



# Reference Configuration - K3s

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SUSE Linux Enterprise Server 15-SP2, K3s  
1.21.2

## Reference Configuration - K3s: Including integration content from Dell Technologies

SUSE Linux Enterprise Server 15-SP2, K3s 1.21.2

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, utilization of microservices becomes the main approach with the dominant technology for such container orchestration being Kubernetes <sup>1</sup> With its large community of developers and abundant features and capabilities, Kubernetes has become the defacto 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

As developers and organizations continue their journey from simple, containerized microservices towards 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 ( CNCF <sup>2</sup> ) conformant and certified <sup>3</sup> 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.

Once on such a digital transformation journey, some of the next focus areas are:

- Compute Platform

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<sup>1</sup> <https://kubernetes.io/> 

<sup>2</sup> <https://www.cncf.io/> 

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

- To optimize availability, performance, scalability and integrity, assess current system platforms or acquire and utilize new variations from:
  - Independent Hardware Vendors ( IHV ), such as Dell Technologies (<https://www.dell.com/en-us>)  ® , as the platform for physical, baremetal, 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.



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### Warning

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## 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 utilized. 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 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. For example:

## Compute Platform

Utilizing the above software application and technology solutions with the server platforms offered by Dell Technologies ( [Dell \(https://www.dell.com/en-us\)](https://www.dell.com/en-us) ) 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.



## Warning

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Draft

## 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: FIXME - 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 loadbalancer 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, & socat

Once setup, users can potentially interact with K3s FixMe - through the web-based user interface (UI), the command-line interface ( CLI ), and programatically through the application programming interface ( API ). Depending upon the assigned roles, group membership and privileges, a user could:

- kubectl
  - directly on the K3s host or
  - remotely, leveraging the KUBECONFIG file of the {pn\_K3s} cluster's deployment ( FixMe )
- 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.

### 4.1 Component overview

By utilizing:

- Software
  - Kubernetes Platform - K3s
  - Linux Operating System - SUSE Linux Enterprise Server
- Compute Platform

one 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
- any important host utilities like
  - 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: OVERVIEW OF 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.

Learn more information about K3s at <https://k3s.io> 

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 Server

SUSE Linux Enterprise Server ( SLES (<https://www.suse.com/products/server/>)  ) is an adaptable and easy-to-manage platform that allows developers and administrators to deploy business-critical workloads on-premises, in the cloud and at the edge. It is a Linux operating system that is adaptable to any environment – optimized for performance, security and reliability. As a multimodal operating system that paves the way for IT transformation in the software-defined era, this simplifies multimodal IT, makes traditional IT infrastructure efficient and provides an engaging platform for developers. As a result, one can easily deploy and transition business-critical workloads across on-premise and public cloud environments.


Designed for interoperability, SUSE Linux Enterprise Server integrates into classical Unix and Windows environments, supports open standard interfaces for systems management, and has been certified for IPv6 compatibility. This modular, general purpose operating system runs on four processor architectures and is available with optional extensions that provide advanced capabilities for tasks such as real time computing and high availability clustering. SUSE Linux Enterprise Server is optimized to run as a high performing guest on leading hypervisors and supports an unlimited number of virtual machines per physical system with a single subscription. This makes it the perfect guest operating system for virtual computing.

## 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:




### Tip

Any [SUSE YES \(https://www.suse.com/yessearch/\)](https://www.suse.com/yessearch/)  certified platform can be used for the nodes of this deployment, as long as the certification refers to the major version of the underlying SUSE operating system required by its release.

### 4.4.1 Dell PowerEdge Rack Servers

Dell EMC PowerEdge rack servers ([https://i.dell.com/sites/csdocuments/Product\\_Docs/en/powered-edge-rack-servers-quick-reference-guide.pdf](https://i.dell.com/sites/csdocuments/Product_Docs/en/powered-edge-rack-servers-quick-reference-guide.pdf))  help you build a modern infrastructure that minimizes IT challenges and drives business success. Choose from a complete portfolio of 1, 2, and 4-socket rack servers to deliver high core density for your traditional applications, virtualization, and cloud-native workloads. Enhanced memory speeds, faster NVMe storage options, and BIOS tuning allows you to match performance to your workload for ultimate efficiency

### 4.4.2 SUSE YES Certified Process

Self Testing Hardware with SUSE Linux Enterprise (<https://www.suse.com/partners/ihv/yes/yes-certified-process>) : To conduct YES self testing, download and install the latest versions and supports packs of SUSE Linux Enterprise and the YES TestConsole with the appropriate YES certification test kit. Test your product per the instructions in the test kit, fix any problems encountered and once corrected, re-run all tests to obtain clean test results. Submit the test results into the SUSE Bulletin System (SBS) for review and validation.

