

Layered Stack Deployment of Rancher Kubernetes Engine Government

Integrated with Cisco (R)

Layered Stack Deployment of Rancher Kubernetes Engine Government: Integrated with Cisco (R)

SUSE Linux Enterprise Server 15 SP3, Rancher Kubernetes Engine Government 1.20.14

The purpose of this document is to provide an overview and procedure of implementing SUSE (R) and partner offerings for Rancher Kubernetes Engine Government (RKE2), a Kubernetes distribution that runs entirely within containers on bare-metal and virtualized nodes. RKE2 solves the problem of installation complexity and the operation is both simplified and easily automated, while entirely accommodating the operating system and platform it is running on. Also being a hardened, FIPS-enabled version, it adopts a compliance-based approach toward security, targeting standard risk management frameworks and best practices with the goal of stronger defense for cloud-native applications.

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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.

- With core focus on security and compliance, Rancher Kubernetes Engine Government inherits close alignment with upstream Kubernetes and provide usability, ease-of-operations, and deployment model for core use cases.


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 [Cisco \(https://www.cisco.com/\)](https://www.cisco.com/)  ® 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 Rancher Kubernetes Engine Government. This can be done in a variety of scenarios to create an enterprise Kubernetes cluster deployment anywhere to provide a very secure environment.

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

Many organizations are deploying Kubernetes clusters everywhere — in the cloud, on-premises, and at the edge — to unify IT operations. Such organizations can realize dramatic benefits, including:

- Consistently deliver a high level of reliability on any infrastructure
- Improve DevOps efficiency with standardized automation
- Ensure enforcement of security policies on any infrastructure

However, simply relying on upstream Kubernetes alone can introduce extra overhead and risk because Kubernetes clusters are typically deployed:

- Without central visibility
- Without consistent security policies
- And must be managed independently

Deploying a scalable kubernetes infrastructure requires consideration of a larger ecosystem, encompassing many software and infrastructure components and providers. Further, the ability to continually address the needs and concerns of:

Developers

For those who focus on writing code to build their apps securely using a preferred workflow, providing a simple, push-button deployment mechanism of their containerized workloads where needed.

IT Operators

General infrastructure requirements still rely upon traditional IT pillars are for the stacked, underlying infrastructure. Ease of deployment, availability, scalability, resiliency, performance, security and integrity are still core concerns to be addressed for administrative control and observability.

Beyond the core infrastructure software layers of managed Kubernetes clusters, organizations may be also be impacted by:

Compute Platform

Potential inconsistencies and impacts of multiple target system platforms for the distributed deployments of the cluster elements, across:

- physical, baremetal, hypervisors and virtual machines

2.2 Business value

With Rancher Kubernetes Engine Government, the operation of Kubernetes is easily automated and entirely independent of the operating system and platform running. Using a supported version of the container runtime engine, one can deploy and run Kubernetes with Rancher Kubernetes Engine Government. It builds a cluster from a single command in a few minutes, and its declarative configuration makes Kubernetes upgrades atomic and safe.

By allowing operation teams to focus on infrastructure and developers to deploy code the way they want too, SUSE and the Rancher offerings helps bring products to market faster and accelerate an organization's digital transformation.

SUSE Rancher is a fundamental part of the complete software stack for teams adopting containers. It provides DevOps teams with integrated tools for running containerized workloads while also addressing the operational and security challenges of managing multiple Kubernetes clusters across any targeted infrastructure.

Developers



SUSE Rancher makes it easy to securely deploy containerized applications no matter where the Kubernetes infrastructure runs — in the cloud, on-premises, or at the edge. Using Helm or the App Catalog to deploy and manage applications across any or all these environments, ensuring multi-cluster consistency with a single deployment process.

IT Operators

SUSE Rancher not only deploys and manages production-grade Kubernetes clusters from datacenter to cloud to the edge, it also unites them with centralized authentication, access control and observability. Further, it streamlines cluster deployment on bare metal or virtual machines and maintains them using defined security policies.

