

Layered Stack Deployment of K3s

Integrated with Lenovo (R)

Layered Stack Deployment of K3s: Integrated with Lenovo (R)

SUSE Linux Enterprise Micro 5.1, K3s 1.20.14

The purpose of this document is to provide an overview and procedure of implementing SUSE (R) and partner offerings for K3s, an official CNCF sandbox project that delivers a lightweight yet powerful certified Kubernetes distribution designed for production workloads across resource-restrained, remote locations or on Edge IoT devices.

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1 Introduction

On the digital transformation journey to a full cloud-native landscape, the use of microservices becomes the main approach with the dominant technology for such container orchestration being Kubernetes.¹ With its large community of developers and abundant features and capabilities, Kubernetes has become the de-facto standard and is included across most container-as-a-service platforms. With all of these technologies in place, both developer and operation teams can effectively deploy, manage and deliver functionality to their end users in a resilient and agile manner.

1.1 Motivation

Once on such a digital transformation journey, also relevant to focus on areas like:

Workload(s)

Determine how to manage and launch internally developed containerized, microservice workloads


Kubernetes

As developers and organizations continue their journey from simple, containerized microservices toward having these workloads orchestrated and deployed where ever they need, being able to install, monitor and use such Kubernetes infrastructures is a core need. Such deployments, being Cloud Native Computing Foundation (CNCF²) conformant and certified³ are essential for both development and production workloads.

- For simplified scenarios, like edge, remote or IoT, this is where K3s leads the industry, being simple and secure.

Compute Platform(s)

To optimize availability, performance, scalability and integrity, assess current system or hosting platforms

from Independent Hardware Vendors (IHV), such as [Lenovo](https://www.lenovo.com/us/en/) (https://www.lenovo.com/us/en/)  ® as the platform for physical, bare metal, hypervisors and virtual machines

¹ <https://kubernetes.io/> 

² <https://www.cncf.io/> 

³ <https://www.cncf.io/certification/software-conformance> 

1.2 Scope

The scope of this document is to provide a layered *reference configuration* for K3s. This can be done in a variety of scenarios to create an edge-oriented, lightweight Kubernetes cluster deployment.

1.3 Audience

This document is intended for IT decision makers, architects, system administrators and technicians who are implementing a flexible, software-defined Kubernetes platform. One should still be familiar with the traditional IT infrastructure pillars — networking, computing and storage — along with the local use cases for sizing, scaling and limitations within each pillars' environments.

2 Business aspect

Agility is driving developers toward more cloud-native methodologies that focus on microservices architectures and streamlined workflows. Container technologies, like Kubernetes, embody this agile approach and help enable cloud-native transformation.

By unifying IT operations with Kubernetes, organizations realize key benefits like increased reliability, improved security and greater efficiencies with standardized automation. Therefore, Kubernetes infrastructure platforms are adopted by enterprises to deliver:

Cluster Operations

Improved Production and DevOps efficiencies with simplified cluster usage and robust operations

Security Policy & User Management

Consistent security policy enforcement plus advanced user management on any Kubernetes infrastructure

Access to Shared Tools & Services

A high level of reliability with easy, consistent access to a broad set of tools and services

2.1 Business problem

Kubernetes is the leading solution to address edge computing use cases in industry verticals such as manufacturing, transportation, power generation, healthcare, retail and banking. Typical edge systems that leverage Kubernetes to run complex workloads include energy meters, aircraft engines, gas & oil rigs, cruise ships, high-speed trains, retail scanners, wind turbine base stations, internet-connected cars, ATMs and much more.

For such target edge systems, which are often unattended, resource constrained and remote, orchestrating containerized workloads on Kubernetes deployments may seem overbearingly complex.

2.2 Business value

After two years of research and development in June 2020, K3s was donated to the CNCF. The donation is a testament of the commitment to the open source community and their mission to run Kubernetes everywhere.

Perfect for Edge

K3s is a highly available, certified Kubernetes distribution specifically designed for production workloads in unattended, resource-constrained, remote locations or inside IoT appliances.

Simplified & Secure

K3s is packaged as a tiny, single binary that reduces the dependencies and steps needed to install, run and auto-update a production Kubernetes cluster. For workloads, automated Manifest and Helm Chart management deployments can be used. Also, multiple architectures, like x86_64, ARM64, and ARMv7, are supported with binaries and images available.

Given its extensive Kubernetes capabilities, K3s can also be a suitable choice for:

- embedded platforms,
- continuous integration and continuous deployment platforms,
- branch locations or individual developer deployments, and
- even core or cloud production instances




Tip

When K3s is imported and combined with SUSE Rancher, organizations are equipped with an easy, complete and reliable management solution for Kubernetes at the edge.

With this increased consistency of the deployed and managed Kubernetes infrastructure clusters, organizations benefit from an even higher level of the Cloud Native Computing model where each layer only relies upon the API and version of the adjacent layer, such as:

Compute Platform

Using the above software application and technology solutions with the Edge Server platforms offered by [Lenovo \(https://www.lenovo.com/us/en/\)](https://www.lenovo.com/us/en/)  provides the highest reliability and uptime for growing small business to enterprise workloads, offering the unmatched value, flexibility and industry-leading efficiency, including:

- low setup costs
- reduced complexity
- easy scalability

3 Architectural overview

This section outlines the core elements of the K3s solution, along with the suggested target platforms and components.

