a free IP in the network must be reserved that will be used later for `ExternalIP` of the managed Service.

SSH to the first host and install the wanted distribution in cluster mode.

For RKE2:

```
# As a root user, create the /etc/rancher/rke2/config.yaml config file with the following
 content:

mkdir -p /etc/rancher/rke2/
cat <<EOF > /etc/rancher/rke2/config.yaml
# An example of the config.yaml file for a server node:
write-kubeconfig-mode: "0644"
tls-san:
  - "${VIP_SERVICE_IP}"
  - "https://${VIP_SERVICE_IP}.sslip.io"
EOF

# Install RKE2
curl -sfL https://get.rke2.io | INSTALL_RKE2_EXEC="server" sh -

# Enable and start the RKE2 service with the configuration specified in the config.yaml
 file
systemctl enable rke2-server.service
systemctl start rke2-server.service

# Fetch the cluster token to be used later:
RKE2_TOKEN=$(tr -d '\n' < /var/lib/rancher/rke2/server/node-token)
```

For K3s:

```
# Export the free IP mentioned above
export VIP_SERVICE_IP=<ip>
export INSTALL_K3S_SKIP_START=false

curl -sfL https://get.k3s.io | INSTALL_K3S_EXEC="server --cluster-init \
 --disable=servicelb --write-kubeconfig-mode=644 --tls-san=${VIP_SERVICE_IP} \
 --tls-san=https://${VIP_SERVICE_IP}.sslip.io" K3S_TOKEN=foobar sh -
```

Note

Make sure that `--disable=servicelb` flag is provided in the `k3s server` command.

Important

From now on, the commands should be run on the local machine.

To access the API server from outside, the IP of the RKE2/K3s VM will be used.

```
# Replace <node-ip> with the actual IP of the machine
export NODE_IP=<node-ip>
export KUBE_DISTRIBUTION=<k3s/rke2>

scp ${NODE_IP}:/etc/rancher/${KUBE_DISTRIBUTION}/${KUBE_DISTRIBUTION}.yaml ~/.kube/config
 && sed \
 -i '' "s/127.0.0.1/${NODE_IP}/g" ~/.kube/config && chmod 600 ~/.kube/config
```

24.3 Configuring an existing cluster

Note

This step is valid only if you intend to use an existing RKE2/K3s cluster.

To use an existing cluster the `tls-san` flags should be modified. Additionally, the `servicelb` LB should be disabled for K3s.

To change the flags for RKE2 or K3s servers, you need to modify either the `/etc/systemd/system/rke2.service` or `/etc/systemd/system/k3s.service` file on all the VMs in the cluster, depending on the distribution.

The flags should be inserted in the `ExecStart`. For example:

For RKE2:

```
# Replace the <vip-service-ip> with the actual ip
ExecStart=/usr/local/bin/rke2 \
    server \
        '--write-kubeconfig-mode=644' \
        '--tls-san=<vip-service-ip>' \
        '--tls-san=https://<vip-service-ip>.sslip.io' \
```

For K3s:

```
# Replace the <vip-service-ip> with the actual ip
ExecStart=/usr/local/bin/k3s \
    server \
        '--cluster-init' \
        '--write-kubeconfig-mode=644' \
        '--disable=servicelb' \
        '--tls-san=<vip-service-ip>' \
        '--tls-san=https://<vip-service-ip>.sslip.io' \
```

Then the following commands should be executed to load the new configurations:

```
systemctl daemon-reload
systemctl restart ${KUBE_DISTRIBUTION}
```

24.4 Installing MetalLB

To deploy `MetalLB`, the MetalLB on K3s (*Chapter 21, MetalLB on K3s (using Layer 2 Mode)*) guide can be used.

NOTE: Ensure that the `VIP_SERVICE_IP` IP address does not overlap with the existing `IPAddressPools` in the cluster.

Create a separate `IpAddressPool` and `L2Advertisement` that will be used only for the managed Service.

NOTE: The IPAddressPool below will be assigned to a Service of type `LoadBalancer` in the `default` Namespace. If multiple `LoadBalancer` services exist there, additional ServiceSelectors (https://metallb.universe.tf/configuration/_advanced_ipaddresspool_configuration/#reduce-scope-of-address-allocation-to-specific-namespace-and-service) may be configured to match this VIP service explicitly.

```
# Export the VIP_SERVICE_IP on the local machine
# Replace with the actual IP
export VIP_SERVICE_IP=<ip>

cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: kubernetes-vip-ip-pool
  namespace: metallb-system
spec:
  addresses:
  - ${VIP_SERVICE_IP}/32
  serviceAllocation:
    priority: 100
    namespaces:
      - default
EOF
```

```
cat <<-EOF | kubectl apply -f -
apiVersion: metallb.io/v1beta1
```

```
kind: L2Advertisement
metadata:
  name: kubernetes-vip-l2-adv
  namespace: metallb-system
spec:
  ipAddressPools:
  - kubernetes-vip-ip-pool
EOF
```

24.5 Installing the Endpoint Copier Operator

```
helm install \
endpoint-copier-operator oci://registry.suse.com/edge/charts/endpoint-copier-operator \
--namespace endpoint-copier-operator \
--create-namespace
```

The command above will deploy the `endpoint-copier-operator` operator Deployment with two replicas. One will be the leader and the other will take over the leader role if needed.

Now, the `kubernetes-vip` Service should be deployed, which will be reconciled by the operator and an EndpointSlices with the configured ports and IP will be created.

For RKE2:

```
cat <<-EOF | kubectl apply -f -
apiVersion: v1
kind: Service
metadata:
  name: kubernetes-vip
  namespace: default
spec:
  ports:
  - name: rke2-api
    port: 9345
    protocol: TCP
    targetPort: 9345
  - name: k8s-api
    port: 6443
    protocol: TCP
    targetPort: 6443
  type: LoadBalancer
EOF
```

For K3s:

```
cat <<-EOF | kubectl apply -f -
```

```
apiVersion: v1
kind: Service
metadata:
  name: kubernetes-vip
  namespace: default
spec:
  internalTrafficPolicy: Cluster
  ipFamilies:
  - IPv4
  ipFamilyPolicy: SingleStack
  ports:
  - name: https
    port: 6443
    protocol: TCP
    targetPort: 6443
  sessionAffinity: None
  type: LoadBalancer
EOF
```

Verify that the `kubernetes-vip` Service has the correct IP address:

```
kubectl get service kubernetes-vip -n default \
 -o=jsonpath='{.status.loadBalancer.ingress[0].ip}'
```

Ensure that the `kubernetes-vip-*` and `kubernetes` EndpointSlices resources in the `default` namespace point to the same IPs.

```
kubectl get endpointslices | grep kubernetes
```

If everything is correct, the last thing left is to use the `VIP_SERVICE_IP` in our `Kubeconfig`.

```
sed -i '' "s/${NODE_IP}/${VIP_SERVICE_IP}/g" ~/.kube/config
```

From now on, all the `kubectl` will go through the `kubernetes-vip` service.

24.6 Adding control-plane nodes

To monitor the entire process, two more terminal tabs can be opened.

First terminal:

```
watch kubectl get nodes
```

Second terminal:

```
watch kubectl get endpointslices
```

Now execute the commands below on the second and third nodes.

For RKE2:

```
# As a root user, create the /etc/rancher/rke2/config.yaml config file with the following
 content:

mkdir -p /etc/rancher/rke2/
cat <<EOF > /etc/rancher/rke2/config.yaml
# An example of the config.yaml file for an additional server node:
server: https://${VIP_SERVICE_IP}:9345
write-kubeconfig-mode: "0644"
tls-san:
  - "${VIP_SERVICE_IP}"
  - "https://${VIP_SERVICE_IP}.sslip.io"
# The one from above
token: ${RKE2_TOKEN}
EOF

# Install RKE2
curl -sfL https://get.rke2.io | INSTALL_RKE2_TYPE="server" sh -

# Enable the RKE2 service with the configuration specified in the config.yaml file

systemctl enable --now rke2-server.service

# Fetch the cluster token to be used later:
RKE2_TOKEN=$(tr -d '\n' < /var/lib/rancher/rke2/server/node-token)
```

For K3s:

```
# Export the VIP_SERVICE_IP in the VM
# Replace with the actual IP
export VIP_SERVICE_IP=<ip>
export INSTALL_K3S_SKIP_START=false

curl -sfL https://get.k3s.io | INSTALL_K3S_EXEC="server \
 --server https://${VIP_SERVICE_IP}:6443 --disable=servicelb \
 --write-kubeconfig-mode=644" K3S_TOKEN=foobar sh -
```

25 Air-gapped deployments with Edge Image Builder

25.1 Intro

This guide will show how to deploy several of the SUSE Edge components completely air-gapped on SUSE Linux Micro 6.2 utilizing Edge Image Builder(EIB) (*Chapter 8, Edge Image Builder*). With this, you'll be able to boot into a customized, ready to boot (CRB) image created by EIB and have the specified components deployed on either a RKE2 or K3s cluster without an Internet connection or any manual steps. This configuration is highly desirable for customers that want to pre-bake all artifacts required for deployment into their OS image, so they are immediately available on boot.

We will cover an air-gapped installation of:

- *Chapter 4, Rancher*
- *Chapter 14, SUSE Security*
- *Chapter 13, SUSE Storage*
- *Chapter 17, Edge Virtualization*
- SUSE Private Registry

Warning

EIB will parse and pre-download all images referenced in the provided Helm charts and Kubernetes manifests. However, some of those may be attempting to pull container images and create Kubernetes resources based on those at runtime. In these cases we have to manually specify the necessary images in the definition file if we want to set up a completely air-gapped environment.

Note

The image lists provided in this guide for each component (Rancher, SUSE Security, SUSE Storage, KubeVirt, and SUSE Private Registry) are a validated baseline for the scenario demonstrated here, not an exhaustive catalog. Any additional or dynamically provisioned workload deployed on top of this baseline — for example, extra Rancher catalog applications or hardware-specific components such as SR-IOV device plugins — pulls its own container images at runtime. Identify and add those images to the definition file independently before deploying in a fully air-gapped environment.

25.2 Prerequisites

If you're following this guide, it's assumed that you are already familiar with EIB (*Chapter 8, Edge Image Builder*). If not, please follow the quick start guide (*Chapter 2, Standalone clusters with Edge Image Builder*) to better understand the concepts shown in practice below.

25.3 Libvirt Network Configuration

Note

To demo the air-gapped deployment, this guide will be done using a simulated air-gapped `libvirt` network and the following configuration will be tailored to that. For your own deployments, you may have to modify the `host1.local.yaml` configuration that will be introduced in the next step.

If you would like to use the same `libvirt` network configuration, follow along. If not, skip to *Section 25.4, "Base Directory Configuration"*.

Let's create an isolated network configuration with an IP address range `192.168.100.2/24` for DHCP:

```
cat << EOF > isolatednetwork.xml
<network>
  <name>isolatednetwork</name>
  <bridge name='virbr1' stp='on' delay='0'/>
  <ip address='192.168.100.1' netmask='255.255.255.0'>
    <dhcp>
      <range start='192.168.100.2' end='192.168.100.254'/>
    </dhcp>
  </ip>
</network>
EOF
```

Now, the only thing left is to create the network and start it:

```
virsh net-define isolatednetwork.xml
virsh net-start isolatednetwork
```

25.4 Base Directory Configuration

The base directory configuration is the same across all different components, so we will set it up here.

We will first create the necessary subdirectories:

```
export CONFIG_DIR=$HOME/config
mkdir -p $CONFIG_DIR/base-images
mkdir -p $CONFIG_DIR/network
mkdir -p $CONFIG_DIR/kubernetes/helm/values
```

Make sure to add whichever base image you plan to use into the `base-images` directory. This guide will focus on the Self Install ISO found here (https://www.suse.com/download/sle-micro/).

Let's copy the downloaded image:

```
cp SL-Micro.x86_64-6.2-Base-SelfInstall-GM.install.iso $CONFIG_DIR/base-images/
slemicro.iso
```

Note

EIB is never going to modify the base image input.

Let's create a file containing the desired network configuration:

```
cat << EOF > $CONFIG_DIR/network/host1.local.yaml
routes:
  config:
  - destination: 0.0.0.0/0
    metric: 100
    next-hop-address: 192.168.100.1
    next-hop-interface: eth0
    table-id: 254
  - destination: 192.168.100.0/24
    metric: 100
    next-hop-address: 192.168.122.1
    next-hop-interface: eth0
    table-id: 254
dns-resolver:
  config:
    server:
    - 192.168.100.1
    - 8.8.8.8
interfaces:
- name: eth0
  type: ethernet
  state: up
  mac-address: 34:8A:B1:4B:16:E7
  ipv4:
```

```
    address:
    - ip: 192.168.100.50
      prefix-length: 24
    dhcp: false
    enabled: true
  ipv6:
    enabled: false
EOF
```

This configuration ensures the following are present on the provisioned systems (using the specified MAC address):

- an Ethernet interface with a static IP address
- routing
- DNS
- hostname (`host1.local`)

The resulting file structure should now look like:

```
├── kubernetes/
│   └── helm/
│       └── values/
├── base-images/
│   └── slemicro.iso
└── network/
    └── host1.local.yaml
```

25.5 Base Definition File

Edge Image Builder is using *definition files* to modify the SUSE Linux Micro images. These files contain the majority of configurable options. Many of these options will be repeated across the different component sections, so we will list and explain those here.

Tip

Full list of customization options in the definition file can be found in the upstream documentation (https://github.com/suse-edge/edge-image-builder/blob/release-1.1/docs/building-images.md#image-definition-file)

We will take a look at the following fields which will be present in all definition files:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
kubernetes:
  version: v1.36.3+rke2r1
embeddedArtifactRegistry:
  images:
    - ...
```

The `image` section is required, and it specifies the input image, its architecture and type, as well as what the output image will be called.

The `operatingSystem` section is optional, and contains configuration to enable login on the provisioned systems with the `root/eib` username/password.

The `kubernetes` section is optional, and it defines the Kubernetes type and version. We are going to use the RKE2 distribution. Use `kubernetes.version: v1.36.3+k3s1` if K3s is desired instead. Unless explicitly configured via the `kubernetes.nodes` field, all clusters we bootstrap in this guide will be single-node ones.

The `embeddedArtifactRegistry` section will include all images which are only referenced and pulled at runtime for the specific component.

25.6 Rancher Installation

Note

The Rancher (*Chapter 4, Rancher*) deployment that will be demonstrated will be highly slimmed down for demonstration purposes. For your actual deployments, additional artifacts may be necessary depending on your configuration.

The Rancher 2.15.1 (https://github.com/rancher/rancher/releases/tag/v2.15.1) release assets contain a `rancher-images.txt` file which lists all the images required for an air-gapped installation.

There are over 600 container images in total which means that the resulting CRB image would be roughly 30GB. For our Rancher installation, we will strip down that list to the smallest working configuration. From there, you can add back any images you may need for your deployments.

We will create the definition file and include the stripped down image list:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
kubernetes:
  version: v1.36.3+rke2r1
  manifests:
    urls:
    - https://github.com/cert-manager/cert-manager/releases/download/v1.20.1/cert-
manager.crds.yaml
  helm:
    charts:
      - name: rancher
        version: 2.15.1
        repositoryName: rancher-prime
        valuesFile: rancher-values.yaml
        targetNamespace: cattle-system
        createNamespace: true
        installationNamespace: kube-system
      - name: cert-manager
        installationNamespace: kube-system
        createNamespace: true
        repositoryName: jetstack
        targetNamespace: cert-manager
        version: 1.20.1
    repositories:
      - name: jetstack
        url: https://charts.jetstack.io
      - name: rancher-prime
        url: https://charts.rancher.com/server-charts/prime
embeddedArtifactRegistry:
```

```
  images:
    - name: registry.rancher.com/rancher/backup-restore-operator:v10.0.2
    - name: registry.rancher.com/rancher/compliance-operator:v1.4.1
    - name: registry.rancher.com/rancher/fleet-agent:v0.16.1
    - name: registry.rancher.com/rancher/fleet:v0.16.1
    - name: registry.rancher.com/rancher/hardened-addon-resizer:1.8.23-build20260717
    - name: registry.rancher.com/rancher/hardened-calico:v3.32.1-build20260722
    - name: registry.rancher.com/rancher/hardened-cluster-autoscaler:v1.10.3-
build20260717
    - name: registry.rancher.com/rancher/hardened-cni-plugins:v1.9.1-build20260717
    - name: registry.rancher.com/rancher/hardened-coredns:v1.14.6-build20260722
    - name: registry.rancher.com/rancher/hardened-dns-node-cache:1.26.8-build20260722
    - name: registry.rancher.com/rancher/hardened-etcd:v3.6.14-k3s1-build20260723
    - name: registry.rancher.com/rancher/hardened-flannel:v0.28.8-build20260722
    - name: registry.rancher.com/rancher/hardened-k8s-metrics-server:v0.9.0-build20260722
    - name: registry.rancher.com/rancher/hardened-kubernetes:v1.36.3-rke2r1-build20260723
    - name: registry.rancher.com/rancher/hardened-multus-cni:v4.3.0-build20260722
    - name: registry.rancher.com/rancher/hardened-multus-dynamic-networks-
controller:v0.3.8-build20260722
    - name: registry.rancher.com/rancher/hardened-multus-thick:v4.3.0-build20260722
    - name: registry.rancher.com/rancher/hardened-traefik:v3.7.8-build20260717
    - name: registry.rancher.com/rancher/hardened-whereabouts:v0.9.4-build20260721
    - name: registry.rancher.com/rancher/k3s-upgrade:v1.36.3-k3s1
    - name: registry.rancher.com/rancher/klipper-helm:v0.13.3-build20260727
    - name: registry.rancher.com/rancher/klipper-lb:v0.4.17
    - name: registry.rancher.com/rancher/kubectl:v1.35.2
    - name: registry.rancher.com/rancher/kuberlr-kubectl:v7.1.1
    - name: registry.rancher.com/rancher/local-path-provisioner:v0.0.36
    - name: registry.rancher.com/rancher/machine:v0.15.0-rancher142
    - name: registry.rancher.com/rancher/nginx-ingress-controller:v1.14.5-hardened2
    - name: registry.rancher.com/rancher/prom-prometheus:v3.8.1
    - name: registry.rancher.com/rancher/prometheus-federator:v6.0.0
    - name: registry.rancher.com/rancher/pushprox:v0.1.10
    - name: registry.rancher.com/rancher/rancher-agent:v2.15.1
    - name: registry.rancher.com/rancher/rancher-csp-adapter:v10.0.0
    - name: registry.rancher.com/rancher/rancher-webhook:v0.11.1
    - name: registry.rancher.com/rancher/rancher:v2.15.1
    - name: registry.rancher.com/rancher/remotedialer-proxy:v0.7.2
    - name: registry.rancher.com/rancher/rke2-cloud-
provider:v1.36.2-0.20260610225606-10b320a3ba51-build20260709
    - name: registry.rancher.com/rancher/rke2-runtime:v1.36.3-rke2r1
    - name: registry.rancher.com/rancher/rke2-upgrade:v1.36.3-rke2r1
    - name: registry.rancher.com/rancher/scc-operator:v0.5.1
    - name: registry.rancher.com/rancher/security-scan:v0.9.1
    - name: registry.rancher.com/rancher/shell:v0.8.1
    - name: registry.rancher.com/rancher/supportability-review-app-frontend:v0.19.0
    - name: registry.rancher.com/rancher/supportability-review-internal:latest
```

```
    - name: registry.rancher.com/rancher/supportability-review-operator:v0.19.0
    - name: registry.rancher.com/rancher/supportability-review:latest
    - name: registry.rancher.com/rancher/system-agent-installer-k3s:v1.36.3-k3s1
    - name: registry.rancher.com/rancher/system-agent-installer-rke2:v1.36.3-rke2r1
    - name: registry.rancher.com/rancher/system-agent:v0.3.16-suc
    - name: registry.rancher.com/rancher/system-upgrade-controller:v0.20.1
    - name: registry.rancher.com/rancher/turtles:v0.27.1
    - name: registry.rancher.com/rancher/ui-plugin-catalog:4.15.0
    - name: registry.rancher.com/rancher/mirrored-ingress-nginx-kube-webhook-
certgen:v1.6.7
```

As compared to the full list of 600+ container images, this slimmed down version only contains ~60 which makes the new CRB image only about 7GB.

We also need to create a Helm values file for Rancher:

```
cat << EOF > $CONFIG_DIR/kubernetes/helm/values/rancher-values.yaml
hostname: 192.168.100.50.sslip.io
replicas: 1
bootstrapPassword: "adminadminadmin"
systemDefaultRegistry: registry.rancher.com
useBundledSystemChart: true
EOF
```

Warning

Setting the `systemDefaultRegistry` to `registry.rancher.com` allows Rancher to automatically look for images in the embedded artifact registry started within the CRB image at boot. Omitting this field may result in failure to find the container images on the node.

Let's build the image:

```
podman run --rm -it --privileged -v $CONFIG_DIR:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file eib-iso-definition.yaml
```

The output should be similar to the following:

```
Downloading file: dl-manifest-1.yaml 100% |
████████████████████████████████████████████████████████████████████████████████| (583/583
 kB, 12 MB/s)
Pulling selected Helm charts... 100% |
████████████████████████████████████████████████████████████████████████████████████████|
 (2/2, 3 it/s)
Generating image customization components...
```

```
Identifier ................... [SUCCESS]
Custom Files ................. [SKIPPED]
Time ......................... [SKIPPED]
Network ...................... [SUCCESS]
Groups ....................... [SKIPPED]
Users ........................ [SUCCESS]
Proxy ........................ [SKIPPED]
Rpm .......................... [SKIPPED]
Os Files ..................... [SKIPPED]
Systemd ...................... [SKIPPED]
Fips ......................... [SKIPPED]
Elemental .................... [SKIPPED]
Suma ......................... [SKIPPED]
Populating Embedded Artifact Registry... 100% |
████████████████████████████████████████████████████████████████████████████| (56/56, 8
 it/min)
Embedded Artifact Registry ... [SUCCESS]
Keymap ....................... [SUCCESS]
Configuring Kubernetes component...
The Kubernetes CNI is not explicitly set, defaulting to 'cilium'.
Downloading file: rke2_installer.sh
Downloading file: rke2-images-core.linux-amd64.tar.zst 100% |
████████████████████████████████████████████████████████| (644/644 MB, 29 MB/s)
Downloading file: rke2-images-cilium.linux-amd64.tar.zst 100% |
████████████████████████████████████████████████████| (400/400 MB, 29 MB/s)
Downloading file: rke2.linux-amd64.tar.gz 100% |
████████████████████████████████████████████████████████████████████████████| (36/36 MB,
 30 MB/s)
Downloading file: sha256sum-amd64.txt 100% |
████████████████████████████████████████████████████████████████████████████| (4.3/4.3
 kB, 29 MB/s)
Kubernetes ................... [SUCCESS]
Certificates ................. [SKIPPED]
Cleanup ...................... [SKIPPED]
Building ISO image...
Kernel Params ................ [SKIPPED]
Build complete, the image can be found at: eib-image.iso
```

Once a node using the built image is provisioned, we can verify the Rancher installation:

```
/var/lib/rancher/rke2/bin/kubectl get all -n cattle-system --kubeconfig /etc/rancher/
rke2/rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                          READY   STATUS      RESTARTS   AGE
pod/helm-operation-6l6ld                      0/2     Completed   0          107s
```

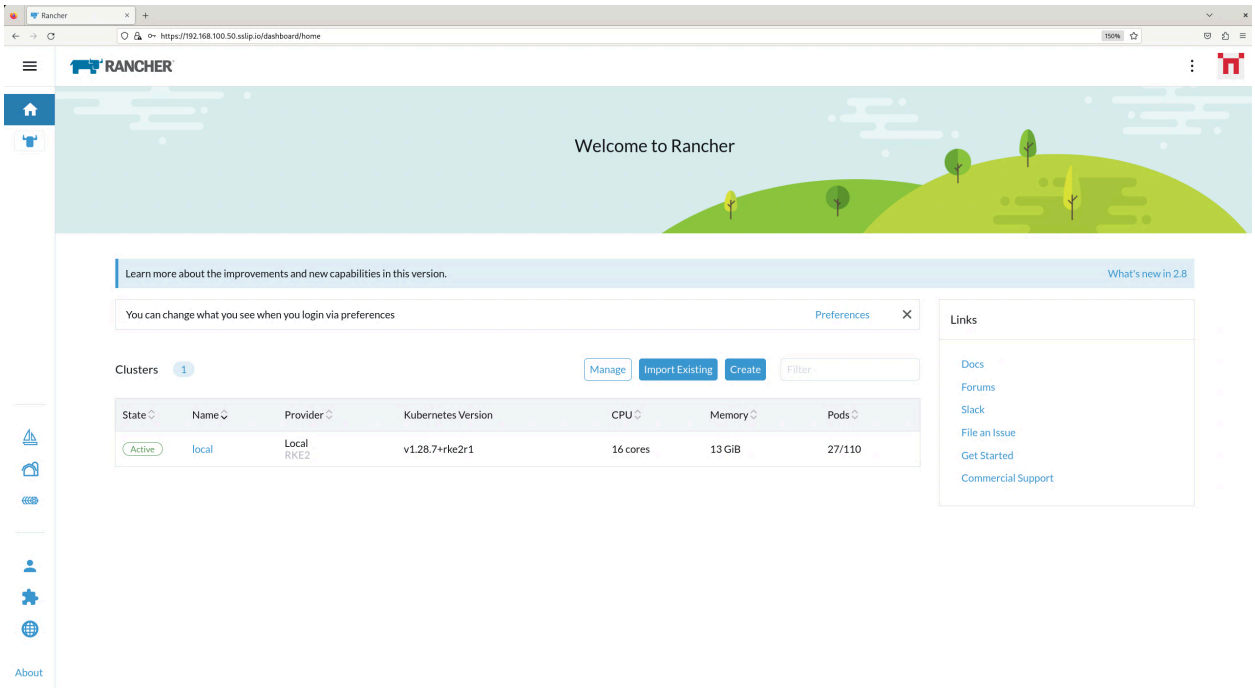
```
pod/helm-operation-8tk2v                        0/2     Completed   0          2m2s
pod/helm-operation-blnrr                        0/2     Completed   0          2m49s
pod/helm-operation-hdcmt                        0/2     Completed   0          3m19s
pod/helm-operation-m74c7                        0/2     Completed   0          97s
pod/helm-operation-qzzr4                        0/2     Completed   0          2m30s
pod/helm-operation-s9jh5                        0/2     Completed   0          3m
pod/helm-operation-tq7ts                        0/2     Completed   0          2m41s
pod/rancher-99d599967-ftjkk                     1/1     Running     0          4m15s
pod/rancher-webhook-79798674c5-6w28t            1/1     Running     0          2m27s
pod/system-upgrade-controller-56696956b-trq5c   1/1     Running     0          104s

NAME                      TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)          AGE
service/rancher           ClusterIP   10.43.255.80   <none>        80/TCP,443/TCP   4m15s
service/rancher-webhook   ClusterIP   10.43.7.238    <none>        443/TCP          2m27s

NAME                                     READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/rancher                  1/1     1            1           4m15s
deployment.apps/rancher-webhook          1/1     1            1           2m27s
deployment.apps/system-upgrade-controller   1/1     1            1           104s

NAME                                                DESIRED   CURRENT   READY   AGE
replicaset.apps/rancher-99d599967                   1         1         1       4m15s
replicaset.apps/rancher-webhook-79798674c5          1         1         1       2m27s
replicaset.apps/system-upgrade-controller-56696956b   1         1         1       104s
```

And when we go to `https://192.168.100.50.sslip.io` and log in with the `adminadminadmin` password that we set earlier, we are greeted with the Rancher dashboard:



25.7 SUSE Security Installation

Unlike the Rancher installation, the SUSE Security installation does not require any special handling in EIB. EIB will automatically air-gap every image required by its underlying component NeuVector.

We will create the definition file:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
kubernetes:
  version: v1.36.3+rke2r1
  helm:
    charts:
      - name: neuvector-crd
        version: 110.0.1+up2.11.1
        repositoryName: rancher-charts
        targetNamespace: neuvector
        createNamespace: true
        installationNamespace: kube-system
        valuesFile: neuvector-values.yaml
      - name: neuvector
        version: 110.0.1+up2.11.1
        repositoryName: rancher-charts
        targetNamespace: neuvector
        createNamespace: true
        installationNamespace: kube-system
        valuesFile: neuvector-values.yaml
    repositories:
      - name: rancher-charts
        url: https://charts.rancher.io/
```

We will also create a Helm values file for NeuVector:

```
cat << EOF > $CONFIG_DIR/kubernetes/helm/values/neuvector-values.yaml
controller:
  replicas: 1
manager:
  enabled: false
```

```
cve:
  scanner:
    enabled: false
    replicas: 1
k3s:
  enabled: true
crdwebhook:
  enabled: false
EOF
```

Let’s build the image:

```
podman run --rm -it --privileged -v $CONFIG_DIR:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file eib-iso-definition.yaml
```

The output should be similar to the following:

```
Pulling selected Helm charts... 100% |
└────────────
```

```
Kernel Params ............... [SKIPPED]
Build complete, the image can be found at: eib-image.iso
```

Once a node using the built image is provisioned, we can verify the SUSE Security installation:

```
/var/lib/rancher/rke2/bin/kubectl get all -n neuvector --kubeconfig /etc/rancher/rke2/
rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                              READY   STATUS      RESTARTS   AGE
pod/neuvector-cert-upgrader-job-bxbnz             0/1     Completed   0          3m39s
pod/neuvector-controller-pod-7d854bfdc7-nhxjf     1/1     Running     0          3m44s
pod/neuvector-enforcer-pod-ct8jm                  1/1     Running     0          3m44s

NAME                                        TYPE        CLUSTER-IP      EXTERNAL-IP
 PORT(S)                          AGE
service/neuvector-svc-admission-webhook   ClusterIP   10.43.234.241   <none>        443/
TCP                           3m44s
service/neuvector-svc-controller          ClusterIP   None            <none>
 18300/TCP,18301/TCP,18301/UDP   3m44s
service/neuvector-svc-crd-webhook         ClusterIP   10.43.50.190    <none>        443/
TCP                           3m44s

NAME                                      DESIRED   CURRENT   READY   UP-TO-DATE
 AVAILABLE   NODE SELECTOR   AGE
daemonset.apps/neuvector-enforcer-pod   1         1         1       1            1
    <none>          3m44s

NAME                                         READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/neuvector-controller-pod   1/1     1            1           3m44s

NAME                                                    DESIRED   CURRENT   READY   AGE
replicaset.apps/neuvector-controller-pod-7d854bfdc7   1         1         1       3m44s

NAME                                          SCHEDULE    TIMEZONE   SUSPEND   ACTIVE
 LAST SCHEDULE   AGE
cronjob.batch/neuvector-cert-upgrader-pod   0 0 1 1 *   <none>     True      0
 <none>          3m44s
cronjob.batch/neuvector-updater-pod         0 0 * * *   <none>     False     0
 <none>          3m44s

NAME                                      STATUS     COMPLETIONS   DURATION   AGE
job.batch/neuvector-cert-upgrader-job   Complete   1/1           7s         3m39s
```

25.8 SUSE Storage Installation

The official documentation (https://longhorn.io/docs/1.12.1/deploy/install/airgap/) for Longhorn contains a `longhorn-images.txt` file which lists all the images required for an air-gapped installation. We will be including their mirrored counterparts from the Rancher container registry in our definition file. Let's create it:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
  packages:
    sccRegistrationCode: [reg-code]
    packageList:
      - open-iscsi
kubernetes:
  version: v1.36.3+rke2r1
  helm:
    charts:
      - name: suse-storage
        releaseName: longhorn
        repositoryName: rancher-application-collection
        targetNamespace: longhorn-system
        createNamespace: true
        version: 1.12.1
    repositories:
      - name: rancher-application-collection
        url: oci://dp.apps.rancher.io/charts
        authentication:
          username: $APPS.RANCHER.IO_USERNAME
          password: $APPS.RANCHER.IO_ACCESS_TOKEN
embeddedArtifactRegistry:
  registries:
    - uri: dp.apps.rancher.io
      authentication:
        username: $APPS.RANCHER.IO_USERNAME
        password: $APPS.RANCHER.IO_ACCESS_TOKEN
  images:
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-attacher:4.12.0-17.6
```

```
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-provisioner:5.3.0-17.8
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-resizer:2.2.1-10.8
    - name: dp.apps.rancher.io/containers/kubernetes-csi-external-snapshotter:8.6.0-17.6
    - name: dp.apps.rancher.io/containers/kubernetes-csi-livenessprobe:2.19.0-17.6
    - name: dp.apps.rancher.io/containers/kubernetes-csi-node-driver-
registrar:2.17.0-17.6
    - name: dp.apps.rancher.io/containers/longhorn-backing-image-manager:1.12.1-1.5
    - name: dp.apps.rancher.io/containers/longhorn-engine:1.12.1-1.6
    - name: dp.apps.rancher.io/containers/longhorn-instance-manager:1.12.1-1.7
    - name: dp.apps.rancher.io/containers/longhorn-manager:1.12.1-1.5
    - name: dp.apps.rancher.io/containers/longhorn-share-manager:1.12.1-1.5
    - name: dp.apps.rancher.io/containers/longhorn-ui:1.12.1-1.3
    - name: dp.apps.rancher.io/containers/rancher-support-bundle-kit:0.0.92-13.12
```

Note

You will notice that the definition file lists the `open-iscsi` package. This is necessary since Longhorn relies on a `iscsiadm` daemon running on the different nodes to provide persistent volumes to Kubernetes.