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, such as:

Compute Platform

Using the above software application and technology solutions with the server platforms offered by Cisco (<https://www.cisco.com/>)  Unified Computing System (UCS (<https://www.cisco.com/c/en/us/products/servers-unified-computing/>) ) brings increased productivity, reduced total cost of ownership, and scalability into your computing realm. Cisco UCS is based upon industry-standard, x86-architecture servers with Cisco innovations and delivers a better balance of CPU, memory, and I/O resources. This balance brings processor power to life with more than 150 world-record-setting benchmark results that demonstrate leadership in application areas including virtualization, cloud computing, enterprise applications, database management systems, enterprise middleware, high-performance computing, and basic CPU integer and floating-point performance metrics.

- Match servers to workloads - The breadth of the server product line makes the process of matching servers to workloads straightforward, enabling you to achieve the best balance of CPU, memory, I/O, internal disk, and external storage-access resources using the blade, rack, multinode, or storage server form factor that best meets your organization's data center requirements and preferred purchasing model.
- Powered by AMD EPYC processors or Intel Xeon Scalable processors
- Industry-leading bandwidth - Cisco UCS virtual interface cards have dramatically simplified the deployment of servers for specific applications. By making the number and type of I/O devices programmable on demand, enables organizations to deploy and repurpose server I/O configurations without ever touching the hardware.
- Lower infrastructure cost - Designed for lower infrastructure cost per server, is a choice that makes scaling fast, easy, and inexpensive in comparison to manually configured approaches.
- Rack server deployment flexibility - Cisco UCS C-Series Rack Servers unique in the industry because they can be integrated with Cisco UCS connectivity and management or used as stand-alone servers
- Integrated Management Controller (IMC) - Running in the system's Baseboard Management Controller (BMC), when a Cisco UCS C-Series Rack Servers is integrated into a Cisco UCS domain, the fabric interconnects interface with the IMC to make the server part of a single unified management domain. When a server is used as a standalone server, direct access to the IMC through the server's management port allows a range of software tools (including Cisco Intersight) to configure the server through its API.

3 Architectural overview

This section outlines the core elements of the Rancher Kubernetes Engine Government solution, along with the suggested target platforms and components.

3.1 Solution architecture

The figure below illustrates the high-level architecture overview of Kubernetes components on instances like Rancher Kubernetes Engine Government:

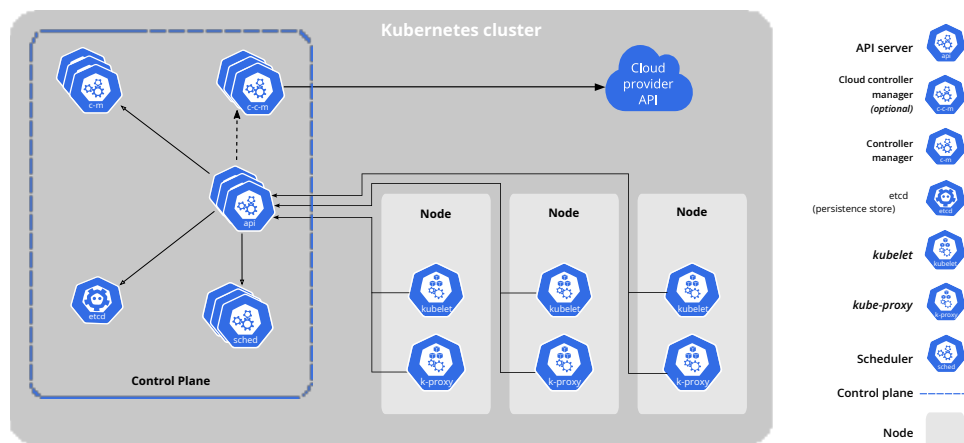


FIGURE 3.1: ARCHITECTURE OVERVIEW - RANCHER KUBERNETES ENGINE GOVERNMENT

A Kubernetes cluster consists of a set of nodes machines, called workers or agents, that host and run containerized applications in Pods. Every cluster has at least one worker node. The control plane manages the worker nodes and the Pods in the cluster. The provider API is a generic element that allows external interaction with the Kubernetes cluster.

Control Plane Components

The control plane's components make global decisions about the cluster (for example, scheduling), as well as detecting and responding to cluster events.

- kube-apiserver
 - The API server is a component of the Kubernetes control plane that exposes the Kubernetes API
- etcd

- Consistent and highly-available key value store used as Kubernetes' backing store for all cluster data.
- kube-scheduler
 - Control plane component that watches for newly created Pods with no assigned node, and selects a node for them to run on.
- kube-controller-manager
 - Control plane component that runs controller processes.

