

Layered Stack Deployment of K3s

Integrated with Hewlett Packard Enterprise (R)

Layered Stack Deployment of K3s: Integrated with Hewlett Packard Enterprise (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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Publication Date: 2022-04-06

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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

¹ <https://kubernetes.io/> ↗

² <https://www.cncf.io/> ↗

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

from Independent Hardware Vendors (IHV), such as [Hewlett Packard Enterprise \(https://www.hpe.com/us/en/home.html\)](https://www.hpe.com/us/en/home.html)  ® as the platform for physical, bare metal, hypervisors and virtual machines

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 server platforms offered by Hewlett Packard Enterprise (HPE (<https://www.hpe.com/us/en/home.html>) ) provides many alternative for scale, cost-effectiveness and performance options that could align with local IT staff platform preferences:

- density-optimized - high performance and efficiency for big data and the most demanding workloads
- mission-critical - systems of intelligence to fuel your digital transformation in a world where time and data are the new currency and business continuity is expected

- composable - fully adaptable and ready for Hybrid-IT to future-proof your data center for today's workloads and tomorrow's disruptors
- IoT - realize the potential of the Internet of Things to provide compute at the network edge
- cloud - high-capacity, mass-compute open infrastructure with security and software to match
- and virtualized use cases.

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:

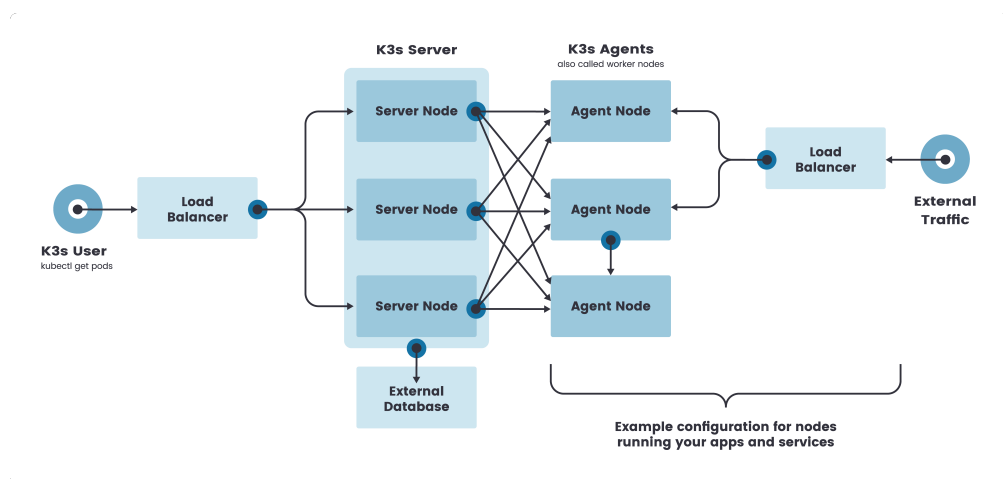


FIGURE 3.1: ARCHITECTURE OVERVIEW - K3S

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
 - Hewlett Packard Enterprise ProLiant
 - Hewlett Packard Enterprise Synergy

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:

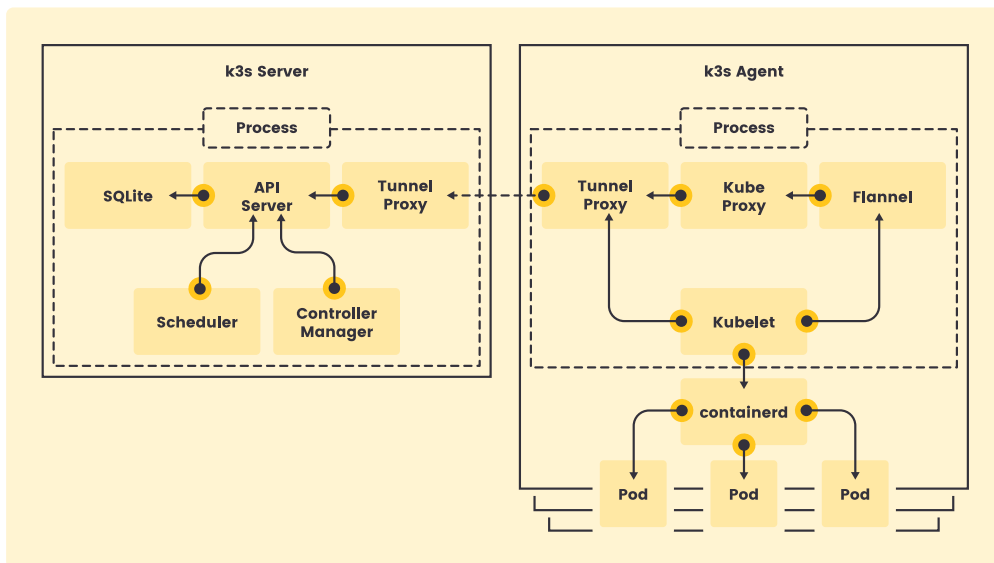


FIGURE 4.1: COMPONENT OVERVIEW - K3S

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.

Even with the broad certification and support model across the range of available HPE platform models, the following table summarizes which might be a best-practice selection for the various deployment types and focus areas:

TABLE 4.1: HEWLETT PACKARD ENTERPRISE PLATFORM MATRIX FOR DEPLOYMENT TYPES

System Platform	Baremetal	Hypervisor	Virtual Machine
ProLiant	DL360,DL380	DL360,DL380	(hosting)
Synergy	SY480	SY480	(hosting)

As listed in the previous table, multiple server product-line and model options abound in the [HPE server portfolio \(https://www.hpe.com/uk/en/servers.html\)](https://www.hpe.com/uk/en/servers.html), as detailed in the following sections.

4.4.1 Hewlett Packard Enterprise iLO

The [Hewlett Packard Enterprise iLO \(https://www.hpe.com/us/en/servers/integrated-lights-out-ilo.html\)](https://www.hpe.com/us/en/servers/integrated-lights-out-ilo.html) [iLO] arms you with the tools to manage your servers efficiently, resolve issues quickly, and keep your business running – from anywhere in the world, allowing you to manage your entire server environment with ease. Upgrade the basic iLO license for additional functionality, such as graphical remote console, multi-user collaboration, video record/playback, remote management, and much more. The latest iLO innovations include:

- Security and performance
- Support for Simple Certificate Enrollment Protocol [SCEP]

- Enablement for 802.1x protocol to securely onboard servers into a network
- Redfish API Conformance

4.4.2 HPE ProLiant DL Rack Servers


The [HPE ProLiant DL](https://www.hpe.com/us/en/servers/proliant-dl-servers.html) (<https://www.hpe.com/us/en/servers/proliant-dl-servers.html>) family of servers are the most flexible, reliable, and performance-optimized HPE ProLiant rack servers—ever. HPE continues to provide industry-leading compute innovations. The new HPE ProLiant rack portfolio, with flexible choices and versatile design, along with improved energy efficiencies, ultimately lowers your TCO. Integrated with a simplified, but comprehensive management suite and industry-leading support, the HPE ProLiant rack portfolio delivers a more reliable, fast, and secure infrastructure solution, helps increase IT staff productivity, and accelerates service delivery. In addition, the rack portfolio is performance-optimized for multiapplication workloads to significantly increase the speed of IT operations and enable IT to respond to business needs of any size, faster.

Specific models that offer relevant choices for Enterprise Kubernetes are:

[HPE ProLiant DL380](https://www.hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-proliant-dl380-gen10-server.1010026818.html) (<https://www.hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-proliant-dl380-gen10-server.1010026818.html>)

The industry-leading HPE DL380 2P/2U server with world-class performance and supreme versatility for multi-workload compute server delivers the latest in security, performance and expandability, backed by a comprehensive warranty. Standardize on the industry's most trusted compute platform. The HPE DL380 server is securely designed to reduce costs and complexity, featuring:

- the First, Second, Third Generation Intel Xeon Processor Scalable Family with up to a 60% performance gain¹ and 27% increase in cores²
- the HPE 2933 MT/s DDR4 SmartMemory supporting 3.0 TB
- support of 12 Gb/s SAS, and up to 20 NVMe drive plus a broad range of compute options
- HPE Persistent Memory offers unprecedented levels of performance for databases and analytic workloads to run everything from the most basic to mission-critical applications and deploy with confidence.