3.1 Solution architecture

The figure below illustrates the high-level architecture of K3s:

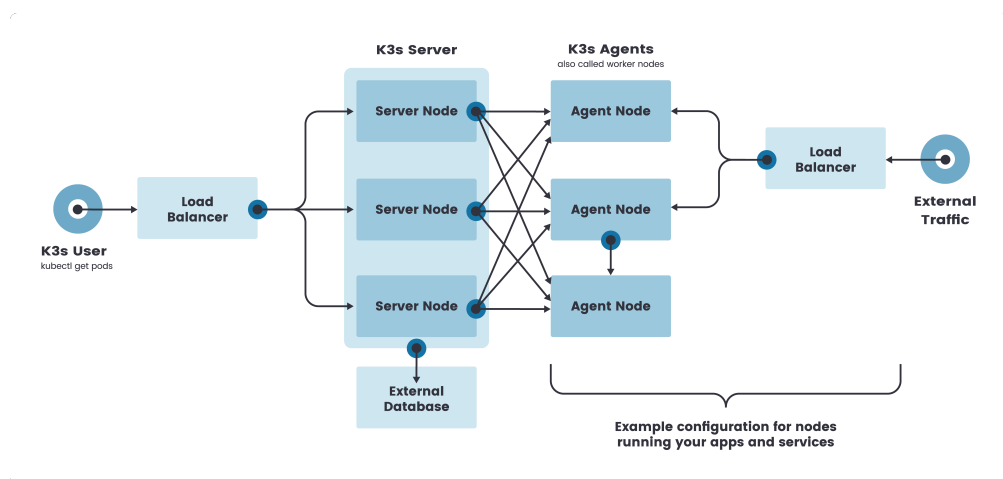


FIGURE 3.1: ARCHITECTURE OVERVIEW - K3S

Container Runtime

- Containerd & runc
- Kine as a datastore shim that allows etcd to be replaced with other databases

Networking

- Flannel for CNI
- Kube-router for network policy

Services

- CoreDNS
- Metrics Server

- Traefik for ingress
- Klipper-lb as an embedded service load balancer provider
- Local-path-provisioner for provisioning volumes using local storage

Workloads

Helm-controller to allow for CRD-driven deployment of helm manifests

Host utilities

iptables/nftables, ebtables, ethtool, and socat

When this is set up, users can interact with K3s via

- kubectl
 - directly on the K3s host or
 - remotely, leveraging the KUBECONFIG file of the K3s cluster's deployment (/etc/rancher/k3s/k3s.yaml)
- manual or automatic, manifest or Helm Chart based, workload deployments

4 Component model

This section describes the various components being used to create a K3s solution deployment, in the perspective of top to bottom ordering. When completed, the K3s instance can be used as the application infrastructure for cloud-native workloads and can be imported into SUSE Rancher for management.

4.1 Component overview

By using:

- Software
 - Kubernetes Platform - K3s
 - Linux Operating System - SUSE Linux Enterprise Micro
- Compute Platform
 - Lenovo ThinkSystem SE350 Edge Server
 - Lenovo ThinkEdge SE450 Edge Server

you can create the necessary infrastructure and services. Further details for these components are described in the following sections.

4.2 Software - K3s

K3s is packaged as a single binary, which is about 50 megabytes in size. Bundled in that single binary is everything needed to run Kubernetes anywhere, including low-powered IoT and Edge-based devices. The binary includes:

- the container runtime
- important host utilities such as iptables, socat and du

The only OS dependencies are the Linux kernel itself and a proper dev, proc and sysfs mounts (this is done automatically on all modern Linux distributions). K3s bundles the Kubernetes components:

- kube-apiserver,
- kube-controller-manager,
- kube-scheduler,
- kubelet and
- kube-proxy

into combined processes that are presented as a simple server and agent model, as represented in the following figure:

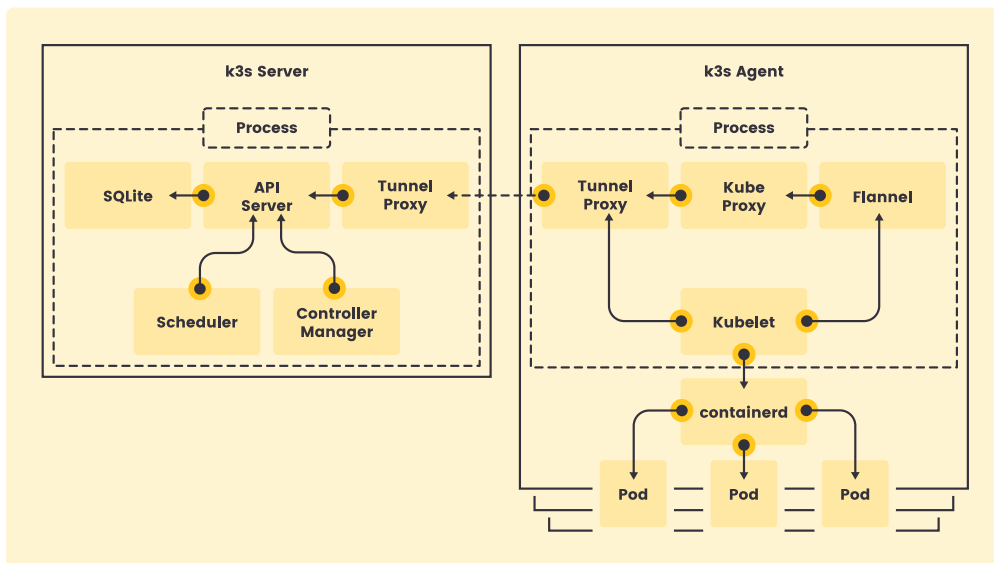


FIGURE 4.1: COMPONENT OVERVIEW - K3S

K3s can run as a complete cluster on a single node or can be expanded into a multi-node cluster. Besides the core Kubernetes components, these are also included:

- containerd,
- Flannel,
- CoreDNS,
- ingress controller and
- a simple host port-based service load balancer.

All of these components are optional and can be swapped out for your implementation of choice. With these included components, you get a fully functional and CNCF-conformant cluster so you can start running apps right away. K3s is now a CNCF Sandbox project, being the first Kubernetes distribution ever to be adopted into sandbox.



Tip

Learn more information about K3s (<https://www.suse.com/products/k3s/>) ↗

As K3s can be deployed on a single or multiple nodes, the next sections describe the suggested component layering approach.

4.3 Software - SUSE Linux Enterprise Micro

SUSE Linux Enterprise Micro combines the assurance of enterprise-grade security and compliance with the immutability and portability of a modern, lightweight operating system. The top 4 features are:

Immutable OS

Immutable design ensures the OS is not altered during runtime and runs reliably every single time. Security signed and verified transactional updates are easy to rollback if things go wrong.

Security and Compliance

Fully open source and built using open standards, SUSE Linux Enterprise Micro leverages SUSE Linux Enterprise common code base, to provide FIPS 140-2, DISA SRG/STIG, integration with CIS and Common Criteria certified configurations. Includes fully supported security framework (SELinux) with policies.

Architectural Flexibility

Both Arm and x86-64 architectures are supported so you can deploy edge applications with confidence across multiple architectures.

Kubernetes-ready

You can easily combine SUSE Linux Enterprise Micro with the latest cloud-native technologies including SUSE Rancher, Rancher Kubernetes Engine, Longhorn persistent block storage, and K3s, the world's most popular Kubernetes distribution for use in low resource, distributed edge locations.

As a result, you get an ultra-reliable infrastructure platform that is also simple to use and comes out-of-the-box with best-in-class compliance. Furthermore, SUSE's flexible subscription model ensures enterprise assurance for any edge, embedded or IoT deployment without vendor lock-in. A free, evaluation copy can be [downloaded \(https://www.suse.com/download/sle-micro/\)](https://www.suse.com/download/sle-micro/) or if the organization already has subscriptions, both install media and updates can be obtained from [SUSE Customer Center \(https://scc.suse.com\)](https://scc.suse.com).

4.4 Compute Platform

Leveraging the enterprise grade functionality of the operating system mentioned in the previous section, many compute platforms can be the foundation of the deployment:

- Virtual machines on supported hypervisors or hosted on cloud service providers
- Physical, baremetal or single-board computers, either on-premises or hosted by cloud service providers



Note

To complete self-testing of hardware with [SUSE YES Certified Process \(https://www.suse.com/partners/ihv/yes/yes-certified-process\)](https://www.suse.com/partners/ihv/yes/yes-certified-process), you can download and install the respective SUSE operating system support-pack version of SUSE Linux Enterprise Server

and the YES test suite. Then run the tests per the instructions in the test kit, fixing any problems encountered and when corrected, re-run all tests to obtain clean test results. Submit the test results into the SUSE Bulletin System (SBS) for audit, review and validation.



Tip

Certified systems and hypervisors can be verified via [SUSE YES Certified Bulletins \(https://www.suse.com/yessearch/\)](https://www.suse.com/yessearch/) and then can be leveraged as supported nodes for this deployment, as long as the certification refers to the respective version of the underlying SUSE operating system required.

Designed and built with the unique requirements for edge servers in mind, Lenovo ThinkEdge Servers are versatile enough to stretch the limitations of server locations, providing a variety of connectivity and security options and easily managed with Lenovo XClarity Controller.

Lenovo XClarity Controller

The [Lenovo XClarity Controller \(https://lenovopress.lenovo.com/lp0880-xcc-support-on-thinksystem-servers\)](https://lenovopress.lenovo.com/lp0880-xcc-support-on-thinksystem-servers) is an embedded out-of-band management system in every Lenovo ThinkSystem and ThinkEdge server to standardize, simplify and automate foundation server management tasks. It provides an uncluttered user interface, intuitive dashboards, at-a-glance status visualizations and easy access to common actions that helps you deploy and manage servers with ease. XClarity Controller is built on open standards to help standardize communication and inter-operability, and improve portability of applications and data. Redfish-compliant REST APIs and other industry standards enable you to manage Lenovo ThinkSystem and ThinkEdge servers on your own terms.

Multiple edge server models exist in [Lenovo Edge Servers portfolio \(https://www.lenovo.com/us/en/servers-storage/solutions/edge-computing/\)](https://www.lenovo.com/us/en/servers-storage/solutions/edge-computing/), as detailed in the following sections.