Node Components

Node components run on every node, maintaining running pods and providing the Kubernetes runtime environment.

- kubelet
 - An agent that runs on each node in the cluster. It makes sure that containers are running in a Pod.
- kube-proxy
 - A network proxy that runs on each node in your cluster, implementing part of the Kubernetes Service concept.

While all Rancher Kubernetes Engine Government roles can be installed on a single system, for the best availability, performance and security, the recommended deployment of a Rancher Kubernetes Engine Government cluster is a pair of nodes for the control plane role, at least three etcd role-based nodes and three or more worker nodes.



Note

Regardless of the deployment instance, Rancher Kubernetes Engine Government could always be deployed by SUSE Rancher or imported as a managed, downstream cluster.

4 Component model

This section describes the various components being used to create a Rancher Kubernetes Engine Government solution deployment, in the perspective of top to bottom ordering. When completed, the Rancher Kubernetes Engine Government 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:

- Kubernetes Platform - Rancher Kubernetes Engine Government
- Operating System - SUSE Linux Enterprise Server
- Compute Platform
 - Cisco UCS

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

4.2 Software - Rancher Kubernetes Engine Government

Rancher Kubernetes Engine Government also known as RKE2, is Rancher's next-generation Kubernetes distribution. It is a fully conformant Kubernetes distribution that focuses on security and compliance within the U.S. Federal Government sector. It solves the common frustration of installation complexity with Kubernetes by removing most host dependencies and presenting a stable path for deployment, upgrades, and rollbacks.

To meet these goals, Rancher Kubernetes Engine Government does the following:

- launches control plane components as static pods, managed by the kubelet. The embedded container runtime is containerd.
- provides defaults and configuration options that allow clusters to pass the CIS Kubernetes Benchmark v1.5 or v1.6 with minimal operator intervention

- enables FIPS 140-2 compliance
- regularly scans components for CVEs using trivy in our build pipeline

With Rancher Kubernetes Engine Government we take lessons learned from developing and maintaining our lightweight Kubernetes distribution, K3s, and apply them to build an enterprise-ready distribution with K3s ease-of-use. What this means is that Rancher Kubernetes Engine Government is, at its simplest, a single binary to be installed and configured on all nodes expected to participate in the Kubernetes cluster. When started, Rancher Kubernetes Engine Government is then able to bootstrap and supervise role-appropriate agents per node while sourcing needed content from the network.

The fundamental roles for the nodes and core functionality of Rancher Kubernetes Engine Government are represented in the following figure:

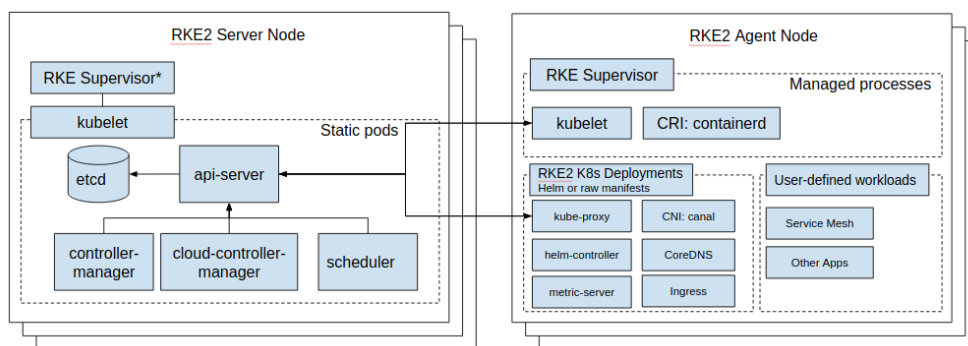


FIGURE 4.1: COMPONENT OVERVIEW - RANCHER KUBERNETES ENGINE GOVERNMENT

Rancher Kubernetes Engine Government brings together several open source technologies to make this all work:

- K3s - [Helm Controller \(https://github.com/k3s-io/helm-controller\)](https://github.com/k3s-io/helm-controller) ↗
- Kubernetes
 - API Server
 - Controller Manager
 - Kubelet
 - Scheduler
 - Proxy
- etcd

- Container Runtime - runc, containerd/cri
- CoreDNS
- NGINX Ingress Controller
- Metrics Server
- Helm

All of these, except the NGINX Ingress Controller, are compiled and statically linked with ¹

While all Rancher Kubernetes Engine Government roles can be installed on a single system, for the best availability, performance and security, the recommended deployment of a Rancher Kubernetes Engine Government cluster is a pair of nodes for the control plane role, at least three etcd role-based nodes and three or more worker nodes.