Let's build the image:

```
podman run --rm -it --privileged -v $CONFIG_DIR:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file eib-iso-definition.yaml
```

The output should be similar to the following:

```
Setting up Podman API listener...
Pulling selected Helm charts... 100% |
 (2/2, 3 it/s)
Generating image customization components...
Identifier ................... [SUCCESS]
Custom Files ................. [SKIPPED]
Time ......................... [SKIPPED]
Network ...................... [SUCCESS]
Groups ....................... [SKIPPED]
Users ........................ [SUCCESS]
Proxy ........................ [SKIPPED]
Resolving package dependencies...
Rpm .......................... [SUCCESS]
Os Files ..................... [SKIPPED]
Systemd ...................... [SKIPPED]
Fips ......................... [SKIPPED]
Elemental .................... [SKIPPED]
```

```
Suma ......................... [SKIPPED]
Populating Embedded Artifact Registry... 100% |
 (15/15, 20956 it/s)
Embedded Artifact Registry ... [SUCCESS]
Keymap ....................... [SUCCESS]
Configuring Kubernetes component...
The Kubernetes CNI is not explicitly set, defaulting to 'cilium'.
Downloading file: rke2_installer.sh
Downloading file: rke2-images-core.linux-amd64.tar.zst 100% (782/782 MB, 108 MB/s)
Downloading file: rke2-images-cilium.linux-amd64.tar.zst 100% (367/367 MB, 104 MB/s)
Downloading file: rke2.linux-amd64.tar.gz 100% (34/34 MB, 108 MB/s)
Downloading file: sha256sum-amd64.txt 100% (3.9/3.9 kB, 7.5 MB/s)
Kubernetes ................... [SUCCESS]
Certificates ................. [SKIPPED]
Cleanup ...................... [SKIPPED]
Building ISO image...
Kernel Params ................ [SKIPPED]
Build complete, the image can be found at: eib-image.iso
```

Once a node using the built image is provisioned, we can verify the Longhorn installation:

```
/var/lib/rancher/rke2/bin/kubectl get all -n longhorn-system --kubeconfig /etc/rancher/
rke2/rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                                     READY   STATUS    RESTARTS   AGE
pod/csi-attacher-787fd9c6c8-sf42d                        1/1     Running   0
 2m28s
pod/csi-attacher-787fd9c6c8-tb82p                        1/1     Running   0
 2m28s
pod/csi-attacher-787fd9c6c8-zhc6s                        1/1     Running   0
 2m28s
pod/csi-provisioner-74486b95c6-b2v9s                     1/1     Running   0
 2m28s
pod/csi-provisioner-74486b95c6-hwllt                     1/1     Running   0
 2m28s
pod/csi-provisioner-74486b95c6-mlrpk                     1/1     Running   0
 2m28s
pod/csi-resizer-859d4557fd-t54zk                         1/1     Running   0
 2m28s
pod/csi-resizer-859d4557fd-vdt5d                         1/1     Running   0
 2m28s
pod/csi-resizer-859d4557fd-x9kh4                         1/1     Running   0
 2m28s
pod/csi-snapshotter-6f69c6c8cc-r62gr                     1/1     Running   0
 2m28s
```

```
pod/csi-snapshotter-6f69c6c8cc-vrwjn                     1/1     Running   0
 2m28s
pod/csi-snapshotter-6f69c6c8cc-z65nb                     1/1     Running   0
 2m28s
pod/engine-image-ei-4623b511-9vhkb                       1/1     Running   0
 3m13s
pod/instance-manager-6f95fd57d4a4cd0459e469d75a300552   1/1     Running   0
 2m43s
pod/longhorn-csi-plugin-gx98x                            3/3     Running   0
 2m28s
pod/longhorn-driver-deployer-55f9c88499-fbm6q            1/1     Running   0
 3m28s
pod/longhorn-manager-dpdp7                               2/2     Running   0
 3m28s
pod/longhorn-ui-59c85fcf94-gg5hq                         1/1     Running   0
 3m28s
pod/longhorn-ui-59c85fcf94-s49jc                         1/1     Running   0
 3m28s

NAME                                  TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)
 AGE
service/longhorn-admission-webhook    ClusterIP   10.43.77.89    <none>        9502/TCP
 3m28s
service/longhorn-backend              ClusterIP   10.43.56.17    <none>        9500/TCP
 3m28s
service/longhorn-conversion-webhook   ClusterIP   10.43.54.73    <none>        9501/TCP
 3m28s
service/longhorn-frontend             ClusterIP   10.43.22.82    <none>        80/TCP
 3m28s
service/longhorn-recovery-backend     ClusterIP   10.43.45.143   <none>        9503/TCP
 3m28s

NAME                                        DESIRED   CURRENT   READY   UP-TO-DATE
 AVAILABLE   NODE SELECTOR   AGE
daemonset.apps/engine-image-ei-4623b511   1         1         1       1            1
      <none>          3m13s
daemonset.apps/longhorn-csi-plugin        1         1         1       1            1
      <none>          2m28s
daemonset.apps/longhorn-manager           1         1         1       1            1
      <none>          3m28s

NAME                                         READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/csi-attacher                 3/3     3            3           2m28s
deployment.apps/csi-provisioner              3/3     3            3           2m28s
deployment.apps/csi-resizer                  3/3     3            3           2m28s
deployment.apps/csi-snapshotter              3/3     3            3           2m28s
deployment.apps/longhorn-driver-deployer     1/1     1            1           3m28s
```

```
deployment.apps/longhorn-ui                 2/2     2            2           3m28s

NAME                                                  DESIRED   CURRENT   READY   AGE
replicaset.apps/csi-attacher-787fd9c6c8               3         3         3       2m28s
replicaset.apps/csi-provisioner-74486b95c6            3         3         3       2m28s
replicaset.apps/csi-resizer-859d4557fd                3         3         3       2m28s
replicaset.apps/csi-snapshotter-6f69c6c8cc            3         3         3       2m28s
replicaset.apps/longhorn-driver-deployer-55f9c88499   1         1         1       3m28s
replicaset.apps/longhorn-ui-59c85fcf94                2         2         2       3m28s
```

25.9 KubeVirt and CDI Installation

The Helm charts for both KubeVirt and CDI are only installing their respective operators. It is up to the operators to deploy the rest of the systems which means we will have to include all necessary container images in our definition file. Let's create it:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
kubernetes:
  version: v1.36.3+rke2r1
  helm:
    charts:
      - name: kubevirt
        repositoryName: suse-edge
        version: 307.0.3+up0.8.0
        targetNamespace: kubevirt-system
        createNamespace: true
        installationNamespace: kube-system
      - name: cdi
        repositoryName: suse-edge
        version: 307.0.3+up0.8.0
        targetNamespace: cdi-system
        createNamespace: true
        installationNamespace: kube-system
    repositories:
```

```
      - name: suse-edge
        url: oci://registry.suse.com/edge/charts
embeddedArtifactRegistry:
  images:
    - name: registry.suse.com/suse/sles/16.0/cdi-apiserver:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-cloner:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-controller:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-importer:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-operator:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-uploadproxy:1.65.0
    - name: registry.suse.com/suse/sles/16.0/cdi-uploadserver:1.65.0
    - name: registry.suse.com/suse/sles/16.0/virt-api:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-controller:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-exportproxy:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-exportserver:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-handler:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-launcher:1.8.3
    - name: registry.suse.com/suse/sles/16.0/virt-operator:1.8.3
```

Let’s build the image:

```
podman run --rm -it --privileged -v $CONFIG_DIR:/eib \
registry.suse.com/edge/3.7/edge-image-builder:1.3.4 \
build --definition-file eib-iso-definition.yaml
```

The output should be similar to the following:

```
Pulling selected Helm charts... 100% |
 (2/2, 48 it/min)
Generating image customization components...
Identifier ................... [SUCCESS]
Custom Files ................. [SKIPPED]
Time ......................... [SKIPPED]
Network ...................... [SUCCESS]
Groups ....................... [SKIPPED]
Users ........................ [SUCCESS]
Proxy ........................ [SKIPPED]
Rpm .......................... [SKIPPED]
Os Files ..................... [SKIPPED]
Systemd ...................... [SKIPPED]
Fips ......................... [SKIPPED]
Elemental .................... [SKIPPED]
Suma ......................... [SKIPPED]
Populating Embedded Artifact Registry... 100% |
 (15/15, 4 it/min)
Embedded Artifact Registry ... [SUCCESS]
```

```
Keymap ....................... [SUCCESS]
Configuring Kubernetes component...
The Kubernetes CNI is not explicitly set, defaulting to 'cilium'.
Downloading file: rke2_installer.sh
Kubernetes ................... [SUCCESS]
Certificates ................. [SKIPPED]
Cleanup ...................... [SKIPPED]
Building ISO image...
Kernel Params ................ [SKIPPED]
Build complete, the image can be found at: eib-image.iso
```

Once a node using the built image is provisioned, we can verify the installation of both KubeVirt and CDI.

Verify KubeVirt:

```
/var/lib/rancher/rke2/bin/kubectl get all -n kubevirt-system --kubeconfig /etc/rancher/
rke2/rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                  READY   STATUS    RESTARTS   AGE
pod/virt-api-59cb997648-mmt67         1/1     Running   0          2m34s
pod/virt-controller-69786b785-7cc96   1/1     Running   0          2m8s
pod/virt-controller-69786b785-wq2dz   1/1     Running   0          2m8s
pod/virt-handler-2l4dm                1/1     Running   0          2m8s
pod/virt-operator-7c444cff46-nps4l    1/1     Running   0          3m1s
pod/virt-operator-7c444cff46-r25xq    1/1     Running   0          3m1s

NAME                                  TYPE        CLUSTER-IP      EXTERNAL-IP   PORT(S)
 AGE
service/kubevirt-operator-webhook     ClusterIP   10.43.167.109   <none>        443/TCP
 2m36s
service/kubevirt-prometheus-metrics   ClusterIP   None            <none>        443/TCP
 2m36s
service/virt-api                      ClusterIP   10.43.18.202    <none>        443/TCP
 2m36s
service/virt-exportproxy              ClusterIP   10.43.142.188   <none>        443/TCP
 2m36s

NAME                          DESIRED   CURRENT   READY   UP-TO-DATE   AVAILABLE   NODE
 SELECTOR            AGE
daemonset.apps/virt-handler   1         1         1       1            1
 kubernetes.io/os=linux   2m8s

NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/virt-api            1/1     1            1           2m34s
deployment.apps/virt-controller     2/2     2            2           2m8s
deployment.apps/virt-operator       2/2     2            2           3m1s
```

```
NAME                                          DESIRED   CURRENT   READY   AGE
replicaset.apps/virt-api-59cb997648           1         1         1       2m34s
replicaset.apps/virt-controller-69786b785     2         2         2       2m8s
replicaset.apps/virt-operator-7c444cff46      2         2         2       3m1s

NAME                              AGE    PHASE
kubevirt.kubevirt.io/kubevirt     3m1s   Deployed
```

Verify CDI:

```
/var/lib/rancher/rke2/bin/kubectl get all -n cdi-system --kubeconfig /etc/rancher/rke2/
rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                     READY   STATUS    RESTARTS   AGE
pod/cdi-apiserver-5598c9bf47-pqfxw       1/1     Running   0          3m44s
pod/cdi-deployment-7cbc5db7f8-g46z7      1/1     Running   0          3m44s
pod/cdi-operator-777c865745-2qcnj        1/1     Running   0          3m48s
pod/cdi-uploadproxy-646f4cd7f7-fzkv7     1/1     Running   0          3m44s

NAME                               TYPE        CLUSTER-IP     EXTERNAL-IP   PORT(S)    AGE
service/cdi-api                    ClusterIP   10.43.2.224    <none>        443/TCP
 3m44s
service/cdi-prometheus-metrics     ClusterIP   10.43.237.13   <none>        8080/TCP
 3m44s
service/cdi-uploadproxy            ClusterIP   10.43.114.91   <none>        443/TCP
 3m44s

NAME                                READY   UP-TO-DATE   AVAILABLE   AGE
deployment.apps/cdi-apiserver       1/1     1            1           3m44s
deployment.apps/cdi-deployment      1/1     1            1           3m44s
deployment.apps/cdi-operator        1/1     1            1           3m48s
deployment.apps/cdi-uploadproxy     1/1     1            1           3m44s

NAME                                          DESIRED   CURRENT   READY   AGE
replicaset.apps/cdi-apiserver-5598c9bf47      1         1         1       3m44s
replicaset.apps/cdi-deployment-7cbc5db7f8     1         1         1       3m44s
replicaset.apps/cdi-operator-777c865745       1         1         1       3m48s
replicaset.apps/cdi-uploadproxy-646f4cd7f7    1         1         1       3m44s
```

25.10 SUSE Private Registry Installation

To include the SUSE Private Registry in an air-gapped deployment, we must update the definition file to include the required helm chart as well as the embedded artifacts for the new images.

Let’s update the definition file:

```
apiVersion: 1.3
image:
  imageType: iso
  arch: x86_64
  baseImage: slemicro.iso
  outputImageName: eib-image.iso
operatingSystem:
  users:
    - username: root
      encryptedPassword: $6$jHugJNNd3HElGsUZ
$eodjVe4te5ps44SVcWshdfWizrP.xAyd71CVEXazBJ/.v799/WRCBXxfYmunlBO2yp1hm/zb4r8EmnrrNCF.P/
kubernetes:
  version: v1.36.3+rke2r1
  helm:
    charts:
      - name: metallb
        version: 307.0.3+up0.16.1
        targetNamespace: metallb-system
        createNamespace: true
        repositoryName: suse-edge-charts
        installationNamespace: kube-system
      - name: suse-storage
        releaseName: longhorn
        repositoryName: rancher-application-collection
        targetNamespace: longhorn-system
        createNamespace: true
        version: 1.12.1
      - name: private-registry-helm
        createNamespace: true
        installationNamespace: kube-system
        repositoryName: privateregistry
        targetNamespace: suse-private-registry
        valuesFile: privateregistry.yaml
        version: 1.1.1
    repositories:
      - name: privateregistry
        authentication:
          username: ${PRIVATE_REGISTRY_USERNAME}
          password: ${PRIVATE_REGISTRY_PASSWORD}
        plainHTTP: false
        skipTLSVerify: false
        url: oci://registry.suse.com/private-registry
      - name: rancher-application-collection
        url: oci://dp.apps.rancher.io/charts
        authentication:
```

```
          username: $APPS.RANCHER.IO_USERNAME
          password: $APPS.RANCHER.IO_ACCESS_TOKEN
embeddedArtifactRegistry:
  registries:
    - uri: registry.suse.com
      authentication:
        username: ${PRIVATE_REGISTRY_USERNAME}
        password: ${PRIVATE_REGISTRY_PASSWORD}
    - uri: dp.apps.rancher.io
        authentication:
          username: $APPS.RANCHER.IO_USERNAME
          password: $APPS.RANCHER.IO_ACCESS_TOKEN
  images:
    - name: registry.suse.com/private-registry/harbor-core:1.1.1-1.19
    - name: registry.suse.com/private-registry/harbor-jobservice:1.1.1-1.19
    - name: registry.suse.com/private-registry/harbor-portal:1.1.1-1.20
    - name: registry.suse.com/private-registry/harbor-registry:1.1.1-1.19
    - name: registry.suse.com/private-registry/harbor-registryctl:1.1.1-1.19
    - name: registry.suse.com/private-registry/harbor-trivy-adapter:1.1.1-1.24
```

Note

You will need certain credentials, which can be retrieved by following the official SUSE Private Registry documentation (https://documentation.suse.com/cloudnative/suse-private-registry/html/private-registry/pr-deployment.html#pr-deployment-kube-secrets). You must also modify the `${PRIVATE_REGISTRY_USERNAME}` and `${PRIVATE_REGISTRY_PASSWORD}` variables. Make sure to list the images containing the component versions you need.

Now we need to add the required Kubernetes manifests to properly configure the SUSE Private Registry. You need to modify the `${MGMT_CLUSTER_REGISTRY_IP}` with a reserved static IP for the SUSE Private Registry in the following files:

1. `kubernetes/manifests/metallb-registry.yaml`

```
apiVersion: metallb.io/v1beta1
kind: L2Advertisement
metadata:
  name: private-registry
  namespace: metallb-system
spec:
  ipAddressPools:
  - private-registry-pool
---
```

```
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: private-registry-pool
  namespace: metallb-system
spec:
  addresses:
  - ${MGMT_CLUSTER_REGISTRY_IP}/32
  serviceAllocation:
    namespaces:
    - suse-private-registry
```

2. `kubernetes/helm/values/privateregistry.yaml`

```
core:
  secretName: suse-registry-tls
expose:
  tls:
    certSource: secret
    enabled: true
    secret:
      secretName: suse-registry-tls
  type: loadBalancer
externalURL: https://${MGMT_CLUSTER_REGISTRY_IP}
persistence:
  persistentVolumeClaim:
    registry:
      size: 20Gi
```

Finally, the `kubernetes/manifests/suse-private-registry-creds.yaml` must be created with the following content:

```
apiVersion: v1
kind: Secret
metadata:
  name: suse-registry
  namespace: suse-private-registry
type: kubernetes.io/dockerconfigjson
data:
  .dockerconfigjson: ${DOCKER_CONFIG_JSON_BASE64}
---
apiVersion: v1
kind: Secret
metadata:
    name: suse-registry-tls
    namespace: suse-private-registry
type: kubernetes.io/tls
```

```
data:
    tls.crt: ${TLS_CRT_BASE64}
    tls.key: ${TLS_KEY_BASE64}
```

To correctly configure the docker config json (base64) for `${DOCKER_CONFIG_JSON_BASE64}`, run:

```
# ${DOCKER_CONFIG_JSON_BASE64} CONTENT
echo -n '{"auths": {"<MGMT_CLUSTER_REGISTRY_IP>": {"username": "<USERNAME>", "password":
 "<PASSWORD>", "auth": "<AUTH>"}}}' | base64
```

Where the IP is the same as the previously configured `${MGMT_CLUSTER_REGISTRY_IP}`, and the `username`, `password`, and `auth` can be retrieved from the SUSE Private Registry official documentation (https://documentation.suse.com/cloudnative/suse-private-registry/html/private-registry/pr-deployment.html#pr-deployment-kube-secrets).

To generate the base64-encoded TLS certificate and key (`tls.crt` and `tls.key`) for `${TLS_CRT_BASE64}` and `${TLS_KEY_BASE64}`, you can create your own by running:

```
# Generate a self-signed certificate and key
openssl req -x509 -newkey rsa:4096 -keyout key.pem -out cert.pem -sha256 -days 365 -nodes

# Convert them to base64 for the suse-private-registry-creds.yaml file
cat cert.pem | base64 -w 0
cat key.pem | base64 -w 0
```

Verify SUSE Private Registry:

```
/var/lib/rancher/rke2/bin/kubectl get pods -n suse-private-registry --kubeconfig /etc/
rancher/rke2/rke2.yaml
```

The output should be similar to the following, showing that everything has been successfully deployed:

```
NAME                                                      READY   STATUS    RESTARTS
 AGE
pod/private-registry-harbor-core-588fd4876f-8tqnv         1/1     Running   0
 4m30s
pod/private-registry-harbor-database-0                    1/1     Running   0
 4m30s
pod/private-registry-harbor-jobservice-7658f97fbc-4vq6n   1/1     Running   0
 4m30s
pod/private-registry-harbor-portal-5455ccc4bc-jpmt5       1/1     Running   0
 4m30s
pod/private-registry-harbor-redis-0                       1/1     Running   0
 4m30s
pod/private-registry-harbor-registry-5648b9d89-wdswz      2/2     Running   0
 4m30s
```

```
pod/private-registry-harbor-trivy-0                       1/1     Running   0
 4m30s
```

25.11 Troubleshooting

If you run into any issues while building the images or are looking to further test and debug the process, please refer to the upstream documentation (https://github.com/suse-edge/edge-image-builder/tree/release-1.1/docs).

26 Building Updated SUSE Linux Micro Images with Kiwi

This section explains how to generate updated SUSE Linux Micro images to be used with Edge Image Builder, with Cluster API (CAPI) + Metal[3], or to write the disk image directly to a block device. This process is useful in situations where the latest patches are required to be included in the initial system boot images (to minimise patch transfer post-installation), or for scenarios where CAPI is used, where it's preferred to reinstall the operating system with a new image rather than upgrading the hosts in place.

This process makes use of Kiwi (https://osinside.github.io/kiwi/) to run the image build. SUSE Edge ships with a containerized version that simplifies the overall process with a helper utility baked in, allowing to specify the target **profile** required. The profile defines the type of output image that is required, with the common ones listed below:

- "**Base**" - A SUSE Linux Micro disk image with a reduced package set (it includes podman).
- "**Base-SelfInstall**" - A SelfInstall image based on the "Base" above.
- "**Base-RT**" - Same as "Base" above but using a real-time (rt) kernel instead.
- "**Base-RT-SelfInstall**" - A SelfInstall image based on the "Base-RT" above
- "**Default**" - A SUSE Linux Micro disk image based on the "Base" above but with a few more tools, including the virtualization stack, Cockpit and salt-minion.
- "**Default-SelfInstall**" - A SelfInstall image based on the "Default" above

See SUSE Linux Micro 6.2 (https://documentation.suse.com/sle-micro/6.2/html/Micro-deployment-images/index.html#alp-images-installer-type) documentation for more details.

Note

This process works for both AMD64/Intel 64 and AArch64 architectures but it is necessary to use a build host with the same architecture of the images being built. In other words, to build an AArch64 image, it is required to use an AArch64 build host, and vice-versa for AMD64/Intel 64 - cross-builds are not supported at this time.

26.1 Prerequisites

Kiwi image builder requires the following:

- A SUSE Linux Micro 6.2 host ("build system") with the same architecture of the image being built.
- The build system needs to be already registered via `SUSEConnect` (the registration is used to pull the latest packages from the SUSE repositories)
- An internet connection that can be used to pull the required packages. If connected via proxy, the build host needs to be pre-configured.
- SELinux needs to be disabled on the build host (as SELinux labelling takes place in the container and it can conflict with the host policy)
- At least 10GB free disk space to accommodate the container image, the build root, and the resulting output image(s)

26.2 Getting Started

Due to certain limitations, it is currently required to disable SELinux. Connect to the SUSE Linux Micro 6.2 image build host and ensure SELinux is disabled:

```
# setenforce 0
```

Create an output directory to be shared with the Kiwi build container to save the resulting images:

```
# mkdir ~/output
```

Pull the latest Kiwi builder image from the SUSE Registry:

```
# podman pull registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1
(...)
```

26.3 Building the Default Image

This is the default behavior of the Kiwi image container if no arguments are provided during the container image run. The following command runs `podman` with two directories mapped to the container:

- The `/etc/zypp/repos.d` SUSE Linux Micro package repository directory from the underlying host.
- The output `~/output` directory created above.

The Kiwi image container requires to run the `build-image` helper script as:

```
# podman run --privileged -v /etc/zypp/repos.d:/micro-sdk/repos/ -v ~/output:/tmp/output
 \
    -it registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1 build-image
(...)
```

Note

It's expected that if you're running this script for the first time that it will **fail** shortly after starting with "**ERROR: Early loop device test failed, please retry the container run.**", this is a symptom of loop devices being created on the underlying host system that are not immediately visible inside of the container image. Simply re-run the command again and it should proceed without issue.

After a few minutes the images can be found in the local output directory:

```
(...)
INFO: Image build successful, generated images are available in the 'output' directory.

# ls -1 output/
SLE-Micro.x86_64-6.2.changes
SLE-Micro.x86_64-6.2.packages
SLE-Micro.x86_64-6.2.raw
SLE-Micro.x86_64-6.2.verified
build
kiwi.result
kiwi.result.json
```

26.4 Building images with other profiles

In order to build different image profiles, the "**-p**" command option in the Kiwi container image helper script is used. For example, to build the "**Default-SelfInstall**" ISO image:

```
# podman run --privileged -v /etc/zypp/repos.d:/micro-sdk/repos/ -v ~/output:/tmp/output
 \
    -it registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1 build-image -p Default-
SelfInstall
(...)
```

Note

To avoid data loss, Kiwi will refuse to run if there are images in the `output` directory. It is required to remove the contents of the output directory before proceeding with `rm -f output/*`.

Alternatively, to build a SelfInstall ISO image with the RealTime kernel ("**kernel-rt**"):

```
# podman run --privileged -v /etc/zypp/repos.d:/micro-sdk/repos/ -v ~/output:/tmp/output
 \
    -it registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1 build-image -p Base-RT-
SelfInstall
(...)
```

26.5 Building images with large sector sizes

Some hardware requires an image with a large sector size, i.e. **4096 bytes** rather than the standard 512 bytes. The containerized Kiwi builder supports the ability to generate images with large block size by specifying the "**-b**" parameter. For example, to build a "**Default-SelfInstall**" image with a large sector size:

```
# podman run --privileged -v /etc/zypp/repos.d:/micro-sdk/repos/ -v ~/output:/tmp/output
 \
    -it registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1 build-image -p Default-
SelfInstall -b
(...)
```

26.6 Using a custom Kiwi image definition file

For advanced use-cases a custom Kiwi image definition file (`SL-Micro.kiwi`) can be used along with any necessary post-build scripts. This requires overriding the default definitions pre-packaged by the SUSE Edge team.

Create a new directory and map it into the container image where the helper script is looking (`/micro-sdk/defs`):

```
# mkdir ~/mydefs/
# cp /path/to/SL-Micro.kiwi ~/mydefs/
# cp /path/to/config.sh ~/mydefs/
# podman run --privileged -v /etc/zypp/repos.d:/micro-sdk/repos/ -v ~/output:/tmp/output
 -v ~/mydefs/:/micro-sdk/defs/ \
    -it registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1 build-image
(...)
```

Warning

This is only required for advanced use-cases and may cause supportability issues. Please contact your SUSE representative for further advice and guidance.

To get the default Kiwi image definition files included in the container, the following commands can be used:

```
$ podman create --name kiwi-builder registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1
$ podman cp kiwi-builder:/micro-sdk/defs/SL-Micro.kiwi .
$ podman cp kiwi-builder:/micro-sdk/defs/SL-Micro.kiwi.4096 .
$ podman rm kiwi-builder
$ ls ./SL-Micro.*
(...)
```

27 SUSE Storage V2 Data Engine

SUSE Storage 1.12.1 includes the Longhorn V2 Data Engine as a Generally Available feature. Starting with SUSE Edge 3.7, the V2 Data Engine is recommended for newly provisioned volumes when the cluster meets the V2 prerequisites.

Important

The SUSE Storage Helm chart does not convert existing V1 volumes to V2. The data engine is an immutable volume property. Existing V1 volumes continue to use V1 until their data is migrated to newly provisioned V2 volumes.

27.1 Prerequisites

Before enabling the V2 Data Engine, review the upstream V2 requirements (https://longhorn.io/docs/1.12.1/deploy/install/#v2-data-engine-requirements). In particular, every node that can host a V2 replica requires:

- A dedicated, unformatted block device. NVMe devices are recommended for production workloads.
- The `nvme-tcp`, `vfio_pci`, and `uio_pci_generic` kernel modules.
- Sufficient CPU and memory for the V2 instance manager. The default configuration uses 2 GiB of huge pages per instance manager.
- A supported CPU and kernel. AMD64 CPUs require SSE4.2, and kernel 6.7 or later is recommended.

Longhorn recommends using only one data engine after migration is complete. Running both engines creates separate instance managers and therefore consumes additional CPU and memory.

27.2 Configure V2 for new volumes

Prepare the required block devices before provisioning application volumes. Register each device as a `block` disk on its Longhorn node by using the SUSE Storage UI, or by updating the corresponding `nodes.longhorn.io` resource.

For a new cluster that has no V1 volumes, use the following Helm values:

```
defaultSettings:
```

```
  v1DataEngine: false
  v2DataEngine: true
persistence:
  dataEngine: v2
```

For an existing cluster with V1 volumes, keep both engines enabled during the migration:

```
defaultSettings:
  v1DataEngine: true
  v2DataEngine: true
persistence:
  dataEngine: v2
```

Apply the values with your normal Helm deployment or upgrade workflow. For example:

```
helm upgrade --install longhorn oci://dp.apps.rancher.io/charts/suse-storage \
  --version 1.12.1 \
  --namespace longhorn-system \
  --create-namespace \
  --reuse-values \
  --values suse-storage-v2-values.yaml
```

On an existing installation, confirm that the running Longhorn setting was enabled. If it remains disabled after the Helm upgrade, enable it explicitly:

```
kubectl -n longhorn-system patch settings.longhorn.io v2-data-engine \
  --type merge --patch '{"value":"true"}'
```

Caution

Do not disable the V1 Data Engine while any V1 volumes remain in the cluster. When upgrading an existing release, also confirm that `--reuse-values` does not preserve an older `persistence.dataEngine` value of `v1`.

Create a dedicated V2 StorageClass rather than changing an existing StorageClass in place:

```
apiVersion: storage.k8s.io/v1
kind: StorageClass
metadata:
  name: longhorn-v2
provisioner: driver.longhorn.io
allowVolumeExpansion: true
reclaimPolicy: Delete
volumeBindingMode: Immediate
```

```
parameters:
  dataEngine: "v2"
  numberOfReplicas: "3"
  staleReplicaTimeout: "2880"
  fsType: "ext4"
```

To make V2 the default for PVCs that do not specify `storageClassName`, move the default annotation to the new StorageClass:

```
kubectl annotate storageclass longhorn \
  storageclass.kubernetes.io/is-default-class="false" --overwrite

kubectl annotate storageclass longhorn-v2 \
  storageclass.kubernetes.io/is-default-class="true" --overwrite
```

This change affects only newly provisioned volumes. It does not change the data engine of existing volumes.

Verify the settings, StorageClass, disks, and volumes:

```
kubectl -n longhorn-system get settings.longhorn.io \
  v1-data-engine v2-data-engine

kubectl get storageclass longhorn-v2 \
  -o jsonpath='dataEngine={.parameters.dataEngine}{"\n"}'

kubectl -n longhorn-system get nodes.longhorn.io

kubectl -n longhorn-system get volumes.longhorn.io \
  -o custom-
columns='NAME:.metadata.name,ENGINE:.spec.dataEngine,STATE:.status.state,ROBUSTNESS:.status.robustness'
```

27.3 Migrate a V1 volume to V2

SUSE Storage 1.12.1 does not support converting an existing volume from V1 to V2 in place. Plan a maintenance window and migrate each workload to a new V2 volume.

1. Back up the application and its V1 volume.
2. Stop or scale down every workload that writes to the source PVC.
3. Create a destination PVC in the same namespace, using the `longhorn-v2` StorageClass and a capacity equal to or greater than the source PVC.

4. Copy the data using the method supported by the application.
5. Validate the copied data before changing the workload to use the destination PVC.
6. Update or recreate the workload so that it references the V2 PVC.
7. Keep the V1 volume until the application has been validated on V2, then remove it according to your retention policy.

For a filesystem volume that is not managed by a database or another application requiring a consistency-aware migration, a single maintenance pod can mount the V1 source read-only and the V2 destination read/write:

```
apiVersion: batch/v1
kind: Job
metadata:
  name: copy-v1-to-v2
  namespace: <application-namespace>
spec:
  backoffLimit: 3
  template:
    spec:
      restartPolicy: Never
      containers:
        - name: copy
          image: registry.suse.com/bci/bci-micro:latest
          command:
            - /bin/bash
            - -c
            - |
              set -euo pipefail
              cp -a /source/. /destination/
              sync
          volumeMounts:
            - name: source
              mountPath: /source
              readOnly: true
            - name: destination
              mountPath: /destination
      volumes:
        - name: source
          persistentVolumeClaim:
            claimName: <v1-pvc-name>
        - name: destination
          persistentVolumeClaim:
            claimName: <v2-pvc-name>
```

Warning

The copy Job is only a generic filesystem example. Use application-native backup and restore or replication for databases, raw block volumes, and applications with their own consistency requirements. Verify ownership, permissions, extended attributes, and application data before deleting the source PVC.

After every workload has been migrated, confirm that no V1 volumes remain:

```
kubectl -n longhorn-system get volumes.longhorn.io \
  -o custom-columns='NAME:.metadata.name,ENGINE:.spec.dataEngine,STATE:.status.state'
```

You can then disable the V1 Data Engine in the Helm values and upgrade the release:

```
defaultSettings:
  v1DataEngine: false
  v2DataEngine: true
persistence:
  dataEngine: v2
```

If the running setting remains enabled after the Helm upgrade, disable it explicitly:

```
kubectl -n longhorn-system patch settings.longhorn.io v1-data-engine \
  --type merge --patch '{"value":"false"}'
```

Run the volume inventory command again and confirm that no V1 volumes were overlooked before removing any V1-specific node storage.

27.4 Usage limitations

Before moving a workload to V2, review the V1 and V2 feature comparison (https://longhorn.io/docs/1.12.1/v1-v2-volume-behavior-and-feature-parity/). The following limitations are especially relevant to SUSE Storage 1.12.1:

- V1 volumes cannot be converted to V2 in place.
- V2 backing images are not supported. Use CDI for KubeVirt image import workflows.
- Strict-local volumes, offline fast replica rebuilding, revision counters, and orphaned instance management are not supported by the V2 Data Engine.

- V2 volumes must be detached before upgrading between SUSE Storage 1.12 patch releases because V2 engine live upgrade is not supported.
- The sharded V2 Data Engine is experimental and does not have feature parity with replicated V2 volumes. Do not use it for production workloads that require unsupported capabilities such as backup and restore, disaster recovery, cloning, or live migration.
- On ARM64, V2 volumes backed by NVMe block devices have an upstream limitation. Review the Longhorn important notes (https://longhorn.io/docs/1.12.1/important-notes/) before deployment.

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Tips and tricks for Edge components

28 Edge Image Builder

28.1 Common

- If you are in a non-Linux environment and following these instructions to build an image, then you are likely running `Podman` via a virtual machine. By default, this virtual machine will be configured to have a small amount of system resources allocated to it and can cause instability for `Edge Image Builder` during resource intensive operations, such as the RPM resolution process. You will need to adjust the resources of the podman machine, either by using Podman Desktop (settings cogwheel → podman machine edit icon) or directly via the `podman-machine-set` command (https://docs.podman.io/en/stable/markdown/podman-machine-set.1.html)

- At this point in time, the `Edge Image Builder` is not able to build images in a cross architecture setup, i.e. you have to run it on:

  - AArch64 systems (such as Apple Silicon) to build SL Micro `aarch64` images

  - AMD64/Intel 64 systems to build SL Micro `x86_64` images.

28.2 SUSE Linux Micro

- Loading kernel modules at boot can be done using the corresponding `/etc/modprobe.d/module.conf` file. Create the corresponding `os-files` folder using Edge Image Builder:

```
.
├── definition.yaml
└── os-files
    └── etc
        └── modprobe.d
            └── module.conf
```

For more information, please refer to the "Managing kernel modules" section of the SUSE Linux Enterprise Server Documentation (https://documentation.suse.com/sles/15-SP7/html/SLES-all/cha-mod.html#sec-mod-modprobe-d)

28.3 Kubernetes

- Creating multi node Kubernetes clusters requires adjusting the `kubernetes` section in the definition file to:
  - list all server and agent nodes under `kubernetes.nodes`
  - set a virtual IP address that would be used for all non-initializer nodes to join the cluster under `kubernetes.network.apiVIP`
  - optionally, set an API host to specify a domain address for accessing the cluster under `kubernetes.network.apiHost` To learn more about this configuration, please refer to the Kubernetes section docs (https://github.com/suse-edge/edge-image-builder/blob/main/docs/building-images.md#kubernetes).
- `Edge Image Builder` relies on the hostnames of the different nodes to determine their Kubernetes type (`server` or `agent`). While this configuration is managed in the definition file, for the general networking setup of the machines we can utilize either DHCP configuration as described in *Chapter 9, Edge Networking*.

29 Elemental

29.1 Common

29.1.1 Expose Rancher service

When using RKE2 or K3s we need to expose services (Rancher in this context) from the management cluster as they are not exposed by default. In both RKE2 and k3s there is a Traefik Ingress controller. The current workflow suggests using MetalLB for announcing a service (via L2 or BGP Advertisement) and the respective Ingress Controller to create an Ingress via `HelmChartConfig` since creating a new Ingress object would override the existing setup.

1. Install Rancher Prime (via Helm) and configure the necessary values

```
hostname: rancher-192.168.64.101.sslip.io
replicas: 1
bootstrapPassword: Admin
global.cattle.psp.enabled: "false"
```

> **Tip**
>
> Follow the Rancher installation (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/install-upgrade-on-a-kubernetes-cluster) documentation for more details.

2. Create a LoadBalancer service to expose Rancher through an Ingress instance.

