

# SUSE CaaS Platform 3 with HPE ProLiant

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# Table of Contents

- 1. Executive Summary .....3
- 2. Target Audience.....3
- 3. Solution Overview .....3
- 4. Solution Components.....4
- 5. Solution Details .....7
- 6. Conclusion ..... 10
- 7. Resources and additional links..... 10

## 1. Executive Summary

This reference configuration is designed to help organizations plan and install an on premises container-as-a-service (CaaS) platform infrastructure to deploy, orchestrate and manage containerized workloads. It provides an implementation overview for a production-ready deployment, with design considerations, implementation suggestions and best practices.

For most enterprise-level businesses, the demand for an on-premise, infrastructure to deploy and orchestrate containers is increasing rapidly, allowing the hosting of both production and other phases of workloads development. As with any software-defined infrastructure, all the classic IT disciplines around networking, computing and storage are involved and need to be effectively planned and integrated.

Implementing an intelligent, software-defined infrastructure consisting of CompanyName} CaaS Platform technology and HPE® ProLiant system hardware enables you to transform your enterprise. The inherent composability of this solution delivers CaaS to help reduce costs, while still providing the flexibility to keep up with your future demands. Leveraging this tested approach, you will have the confidence to deploy a working solution in an agile manner and be able to maintain and scale it as needed over time.

## 2. Target Audience

This document is intended for IT decision makers, architects, system administrators and technicians who are implementing a flexible, software-defined CaaS platform. You should 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.

## 3. Solution Overview

Even on the journey to a full [Cloud Native Landscape](#), the classic IT pillars are still in play. General requirements include the need for a small, purpose-built operating system with a container runtime engine and a container orchestration platform to distribute workloads across a target, clustered instance. The dominant technology for container orchestration is Kubernetes. With its large community of developers and a plethora of features and capabilities, Kubernetes has become the defacto standard and is included across most CaaS platforms. With all of these attributes in place, both developer and operation teams can effectively deploy, manage and deliver functionality to their end users in a resilient and agile manner.

*Note: As a further reference, the [National Institute of Standards and Technology's \(NIST\) Definition of Microservices, Application Containers and System Virtual Machines](#) describes the important characteristics of application containers.*

While the footprint of each of the containerized microservices is typically much smaller than a similar bare-metal or virtual machine workload, all of the IT pillars must still accommodate the sheer scale of such high-volume workloads. Core networking technologies, including high-speed, scalable network switches and network interfaces must provide the foundational bandwidth for compute resource nodes, the workload and for non-direct attached storage resources. Physical resource nodes or even virtual machines running atop a hypervisor can deliver the CaaS functionality. A modular, rack-based infrastructure, like HPE ProLiant provides an ideal target platform enabling you to start small and scale-out over time with inherent consistency. This platform provides compute, network and storage resources, based upon industry-leading x86-based servers with balanced performance and efficiency. Finally, it is the CaaS software — the SUSE CaaS Platform — that provides the user interface for setup, configuration, maintenance, and long term operation of

the core software-defined infrastructure requirements, bonding them into a cohesive service offering. Each of these components is detailed in the following sections.

## 4. Solution Components

### 4.1 Facility

While beyond the scope of this document, the heating, ventilation, air conditioning (HVAC) requirements of hosting such an infrastructure solution should be carefully considered and planned. To aid in determining the power requirements for system deployment, use the online or downloadable version of [HPE Power Advisor](#). Using this tool, you can plan for the needs for your solution and order the correct Power Distribution Unit (PDU) to account for the local power conditions and connections in the final installation location.

### 4.2 Network

Networking and the associated services are the technology components that typically require the most advanced planning. Connectivity, capacity and bandwidth requirements for a CaaS infrastructure have a fair amount of complexity, especially when integrated with an existing IT infrastructure and accounting for the magnitude of microservices being deployed.