4.4.1 [Lenovo ThinkSystem SE350 Edge Server](#)



Note

The ThinkSystem SE350 Edge Server is SUSE YES Certified Hardware.

Lenovo ThinkSystem SE350 Edge Server (<https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge/thinksystem-se350/77xx6dsse35>) 

The ThinkSystem SE350 Edge Server is a purpose-built server that is half the width and significantly shorter than a traditional server, making it ideal for deployment in tight spaces. It can be mounted on a wall, stacked on a shelf or mounted in a rack. The ThinkSystem SE350 puts increased processing power, storage and network closer to where data is generated, allowing actions resulting from the analysis of that data to take place more quickly.

- 4–16 server cores with up to 256 GB of memory
- broad-wired and wireless connectivity
- rugged, extended operating temperature of 0–55°C, up to 40G shock & 3Grms vibration with optional dust filter
- up to 16 TB of SSD storage
- small form factors with flexible mounting options
- low-touch deployment
- highly secure with optional SED encrypted storage for user data, as well as motion and intrusion tamper detection

4.4.2 Lenovo ThinkEdge SE450 Edge Server



Note

The ThinkEdge SE450 Edge Server is SUSE YES Certified Hardware.

Lenovo ThinkEdge SE450 Edge Server (<https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge-se450/len21te0002>) 

The ThinkEdge SE450 Edge Server is a single-socket server, with a 2U height and short depth case that can go almost anywhere. It can be mounted on a wall, placed on the floor like a tower server, or mounted in a rack. This rugged edge server can handle continuous operating temperatures from 5°C to 45°C, and some configurations are designed to meet NEBS Level-3 and ETSI requirements for 96 hours operating excursions from –5°C to 55°C as well as tolerance to locations with high dust and vibration. The ThinkEdge SE450 Edge Server is based on the 3rd Gen Intel Xeon Scalable processor and is designed to virtualize

traditional IT applications as well as new transformative AI systems, providing the processing power, storage, accelerator, and networking technologies required for today's edge workloads.

- 10-36 server cores with up to 1TB of memory
- broad-wired and wireless connectivity
- supports up to four single-width GPUs or two double-width GPUs
- offers up to four PCIe 4.0 slots plus a slot dedicated to the OCP adapter
- offers additional physical security features such as a chassis intrusion switch and a lockable front bezel



Note

A sample bill of materials, in the [Chapter 9, Appendix](#), cites the necessary quantities of all components, along with a reference to the minimum resource requirements needed by the software components.

5 Deployment

This section describes the process steps for the deployment of the K3s solution. It describes the process steps to deploy each of the component layers starting as a base functional *proof-of-concept*, having considerations on migration toward *production*, providing *scaling* guidance that is needed to create the solution.

5.1 Deployment overview

The deployment stack is represented in the following figure:

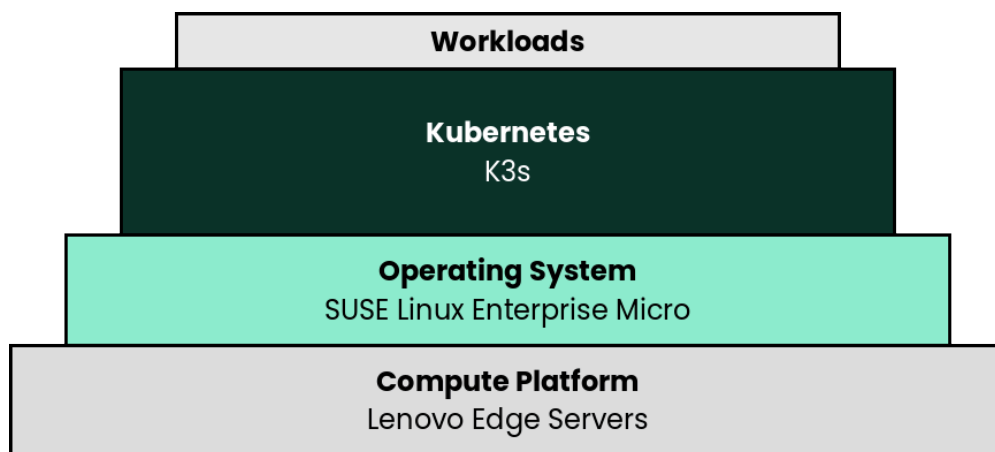


FIGURE 5.1: DEPLOYMENT STACK - SUSE RANCHER

and details are covered for each layer in the following sections.



Note

The following section's content is ordered and described from the bottom layer up to the top.

5.2 Compute Platform

The base, starting configuration can reside all within a single Lenovo Edge Server. Based upon the relatively small resource requirements for a K3s deployment, a viable approach is to deploy as a virtual machine (VM) on the target nodes, on top of an existing hypervisor, like KVM. For a physical host, there are tools that can be used during the setup of the server to provision virtual machines, or similar steps can be used to deploy the software stack on the bare-metal system.

Preparation(s)

The Lenovo XClarity Controller (<https://lenovopress.lenovo.com/lp0880-xcc-support-on-thinksystem-servers>)⁷ is designed for secure local and remote server management and helps IT administrators deploy, update and monitor Lenovo servers anywhere, anytime.

1. Upgrade your basic XClarity Standard license to Enterprise Upgrade for additional functionality, such as graphical remote console and virtual media access to allow the remote usage of software image files (ISO files), which can be used for installing operating systems or updating servers.