```
kubectl apply -f - <<EOF
apiVersion: helm.cattle.io/v1
kind: HelmChartConfig
metadata:
  name: rke2-traefik
  namespace: kube-system
spec:
  valuesContent: |-
    ingressClass:
      isDefaultClass: true
    ports:
      web:
```

```
        hostPort: null    # disallow hostPort
        exposedPort: 80
      websecure:
        hostPort: null    # disallow hostPort
        exposedPort: 443
    service:
      enabled: true
      spec:
        type: LoadBalancer
        externalTrafficPolicy: Local
        allocateLoadBalancerNodePorts: false
EOF
```

3. Create an IP Address Pool for the Ingress provider's `LoadBalancer` type service using the (Virtual) IP address we set up earlier in the Helm values

```
kubectl apply -f - <<EOF
apiVersion: metallb.io/v1beta1
kind: IPAddressPool
metadata:
  name: ingress-ippool
  namespace: metallb-system
spec:
  addresses:
  - 192.168.64.101/32
  serviceAllocation:
    priority: 100
    serviceSelectors:
    - matchExpressions:
      - {key: app.kubernetes.io/name, operator: In, values: [rke2-traefik]}
EOF
```

4. Create an L2 Advertisement for that IP address pool

```
kubectl apply -f - <<EOF
apiVersion: metallb.io/v1beta1
kind: L2Advertisement
metadata:
  name: ingress-l2-adv
  namespace: metallb-system
spec:
  ipAddressPools:
  - ingress-ippool
EOF
```

5. Ensure Elemental is properly installed

a. Install the Elemental Operator and Elemental UI on the management nodes

b. Add the Elemental configuration on the downstream node together with a registration code, as that will prompt Edge Image Builder to include the remote registration option for the machine.

Tip

Check *Section 1.5, "Install Elemental"* and *Section 1.6, "Configure Elemental"* for additional information and examples.

29.2 Hardware Specific

29.2.1 Trusted Platform Module

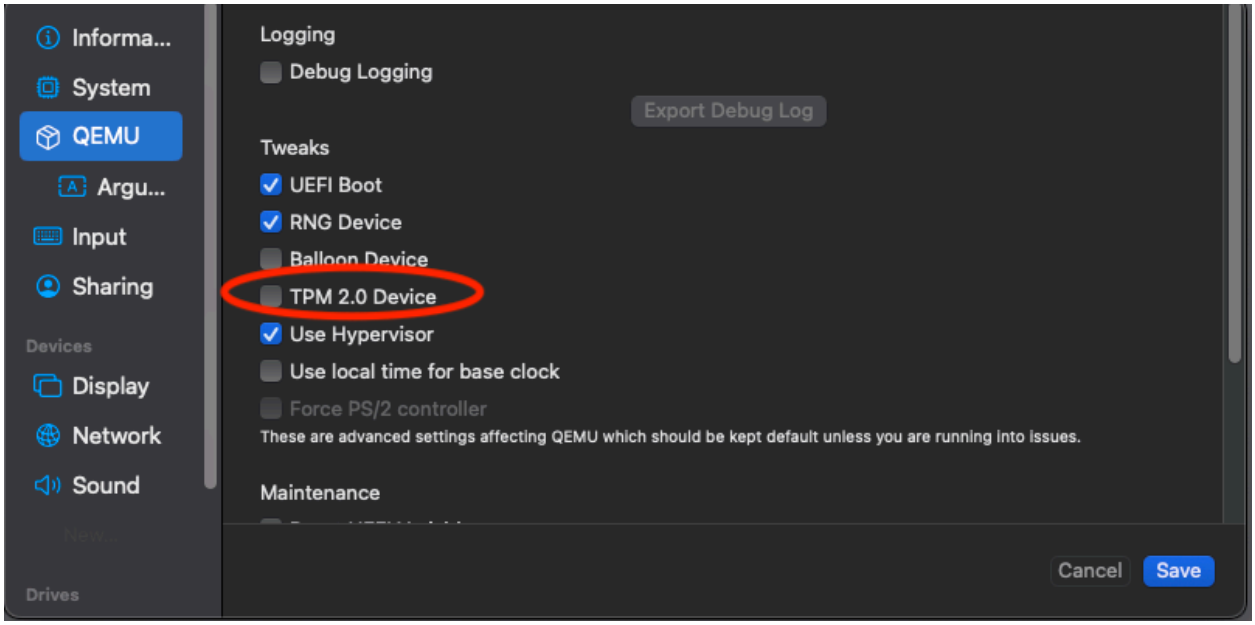
It is necessary to properly handle the Trusted Platform Module (https://elemental.docs.rancher.com/tpm/) (TPM) configuration. Failing to do so will result in errors similar to the following:

```
Nov 25 18:17:06 eled elemental-register[4038]: Error: registering machine: cannot
 generate authentication token: opening tpm for getting attestation data: TPM device not
 available
```

This can be mitigated by one of the following approaches:

- Enable TPM in the Virtual Machine settings

Example with UTM on MacOS



- Emulate TPM by using negative value for the TPM seed in the `MachineRegistration` resource

```
apiVersion: elemental.cattle.io/v1beta1
kind: MachineRegistration
metadata:
  name: ...
  namespace: ...
spec:
    ...
    elemental:
      ...
      registration:
        emulate-tpm: true
        emulated-tpm-seed: -1
```

- Disable TPM in the `MachineRegistration` resource

```
apiVersion: elemental.cattle.io/v1beta1
kind: MachineRegistration
metadata:
  name: ...
  namespace: ...
spec:
    ...
    elemental:
      ...
      registration:
        emulate-tpm: false
```

V Day 2 Operations

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This section explains how administrators can handle different "Day Two" operation tasks both on the management and on the downstream clusters.

30 Edge 3.7 migration

This section explains how to migrate your `management` and `downstream` clusters from `SUSE Edge 3.6` to `SUSE Edge 3.7.0`.

Important

Always perform cluster migrations from the `latest Z-stream` release of `SUSE Edge 3.6`.

Always migrate to the `SUSE Edge 3.7.0` release. For subsequent post-migration upgrades, refer to the management (*Chapter 31, Management Cluster*) and downstream (*Chapter 32, Downstream clusters*) cluster sections.

The following table lists the different types of clusters and the methods to upgrade clusters:

TABLE 30.1: CLUSTERS AND METHODS TO UPGRADE DOWNSTREAM CLUSTERS

Cluster type	Method
EIB provisioned clusters	See *Section 30.1.3, "Fleet"* for details.
Phone-home provisioned clusters	See Upgrading the Kubernetes Version (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/upgrade-and-roll-back-kubernetes#upgrading-the-kubernetes-version) for Kubernetes version upgrade and Downstream clusters (*Chapter 32, Downstream clusters*) for SUC, Operating system, and other components.

30.1 Management Cluster

This section covers the following topics:

Section 30.1.1, "Prerequisites" - prerequisite steps to complete before starting the migration.

Section 30.1.2, "Upgrade Controller" - how to do a `management` cluster migration using the *Chapter 19, Upgrade Controller*.

Section 30.1.3, "Fleet" - how to do a `management` cluster migration using *Chapter 6, Fleet*.

30.1.1 Prerequisites

30.1.2 Upgrade Controller

Important

The `Upgrade Controller` currently supports `SUSE Edge` release migrations only for **non air-gapped management** clusters.

The following topics are covered as part of this section:

Section 30.1.2.1, "Prerequisites" - prerequisites specific to the `Upgrade Controller`.

Section 30.1.2.2, "Migration steps" - steps for migrating a `management` cluster to a new `SUSE Edge` version using the `Upgrade Controller`.

30.1.2.1 Prerequisites

30.1.2.1.1 SUSE Edge 3.7 Upgrade Controller

Before using the `Upgrade Controller`, you must first ensure that it is running a version that is capable of migrating to the desired `SUSE Edge` release.

To do this:

1. If you already have `Upgrade Controller` deployed from a previous `SUSE Edge` release, upgrade its chart:

   ```
   helm upgrade upgrade-controller -n upgrade-controller-system oci://
   registry.suse.com/edge/charts/upgrade-controller --version 307.0.4+up0.1.3
   ```

2. If you do **not** have `Upgrade Controller` deployed, follow *Section 19.3, "Installing the Upgrade Controller"*.

30.1.2.2 Migration steps

Performing a `management` cluster migration with the `Upgrade Controller` is fundamentally similar to executing an upgrade.

The only difference is that your `UpgradePlan` **must** specify the `3.7.0` release version:

```
apiVersion: lifecycle.suse.com/v1alpha1
kind: UpgradePlan
metadata:
  name: upgrade-plan-mgmt
  # Change to the namespace of your Upgrade Controller
  namespace: CHANGE_ME
spec:
  releaseVersion: 3.7.0
```

For information on how to use the above `UpgradePlan` to do a migration, refer to Upgrade Controller upgrade process (*Section 31.1, "Upgrade Controller"*).

30.1.3 Fleet

Note

Whenever possible, use the *Section 30.1.2, "Upgrade Controller"* for migration.

Refer to this section only for use cases not covered by the `Upgrade Controller`.

Performing a `management` cluster migration with `Fleet` is fundamentally similar to executing an upgrade. The **key** differences being that:

1. The fleets **must be used** from the release-3.7.0 (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0) release of the `suse-edge/fleet-examples` repository.
2. Charts scheduled for an upgrade **must** be upgraded to versions compatible with the `SUSE Edge 3.7.0` release. For a list of the `SUSE Edge 3.7.0` components, refer to *Section 40.3, "Release 3.7.0"*.

Important

To ensure a successful `SUSE Edge 3.7.0` migration, it is important that users comply with the points outlined above.

Considering the points above, users can follow the `management` cluster Fleet (*Section 31.2, "Fleet"*) documentation for a comprehensive guide on the steps required to perform a migration.

30.2 Downstream Clusters

Section 30.2.1, "Fleet" - how to do a `downstream` cluster migration using *Chapter 6, Fleet*.

30.2.1 Fleet

Performing a `downstream` cluster migration with `Fleet` is fundamentally similar to executing an upgrade. The **key** differences being that:

1. The fleets **must be used** from the release-3.7.0 (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0) release of the `suse-edge/fleet-examples` repository.
2. Charts scheduled for an upgrade **must** be upgraded to versions compatible with the `SUSE Edge 3.7.0` release. For a list of the `SUSE Edge 3.7.0` components, refer to *Section 40.3, "Release 3.7.0"*.

Important

To ensure a successful `SUSE Edge 3.7.0` migration, it is important that users comply with the points outlined above.

Considering the points above, users can follow the `downstream` cluster Fleet (*Section 32.1, "Fleet"*) documentation for a comprehensive guide on the steps required to perform a migration.

31 Management Cluster

Currently, there are two ways to perform "Day 2" operations on your `management` cluster:

1. Through *Chapter 19, Upgrade Controller* - *Section 31.1, "Upgrade Controller"*
2. Through *Chapter 6, Fleet* - *Section 31.2, "Fleet"*

31.1 Upgrade Controller

Revision History

2025-01-16

Important

The `Upgrade Controller` currently only supports `Day 2` operations for **non air-gapped management** clusters.

This section covers how to perform the various `Day 2` operations related to upgrading your `management` cluster from one `SUSE Edge` platform version to another.

The `Day 2` operations are automated by the Upgrade Controller (*Chapter 19, Upgrade Controller*) and include:

- SUSE Linux Micro (*Chapter 7, SUSE Linux Micro*) OS upgrade
- *Chapter 12, RKE2* or *Chapter 11, K3s* Kubernetes upgrade
- SUSE additional components (SUSE Rancher Prime, SUSE Security, etc.) upgrade

31.1.1 Prerequisites

Before upgrading your `management` cluster, the following prerequisites must be met:

1. `SCC registered nodes` - ensure your cluster nodes' OS are registered with a subscription key that supports the OS version specified in the `SUSE Edge` release (*Chapter 40, Release Notes*) you intend to upgrade to.
2. `Upgrade Controller` - make sure that the `Upgrade Controller` has been deployed on your `management` cluster. For installation steps, refer to *Section 19.3, "Installing the Upgrade Controller"*.

31.1.2 Upgrade

1. Determine the `SUSE Edge` release (*Chapter 40, Release Notes*) version that you wish to upgrade your `management` cluster to.

2. In the `management` cluster, deploy an `UpgradePlan` that specifies the desired `release version`. The `UpgradePlan` must be deployed in the namespace of the `Upgrade Controller`.

```
kubectl apply -n <upgrade_controller_namespace> -f - <<EOF
apiVersion: lifecycle.suse.com/v1alpha1
kind: UpgradePlan
metadata:
  name: upgrade-plan-mgmt
  namespace: upgrade-controller-system  # replaces it if the upgrade controller has
 been deployed in a different namespace
spec:
  # Version retrieved from release notes
  releaseVersion: 3.X.Y
EOF
```

Note

There may be use-cases where you would want to make additional configurations over the `UpgradePlan`. For all possible configurations, refer to *Section 19.6.1, "UpgradePlan"*.

3. Deploying the `UpgradePlan` to the `Upgrade Controller's` namespace will begin the `upgrade process`.

Note

For more information on the actual `upgrade process`, refer to *Section 19.5, "How does the Upgrade Controller work?"*.

For information on how to track the `upgrade process`, refer to *Section 19.7, "Tracking the upgrade process"*.

31.1.3 Post-Upgrade Steps

`SUSE Edge` upgrades from latest `3.6` z-stream to `3.7.0` require a final manual steps to be performed after the `Upgrade Controller` has completed the upgrade process, related to some Helm parameters changes in the `rke2-traefik` Helm chart included in `SUSE Edge` `3.7.0` release.

- apply the following changes in the `helmchartconfigs.helm.cattle.io/rke2-traefik` API object in `kube-system` namespace (or, in case that API object does not exist, apply them in the `helmcharts.helm.cattle.io/rke2-traefik` API object):

Use the `HelmChartConfig` (or `HelmChart`) manifests to apply these changes as shown below, to assure the `Upgrade Controller` will keep them in future Management cluster upgrades.

```
# You can use `kubectl edit', `kubectl patch` or `kubectl apply` commands to apply the
 changes indicated below
apiVersion: helm.cattle.io/v1
kind: HelmChartConfig
metadata:
  name: rke2-traefik
  namespace: kube-system
spec:
  failurePolicy: reinstall
  valuesContent: |-
    ingressClass:
      isDefaultClass: true
    ports:
      web:
        hostPort: null
        exposedPort: 80
      websecure:
        hostPort: null
        exposedPort: 443
    service:
      enabled: true
      # type: LoadBalancer              # CHANGE_1: This Helm parameter has been REMOVED
      # ipFamilyPolicy: PreferDualStack # CHANGE_2: This Helm parameter has been REMOVED
      spec:
        type: LoadBalancer              # CHANGE_3: NEW Helm parameter replacing the old/
removed one (above)
        ipFamilyPolicy: PreferDualStack # CHANGE_4: NEW Helm parameter replacing the old/
removed one (above)
        externalTrafficPolicy: Local
        allocateLoadBalancerNodePorts: false
    providers:
      kubernetesIngressNGINX:           # CHANGE_5: NEW Helm parameter replacing the old/
removed "KubernetesIngressNginx"
```

```
        enabled: true
        ingressClass: "rke2-ingress-nginx-migration"
        controllerClass: "rke2.cattle.io/ingress-nginx-migration"
EOF
```

Or, in case the `helmchartconfigs.helm.cattle.io/rke2-traefik` API object in the `kube-system` namespace does not exist:

```
# You can use `kubectl edit', `kubectl patch` or `kubectl apply` commands to apply the
 changes indicated below
apiVersion: helm.cattle.io/v1
kind: HelmChart
metadata:
  name: rke2-traefik
  namespace: kube-system
spec:
  chart: rke2-traefik
  version: {rke2-traefik Helm chart version}
  repo: https://rke2-charts.rancher.io
  bootstrap: false
  failurePolicy: reinstall
  backOffLimit: 20
  targetNamespace: kube-system
  set:
    global.cattle.systemDefaultRegistry: registry.rancher.com
    global.rke2DataDir: /var/lib/rancher/rke2
    global.systemDefaultRegistry: registry.rancher.com
  valuesContent: |-
    ingressClass:
      isDefaultClass: true
    ports:
      web:
        hostPort: null
        exposedPort: 80
      websecure:
        hostPort: null
        exposedPort: 443
    service:
      enabled: true
      # type: LoadBalancer              # CHANGE_1: This Helm parameter has been REMOVED
      # ipFamilyPolicy: PreferDualStack # CHANGE_2: This Helm parameter has been REMOVED
      spec:
        type: LoadBalancer              # CHANGE_3: NEW Helm parameter replacing the old/
removed one (above)
        ipFamilyPolicy: PreferDualStack # CHANGE_4: NEW Helm parameter replacing the old/
removed one (above)
        externalTrafficPolicy: Local
```

```
        allocateLoadBalancerNodePorts: false
    providers:
      kubernetesIngressNGINX:           # CHANGE_5: NEW Helm parameter replacing the old/
removed "KubernetesIngressNginx"
        enabled: true
        ingressClass: "rke2-ingress-nginx-migration"
        controllerClass: "rke2.cattle.io/ingress-nginx-migration"
EOF
```

The `{rke2-traefik Helm chart version}` shown above is the one provided by the RKE2/k3s release used in the `SUSE Edge` `3.7.0` release to upgrade to (you can get it from the corresponding RKE2 release page (https://github.com/rancher/rke2/releases/) / k3s release page (https://github.com/k3s-io/k3s/releases/)).

31.2 Fleet

Revision History

2025-01-14

This section offers information on how to perform "Day 2" operations using the Fleet (*Chapter 6, Fleet*) component.

The following topics are covered as part of this section:

1. *Section 31.2.1, "Components"* - default components used for all "Day 2" operations.
2. *Section 31.2.2, "Determine your use-case"* - provides an overview of the Fleet custom resources that will be used and their suitability for different "Day 2" operations use-cases.
3. *Section 31.2.3, "Day 2 workflow"* - provides a workflow guide for executing "Day 2" operations with Fleet.
4. *Section 31.2.4, "OS upgrade"* - describes how to do OS upgrades using Fleet.
5. *Section 31.2.5, "Kubernetes version upgrade"* - describes how to do Kubernetes version upgrades using Fleet.
6. *Section 31.2.6, "Helm chart upgrade"* - describes how to do Helm chart upgrades using Fleet.

31.2.1 Components

Below you can find a description of the default components that should be set up on your `management` cluster so that you can successfully perform "Day 2" operations using Fleet.

31.2.1.1 Rancher

Optional; Responsible for managing `downstream clusters` and deploying the `System Upgrade Controller` on your `management cluster`.

For more information, see *Chapter 4, Rancher*.

31.2.1.2 System Upgrade Controller (SUC)

System Upgrade Controller is responsible for executing tasks on specified nodes based on configuration data provided through a custom resource, called a `Plan`.

SUC is actively utilized to upgrade the operating system and Kubernetes distribution.

For more information about the **SUC** component and how it fits in the Edge stack, see *Chapter 18, System Upgrade Controller*.

31.2.2 Determine your use-case

Fleet uses two types of custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) to enable the management of Kubernetes and Helm resources.

Below you can find information about the purpose of these resources and the use-cases they are best suited for in the context of "Day 2" operations.

31.2.2.1 GitRepo

A `GitRepo` is a Fleet (*Chapter 6, Fleet*) resource that represents a Git repository from which `Fleet` can create `Bundles`. Each `Bundle` is created based on configuration paths defined inside of the `GitRepo` resource. For more information, see the GitRepo (https://fleet.rancher.io/gitrepo-add) documentation.

In the context of "Day 2" operations, `GitRepo` resources are normally used to deploy `SUC` or `SUC Plans` in **non air-gapped** environments that utilize a *Fleet GitOps* approach.

Alternatively, `GitRepo` resources can also be used to deploy `SUC` or `SUC Plans` on **air-gapped** environments, **provided you mirror your repository setup through a local git server**.

31.2.2.2 Bundle

`Bundles` hold **raw** Kubernetes resources that will be deployed on the targeted cluster. Usually they are created from a `GitRepo` resource, but there are use-cases where they can be deployed manually. For more information refer to the Bundle (https://fleet.rancher.io/bundle-add) documentation.

In the context of "Day 2" operations, `Bundle` resources are normally used to deploy `SUC` or `SUC Plans` in **air-gapped** environments that do not use some form of *local GitOps* procedure (e.g. a **local git server**).

Alternatively, if your use-case does not allow for a *GitOps* workflow (e.g. using a Git repository), `Bundle` resources could also be used to deploy `SUC` or `SUC Plans` in **non air-gapped** environments.

31.2.3 Day 2 workflow

The following is a "Day 2" workflow that should be followed when upgrading a management cluster to a specific Edge release.

1. OS upgrade (*Section 31.2.4, "OS upgrade"*)
2. Kubernetes version upgrade (*Section 31.2.5, "Kubernetes version upgrade"*)
3. Helm chart upgrade (*Section 31.2.6, "Helm chart upgrade"*)

31.2.4 OS upgrade

Revision History

2025-05-20

This section describes how to perform an operating system upgrade using *Chapter 6, Fleet* and the *Chapter 18, System Upgrade Controller*.

The following topics are covered as part of this section:

1. *Section 31.2.4.1, "Components"* - additional components used by the upgrade process.
2. *Section 31.2.4.2, "Overview"* - overview of the upgrade process.
3. *Section 31.2.4.3, "Requirements"* - requirements of the upgrade process.
4. *Section 31.2.4.4, "OS upgrade - SUC plan deployment"* - information on how to deploy `SUC plans`, responsible for triggering the upgrade process.

31.2.4.1 Components

This section covers the custom components that the `OS upgrade` process uses over the default "Day 2" components (*Section 31.2.1, "Components"*).

31.2.4.1.1 systemd.service

The OS upgrade on a specific node is handled by a systemd.service (https://www.freedesktop.org/software/systemd/man/latest/systemd.service.html).

A different service is created depending on what type of upgrade the OS requires from one Edge version to another:

- For Edge versions that require the same OS version (e.g. `6.1`), the `os-pkg-update.service` will be created. It uses transactional-update (https://kubic.opensuse.org/documentation/man-pages/transactional-update.8.html) to perform a normal package upgrade (https://en.opensuse.org/SDB:Zypper_usage#Updating_packages).
- For Edge versions that require an OS version migration (e.g `6.1` → `6.2`), the `os-migration.service` will be created. It uses transactional-update (https://kubic.opensuse.org/documentation/man-pages/transactional-update.8.html) to perform:
  a. A normal package upgrade (https://en.opensuse.org/SDB:Zypper_usage#Updating_packages) which ensures that all packages are at up-to-date in order to mitigate any failures in the migration related to old package versions.
  b. An OS migration by utilizing the `zypper migration` command.

The services mentioned above are shipped on each node through a `SUC plan` which must be located on the management cluster that is in need of an OS upgrade.

31.2.4.2 Overview

The upgrade of the operating system for management cluster nodes is done by utilizing `Fleet` and the `System Upgrade Controller (SUC)`.

Fleet is used to deploy and manage `SUC plans` onto the desired cluster.

Note

`SUC plans` are custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) that describe the steps that `SUC` needs to follow in order for a specific task to be executed on a set of nodes. For an example of how an `SUC plan` looks like, refer to the upstream repository (https://github.com/rancher/system-upgrade-controller?tab=readme-ov-file#example-plans).

The `OS SUC plans` are shipped to each cluster by deploying a GitRepo (https://fleet.rancher.io/gitrepo-add) or Bundle (https://fleet.rancher.io/bundle-add) resource to a specific Fleet workspace (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups). Fleet retrieves the deployed `GitRepo/Bundle` and deploys its contents (the `OS SUC plans`) to the desired cluster(s).

Note

`GitRepo/Bundle` resources are always deployed on the `management cluster`. Whether to use a `GitRepo` or `Bundle` resource depends on your use-case, check *Section 31.2.2, "Determine your use-case"* for more information.

`OS SUC plans` describe the following workflow:

1. Always cordon (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_cordon/) the nodes before OS upgrades.
2. Always upgrade `control-plane` nodes before `worker` nodes.
3. Always upgrade the cluster on a **one** node at a time basis.

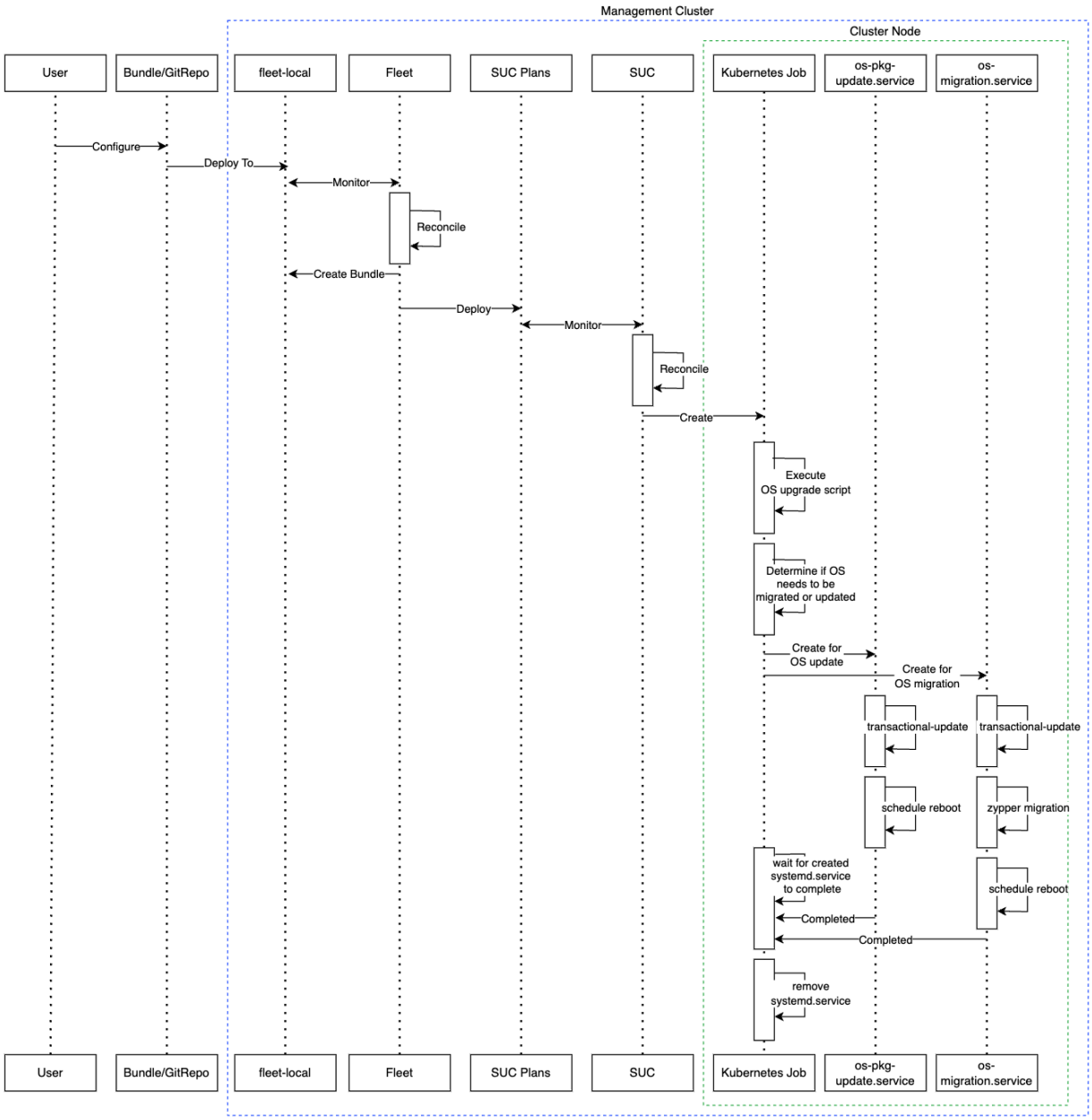
Once the `OS SUC plans` are deployed, the workflow looks like this:

1. SUC reconciles the deployed `OS SUC plans` and creates a `Kubernetes Job` on **each node**.
2. The `Kubernetes Job` creates a systemd.service (*Section 31.2.4.1.1, "systemd.service"*) for either package upgrade, or OS migration.
3. The created `systemd.service` triggers the OS upgrade process on the specific node.

Important

Once the OS upgrade process finishes, the corresponding node will be `rebooted` to apply the updates on the system.

Below you can find a diagram of the above description:



31.2.4.3 Requirements

General:

1. **SCC registered machine** - All management cluster nodes should be registered to `https://scc.suse.com/` which is needed so that the respective `systemd.service` can successfully connect to the desired RPM repository.

   Important

   For Edge releases that require an OS version migration (e.g. `6.1` → `6.2`), make sure that your SCC key supports the migration to the new version.

2. **Make sure that SUC Plan tolerations match node tolerations** - If your Kubernetes cluster nodes have custom **taints**, make sure to add tolerations (https://kubernetes.io/docs/concepts/scheduling-eviction/taint-and-toleration/) for those taints in the **SUC Plans**. By default, **SUC Plans** have tolerations only for **control-plane** nodes. Default tolerations include:

   - *CriticalAddonsOnly=true:NoExecute*
   - *node-role.kubernetes.io/control-plane:NoSchedule*
   - *node-role.kubernetes.io/etcd:NoExecute*

   Note

   Any additional tolerations must be added under the `.spec.tolerations` section of each Plan. **SUC Plans** related to the OS upgrade can be found in the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository under `fleets/day2/system-upgrade-controller-plans/os-upgrade`. **Make sure you use the Plans from a valid repository release (https://github.com/suse-edge/fleet-examples/releases) tag.**

   An example of defining custom tolerations for the **control-plane** SUC Plan would look like this:

```
apiVersion: upgrade.cattle.io/v1
kind: Plan
metadata:
  name: os-upgrade-control-plane
spec:
  ...
```

```
  tolerations:
  # default tolerations
  - key: "CriticalAddonsOnly"
    operator: "Equal"
    value: "true"
    effect: "NoExecute"
  - key: "node-role.kubernetes.io/control-plane"
    operator: "Equal"
    effect: "NoSchedule"
  - key: "node-role.kubernetes.io/etcd"
    operator: "Equal"
    effect: "NoExecute"
  # custom toleration
  - key: "foo"
    operator: "Equal"
    value: "bar"
    effect: "NoSchedule"
...
```

Air-gapped:

1. **Mirror SUSE RPM repositories** - OS RPM repositories should be locally mirrored so that the `systemd.service` can have access to them. This can be achieved by using either RMT (https://documentation.suse.com/sles/15-SP6/html/SLES-all/book-rmt.html) or SUSE Multi-Linux Manager Documentation (https://documentation.suse.com/multi-linux-manager/5.1/en/docs/index.html)..

31.2.4.4 OS upgrade - SUC plan deployment

Important

For environments previously upgraded using this procedure, users should ensure that **one** of the following steps is completed:

- `Remove any previously deployed SUC Plans related to older Edge release versions from the management cluster` - can be done by removing the desired cluster from the existing `GitRepo/Bundle` target configuration (https://fleet.rancher.io/gitrepo-targets#target-matching), or removing the `GitRepo/Bundle` resource altogether.
- `Reuse the existing GitRepo/Bundle resource` - can be done by pointing the resource's revision to a new tag that holds the correct fleets for the desired `suse-edge/fleet-examples` release (https://github.com/suse-edge/fleet-examples/releases).

This is done in order to avoid clashes between `SUC Plans` for older Edge release versions.

If users attempt to upgrade, while there are existing `SUC Plans` on the management cluster, they will see the following fleet error:

```
Not installed: Unable to continue with install: Plan <plan_name> in namespace
 <plan_namespace> exists and cannot be imported into the current release: invalid
 ownership metadata; annotation validation error..
```

As mentioned in *Section 31.2.4.2, "Overview"*, OS upgrades are done by shipping `SUC plans` to the desired cluster through one of the following ways:

- Fleet `GitRepo` resource - *Section 31.2.4.4.1, "SUC plan deployment - GitRepo resource"*.
- Fleet `Bundle` resource - *Section 31.2.4.4.2, "SUC plan deployment - Bundle resource"*.

To determine which resource you should use, refer to *Section 31.2.2, "Determine your use-case"*.

For use-cases where you wish to deploy the `OS SUC plans` from a third-party GitOps tool, refer to *Section 31.2.4.4.3, "SUC Plan deployment - third-party GitOps workflow"*

31.2.4.4.1 SUC plan deployment - GitRepo resource

A **GitRepo** resource, that ships the needed `OS SUC plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 31.2.4.4.1.1, "GitRepo creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 31.2.4.4.1.2, "GitRepo creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the OS upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

31.2.4.4.1.1 GitRepo creation - Rancher UI

To create a `GitRepo` resource through the Rancher UI, follow their official documentation (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

The Edge team maintains a ready to use fleet (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/os-upgrade). Depending on your environment this fleet could be used directly or as a template.

> **Important**
>
> Always use this fleet from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

For use-cases where no custom changes need to be included to the `SUC plans` that the fleet ships, users can directly refer the `os-upgrade` fleet from the `suse-edge/fleet-examples` repository.

In cases where custom changes are needed (e.g. to add custom tolerations), users should refer the `os-upgrade` fleet from a separate repository, allowing them to add the changes to the SUC plans as required.

An example of how a `GitRepo` can be configured to use the fleet from the `suse-edge/fleet-examples` repository, can be viewed here (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/os-upgrade-gitrepo.yaml).

31.2.4.4.1.2 GitRepo creation - manual

1. Pull the **GitRepo** resource:

```
curl -o os-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/os-upgrade-gitrepo.yaml
```

2. Edit the **GitRepo** configuration:

   - Remove the `spec.targets` section - only needed for downstream clusters.

```
# Example using sed
sed -i.bak '/^  targets:/,$d' os-upgrade-gitrepo.yaml && rm -f os-upgrade-gitrepo.yaml.bak

# Example using yq (v4+)
yq eval 'del(.spec.targets)' -i os-upgrade-gitrepo.yaml
```

   - Point the namespace of the `GitRepo` to the `fleet-local` namespace - done in order to deploy the resource on the management cluster.

```
# Example using sed
sed -i.bak 's/namespace: fleet-default/namespace: fleet-local/' os-upgrade-gitrepo.yaml && rm -f os-upgrade-gitrepo.yaml.bak

# Example using yq (v4+)
yq eval '.metadata.namespace = "fleet-local"' -i os-upgrade-gitrepo.yaml
```

3. Apply the **GitRepo** resource your `management cluster`:

```
kubectl apply -f os-upgrade-gitrepo.yaml
```

4. View the created **GitRepo** resource under the `fleet-local` namespace:

```
kubectl get gitrepo os-upgrade -n fleet-local

# Example output
NAME            REPO                                                COMMIT
 BUNDLEDEPLOYMENTS-READY   STATUS
```

```
os-upgrade      https://github.com/suse-edge/fleet-examples.git   release-3.7.0  0/0
```

31.2.4.4.2 SUC plan deployment - Bundle resource

A **Bundle** resource, that ships the needed `OS SUC Plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 31.2.4.4.2.1, "Bundle creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 31.2.4.4.2.2, "Bundle creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the OS upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

31.2.4.4.2.1 Bundle creation - Rancher UI

The Edge team maintains a ready to use bundle (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml) that can be used in the below steps.

> **Important**
>
> Always use this bundle from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

To create a bundle through Rancher's UI:

1. In the upper left corner, click # → **Continuous Delivery**
2. Go to **Advanced** > **Bundles**
3. Select **Create from YAML**

4. From here you can create the Bundle in one of the following ways:

> **Note**
>
> There might be use-cases where you would need to include custom changes to the `SUC plans` that the bundle ships (e.g. to add custom tolerations). Make sure to include those changes in the bundle that will be generated by the below steps.

   a. By manually copying the bundle content (https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml) from `suse-edge/fleet-examples` to the **Create from YAML** page.

   b. By cloning the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository from the desired release (https://github.com/suse-edge/fleet-examples/releases) tag and selecting the **Read from File** option in the **Create from YAML** page. From there, navigate to the bundle location (`bundles/day2/system-upgrade-controller-plans/os-upgrade`) and select the bundle file. This will auto-populate the **Create from YAML** page with the bundle content.

5. Edit the Bundle in the Rancher UI:

   - Change the **namespace** of the `Bundle` to point to the `fleet-local` namespace.