### 4.4.3 R640 Rack Servers

<https://www.dell.com/en-us/work/shop/productdetailstxn/powerededge-r640> 


The PowerEdge R640 is SUSE YES Certified Hardware.



Uncompromising performance and density:

The PowerEdge R640 is the ideal dual-socket, 1U platform for dense scale-out data center computing. The R640 combines density, performance and scalability to optimize application performance and data center density

- CPU: Up to two 2nd Generation Intel® Xeon® Scalable processors with up to 28 cores per processor
- Accelerators: Up to one single-width FPGA, Up to three single-width GPU (NVIDIA T4)
- Memory Speed: DIMM Speed (Up to 2933MT/s)
- Memory Type: RDIMM, LRDIMM, NVDIMM, DCPMM (Intel® Optane™ DC persistent memory)
- Memory Module Slots: 24 DDR4 DIMM slots (12 NVDIMM or 12 DCPMM only) Supports registered ECC DDR4 DIMMs only
- Memory RAM: RDIMM 1.53TB, LRDIMM 3TB, NVDIMM 192GB, DCPMM 6.14TB (7.68TB with LRDIMM)
- Storage - Front Bays: Up to 10 x 2.5" with up to 8 NVMe, SAS/SATA/SSD/NVMe, max 76.8TB Up to 10 NVMe, max 64TB Up to 4 x 3.5" SAS/SATA, max 56T
- Storage - Read Bays: Up to 2 x 2.5" SAS/SATA/SSD/NVMe, max 15.36TB

For more information, see R640 Datasheet, [https://i.dell.com/sites/csdocuments/Product\\_Docs/en/poweredge-r640-spec-sheet.pdf](https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-r640-spec-sheet.pdf) 

Maximize application performance and density:

The scalable business architecture of the R640 is designed to maximize application performance and provide the flexibility to optimize configurations based on the application and use case. With the R640 you can create an NVMe cache pool and use either 2.5" or 3.5" drives for data storage. Combined with up to 24 DIMM's, 12 of which can be DCPMMs or NVDIMMs, you have the resources to maximize application performance with the optimum configuration in only a 1U chassis.

- Simplify deployments and speed deployments with Dell EMC ready nodes for ScaleIO and VSAN.
- Maximize storage performance with up to 10 NVMe drives or 12 2.5” drives.
- Scale compute resources with 2nd Generation Intel® Xeon® Scalable processors and tailor performance based on your unique workload requirements.

Automate maintenance with Dell EMC OpenManage:

The Dell EMC OpenManage™ portfolio helps deliver peak efficiency for PowerEdge servers, delivering intelligent, automated management of routine tasks. Combined with unique agent-free management capabilities, the R640 is simply managed, freeing up time for high profile projects.

- Simplify management with the OpenManage Enterprise™ console, with customized reporting and automatic discovery.
- Take advantage of QuickSync 2 capabilities and gain access to your servers easily through your phone or tablet.

Guard your data center with built in security:

Every PowerEdge server is designed as part of a cyber resilient architecture, integrating security into the full server life cycle. The R640 leverages new security features built-into every new PowerEdge server strengthening protection so you can reliably and securely deliver accurate data to your customers no matter where they are. By considering each aspect of system security, from design to retirement, Dell EMC ensures trust and delivers a worry-free, secure infrastructure without compromise.

- Rely on a secure component supply chain to ensure protection from factory to the data center.
- Maintain data safety with cryptographically signed firmware packages and Secure Boot.
- Prevent unauthorized or malicious change with Server Lockdown.
- Wipe all data from storage media including hard drives, SSDs and system memory quickly and securely with System Erase.

#### 4.4.4 R740 Rack Servers

<https://www.dell.com/en-us/work/shop/povw/poweredge-r740> 

The PowerEdge R740 is SUSE YES Certified Hardware.