Deployment Process

On the respective compute module node, determine if a hypervisor is already available for the solution's virtual machines.

1. If this will be the first use of this node, an option is to deploy a KVM hypervisor, based upon SUSE Linux Enterprise Server by following the [Virtualization Guide \(https://documentation.suse.com/sles/15-SP3/single-html/SLES-virtualization/#book-virt\)](https://documentation.suse.com/sles/15-SP3/single-html/SLES-virtualization/#book-virt)⁷.
 - Given the simplicity of the deployment, the operating system and hypervisor can be installed with the SUSE Linux Enterprise Server ISO media and the Lenovo XClarity Controller virtual media and virtual console methodology.
2. Then for the solution VM, use the hypervisor user interface to allocate the necessary CPU, memory, disk and networking as noted in the SUSE Rancher [hardware requirements \(https://documentation.suse.com/cloudnative/rancher-manager/latest/en/installation-and-upgrade/requirements/requirements.html\)](https://documentation.suse.com/cloudnative/rancher-manager/latest/en/installation-and-upgrade/requirements/requirements.html)⁷.

Deployment Consideration(s)

To further optimize deployment factors, leverage the following practices:

- *Automation*

- For nodes running KVM, you can leverage either [virt-install](https://documentation.suse.com/sles/15-SP3/single-html/SLES-virtualization/#book-virt) (<https://documentation.suse.com/sles/15-SP3/single-html/SLES-virtualization/#book-virt>) or Terraform Libvirt Provider (<https://registry.terraform.io/providers/dmacvicar/libvirt/latest/docs>) to quickly and efficiently automate the deployment of multiple virtual machines.

- *Availability*

- While the initial deployment only requires a single VM, as noted in later deployment sections, having multiple VMs provides resiliency to accomplish high availability. To reduce single points of failure, it would be beneficial to have the multi-VM deployments spread across multiple hypervisor nodes. So, consideration of consistent hypervisor and compute module configurations with the needed resources for the VMs will yield a robust, reliable production implementation.

5.3 SUSE Linux Enterprise Micro

As the base software layer, use an enterprise-grade Linux operating system. For example, SUSE Linux Enterprise Micro.

Preparation(s)

To meet the solution stack prerequisites and requirements, SUSE operating system offerings, like [SUSE Linux Enterprise Micro](https://www.suse.com/products/micro/) (<https://www.suse.com/products/micro/>) can be used.

1. Ensure these services are in place and configured for this node to use:

- Domain Name Service (DNS) - an external network-accessible service to map IP Addresses to host names
- Network Time Protocol (NTP) - an external network-accessible service to obtain and synchronize system times to aid in time stamp consistency
- Software Update Service - access to a network-based repository for software update packages. This can be accessed directly from each node via registration to

- the general, internet-based [SUSE Customer Center \(https://scc.suse.com\)](https://scc.suse.com) (SCC) or
- an organization's [SUSE Manager \(https://www.suse.com/products/suse-manager/\)](https://www.suse.com/products/suse-manager/) infrastructure or
- a local server running an instance of [Repository Mirroring Tool \(https://documentation.suse.com/sles/15-SP3/single-html/SLES-rmt/#book-rmt\)](https://documentation.suse.com/sles/15-SP3/single-html/SLES-rmt/#book-rmt) (RMT)



Note

During the node's installation, it can be pointed to the respective update service. This can also be accomplished post-installation with the command line tool named [SUSEConnect \(https://www.suse.com/support/kb/doc/?id=000018564\)](https://www.suse.com/support/kb/doc/?id=000018564).

Deployment Process

On the compute platform node, install the noted SUSE operating system, by following these steps:

1. Download the [SUSE Linux Enterprise Micro \(https://www.suse.com/download/sle-micro/\)](https://www.suse.com/download/sle-micro/) product (either for the ISO or Virtual Machine image)
 - Identify the appropriate, supported version of SUSE Linux Enterprise Micro by reviewing the support matrix for [SUSE Rancher \(https://www.suse.com/suse-rancher/support-matrix/all-supported-versions/\)](https://www.suse.com/suse-rancher/support-matrix/all-supported-versions/) versions Web page.
2. The installation process is described and can be performed with default values by following steps from the product documentation, see [Installation Quick Start \(https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-deployment/#book-deployment-slemicro\)](https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-deployment/#book-deployment-slemicro)



Tip

Adjust both the password and the local network addressing setup to comply with local environment guidelines and requirements.