HPE ProLiant DL360 (<https://www.hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-proliant-dl360-gen10-server.1010007891.html>) 

Adaptable for diverse workloads and environments, the compact 1U HPE DL360 server delivers security, agility and flexibility without compromise. It supports:


- the Intel Xeon Scalable processor with up to a 60% performance gain¹ and 27% increase in cores²
- along with 2933 MT/s HPE DDR4 SmartMemory supporting up to 3.0 TB² with an increase in performance of up to 82%³
- the added performance that HPE Persistent Memory⁶, HPE NVDIMMs⁷ and 10 NVMe bring, the HPE DL360 means business. Deploy, update, monitor and maintain with ease
- automating essential server life cycle management tasks with HPE OneView and HPE Integrated Lights Out to deploy this 2P secure platform for diverse workloads in space constrained environments.



Note

HPE Servers Support & OS Certification Matrices (https://techlibrary.hpe.com/us/en/enterprise/servers/supportmatrix/suse_linux.aspx)  outlines the minimum version of SLE required for installation, yet later service pack releases may also be used and supported.

4.4.3 HPE Synergy Servers


HPE Synergy (<https://www.hpe.com/us/en/integrated-systems/synergy.html>) , the first Composable Infrastructure, empowers IT to create and deliver new value easily and continuously. This single infrastructure reduces operational complexity for traditional workloads and increases operational velocity for the new breed of applications and services. Through a single interface, HPE Synergy composes compute, storage and fabric pools into any configuration for any application.

It also enables a broad range of workloads — from bare metal, to virtual machines, to containers, to operational models like hybrid cloud and DevOps. HPE Synergy enables IT to rapidly react to new business demands with the following components:

- HPE Synergy 12000 Frames are uniquely architected as Composable Infrastructure (CI) to match the powerful 'infrastructure-as-code' capabilities of the HPE intelligent software architecture. Flexible access to compute, storage, and fabric resources allows for use and re-purposing. Linking multiple HPE Synergy Frames efficiently scales the infrastructure with a dedicated single view of the entire management network.
- Creating multiple composable domains in the infrastructure can efficiently deliver available resources to the business. HPE Synergy Frames reduce complexity by using intelligent auto-discovery to find all available resources to accelerate workload deployments. This drives IT efficiency as the business grows and delivers balanced performance across resources to increase solution effectiveness.
- With [HPE Synergy SY480 \(https://www.hpe.com/us/en/integrated-systems/synergy.html\)](https://www.hpe.com/us/en/integrated-systems/synergy.html)  Compute Module, one gains operational efficiency and control, and can deploy IT resources quickly for any workload through a single interface. HPE Synergy is a powerful software-defined solution. HPE Synergy Composable Compute resources create pools of flexible compute capacity that can be configured almost instantly to rapidly provision infrastructure for a broad range of applications. The HPE Synergy SY480 Compute Module delivers an efficient and flexible two-socket workhorse to support most demanding workloads. Powered by:
 - Intel Xeon Scalable Family of processors
 - up to 4.5 TB DDR4, more storage capacity and controllers
 - a variety of GPU options within a composable architectureHPE Synergy SY480 Compute Module is the ideal platform for general-purpose enterprise workload performance now and in the future.



Note

[HPE Servers Support & OS Certification Matrices \(https://techlibrary.hpe.com/us/en/enterprise/servers/supportmatrix/suse_linux.aspx\)](https://techlibrary.hpe.com/us/en/enterprise/servers/supportmatrix/suse_linux.aspx)  outlines the minimum version of SLE required for installation, yet later service pack releases may also be used and supported.