Optimized for workload acceleration:

The PowerEdge R740 was designed to accelerate application performance leveraging accelerator card and storage scalability. The 2-socket, 2U platform has the optimum balance of resources to power the most demanding environments

- CPU: Up to two 2nd Generation Intel® Xeon® Scalable processors with up to 28 cores per processor
- Accelerator: Up to three 300W or six 150W GPUs, Up to three double-width or four single-width FPGAs
- Memory RDIMM, LRDIMM, NVDIMM, DCPMM (Intel® Optane™ DC persistent memory)
- Memory Module Slots: 24 DDR4 DIMM slots (12 NVDIMM or 12 DCPMM only), Supports registered ECC DDR4 DIMMs only
- Memory RAM: RDIMM 1.53TB, LRDIMM 3TB, NVDIMM 192GB, DCPMM 6.14TB (7.68TB with LRDIMM)
- Storage - Front Bays: Up to 16 x 2.5" SAS/SATA/SSD, max 122.88TB, Up to 8 x 3.5" SAS/SATA, max 128TB

For more information, see R740 Datasheet, [https://i.dell.com/sites/csdocuments/Product\\_Docs/en/poweredge-r740-spec-sheet.pdf](https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-r740-spec-sheet.pdf) ↗

Expand and optimize application performance:

The scalable business architecture of the R740 can scale up to three 300W or six 150W GPUs, or up to three double-width or four single-width FPGAs. With up to 16 2.5" drives or 8 3.5" drives the R740 provides the versatility to adapt to virtually any application and provides the perfect platform for VDI deployments.

- Scale your VDI deployments with 3 double-width GPUs, supporting up to 50% more users when compared to R730.
- Free up storage space using internal M.2 SSDs optimized for boot.
- Scale compute resources with 2nd Generation Intel® Xeon® Scalable processors and tailor performance based on your unique workload requirements.

Automate systems management with OpenManage:

The Dell EMC OpenManage™ portfolio helps deliver peak efficiency for PowerEdge servers, delivering intelligent, automated management of routine tasks. Combined with unique agent-free management capabilities, the R740 is simply managed, freeing up time for high profile projects.

- Simplify management with the New OpenManage Enterprise™ console, with customized reporting and automatic discovery.
- Take advantage of QuickSync 2 capabilities and gain access to your servers easily through your phone or tablet.

Rely on PowerEdge with built-in security:

Every PowerEdge server is designed as part of a cyber resilient architecture, integrating security into the full server lifecycle. The R740 leverages new security features built-into every new PowerEdge server strengthening protection so you can reliably and securely deliver accurate data to your customers no matter where they are. By considering each aspect of system security, from design to retirement, Dell EMC ensures trust and delivers a worry-free, secure infrastructure without compromise.

- Rely on a secure component supply chain to ensure protection from factory to the data center.
- Maintain data safety with cryptographically signed firmware packages and Secure Boot.
- Prevent unauthorized or malicious change with Server Lockdown.
- Wipe all data from storage media including hard drives, SSDs and system memory quickly and securely with System Erase

#### 4.4.5 R650 Rack Servers

[https://www.dell.com/en-us/work/shop/cty/pdp/spd/poweredge-r650/pe\\_r650\\_14796\\_vi\\_vp](https://www.dell.com/en-us/work/shop/cty/pdp/spd/poweredge-r650/pe_r650_14796_vi_vp)

The PowerEdge R650 is SUSE YES Certified Hardware.

Compelling performance, high scalability, and density

The Dell EMC PowerEdge R650, is a full-featured enterprise server, designed to optimize workloads performance and data center density

- CPU: Up to two 3rd Generation Intel Xeon Scalable processors, with up to 40 cores per processor
- Memory: 32 DDR4 DIMM slots, supports RDIMM 2 TB max or LRDIMM 4 TB max, speeds up to 3200 MT/s, Up to 16 Intel Persistent Memory 200 series (BPS) slots, 8 TB max, Supports registered ECC DDR4 DIMMs only
- Storage Controllers - Internal controllers: PERC H745, HBA355I, S150, H345, H755, H755N
- Storage Controllers - Boot Optimized Storage Subsystem (BOSS-S2): HW RAID 2 x M.2 SSDs 240 GB or 480 GB
- Storage Controllers - External PERC (RAID): PERC H840, HBA355E
- Drive Bays - Front bays: Up to 10 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 153 TB, Up to 4 x 3.5-inch SAS/SATA (HDD/SSD) max 64 TB, Up to 8 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 122.8 TB
- Drive Bays - Rear bays: Up to 2 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 30.7 TB