With the range of available network interface card options for HPE ProLiant, the baseline network bandwidth can be easily provided for each resource node and collectively within the CaaS deployment. For improve resiliency and performance, it is also possible to bond multiple network interfaces together. While beyond the scope of this document, the only remaining consideration is for capacity and bandwidth for the interconnecting top-of-rack switches.

### 4.3 Computing

**HPE ProLiant Servers.** This family of servers are the most flexible, reliable, and performance-optimized ProLiant rack servers—ever. HPE continues to provide industry-leading compute innovations. The new HPE ProLiant rack portfolio, with flexible choices and versatile design, along with improved energy efficiencies, ultimately lowers your TCO. Integrated with a simplified, but comprehensive management suite and industry-leading support, the ProLiant rack portfolio delivers a more reliable, fast, and secure infrastructure solution, helps increase IT staff productivity, and accelerates service delivery. In addition, the rack portfolio is performance-optimized for multi-application workloads to significantly increase the speed of IT operations and enable IT to respond to business needs of any size, faster.

**HPE ProLiant DL360 Compute.** In a form factor that provides performance-drive density, it delivers security, agility and flexibility without compromise. It supports the Intel® Xeon® Scalable processor with up to a 60% performance gain and 27% increase in cores, along with 2933 MT/s HPE DDR4 SmartMemory supporting up to 3.0 TB with an increase in performance of up to 82%. With the added performance that persistent memory, HPE NVDIMMs and 10 NVMe bring, the HPE ProLiant DL360 means business. Deploy, update, monitor and maintain with ease by automating essential server life cycle management tasks with HPE OneView and HPE Integrated Lights Out 5 (iLO 5). Deploy this 2P secure platform for diverse workloads in space constrained environments.

*Tip: Any [SUSE YES](#) certified HPE platform can be used for the physical nodes of this deployment, as long as the certification refers to the major version of the underlying SUSE operating system required by the SUSE CaaS Platform release. For this the implementation, HPE ProLiant DL360 servers were utilized for all node roles. Example configurations are included in the "Resources and Additional Links" section.*

#### 4.4 Storage

Each of the resource nodes is expected to have local, direct-attach storage, which is predominantly used for the node's operating system. For this deployment, a pair of disk drives, configured as a RAID1 volume, is used.

This storage configuration is also used for the ephemeral container images running on any given node. These are simply copies of the reference container image version, obtained from a centralized location like a registry, which is utilized during the workload's runtime. After the workload is terminated or moved, this disk space is reclaimed and becomes available for subsequent usages.

*Note: This local storage element can become both a limiter for both the number and size of container workloads running on a given node plus; it can also become a performance limiter. As such, having performant local storage devices (such as solid-state drives) is encouraged. Monitoring of workloads and scale can also help to determine if capacity or performance constraints are becoming an issue.*

For any stateful microservice deployments, additional storage technologies should be integrated to house persistent volumes. Both static and dynamic volume claims can be utilized via the modular Container-Storage-Interface (CSI) technologies. A commonly utilized approach for these non-cloud-native workloads requiring persistent storage is a Ceph-based, software-defined storage infrastructure. This solution can provide block and file, or other protocol integration options with a Kubernetes-based CaaS platform.

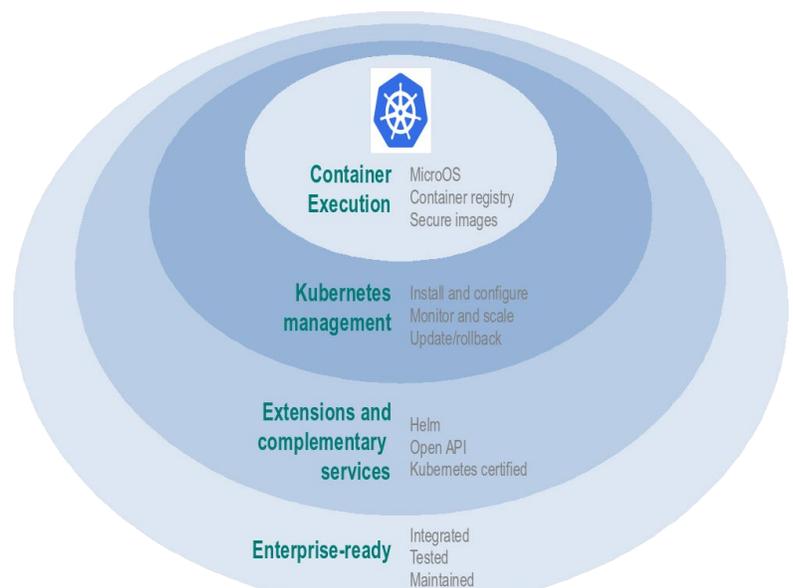
*Note: Such integrations, with solutions like SUSE Enterprise Storage, are detailed in other reference documents such as [SUSE CaaS Platform Integration with SUSE Enterprise Storage on HPE® Platforms](#).*