Deployment Consideration(s)

To further optimize deployment factors, leverage the following practices:

- *Automation*
 - To reduce user intervention, unattended deployments of SUSE Linux Enterprise Micro can be automated
 - for ISO-based installations, by referring to the [AutoYaST Guide](https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-autoyast/#book-autoyast) (<https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-autoyast/#book-autoyast>) ↗
 - for raw-image based installation, by configuring the Ignition and Combustion tooling as described in the [Installation Quick Start](https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-deployment/#book-deployment-slemicro) (<https://documentation.suse.com/sle-micro/5.5/single-html/SLE-Micro-deployment/#book-deployment-slemicro>) ↗


5.4 K3s

Preparation(s)

1. Identify the appropriate, desired version of the K3s binary (for example vX.YY.ZZ +k3s1) by reviewing
 - the "Supported K3s Versions" associated with the respective [SUSE Rancher](https://www.suse.com/suse-rancher/support-matrix/all-supported-versions/) (<https://www.suse.com/suse-rancher/support-matrix/all-supported-versions/>) ↗ version from "K3s Downstream Clusters" section, or
 - the "Releases" on the [Download](https://github.com/k3s-io/k3s/) (<https://github.com/k3s-io/k3s/>) ↗ Web page.
2. On the target node with a default installation of SUSE Linux Enterprise Micro operating system, log in to the node either as root or as a user with sudo privileges and install a required package for the next layer.

```
sudo transactional-update pkg install apparmor-parser
sudo reboot
```

3. For the underlying operating system firewall service, either

- enable and configure the necessary inbound ports (<https://documentation.suse.com/cloudnative/k3s/latest/en/reference/resource-profiling.html>)  or
- stop and completely disable the firewall service.

Deployment Process

Perform the following steps to install the first K3s server on one of the nodes to be used for the Kubernetes control plane

1. Set the following variable with the noted version of K3s, as found during the preparation steps.

```
K3s_VERSION=""
```

2. Install the version of K3s with embedded etcd enabled:

```
curl -sfL https://get.k3s.io | \
    INSTALL_K3S_VERSION=${K3s_VERSION} \
    INSTALL_K3S_EXEC='server --cluster-init --write-kubeconfig-mode=644' \
    sh -s -
```

- Since SELinux is resident on SUSE Linux Enterprise Micro, the K3s install command will include another required package "k3s-selinux" as a transactional-update in a new snapshot. So a reboot is required to access the installed package and complete the deployment.

```
systemctl reboot
```



Tip

To address *Availability* and possible *scaling* to a multiple node cluster, etcd is enabled instead of using the default SQLite datastore.

- Monitor the progress of the installation: `watch -c "kubectl get deployments -A"`
 - The K3s deployment is complete when elements of all the deployments (coredns, local-path-provisioner, metrics-server, and traefik) show at least "1" as "AVAILABLE"
 - Use Ctrl + c to exit the watch loop after all deployment pods are running

Deployment Consideration(s)

To further optimize deployment factors, leverage the following practices:

- *Availability*

- A full high-availability K3s cluster is recommended for production workloads. The etcd key/value store (aka database) requires an odd number of servers (aka master nodes) be allocated to the K3s cluster. In this case, two additional control-plane servers should be added; for a total of three.

1. Deploy the same operating system on the new compute platform nodes, then log in to the new nodes as root or as a user with sudo privileges.
2. Execute the following sets of commands on each of the remaining control-plane nodes:

- Set the following additional variables, as appropriate for this cluster

```
# Private IP preferred, if available
FIRST_SERVER_IP=""

# From /var/lib/rancher/k3s/server/node-token file on the first
server
NODE_TOKEN=""

# Match the first of the first server
K3s_VERSION=""
```

- Install K3s

```
curl -sfL https://get.k3s.io | \
  INSTALL_K3S_VERSION=${K3s_VERSION} \
  K3S_URL=https://${FIRST_SERVER_IP}:6443 \
  K3S_TOKEN=${NODE_TOKEN} \
  K3S_KUBECONFIG_MODE="644" INSTALL_K3S_EXEC='server' \
  sh -
```

- Monitor the progress of the installation: watch -c "kubectl get deployments -A"

- The K3s deployment is complete when elements of all the deployments (coredns, local-path-provisioner, metrics-server, and traefik) show at least "1" as "AVAILABLE"
- Use Ctrl + c to exit the watch loop after all deployment pods are running



Note

This can be changed to the normal Kubernetes default by adding a taint to each server node. See the official Kubernetes documentation for more information on how to do that.

- (Optional) In cases where agent nodes are desired, execute the following sets of commands, using the same "K3s_VERSION", "FIRST_SERVER_IP", and "NODE_TOKEN" variable settings as above, on each of the agent nodes to add it to the K3s cluster:

```
curl -sfL https://get.k3s.io | \
INSTALL_K3S_VERSION=${K3s_VERSION} \
K3S_URL=https://${FIRST_SERVER_IP}:6443 \
K3S_TOKEN=${NODE_TOKEN} \
K3S_KUBECONFIG_MODE="644" \
sh -
```

After this successful deployment of the K3s solution, review the [product documentation \(https://documentation.suse.com/cloudnative/k3s/\)](https://documentation.suse.com/cloudnative/k3s/) for details on how to directly use this Kubernetes cluster. Furthermore, by reviewing the SUSE Rancher [product documentation \(https://documentation.suse.com/cloudnative/rancher-manager/\)](https://documentation.suse.com/cloudnative/rancher-manager/) this solution can also be:

- imported (refer to sub-section "Importing Existing Clusters"), then
- managed (refer to sub-section "Cluster Administration") and
- accessed (refer to sub-section "Cluster Access") to address orchestration of workloads, maintaining security and many more functions are readily available.