For more information, see R650 Datasheet, <https://www.delltechnologies.com/asset/en-us/products/servers/technical-support/dell-emc-powerededge-r650-spec-sheet.pdf> ↗

Innovate at scale with challenging and emerging workloads

The Dell EMC PowerEdge R650, powered by the 3rd Generation Intel® Xeon® Scalable processors is the optimal rack server to address application performance and acceleration. The PowerEdge R650, is a dual-socket/1U rack server that delivers outstanding performance for the most demanding workloads. It supports 8 channels of memory per CPU, and up to 32 DDR4 DIMMs @ 3200 MT/s speeds. In addition, to address substantial throughput improvements the PowerEdge R650 supports PCIe Gen 4 and up to 10 NVMe drives with improved air-cooling features and optional Direct Liquid Cooling to support increasing power and thermal requirements. This makes the PowerEdge R650 an ideal server for data center standardization on a wide range of workloads including; Database and Analytics, HighFrequency Trading, Traditional corporate IT, Virtual Desktop Infrastructure, and even HPC or AI/ML environments that require performance, and GPU support in a dense 1U form factor

Increase efficiency and accelerate operations with autonomous collaboration

The Dell EMC OpenManage systems management portfolio tames the complexity of managing and securing IT infrastructure. Using Dell Technologies' intuitive end-to-end tools, IT can deliver a secure, integrated experience by reducing process and information silos in order to focus on

growing the business. The Dell EMC OpenManage portfolio is the key to your innovation engine, unlocking the tools and automation that help you scale, manage, and protect your technology environment.

- Built-in telemetry streaming, thermal management, and RESTful API with Redfish offer streamlined visibility and control for better server management
- Intelligent automation lets you enable cooperation between human actions and system capabilities for added productivity
- Integrated change management capabilities for update planning and seamless, zero-touch configuration and implementation
- Full-stack management integration with Microsoft, VMware, ServiceNow, Ansible and many other tools

Protect your data assets and infrastructure with proactive resilience

The Dell EMC PowerEdge R650 server is designed with a cyber-resilient architecture, integrating security deeply into every phase in the lifecycle, from design to retirement.

- Operate your workloads on a secure platform anchored by cryptographically trusted booting and silicon root of trust
- Maintain server firmware safety with digitally signed firmware packages
- Prevent unauthorized configuration or firmware change with system lockdown
- Securely and quickly wipe all data from storage media, including hard drives, SSDs and system memory with System Erase

#### 4.4.6 R750 Rack Servers


[https://www.dell.com/en-us/work/shop/cty/pdp/spd/poweredge-r750/pe\\_r750\\_14794\\_vi\\_vp](https://www.dell.com/en-us/work/shop/cty/pdp/spd/poweredge-r750/pe_r750_14794_vi_vp) 

The PowerEdge R750 is SUSE YES Certified Hardware.

General purpose server optimized to address the most demanding workloads

The Dell EMC PowerEdge R750, is a full-featured enterprise server, delivering outstanding performance for the most demanding workloads

- CPU: Up to two 3rd Generation Intel Xeon Scalable processors, with up to 40 cores per processor
- Memory: 32 DDR4 DIMM slots, supports RDIMM 2 TB max or LRDIMM 8 TB max, speeds up to 3200 MT/s, Up to 16 Intel Persistent Memory 200 series (BPS) slots, 8 TB max, Supports registered ECC DDR4 DIMMs only
- Storage Controllers - Internal controllers: PERC H745, HBA355I, S150, H345, H755, H755N
- Storage Controllers - Boot Optimized Storage Subsystem (BOSS-S2): HW RAID 2 x M.2 SSDs 240 GB or 480 GB
- Storage Controllers - External PERC (RAID): PERC H840, HBA355E
- Drive Bays - Front bays: Up to 12 x 3.5-inch SAS/SATA (HDD/SSD) max 192 TB, Up to 8 x 2.5-inch NVMe (SSD) max 122.88 TB, Up to 16 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 245.76 TB, Up to 24 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 368.84 TB
- Drive Bays - Rear bays: Rear bays: Up to 2 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 30.72 TB, Up to 4 x 2.5-inch SAS/SATA/NVMe (HDD/SSD) max 61.44 TB

For more information, see R750 Datasheet, [https://i.dell.com/sites/csdocuments/Product\\_Docs/en/poweredge-R750-spec-sheet.pdf](https://i.dell.com/sites/csdocuments/Product_Docs/en/poweredge-R750-spec-sheet.pdf) 