#### 4.5 Software

SUSE CaaS Platform is an enterprise-class container management solution that enables IT and DevOps professionals to more easily deploy, manage, and scale container-based applications and services. It includes Kubernetes to automate lifecycle management of modern applications and surrounding technologies that enrich Kubernetes and make the platform itself easy to operate. As a result, enterprises that use SUSE CaaS Platform can reduce application delivery cycle times and improve business agility.

SUSE is focused on delivering an exceptional operator experience with SUSE CaaS Platform. With deep competencies in infrastructure, systems, process integration, platform security, lifecycle management and enterprise-grade support, SUSE aims to ensure that IT operations teams can deliver the power of Kubernetes to their users quickly, securely and efficiently.

With SUSE CaaS Platform you can: \* Achieve faster time to value with an enterprise-ready container management platform, built from industry-leading technologies, and delivered as a complete package — with everything you need to quickly offer container services. \* Simplify



SUSE CaaS Platform Features

management and control of your container platform with efficient installation, easy scaling, and update automation. \*  
Maximize return on your investment, with a flexible container services solution for today and tomorrow.

**Host Operating System.** Typically a small footprint operating system installation, having just enough functionality to support the container runtime engine, leaving as many CPU, memory and I/O resources available for the containerized workloads as possible.

- SUSE currently delivers this as MicroOS, a read-mostly, operating system based upon SUSE Linux Enterprise Server built for microservices. This is complemented by a distributed key-value store provided by etcd to retain persistent configuration data. In addition, MicroOS provides a snapshot-driven, transactional-update methodology to perform atomic upgrades.

**Container Runtime Engine(s).** Comprised of both a format for and service to run containerized applications on top of the host operating system.

- SUSE provides support for Docker® Community Edition Engine, a format for application containers.
- SUSE also offers a technical preview of CRI-O, an implementation of Container Runtime Interface (CRI), designed specifically for Kubernetes as a lightweight alternative, using Open Container Initiative (OCI) images.

**Container Networking.** An intra-cluster service and overlay network used for container and orchestration communication.

- SUSE currently utilizes the Container Network Interface (CNI) with the Flannel plugin and a configuration management web-interface to set up and deploy these networks.

**Container Orchestration.** A service to manage deployments of containerized workload, known as Kubernetes or K8s, which is the current, defacto standard open source implementation for large scale container orchestration.

- SUSE currently delivers and supports a Cloud-Native Computing Foundation (CNCF) certified Kubernetes distribution. It includes a role-based access control technology to limit access to resources, functions and services as desired.

In addition to these high-level architectural components, SUSE CaaS Platform provides and relies upon the following types of nodes and roles:

*Note: Refer to the "Architectural Overview" section of [SUSE CaaS Platform Deployment Guide](#) for more details.*

**Administration Node.** Provides a cluster infrastructure management system. Each service is run as container on this host. It includes configuration management, plus a web-based dashboard to manage other node types within the cluster

**Master Node(s).** Oversees Kubernetes container workload orchestration services across the cluster and manages the Kubernetes Worker Nodes

**Worker Node(s).** Is where the user-defined containerized workloads and services run in Kubernetes pods. A pod is the smallest and simplest unit that you create and deploy as a running process for Kubernetes, encapsulating one or more container images and resources.