6 Summary

Using components and offerings from [SUSE \(https://www.suse.com\)](https://www.suse.com) and the Rancher portfolio plus [Lenovo ThinkSystem SE350 Edge Server \(https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge/thinksystem-se350/77xx6dsse35\)](https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge/thinksystem-se350/77xx6dsse35) plus [Lenovo ThinkEdge SE450 Edge Server \(https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge-se450/len21te0002\)](https://www.lenovo.com/us/en/p/servers-storage/servers/edge/thinkedge-se450/len21te0002) streamline the ability to quickly and effectively engage in a digital transformation, taking advantage of cloud-native resources and disciplines. Using such technology approaches lets you deploy and leverage transformations of infrastructure into a durable, reliable enterprise-grade environment.

Simplify

Simplify and optimize your existing IT environments

- Using K3s enables you to quickly and simply deploy a Kubernetes cluster in a wide array of locations, across edge, branch, core and cloud.

Modernize

Bring applications and data into modern computing

- With K3s, the digital transformation to containerized applications can progress since both developers and production can leverage these deployments for the actual workloads.



Accelerate

Accelerate business transformation through the power of open source software

- Given the open source nature of K3s and the minimal underlying software components, you can expand into a very distributed ecosystem, bringing computing to where the data exists or arrives, to answer the necessary business needs.

7 References



WHITE PAPERS

- **A Buyer's Guide to Enterprise Kubernetes Management Platforms** - https://more.suse.com/FY22_Buyers_Guide_to_Enterprise_Container_Management_Buyers-Guide-to-Kubernetes-Management-Platforms.html 
- **How to Build an Enterprise Kubernetes Strategy** - <https://more.suse.com/FY22-global-web-How-to-Build-Enterprise-K8s-Strategy.html> 













BOOKS









- **Kubernetes Management** - <https://more.suse.com/rs/937-DCH-261/images/002022021-DummiesGuide.pdf> 

TRAINING

- **SUSE** - <https://training.suse.com/> 
- **Rancher** - <https://rancher.com/training/> 

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- Projects
 - Rancher Kubernetes Engine Government (RKE2) - <https://github.com/rancher/rke2>  (documentation (<https://docs.rke2.io/>) )
- Lenovo - <https://www.lenovo.com/us/en/> 
- ThinkEdge - <https://www.lenovo.com/us/en/servers-storage/solutions/edge-computing/> 

8 Glossary

- Document Scope

Reference Configuration

A guide with the basic steps to deploy the layered stack of components from both the SUSE and partner portfolios. This is considered a fundamental basis to demonstrate a specific, tested configuration of components.

Reference Architectures¹

A guide with the general steps to deploy and validate the structured solution components from both the SUSE and partner portfolios. This provides a shareable template of consistency for consumers to leverage for similar production ready solutions, including design considerations, implementation suggestions and best practices.

Best Practice

Information that can overlap both the SUSE and partner space. It can either be provided as a stand-alone guide that provides reliable technical information not covered in other product documentation, based on real-life installation and implementation experiences from subject matter experts or complementary, embedded sections within any of the above documentation types describing considerations and possible steps forward.

- Factor(s)

Automation²

Infrastructure automation enables speed through faster execution when configuring the infrastructure and aims at providing visibility to help other teams across the enterprise work quickly and more efficiently. Automation removes the risk associated with human error, like manual misconfiguration; removing this can decrease downtime and increase reliability. These outcomes and attributes help the enterprise move toward implementing a culture of DevOps, the combined working of development and operations.

¹ link: [Reference Architecture \(https://en.wikipedia.org/wiki/Reference_architecture\)](https://en.wikipedia.org/wiki/Reference_architecture) ↗

² link: [Infrastructure-as-Code \(https://en.wikipedia.org/wiki/Infrastructure_as_code\)](https://en.wikipedia.org/wiki/Infrastructure_as_code) ↗

Availability³

The probability that an item operates satisfactorily, without failure or downtime, under stated conditions as a function of its reliability, redundancy and maintainability attributes. Some major objectives to achieve a desired service level objectives are:

- Preventing or reducing the likelihood and frequency of failures via design decisions within the allowed cost of ownership
- Correcting or coping with possible component failures via resiliency, automated failover and disaster-recovery processes
- Estimating and analyzing current conditions to prevent unexpected failures via predictive maintenance

Integrity⁴

Integrity is the maintenance of, and the insurance of the accuracy and consistency of a specific element over its entire lifecycle. Both physical and logical aspects must be managed to ensure stability, performance, re-usability and maintainability.

Performance⁵

In the context of a system's expected life cycle, performance is an assessment of transactions, responsiveness and underlying stability of the provider technology while doing tuning and adjustments. Other risk factors and discerning potential impacts to surrounding use cases are also integral parts of the profile to address beyond service levels, capacity and problem management.

Security⁶

Security is about ensuring freedom from or resilience against potential harm, including protection from destructive or hostile forces. To minimize risks, one must manage governance to avoid tampering, maintain access controls to prevent unauthorized usage and integrate layers of defense, reporting and recovery tactics.