Innovate at scale with challenging and emerging workloads

The Dell EMC PowerEdge R750, powered by the 3rd Generation Intel® Xeon® Scalable processors is a rack server to address application performance and acceleration. The PowerEdge R750, is a dual-socket/2U rack server that delivers outstanding performance for the most demanding workloads. It supports 8 channels of memory per CPU, and up to 32 DDR4 DIMMs @ 3200 MT/s speeds. In addition, to address substantial throughput improvements the PowerEdge R750 supports PCIe Gen 4 and up to 24 NVMe drives with improved air-cooling features and optional Direct Liquid Cooling to support increasing power and thermal requirements. This makes the PowerEdge R750 an ideal server for data center standardization on a wide range of workloads including; Database and Analytics, Highperformance computing (HPC), Traditional corporate IT, Virtual Desktop Infrastructure, and AI/ML environments that require performance, extensive storage and GPU support

Increase efficiency and accelerate operations with autonomous collaboration

The Dell EMC OpenManage systems management portfolio tames the complexity of managing and securing IT infrastructure. Using Dell Technologies' intuitive end-to-end tools, IT can deliver a secure, integrated experience by reducing process and information silos in order to focus on growing the business. The Dell EMC OpenManage portfolio is the key to your innovation engine, unlocking the tools and automation that help you scale, manage, and protect your technology environment.

- Built-in telemetry streaming, thermal management, and RESTful API with Redfish offer streamlined visibility and control for better server management
- Intelligent automation lets you enable cooperation between human actions and system capabilities for added productivity
- Integrated change management capabilities for update planning and seamless, zero-touch configuration and implementation
- Full-stack management integration with Microsoft, VMware, ServiceNow, Ansible and many other tool

Protect your data assets and infrastructure with proactive resilience

The Dell EMC PowerEdge R750 server is designed with a cyber-resilient architecture, integrating security deeply into every phase in the lifecycle, from design to retirement.

- Operate your workloads on a secure platform anchored by cryptographically trusted booting and silicon root of trust
- Maintain server firmware safety with digitally signed firmware packages
- Prevent unauthorized configuration or firmware change with system lockdown
- Securely and quickly wipe all data from storage media, including hard drives, SSDs and system memory with System Erase



## Note

A sample bill of materials, in the [Appendix A, 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 towards *production*, providing *scaling* guidance that is needed to create the solution.

### 5.1 Deployment overview

The deployment stack is represented in the following figure:

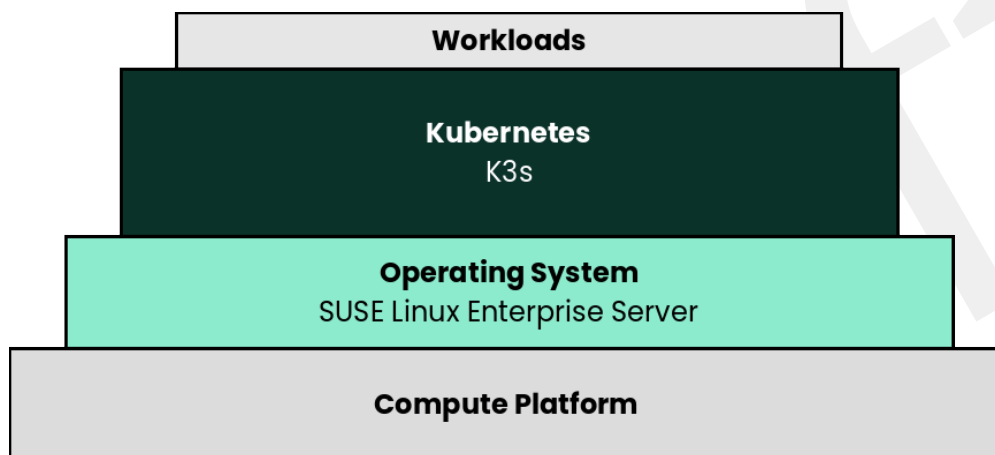


FIGURE 5.1: K3S DEPLOYMENT STACK

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 server. Based upon the relatively small resource requirements for a SUSE Rancher 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 physical host, there are tools that can be used during the setup of the server, see below.

The Integrated Dell Remote Access Controller ( iDRAC (<https://www.delltechnologies.com/en-ca/solutions/openmanage/idrac.htm>) ) is designed for secure local and remote server management and helps IT administrators deploy, update and monitor Dell EMC PowerEdge servers anywhere, anytime.