Rancher Kubernetes Engine Government 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 configurable and included:

- Multiple Kubernetes versions
- CoreDNS, Metrics, Ingress controller
- CNI: Canal (Calico & Flannel), Cilium or Calico
- Fleet Agent : for GitOps deployment of cloud-native applications

All of these components are configurable 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.



Tip

Learn more information about Rancher Kubernetes Engine Government at <https://documentation.suse.com/cloudnative/rke2/> .

While all Rancher Kubernetes Engine Government roles can be installed on a single system, a multi-node cluster, is a more production-like approach and will be described in the deployment section.

¹ <https://github.com/golang/go/tree/dev.boringcrypto/misc/boring> 



Tip

To improve availability, performance and security, the recommended deployment of a Rancher Kubernetes Engine Government cluster is a pair of nodes for the control plane role, at least three etcd role-based nodes and three or more worker nodes.

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-premises 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:

- 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.

[Cisco UCS C-Series Rack Servers \(https://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.html\)](https://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.html)

Cisco UCS C-Series Rack Servers delivers unified computing in an industry-standard form factor to reduce TCO and increase agility. Each server addresses varying workload challenges through a balance of processing, memory, I/O, and internal storage resources. These servers can be deployed as stand-alone servers or as part of a Cisco Unified Computing System (Cisco UCS) managed environment to take advantage of Cisco's standards-based unified computing innovations that help reduce customers' Total Cost of Ownership (TCO) and increase their business agility. ~

Server product-line and model options abound in the [Cisco UCS C-Series Rack Servers \(https://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.html\)](https://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.html), including:

- [Cisco UCS C240 SD M5 \(https://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/datasheet-c78-743260.html\)](https://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/datasheet-c78-743260.html) is a high-performance compute solution in a dense 2-socket, 2-Rack-Unit, 22" form-factor to handle the


most critical real-time compute applications. This front-access server can be deployed as stand-alone servers or as part of a Cisco Unified Computing System (Cisco UCS) to deliver an exceptional management experience for a variety of applications by:


- incorporating the 2nd generation of Intel Xeon Scalable processors, Intel Optane Memory, and various drive options including All-NVMe, SAS and SATA drives.
- being density optimized to accommodate space constrained environments while still offering industry-leading performance and expandability. It supports a wide range of workloads from enterprise to edge applications such as Multi-access Edge Compute (MEC).



Note

Cisco UCS Hardware Compatibility List (<https://ucshcltool.cloudapps.cisco.com/public/>)  provides a lookup tool for Servers & OS Support, for versions of SUSE offerings.

- Cisco Intersight (<https://intersight.com>) : To simplify multiple compute module setups and configurations, leverage Cisco Intersight which is an API driven, cloud-based system management platform that integrates with the Cisco Integrated Management Controller. It is designed to help organizations to achieve their IT management and operations with a higher level of automation, simplicity, and operational efficiency. It is a new generation of global management tool for the Cisco UCS and Cisco HyperFlex systems and provides a holistic and unified approach to managing the customers' distributed and virtualized environments. Cisco Intersight simplifies the installation, monitoring, troubleshooting, upgrade, and support for your infrastructure with the following benefits:
 - Provide Cloud Based Management: The ability to manage Cisco UCS and Cisco HyperFlex from the cloud provides the customers the speed, simplicity, and easy scaling in the management of their infrastructure whether in the datacenters or remote and branch office locations.
 - Automation: Unified API in Cisco UCS and Cisco HyperFlex systems enables policy-driven configuration and management of the infrastructure and it makes Intersight itself and the devices connected to it fully programmable and DevOps friend-

ly. An even more advanced infrastructure-as-code approach with Intersight can use Terraform (<https://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/intersight/nb-06-intersight-terraf-ser-aag-cte-en.html>) .