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:

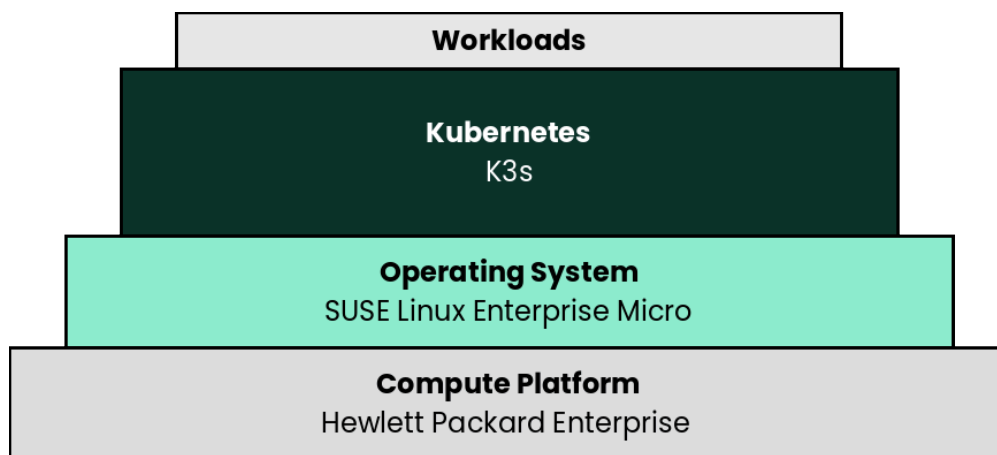


FIGURE 5.1: DEPLOYMENT STACK - K3S

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 Hewlett Packard Enterprise Synergy Frame. 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, see below.

Preparation(s)

The HPE Integrated Lights Out (<https://www.hpe.com/us/en/servers/integrated-lights-out-ilo.html>)  [iLO] is designed for secure local and remote server management and helps IT administrators deploy, update and monitor HPE servers anywhere, anytime.

1. Upgrade your basic iLO license 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.
 - (Optional) - iLO Federation (<https://www.hpe.com/us/en/servers/integrated-lights-out-ilo.html>)  enables you to manage multiple servers from one system using the iLO web interface.
2. For nodes situated in an HPE Synergy enclosure, like HPE Synergy SY480 used in the deployment:
 - Setup the necessary items in the Hewlett Packard Enterprise OneView (<https://www.hpe.com/us/en/integrated-systems/software.html>)  interface, including:
 - Settings → Addresses and Identifiers (Subnets and Address Ranges)
 - Networks → Create (associate subnets and designate bandwidths)
 - Network Sets → Create (aggregate all the necessary Networks)
 - Logical Interconnects → Edit (include the respective Network Sets)
 - Logical Interconnect Groups → Edit (include the respective Network Sets)
 - Server Profile Templates → Create (or use existing hypervisor templates)
 - OS Deployment mode → could be configured to boot from PXE, local storage, shared storage

- Firmware (upgrade to the latest and strive for consistency across node types)
- Manage Connections (assign the Network Set to be bonded across NICs)
- Local Storage (create the internal RAID1 set and request additional drives for the respective roles)
- Manage Boot/BIOS/iLO Settings
- Server Profile → Create (assign the role template to the target model)
- Add Servers and Assign Server Roles
 - Use the Discover function from Hewlett Packard Enterprise OneView to see all of the available nodes that can be assigned to to their respective roles:
 - Then drag and drop the nodes into the roles and ensure there is no missing configuration information, by reviewing and editing each node's server details
 - Manage Settings - setup DNS/NTP, designate Disk Models/NIC Mappings/Interface Model/Networks
 - Manage Subnet and Netmask - edit Management Network information, ensuring a match exists to those setup in Hewlett Packard Enterprise OneView

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).

- Given the simplicity of the deployment, the operating system and hypervisor can be installed with the SUSE Linux Enterprise Server ISO media and the Hewlett Packard Enterprise Integrated Lights Out 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 link:SUSE Rancher hardware requirements (<https://documentation.suse.com/cloudnative/rancher-manager/latest/en/installation-and-upgrade/requirements/requirements.html>) ↗.