**Client System.** One or more existing system, with your choice of operating system, used to access the cluster and various services provided from a command line, via kubectl and helm, and a web browser.

The following networking requirements must be in place for a successful deployment:

*Note: Refer to the "Networking Requirements" section of [SUSE CaaS Platform Deployment Guide](#) for more details and port specifics.*

## Cluster network

- Choose a subnet range that will span the total number of cluster nodes. This range can also be segmented or secured for access to specific node roles as desired.
- All of the cluster node types must be able to communicate on the same network, with this primary network interface card. A client system with similar network access is also required for command-line and web browser interaction with the cluster, especially during setup.
- Higher speed network interface cards (minimum of 10GigE and above) and switching are preferred. This is because the number of containerized workloads can be high and the cards share this infrastructure capacity, both from an external and intra-cluster perspective.

## Internal networks

- Known as the Overlay and Service networks, these are used by Kubernetes and the underlying Flannel network plug-in to manage the internal cluster and container connections. These are implemented with bridges to the main cluster network.

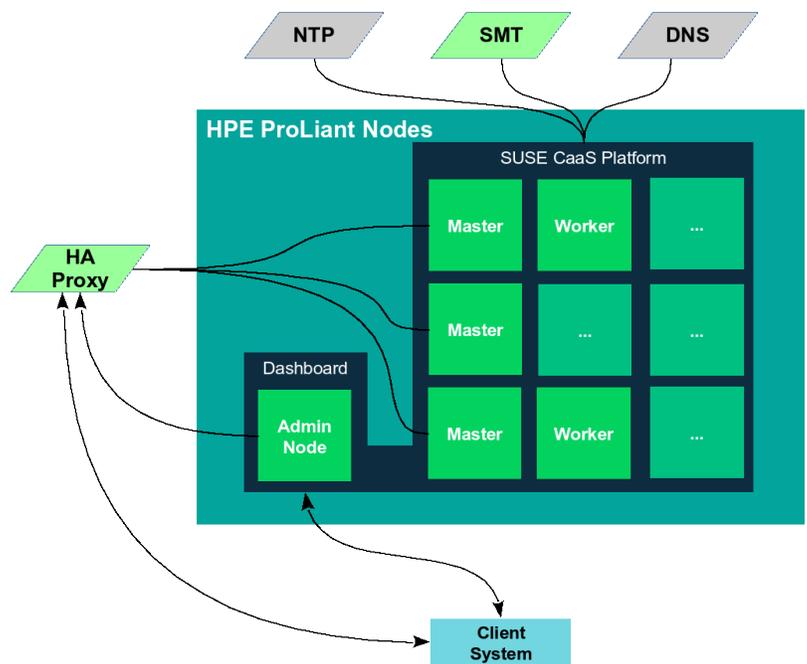
*Important: These internal network ranges should be planned prior to deployment. They are usually non-routable network ranges and cannot be changed without redeploying the entire cluster.*

## Core Network Infrastructure Components / Services

- 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 SUSE Customer Center or from local servers running a [SUSE Subscription Management Tool](#) (SMT) instance. As each node is deployed, it can be pointed to the respective update service; and the update notification and applicate will be managed by the configuration management web interface.

## 5. Solution Details

This document focuses on a new SUSE CaaS Platform deployment which could be scaled over time. A starting point could be a single hypervisor host with virtual machines set up for each of the needed roles to create a basic, minimal cluster to simply evaluate functionality. Over time more physical nodes could be added to augment the cluster or to replace some of the initial, virtual-machine-based roles. To provide a production-ready cluster and take advantage of the HPE ProLiant platform and its inherent features, each of the cluster roles are instantiated on physical nodes per the following figure:



Deployment Logical View

## 5.1 Deployment Flow

The remainder of this section is a companion guide to the official network, system and software product deployment documentation, citing specific settings as needed for this reference implementation. Default settings are assumed to be in use, unless otherwise cited, to accomplish the respective best practices and design decisions herein.