```
# Example
kind: Bundle
apiVersion: fleet.cattle.io/v1alpha1
metadata:
  name: os-upgrade
  namespace: fleet-local
...
```

   - Change the **target** clusters for the `Bundle` to point to your `local`(management) cluster:

```
spec:
  targets:
  - clusterName: local
```

> **Note**
>
> There are some use-cases where your `local` cluster could have a different name.

To retrieve your `local` cluster name, execute the command below:

```
kubectl get clusters.fleet.cattle.io -n fleet-local
```

6. Select **Create**

31.2.4.4.2.2 Bundle creation - manual

1. Pull the **Bundle** resource:

```
curl -o os-upgrade-bundle.yaml https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml
```

2. Edit the `Bundle` configuration:

   - Change the **target** clusters for the `Bundle` to point to your `local`(management) cluster:

```
spec:
  targets:
  - clusterName: local
```

> **Note**
>
> There are some use-cases where your `local` cluster could have a different name.
>
> To retrieve your `local` cluster name, execute the command below:
>
> ```
> kubectl get clusters.fleet.cattle.io -n fleet-local
> ```

   - Change the **namespace** of the `Bundle` to point to the `fleet-local` namespace.

```
# Example
kind: Bundle
apiVersion: fleet.cattle.io/v1alpha1
metadata:
  name: os-upgrade
  namespace: fleet-local
...
```

3. Apply the **Bundle** resource to your `management cluster`:

```
kubectl apply -f os-upgrade-bundle.yaml
```

4. View the created **Bundle** resource under the `fleet-local` namespace:

```
kubectl get bundles -n fleet-local
```

31.2.4.4.3 SUC Plan deployment - third-party GitOps workflow

There might be use-cases where users would like to incorporate the `OS SUC plans` to their own third-party GitOps workflow (e.g. `Flux`).

To get the OS upgrade resources that you need, first determine the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag of the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository that you would like to use.

After that, resources can be found at `fleets/day2/system-upgrade-controller-plans/os-upgrade`, where:

- `plan-control-plane.yaml` is a SUC plan resource for **control-plane** nodes.
- `plan-worker.yaml` is a SUC plan resource for **worker** nodes.
- `secret.yaml` is a Secret that contains the `upgrade.sh` script, which is responsible for creating the systemd.service (*Section 31.2.4.1.1, "systemd.service"*).
- `config-map.yaml` is a ConfigMap that holds configurations that are consumed by the `upgrade.sh` script.

Important

These `Plan` resources are interpreted by the `System Upgrade Controller` and should be deployed on each downstream cluster that you wish to upgrade. For SUC deployment information, see *Section 18.2, "Installing the System Upgrade Controller"*.

To better understand how your GitOps workflow can be used to deploy the **SUC Plans** for OS upgrade, it can be beneficial to take a look at overview (*Section 31.2.4.2, "Overview"*).

31.2.5 Kubernetes version upgrade

Revision History

2025-01-14

This section describes how to perform a Kubernetes upgrade using *Chapter 6, Fleet* and the *Chapter 18, System Upgrade Controller*.

The following topics are covered as part of this section:

1. *Section 31.2.5.1, "Components"* - additional components used by the upgrade process.
2. *Section 31.2.5.2, "Overview"* - overview of the upgrade process.
3. *Section 31.2.5.3, "Requirements"* - requirements of the upgrade process.
4. *Section 31.2.5.4, "K8s upgrade - SUC plan deployment"* - information on how to deploy `SUC plans`, responsible for triggering the upgrade process.

31.2.5.1 Components

This section covers the custom components that the `K8s upgrade` process uses over the default "Day 2" components (*Section 31.2.1, "Components"*).

31.2.5.1.1 rke2-upgrade

Container image responsible for upgrading the RKE2 version of a specific node.

Shipped through a Pod created by **SUC** based on a **SUC Plan**. The Plan should be located on each **cluster** that is in need of a RKE2 upgrade.

For more information regarding how the `rke2-upgrade` image performs the upgrade, see the upstream (https://github.com/rancher/rke2-upgrade/tree/master) documentation.

31.2.5.1.2 k3s-upgrade

Container image responsible for upgrading the K3s version of a specific node.

Shipped through a Pod created by **SUC** based on a **SUC Plan**. The Plan should be located on each **cluster** that is in need of a K3s upgrade.

For more information regarding how the `k3s-upgrade` image performs the upgrade, see the upstream (https://github.com/k3s-io/k3s-upgrade) documentation.

31.2.5.2 Overview

The Kubernetes distribution upgrade for management cluster nodes is done by utilizing `Fleet` and the `System Upgrade Controller (SUC)`.

`Fleet` is used to deploy and manage `SUC plans` onto the desired cluster.

> **Note**
>
> `SUC plans` are custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) that describe the steps that **SUC** needs to follow in order for a specific task to be executed on a set of nodes. For an example of how an `SUC plan` looks like, refer to the upstream repository (https://github.com/rancher/system-upgrade-controller?tab=readme-ov-file#example-plans).

The `K8s SUC plans` are shipped on each cluster by deploying a GitRepo (https://fleet.rancher.io/gitrepo-add) or Bundle (https://fleet.rancher.io/bundle-add) resource to a specific Fleet workspace (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups). Fleet retrieves the deployed `GitRepo/Bundle` and deploys its contents (the `K8s SUC plans`) to the desired cluster(s).

> **Note**
>
> `GitRepo/Bundle` resources are always deployed on the `management cluster`. Whether to use a `GitRepo` or `Bundle` resource depends on your use-case, check *Section 31.2.2, "Determine your use-case"* for more information.

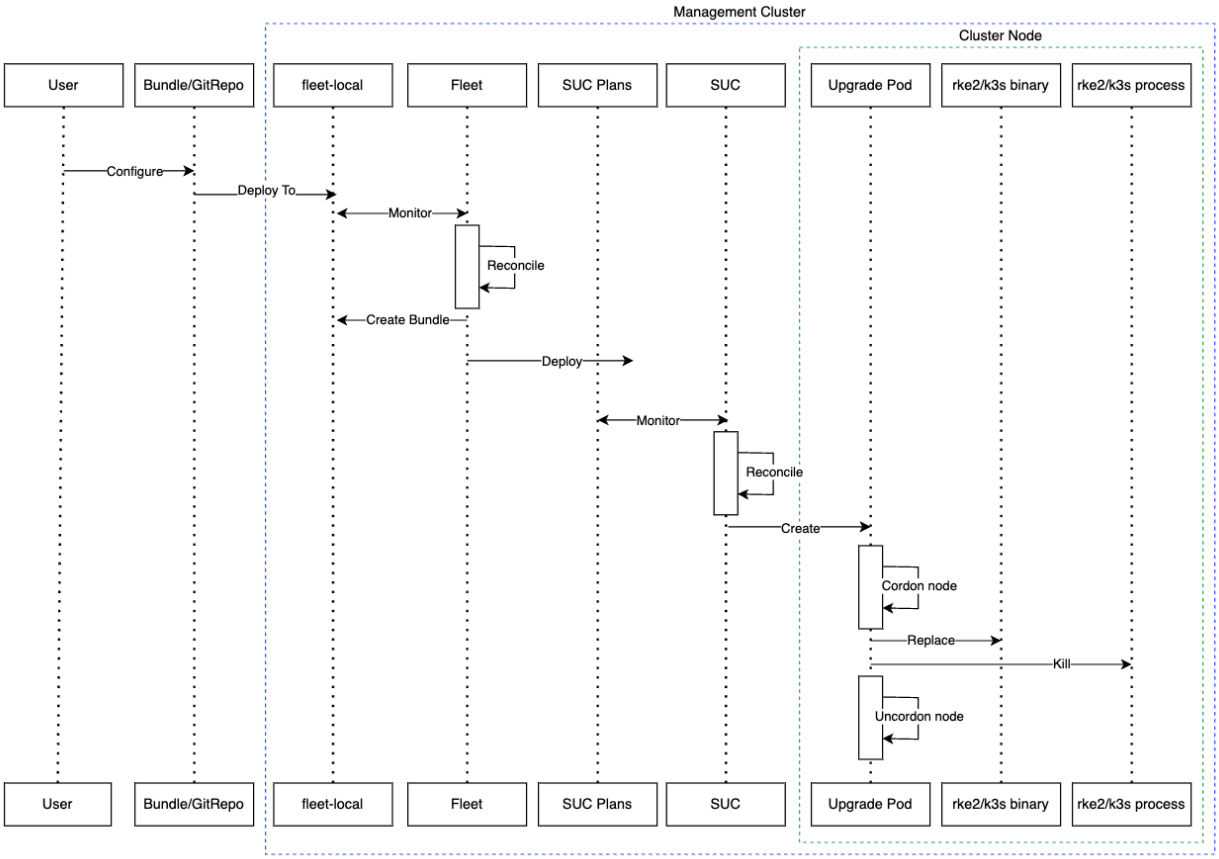
`K8s SUC plans` describe the following workflow:

1. Always cordon (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_cordon/) the nodes before K8s upgrades.
2. Always upgrade `control-plane` nodes before `worker` nodes.
3. Always upgrade the `control-plane` nodes **one** node at a time and the `worker` nodes **two** nodes at a time.

Once the `K8s SUC plans` are deployed, the workflow looks like this:

1. SUC reconciles the deployed `K8s SUC plans` and creates a `Kubernetes Job` on **each node**.
2. Depending on the Kubernetes distribution, the Job will create a Pod that runs either the rke2-upgrade (*Section 31.2.5.1.1, "rke2-upgrade"*) or the k3s-upgrade (*Section 31.2.5.1.2, "k3s-upgrade"*) container image.
3. The created Pod will go through the following workflow:
   a. Replace the existing `rke2/k3s` binary on the node with the one from the `rke2-upgrade/k3s-upgrade` image.
   b. Kill the running `rke2/k3s` process.
4. Killing the `rke2/k3s` process triggers a restart, launching a new process that runs the updated binary, resulting in an upgraded Kubernetes distribution version.

Below you can find a diagram of the above description:



31.2.5.3 Requirements

1. **Backup your Kubernetes distribution:**

   a. For **RKE2 clusters**, see the RKE2 Backup and Restore (https://docs.rke2.io/datastore/backup_restore) documentation.

   b. For **K3s clusters**, see the K3s Backup and Restore (https://docs.k3s.io/datastore/backup-restore) documentation.

2. **Make sure that SUC Plan tolerations match node tolerations** - If your Kubernetes cluster nodes have custom **taints**, make sure to add tolerations (https://kubernetes.io/docs/concepts/scheduling-eviction/taint-and-toleration/) for those taints in the **SUC Plans**. By default **SUC Plans** have tolerations only for **control-plane** nodes. Default tolerations include:

   - *CriticalAddonsOnly=true:NoExecute*
   - *node-role.kubernetes.io/control-plane:NoSchedule*
   - *node-role.kubernetes.io/etcd:NoExecute*

   Note

   Any additional tolerations must be added under the `.spec.tolerations` section of each Plan. **SUC Plans** related to the Kubernetes version upgrade can be found in the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository under:

   - For **RKE2** - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade`
   - For **K3s** - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade`

   Make sure you use the Plans from a valid repository release (https://github.com/suse-edge/fleet-examples/releases) tag.

   An example of defining custom tolerations for the RKE2 **control-plane** SUC Plan, would look like this:

```
apiVersion: upgrade.cattle.io/v1
kind: Plan
metadata:
```

```
  name: rke2-upgrade-control-plane
spec:
  ...
  tolerations:
  # default tolerations
  - key: "CriticalAddonsOnly"
    operator: "Equal"
    value: "true"
    effect: "NoExecute"
  - key: "node-role.kubernetes.io/control-plane"
    operator: "Equal"
    effect: "NoSchedule"
  - key: "node-role.kubernetes.io/etcd"
    operator: "Equal"
    effect: "NoExecute"
  # custom toleration
  - key: "foo"
    operator: "Equal"
    value: "bar"
    effect: "NoSchedule"
...
```

31.2.5.4 K8s upgrade - SUC plan deployment

Important

For environments previously upgraded using this procedure, users should ensure that **one** of the following steps is completed:

- `Remove any previously deployed SUC Plans related to older Edge release versions from the management cluster` - can be done by removing the desired cluster from the existing `GitRepo/Bundle` target configuration (https://fleet.rancher.io/gitrepo-targets#target-matching), or removing the `GitRepo/Bundle` resource altogether.
- `Reuse the existing GitRepo/Bundle resource` - can be done by pointing the resource's revision to a new tag that holds the correct fleets for the desired `suse-edge/fleet-examples` release (https://github.com/suse-edge/fleet-examples/releases).

This is done in order to avoid clashes between `SUC Plans` for older Edge release versions.

If users attempt to upgrade, while there are existing `SUC Plans` on the management cluster, they will see the following fleet error:

```
Not installed: Unable to continue with install: Plan <plan_name> in namespace
 <plan_namespace> exists and cannot be imported into the current release: invalid
 ownership metadata; annotation validation error..
```

As mentioned in *Section 31.2.5.2, "Overview"*, Kubernetes upgrades are done by shipping `SUC plans` to the desired cluster through one of the following ways:

- Fleet GitRepo resource (*Section 31.2.5.4.1, "SUC plan deployment - GitRepo resource"*)
- Fleet Bundle resource (*Section 31.2.5.4.2, "SUC plan deployment - Bundle resource"*)

To determine which resource you should use, refer to *Section 31.2.2, "Determine your use-case"*.

For use-cases where you wish to deploy the `K8s SUC plans` from a third-party GitOps tool, refer to *Section 31.2.5.4.3, "SUC Plan deployment - third-party GitOps workflow"*

31.2.5.4.1 SUC plan deployment - GitRepo resource

A **GitRepo** resource, that ships the needed `K8s SUC plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 31.2.5.4.1.1, "GitRepo creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 31.2.5.4.1.2, "GitRepo creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the Kubernetes upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

31.2.5.4.1.1 GitRepo creation - Rancher UI

To create a `GitRepo` resource through the Rancher UI, follow their official documentation (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

The Edge team maintains ready to use fleets for both rke2 (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/rke2-upgrade) and k3s (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/k3s-upgrade) Kubernetes distributions. Depending on your environment, this fleet could be used directly or as a template.

Important

Always use these fleets from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

For use-cases where no custom changes need to be included to the `SUC plans` that these fleets ship, users can directly refer the fleets from the `suse-edge/fleet-examples` repository.

In cases where custom changes are needed (e.g. to add custom tolerations), users should refer the fleets from a separate repository, allowing them to add the changes to the SUC plans as required.

Configuration examples for a `GitRepo` resource using the fleets from `suse-edge/fleet-examples` repository:

- RKE2 (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/rke2-upgrade-gitrepo.yaml)
- K3s (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/k3s-upgrade-gitrepo.yaml)

31.2.5.4.1.2 GitRepo creation - manual

1. Pull the **GitRepo** resource:

   - For **RKE2** clusters:

     ```
     curl -o rke2-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/rke2-upgrade-gitrepo.yaml
     ```

   - For **K3s** clusters:

     ```
     curl -o k3s-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/k3s-upgrade-gitrepo.yaml
     ```

2. Edit the **GitRepo** configuration:

   - Remove the `spec.targets` section - only needed for downstream clusters.

     - For RKE2:

       ```
       # Example using sed
       sed -i.bak '/^  targets:/,$d' rke2-upgrade-gitrepo.yaml && rm -f rke2-
       upgrade-gitrepo.yaml.bak

       # Example using yq (v4+)
       yq eval 'del(.spec.targets)' -i rke2-upgrade-gitrepo.yaml
       ```

     - For K3s:

       ```
       # Example using sed
       sed -i.bak '/^  targets:/,$d' k3s-upgrade-gitrepo.yaml && rm -f k3s-
       upgrade-gitrepo.yaml.bak

       # Example using yq (v4+)
       yq eval 'del(.spec.targets)' -i k3s-upgrade-gitrepo.yaml
       ```

   - Point the namespace of the `GitRepo` to the `fleet-local` namespace - done in order to deploy the resource on the management cluster.

     - For RKE2:

       ```
       # Example using sed
       sed -i.bak 's/namespace: fleet-default/namespace: fleet-local/' rke2-
       upgrade-gitrepo.yaml && rm -f rke2-upgrade-gitrepo.yaml.bak
       ```

```
# Example using yq (v4+)
yq eval '.metadata.namespace = "fleet-local"' -i rke2-upgrade-
gitrepo.yaml
```

- For K3s:

```
# Example using sed
sed -i.bak 's/namespace: fleet-default/namespace: fleet-local/' k3s-
upgrade-gitrepo.yaml && rm -f k3s-upgrade-gitrepo.yaml.bak

# Example using yq (v4+)
yq eval '.metadata.namespace = "fleet-local"' -i k3s-upgrade-gitrepo.yaml
```

3. Apply the **GitRepo** resources to your `management cluster`:

```
# RKE2
kubectl apply -f rke2-upgrade-gitrepo.yaml

# K3s
kubectl apply -f k3s-upgrade-gitrepo.yaml
```

4. View the created **GitRepo** resource under the `fleet-local` namespace:

```
# RKE2
kubectl get gitrepo rke2-upgrade -n fleet-local

# K3s
kubectl get gitrepo k3s-upgrade -n fleet-local

# Example output
NAME           REPO                                                COMMIT
 BUNDLEDEPLOYMENTS-READY   STATUS
k3s-upgrade    https://github.com/suse-edge/fleet-examples.git   fleet-local   0/0
rke2-upgrade   https://github.com/suse-edge/fleet-examples.git   fleet-local   0/0
```

31.2.5.4.2 SUC plan deployment - Bundle resource

A **Bundle** resource, that ships the needed `Kubernetes upgrade SUC Plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 31.2.5.4.2.1, "Bundle creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 31.2.5.4.2.2, "Bundle creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the Kubernetes upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

31.2.5.4.2.1 Bundle creation - Rancher UI

The Edge team maintains ready to use bundles for both rke2 (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml) and k3s (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml) Kubernetes distributions. Depending on your environment these bundles could be used directly or as a template.

> **Important**
>
> Always use this bundle from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

To create a bundle through Rancher's UI:

1. In the upper left corner, click # → **Continuous Delivery**
2. Go to **Advanced** > **Bundles**
3. Select **Create from YAML**
4. From here you can create the Bundle in one of the following ways:

> **Note**
>
> There might be use-cases where you would need to include custom changes to the `SUC plans` that the bundle ships (e.g. to add custom tolerations). Make sure to include those changes in the bundle that will be generated by the below steps.

   a. By manually copying the bundle content for RKE2 (https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml) or K3s (https://

raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml) from `suse-edge/fleet-examples` to the **Create from YAML** page.

b. By cloning the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples.git) repository from the desired release (https://github.com/suse-edge/fleet-examples/releases) tag and selecting the **Read from File** option in the **Create from YAML** page. From there, navigate to the bundle that you need (`bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml` for RKE2 and `bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml` for K3s). This will auto-populate the **Create from YAML** page with the bundle content.

5. Edit the Bundle in the Rancher UI:

- Change the **namespace** of the `Bundle` to point to the `fleet-local` namespace.

```
# Example
kind: Bundle
apiVersion: fleet.cattle.io/v1alpha1
metadata:
  name: rke2-upgrade
  namespace: fleet-local
...
```

- Change the **target** clusters for the `Bundle` to point to your `local`(management) cluster:

```
spec:
  targets:
  - clusterName: local
```

Note

There are some use-cases where your `local` cluster could have a different name.

To retrieve your `local` cluster name, execute the command below:

```
kubectl get clusters.fleet.cattle.io -n fleet-local
```

6. Select **Create**

31.2.5.4.2.2 Bundle creation - manual

1. Pull the **Bundle** resources:

   - For **RKE2** clusters:

     ```
     curl -o rke2-plan-bundle.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-
     plans/rke2-upgrade/plan-bundle.yaml
     ```

   - For **K3s** clusters:

     ```
     curl -o k3s-plan-bundle.yaml https://raw.githubusercontent.com/suse-edge/fleet-
     examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/
     k3s-upgrade/plan-bundle.yaml
     ```

2. Edit the `Bundle` configuration:

   - Change the **target** clusters for the `Bundle` to point to your `local`(management) cluster:

     ```
     spec:
       targets:
       - clusterName: local
     ```

     Note

     There are some use-cases where your `local` cluster could have a different name.

     To retrieve your `local` cluster name, execute the command below:

     ```
     kubectl get clusters.fleet.cattle.io -n fleet-local
     ```

   - Change the **namespace** of the `Bundle` to point to the `fleet-local` namespace.

     ```
     # Example
     kind: Bundle
     apiVersion: fleet.cattle.io/v1alpha1
     metadata:
       name: rke2-upgrade
       namespace: fleet-local
     ...
     ```

3. Apply the **Bundle** resources to your `management cluster`:

```
# For RKE2
kubectl apply -f rke2-plan-bundle.yaml

# For K3s
kubectl apply -f k3s-plan-bundle.yaml
```

4. View the created **Bundle** resource under the `fleet-local` namespace:

```
# For RKE2
kubectl get bundles rke2-upgrade -n fleet-local

# For K3s
kubectl get bundles k3s-upgrade -n fleet-local

# Example output
NAME           BUNDLEDEPLOYMENTS-READY   STATUS
k3s-upgrade    0/0
rke2-upgrade   0/0
```

31.2.5.4.3 SUC Plan deployment - third-party GitOps workflow

There might be use-cases where users would like to incorporate the `Kubernetes upgrade SUC plans` to their own third-party GitOps workflow (e.g. `Flux`).

To get the K8s upgrade resources that you need, first determine the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag of the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples.git) repository that you would like to use.

After that, the resources can be found at:

- For a RKE2 cluster upgrade:
  - For `control-plane` nodes - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade/plan-control-plane.yaml`
  - For `worker` nodes - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade/plan-worker.yaml`
- For a K3s cluster upgrade:
  - For `control-plane` nodes - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade/plan-control-plane.yaml`
  - For `worker` nodes - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade/plan-worker.yaml`

Important

These `Plan` resources are interpreted by the `System Upgrade Controller` and should be deployed on each downstream cluster that you wish to upgrade. For SUC deployment information, see *Section 18.2, "Installing the System Upgrade Controller"*.

To better understand how your GitOps workflow can be used to deploy the **SUC Plans** for Kubernetes version upgrade, it can be beneficial to take a look at the overview (*Section 31.2.5.2, "Overview"*) of the update procedure using `Fleet`.

31.2.6 Helm chart upgrade

Revision History

2025-07-30

This section covers the following parts:

1. *Section 31.2.6.1, "Preparation for air-gapped environments"* - holds information on how to ship Edge related OCI charts and images to your private registry.
2. *Section 31.2.6.2, "Upgrade procedure"* - holds information on different Helm chart upgrade use-cases and their upgrade procedure.

31.2.6.1 Preparation for air-gapped environments

31.2.6.1.1 Ensure you have access to your Helm chart Fleet

Depending on what your environment supports, you can take one of the following options:

1. Host your chart's Fleet resources on a local Git server that is accessible by your `management cluster`.
2. Use Fleet's CLI to convert a Helm chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle) that you can directly use and will not need to be hosted somewhere. Fleet's CLI can be retrieved from their release (https://github.com/rancher/fleet/releases/tag/v0.16.1) page, for Mac users there is a fleet-cli (https://formulae.brew.sh/formula/fleet-cli) Homebrew Formulae.

31.2.6.1.2 Find the required assets for your Edge release version

1. Go to the "Day 2" release (https://github.com/suse-edge/fleet-examples/releases) page and find the Edge release that you want to upgrade your chart to and click **Assets**.
2. From the **"Assets"** section, download the following files:

Release File	Description
edge-save-images.sh	Pulls the images specified in the `edge-release-images.txt` file and packages them inside of a '.tar.gz' archive.
edge-save-oci-artefacts.sh	Pulls the OCI chart images related to the specific Edge release and packages them inside of a '.tar.gz' archive.
edge-load-images.sh	Loads images from a '.tar.gz' archive, retags and pushes them to a private registry.
edge-load-oci-artefacts.sh	Takes a directory containing Edge OCI '.tgz' chart packages and loads them to a private registry.

edge-release-helm-oci-artefacts.txt	Contains a list of OCI chart images related to a specific Edge release.
edge-release-images.txt	Contains a list of images related to a specific Edge release.

31.2.6.1.3 Create the Edge release images archive

On a machine with internet access:

1. Make `edge-save-images.sh` executable:

```
chmod +x edge-save-images.sh
```

2. Generate the image archive:

```
./edge-save-images.sh --source-registry registry.suse.com
```

3. This will create a ready to load archive named `edge-images.tar.gz`.

> **Note**
> If the `-i|--images` option is specified, the name of the archive may differ.

4. Copy this archive to your **air-gapped** machine:

```
scp edge-images.tar.gz <user>@<machine_ip>:/path
```

31.2.6.1.4 Create the Edge OCI chart images archive

On a machine with internet access:

1. Make `edge-save-oci-artefacts.sh` executable:

```
chmod +x edge-save-oci-artefacts.sh
```

2. Generate the OCI chart image archive:

```
./edge-save-oci-artefacts.sh --source-registry registry.suse.com
```

3. This will create an archive named `oci-artefacts.tar.gz`.

> **Note**
>
> If the `-a|--archive` option is specified, the name of the archive may differ.

4. Copy this archive to your **air-gapped** machine:

```
scp oci-artefacts.tar.gz <user>@<machine_ip>:/path
```

31.2.6.1.5 Load Edge release images to your air-gapped machine

On your air-gapped machine:

1. Log into your private registry (if required):

```
podman login <REGISTRY.YOURDOMAIN.COM:PORT>
```

2. Make `edge-load-images.sh` executable:

```
chmod +x edge-load-images.sh
```

3. Execute the script, passing the previously **copied** `edge-images.tar.gz` archive:

```
./edge-load-images.sh --source-registry registry.suse.com --registry
 <REGISTRY.YOURDOMAIN.COM:PORT> --images edge-images.tar.gz
```

> **Note**
>
> This will load all images from the `edge-images.tar.gz`, retag and push them to the registry specified under the `--registry` option.

31.2.6.1.6 Load the Edge OCI chart images to your air-gapped machine

On your air-gapped machine:

1. Log into your private registry (if required):

```
podman login <REGISTRY.YOURDOMAIN.COM:PORT>
```

2. Make `edge-load-oci-artefacts.sh` executable:

```
chmod +x edge-load-oci-artefacts.sh
```

3. Untar the copied `oci-artefacts.tar.gz` archive:

```
tar -xvf oci-artefacts.tar.gz
```

4. This will produce a directory with the naming template `edge-release-oci-tgz-<date>`

5. Pass this directory to the `edge-load-oci-artefacts.sh` script to load the Edge OCI chart images to your private registry:

> **Note**
>
> This script assumes the `helm` CLI has been pre-installed on your environment. For Helm installation instructions, see Installing Helm (https://helm.sh/docs/intro/install/).

```
./edge-load-oci-artefacts.sh --archive-directory edge-release-oci-tgz-<date> --
registry <REGISTRY.YOURDOMAIN.COM:PORT> --source-registry registry.suse.com
```

31.2.6.1.7 Configure your private registry in your Kubernetes distribution

For RKE2, see Private Registry Configuration (https://docs.rke2.io/install/private_registry)

For K3s, see Private Registry Configuration (https://docs.k3s.io/installation/private-registry)

31.2.6.2 Upgrade procedure

This section focuses on the following Helm upgrade procedure use-cases:

1. *Section 31.2.6.2.1, "I have a new cluster and would like to deploy and manage an Edge Helm chart"*
2. *Section 31.2.6.2.2, "I would like to upgrade a Fleet managed Helm chart"*
3. *Section 31.2.6.2.3, "I would like to upgrade a Helm chart deployed via EIB"*

Important

Manually deployed Helm charts cannot be reliably upgraded. We suggest to redeploy the Helm chart using the *Section 31.2.6.2.1, "I have a new cluster and would like to deploy and manage an Edge Helm chart"* method.

31.2.6.2.1 I have a new cluster and would like to deploy and manage an Edge Helm chart

This section covers how to:

1. *Section 31.2.6.2.1.1, "Prepare the fleet resources for your chart"*.
2. *Section 31.2.6.2.1.2, "Deploy the fleet for your chart"*.
3. *Section 31.2.6.2.1.3, "Manage the deployed Helm chart"*.

31.2.6.2.1.1 Prepare the fleet resources for your chart

1. Acquire the chart's Fleet resources from the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag that you wish to use.
2. Navigate to the Helm chart fleet (`fleets/day2/chart-templates/<chart>`)
3. **If you intend to use a GitOps workflow**, copy the chart Fleet directory to the Git repository from where you will do GitOps.

4. **Optionally**, if the Helm chart requires configurations to its **values**, edit the `.helm.values` configuration inside the `fleet.yaml` file of the copied directory.

5. **Optionally**, there may be use-cases where you need to add additional resources to your chart's fleet so that it can better fit your environment. For information on how to enhance your Fleet directory, see Git Repository Contents (https://fleet.rancher.io/gitrepo-content).

Note

In some cases, the default timeout Fleet uses for Helm operations may be insufficient, resulting in the following error:

```
failed pre-install: context deadline exceeded
```

In such cases, add the timeoutSeconds (https://fleet.rancher.io/ref-crds#helmoptions) property under the `helm` configuration of your `fleet.yaml` file.

An **example** for the `longhorn` helm chart would look like:

- User Git repository structure:

```
<user_repository_root>
├── longhorn
│   └── fleet.yaml
└── longhorn-crd
    └── fleet.yaml
```

- `fleet.yaml` content populated with user `Longhorn` data:

```
defaultNamespace: longhorn-system

helm:
  # timeoutSeconds: 10
  releaseName: "longhorn"
  chart: "longhorn"
  repo: "https://charts.rancher.io/"
  version: "1.12.1"
  takeOwnership: true
  # custom chart value overrides
  values:
    # Example for user provided custom values content
    defaultSettings:
      deletingConfirmationFlag: true
```

```
# https://fleet.rancher.io/bundle-diffs
diff:
  comparePatches:
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: engineimages.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: nodes.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: volumes.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
```

Note

These are just example values that are used to illustrate custom configurations over the `longhorn` chart. They should **NOT** be treated as deployment guidelines for the `longhorn` chart.

31.2.6.2.1.2 Deploy the fleet for your chart

You can deploy the fleet for your chart by either using a GitRepo (*Section 31.2.6.2.1.2.1, "GitRepo"*) or Bundle (*Section 31.2.6.2.1.2.2, "Bundle"*).

Note

While deploying your Fleet, if you get a `Modified` message, make sure to add a corresponding `comparePatches` entry to the Fleet's `diff` section. For more information, see Generating Diffs to Ignore Modified GitRepos (https://fleet.rancher.io/bundle-diffs).

31.2.6.2.1.2.1 GitRepo

Fleet's GitRepo (https://fleet.rancher.io/ref-gitrepo) resource holds information on how to access your chart's Fleet resources and to which clusters it needs to apply those resources.

The `GitRepo` resource can be deployed through the Rancher UI (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui), or manually, by deploying (https://fleet.rancher.io/tut-deployment) the resource to the `management cluster`.

Example **Longhorn** `GitRepo` resource for **manual** deployment:

```
apiVersion: fleet.cattle.io/v1alpha1
kind: GitRepo
metadata:
  name: longhorn-git-repo
  namespace: fleet-local
spec:
  # If using a tag
  # revision: user_repository_tag
  #
  # If using a branch
  # branch: user_repository_branch
  paths:
  # As seen in the 'Prepare your Fleet resources' example
  - longhorn
  - longhorn-crd
  repo: user_repository_url
```

31.2.6.2.1.2.2 Bundle

Bundle (https://fleet.rancher.io/bundle-add) resources hold the raw Kubernetes resources that need to be deployed by Fleet. Normally it is encouraged to use the `GitRepo` approach, but for use-cases where the environment is air-gapped and cannot support a local Git server, `Bundles` can help you in propagating your Helm chart Fleet to your target clusters.

A `Bundle` can be deployed either through the Rancher UI (`Continuous Delivery → Advanced → Bundles → Create from YAML`) or by manually deploying the `Bundle` resource in the correct Fleet namespace. For information about Fleet namespaces, see the upstream documentation (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups).

`Bundles` for Edge Helm charts can be created by utilizing Fleet's Convert a Helm Chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle) approach.

Below you can find an example on how to create a `Bundle` resource from the longhorn (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn/fleet.yaml) and longhorn-crd (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn-crd/fleet.yaml) Helm chart fleet templates and manually deploy this bundle to your `management cluster`.

Note

To illustrate the workflow, the below example uses the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) directory structure.

1. Navigate to the longhorn (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn/fleet.yaml) Chart fleet template:

```
cd fleets/day2/chart-templates/longhorn/longhorn
```

2. Create a `targets.yaml` file that will instruct Fleet to which clusters it should deploy the Helm chart:

```
cat > targets.yaml <<EOF
targets:
# Match your local (management) cluster
- clusterName: local
EOF
```

Note

There are some use-cases where your local cluster could have a different name.

To retrieve your local cluster name, execute the command below:

```
kubectl get clusters.fleet.cattle.io -n fleet-local
```

3. Convert the `Longhorn` Helm chart Fleet to a Bundle resource using the fleet-cli (https://fleet.rancher.io/cli/fleet-cli/fleet).

Note

Fleet's CLI can be retrieved from their release (https://github.com/rancher/fleet/releases/tag/v0.16.1) **Assets** page (`fleet-linux-amd64`).

For Mac users there is a fleet-cli (https://formulae.brew.sh/formula/fleet-cli) Homebrew Formulae.

```
fleet apply --compress --targets-file=targets.yaml -n fleet-local -o - longhorn-
bundle > longhorn-bundle.yaml
```

4. Navigate to the longhorn-crd (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn-crd/fleet.yaml) Chart fleet template:

```
cd fleets/day2/chart-templates/longhorn/longhorn-crd
```

5. Create a `targets.yaml` file that will instruct Fleet to which clusters it should deploy the Helm chart:

```
cat > targets.yaml <<EOF
targets:
# Match your local (management) cluster
- clusterName: local
EOF
```

6. Convert the `Longhorn CRD` Helm chart Fleet to a Bundle resource using the fleet-cli (https://fleet.rancher.io/cli/fleet-cli/fleet).