The Virtual Media (<https://dell.com/support/kbdoc/en-ca/000124001/using-the-virtual-media-function-on-idrac-6-7-8-and-9>) function allows the remote usage of software image files (ISO-files), which can be used for installing operating systems or updating servers.

## 5.3 SUSE Linux Enterprise Server

Utilize an enterprise-grade Linux operating system , like SUSE Linux Enterprise Server, as the base software layer.

### Preparation(s)


To meet the solution stack prerequisites and requirements, SUSE operating system offerings, like SUSE Linux Enterprise Server (<https://www.suse.com/products/server/>) can be utilized.

#### 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 hostnames
- Network Time Protocol ( NTP ) - an external network-accessible service to obtain and synchronize system times to aid in timestamp 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/login>) ( SCC ) or
  - an organization's 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-SP2/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:

### 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/5.0/single-html/SLE-Micro-autoyast/#book-autoyast) (<https://documentation.suse.com/sle-micro/5.0/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/5.0/single-html/SLE-Micro-installation/#article-installation) (<https://documentation.suse.com/sle-micro/5.0/single-html/SLE-Micro-installation/#article-installation>) 

## 5.4 K3s

Utilize an enterprise-grade Linux operating system , like SUSE Linux Enterprise Server, as the base software layer.

### Preparation(s)

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

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 hostnames
- Network Time Protocol ( NTP ) - an external network-accessible service to obtain and synchronize system times to aid in timestamp 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 \(https://scc.suse.com/login\)](https://scc.suse.com/login) ( 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 \(https://documentation.suse.com/sles/15-SP2/single-html/SLES-rmt/#book-rmt\)](https://documentation.suse.com/sles/15-SP2/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).

2. Identify the appropriate, desired version of the K3s binary (e.g. vX.YY.ZZ + k3s1), by reviewing the "Releases" on the [Download \(https://github.com/k3s-io/k3s/\)](https://github.com/k3s-io/k3s/) web page.