- **Analytics and Telemetry:** Intersight monitors the health and relationships of all the physical and virtual infrastructure components. It also collects telemetry and configuration information for developing the intelligence of the platform in the way in accordance with Cisco information security requirements.
- **Connected Cisco Technical Assistance Center (TAC):** Solid integration with Cisco TAC enables more efficient and proactive technical support. Intersight provides enhanced operations automation by expediting sending files to speed troubleshooting.
- **Recommendation Engine:** Driven by analytics and machine learning, Intersight recommendation engine provides actionable intelligence for IT operations management from the daily increasing knowledge base and practical insights learned in the entire system.
- **Management as A Service:** Cisco Intersight provides management as a service and is designed to be infinitely scalable and easy to implement. It relieves users of the burden of maintaining systems management software and hardware.



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 Rancher Kubernetes Engine Government 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:

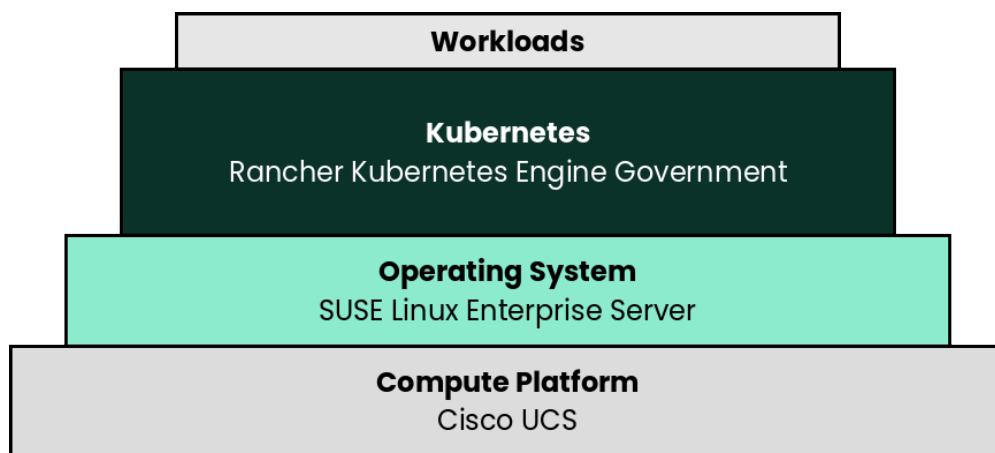


FIGURE 5.1: DEPLOYMENT STACK - RANCHER KUBERNETES ENGINE GOVERNMENT

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 Cisco UCS server. Based upon the relatively small resource requirements for a Rancher Kubernetes Engine Government deployment, a viable approach is to deploy as a virtual machine (VM) on the target nodes, on top of an existing hypervisor, like KVM.

Preparation(s)

For a physical host, that is racked, cabled and powered up, like [Cisco UCS C240 SD M5](https://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/datasheet-c78-743260.html) (<https://www.cisco.com/c/en/us/products/collateral/servers-unified-computing/ucs-c-series-rack-servers/datasheet-c78-743260.html>)  used in the deployment:

1. If using Cisco UCS Integrated Management Controller (IMC):

- Provide a DHCP Server for an IP address to the Cisco UCS Integrated Management Controller or use a monitor, keyboard, and mouse for initial IMC configuration

2. Log into the interface as admin

- On left menu click on Storage → Cisco 12G Modular Raid Controller
 - Create virtual drive from unused physical drives, for example pick two drives for the operating system and click on >> button. Under virtual drive properties enter boot as the name and click on Create Virtual Drive, then OK.
- On the left menu click on Networking → Adapter Card ML0M
 - Click on the vNICs tab, and the factory default configuration comes with two vNICs defined with one vNIC assigned to port 0 and one vNIC assigned to port 1. Both vNICs are configured to allow any kind of traffic, with or without a VLAN tag. VLAN IDs must be managed on the operating system level.



Tip



A great feature of the Cisco VIC card is the possibility to define multiple virtual network adapters presented to the operating system, which are configured best for specific use. Like, admin traffic should be configured with MTU 1500 to be compatible with all communication partners, whereas the network for storage intensive

traffic should be configured with MTU 9000 for best throughput. For high-availability, the two network devices per traffic type will be combined in a bond on the operating system layer.