Given the detailed information contained in the [SUSE CaaS Platform Deployment Guide](#), only the following additional, incremental configurations and modifications are described below:

### **Pre-Installation Checklist**

- Obtain the following software media and documentation artifacts:
  - Download SUSE CaaS Platform x86\_64 install media (DVD1) from the [SUSE CaaS Platform site](#).
    - To ensure access to technical support and software updates, utilize either trial or purchased subscriptions for all resource nodes. The bill of materials section in the "Resources and Additional Links" section outlines the type and quantity of subscriptions needed.
    - Obtain and preview the [SUSE CaaS Platform documentation](#), focusing on the:
      - Installation Quick Start
      - Deployment Guide
  - Minimum CPU/Memory/Disk/Networking requirements of SUSE CaaS Platform being applied to any available HPE ProLiant resource nodes. See the in [SUSE CaaS Platform Deployment Guide](#) for this information.
  - Consistent and up-to-date versions for BIOS/uEFI/device firmware to reduce potential troubleshooting issues later.
  - The BIOS/uEFI settings are reset to defaults for a known baseline, consistent state or with desired values.
  - Use of either local or shared direct-attach storage elements, in a RAID1 configuration, to be used as the operating system installation target.
  - Network interfaces, including HPE iLO are configured as desired to match the target network topology and connectivity.
- Verify the following considerations for various network service configurations are ready to access:
  - Ensure that you have access to a valid, reliable external NTP service; this is a critical requirement for all nodes.
  - Set up external DNS A records for all nodes. Decide on subnet ranges and configure the switch ports accordingly to match the nodes in use.
  - Ensure that you have access to software security updates and fixes by registering nodes to the [SUSE Customer Center](#), or by creating a local [Subscription Management Tool](#) service.

**Administration Node Installation.** Install the SUSE CaaS Platform Administration Node either as a virtual machine or as the first physical resource node. If a physical node, configure the following HPE iLO virtual media image for use: SUSE CaaS Platform ISO image (bootable)

*Note: For the sake of consistency in this document, the installation process used across all nodes, whether virtual or physical, was done from ISO images. Other options are available as noted in the [SUSE CaaS Platform Deployment Guide](#).*

- Follow the "Installing the Administration Node" steps described in the [SUSE CaaS Platform Deployment Guide](#).
- When the installation is complete and the system reboots, use a client system to access the Velum Dashboard web-interface at the Fully-Qualified Domain Name (FQDN) of the Administration Node.
- Continue the setup described in the "Configuring the Administration Node" section of the [SUSE CaaS Platform Deployment Guide](#). Ensure the following items are addressed:

- On the home page, select "Create Admin" to set up an account with a valid email address and password. Then log in and do the following:
  - Check the "Install Tiler (Helm's server component)" box in "Cluster Services" as this will be used extensively later.
  - Ensure the Overlay and Service network settings match the desired values, if the default values are not satisfactory.
  - Select the desired container runtime. For this deployment, the Docker open source engine was used.
- On the "Bootstrap your CaaS Platform" page:
  - Refer to the location of the AutoYast file, in case you'd like to help automate other resource node installations.

**Master and Worker Nodes Installation.** Begin the installation of the remaining resource nodes; at least one master and two worker nodes are required for a minimal cluster. For production use, the recommendation is to deploy:

- A minimum three master nodes, keeping the total count as an odd number, so increment in pairs beyond the minimum.
- Up to 150 worker nodes.

*Note: To provide more resiliency and failover capabilities, it is recommended to install three Master Nodes plus two Worker Nodes. Additional nodes, for master or worker roles, can be added to the cluster or swapped into the cluster at any point in time.*

- Complete the installation steps as described in the "Installing Master and Worker Nodes" section of the [SUSE CaaS Platform Deployment Guide](#)

**HAProxy Setup.** Either a load-balancer or HAProxy is a suggested approach to make the cluster accessible to client systems and, more specifically, to some of the Kubernetes Master Node API functions.. It does this via a virtual IP address, which then sends the call to any active masters. While not required for a single master cluster, setting this up in advance allows for expansion and substitutions later on.