Deployment Consideration(s)

To further optimize deployment factors, leverage the following practices:

- *Automation*
 - For HPE Synergy servers, you can simplify multiple compute module setups and configurations, leveraging the Hewlett Packard Enterprise OneView SDK for Terraform Provider (<https://github.com/HewlettPackard/terraform-provider-oneview>) ↗.
 - For nodes running KVM, you can leverage either `virt-install` (<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 consid-

eration 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 \(https://documentation.suse.com/cloudnative/k3s/latest/en/reference/resource-profiling.html\)](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 [Hewlett Packard Enterprise ProLiant Rack Servers \(https://www.hpe.com/us/en/servers/proliant-dl-servers.html\)](https://www.hpe.com/us/en/servers/proliant-dl-servers.html) plus [Hewlett Packard Enterprise Synergy Servers \(https://www.hpe.com/us/en/integrated-systems/synergy.html\)](https://www.hpe.com/us/en/integrated-systems/synergy.html) 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/> 

WEB SITES

- **SUSE** - <https://www.suse.com> 
- **SUSE Customer Center (SCC)** - <https://scc.suse.com> 
- **Products**
 - **SUSE Rancher** - <https://www.suse.com/products/rancher/>  (documentation (<https://documentation.suse.com/cloudnative/rancher-manager/>) 
 - **Rancher Kubernetes Engine (RKE)** - <https://rancher.com/products/rke/>  (documentation (<https://rancher.com/docs/rke/latest/en/>) 
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 - **SUSE Linux Enterprise Micro (SLEMicro)** - <https://www.suse.com/products/micro/>  (documentation (<https://documentation.suse.com/sle-micro/5.5/>) 
 - **SUSE Linux Enterprise Server (SLES)** - <https://www.suse.com/products/server/>  (documentation (<https://documentation.suse.com/sles/15-SP3/>) 

- SUSE Manager - <https://www.suse.com/products/suse-manager/>  (documentation (<https://documentation.suse.com/suma/4.3/>) )
- SUSE Repository Mirroring Tool (RMT) - <https://www.suse.com/products/server/>  (documentation (<https://documentation.suse.com/sles/15-SP3/single-html/SLES-rmt/#book-rmt>) )
- Projects
 - Rancher Kubernetes Engine Government (RKE2) - <https://github.com/rancher/rke2>  (documentation (<https://docs.rke2.io/>) )
- Hewlett Packard Enterprise - <https://www.hpe.com/us/en/home.html> 
 - ProLiant - <https://www.hpe.com/us/en/servers/proliant-dl-servers.html> 
 - Synergy - <https://www.hpe.com/us/en/integrated-systems/synergy.html> 

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.

Security⁵

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)

Proof-of-Concept⁶

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 (MVP⁷) that has just enough features to satisfy an

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

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

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

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.

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	867959-B21 ABA	Hewlett Packard Enterprise ProLiant DL360 Gen10 8SFF CTO server	• items below listed per node
	2	P02592-L21	• Intel Xeon-Gold 5218 (2.3GHz/16-core/125W) Processor Kit	
	12	P00918-B21	• Single Rank x8 DDR4-2933 CAS-21-21-21 Registered Smart Memory Kit	
	2	P18434-B21	• 960GB SATA 6G Mixed Use SFF (2.5in) SC 3yr Wty Multi Vendor SSD	
	1	P01366-B21	• 96W Smart Storage Lithium-ion Battery with 145mm Cable Kit	
	1	804326-B21	• Smart Array E208i-a SR Gen10 (8 Internal Lanes/	