```
fleet apply --compress --targets-file=targets.yaml -n fleet-local -o - longhorn-crd-
bundle > longhorn-crd-bundle.yaml
```

7. Deploy the `longhorn-bundle.yaml` and `longhorn-crd-bundle.yaml` files to your `management cluster`:

```
kubectl apply -f longhorn-crd-bundle.yaml
kubectl apply -f longhorn-bundle.yaml
```

Following these steps will ensure that `SUSE Storage` is deployed on all of the specified management cluster.

31.2.6.2.1.3 Manage the deployed Helm chart

Once deployed with Fleet, for Helm chart upgrades, see *Section 31.2.6.2.2, "I would like to upgrade a Fleet managed Helm chart"*.

31.2.6.2.2 I would like to upgrade a Fleet managed Helm chart

1. Determine the version to which you need to upgrade your chart so that it is compatible with the desired Edge release. Helm chart version per Edge release can be viewed from the release notes (*Chapter 40, Release Notes*).
2. In your Fleet monitored Git repository, edit the Helm chart's `fleet.yaml` file with the correct chart **version** and **repository** from the release notes (*Chapter 40, Release Notes*).
3. After committing and pushing the changes to your repository, this will trigger an upgrade of the desired Helm chart

31.2.6.2.3 I would like to upgrade a Helm chart deployed via EIB

Chapter 8, Edge Image Builder deploys Helm charts by creating a `HelmChart` resource and utilizing the `helm-controller` introduced by the RKE2 (https://docs.rke2.io/helm)/K3s (https://docs.k3s.io/helm) Helm integration feature.

To ensure that a Helm chart deployed via `EIB` is successfully upgraded, users need to do an upgrade over the respective `HelmChart` resources.

Below you can find information on:

- The general overview (*Section 31.2.6.2.3.1, "Overview"*) of the upgrade process.
- The necessary upgrade steps (*Section 31.2.6.2.3.2, "Upgrade Steps"*).
- An example (*Section 31.2.6.2.3.3, "Example"*) showcasing a Longhorn (https://longhorn.io) chart upgrade using the explained method.
- How to use the upgrade process with a different GitOps tool (*Section 31.2.6.2.3.4, "Helm chart upgrade using a third-party GitOps tool"*).

31.2.6.2.3.1 Overview

Helm charts that are deployed via `EIB` are upgraded through a `fleet` called eib-charts-upgrader (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/eib-charts-upgrader).

This `fleet` processes **user-provided** data to **update** a specific set of HelmChart resources.

Updating these resources triggers the helm-controller (https://github.com/k3s-io/helm-controller), which **upgrades** the Helm charts associated with the modified `HelmChart` resources.

The user is only expected to:

1. Locally pull (https://helm.sh/docs/helm/helm_pull/) the archives for each Helm chart that needs to be upgraded.
2. Pass these archives to the generate-chart-upgrade-data.sh (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/scripts/day2/generate-chart-upgrade-data.sh) `generate-chart-upgrade-data.sh` script, which will include the data from these archives to the `eib-charts-upgrader` fleet.
3. Deploy the `eib-charts-upgrader` fleet to their `management cluster`. This is done through either a `GitRepo` or `Bundle` resource.

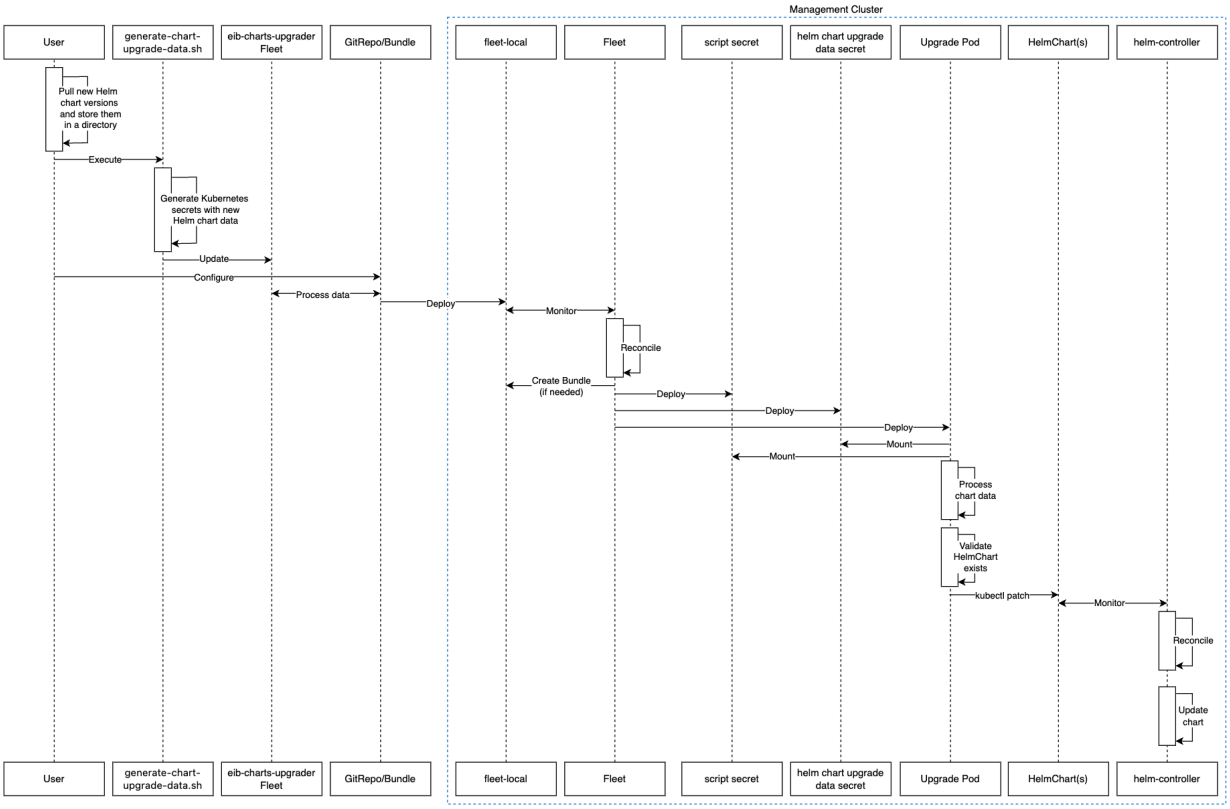
Once deployed, the `eib-charts-upgrader`, with the help of Fleet, will ship its resources to the desired management cluster.

These resources include:

1. A set of `Secrets` holding the **user-provided** Helm chart data.
2. A `Kubernetes Job` which will deploy a `Pod` that will mount the previously mentioned `Secrets` and based on them patch (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_patch/) the corresponding HelmChart resources.

As mentioned previously this will trigger the `helm-controller` which will perform the actual Helm chart upgrade.

Below you can find a diagram of the above description:



31.2.6.2.3.2 Upgrade Steps

1. Clone the `suse-edge/fleet-examples` repository from the correct release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0).

2. Create a directory in which you will store the pulled Helm chart archive(s).

```
mkdir archives
```

3. Inside of the newly created archive directory, pull (https://helm.sh/docs/helm/helm_pull/) the archive(s) for the Helm chart(s) you wish to upgrade:

```
cd archives
helm pull [chart URL | repo/chartname]

# Alternatively if you want to pull a specific version:
# helm pull [chart URL | repo/chartname] --version 0.0.0
```

4. From **Assets** of the desired release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0), download the `generate-chart-upgrade-data.sh` script.

5. Execute the `generate-chart-upgrade-data.sh` script:

```
chmod +x ./generate-chart-upgrade-data.sh

./generate-chart-upgrade-data.sh --archive-dir /foo/bar/archives/ --fleet-path /foo/
bar/fleet-examples/fleets/day2/eib-charts-upgrader
```

   For each chart archive in the `--archive-dir` directory, the script generates a `Kubernetes Secret YAML` file containing the chart upgrade data and stores it in the `base/secrets` directory of the fleet specified by `--fleet-path`.
   The `generate-chart-upgrade-data.sh` script also applies additional modifications to the fleet to ensure the generated `Kubernetes Secret YAML` files are correctly utilized by the workload deployed by the fleet.

> **Important**
> Users should not make any changes over what the `generate-chart-upgrade-data.sh` script generates.

The steps below depend on the environment that you are running:

1. For an environment that supports GitOps (e.g. is non air-gapped, or is air-gapped, but allows for local Git server support):

   a. Copy the `fleets/day2/eib-charts-upgrader` Fleet to the repository that you will use for GitOps.

   > **Note**
   > Make sure that the Fleet includes the changes that have been made by the `generate-chart-upgrade-data.sh` script.

   b. Configure a `GitRepo` resource that will be used to ship all the resources of the `eib-charts-upgrader` Fleet.

i. For `GitRepo` configuration and deployment through the Rancher UI, see Accessing Fleet in the Rancher UI (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

ii. For `GitRepo` manual configuration and deployment, see Creating a Deployment (https://fleet.rancher.io/tut-deployment).

2. For an environment that does not support GitOps (e.g. is air-gapped and does not allow local Git server usage):

   a. Download the `fleet-cli` binary from the `rancher/fleet` release (https://github.com/rancher/fleet/releases/tag/v0.16.1) page (`fleet-linux-amd64` for Linux). For Mac users, there is a Homebrew Formulae that can be used - fleet-cli (https://formulae.brew.sh/formula/fleet-cli).

   b. Navigate to the `eib-charts-upgrader` Fleet:

```
cd /foo/bar/fleet-examples/fleets/day2/eib-charts-upgrader
```

   c. Create a `targets.yaml` file that will instruct Fleet where to deploy your resources:

```
cat > targets.yaml <<EOF
targets:
# To map the local(management) cluster
- clusterName: local
EOF
```

> **Note**
>
> There are some use-cases where your `local` cluster could have a different name.
>
> To retrieve your `local` cluster name, execute the command below:
>
> ```
> kubectl get clusters.fleet.cattle.io -n fleet-local
> ```

   d. Use the `fleet-cli` to convert the Fleet to a `Bundle` resource:

```
fleet apply --compress --targets-file=targets.yaml -n fleet-local -o - eib-charts-upgrade > bundle.yaml
```

This will create a Bundle (`bundle.yaml`) that will hold all the templated resource from the `eib-charts-upgrader` Fleet.

For more information regarding the `fleet apply` command, see fleet apply (https://fleet.rancher.io/cli/fleet-cli/fleet_apply).

For more information regarding converting Fleets to Bundles, see Convert a Helm Chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle).

e. Deploy the `Bundle`. This can be done in one of two ways:

   i. Through Rancher's UI - Navigate to **Continuous Delivery → Advanced → Bundles → Create from YAML** and either paste the `bundle.yaml` contents, or click the `Read from File` option and pass the file itself.

   ii. Manually - Deploy the `bundle.yaml` file manually inside of your `management cluster`.

Executing these steps will result in a successfully deployed `GitRepo/Bundle` resource. The resource will be picked up by Fleet and its contents will be deployed onto the target clusters that the user has specified in the previous steps. For an overview of the process, refer to *Section 31.2.6.2.3.1, "Overview"*.

For information on how to track the upgrade process, you can refer to *Section 31.2.6.2.3.3, "Example"*.

Important

Once the chart upgrade has been successfully verified, remove the `Bundle/GitRepo` resource.

This will remove the no longer necessary upgrade resources from your `management` cluster, ensuring that no future version clashes might occur.

31.2.6.2.3.3 Example

Note

The example below demonstrates how to upgrade a Helm chart deployed via `EIB` from one version to another on a `management` cluster. Note that the versions used in this example are **not** recommendations. For version recommendations specific to an Edge release, refer to the release notes (*Chapter 40, Release Notes*).

Use-case:

- A `management` cluster is running an older version of Longhorn (https://longhorn.io).
- The cluster has been deployed through EIB, using the following image definition *snippet*:

```
kubernetes:
  helm:
    charts:
    - name: longhorn-crd
      repositoryName: rancher-charts
      targetNamespace: longhorn-system
      createNamespace: true
      version: 104.2.0+up1.7.1
      installationNamespace: kube-system
    - name: longhorn
      repositoryName: rancher-charts
      targetNamespace: longhorn-system
      createNamespace: true
      version: 104.2.0+up1.7.1
      installationNamespace: kube-system
    repositories:
    - name: rancher-charts
      url: https://charts.rancher.io/
...
```

- `SUSE Storage` needs to be upgraded to a version that is compatible with the Edge 3.7 release. Meaning it needs to be upgraded to `1.12.1`.
- It is assumed that the `management cluster` is **air-gapped**, without support for a local Git server and has a working Rancher setup.

Follow the Upgrade Steps (*Section 31.2.6.2.3.2, "Upgrade Steps"*):

1. Clone the `suse-edge/fleet-example` repository from the `release-3.7.0` tag.

```
git clone -b release-3.7.0 https://github.com/suse-edge/fleet-examples.git
```

2. Create a directory where the `Longhorn` upgrade archive will be stored.

```
mkdir archives
```

3. Pull the desired `Longhorn` chart archive version:

```
# First add the Rancher Helm chart repository
helm repo add rancher-charts https://charts.rancher.io/
```

```
# Pull the Longhorn 1.12.1 chart archive
helm pull oci://dp.apps.rancher.io/charts/suse-storage --version 1.12.1
```

4. Outside of the `archives` directory, download the `generate-chart-upgrade-data.sh` script from the `suse-edge/fleet-examples` release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0).

5. Directory setup should look similar to:

```
.
├── archives
│   └── longhorn-1.12.1.tgz
├── fleet-examples
...
│   ├── fleets
│   │   ├── day2
│   │   │   ├── ...
│   │   │   ├── eib-charts-upgrader
│   │   │   │   ├── base
│   │   │   │   │   ├── job.yaml
│   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   ├── patches
│   │   │   │   │   │   └── job-patch.yaml
│   │   │   │   │   ├── rbac
│   │   │   │   │   │   ├── cluster-role-binding.yaml
│   │   │   │   │   │   ├── cluster-role.yaml
│   │   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   │   └── sa.yaml
│   │   │   │   │   └── secrets
│   │   │   │   │       ├── eib-charts-upgrader-script.yaml
│   │   │   │   │       └── kustomization.yaml
│   │   │   │   ├── fleet.yaml
│   │   │   │   └── kustomization.yaml
│   │   │   └── ...
│   └── ...
└── generate-chart-upgrade-data.sh
```

6. Execute the `generate-chart-upgrade-data.sh` script:

```
# First make the script executable
chmod +x ./generate-chart-upgrade-data.sh

# Then execute the script
./generate-chart-upgrade-data.sh --archive-dir ./archives --fleet-path ./fleet-
examples/fleets/day2/eib-charts-upgrader
```

The directory structure after the script execution should look similar to:

```
.
├── archives
│   └── longhorn-1.12.1.tgz
├── fleet-examples
...
│   ├── fleets
│   │   ├── day2
│   │   │   ├── ...
│   │   │   ├── eib-charts-upgrader
│   │   │   │   ├── base
│   │   │   │   │   ├── job.yaml
│   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   ├── patches
│   │   │   │   │   │   └── job-patch.yaml
│   │   │   │   │   ├── rbac
│   │   │   │   │   │   ├── cluster-role-binding.yaml
│   │   │   │   │   │   ├── cluster-role.yaml
│   │   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   │   └── sa.yaml
│   │   │   │   │   └── secrets
│   │   │   │   │       ├── eib-charts-upgrader-script.yaml
│   │   │   │   │       ├── kustomization.yaml
│   │   │   │   │       ├── longhorn-VERSION.yaml - secret created by the generate-
chart-upgrade-data.sh script
│   │   │   │   │       └── longhorn-crd-VERSION.yaml - secret created by the
 generate-chart-upgrade-data.sh script
│   │   │   │   ├── fleet.yaml
│   │   │   │   └── kustomization.yaml
│   │   │   └── ...
│   └── ...
└── generate-chart-upgrade-data.sh
```

The files changed in git should look like this:

```
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
 modified:   fleets/day2/eib-charts-upgrader/base/patches/job-patch.yaml
 modified:   fleets/day2/eib-charts-upgrader/base/secrets/kustomization.yaml

Untracked files:
  (use "git add <file>..." to include in what will be committed)
 fleets/day2/eib-charts-upgrader/base/secrets/longhorn-VERSION.yaml
 fleets/day2/eib-charts-upgrader/base/secrets/longhorn-crd-VERSION.yaml
```

7. Create a `Bundle` for the `eib-charts-upgrader` Fleet:

   a. First, navigate to the Fleet itself:

   ```
   cd ./fleet-examples/fleets/day2/eib-charts-upgrader
   ```

   b. Then create a `targets.yaml` file:

   ```
   cat > targets.yaml <<EOF
   targets:
   - clusterName: local
   EOF
   ```

   c. Then use the `fleet-cli` binary to convert the Fleet to a Bundle:

   ```
   fleet apply --compress --targets-file=targets.yaml -n fleet-local -o - eib-charts-upgrade > bundle.yaml
   ```

8. Deploy the Bundle through the Rancher UI:

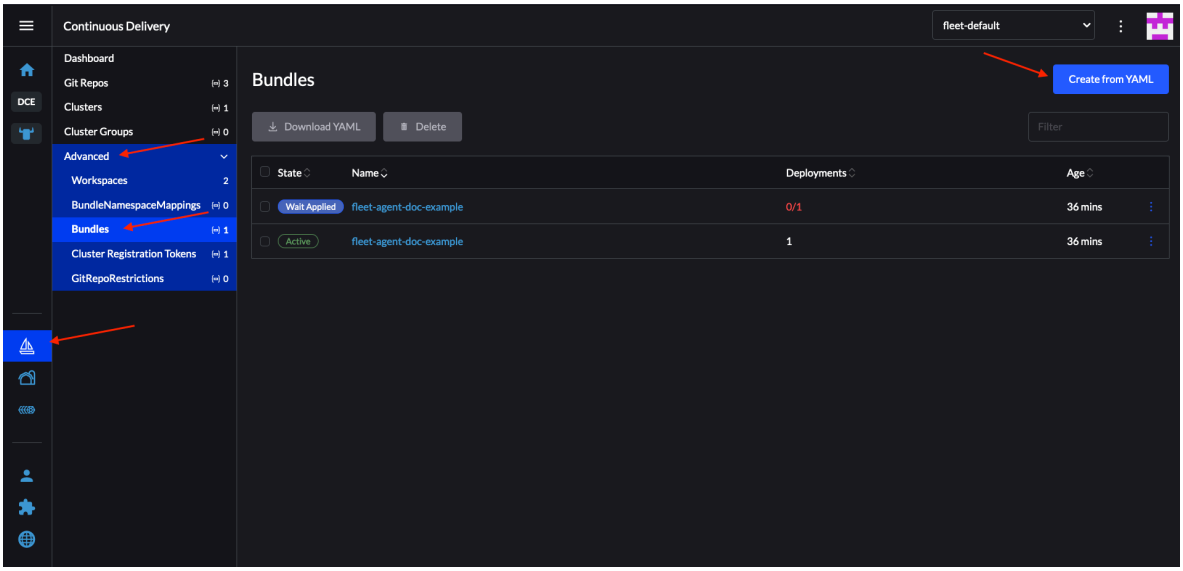


FIGURE 31.1: DEPLOY BUNDLE THROUGH RANCHER UI

From here, select **Read from File** and find the `bundle.yaml` file on your system. This will auto-populate the `Bundle` inside of Rancher's UI.

Select **Create**.

9. After a successful deployment, your Bundle would look similar to:

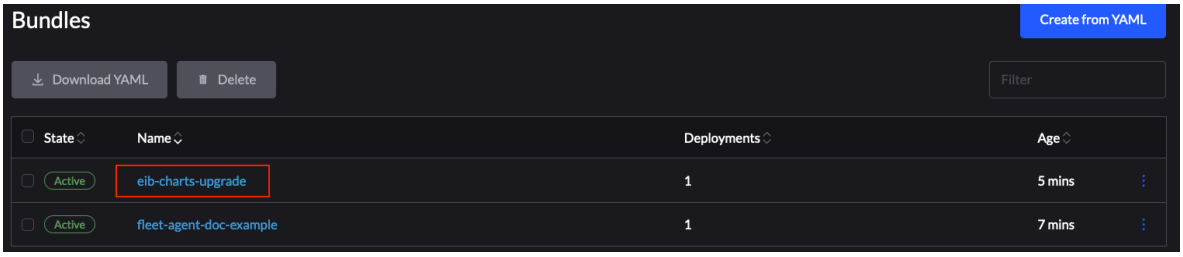
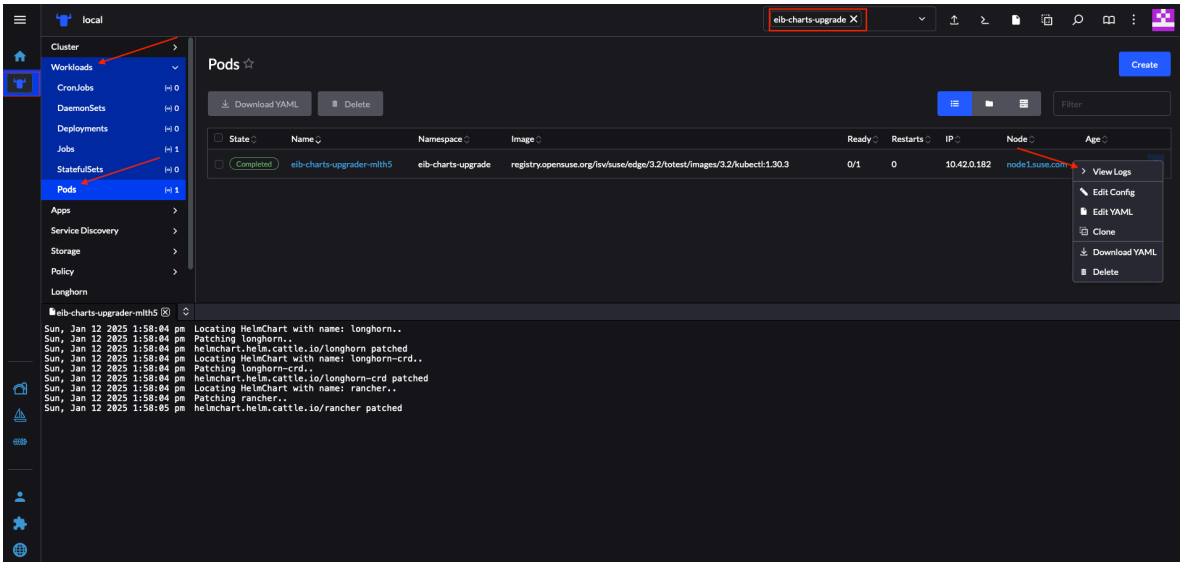


FIGURE 31.2: SUCCESSFULLY DEPLOYED BUNDLE

After the successful deployment of the `Bundle`, to monitor the upgrade process:

1. Verify the logs of the `Upgrade Pod`:



2. Now verify the logs of the Pod created for the upgrade by the helm-controller:

   a. The Pod name will be with the following template - `helm-install-longhorn-<random-suffix>`

   b. The Pod will be in the namespace where the `HelmChart` resource was deployed. In our case this is `kube-system`.

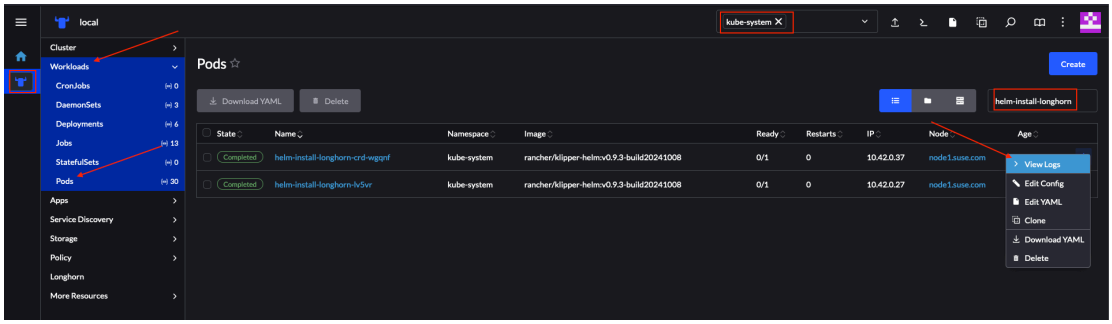


FIGURE 31.3: LOGS FOR SUCCESSFULLY UPGRADED LONGHORN CHART

3. Verify that the `HelmChart` version has been updated by navigating to Rancher's `HelmCharts` section (`More Resources → HelmCharts`). Select the namespace where the chart was deployed, for this example it would be `kube-system`.

4. Finally check that the Longhorn Pods are running.

After making the above validations, it is safe to assume that the Longhorn Helm chart has been upgraded to the `1.12.1` version.

31.2.6.2.3.4 Helm chart upgrade using a third-party GitOps tool

There might be use-cases where users would like to use this upgrade procedure with a GitOps workflow other than Fleet (e.g. `Flux`).

To produce the resources needed for the upgrade procedure, you can use the `generate-chart-upgrade-data.sh` script to populate the `eib-charts-upgrader` Fleet with the user provided data. For more information on how to do this, see *Section 31.2.6.2.3.2, "Upgrade Steps"*.

After you have the full setup, you can use kustomize (https://kustomize.io) to generate a full working solution that you can deploy in your cluster:

```
cd /foo/bar/fleets/day2/eib-charts-upgrader

kustomize build .
```

If you want to include the solution to your GitOps workflow, you can remove the `fleet.yaml` file and use what is left as a valid `Kustomize` setup. Just do not forget to first run the `generate-chart-upgrade-data.sh` script, so that it can populate the `Kustomize` setup with the data for the Helm charts that you wish to upgrade to.

To understand how this workflow is intended to be used, it can be beneficial to look at *Section 31.2.6.2.3.1, "Overview"* and *Section 31.2.6.2.3.2, "Upgrade Steps"*.

32 Downstream clusters

This section covers the possible ways to perform "Day 2" operations for different parts of your `downstream` cluster.

32.1 Fleet

Revision History

2025-01-14

This section offers information on how to perform "Day 2" operations using the Fleet (*Chapter 6, Fleet*) component.

The following topics are covered as part of this section:

1. *Section 32.1.1, "Components"* - default components used for all "Day 2" operations.
2. *Section 32.1.2, "Determine your use-case"* - provides an overview of the Fleet custom resources that will be used and their suitability for different "Day 2" operations use-cases.
3. *Section 32.1.3, "Day 2 workflow"* - provides a workflow guide for executing "Day 2" operations with Fleet.
4. *Section 32.1.4, "OS upgrade"* - describes how to do OS upgrades using Fleet.
5. *Section 32.1.5, "Kubernetes version upgrade"* - describes how to do Kubernetes version upgrades using Fleet.
6. *Section 32.1.6, "Helm chart upgrade"* - describes how to do Helm chart upgrades using Fleet.

32.1.1 Components

Below you can find a description of the default components that should be set up on your `downstream` cluster so that you can successfully perform "Day 2" operations using Fleet.

32.1.1.1 System Upgrade Controller (SUC)

Note

Must be deployed on each downstream cluster.

System Upgrade Controller is responsible for executing tasks on specified nodes based on configuration data provided through a custom resource, called a `Plan`.

SUC is actively utilized to upgrade the operating system and Kubernetes distribution.

For more information about the **SUC** component and how it fits in the Edge stack, see *Chapter 18, System Upgrade Controller*.

For information on how to deploy **SUC**, first determine your use-case (*Section 32.1.2, "Determine your use-case"*) and then refer to System Upgrade Controller installation - GitRepo (*Section 18.2.1.1, "System Upgrade Controller installation - GitRepo"*), or System Upgrade Controller installation - Bundle (*Section 18.2.1.2, "System Upgrade Controller installation - Bundle"*).

32.1.2 Determine your use-case

Fleet uses two types of custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) to enable the management of Kubernetes and Helm resources.

Below you can find information about the purpose of these resources and the use-cases they are best suited for in the context of "Day 2" operations.

32.1.2.1 GitRepo

A `GitRepo` is a Fleet (*Chapter 6, Fleet*) resource that represents a Git repository from which `Fleet` can create `Bundles`. Each `Bundle` is created based on configuration paths defined inside of the `GitRepo` resource. For more information, see the GitRepo (https://fleet.rancher.io/gitrepo-add) documentation.

In the context of "Day 2" operations, `GitRepo` resources are normally used to deploy `SUC` or `SUC Plans` in **non air-gapped** environments that utilize a *Fleet GitOps* approach.

Alternatively, `GitRepo` resources can also be used to deploy `SUC` or `SUC Plans` on **air-gapped** environments, **provided you mirror your repository setup through a local git server**.

32.1.2.2 Bundle

`Bundles` hold **raw** Kubernetes resources that will be deployed on the targeted cluster. Usually they are created from a `GitRepo` resource, but there are use-cases where they can be deployed manually. For more information refer to the Bundle (https://fleet.rancher.io/bundle-add) documentation.

In the context of "Day 2" operations, `Bundle` resources are normally used to deploy `SUC` or `SUC Plans` in **air-gapped** environments that do not use some form of *local GitOps* procedure (e.g. a **local git server**).

Alternatively, if your use-case does not allow for a *GitOps* workflow (e.g. using a Git repository), `Bundle` resources could also be used to deploy `SUC` or `SUC Plans` in **non air-gapped** environments.

32.1.3 Day 2 workflow

The following is a "Day 2" workflow that should be followed when upgrading a downstream cluster to a specific Edge release.

1. OS upgrade (*Section 32.1.4, "OS upgrade"*)
2. Kubernetes version upgrade (*Section 32.1.5, "Kubernetes version upgrade"*)
3. Helm chart upgrade (*Section 32.1.6, "Helm chart upgrade"*)

32.1.4 OS upgrade

Revision History

2025-05-20

This section describes how to perform an operating system upgrade using *Chapter 6, Fleet* and the *Chapter 18, System Upgrade Controller*.

The following topics are covered as part of this section:

1. *Section 32.1.4.1, "Components"* - additional components used by the upgrade process.
2. *Section 32.1.4.2, "Overview"* - overview of the upgrade process.
3. *Section 32.1.4.3, "Requirements"* - requirements of the upgrade process.
4. *Section 32.1.4.4, "OS upgrade - SUC plan deployment"* - information on how to deploy `SUC plans`, responsible for triggering the upgrade process.

32.1.4.1 Components

This section covers the custom components that the `OS upgrade` process uses over the default "Day 2" components (*Section 32.1.1, "Components"*).

32.1.4.1.1 systemd.service

The OS upgrade on a specific node is handled by a systemd.service (https://www.freedesktop.org/software/systemd/man/latest/systemd.service.html).

A different service is created depending on what type of upgrade the OS requires from one Edge version to another:

- For Edge versions that require the same OS version (e.g. `6.1`), the `os-pkg-update.service` will be created. It uses transactional-update (https://kubic.opensuse.org/documentation/man-pages/transactional-update.8.html) to perform a normal package upgrade (https://en.opensuse.org/SDB:Zypper_usage#Updating_packages).
- For Edge versions that require an OS version migration (e.g `6.1` → `6.2`), the `os-migration.service` will be created. It uses transactional-update (https://kubic.opensuse.org/documentation/man-pages/transactional-update.8.html) to perform:
  a. A normal package upgrade (https://en.opensuse.org/SDB:Zypper_usage#Updating_packages) which ensures that all packages are at up-to-date in order to mitigate any failures in the migration related to old package versions.
  b. An OS migration by utilizing the `zypper migration` command.

The services mentioned above are shipped on each node through a `SUC plan` which must be located on the downstream cluster that is in need of an OS upgrade.

32.1.4.2 Overview

The upgrade of the operating system for downstream cluster nodes is done by utilizing `Fleet` and the `System Upgrade Controller (SUC)`.

Fleet is used to deploy and manage `SUC plans` onto the desired cluster.

Note

`SUC plans` are custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) that describe the steps that `SUC` needs to follow in order for a specific task to be executed on a set of nodes. For an example of how an `SUC plan` looks like, refer to the upstream repository (https://github.com/rancher/system-upgrade-controller?tab=readme-ov-file#example-plans).

The `OS SUC plans` are shipped to each cluster by deploying a GitRepo (https://fleet.rancher.io/gitrepo-add) or Bundle (https://fleet.rancher.io/bundle-add) resource to a specific Fleet workspace (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups). Fleet retrieves the deployed `GitRepo/Bundle` and deploys its contents (the `OS SUC plans`) to the desired cluster(s).

Note

`GitRepo/Bundle` resources are always deployed on the `management cluster`. Whether to use a `GitRepo` or `Bundle` resource depends on your use-case, check *Section 32.1.2, "Determine your use-case"* for more information.

`OS SUC plans` describe the following workflow:

1. Always cordon (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_cordon/) the nodes before OS upgrades.
2. Always upgrade `control-plane` nodes before `worker` nodes.
3. Always upgrade the cluster on a **one** node at a time basis.

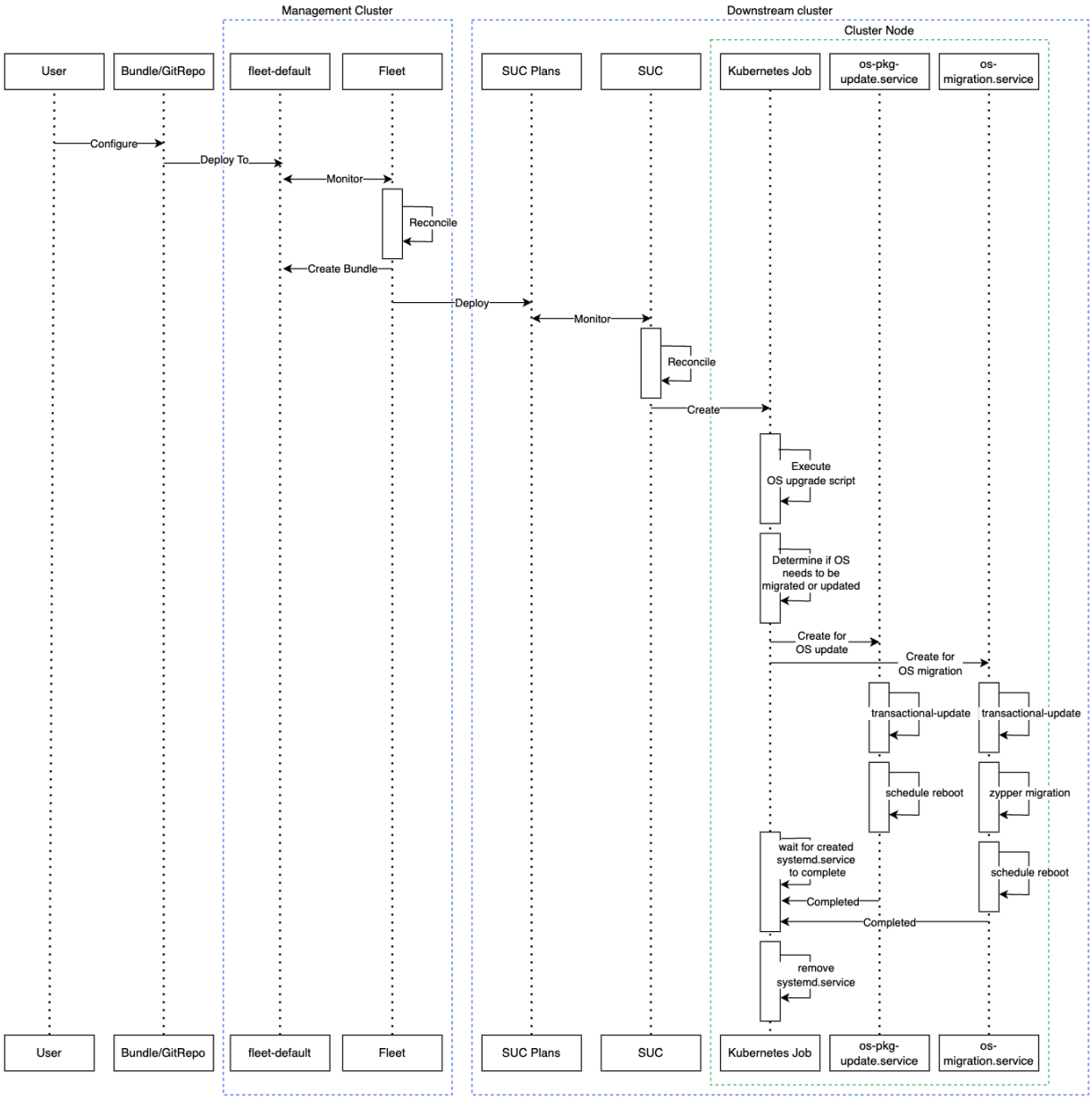
Once the `OS SUC plans` are deployed, the workflow looks like this:

1. SUC reconciles the deployed `OS SUC plans` and creates a `Kubernetes Job` on **each node**.
2. The `Kubernetes Job` creates a systemd.service (*Section 32.1.4.1.1, "systemd.service"*) for either package upgrade, or OS migration.
3. The created `systemd.service` triggers the OS upgrade process on the specific node.

Important

Once the OS upgrade process finishes, the corresponding node will be `rebooted` to apply the updates on the system.

Below you can find a diagram of the above description:



32.1.4.3 Requirements

General:

1. **SCC registered machine** - All downstream cluster nodes should be registered to `https://scc.suse.com/` which is needed so that the respective `systemd.service` can successfully connect to the desired RPM repository.

   Important

   For Edge releases that require an OS version migration (e.g. `6.1` → `6.2`), make sure that your SCC key supports the migration to the new version.

2. **Make sure that SUC Plan tolerations match node tolerations** - If your Kubernetes cluster nodes have custom **taints**, make sure to add tolerations (https://kubernetes.io/docs/concepts/scheduling-eviction/taint-and-toleration/) for those taints in the **SUC Plans**. By default, **SUC Plans** have tolerations only for **control-plane** nodes. Default tolerations include:

   - *CriticalAddonsOnly=true:NoExecute*
   - *node-role.kubernetes.io/control-plane:NoSchedule*
   - *node-role.kubernetes.io/etcd:NoExecute*

   Note

   Any additional tolerations must be added under the `.spec.tolerations` section of each Plan. **SUC Plans** related to the OS upgrade can be found in the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository under `fleets/day2/system-upgrade-controller-plans/os-upgrade`. **Make sure you use the Plans from a valid repository release (https://github.com/suse-edge/fleet-examples/releases) tag.**

   An example of defining custom tolerations for the **control-plane** SUC Plan would look like this:

```
apiVersion: upgrade.cattle.io/v1
kind: Plan
metadata:
  name: os-upgrade-control-plane
spec:
  ...
```

```
  tolerations:
  # default tolerations
  - key: "CriticalAddonsOnly"
    operator: "Equal"
    value: "true"
    effect: "NoExecute"
  - key: "node-role.kubernetes.io/control-plane"
    operator: "Equal"
    effect: "NoSchedule"
  - key: "node-role.kubernetes.io/etcd"
    operator: "Equal"
    effect: "NoExecute"
  # custom toleration
  - key: "foo"
    operator: "Equal"
    value: "bar"
    effect: "NoSchedule"
...
```

Air-gapped:

1. **Mirror SUSE RPM repositories** - OS RPM repositories should be locally mirrored so that the `systemd.service` can have access to them. This can be achieved by using either RMT (https://documentation.suse.com/sles/15-SP6/html/SLES-all/book-rmt.html) or SUSE Multi-Linux Manager Documentation (https://documentation.suse.com/multi-linux-manager/5.1/en/docs/index.html)..

32.1.4.4 OS upgrade - SUC plan deployment

Important

For environments previously upgraded using this procedure, users should ensure that **one** of the following steps is completed:

- `Remove any previously deployed SUC Plans related to older Edge release versions from the downstream cluster` - can be done by removing the desired cluster from the existing `GitRepo/Bundle` target configuration (https://fleet.rancher.io/gitrepo-targets#target-matching), or removing the `GitRepo/Bundle` resource altogether.
- `Reuse the existing GitRepo/Bundle resource` - can be done by pointing the resource's revision to a new tag that holds the correct fleets for the desired `suse-edge/fleet-examples` release (https://github.com/suse-edge/fleet-examples/releases).

This is done in order to avoid clashes between `SUC Plans` for older Edge release versions.

If users attempt to upgrade, while there are existing `SUC Plans` on the downstream cluster, they will see the following fleet error:

```
Not installed: Unable to continue with install: Plan <plan_name> in namespace
 <plan_namespace> exists and cannot be imported into the current release: invalid
 ownership metadata; annotation validation error..
```

As mentioned in *Section 32.1.4.2, "Overview"*, OS upgrades are done by shipping `SUC plans` to the desired cluster through one of the following ways:

- Fleet `GitRepo` resource - *Section 32.1.4.4.1, "SUC plan deployment - GitRepo resource"*.
- Fleet `Bundle` resource - *Section 32.1.4.4.2, "SUC plan deployment - Bundle resource"*.

To determine which resource you should use, refer to *Section 32.1.2, "Determine your use-case"*.

For use-cases where you wish to deploy the `OS SUC plans` from a third-party GitOps tool, refer to *Section 32.1.4.4.3, "SUC Plan deployment - third-party GitOps workflow"*

32.1.4.4.1 SUC plan deployment - GitRepo resource

A **GitRepo** resource, that ships the needed `OS SUC plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 32.1.4.4.1.1, "GitRepo creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 32.1.4.4.1.2, "GitRepo creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the OS upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

32.1.4.4.1.1 GitRepo creation - Rancher UI

To create a `GitRepo` resource through the Rancher UI, follow their official documentation (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

The Edge team maintains a ready to use fleet (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/os-upgrade). Depending on your environment this fleet could be used directly or as a template.

> **Important**
>
> Always use this fleet from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

For use-cases where no custom changes need to be included to the `SUC plans` that the fleet ships, users can directly refer the `os-upgrade` fleet from the `suse-edge/fleet-examples` repository.

In cases where custom changes are needed (e.g. to add custom tolerations), users should refer the `os-upgrade` fleet from a separate repository, allowing them to add the changes to the SUC plans as required.

An example of how a `GitRepo` can be configured to use the fleet from the `suse-edge/fleet-examples` repository, can be viewed here (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/os-upgrade-gitrepo.yaml).

32.1.4.4.1.2 GitRepo creation - manual

1. Pull the **GitRepo** resource:

```
curl -o os-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/os-upgrade-gitrepo.yaml
```

2. Edit the **GitRepo** configuration, under `spec.targets` specify your desired target list. By default the `GitRepo` resources from the `suse-edge/fleet-examples` are **NOT** mapped to any downstream clusters.

   - To match all clusters change the default `GitRepo` **target** to:

```
spec:
  targets:
  - clusterSelector: {}
```

   - Alternatively, if you want a more granular cluster selection see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets)

3. Apply the **GitRepo** resource your `management cluster`:

```
kubectl apply -f os-upgrade-gitrepo.yaml
```

4. View the created **GitRepo** resource under the `fleet-default` namespace:

```
kubectl get gitrepo os-upgrade -n fleet-default

# Example output
NAME            REPO                                                COMMIT
 BUNDLEDEPLOYMENTS-READY   STATUS
os-upgrade      https://github.com/suse-edge/fleet-examples.git   release-3.7.0  0/0
```

32.1.4.4.2 SUC plan deployment - Bundle resource

A **Bundle** resource, that ships the needed `OS SUC Plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 32.1.4.4.2.1, "Bundle creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 32.1.4.4.2.2, "Bundle creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the OS upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

32.1.4.4.2.1 Bundle creation - Rancher UI

The Edge team maintains a ready to use bundle (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml) that can be used in the below steps.

Important

Always use this bundle from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

To create a bundle through Rancher's UI:

1. In the upper left corner, click **#** → **Continuous Delivery**
2. Go to **Advanced** > **Bundles**
3. Select **Create from YAML**
4. From here you can create the Bundle in one of the following ways:

Note

There might be use-cases where you would need to include custom changes to the `SUC plans` that the bundle ships (e.g. to add custom tolerations). Make sure to include those changes in the bundle that will be generated by the below steps.

a. By manually copying the bundle content (https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml) from `suse-edge/fleet-examples` to the **Create from YAML** page.

b. By cloning the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository from the desired release (https://github.com/suse-edge/fleet-examples/releases) tag and selecting the **Read from File** option in the **Create from YAML** page. From there, navigate to the bundle location (`bundles/day2/system-upgrade-controller-plans/os-upgrade`) and select the bundle file. This will auto-populate the **Create from YAML** page with the bundle content.

5. Change the **target** clusters for the `Bundle`:

   - To match all downstream clusters change the default Bundle `.spec.targets` to:

     ```
     spec:
       targets:
       - clusterSelector: {}
     ```

   - For a more granular downstream cluster mappings, see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets).

6. Select **Create**

32.1.4.4.2.2 Bundle creation - manual

1. Pull the **Bundle** resource:

   ```
   curl -o os-upgrade-bundle.yaml https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/os-upgrade/os-upgrade-bundle.yaml
   ```

2. Edit the `Bundle` **target** configurations, under `spec.targets` provide your desired target list. By default the `Bundle` resources from the `suse-edge/fleet-examples` are **NOT** mapped to any downstream clusters.

   - To match all clusters change the default `Bundle` **target** to:

     ```
     spec:
     ```

```
  targets:
  - clusterSelector: {}
```

- Alternatively, if you want a more granular cluster selection see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets)

3. Apply the **Bundle** resource to your `management cluster`:

```
kubectl apply -f os-upgrade-bundle.yaml
```

4. View the created **Bundle** resource under the `fleet-default` namespace:

```
kubectl get bundles -n fleet-default
```

32.1.4.4.3 SUC Plan deployment - third-party GitOps workflow

There might be use-cases where users would like to incorporate the `OS SUC plans` to their own third-party GitOps workflow (e.g. `Flux`).

To get the OS upgrade resources that you need, first determine the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag of the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository that you would like to use.

After that, resources can be found at `fleets/day2/system-upgrade-controller-plans/os-upgrade`, where:

- `plan-control-plane.yaml` is a SUC plan resource for **control-plane** nodes.
- `plan-worker.yaml` is a SUC plan resource for **worker** nodes.
- `secret.yaml` is a Secret that contains the `upgrade.sh` script, which is responsible for creating the systemd.service (*Section 32.1.4.1.1, "systemd.service"*).
- `config-map.yaml` is a ConfigMap that holds configurations that are consumed by the `upgrade.sh` script.

Important

These `Plan` resources are interpreted by the `System Upgrade Controller` and should be deployed on each downstream cluster that you wish to upgrade. For SUC deployment information, see *Section 18.2, "Installing the System Upgrade Controller"*.

To better understand how your GitOps workflow can be used to deploy the **SUC Plans** for OS upgrade, it can be beneficial to take a look at overview (*Section 32.1.4.2, "Overview"*).

32.1.5 Kubernetes version upgrade

Revision History

2025-01-14

Important

This section covers Kubernetes upgrades for downstream clusters that have **NOT** been created through a Rancher (*Chapter 4, Rancher*) instance. For information on how to upgrade the Kubernetes version of `Rancher` created clusters, see Upgrading and Rolling Back Kubernetes (https://ranchermanager.docs.rancher.com/v2.15/getting-started/installation-and-upgrade/upgrade-and-roll-back-kubernetes#upgrading-the-kubernetes-version).

This section describes how to perform a Kubernetes upgrade using *Chapter 6, Fleet* and the *Chapter 18, System Upgrade Controller*.

The following topics are covered as part of this section:

1. *Section 32.1.5.1, "Components"* - additional components used by the upgrade process.
2. *Section 32.1.5.2, "Overview"* - overview of the upgrade process.
3. *Section 32.1.5.3, "Requirements"* - requirements of the upgrade process.
4. *Section 32.1.5.4, "K8s upgrade - SUC plan deployment"* - information on how to deploy `SUC plans`, responsible for triggering the upgrade process.

32.1.5.1 Components

This section covers the custom components that the `K8s upgrade` process uses over the default "Day 2" components (*Section 32.1.1, "Components"*).

32.1.5.1.1 rke2-upgrade

Container image responsible for upgrading the RKE2 version of a specific node.

Shipped through a Pod created by **SUC** based on a **SUC Plan**. The Plan should be located on each **cluster** that is in need of a RKE2 upgrade.

For more information regarding how the `rke2-upgrade` image performs the upgrade, see the upstream (https://github.com/rancher/rke2-upgrade/tree/master) documentation.

32.1.5.1.2 k3s-upgrade

Container image responsible for upgrading the K3s version of a specific node.

Shipped through a Pod created by **SUC** based on a **SUC Plan**. The Plan should be located on each **cluster** that is in need of a K3s upgrade.

For more information regarding how the `k3s-upgrade` image performs the upgrade, see the upstream (https://github.com/k3s-io/k3s-upgrade) documentation.

32.1.5.2 Overview

The Kubernetes distribution upgrade for downstream cluster nodes is done by utilizing `Fleet` and the `System Upgrade Controller (SUC)`.

`Fleet` is used to deploy and manage `SUC plans` onto the desired cluster.

> **Note**
>
> `SUC plans` are custom resources (https://kubernetes.io/docs/concepts/extend-kubernetes/api-extension/custom-resources/) that describe the steps that **SUC** needs to follow in order for a specific task to be executed on a set of nodes. For an example of how an `SUC plan` looks like, refer to the upstream repository (https://github.com/rancher/system-upgrade-controller?tab=readme-ov-file#example-plans).

The `K8s SUC plans` are shipped on each cluster by deploying a GitRepo (https://fleet.rancher.io/gitrepo-add) or Bundle (https://fleet.rancher.io/bundle-add) resource to a specific Fleet workspace (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups). Fleet retrieves the deployed `GitRepo/Bundle` and deploys its contents (the `K8s SUC plans`) to the desired cluster(s).

Note

`GitRepo/Bundle` resources are always deployed on the `management cluster`. Whether to use a `GitRepo` or `Bundle` resource depends on your use-case, check *Section 32.1.2, "Determine your use-case"* for more information.

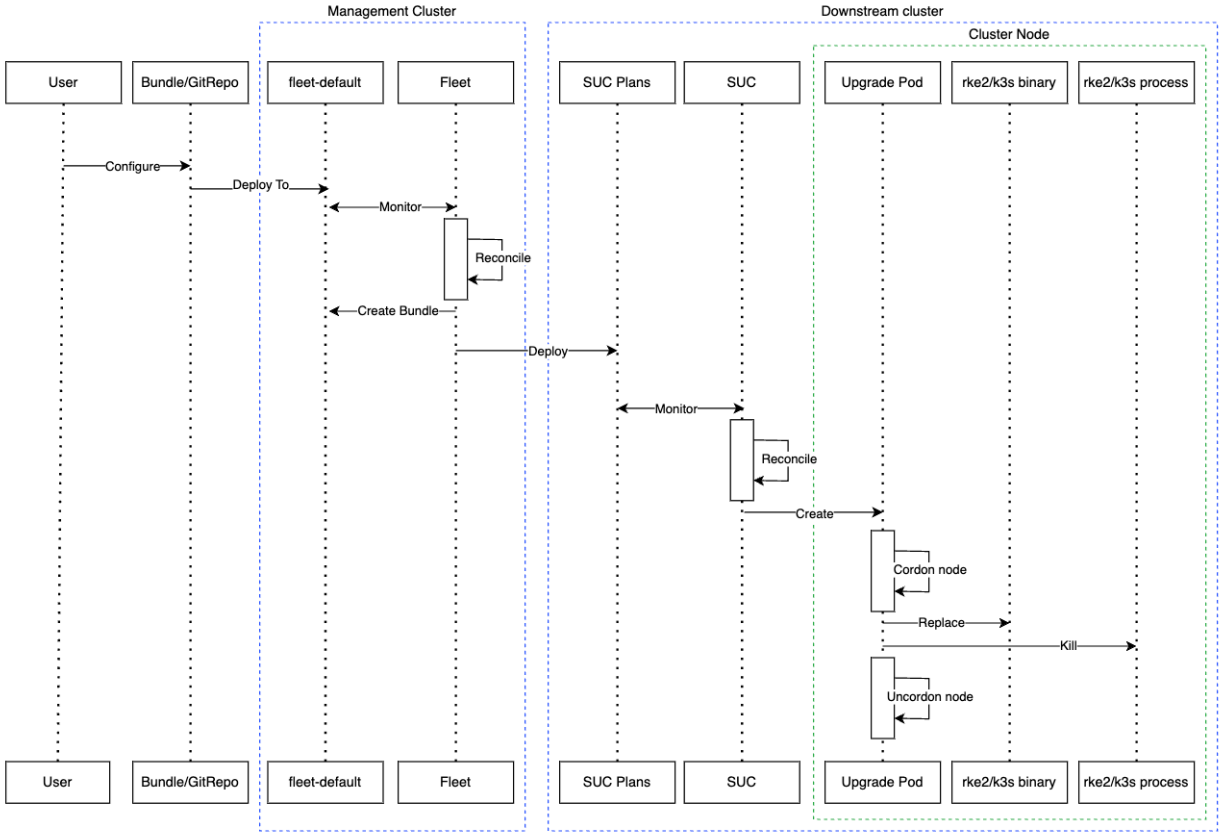
`K8s SUC plans` describe the following workflow:

1. Always cordon (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_cordon/) the nodes before K8s upgrades.
2. Always upgrade `control-plane` nodes before `worker` nodes.
3. Always upgrade the `control-plane` nodes **one** node at a time and the `worker` nodes **two** nodes at a time.

Once the `K8s SUC plans` are deployed, the workflow looks like this:

1. SUC reconciles the deployed `K8s SUC plans` and creates a `Kubernetes Job` on **each node**.
2. Depending on the Kubernetes distribution, the Job will create a Pod that runs either the rke2-upgrade (*Section 32.1.5.1.1, "rke2-upgrade"*) or the k3s-upgrade (*Section 32.1.5.1.2, "k3s-upgrade"*) container image.
3. The created Pod will go through the following workflow:
   a. Replace the existing `rke2/k3s` binary on the node with the one from the `rke2-upgrade/k3s-upgrade` image.
   b. Kill the running `rke2/k3s` process.
4. Killing the `rke2/k3s` process triggers a restart, launching a new process that runs the updated binary, resulting in an upgraded Kubernetes distribution version.

Below you can find a diagram of the above description:



32.1.5.3 Requirements

1. **Backup your Kubernetes distribution:**

   a. For **RKE2 clusters**, see the RKE2 Backup and Restore (https://docs.rke2.io/datastore/backup_restore) documentation.

   b. For **K3s clusters**, see the K3s Backup and Restore (https://docs.k3s.io/datastore/backup-restore) documentation.

2. **Make sure that SUC Plan tolerations match node tolerations** - If your Kubernetes cluster nodes have custom **taints**, make sure to add tolerations (https://kubernetes.io/docs/concepts/scheduling-eviction/taint-and-toleration/) for those taints in the **SUC Plans**. By default **SUC Plans** have tolerations only for **control-plane** nodes. Default tolerations include:

   - *CriticalAddonsOnly=true:NoExecute*
   - *node-role.kubernetes.io/control-plane:NoSchedule*
   - *node-role.kubernetes.io/etcd:NoExecute*

   Note

   Any additional tolerations must be added under the `.spec.tolerations` section of each Plan. **SUC Plans** related to the Kubernetes version upgrade can be found in the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) repository under:

   - For **RKE2** - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade`
   - For **K3s** - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade`

   Make sure you use the Plans from a valid repository release (https://github.com/suse-edge/fleet-examples/releases) tag.

   An example of defining custom tolerations for the RKE2 **control-plane** SUC Plan, would look like this:

```
apiVersion: upgrade.cattle.io/v1
kind: Plan
metadata:
```

```
  name: rke2-upgrade-control-plane
spec:
  ...
  tolerations:
  # default tolerations
  - key: "CriticalAddonsOnly"
    operator: "Equal"
    value: "true"
    effect: "NoExecute"
  - key: "node-role.kubernetes.io/control-plane"
    operator: "Equal"
    effect: "NoSchedule"
  - key: "node-role.kubernetes.io/etcd"
    operator: "Equal"
    effect: "NoExecute"
  # custom toleration
  - key: "foo"
    operator: "Equal"
    value: "bar"
    effect: "NoSchedule"
...
```

32.1.5.4 K8s upgrade - SUC plan deployment

Important

For environments previously upgraded using this procedure, users should ensure that **one** of the following steps is completed:

- `Remove any previously deployed SUC Plans related to older Edge release versions from the downstream cluster` - can be done by removing the desired cluster from the existing `GitRepo/Bundle` target configuration (https://fleet.rancher.io/gitrepo-targets#target-matching), or removing the `GitRepo/Bundle` resource altogether.
- `Reuse the existing GitRepo/Bundle resource` - can be done by pointing the resource's revision to a new tag that holds the correct fleets for the desired `suse-edge/fleet-examples` release (https://github.com/suse-edge/fleet-examples/releases).

This is done in order to avoid clashes between `SUC Plans` for older Edge release versions.

If users attempt to upgrade, while there are existing `SUC Plans` on the downstream cluster, they will see the following fleet error:

```
Not installed: Unable to continue with install: Plan <plan_name> in namespace
 <plan_namespace> exists and cannot be imported into the current release: invalid
 ownership metadata; annotation validation error..
```

As mentioned in *Section 32.1.5.2, "Overview"*, Kubernetes upgrades are done by shipping `SUC plans` to the desired cluster through one of the following ways:

- Fleet GitRepo resource (*Section 32.1.5.4.1, "SUC plan deployment - GitRepo resource"*)
- Fleet Bundle resource (*Section 32.1.5.4.2, "SUC plan deployment - Bundle resource"*)

To determine which resource you should use, refer to *Section 32.1.2, "Determine your use-case"*.

For use-cases where you wish to deploy the `K8s SUC plans` from a third-party GitOps tool, refer to *Section 32.1.5.4.3, "SUC Plan deployment - third-party GitOps workflow"*

32.1.5.4.1 SUC plan deployment - GitRepo resource

A **GitRepo** resource, that ships the needed `K8s SUC plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 32.1.5.4.1.1, "GitRepo creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 32.1.5.4.1.2, "GitRepo creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the Kubernetes upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

32.1.5.4.1.1 GitRepo creation - Rancher UI

To create a `GitRepo` resource through the Rancher UI, follow their official documentation (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

The Edge team maintains ready to use fleets for both rke2 (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/rke2-upgrade) and k3s (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/system-upgrade-controller-plans/k3s-upgrade) Kubernetes distributions. Depending on your environment, this fleet could be used directly or as a template.

Important

Always use these fleets from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

For use-cases where no custom changes need to be included to the `SUC plans` that these fleets ship, users can directly refer the fleets from the `suse-edge/fleet-examples` repository.

In cases where custom changes are needed (e.g. to add custom tolerations), users should refer the fleets from a separate repository, allowing them to add the changes to the SUC plans as required.

Configuration examples for a `GitRepo` resource using the fleets from `suse-edge/fleet-examples` repository:

- RKE2 (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/rke2-upgrade-gitrepo.yaml)
- K3s (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/gitrepos/day2/k3s-upgrade-gitrepo.yaml)

32.1.5.4.1.2 GitRepo creation - manual

1. Pull the **GitRepo** resource:

   - For **RKE2** clusters:

     ```
     curl -o rke2-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/rke2-upgrade-gitrepo.yaml
     ```

   - For **K3s** clusters:

     ```
     curl -o k3s-upgrade-gitrepo.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/gitrepos/day2/k3s-upgrade-gitrepo.yaml
     ```

2. Edit the **GitRepo** configuration, under `spec.targets` specify your desired target list. By default the `GitRepo` resources from the `suse-edge/fleet-examples` are **NOT** mapped to any downstream clusters.

   - To match all clusters change the default `GitRepo` **target** to:

     ```
     spec:
       targets:
       - clusterSelector: {}
     ```

   - Alternatively, if you want a more granular cluster selection see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets)

3. Apply the **GitRepo** resources to your `management cluster`:

   ```
   # RKE2
   kubectl apply -f rke2-upgrade-gitrepo.yaml

   # K3s
   kubectl apply -f k3s-upgrade-gitrepo.yaml
   ```

4. View the created **GitRepo** resource under the `fleet-default` namespace:

   ```
   # RKE2
   kubectl get gitrepo rke2-upgrade -n fleet-default

   # K3s
   kubectl get gitrepo k3s-upgrade -n fleet-default

   # Example output
   ```

```
NAME           REPO                                                COMMIT
 BUNDLEDEPLOYMENTS-READY   STATUS
k3s-upgrade    https://github.com/suse-edge/fleet-examples.git   fleet-default   0/0
rke2-upgrade   https://github.com/suse-edge/fleet-examples.git   fleet-default   0/0
```

32.1.5.4.2 SUC plan deployment - Bundle resource

A **Bundle** resource, that ships the needed `Kubernetes upgrade SUC Plans`, can be deployed in one of the following ways:

1. Through the `Rancher UI` - *Section 32.1.5.4.2.1, "Bundle creation - Rancher UI"* (when `Rancher` is available).
2. By manually deploying (*Section 32.1.5.4.2.2, "Bundle creation - manual"*) the resource to your `management cluster`.

Once deployed, to monitor the Kubernetes upgrade process of the nodes of your targeted cluster, refer to *Section 18.3, "Monitoring System Upgrade Controller Plans"*.

32.1.5.4.2.1 Bundle creation - Rancher UI

The Edge team maintains ready to use bundles for both rke2 (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml) and k3s (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml) Kubernetes distributions. Depending on your environment these bundles could be used directly or as a template.

Important

Always use this bundle from a valid Edge release (https://github.com/suse-edge/fleet-examples/releases) tag.

To create a bundle through Rancher's UI:

1. In the upper left corner, click **#** → **Continuous Delivery**
2. Go to **Advanced** > **Bundles**

3. Select **Create from YAML**

4. From here you can create the Bundle in one of the following ways:

> **Note**
>
> There might be use-cases where you would need to include custom changes to the `SUC plans` that the bundle ships (e.g. to add custom tolerations). Make sure to include those changes in the bundle that will be generated by the below steps.

   a. By manually copying the bundle content for RKE2 (https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml) or K3s (https://raw.githubusercontent.com/suse-edge/fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml) from `suse-edge/fleet-examples` to the **Create from YAML** page.

   b. By cloning the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples.git) repository from the desired release (https://github.com/suse-edge/fleet-examples/releases) tag and selecting the **Read from File** option in the **Create from YAML** page. From there, navigate to the bundle that you need (`bundles/day2/system-upgrade-controller-plans/rke2-upgrade/plan-bundle.yaml` for RKE2 and `bundles/day2/system-upgrade-controller-plans/k3s-upgrade/plan-bundle.yaml` for K3s). This will auto-populate the **Create from YAML** page with the bundle content.

5. Change the **target** clusters for the `Bundle`:

   - To match all downstream clusters change the default Bundle `.spec.targets` to:

```
spec:
  targets:
  - clusterSelector: {}
```

   - For a more granular downstream cluster mappings, see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets).

6. Select **Create**

32.1.5.4.2.2 Bundle creation - manual

1. Pull the **Bundle** resources:

   - For **RKE2** clusters:

     ```
     curl -o rke2-plan-bundle.yaml https://raw.githubusercontent.com/suse-edge/
     fleet-examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-
     plans/rke2-upgrade/plan-bundle.yaml
     ```

   - For **K3s** clusters:

     ```
     curl -o k3s-plan-bundle.yaml https://raw.githubusercontent.com/suse-edge/fleet-
     examples/refs/tags/release-3.7.0/bundles/day2/system-upgrade-controller-plans/
     k3s-upgrade/plan-bundle.yaml
     ```

2. Edit the `Bundle` **target** configurations, under `spec.targets` provide your desired target list. By default the `Bundle` resources from the `suse-edge/fleet-examples` are **NOT** mapped to any downstream clusters.

   - To match all clusters change the default `Bundle` **target** to:

     ```
     spec:
       targets:
       - clusterSelector: {}
     ```

   - Alternatively, if you want a more granular cluster selection see Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets)

3. Apply the **Bundle** resources to your `management cluster`:

   ```
   # For RKE2
   kubectl apply -f rke2-plan-bundle.yaml

   # For K3s
   kubectl apply -f k3s-plan-bundle.yaml
   ```

4. View the created **Bundle** resource under the `fleet-default` namespace:

   ```
   # For RKE2
   kubectl get bundles rke2-upgrade -n fleet-default

   # For K3s
   kubectl get bundles k3s-upgrade -n fleet-default
   ```

```
# Example output
NAME            BUNDLEDEPLOYMENTS-READY   STATUS
k3s-upgrade     0/0
rke2-upgrade    0/0
```

32.1.5.4.3 SUC Plan deployment - third-party GitOps workflow

There might be use-cases where users would like to incorporate the `Kubernetes upgrade SUC plans` to their own third-party GitOps workflow (e.g. `Flux`).

To get the K8s upgrade resources that you need, first determine the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag of the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples.git) repository that you would like to use.

After that, the resources can be found at:

- For a RKE2 cluster upgrade:
  - For `control-plane` nodes - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade/plan-control-plane.yaml`
  - For `worker` nodes - `fleets/day2/system-upgrade-controller-plans/rke2-upgrade/plan-worker.yaml`
- For a K3s cluster upgrade:
  - For `control-plane` nodes - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade/plan-control-plane.yaml`
  - For `worker` nodes - `fleets/day2/system-upgrade-controller-plans/k3s-upgrade/plan-worker.yaml`

Important

These `Plan` resources are interpreted by the `System Upgrade Controller` and should be deployed on each downstream cluster that you wish to upgrade. For SUC deployment information, see *Section 18.2, "Installing the System Upgrade Controller"*.

To better understand how your GitOps workflow can be used to deploy the **SUC Plans** for Kubernetes version upgrade, it can be beneficial to take a look at the overview (*Section 32.1.5.2, "Overview"*) of the update procedure using `Fleet`.

32.1.6 Helm chart upgrade

Revision History

2025-07-30

This section covers the following parts:

1. *Section 32.1.6.1, "Preparation for air-gapped environments"* - holds information on how to ship Edge related OCI charts and images to your private registry.
2. *Section 32.1.6.2, "Upgrade procedure"* - holds information on different Helm chart upgrade use-cases and their upgrade procedure.

32.1.6.1 Preparation for air-gapped environments

32.1.6.1.1 Ensure you have access to your Helm chart Fleet

Depending on what your environment supports, you can take one of the following options:

1. Host your chart's Fleet resources on a local Git server that is accessible by your `management cluster`.
2. Use Fleet's CLI to convert a Helm chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle) that you can directly use and will not need to be hosted somewhere. Fleet's CLI can be retrieved from their release (https://github.com/rancher/fleet/releases/tag/v0.16.1) page, for Mac users there is a fleet-cli (https://formulae.brew.sh/formula/fleet-cli) Homebrew Formulae.

32.1.6.1.2 Find the required assets for your Edge release version

1. Go to the "Day 2" release (https://github.com/suse-edge/fleet-examples/releases) page and find the Edge release that you want to upgrade your chart to and click **Assets**.
2. From the **"Assets"** section, download the following files:

Release File	Description

edge-save-images.sh	Pulls the images specified in the `edge-release-images.txt` file and packages them inside of a '.tar.gz' archive.
edge-save-oci-artefacts.sh	Pulls the OCI chart images related to the specific Edge release and packages them inside of a '.tar.gz' archive.
edge-load-images.sh	Loads images from a '.tar.gz' archive, retags and pushes them to a private registry.
edge-load-oci-artefacts.sh	Takes a directory containing Edge OCI '.tgz' chart packages and loads them to a private registry.
edge-release-helm-oci-artefacts.txt	Contains a list of OCI chart images related to a specific Edge release.
edge-release-images.txt	Contains a list of images related to a specific Edge release.

32.1.6.1.3 Create the Edge release images archive

On a machine with internet access:

1. Make `edge-save-images.sh` executable:

```
chmod +x edge-save-images.sh
```

2. Generate the image archive:

```
./edge-save-images.sh --source-registry registry.suse.com
```

3. This will create a ready to load archive named `edge-images.tar.gz`.

> **Note**
>
> If the `-i|--images` option is specified, the name of the archive may differ.

4. Copy this archive to your **air-gapped** machine:

```
scp edge-images.tar.gz <user>@<machine_ip>:/path
```

32.1.6.1.4 Create the Edge OCI chart images archive

On a machine with internet access:

1. Make `edge-save-oci-artefacts.sh` executable:

```
chmod +x edge-save-oci-artefacts.sh
```

2. Generate the OCI chart image archive:

```
./edge-save-oci-artefacts.sh --source-registry registry.suse.com
```

3. This will create an archive named `oci-artefacts.tar.gz`.

> **Note**
>
> If the `-a|--archive` option is specified, the name of the archive may differ.

4. Copy this archive to your **air-gapped** machine:

```
scp oci-artefacts.tar.gz <user>@<machine_ip>:/path
```

32.1.6.1.5 Load Edge release images to your air-gapped machine

On your air-gapped machine:

1. Log into your private registry (if required):

```
podman login <REGISTRY.YOURDOMAIN.COM:PORT>
```

2. Make `edge-load-images.sh` executable:

```
chmod +x edge-load-images.sh
```

3. Execute the script, passing the previously **copied** `edge-images.tar.gz` archive:

```
./edge-load-images.sh --source-registry registry.suse.com --registry
 <REGISTRY.YOURDOMAIN.COM:PORT> --images edge-images.tar.gz
```

> **Note**
>
> This will load all images from the `edge-images.tar.gz`, retag and push them to the registry specified under the `--registry` option.

32.1.6.1.6 Load the Edge OCI chart images to your air-gapped machine

On your air-gapped machine:

1. Log into your private registry (if required):

```
podman login <REGISTRY.YOURDOMAIN.COM:PORT>
```

2. Make `edge-load-oci-artefacts.sh` executable:

```
chmod +x edge-load-oci-artefacts.sh
```

3. Untar the copied `oci-artefacts.tar.gz` archive:

```
tar -xvf oci-artefacts.tar.gz
```

4. This will produce a directory with the naming template `edge-release-oci-tgz-<date>`

5. Pass this directory to the `edge-load-oci-artefacts.sh` script to load the Edge OCI chart images to your private registry:

> **Note**
>
> This script assumes the `helm` CLI has been pre-installed on your environment. For Helm installation instructions, see Installing Helm (https://helm.sh/docs/intro/install/).