- For HAProxy, this process can be run on any host or virtual machine that has access to the cluster network. The steps to deploy this service are described in the "Configuring Load Balancing with HAProxy" section of the [SUSE Linux Enterprise High Availability Extension 12 SP3 Administration Guide](#)

*Note: As noted in the [SUSE CaaS Platform Deployment Guide](#), HAProxy should be configured to provide load balancing for the Kubernetes API server (port 6443) and for DEX (OIDC Connect, port 32000). Also ensure that the "stats" configuration stanza does not conflict with any other services (default of port 80) on the target node.*

**Bootstrap the Cluster.** When all the cluster nodes are installed and rebooted, use the client system again to login and access the Velum Dashboard web-interface at the FQDN of the Administration Node to continue the cluster formation.

- There should be a corresponding list of nodes in the "Pending Nodes" section, so select "Accept All Nodes."
  - Designate the "Master" and "Worker" to the respective nodes, then "Next."
  - Enter the Kubernetes Master LB/HAProxy virtual IP FQDN setting for the "External Kubernetes API FQDN."
  - Enter the FQDN of the Administration Node in "External Dashboard FQDN". Then select "Bootstrap Cluster."

- Once this process completes, you should have a fully functional SUSE CaaS Platform cluster. You can validate this by logging into the Administration Node and running:

```
root@caasp-admin# kubectl cluster-info
```

```
root@caasp-admin# kubectl get nodes
```

```
root@caasp-admin# kubectl get pods -n kube-system
```

- You can also validate this by logging into a client system:
  - Using a web browser, login to the Velum Dashboard web-interface with the admin credentials at the FQDN of the Administration Node.
  - Download the kubeconfig file, and put a copy in the default location of `~/kube/config`.
  - Ensure the client system has kubectl installed, then run the same set of kubectl commands from the previous section.

*Note: If using a SUSE Linux Enterprise 12 or newer release host as the client, both the kubectl and helm commands can be found in [SUSE Package Hub](#).*

*Tip: Installation of these two commands are instrumental in the use of the cluster to deploy, manage and delete containerized workloads. A web-based [dashboard](#) for Kubernetes can also be deployed on the cluster to facilitate interaction.*

To further validate the functionality of the cluster, you can find a representative set of the upstream Kubernetes conformance test suite at [Heptio / Sonobuoy](#). This can be easily run via a browser from the client system that has access to the admin kubeconfig file.

## 5.2 Additional Considerations

Review the information in the tables below to understand the administration aspects of the cluster. In addition, review the following sections of the [SUSE CaaS Platform Administration Guide](#): \* Changing or scaling the cluster node count by adding and removing resource nodes \* Updating the cluster node's operating system and core packages \* Setting up resource metrics gathering for monitoring and visualization \* Addressing security, by creating users and managing fine-grained, role-based access controls \* Creating and utilizing a local container image registry \* Accessing log locations and creating collection options

## 6. Conclusion

After understanding and working through the steps described in this document, you should have a working container-as-a-service platform that is scalable through the addition of even more resource nodes, as needed. SUSE CaaS Platform provides a complete suite of the necessary software and processes which leverages the flexibility, reliability and performance aspects of HPE ProLiant to create a production-worthy and agile platform for deployment of containerized microservice workloads.