## 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 -
```



### 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 into 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 \(https://rancher.com/docs/k3s/latest/en/\)](https://rancher.com/docs/k3s/latest/en/)  for details on how to directly utilize this Kubernetes cluster. Furthermore, by reviewing the SUSE Rancher [product documentation \(https://rancher.com/docs/rancher/v2.5/en/\)](https://rancher.com/docs/rancher/v2.5/en/)  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 and the Rancher portfolio streamlines 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://info.rancher.com/enterprise-kubernetes-management-buyers-guide>
- How to Build an Enterprise Kubernetes Strategy - <https://info.rancher.com/how-to-build-enterprise-kubernetes-strategy>

### BOOKS

- Kubernetes Management - <https://info.rancher.com/kubernetes-management-for-dummies-rancher-and-suse-0-0>

### TRAINING

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

### WEBSITES

- SUSE - <https://www.suse.com>
- SUSE Customer Center ( SCC ) - <https://scc.suse.com/login>
- Products
  - SUSE Rancher - <https://rancher.com/products/rancher/> ( documentation (<https://rancher.com/docs/rancher/v2.5/en/>) )
  - Rancher Kubernetes Engine ( RKE ) - <https://rancher.com/products/rke/> ( documentation (<https://rancher.com/docs/rke/latest/en/>) )
  - K3s - <https://rancher.com/products/k3s/> ( documentation (<https://rancher.com/docs/k3s/latest/en/>) )
  - SUSE Linux Enterprise Micro ( SLEMicro ) - <https://www.suse.com/products/micro/> ( documentation (<https://documentation.suse.com/sle-micro/5.0/>) )
  - SUSE Linux Enterprise Server ( SLES ) - <https://www.suse.com/products/server/> ( documentation (<https://documentation.suse.com/sles/15-SP2/>) )

- SUSE Manager - <https://www.suse.com/products/suse-manager/>  ( documentation (<https://documentation.suse.com/suma/4.2/>)  )
- SUSE Repository Mirroring Tool ( RMT ) - <https://www.suse.com/products/server/>  ( documentation (<https://documentation.suse.com/sles/15-SP2/single-html/SLES-rmt/#book-rmt>)  )
- Projects
  - Rancher Kubernetes Engine Government ( RKE2 ) - <https://github.com/rancher/rke2>  ( documentation (<https://docs.rke2.io/>)  )

# 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 Architectures <sup>1</sup>

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 standalone 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)

## Automation <sup>2</sup>

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 towards implementing a culture of DevOps, the combined working of development and operations.

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

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

### Availability<sup>3</sup>

The probability that an item operates satisfactorily, without failures or downtimes, 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

### Integrity<sup>4</sup>

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.

### Security<sup>5</sup>

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-Concept<sup>6</sup>

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 ( MVP<sup>7</sup> ) that has just enough features to satisfy an

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

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 utilized 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 utilization 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.

## A Appendix

The following sections provide a bill of materials listing for each component layer.

### A.1 Compute Platform Bill of Materials

Role	Qty	SKU	Component	Notes
Example 1: 1-3 Compute Platform - Dell PowerEdge R640	1	321-BCQQ	2.5 in. chassis with up to 10 hard drives, 8 NVMe drives, and 3 PCIe slots, 2 CPU only	
	2	338-BTSI	Intel Xeon Gold 6238 2.1 G, 22C/44 T, 10.4 GT/s, 30.25 M Cache, Turbo, HT (140 W) DDR4-2933	
	12	370-AEVN	32 GB RDIMM, 3200 MT/s, Dual Rank	
	1	405-AAJU	HBA330 12 Gbps SAS HBA Controller (NON-RAID), minicard	
	1	385-BBKT	iDRAC9, Enterprise	
	1	330-BBGN	Riser Config 2, 3 x 16 LP	
	1	406-BBLG	Mellanox ConnectX-4 Lx Dual Port 25 GbE SFP 28 rNDC	

Role	Qty	SKU	Component	Notes
	1	406-BBLD	Mellanox ConnectX-4 Lx dual port 25 GbE SFP28 NIC, low profile	
	1	450-ADWS	Dual, hot-plug, redundant power supply (1 + 1), 750 W	