- Deployment Flavor(s)

3 link: [Availability \(https://en.wikipedia.org/wiki/Availability\)](https://en.wikipedia.org/wiki/Availability) ↗

4 link: [Data Integrity \(https://en.wikipedia.org/wiki/Data_integrity\)](https://en.wikipedia.org/wiki/Data_integrity) ↗

5 link: [Performance Engineering \(https://en.wikipedia.org/wiki/Performance_engineering\)](https://en.wikipedia.org/wiki/Performance_engineering) ↗

6 link: [Security \(https://en.wikipedia.org/wiki/Security\)](https://en.wikipedia.org/wiki/Security) ↗

Proof-of-Concept⁷

A partial or nearly complete prototype constructed to demonstrate functionality and feasibility for verifying specific aspects or concepts under consideration. This is often a starting point when evaluating a new, transitional technology. Sometimes it starts as a Minimum Viable Product (MVP⁸) that has just enough features to satisfy an initial set of requests. After such insights and feedback are obtained and potentially addressed, redeployments may be used to iteratively branch into other realms or to incorporate other known working functionality.

Production

A deployed environment that target customers or users can interact with and rely upon to meet their needs, plus be operationally sustainable in terms of resource usage and economic constraints.

Scaling

The flexibility of a system environment to either vertically scale-up, horizontally scale-out or conversely scale-down by adding or subtracting resources as needed. Attributes like capacity and performance are often the primary requirements to address, while still maintaining functional consistency and reliability.

⁷ link: [Proof of Concept \(https://en.wikipedia.org/wiki/Proof_of_concept\)](https://en.wikipedia.org/wiki/Proof_of_concept) ↗

⁸ link: [Minimum Viable Product \(https://en.wikipedia.org/wiki/Minimum_viable_product\)](https://en.wikipedia.org/wiki/Minimum_viable_product) ↗

9 Appendix

The following sections provide a bill of materials listing for the respective component layer(s) of the described deployment.

9.1 Compute platform bill of materials

Sample set of computing platform models, components and resources.

Role	Qty	SKU	Component	Notes
Example 1	1-3	B6EQ	ThinkSystem SE350 Edge Server Chassis	<ul style="list-style-type: none">• items below listed per enclosure
	1	B6F4	<ul style="list-style-type: none">• ThinkSystem SE350 Edge Server 10GbE SFP + 2-Port,	

Role	Qty	SKU	Component	Notes
			10/100/1GbE RJ45 2-Port Intel i350 1	
	1	B8ZR	<ul style="list-style-type: none"> Standard Shock & Vibration (15G & 0.21Grms) 	
	1	B8ZT	<ul style="list-style-type: none"> Operational Temperature 0-45C 	
	1	BFYE	<ul style="list-style-type: none"> Operating mode selection for: "Efficiency - Favoring Performance Mode" 	
	1	B93A	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Server Intel Xeon D-2143IT 8C 65W 2.20 GHz 	
	2	AUU1	<ul style="list-style-type: none"> ThinkSystem 8GB TruDDR4 2666 MHz (1Rx8 1.2V) RDIMM 	
	1	B6FF	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Server M.2 SA- 	

Role	Qty	SKU	Component	Notes
Sample set of software, support and services.			TA/NVMe 4-bay Data Drive En- ablement Kit	
	1	5977	<ul style="list-style-type: none"> Select Storage de- vices - no con- figured RAID re- quired 	
	1	B8JJ	<ul style="list-style-type: none"> ThinkSystem M.2 5300 960GB SA- TA 6Gbps Non- Hot Swap SSD 	
	1	B6FH	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Serv- er M.2 Adapter SATA Cable 	
	1	B88P	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Serv- er M.2 Mirroring Enablement Kit 	
	2	AUUV	<ul style="list-style-type: none"> ThinkSystem M.2 128GB SATA 6Gbps Non-Hot Swap SSD 	
	1	B6FD	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Serv- er PCIe Riser Cage 	
	1	B6FU	<ul style="list-style-type: none"> ThinkSystem SE350 Edge Serv- er - 12V PDM 	
	2	B6FW	<ul style="list-style-type: none"> ThinkEdge 240W 230V/115V Exter- nal Power Supply 	
	2	6311	<ul style="list-style-type: none"> 2.8m, 10A/100-250V, C13 to IEC 320- C14 Rack Power Cable 	
30	1	BNAM	<ul style="list-style-type: none"> ThinkSystem 	

Role	Qty	SKU	Component	Notes
Operating System	1-3	874-007864	SUSE Linux Enterprise Micro, <ul style="list-style-type: none"> • x86_64, • Priority Subscription, • 1 Year 	Configuration: <ul style="list-style-type: none"> • per node (up to 16 cores, stackable)
Kubernetes Management	1	R-0001-PS1	SUSE Rancher, <ul style="list-style-type: none"> • x86-64, • Priority Subscription, • 1 Year 	Configuration: <ul style="list-style-type: none"> • per deployed instance
Rancher Management	2	R-0004-PS1	Rancher 10 Nodes <ul style="list-style-type: none"> • x86-64 or aarch64, • Priority Subscription, • 1 Year, 	Configuration: <ul style="list-style-type: none"> • requires priority server subscription
Consulting and Training	1	R-0001-QSO	Rancher Quick Start, <ul style="list-style-type: none"> • Go Live Services 	



Note

For the software components, other support term durations are also available.

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LNVGY-SE450=1 IHV-LNVGY=1 Integrity=1 LN=1 Performance=1 PoC=1 Production=1 RA=1 RC=1
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```
with the Invariant Sections being LIST THEIR TITLES, with the  
Front-Cover Texts being LIST, and with the Back-Cover Texts being LIST.
```

If you have Invariant Sections without Cover Texts, or some other combination of the three, merge those two alternatives to suit the situation.

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