3. These new settings become active with the next power cycle of the server. At the top right side of the window click on Host Power → Power Off, in the pop-up windows click on OK.
4. On the top menu item list, select Launch vKVM
 - Select the Virtual Media tab and activate Virtual Devices found in Virtual Media tab
 - Click the Virtual Media tab to select Map CD/DVD
 - In the Virtual Media - CD/DVD window, browse to respective operating system media, open and use the image for a system boot.

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 Cisco IMC virtual media and virtual console methodology.
2. Then for the solution VM, use the hypervisor user interface to allocate the necessary CPU, memory, disk and networking as noted in the SUSE Rancher [hardware requirements \(https://documentation.suse.com/cloudnative/rancher-manager/latest/en/installation-and-upgrade/requirements/requirements.html\)](https://documentation.suse.com/cloudnative/rancher-manager/latest/en/installation-and-upgrade/requirements/requirements.html) .

Deployment Consideration(s)


To further optimize deployment factors, leverage the following practices:

- *Automation*

- To monitor and operate a Cisco UCS server from Intersight, the first step is to claim the device. The following procedure provides the steps to claim the Cisco UCS C240 server manually in Intersight.
 - Logon to Intersight web interface and navigate to Admin > Targets
 - On the top right corner of the window click on Claim a New Target
 - In the next window, select Compute / Fabric → Cisco UCS Server (Standalone), click on Start
 - In another tab of the web browser, logon to the CIntegreated Management Controller portal of the Cisco UCS C240 SD M5 and navigate to Admin → Device Connector
 - Back in Intersight, enter the Device ID and Claim Code from the server and click on Claim. The server is now listed in Intersight under Targets and under Servers
 - Enable TunnelD vKVM and click on Save. TunnelD vKVM allows Intersight to open the vKVM window in case the client has no direct network access to the server on the local lan or via VPN.
 - Navigate to Operate → Servers → name of the new server to see the details and Actions available for this system.
 - The available actions are based on the Intersight license level available for this server and the privileges of the used user account.



Note

Please have a look at [Intersight Licensing \(https://intersight.com/help/saas/getting_started/licensing_requirements/lic_intro\)](https://intersight.com/help/saas/getting_started/licensing_requirements/lic_intro)  to get an overview of the functions available with the different license tiers.

- Now you can remotely manage the server and leverage existing or setup specific deployment profiles for the use case, plus perform the operating system installation.



Tip

An even more advanced infrastructure-as-code approach with Intersight can use Terraform (<https://www.cisco.com/c/en/us/products/collateral/cloud-systems-management/intersight/nb-06-intersight-terraform-ser-aag-cte-en.html>) .


- *Availability*

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




5.3 SUSE Linux Enterprise Server

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

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 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 Server \(https://www.suse.com/download/sles/\)](https://www.suse.com/download/sles/)  product (either for the ISO or Virtual Machine image)

- Identify the appropriate, supported version of SUSE Linux Enterprise Server 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 \(https://documentation.suse.com/sles/15-SP3/single-html/SLES-installation/#article-installation\)](https://documentation.suse.com/sles/15-SP3/single-html/SLES-installation/#article-installation) 




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 Server can be automated
 - for ISO-based installations, by referring to the [AutoYaST Guide \(https://documentation.suse.com/sles/15-SP3/single-html/SLES-autoyast/#book-autoyast\)](https://documentation.suse.com/sles/15-SP3/single-html/SLES-autoyast/#book-autoyast) 


5.4 Rancher Kubernetes Engine Government

Preparation(s)

1. Identify the appropriate, desired version of the Rancher Kubernetes Engine Government (for example vX.YY.ZZ + rke2rV) by reviewing

- the "Supported Rancher Kubernetes Engine Government 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 "Rancher Kubernetes Engine Government Downstream Clusters" section, or
 - the "Releases" on the [Download \(https://github.com/rancher/rke2/\)](https://github.com/rancher/rke2/)  Web page.
- For Rancher Kubernetes Engine Government versions 1.21 and higher, if the host kernel supports AppArmor, the AppArmor tools (usually available via the "apparmor-parser" package) must also be present prior to installing Rancher Kubernetes Engine Government.
 - On the SUSE Linux Enterprise Server node, install this required package

```
zypper install apparmor-parser
```

- For the underlying operating system firewall service, either
 - enable and configure the necessary inbound [ports \(https://rancher.com/docs/rke/latest/en/os/#ports\)](https://rancher.com/docs/rke/latest/en/os/#ports)  or
 - stop and completely disable the firewall service.