	2 min – 8 max	400-BELT	Dell 1.6 TB, NVMe, Mixed Use Express Flash, 2.5 SFF Drive, U.2, P4610 with Carrier	
	2	400-AZQO	800 GB SSD SAS Mix Use 12 Gbps 512e 2.5 in Hot-plug AG Drive, 3 DWPD, 4380 TBW	
	1	403-BCHI	BOSS Cntrl + 2 M.2 240G, R1, LP1	
Example 2: 1-3 Compute Platform - Dell PowerEdge R740	1	321-BCRC	Chassis up to 24 x 2.5 in. hard drives including 12 NVME drives, 2 CPU configuration	
	1	338-BTSI	Intel Xeon Gold 6238 2.1 G, 22C/44 T, 10.4 GT/s, 30.25 M Cache, Turbo, HT (140 W) DDR4-2933	
	12	370-AEVN	32 GB RDIMM, 2933MT/s, Dual Rank	

Role	Qty	SKU	Component	Notes
	1	405-AANK	HBA330 controller adapter, low profile	
	1	385-BBKT	iDRAC9, Enterprise	
	1	330-BBHD	Riser Config 6, 5 x 8, 3 x1 6 slots	
	1	406-BBLG	Mellanox ConnectX-4 Lx Dual Port 25 GbE SFP28 rNDC	
	1	406-BBLE	Mellanox ConnectX-4 Lx Dual Port 25 GbE SFP28 network interface controller	
	1	450-ADWM	Dual, hot-plug, redundant power supply (1 + 1), 1100 W	
	1	403-BCHP	BOSS Cntrl + 2 M.2 240G, R1, FH	
	1 to 24	400-AZQO	800 GB, 1.92 TB, or 3.84 TB SSD SAS mixed use 12 Gbps 512e 2.5 in. hot-plug AG drive with carrier, 3 DWPD, 4380 TBW, CK	
	1 to 12	400-BLKD	Dell 1.6 TB, 3.2 TB, or 6.4 TB, NVMe, mixed use express flash, 2.5 SFF drive, U.2, P4610 with carrier, CK	



Role	Qty	SKU	Component	Notes
Example 3: 1-3 Compute Platform - Dell PowerEdge R650	1	338-BZXK	Gold 6330 2G, 42M, 205W	
	1	338-BZXK	Gold 6330 2G, 42M, 205W	
	16	370-AEVQ	16GB RDIMM, 3200MT/s, Dual Rank	
	1	450-AIQZ	Dual, Hot-plug, PSU 1 + 1, 1400W, MM	
	1	528-CRVW	iDRAC9 Datacenter 15G	
	1	340-CUQN	R650 Ship 4x3.5, 10x2.5	
	1	321-BGHG	8x2.5 Chipset NVMe RAID Config, 2CPU	
	1	405-AAZE	PERC H755N Front	
	1	330-BBRP	Riser C0-2, 3x16 LP, HL	
	1	403-BCMB	BOSS-S2 Cntrl + 2 M.2 480G	
	3	400-BLKD	1.6TB, NVMe, 2.5 Dr, MU, P5600	
	1	540-BCOF	Mlnx ConX5 DP 10/25Gbe SFP28 OCP3.0	


Role	Qty	SKU	Component	Notes
Example 4: 1-3 Compute Platform - Dell PowerEdge R750	1	540-BCMQ	Mlnx ContX-5 DP 25Gb SFP Adpt, LP	
	1	338-BZXK	Gold 6330 2G, 42M, 205W	
	1	338-BZXK	Gold 6330 2G, 42M, 205W	
	16	370-AEVQ	16GB RDIMM, 3200MT/s, Dual Rank	
	1	450-AIQZ	Dual, Hot-plug, PSU 1 + 1, 1400W, MM	
	1	528-CRVW	iDRAC9 Datacenter 15G	
	3	400-BLKD	1.6TB, NVMe, 2.5 Dr, MU, P5600	
	1	321-BGET	8x2.5" NVMe RAID	
	1	330-BBRW	Riser Config2,Full Length,4x16,2x8 slots	
	1	540-BCNM	Mlnx ContX-5 DP 25Gb SFP Adpt, FH	
	1	403-BCMB	BOSS-S2 Cntrl + 2 M.2 480G	
	1	405-AAZE	PERC H755N Front	

Role	Qty	SKU	Component	Notes
	1	540-BCOF	Mlnx ConX5 DP 10/25Gbe SFP28 OCP3.0	

## A.2 Software Bill of Materials

Role	Qty	SKU	Component	Notes
Operating System	1-3	874-006875	SUSE Linux Enterprise Server,	Configuration: <ul style="list-style-type: none"> <li>• per node (up to 2 sock-</li> </ul>

Role	Qty	SKU	Component	Notes
			<ul style="list-style-type: none"> <li>• x86_64,</li> <li>• Priority Subscription,</li> <li>• 1 Year</li> </ul>	ets, stack-able) or 2 VMs
Kubernetes Management	1	R-0001-PS1	SUSE Rancher, <ul style="list-style-type: none"> <li>• x86-64,</li> <li>• Priority Subscription,</li> <li>• 1 Year</li> </ul>	Configuration: <ul style="list-style-type: none"> <li>• per deployed instance</li> </ul>
Rancher Management	2	R-0004-PS1	Rancher 10 Nodes <ul style="list-style-type: none"> <li>• x86-64 or aarch64,</li> <li>• Priority Subscription,</li> <li>• 1 Year,</li> </ul>	Configuration: <ul style="list-style-type: none"> <li>• requires priority server subscription</li> </ul>
Consulting and Training	1	R-0001-QSO	Rancher Quick Start, <ul style="list-style-type: none"> <li>• Go Live Services</li> </ul>	Terms: <ul style="list-style-type: none"> <li>• Review of client architecture</li> <li>• Bi-weekly cadence calls for 12 weeks</li> <li>• On-demand consulting (24 hours)</li> <li>• Two developer workshops</li> </ul>



Note

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

SUSE Linux Enterp... \*

## A.3 Documentation Configuration / Attributes

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```
Automation=1@ Availability=1@ FCTR=1@ FLVR=1@ IHV-DELL-PowerEdge=1@ IHV-DELL=1@
Integrity=1@ PoC=1@ Production=1@ RC=1@ Scaling=1@ Security=1@ focusK3s=1@ iIHV=1@
layerSLES=1@ Appendix=1 Arch0v=1 BP=1 BPBV=1 CompMod=1 DepConsiderations=1 Deployment=1
GFDL=1 Glossary=1 HWComp=1 HWDepCfg=1 LN=1 RA=1 References=1 Requirements=1 SWComp=1
SWDepCfg=1 env-daps=1 iK3s=1 iRKE1=1 iRKE2=1 iRMT=1 iRancher=1 iSLEMicro=1 iSLES=1
iSUMa=1
```

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