```
./edge-load-oci-artefacts.sh --archive-directory edge-release-oci-tgz-<date> --
registry <REGISTRY.YOURDOMAIN.COM:PORT> --source-registry registry.suse.com
```

32.1.6.1.7 Configure your private registry in your Kubernetes distribution

For RKE2, see Private Registry Configuration (https://docs.rke2.io/install/private_registry)

For K3s, see Private Registry Configuration (https://docs.k3s.io/installation/private-registry)

32.1.6.2 Upgrade procedure

This section focuses on the following Helm upgrade procedure use-cases:

1. *Section 32.1.6.2.1, "I have a new cluster and would like to deploy and manage an Edge Helm chart"*

2. *Section 32.1.6.2.2, "I would like to upgrade a Fleet managed Helm chart"*

3. *Section 32.1.6.2.3, "I would like to upgrade a Helm chart deployed via EIB"*

> **Important**
>
> Manually deployed Helm charts cannot be reliably upgraded. We suggest to redeploy the Helm chart using the *Section 32.1.6.2.1, "I have a new cluster and would like to deploy and manage an Edge Helm chart"* method.

32.1.6.2.1 I have a new cluster and would like to deploy and manage an Edge Helm chart

This section covers how to:

1. *Section 32.1.6.2.1.1, "Prepare the fleet resources for your chart"*.
2. *Section 32.1.6.2.1.2, "Deploy the fleet for your chart"*.
3. *Section 32.1.6.2.1.3, "Manage the deployed Helm chart"*.

32.1.6.2.1.1 Prepare the fleet resources for your chart

1. Acquire the chart's Fleet resources from the Edge release (https://github.com/suse-edge/fleet-examples/releases) tag that you wish to use.
2. Navigate to the Helm chart fleet (`fleets/day2/chart-templates/<chart>`)
3. **If you intend to use a GitOps workflow**, copy the chart Fleet directory to the Git repository from where you will do GitOps.
4. **Optionally**, if the Helm chart requires configurations to its **values**, edit the `.helm.values` configuration inside the `fleet.yaml` file of the copied directory.
5. **Optionally**, there may be use-cases where you need to add additional resources to your chart's fleet so that it can better fit your environment. For information on how to enhance your Fleet directory, see Git Repository Contents (https://fleet.rancher.io/gitrepo-content).

> **Note**
>
> In some cases, the default timeout Fleet uses for Helm operations may be insufficient, resulting in the following error:
>
> ```
> failed pre-install: context deadline exceeded
> ```
>
> In such cases, add the timeoutSeconds (https://fleet.rancher.io/ref-crds#helmoptions) property under the `helm` configuration of your `fleet.yaml` file.

An **example** for the `longhorn` helm chart would look like:

- User Git repository structure:

```
<user_repository_root>
```

```
├── longhorn
│   └── fleet.yaml
└── longhorn-crd
    └── fleet.yaml
```

- `fleet.yaml` content populated with user `Longhorn` data:

```
defaultNamespace: longhorn-system

helm:
  # timeoutSeconds: 10
  releaseName: "longhorn"
  chart: "longhorn"
  repo: "https://charts.rancher.io/"
  version: "1.12.1"
  takeOwnership: true
  # custom chart value overrides
  values:
    # Example for user provided custom values content
    defaultSettings:
      deletingConfirmationFlag: true

# https://fleet.rancher.io/bundle-diffs
diff:
  comparePatches:
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: engineimages.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: nodes.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
  - apiVersion: apiextensions.k8s.io/v1
    kind: CustomResourceDefinition
    name: volumes.longhorn.io
    operations:
    - {"op":"remove", "path":"/status/conditions"}
    - {"op":"remove", "path":"/status/storedVersions"}
    - {"op":"remove", "path":"/status/acceptedNames"}
```

> **Note**
>
> These are just example values that are used to illustrate custom configurations over the `longhorn` chart. They should **NOT** be treated as deployment guidelines for the `longhorn` chart.

32.1.6.2.1.2 Deploy the fleet for your chart

You can deploy the fleet for your chart by either using a GitRepo (*Section 32.1.6.2.1.2.1, "GitRepo"*) or Bundle (*Section 32.1.6.2.1.2.2, "Bundle"*).

> **Note**
>
> While deploying your Fleet, if you get a `Modified` message, make sure to add a corresponding `comparePatches` entry to the Fleet's `diff` section. For more information, see Generating Diffs to Ignore Modified GitRepos (https://fleet.rancher.io/bundle-diffs).

32.1.6.2.1.2.1 GitRepo

Fleet's GitRepo (https://fleet.rancher.io/ref-gitrepo) resource holds information on how to access your chart's Fleet resources and to which clusters it needs to apply those resources.

The `GitRepo` resource can be deployed through the Rancher UI (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui), or manually, by deploying (https://fleet.rancher.io/tut-deployment) the resource to the `management cluster`.

Example **Longhorn** `GitRepo` resource for **manual** deployment:

```
apiVersion: fleet.cattle.io/v1alpha1
kind: GitRepo
metadata:
  name: longhorn-git-repo
  namespace: fleet-default
spec:
  # If using a tag
  # revision: user_repository_tag
  #
  # If using a branch
  # branch: user_repository_branch
```

```
paths:
# As seen in the 'Prepare your Fleet resources' example
- longhorn
- longhorn-crd
repo: user_repository_url
targets:
# Match all clusters
- clusterSelector: {}
```

32.1.6.2.1.2.2 Bundle

Bundle (https://fleet.rancher.io/bundle-add) resources hold the raw Kubernetes resources that need to be deployed by Fleet. Normally it is encouraged to use the `GitRepo` approach, but for use-cases where the environment is air-gapped and cannot support a local Git server, `Bundles` can help you in propagating your Helm chart Fleet to your target clusters.

A `Bundle` can be deployed either through the Rancher UI (`Continuous Delivery → Advanced → Bundles → Create from YAML`) or by manually deploying the `Bundle` resource in the correct Fleet namespace. For information about Fleet namespaces, see the upstream documentation (https://fleet.rancher.io/namespaces#gitrepos-bundles-clusters-clustergroups).

`Bundles` for Edge Helm charts can be created by utilizing Fleet's Convert a Helm Chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle) approach.

Below you can find an example on how to create a `Bundle` resource from the longhorn (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn/fleet.yaml) and longhorn-crd (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn-crd/fleet.yaml) Helm chart fleet templates and manually deploy this bundle to your `management cluster`.

Note

To illustrate the workflow, the below example uses the suse-edge/fleet-examples (https://github.com/suse-edge/fleet-examples) directory structure.

1. Navigate to the longhorn (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn/fleet.yaml) Chart fleet template:

```
cd fleets/day2/chart-templates/longhorn/longhorn
```

2. Create a `targets.yaml` file that will instruct Fleet to which clusters it should deploy the Helm chart:

```
cat > targets.yaml <<EOF
targets:
# Matches all downstream clusters
- clusterSelector: {}
EOF
```

For a more granular downstream cluster selection, refer to Mapping to Downstream Clusters (https://fleet.rancher.io/gitrepo-targets).

3. Convert the `Longhorn` Helm chart Fleet to a Bundle resource using the fleet-cli (https://fleet.rancher.io/cli/fleet-cli/fleet).

Note

Fleet's CLI can be retrieved from their release (https://github.com/rancher/fleet/releases/tag/v0.16.1) **Assets** page (`fleet-linux-amd64`).

For Mac users there is a fleet-cli (https://formulae.brew.sh/formula/fleet-cli) Homebrew Formulae.

```
fleet apply --compress --targets-file=targets.yaml -n fleet-default -o - longhorn-
bundle > longhorn-bundle.yaml
```

4. Navigate to the longhorn-crd (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/fleets/day2/chart-templates/longhorn/longhorn-crd/fleet.yaml) Chart fleet template:

```
cd fleets/day2/chart-templates/longhorn/longhorn-crd
```

5. Create a `targets.yaml` file that will instruct Fleet to which clusters it should deploy the Helm chart:

```
cat > targets.yaml <<EOF
targets:
```

```
# Matches all downstream clusters
- clusterSelector: {}
EOF
```

6. Convert the `Longhorn CRD` Helm chart Fleet to a Bundle resource using the fleet-cli (https://fleet.rancher.io/cli/fleet-cli/fleet)↗.

```
fleet apply --compress --targets-file=targets.yaml -n fleet-default -o - longhorn-crd-bundle > longhorn-crd-bundle.yaml
```

7. Deploy the `longhorn-bundle.yaml` and `longhorn-crd-bundle.yaml` files to your `management cluster`:

```
kubectl apply -f longhorn-crd-bundle.yaml
kubectl apply -f longhorn-bundle.yaml
```

Following these steps will ensure that `SUSE Storage` is deployed on all of the specified downstream cluster.

32.1.6.2.1.3 Manage the deployed Helm chart

Once deployed with Fleet, for Helm chart upgrades, see *Section 32.1.6.2.2, "I would like to upgrade a Fleet managed Helm chart"*.

32.1.6.2.2 I would like to upgrade a Fleet managed Helm chart

1. Determine the version to which you need to upgrade your chart so that it is compatible with the desired Edge release. Helm chart version per Edge release can be viewed from the release notes (*Chapter 40, Release Notes*).

2. In your Fleet monitored Git repository, edit the Helm chart's `fleet.yaml` file with the correct chart **version** and **repository** from the release notes (*Chapter 40, Release Notes*).

3. After committing and pushing the changes to your repository, this will trigger an upgrade of the desired Helm chart

32.1.6.2.3 I would like to upgrade a Helm chart deployed via EIB

Chapter 8, Edge Image Builder deploys Helm charts by creating a `HelmChart` resource and utilizing the `helm-controller` introduced by the RKE2 (https://docs.rke2.io/helm)/K3s (https://docs.k3s.io/helm) Helm integration feature.

To ensure that a Helm chart deployed via `EIB` is successfully upgraded, users need to do an upgrade over the respective `HelmChart` resources.

Below you can find information on:

- The general overview (*Section 32.1.6.2.3.1, "Overview"*) of the upgrade process.
- The necessary upgrade steps (*Section 32.1.6.2.3.2, "Upgrade Steps"*).
- An example (*Section 32.1.6.2.3.3, "Example"*) showcasing a Longhorn (https://longhorn.io) chart upgrade using the explained method.
- How to use the upgrade process with a different GitOps tool (*Section 32.1.6.2.3.4, "Helm chart upgrade using a third-party GitOps tool"*).

32.1.6.2.3.1 Overview

Helm charts that are deployed via `EIB` are upgraded through a `fleet` called eib-charts-upgrader (https://github.com/suse-edge/fleet-examples/tree/release-3.7.0/fleets/day2/eib-charts-upgrader).

This `fleet` processes **user-provided** data to **update** a specific set of HelmChart resources.

Updating these resources triggers the helm-controller (https://github.com/k3s-io/helm-controller), which **upgrades** the Helm charts associated with the modified `HelmChart` resources.

The user is only expected to:

1. Locally pull (https://helm.sh/docs/helm/helm_pull/) the archives for each Helm chart that needs to be upgraded.
2. Pass these archives to the generate-chart-upgrade-data.sh (https://github.com/suse-edge/fleet-examples/blob/release-3.7.0/scripts/day2/generate-chart-upgrade-data.sh) `generate-chart-upgrade-data.sh` script, which will include the data from these archives to the `eib-charts-upgrader` fleet.
3. Deploy the `eib-charts-upgrader` fleet to their `management cluster`. This is done through either a `GitRepo` or `Bundle` resource.

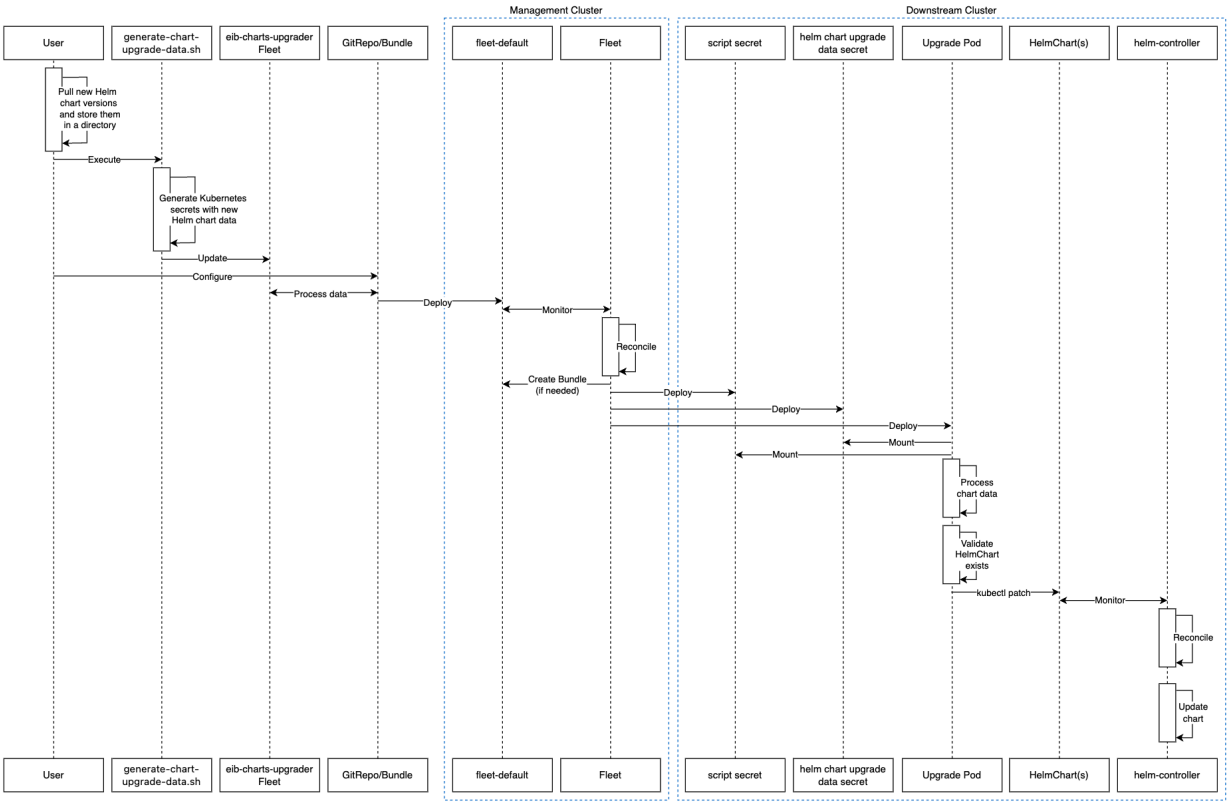
Once deployed, the `eib-charts-upgrader`, with the help of Fleet, will ship its resources to the desired downstream cluster.

These resources include:

1. A set of `Secrets` holding the **user-provided** Helm chart data.
2. A `Kubernetes Job` which will deploy a `Pod` that will mount the previously mentioned `Secrets` and based on them patch (https://kubernetes.io/docs/reference/kubectl/generated/kubectl_patch/) the corresponding HelmChart resources.

As mentioned previously this will trigger the `helm-controller` which will perform the actual Helm chart upgrade.

Below you can find a diagram of the above description:



32.1.6.2.3.2 Upgrade Steps

1. Clone the `suse-edge/fleet-examples` repository from the correct release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0).

2. Create a directory in which you will store the pulled Helm chart archive(s).

```
mkdir archives
```

3. Inside of the newly created archive directory, pull (https://helm.sh/docs/helm/helm_pull/) the archive(s) for the Helm chart(s) you wish to upgrade:

```
cd archives
helm pull [chart URL | repo/chartname]

# Alternatively if you want to pull a specific version:
# helm pull [chart URL | repo/chartname] --version 0.0.0
```

4. From **Assets** of the desired release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0), download the `generate-chart-upgrade-data.sh` script.

5. Execute the `generate-chart-upgrade-data.sh` script:

```
chmod +x ./generate-chart-upgrade-data.sh

./generate-chart-upgrade-data.sh --archive-dir /foo/bar/archives/ --fleet-path /foo/
bar/fleet-examples/fleets/day2/eib-charts-upgrader
```

For each chart archive in the `--archive-dir` directory, the script generates a `Kubernetes Secret YAML` file containing the chart upgrade data and stores it in the `base/secrets` directory of the fleet specified by `--fleet-path`.
The `generate-chart-upgrade-data.sh` script also applies additional modifications to the fleet to ensure the generated `Kubernetes Secret YAML` files are correctly utilized by the workload deployed by the fleet.

Important

Users should not make any changes over what the `generate-chart-upgrade-data.sh` script generates.

The steps below depend on the environment that you are running:

1. For an environment that supports GitOps (e.g. is non air-gapped, or is air-gapped, but allows for local Git server support):

   a. Copy the `fleets/day2/eib-charts-upgrader` Fleet to the repository that you will use for GitOps.

   > **Note**
   >
   > Make sure that the Fleet includes the changes that have been made by the `generate-chart-upgrade-data.sh` script.

   b. Configure a `GitRepo` resource that will be used to ship all the resources of the `eib-charts-upgrader` Fleet.

      i. For `GitRepo` configuration and deployment through the Rancher UI, see Accessing Fleet in the Rancher UI (https://ranchermanager.docs.rancher.com/v2.15/integrations-in-rancher/fleet/overview#accessing-fleet-in-the-rancher-ui).

      ii. For `GitRepo` manual configuration and deployment, see Creating a Deployment (https://fleet.rancher.io/tut-deployment).

2. For an environment that does not support GitOps (e.g. is air-gapped and does not allow local Git server usage):

   a. Download the `fleet-cli` binary from the `rancher/fleet` release (https://github.com/rancher/fleet/releases/tag/v0.16.1) page (`fleet-linux-amd64` for Linux). For Mac users, there is a Homebrew Formulae that can be used - fleet-cli (https://formulae.brew.sh/formula/fleet-cli).

   b. Navigate to the `eib-charts-upgrader` Fleet:

   ```
   cd /foo/bar/fleet-examples/fleets/day2/eib-charts-upgrader
   ```

   c. Create a `targets.yaml` file that will instruct Fleet where to deploy your resources:

   ```
   cat > targets.yaml <<EOF
   targets:
   # To match all downstream clusters
   - clusterSelector: {}
   EOF
   ```

For information on how to map target clusters, see the upstream documentation (https://fleet.rancher.io/gitrepo-targets).

d. Use the `fleet-cli` to convert the Fleet to a `Bundle` resource:

```
fleet apply --compress --targets-file=targets.yaml -n fleet-default -o - eib-charts-upgrade > bundle.yaml
```

This will create a Bundle (`bundle.yaml`) that will hold all the templated resource from the `eib-charts-upgrader` Fleet.

For more information regarding the `fleet apply` command, see fleet apply (https://fleet.rancher.io/cli/fleet-cli/fleet_apply).

For more information regarding converting Fleets to Bundles, see Convert a Helm Chart into a Bundle (https://fleet.rancher.io/bundle-add#convert-a-helm-chart-into-a-bundle).

e. Deploy the `Bundle`. This can be done in one of two ways:

i. Through Rancher's UI - Navigate to **Continuous Delivery → Advanced → Bundles → Create from YAML** and either paste the `bundle.yaml` contents, or click the `Read from File` option and pass the file itself.

ii. Manually - Deploy the `bundle.yaml` file manually inside of your `management cluster`.

Executing these steps will result in a successfully deployed `GitRepo/Bundle` resource. The resource will be picked up by Fleet and its contents will be deployed onto the target clusters that the user has specified in the previous steps. For an overview of the process, refer to *Section 32.1.6.2.3.1, "Overview"*.

For information on how to track the upgrade process, you can refer to *Section 32.1.6.2.3.3, "Example"*.

Important

Once the chart upgrade has been successfully verified, remove the `Bundle/GitRepo` resource.

This will remove the no longer necessary upgrade resources from your `downstream` cluster, ensuring that no future version clashes might occur.

32.1.6.2.3.3 Example

Note

The example below demonstrates how to upgrade a Helm chart deployed via `EIB` from one version to another on a `downstream` cluster. Note that the versions used in this example are **not** recommendations. For version recommendations specific to an Edge release, refer to the release notes (*Chapter 40, Release Notes*).

Use-case:

- A cluster named `doc-example` is running an older version of Longhorn (https://longhorn.io).
- The cluster has been deployed through EIB, using the following image definition *snippet*:

```
kubernetes:
  helm:
    charts:
    - name: longhorn-crd
      repositoryName: rancher-charts
      targetNamespace: longhorn-system
      createNamespace: true
      version: 104.2.0+up1.7.1
      installationNamespace: kube-system
    - name: longhorn
      repositoryName: rancher-charts
      targetNamespace: longhorn-system
      createNamespace: true
      version: 104.2.0+up1.7.1
      installationNamespace: kube-system
    repositories:
    - name: rancher-charts
      url: https://charts.rancher.io/
...
```

- `SUSE Storage` needs to be upgraded to a version that is compatible with the Edge 3.7 release. Meaning it needs to be upgraded to `1.12.1`.
- It is assumed that the `management cluster` in charge of managing `doc-example` is **air-gapped**, without support for a local Git server and has a working Rancher setup.

Follow the Upgrade Steps (*Section 32.1.6.2.3.2, "Upgrade Steps"*):

1. Clone the `suse-edge/fleet-example` repository from the `release-3.7.0` tag.

```
git clone -b release-3.7.0 https://github.com/suse-edge/fleet-examples.git
```

2. Create a directory where the `Longhorn` upgrade archive will be stored.

```
mkdir archives
```

3. Pull the desired `Longhorn` chart archive version:

```
# First add the Rancher Helm chart repository
helm repo add rancher-charts https://charts.rancher.io/

# Pull the Longhorn 1.12.1 chart archive
helm pull oci://dp.apps.rancher.io/charts/suse-storage --version 1.12.1
```

4. Outside of the `archives` directory, download the `generate-chart-upgrade-data.sh` script from the `suse-edge/fleet-examples` release tag (https://github.com/suse-edge/fleet-examples/releases/tag/release-3.7.0).

5. Directory setup should look similar to:

```
.
├── archives
│   └── longhorn-1.12.1.tgz
├── fleet-examples
...
│   ├── fleets
│   │   ├── day2
│   │   │   ├── ...
│   │   │   ├── eib-charts-upgrader
│   │   │   │   ├── base
│   │   │   │   │   ├── job.yaml
│   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   ├── patches
│   │   │   │   │   │   └── job-patch.yaml
│   │   │   │   │   ├── rbac
│   │   │   │   │   │   ├── cluster-role-binding.yaml
│   │   │   │   │   │   ├── cluster-role.yaml
│   │   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   │   └── sa.yaml
│   │   │   │   │   └── secrets
│   │   │   │   │       ├── eib-charts-upgrader-script.yaml
│   │   │   │   │       └── kustomization.yaml
│   │   │   │   ├── fleet.yaml
│   │   │   │   └── kustomization.yaml
│   │   │   └── ...
```

```
│   └── ...
└── generate-chart-upgrade-data.sh
```

6. Execute the `generate-chart-upgrade-data.sh` script:

```
# First make the script executable
chmod +x ./generate-chart-upgrade-data.sh

# Then execute the script
./generate-chart-upgrade-data.sh --archive-dir ./archives --fleet-path ./fleet-
examples/fleets/day2/eib-charts-upgrader
```

The directory structure after the script execution should look similar to:

```
.
├── archives
│   └── longhorn-1.12.1.tgz
├── fleet-examples
...
│   ├── fleets
│   │   ├── day2
│   │   │   ├── ...
│   │   │   ├── eib-charts-upgrader
│   │   │   │   ├── base
│   │   │   │   │   ├── job.yaml
│   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   ├── patches
│   │   │   │   │   │   └── job-patch.yaml
│   │   │   │   │   ├── rbac
│   │   │   │   │   │   ├── cluster-role-binding.yaml
│   │   │   │   │   │   ├── cluster-role.yaml
│   │   │   │   │   │   ├── kustomization.yaml
│   │   │   │   │   │   └── sa.yaml
│   │   │   │   │   └── secrets
│   │   │   │   │       ├── eib-charts-upgrader-script.yaml
│   │   │   │   │       ├── kustomization.yaml
│   │   │   │   │       ├── longhorn-VERSION.yaml - secret created by the generate-
chart-upgrade-data.sh script
│   │   │   │   │       └── longhorn-crd-VERSION.yaml - secret created by the
 generate-chart-upgrade-data.sh script
│   │   │   │   ├── fleet.yaml
│   │   │   │   └── kustomization.yaml
│   │   │   └── ...
│   └── ...
└── generate-chart-upgrade-data.sh
```

The files changed in git should look like this:

```
Changes not staged for commit:
  (use "git add <file>..." to update what will be committed)
  (use "git restore <file>..." to discard changes in working directory)
 modified:   fleets/day2/eib-charts-upgrader/base/patches/job-patch.yaml
 modified:   fleets/day2/eib-charts-upgrader/base/secrets/kustomization.yaml

Untracked files:
  (use "git add <file>..." to include in what will be committed)
 fleets/day2/eib-charts-upgrader/base/secrets/longhorn-VERSION.yaml
 fleets/day2/eib-charts-upgrader/base/secrets/longhorn-crd-VERSION.yaml
```

7. Create a `Bundle` for the `eib-charts-upgrader` Fleet:

   a. First, navigate to the Fleet itself:

   ```
   cd ./fleet-examples/fleets/day2/eib-charts-upgrader
   ```

   b. Then create a `targets.yaml` file:

   ```
   cat > targets.yaml <<EOF
   targets:
   - clusterName: doc-example
   EOF
   ```

   c. Then use the `fleet-cli` binary to convert the Fleet to a Bundle:

   ```
   fleet apply --compress --targets-file=targets.yaml -n fleet-default -o - eib-
   charts-upgrade > bundle.yaml
   ```

   d. Now, transfer the `bundle.yaml` on your `management cluster` machine.

8. Deploy the Bundle through the Rancher UI:

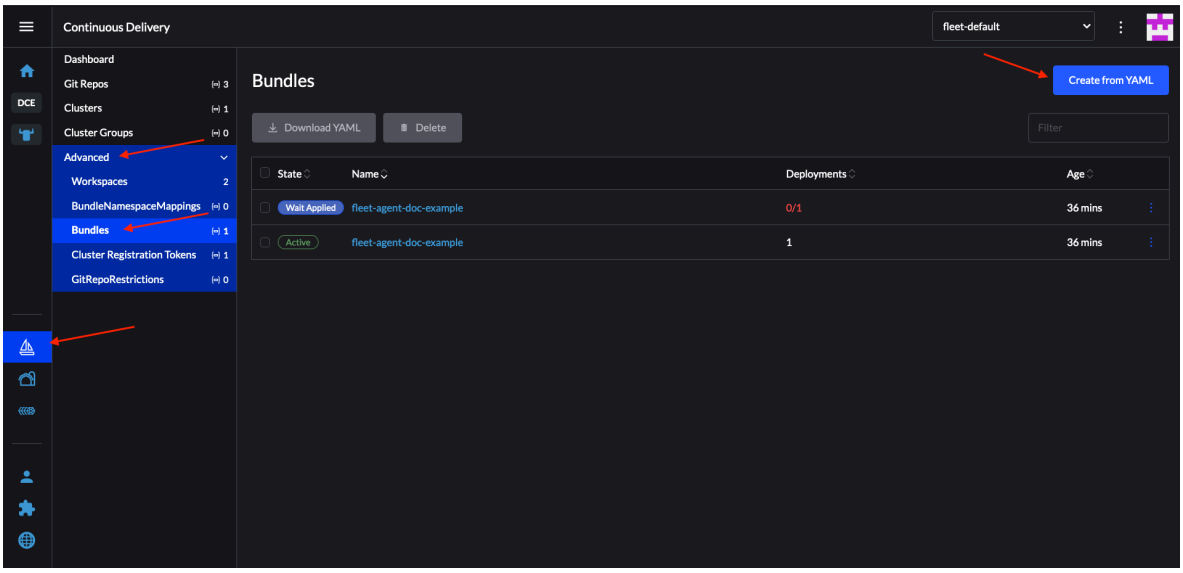


FIGURE 32.1: DEPLOY BUNDLE THROUGH RANCHER UI

From here, select **Read from File** and find the `bundle.yaml` file on your system.
This will auto-populate the `Bundle` inside of Rancher's UI.
Select **Create**.

9. After a successful deployment, your Bundle would look similar to:

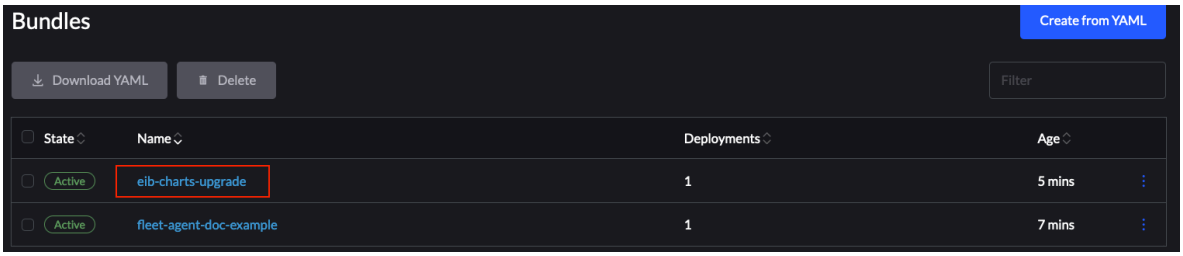
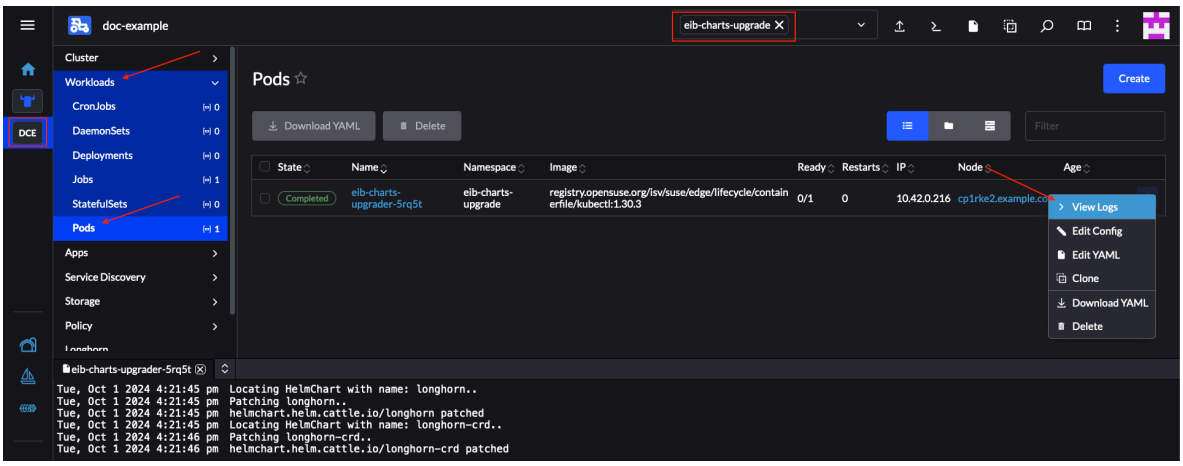


FIGURE 32.2: SUCCESSFULLY DEPLOYED BUNDLE

After the successful deployment of the `Bundle`, to monitor the upgrade process:

1. Verify the logs of the `Upgrade Pod`:



2. Now verify the logs of the Pod created for the upgrade by the helm-controller:

   a. The Pod name will be with the following template - `helm-install-longhorn-<random-suffix>`

   b. The Pod will be in the namespace where the `HelmChart` resource was deployed. In our case this is `kube-system`.

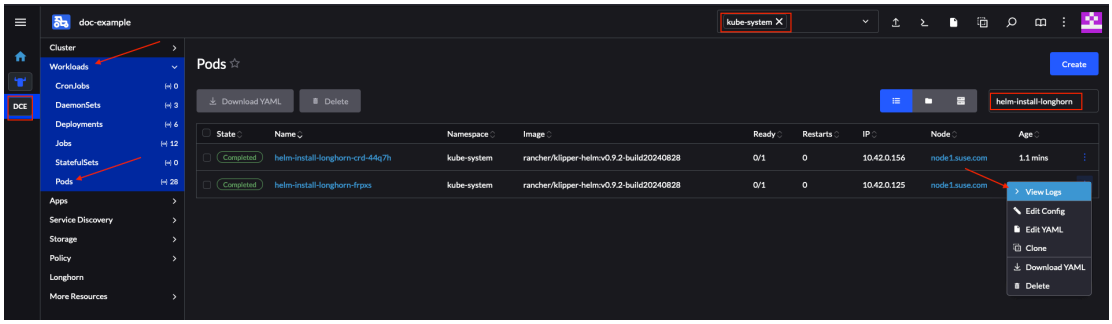


FIGURE 32.3: LOGS FOR SUCCESSFULLY UPGRADED LONGHORN CHART

3. Verify that the `HelmChart` version has been updated by navigating to Rancher's `HelmCharts` section (`More Resources → HelmCharts`). Select the namespace where the chart was deployed, for this example it would be `kube-system`.

4. Finally check that the Longhorn Pods are running.

After making the above validations, it is safe to assume that the Longhorn Helm chart has been upgraded to the `1.12.1` version.

32.1.6.2.3.4 Helm chart upgrade using a third-party GitOps tool

There might be use-cases where users would like to use this upgrade procedure with a GitOps workflow other than Fleet (e.g. `Flux`).

To produce the resources needed for the upgrade procedure, you can use the `generate-chart-upgrade-data.sh` script to populate the `eib-charts-upgrader` Fleet with the user provided data. For more information on how to do this, see *Section 32.1.6.2.3.2, "Upgrade Steps"*.

After you have the full setup, you can use kustomize (https://kustomize.io) to generate a full working solution that you can deploy in your cluster:

```
cd /foo/bar/fleets/day2/eib-charts-upgrader

kustomize build .
```

If you want to include the solution to your GitOps workflow, you can remove the `fleet.yaml` file and use what is left as a valid `Kustomize` setup. Just do not forget to first run the `generate-chart-upgrade-data.sh` script, so that it can populate the `Kustomize` setup with the data for the Helm charts that you wish to upgrade to.

To understand how this workflow is intended to be used, it can be beneficial to look at *Section 32.1.6.2.3.1, "Overview"* and *Section 32.1.6.2.3.2, "Upgrade Steps"*.

VI Troubleshooting

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39 Collecting Diagnostics for Support 338

This section provides guidance to diagnose and resolve common issues with SUSE Edge deployments and operations. It covers various topics, offering component-specific troubleshooting steps, key tools, and relevant log locations.

33 General Troubleshooting Principles

Before diving into component-specific issues, consider these general principles:

- **Check logs**: Logs are the primary source of information. Most of the times the errors are self explanatory and contain hints on what failed.
- **Check clocks**: Having clock differences between systems can lead to all kinds of different errors. Ensure clocks are in sync. EIB can be instructed to force clock sync at boot time, see Configuring OS Time (*Chapter 2, Standalone clusters with Edge Image Builder*).
- **Boot Issues**: If the system is stuck during boot, note down the last messages displayed. Access the console (physical or via BMC) to observe boot messages.
- **Network Issues**: Verify network interface configuration (`ip a`), routing table (`ip route`), test connectivity from/to other nodes and external services (`ping`, `nc`). Ensure firewall rules are not blocking necessary ports.
- **Verify component status**: Use `kubectl get` and `kubectl describe` for Kubernetes resources. Use `kubectl get events --sort-by='.lastTimestamp' -n <namespace>` to see the events on a particular Kubernetes namespace.
- **Verify services status**: Use `systemctl status <service>` for systemd services.
- **Check syntax**: Software expects certain structure and syntax on configuration files. For yaml files, for example, use `yamllint` or similar tools to verify the proper syntax.
- **Isolate the problem**: Try to narrow down the issue to a specific component or layer (for example, network, storage, OS, Kubernetes, Metal[3], Ironic,…).
- **Documentation**: Always refer to the official SUSE Edge documentation (https://documentation.suse.com/suse-edge/) and also upstream documentation for detailed information.
- **Versions**: SUSE Edge is an opinionated and thoroughly tested version of different SUSE components. The versions of each component per SUSE Edge release can be observed in the SUSE Edge support matrix (https://documentation.suse.com/suse-edge/support-matrix/html/support-matrix/index.html).
- **Known issues**: For each SUSE Edge release there is a “Known issues” section on the release notes that contains information of issues that will be fixed on future releases but can affect the current one.

34 Troubleshooting Kiwi

Kiwi is used to generate updated SUSE Linux Micro images to be used with Edge Image Builder.

COMMON ISSUES

- **SL Micro Version Mismatch**: The build host operating system version must match the operating system version being built (SL Micro 6.0 host → SL Micro 6.0 image).
- **SELinux in Enforcing State**: Due to certain limitations, it is currently required to disable SELinux temporarily to be able to build images with Kiwi. Check the SElinux status with `getenforce` and disable it before running the build process with `setenforce 0`.
- **Build host not registered**: The build process uses the build host subscriptions to be able to pull packages from SUSE SCC. If the host is not registered it fails.
- **Loop Device Test Failure**: The first time that the Kiwi build process is executed, it will fail shortly after starting with "ERROR: Early loop device test failed, please retry the container run.", this is a symptom of loop devices being created on the underlying host system that are not immediately visible inside of the container image. Re-run the Kiwi build process again and it should proceed without issue.
- **Missing Permissions**: The build process expects to be run as root user (or via sudo).
- **Wrong Privileges**: The build process expects the `--privileged` flag when running the container. Double-check that it is present.

LOGS

- **Build container logs**: Check the logs of the build container. The logs are generated in the directory that was used to store the artifacts. Check docker logs or podman logs for the necessary information as well.
- **Temporary build directories**: Kiwi creates temporary directories during the build process. Check these for intermediate logs or artifacts if the main output is insufficient.

TROUBLESHOOTING STEPS

1. **Review `build-image` output**: The error message in the console output is usually very indicative.
2. **Check build environment**: Ensure all prerequisites for Kiwi itself (for example, docker/podman, SElinux, sufficient disk space) are met on the machine running Kiwi.

3. **Inspect build container logs**: Review the logs of the failed container for more detailed errors (see above).
4. **Verify definition file**: If you are using a custom Kiwi image definition file, double-check the file for any typos or syntax.

Note

Check the Kiwi Troubleshooting Guide (https://documentation.suse.com/appliance/kiwi-9/html/kiwi/troubleshooting.html).

35 Troubleshooting Edge Image Builder (EIB)

EIB is used to create custom SUSE Edge images.

COMMON ISSUES

- **Wrong SCC code**: Ensure the SCC code used in the EIB definition file matches the SL Micro version and architecture.
- **Missing dependencies**: Ensure there are no missing packages or tools within the build environment.
- **Incorrect image size**: For raw images, the `diskSize` parameter is required and it depends heavily on the images, RPMs, and other artifacts being included in the image.
- **Permissions**: If storing a script on the custom/files directory, ensure it has executable permissions as those files are just available at combustion time but no changes are performed by EIB.
- **Operating system group dependencies**: When creating an image with custom users and groups, the groups being set as "`primaryGroup`" should be explicitly created.
- **Operating system user's sshkeys requires a home folder**: When creating an image with users with sshkeys, the home folder needs to be created as well with `createHomeDir=true`.
- **Combustion issues**: EIB relies on combustion for the customization of the OS and deployment of all the other SUSE Edge components. This also includes custom scripts being placed in the custom/scripts folder. Note that the combustion process is being executed at `initrd` time, so the system is not completely booted when the scripts are executed.
- **Podman machine size**: As explained in the EIB Tips and Tricks section (*Part IV, "Tips and Tricks"*), verify the podman machine has enough CPU/memory to run the EIB container on non-Linux operating systems.
- **Incorrect image**: Ensure the base image being used is properly downloaded by verifying the `checksum` (https://www.suse.com/support/security/download-verification/). If you are building the image with kiwi-builder (*Chapter 26, Building Updated SUSE Linux Micro Images with Kiwi*), check the sum file generated by the process as well.

LOGS

- **EIB output**: The console output of the `eib build` command is crucial.
- **Build container logs**: Check the logs of the build container. The logs are generated in the directory that was used to store the artifacts. Check `docker logs` or `podman logs` for the necessary information as well.

> **Note**
>
> For more information, see Debugging (https://github.com/suse-edge/edge-image-builder/blob/main/docs/debugging.md).

- **Temporary build directories**: EIB creates temporary directories during the build process. Check these for intermediate logs or artifacts if the main output is insufficient.
- **Combustion logs**: If the image being built with EIB does not boot for any reason, a root shell is available. Connect to the host console (either physically, via BMC, etc.) and check combustion logs with `journalctl -u combustion` and in general all the operating system logs with `journalctl` to find the root cause of the failure.

TROUBLESHOOTING STEPS

1. **Review `eib-build` output**: The error message in the console output is usually very indicative.
2. **Check build environment**: Ensure all prerequisites for EIB itself (for example, docker/podman, sufficient disk space) are met on the machine running EIB.
3. **Inspect build container logs**: Review the logs of the failed container for more detailed errors (see above).
4. **Verify `eib` configuration"**: Double-check the `eib` configuration file for any typos or incorrect paths to source files or build scripts.
    - **Test components individually**: If your EIB build involves custom scripts or stages, run them independently to isolate failures.

> **Note**
>
> Check Edge Image Builder Debugging (https://github.com/suse-edge/edge-image-builder/blob/main/docs/debugging.md).

36 Troubleshooting Edge Networking (NMC)

NMC is injected on SL Micro EIB images to configure the network of the Edge hosts at boot time via combustion. It is also being executed on the Metal3 workflow as part of the inspection process. Issues can happen when the host is being booted for the first time or on the Metal3 inspection process.

COMMON ISSUES

- **Host not being able to boot properly the first time**: Malformed network definition files can lead to the combustion phase to fail and then the host drops a root shell.
- **Files are not properly generated**: Ensure the network files matches NMState (https://nmstate.io/examples.html) format.
- **Network interfaces are not correctly configured**: Ensure the MAC addresses match the interfaces being used on the host.
- **Mismatch between interface names**: SL Micro enables Predictable Naming Scheme for Network Interfaces (https://documentation.suse.com/smart/network/html/network-interface-predictable-naming/index.html) by default so there is no `eth0` anymore but other naming schema such as `enp2s0`.

LOGS

- **Combustion logs**: As nmc is being used at combustion time, check combustion logs with `journalctl -u combustion` on the host being provisioned.

TROUBLESHOOTING STEPS

1. **Verify the yaml syntax**: nmc configuration files are yaml files, check the proper syntax with `yamllint` or similar tools.
2. **Run nmc manually**: As nmc is part of the EIB container, to debug any issues, a local podman command can be used.

   a. Create a temporary folder to store the nmc files.

   ```
   mkdir -p ${HOME}/tmp/foo
   ```

   b. Save the nmc files on that location.

   ```
   ❯ tree --noreport ${HOME}/tmp/foo
   /Users/johndoe/tmp/foo
   ```

```
├── host1.example.com.yaml
└── host2.example.com.yaml
```

c. Run the EIB container with nmc as the entrypoint and the generate command to perform the same tasks nmc would do at combustion time:

```
podman run -it --rm -v ${HOME}/tmp/foo:/tmp/foo:Z --entrypoint=/usr/bin/nmc
 registry.suse.com/edge/3.7/edge-image-builder:1.3.4 generate --config-dir /
tmp/foo --output-dir /tmp/foo/

[2025-06-04T11:58:37Z INFO  nmc::generate_conf] Generating config from "/tmp/
foo/host2.example.com.yaml"...
[2025-06-04T11:58:37Z INFO  nmc::generate_conf] Generating config from "/tmp/
foo/host1.example.com.yaml"...
[2025-06-04T11:58:37Z INFO  nmc] Successfully generated and stored network
 config
```

d. Observe the logs and files being generated on the temporary folder.

37 Troubleshooting Phone-Home scenarios

Phone-home scenarios involve using Elemental to connect back to the Management cluster and EIB to create an OS image including the elemental-registration bits. Issues can happen when the host is being booted for the first time, during the EIB build process or trying to register to the Management cluster.

COMMON ISSUES

- **System fails to register**: Node not being registered in the UI. Ensure the host is booted properly and, is able to communicate back to Rancher, clock is in sync and the Elemental services are ok.
- **System fails to be provisioned**: Node is registered but it fails to be provisioned. Ensure the host is able to communicate back to Rancher, clock is in sync and the Elemental services are ok.

LOGS

- **System logs**: `journalctl`
- **Elemental-system-agent logs**: `journalctl -u elemental-system-agent`
- **K3s/RKE2 logs**: `journalctl -u k3s or journalctl -u rke2-server` (or `rke2-agent`)
- **Elemental operator pod**: `kubectl logs -n cattle-elemental-system -l app=elemental-operator`

TROUBLESHOOTING STEPS

1. **Review logs**: Check Elemental operator pod logs to see if there are any issues. Check the host logs if the node is booted.
2. **Check MachineRegistration and TPM**: By default, TPM is used for authentication (https://elemental.docs.rancher.com/authentication/) but there are alternatives for hosts without TPM.

38 Troubleshooting Other components

Other SUSE Edge components troubleshooting guides can be consulted on their official documentation:

- SUSE Linux Micro Troubleshooting (https://documentation.suse.com/smart/micro-clouds/html/SLE-Micro-5.5-admin/index.html#id-1.10)
- RKE2 Known Issues (https://docs.rke2.io/known_issues)
- K3s Known Issues (https://docs.k3s.io/known-issues)
- Rancher General Troubleshooting (https://ranchermanager.docs.rancher.com/troubleshooting/general-troubleshooting)
- SUSE Multi-Linux Manager Troubleshooting (https://documentation.suse.com/multi-linux-manager/5.1/en/docs/administration/troubleshooting/tshoot-intro.html)
- Elemental Support (https://elemental.docs.rancher.com/troubleshooting-support/)
- Rancher Turtles Troubleshooting (https://turtles.docs.rancher.com/turtles/stable/en/troubleshooting/troubleshooting.html)
- Longhorn Troubleshooting (https://longhorn.io/docs/1.12.1/troubleshoot/troubleshooting/)
- Neuvector Troubleshooting (https://open-docs.neuvector.com/next/troubleshooting/troubleshooting/)
- Fleet Troubleshooting (https://fleet.rancher.io/troubleshooting)

You can also see SUSE Knowledgebase (https://www.suse.com/support/kb/).

39 Collecting Diagnostics for Support

When contacting SUSE Support, providing comprehensive diagnostic information is crucial.

ESSENTIAL INFORMATION TO COLLECT

- **Detailed problem description**: What happened, when did it happen, what were you doing, what is the expected behavior, and what is the actual behavior?
- **Steps to reproduce**: Can you reliably reproduce the issue? If so, list the exact steps.
- **Component versions**: SUSE Edge version, components versions (RKE2/K3, EIB, Metal^3, Elemental,..).
- **Relevant logs**:
  - `journalctl` output (filtered by service if possible, or full boot logs).
  - Kubernetes pod logs (kubectl logs).
  - Metal^3/Elemental component logs.
  - EIB build logs and other logs
- **System information**:
  - `uname -a`
  - `df -h`
  - `ip a`
  - `/etc/os-release`
- **Configuration files**: Relevant configuration files for Elemental, Metal^3, EIB such as helm chart values, configmaps, etc.
- **Kubernetes information**: Nodes, Services, Deployments, etc.
- **Kubernetes objects affected**: BMH, MachineRegistration, etc.

HOW TO COLLECT

- **For logs**: Redirect command output to files (for example, `journalctl -u k3s > k3s_logs.txt`).

- **For Kubernetes resources**: Use `kubectl get <resource> -o yaml > <resource_name>.yaml` to get detailed YAML definitions.
- **For system information**: Collect output of the commands listed above.
- **For SL Micro**: Check the SUSE Linux Micro Troubleshooting Guide (https://documentation.suse.com/sle-micro/5.5/html/SLE-Micro-all/cha-adm-support-slemicro.html) documentation on how to gather system information for support with `supportconfig`.
- **For RKE2/Rancher**: Check the The Rancher v2.x Linux log collector script (https://www.suse.com/support/kb/doc/?id=000020191) article to run The Rancher v2.x Linux log collector script.
- **For Edge (Nessie)**: Nessie 1.1.0 is a powerful diagnostic tool designed to collect logs and configuration data from SUSE Edge environments. It gathers comprehensive information from both the host system and Kubernetes clusters, making it invaluable for troubleshooting and support.
  - Nessie has two "modes" a kubernetes mode and a system mode.
    - To collect logs from a SUSE Edge cluster, run (provided that you have access to the kubeconfig file locally):

```
podman run --rm --privileged \
  -v /etc/rancher/k3s/k3s.yaml:/etc/rancher/k3s/k3s.yaml:ro \
  -v /var/log/journal:/var/log/journal:ro \
  -v /run/systemd:/run/systemd:ro \
  -v /etc/machine-id:/etc/machine-id:ro \
  -v /tmp:/tmp \
  -e NESSIE_LOG_DIR="/tmp" \
  -e NESSIE_ZIP_DIR="/tmp" \
  registry.suse.com/edge/3.7/nessie:1.1.0
```

> **Note**
>
> Adjust the paths of the `k3s.yaml/rke2.yaml` file if needed. See Nessie (https://github.com/suse-edge/support-tools/blob/main/nessie/README.md) for more information. You should be able to run this container in non-privileged mode if you have proper permissions (typically `k3s.yaml` / `rke2-server.yaml` files are owned by root).

- To collect logs in the system mode from the actual operating system, run:

```
podman run --rm --privileged \
  -v /var/log/journal:/var/log/journal:ro \
  -v /run/systemd:/run/systemd:ro \
  -v /etc/machine-id:/etc/machine-id:ro \
  -v /tmp:/tmp \
  -e NESSIE_LOG_DIR="/tmp" \
  -e NESSIE_ZIP_DIR="/tmp" \
  -e NESSIE_VERBOSE="1" \
  -e NESSIE_SKIP_POD_LOGS="true" \
  -e NESSIE_SKIP_K8S_CONFIGS="true" \
  -e NESSIE_SKIP_METRICS="true" \
  registry.suse.com/edge/3.7/nessie:1.1.0
```

> **Note**
>
> Please make sure to check Nessie (https://github.com/suse-edge/support-tools/blob/main/nessie/README.md) for more details and information on how to run Nessie in your environment. Likewise, you should be able to run this container in non-privileged mode provided you have proper permissions.

Contact Support. Please check the article available at How-to effectively work with SUSE Technical Support (https://www.suse.com/support/kb/doc/?id=000019452) and the support handbook located at SUSE Technical Support Handbook (https://www.suse.com/support/handbook/) for more details on how to contact SUSE support.

VII Appendix

40 Release Notes 342

40 Release Notes

40.1 Abstract

Revision History

2026-01-20

SUSE Edge 3.7 is a tightly integrated and comprehensively validated end-to-end solution for addressing the unique challenges of the deployment of infrastructure and cloud-native applications at the edge. Its driving focus is to provide an opinionated, yet highly flexible, highly scalable, and secure platform that spans initial deployment image building, node provisioning and onboarding, application deployment, observability, and lifecycle management.

The solution is designed with the notion that there is no "one-size-fits-all" edge platform due to our customers' widely varying requirements and expectations. Edge deployments push us to solve, and continually evolve, some of the most challenging problems, including massive scalability, restricted network availability, physical space constraints, new security threats and attack vectors, variations in hardware architecture and system resources, the requirement to deploy and interface with legacy infrastructure and applications, and customer solutions that have extended lifespans.

SUSE Edge is built on best-of-breed open source software from the ground up, consistent with both our 30-year history in delivering secure, stable, and certified SUSE Linux platforms and our experience in providing highly scalable and feature-rich Kubernetes management with our Rancher portfolio. SUSE Edge builds on-top of these capabilities to deliver functionality that can address a wide number of market segments, including retail, medical, transportation, logistics, telecommunications, smart manufacturing, and Industrial IoT.

For more information on product support lifecycle updates for SUSE Edge, see Product Support Lifecycle (https://www.suse.com/lifecycle/#suse-edge-37).

Note

SUSE Telco Cloud is a derivative of SUSE Edge, with additional optimizations and components that enable the platform to address the requirements found in telecommunications use-cases.

40.2 About

These Release Notes are, unless explicitly specified and explained, identical across all architectures, and the most recent version, along with the release notes of all other SUSE products are always available online at https://www.suse.com/releasenotes.

Entries are only listed once, but they can be referenced in several places if they are important and belong to more than one section. Release notes usually only list changes that happened between two subsequent releases. Certain important entries from the release notes of previous product versions may be repeated. To make these entries easier to identify, they contain a note to that effect.

However, repeated entries are provided as a courtesy only. Therefore, if you are skipping one or more releases, check the release notes of the skipped releases also. If you are only reading the release notes of the current release, you could miss important changes that may affect system behavior. SUSE Edge versions are defined as x.y.z, where 'x' denotes the major version, 'y' denotes the minor, and 'z' denotes the patch version, also known as the "z-stream". SUSE Edge product lifecycles are defined based around a given minor release, e.g. "3.7", but ship with subsequent patch updates through its lifecycle, e.g. "3.7.1".

Note

SUSE Edge z-stream releases are tightly integrated and thoroughly tested as a versioned stack. Upgrade of any individual components to a different versions to those listed above is likely to result in system downtime. While it’s possible to run Edge clusters in untested configurations, it is not recommended, and it may take longer to provide resolution through the support channels.

40.3 Release 3.7.0

Availability Date: 23rd September 2026

Full Support End Date: 22nd March 2027

Maintenance Support End Date: 22nd March 2028

EOL: 23rd March 2028

Summary: SUSE Edge 3.7.0 is the first release in the SUSE Edge 3.7 release stream.

40.3.1 New Features

- Updated to Kubernetes 1.36.3 and Rancher Prime 2.15.1
- Updated to SUSE Security (NeuVector) 5.6.1 NeuVector Release Notes (https://open-docs.neuvector.com/releasenotes/5x)
- Updated to SUSE Storage (Longhorn) 1.12.1 Upstream Longhorn Release Notes (https://longhorn.io/docs/1.12.1/)
- SUSE Storage V2 Data Engine is the recommended default for newly provisioned volumes on clusters that meet the V2 prerequisites. See *Chapter 27, SUSE Storage V2 Data Engine* for setup and migration guidance.
- Updated to Rancher Turtles (CAPI) 0.27.0 Rancher Turtles Documentation (https://turtles.docs.rancher.com/)
- Updated to MetalLB 0.16.1 Upstream Release Notes (https://metallb.universe.tf/release-notes/#version-0-16-1)
- Updated to KubeVirt 1.8.3 and CDI (Containerized Data Importer) 1.65.0, using SLES 16.0 container images
- Updated the KubeVirt Dashboard Extension to 1.4.2
- Updated to Elemental 1.9.2 Elemental Release Notes (https://elemental.docs.rancher.com/release-notes/)
- Updated to Cert-Manager 1.20.1 Upstream Release Notes (https://cert-manager.io/docs/release-notes/)
- Updated Metal3 to 0.16.0 with Bare Metal Operator 0.13.3 and Ironic 38.0.0

40.3.2 Bug & Security Fixes

- Kubernetes 1.36.3 contains bug fixes and security updates Kubernetes Changelog (https://github.com/kubernetes/kubernetes/blob/master/CHANGELOG/CHANGELOG-1.36.md)
- Rancher Prime 2.15.1 contains bug fixes Upstream Rancher Release Notes (https://github.com/rancher/rancher/releases/tag/v2.15.1)
- SUSE Storage (Longhorn) 1.12.1 contains bug fixes Upstream Longhorn Release Notes (https://github.com/longhorn/longhorn/releases/tag/v1.12.1)

- SUSE Security (NeuVector) 5.6.1 contains new features and bug fixes NeuVector Release Notes (https://open-docs.neuvector.com/releasenotes/5x)
- Metal3 chart 0.16.0 includes the following bug fixes:
  - Fix race condition in IPA image with NTP sync
  - Fix an issue with iDRAC 10 compatibility
  - Fix autologin in IPA image

40.3.3 Known Issues

Warning

If deploying new clusters, please follow *Chapter 26, Building Updated SUSE Linux Micro Images with Kiwi* to build fresh images first. This is suggested for management and downstream clusters to ensure the images contain the latest security and bug fixes.

Release-specific known issues will be added as release validation completes.

40.3.3.1 SUSE Storage V2 Data Engine limitations

SUSE Storage 1.12.1 cannot convert an existing V1 volume to V2 in place. Existing volumes remain on V1 after an upgrade and must be migrated to newly provisioned V2 volumes. Keep both data engines enabled until all V1 workloads have been migrated and validated.

V2 volumes must be detached before upgrading between SUSE Storage 1.12 patch releases because V2 engine live upgrade is not supported. V2 backing images are also not supported; KubeVirt deployments should use CDI for image import workflows. Additional feature differences and the customer migration procedure are documented in *Chapter 27, SUSE Storage V2 Data Engine*.

40.3.4 Component Versions

The following table describes the individual components that make up the 3.7.0 release, including the version, the Helm chart version (if applicable), and from where the released artifact can be pulled in the binary format. Please follow the associated documentation for usage and deployment examples.

Name	Version	Helm Chart Version	Artifact Location (URL/Image)
SUSE Linux Micro	6.2 (latest)	N/A	SUSE Linux Micro Download Page (https://www.suse.com/download/sle-micro/)
SUSE Linux Micro	6.2 (latest)	N/A	Checksums and signatures are available for download at SUSE Linux Micro Download Page (https://www.suse.com/download/sle-micro/) SL-Micro.x86_64-6.2-Base-SelfInstall-GM.install.iso SL-Micro.x86_64-6.2-Base-RT-SelfInstall-GM.install.iso SL-Micro.x86_64-6.2-Base-GM.raw.xz SL-Micro.x86_64-6.2-Base-RT-GM.raw.xz
SUSE Multi-Linux Manager	5.2	N/A	SUSE Multi-Linux Manager Download Page (https://)

			www.suse.com/download/suse-manager/)
K3s	1.36.3	N/A	Upstream K3s Release (https://github.com/k3s-io/k3s/releases/tag/v1.36.3%2Bk3s1)
RKE2	1.36.3	N/A	Upstream RKE2 Release (https://github.com/rancher/rke2/releases/tag/v1.36.3%2Brke2r1)
SUSE Rancher Prime	2.15.1	2.15.1	Rancher Prime Helm Repository (https://charts.rancher.com/server-charts/prime/index.yaml) Rancher 2.15.1 Container Images (https://prime.ribs.rancher.io/rancher/v2.15.1/rancher-images.txt)
SUSE Storage (Longhorn)	1.12.1	1.12.1	SUSE Storage Helm Repository (https://apps.rancher.io/applications/suse-storage) SUSE Storage Container Images (https://apps.rancher.io/applications/suse-storage/components)

SUSE Security (NeuVector)	5.6.1	110.0.1+up2.11.1	Rancher Charts Helm Repository (https://charts.rancher.io/index.yaml) registry.rancher.com/rancher/neuvector-controller:5.6.1 registry.rancher.com/rancher/neuvector-enforcer:5.6.1 registry.rancher.com/rancher/neuvector-compliance-config:1.0.16 registry.rancher.com/rancher/neuvector-updater:0.0.14
Rancher Turtles Providers (CAPI)	0.27.0	307.0.8+up0.27.0	registry.suse.com/edge/3.7/rancher-turtles-providers-chart:307.0.8+up0.27.0 registry.rancher.com/rancher/cluster-api-controller:v1.13.3 registry.rancher.com/rancher/turtles:v0.27.1 registry.suse.com/rancher/cluster-api-provider-rke2-bootstrap:v0.25.0

			registry.suse.com/rancher/cluster-api-provider-rke2-control-plane:v0.25.0
Metal[3]	0.16.0	307.0.31+up0.16.0	registry.suse.com/edge/3.7/metal3-chart:307.0.31+up0.16.0 registry.suse.com/edge/3.7/baremetal-operator:0.13.3.0 registry.suse.com/edge/3.7/ironic:38.0.0.0 registry.suse.com/edge/3.7/ironic-ipa-downloader:3.1.2 registry.suse.com/edge/3.7/ironic-python-agent:3.0.10
MetalLB	0.16.1	307.0.3+up0.16.1	registry.suse.com/edge/3.7/metallb-chart:307.0.3+up0.16.1 registry.suse.com/edge/3.7/metallb-controller:v0.16.1

			registry.suse.com/edge/3.7/metallb-speaker:v0.16.1 registry.suse.com/edge/3.7/frr:10.2.1 registry.suse.com/edge/3.7/frr-k8s:v0.0.25
Elemental	1.9.2	1.9.2	registry.suse.com/rancher/elemental-operator-chart:1.9.2 registry.suse.com/rancher/elemental-operator-crds-chart:1.9.2 registry.suse.com/rancher/elemental-operator:1.9.2
Elemental Dashboard Extension	3.0.1	3.0.1	Elemental Extension Helm Chart (https://github.com/rancher/ui-plugin-charts/tree/main/charts/elemental/3.0.1)
Edge Image Builder	1.3.4	N/A	registry.suse.com/edge/3.7/edge-image-builder:1.3.4

KubeVirt	1.8.3	307.0.3+up0.8.0	registry.suse.com/edge/3.7/kubevirt-chart:307.0.3+up0.8.0 registry.suse.com/suse/sles/16.0/virt-operator:1.8.3 registry.suse.com/suse/sles/16.0/virt-api:1.8.3 registry.suse.com/suse/sles/16.0/virt-controller:1.8.3 registry.suse.com/suse/sles/16.0/virt-handler:1.8.3 registry.suse.com/suse/sles/16.0/virt-launcher:1.8.3 registry.suse.com/suse/sles/16.0/virt-exportproxy:1.8.3 registry.suse.com/suse/sles/16.0/virt-exportserver:1.8.3
KubeVirt Dashboard Extension	1.4.2	307.0.5+up1.4.2	registry.suse.com/edge/3.7/kubevirt-dashboard-extension-chart:307.0.5+up1.4.2
Containerized Data Importer (CDI)	1.65.0	307.0.3+up0.8.0	registry.suse.com/edge/3.7/cdi-chart:307.0.3+up0.8.0

			registry.suse.com/suse/sles/16.0/cdi-operator:1.65.0 registry.suse.com/suse/sles/16.0/cdi-controller:1.65.0 registry.suse.com/suse/sles/16.0/cdi-apiserver:1.65.0 registry.suse.com/suse/sles/16.0/cdi-uploadproxy:1.65.0 registry.suse.com/suse/sles/16.0/cdi-cloner:1.65.0 registry.suse.com/suse/sles/16.0/cdi-importer:1.65.0 registry.suse.com/suse/sles/16.0/cdi-uploadserver:1.65.0
Endpoint Copier Operator	0.3.0	307.0.1+up0.3.0	registry.suse.com/edge/3.7/endpoint-copier-operator-chart:307.0.1+up0.3.0 registry.suse.com/edge/3.7/endpoint-copier-operator:0.3.0
SR-IOV Network Operator	1.6.0	307.1.0+up1.6.0	registry.suse.com/edge/3.7/sriov-network-operator-chart:307.1.0+up1.6.0

			registry.suse.com/edge/3.7/sriov-crd-chart:307.1.0+up1.6.0 registry.suse.com/edge/3.7/sriov-network-metrics-exporter:v1.2.0 registry.suse.com/edge/3.7/kube-rbac-proxy:0.22.1
System Upgrade Controller	0.20.1	110.0.0	Rancher Charts Helm Repository (https://charts.rancher.io/index.yaml) registry.rancher.com/rancher/system-upgrade-controller:v0.20.1
Upgrade Controller	0.1.3	307.0.4+up0.1.3	registry.suse.com/edge/3.7/upgrade-controller-chart:307.0.4+up0.1.3 registry.suse.com/edge/3.7/upgrade-controller:0.1.3 registry.rancher.com/rancher/kubectl:v1.35.2 registry.suse.com/edge/3.7/release-manifest:3.7.0

SUSE Private Registry	1.1.1	1.1.1	oci://registry.suse.com/private-registry/private-registry-helm[SUSE Private Registry Helm Repository] registry.suse.com/private-registry/harbor-core:1.1.1-1.19 registry.suse.com/private-registry/harbor-jobservice:1.1.1-1.19 registry.suse.com/private-registry/harbor-portal:1.1.1-1.20 registry.suse.com/private-registry/harbor-registry:1.1.1-1.19 registry.suse.com/private-registry/harbor-registryctl:1.1.1-1.19 registry.suse.com/private-registry/harbor-trivy-adapter:1.1.1-1.24
Kiwi Builder	10.2.29.1	N/A	registry.suse.com/edge/3.7/kiwi-builder:10.2.29.1
Cert-Manager	1.20.1	1.20.1	Jetstack Helm Repository (https://charts.jetstack.io)

			quay.io/jetstack/cert-manager-controller:v1.20.1 quay.io/jetstack/cert-manager-webhook:v1.20.1 quay.io/jetstack/cert-manager-cainjector:v1.20.1

40.4 Removed features

Unless otherwise stated, these apply to the 3.7.0 release and all subsequent z-stream versions.

- Akri was a Technology Preview offering in previous Edge releases and deprecated from 3.4.0 onwards. It is now completely removed from the offering.

40.5 Technology Previews

Unless otherwise stated, these apply to the 3.7.0 release and all subsequent z-stream versions.

- Single-stack IPv6 management cluster deployments are a Technology Preview offering and are not subject to the standard scope of support.

40.6 Component Verification

The components mentioned above may be verified using the Software Bill Of Materials (SBOM) data - for example, using `cosign` as outlined below:

Download the SUSE Edge Container public key from the SUSE Signing Keys source (https://www.suse.com/support/security/keys/):

```
> cat key.pem
-----BEGIN PUBLIC KEY-----
MIICIjANBgkqhkiG9w0BAQEFAAOCAg8AMIICCgKCAgEA7N0S2d8LFKW4WU43bq7Z
IZT537xlKe17OQEpYjNrdtqnSwA0/jLtK83m7bTzfYRK4wty/so0g3BGo+x6yDFt
SVXTPBqnYvabU/j7UKaybJtX3jc4SjaezeBqdi96h6yEslvg4VTZDpy6TFP5ZHxZ
```

```
A0fX6m5kU2/RYhGXItoeUmL5hZ+APYgYG4/455NBaZT2yOywJ6+1zRgpR0cRAekI
OZXl51k0ebsGV6ui/NGECO6MB5e3arAhszf8eHDE02FeNJw5cimXkgDh/1Lg3KpO
dvUNm0EPWvnkNYeMCKR+687QG0bXqSVyCbY6+HG/HLkeBWkv6Hn41oeTSLrjYVGa
T3zxPVQM726sami6pgZ5vULyOleQuKBZrlFhFLbFyXqv1/DokUqEppm2Y3xZQv77
fMNogapp0qYz+nE3wSK4UHPd9z+2bq5WEkQSalYxadyuqOzxqZgSoCNoX5iIuWte
Zf1RmHjiEndg/2UgxKUysVnyCpiWoGbalM4dnWE24102050Gj6M4B5fe73hbaRlf
NBqP+97uznnRlSl8FizhXzdzJiVPcRav1tDdRUyDE2XkNRXmGfD3aCmILhB27SOA
Lppkouw849PWBt9kDMvzelUYLpINYpHRi2+/eyhHNlufeyJ7e7d6N9VcvjR/6qWG
64iSkcF2DTW61CN5TrCe0k0CAwEAAQ==
-----END PUBLIC KEY-----
```


Verify the container image hash, for example using `crane`:

```
> crane digest registry.suse.com/edge/3.7/baremetal-operator:0.13.3.0 --platform linux/
amd64
sha256:247e687143b2d21d9cebcef0bbac8ca3d14b4d1b6e0ba04812dd61d44b32b776
```

Note

For multi-arch images it is also necessary to specify a platform when obtaining the digest, e.g `--platform linux/amd64` or `--platform linux/arm64`. Failure to do this will result in an error in the following step (`Error: no matching attestations`).

Verify with `cosign`:

```
> cosign verify-attestation --type spdxjson --key key.pem registry.suse.com/edge/3.7/
baremetal-
operator@sha256:247e687143b2d21d9cebcef0bbac8ca3d14b4d1b6e0ba04812dd61d44b32b776 > /dev/
null
#
Verification for registry.suse.com/edge/3.7/baremetal-operator@sha256:example-digest-
placeholder --
The following checks were performed on each of these signatures:
  - The cosign claims were validated
  - Existence of the claims in the transparency log was verified offline
  - The signatures were verified against the specified public key
```

Extract SBOM data as described at the SUSE SBOM documentation (https://www.suse.com/support/security/sbom/):

```
> cosign verify-attestation --type spdxjson --key key.pem registry.suse.com/edge/3.7/
baremetal-
operator@sha256:247e687143b2d21d9cebcef0bbac8ca3d14b4d1b6e0ba04812dd61d44b32b776 | jq
 '.payload | @base64d | fromjson | .predicate'
```

40.7 Upgrade Steps

Refer to the *Part V, "Day 2 Operations"* for details around how to upgrade to a new release.

40.8 Product Support Lifecycle

SUSE Edge is backed by award-winning support from SUSE, an established technology leader with a proven history of delivering enterprise-quality support services. For more information, see https://www.suse.com/lifecycle and the Support Policy page at https://www.suse.com/support/policy.html. If you have any questions about raising a support case, how SUSE classifies severity levels, or the scope of support, please see the Technical Support Handbook at https://www.suse.com/support/handbook/.

SUSE Edge "3.7" is supported for 18-months of production support, with an initial 6-months of "full support", followed by 12-months of "maintenance support". After these support phases the product reaches "end of life" (EOL) and is no longer supported. More info about the lifecycle phases can be found in the table below:

Full Support (6 months)	Urgent and selected high-priority bug fixes will be released during the full support window, and all other patches (non-urgent, enhancements, new capabilities) will be released via the regular release schedule.
Maintenance Support (12 months)	During this period, only critical fixes will be released via patches. Other bug fixes may be released at SUSE's discretion but should not be expected.
End of Life (EOL)	Once a product release reaches its End of Life date, the customer may continue to use the product within the terms of product licensing agreement. Support Plans from SUSE do not apply to product releases past their EOL date.

Unless explicitly stated, all components listed are considered Generally Available (GA), and are covered by SUSE's standard scope of support. Some components may be listed as "Technology Preview", where SUSE is providing customers with access to early pre-GA features and functionality for evaluation, but

are not subject to the standard support policies and are not recommended for production use-cases. SUSE very much welcomes feedback and suggestions on the improvements that can be made to Technology Preview components, but SUSE reserves the right to deprecate a Technology Preview feature before it becomes Generally Available if it doesn't meet the needs of our customers or doesn't reach a state of maturity that we require.

Please note that SUSE must occasionally deprecate features or change API specifications. Reasons for feature deprecation or API change could include a feature being updated or replaced by a new implementation, a new feature set, upstream technology is no longer available, or the upstream community has introduced incompatible changes. It is not intended that this will ever happen within a given minor release (x.z), and so all z-stream releases will maintain API compatibility and feature functionality. SUSE will endeavor to provide deprecation warnings with plenty of notice within the release notes, along with workarounds, suggestions, and mitigations to minimize service disruption.

The SUSE Edge team also welcomes community feedback, where issues can be raised within the respective code repository within https://www.github.com/suse-edge.

40.9 Obtaining source code

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40.10 Legal notices

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