Role	Qty	SKU	Component	Notes
			No Cache) 12G SAS Modular Con- troller	
	1	879482-B21	<ul style="list-style-type: none"> InfiniBand FDR/ Ethernet 40/50Gb 2-port 547FLR- QSFP Adapter 	
	1	BD505A	<ul style="list-style-type: none"> iLO Advanced 1- server License with 3yr Support on iLO Licensed Features 	
Example 2	1-3	868703-B21 ABA	Hewlett Packard Enter- prise ProLiant DL380 Gen10 8SFF CTO server	<ul style="list-style-type: none"> items be- low listed per node
	2	P02510-L21	<ul style="list-style-type: none"> Intel Xeon-Gold 6242 (2.8GHz/16- core/150W) FIO Processor Ki 	
	12	P00922-B21	<ul style="list-style-type: none"> 16GB (1x16GB) Dual Rank x8 DDR4-2933 	

Role	Qty	SKU	Component	Notes
			CAS-21-21-21 Registered Smart Memory Kit	
	2	P18434-B21	<ul style="list-style-type: none"> 960GB SATA 6G Mixed Use SFF (2.5in) SC 3yr Wty Multi Vendor SSD 	
	1	P01366-B21	<ul style="list-style-type: none"> 96W Smart Stor- age Lithium-ion Battery with 145mm Cable Kit 	
	1	804326-B21	<ul style="list-style-type: none"> Smart Array E208i-a SR Gen10 (8 Internal Lanes/ 	

Role	Qty	SKU	Component	Notes
			No Cache) 12G SAS Modular Controller	
	1	879482-B21	<ul style="list-style-type: none"> InfiniBand FDR/Ethernet 40/50Gb 2-port 547FLR-QSFP Adapter 	
	1	BD505A	<ul style="list-style-type: none"> iLO Advanced 1-server License with 3yr Support on iLO Licensed Features 	
Example 3 Chassis	1	797740-B21	Enclosure : Hewlett Packard Enterprise Synergy 12000 Configurer-to-order Frame with 1x Frame Linke Module, 10x Fans	<ul style="list-style-type: none"> items below listed per enclosure
	1	804938-B21	<ul style="list-style-type: none"> Frame Rack Rail Kit 	
	1	804942-B21	<ul style="list-style-type: none"> Frame Link Module 	
	2	804353-B21	<ul style="list-style-type: none"> Composer 	
	2	779218-B21	<ul style="list-style-type: none"> Network : 20Gb Interconnect Link Module 	
	2	794502-B23	<ul style="list-style-type: none"> Hewlett Packard Enterprise Virtual Connect SE 40Gb F8 Module for Synergy 	
	2	755985-B21	<ul style="list-style-type: none"> Storage : 12G SAS Connectivity Module for Synergy 	
37 Example 3 Node	1-3	871940-B21	Compute platform bill of materials <ul style="list-style-type: none"> Compute Module : Hewlett Packard Enterprise Synergy SY480 Gen10 	SUSE Linux Enterp... <ul style="list-style-type: none"> items below listed per node

Role	Qty	SKU	Component	Notes
			CAS-19-19-19 Registered Smart Memory Kit	
	1	804424-B21	<ul style="list-style-type: none"> Smart Array P204i-c SR Gen10 (4 Internal Lanes/1GB Cache) 12G SAS Modular Controller 	
	2	875478-B21	<ul style="list-style-type: none"> 1.92TB SATA 6G Mixed Use SFF (2.5in) SC 3yr WTY Digitally Signed Firmware SSD 	

9.2 Software bill of materials

Sample set of software, support and services.

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.

9.3 Documentation configuration / attributes


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```
Appendix=1 Arch0v=1 Automation=1 Availability=1 BP=1 BPBV=1 CompMod=1 DepConsiderations=1
Deployment=1 FCTR=1 FLVR=1 GFDL=1 Glossary=1 HWComp=1 HWDepCfg=1 IHV-HPE-ProLiant=1
IHV-HPE-Synergy=1 IHV-HPE=1 Integrity=1 LN=1 PoC=1 Production=1 RA=1 RC=1 References=1
Requirements=1 SWComp=1 SWDepCfg=1 Scaling=1 Security=1 docdate=2022-04-06 env-daps=1
focusK3s=1 iIHV=1 iK3s=1 iRKE1=1 iRKE2=1 iRMT=1 iRancher=1 iSLEMicr=1 iSLES=1 iSUMa=1
layerSLEMicr=1
```

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