Deployment Process

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

- Set the following variable with the noted version of Rancher Kubernetes Engine Government, as found during the preparation steps.

```
RKE2_VERSION=""
```

- Install the appropriate version of Rancher Kubernetes Engine Government:
 - Download the installer script:

```
curl -sfL https://get.rke2.io | \
```

```
INSTALL_RKE2_VERSION=${RKE2_VERSION} sh -
```

- Set the following variable with the URL that will be used to access the SUSE Rancher server. This may be based on one or more DNS entries, a reverse-proxy server, or a load balancer:

```
RKE2_subjectAltName=
```

- Create the RKE2 config.yaml file:

```
mkdir -p /etc/rancher/rke2/  
cat <<EOF> /etc/rancher/rke2/config.yaml  
write-kubeconfig-mode: "0644"  
tls-san:  
  - "${RKE2_subjectAltName}"  
EOF
```

3. Start and enable the RKE2 service, which will begin installing the required Kubernetes components:

```
systemctl enable --now rke2-server.service
```

- Include the Rancher Kubernetes Engine Government binary directories in this user's path:

```
echo "PATH=${PATH}:/opt/rke2/bin:/var/lib/rancher/rke2/bin/" >> ~/.bashrc  
source ~/.bashrc
```

- Monitor the progress of the installation:

```
export KUBECONFIG=/etc/rancher/rke2/rke2.yaml  
watch -c "kubectl get deployments -A"
```



Note

For the first two to three minutes of the installation, the initial output will include the error phrase "The connection to the server 127.0.0.1:6443 was refused - did you specify the right host or port?". As Kubernetes services get started this will be replaced with "No resources found". About

four minutes after beginning the installation, the output will begin showing the deployments being created, and after six to seven minutes the installation should be complete.

- The Rancher Kubernetes Engine Government deployment is complete when elements of all the deployments (coredns, ingress, and metrics-server) 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 Rancher Kubernetes Engine Government 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 Rancher Kubernetes Engine Government 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
2. Log in to the first server node and create a new config.yaml file for the remaining two server nodes:

- Set the following variables, as appropriate for this cluster

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

# Private IP preferred, if available
SECOND_SERVER_IP=""

# Private IP preferred, if available
THIRD_SERVER_IP=""

# From the /var/lib/rancher/rke2/server/node-token file on the
first server
NODE_TOKEN=""
```

```
# Match the first of the first server (Hint: `kubectl get nodes`)
RKE2_VERSION=""
```

- Create the new config.yaml file:

```
echo "server: https://${FIRST_SERVER_IP}:9345" > config.yaml
echo "token: ${NODE_TOKEN}" >> config.yaml
cat /etc/rancher/rke2/config.yaml >> config.yaml
```



Tip

The next steps require using SCP and SSH. Setting up passwordless SSH, and/or using `ssh-agent`, from the first server node to the second and third nodes will make these steps quicker and easier.

- Copy the new config.yaml file to the remaining two server nodes:

```
scp config.yaml ${SECOND_SERVER_IP}:/
scp config.yaml ${THIRD_SERVER_IP}:/
```

- Move the config.yaml file to the correct location in the file system:

```
ssh ${SECOND_SERVER_IP} << EOF
mkdir -p /etc/rancher/rke2/
cp ~/config.yaml /etc/rancher/rke2/config.yaml
cat /etc/rancher/rke2/config.yaml
EOF

ssh ${THIRD_SERVER_IP} << EOF
mkdir -p /etc/rancher/rke2/
cp ~/config.yaml /etc/rancher/rke2/config.yaml
cat /etc/rancher/rke2/config.yaml
EOF
```

- Execute the following sets of commands on each of the remaining control-plane nodes:

- Install Rancher Kubernetes Engine Government

```
ssh ${SECOND_SERVER_IP} << EOF
curl -sfL https://get.rke2.io | \
  INSTALL_RKE2_VERSION=${RKE2_VERSION} sh -
```

```
systemctl enable --now rke2-server.service
EOF

ssh ${THIRD_SERVER_IP} << EOF
curl -sfL https://get.rke2.io | \
  INSTALL_RKE2_VERSION=${RKE2_VERSION} sh -
systemctl enable --now rke2-server.service
EOF
```

- Monitor the progress of the new server nodes joining the Rancher Kubernetes Engine Government cluster: `watch -c "kubectl get nodes"`
 - It takes up to eight minutes for each node to join the cluster
 - A node has deployed correctly when its status is "Ready" and it holds the roles of "control-plane,etcd,master"
 - 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.

3. (Optional) In cases where agent nodes are desired, execute the following sets of commands, using the same, "*RKE2_VERSION*", "*FIRST_SERVER_IP*" and "*NODE_TOKEN*" variable settings as above, on each of the agent nodes to add it to the Rancher Kubernetes Engine Government cluster:

```
curl -sfL https://get.rke2.io | \
  INSTALL_RKE2_VERSION=${RKE2_VERSION} \
  RKE2_URL=https://${FIRST_SERVER_IP}:6443 \
  RKE2_TOKEN=${NODE_TOKEN} \
  RKE2_KUBECONFIG_MODE="644" \
```

```
sh -
```

After this successful deployment of the Rancher Kubernetes Engine Government solution, review the [product documentation \(https://documentation.suse.com/cloudnative/rke2/\)](https://documentation.suse.com/cloudnative/rke2/) 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 [Cisco UCS \(https://www.cisco.com/c/en/us/products/servers-unified-computing/\)](https://www.cisco.com/c/en/us/products/servers-unified-computing/) Rack Servers 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 Rancher Kubernetes Engine Government enables you to simplify, maintain and scale Kubernetes cluster deployments in a supportable fashion, with a primary focus on security aspects as well.

Modernize

Bring applications and data into modern computing

- With Rancher Kubernetes Engine Government, the digital transformation to containerized applications can benefit from the provided, production-quality application infrastructures for each of the respective user bases and to facilitate the actual workload deployments and resilient usage.



Accelerate

Accelerate business transformation through the power of open source software

- Given the open source nature of Rancher Kubernetes Engine Government and the underlying software components, you can simplify deployment with automation, maintain secure production instance and make significant IT savings as you scale orchestrated microservice deployments anywhere you need to and for whatever use cases are needed, in an agile and innovative way.

7 References



WHITE PAPERS

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













BOOKS









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

TRAINING

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

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- **SUSE** - <https://www.suse.com> 
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 - **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/>) 
 - **K3s** - <https://www.suse.com/products/k3s/>  (documentation (<https://documentation.suse.com/cloudnative/k3s/>) 
 - **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/>) )
- Cisco - <https://www.cisco.com/> 
- C-Series Rack Servers - <https://www.cisco.com/c/en/us/products/servers-unified-computing/ucs-c-series-rack-servers/index.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
Compute Platform	1-3	UCSC-C240-M5SD	Cisco UCS C240 SD M5	• items below listed per node
	2	UCS-CPU-I6248	• Intel Xeon-Gold 6248 (2.5GHz/20-core/150W) Processor	
	8	UCS-MR-X32G2RT-H	• S32 GB DDR4-2933-MHz RDIMM/2Rx4	
	1	UCSC-RAID-M5	• Cisco 12G Modular RAID controller with 1GB cache	
	4	UCS-HD12TB10K12N	• 1.2 TB 12G SAS 10K RPM SFF HDD	

9.2 Software bill of materials

Sample set of software, support and services.

Role	Qty	SKU	Component	Notes
Operating System	1-3	874-006875	SUSE Linux Enterprise Server, <ul style="list-style-type: none"> • x86_64, • Priority Subscription, • 1 Year 	Configuration: <ul style="list-style-type: none"> • per node (up to 2 sockets, stackable) or 2 VMs
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-Cisco-C240-SD=1
IHV-Cisco=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=2022-04-12 env-daps=1 focusRKE2=1
iIHV=1 iK3s=1 iRKE1=1 iRKE2=1 iRMT=1 iRancher=1 iSLEMicro=1 iSLES=1 iSUMa=1 layerSLES=1
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