## 7. Resources and additional links

### HPE ProLiant

- [HPE ProLiant DL360 System](#)

Bill of Materials - HPE ProLiant DL360 Systems

Role	Quantity	Product Number	Product Name	Description
Admin	1	DL360 Gen9	HPE ProLiant DL360 Gen9	HPE ProLiant DL360 Gen9 4LFF Configure-to-order Server HPE Dynamic Smart Array B140i, 4-Bay LFF Drive Cage
	1	755382-L21	Processor	Intel Xeon E5-2620v3 (2.4GHz/6-core/15MB/85W)
	4	726718-B21	Memory	8GB (1x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit
	1	665243-B21	Flexible LOM	HPE Ethernet 10Gb 2-port 560FLR-SFP+ FIO Adapter
	2	720478-B21	Power Supplies	HPE 500W Flex Slot Platinum Hot Plug Power supply Kit
	1	749974-B21	Storage Controller	HPE Smart Array P440ar/2GB FBWC 12Gb 2-ports Int FIO SAS Controller
	1	766211-B21	Storage cable	HPE DL360 Gen9 LFF P440ar/H240ar SAS Cbl
	2	652757-B21	Hard Drives	HPE 2TB 6G SAS 7.2K rpm LFF (3.5-inch) SC Midline 1yr Warranty Hard Drive
	1	663202-B21	Rail Kit	HPE 1U Large Form Factor Ball Bearing Rail Kit
	1	663203-B21	Cable Management Arm	HPE 1U Cable Management Arm for Ball Bearing Rail Kit
Master	1	755259-B21	ProLiant DL360 Gen9	HPE ProLiant DL360 Gen9 4LFF Configure-to-order Server HPE Dynamic Smart Array B140i, 4-Bay LFF Drive Cage
	1	755382-L21	Processor 1	Intel® Xeon® E5-2690v3 (2.6GHz/12-core/30MB/135W) FIO Processor Kit
	1	755382-B21	Processor 2	Intel® Xeon® E5-2690v3 (2.6GHz/12-core/30MB/135W) FIO Processor Kit

	4	726718-B21	Memory for 1st processor	8GB (1x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit
	4	726718-B21	Memory for 2nd processor	8GB (1x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit
	1	665243-B21	FlexibleLOM	HPE Ethernet 10Gb 2-port 560FLR-SFP+ FIO Adapter
	2	720478-B21	Power Supplies	HPE 800W Flex Slot Platinum Hot Plug Power Supply Kit
	2	765424-B21	Hard Drives	HPE 600GB 12G SAS 15K rpm LFF (3.5-inch) SC Enterprise 3yr Warranty Hard Drive
	1	749974-B21	Storage Controller	HPE Smart Array P440ar/2GB FBWC 12Gb 2-ports Int FIO SAS Controller
	1	766211-B21	Storage Cable	HPE DL360 Gen9 LFF P440ar/H240ar SAS Cbl
	1	663202-B21	Rail Kit	HPE 1U Large Form Factor Ball Bearing Rail Kit
	1	663203-B21	Cable Management Arm	HPE 1U Cable Management Arm for Ball Bearing Rail Kit
Worker	1	755258-B21	ProLiant DL360 Gen9	HPE ProLiant DL360 Gen9 8SFF Configure-to-order Server HPE Dynamic Smart Array B140i, 8-Bay SFF Drive Cage
	1	780003-L21	Processor 1	Intel® Xeon® E5-2699v3 (2.6GHz/18-core/45MB/145W) FIO Processor Kit
	1	780003-B21	Processor 2	Intel® Xeon® E5-2699v3 (2.6GHz/18-core/45MB/145W) FIO Processor Kit
	4	726719-B21	Memory for 1st processor	16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit

	4	726719-B21	Memory for 2nd processor	16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit
	1	665243-B21	FlexibleLOM	HPE Ethernet 10Gb 2-port 560FLR-SFP+ FIO Adapter
	2	720479-B21	Power Supply	HPE 800W Flex Slot Platinum Hot Plug Power Supply Kit
	2	759212-B21	Hard Drives	HPE 600GB 12G SAS 15K rpm SFF (2.5-inch) SC Enterprise 3yr Warranty Hard Drive
	1	749974-B21	Storage Controller	HPE Smart Array P440ar/2GB FBWC 12Gb 2-ports Int FIO SAS Controller
	1	663201-B21	Rail Kit	HPE 1U SFF Ball Bearing Rail Kit
	1	663203-B21	Cable Management Arm	HPE 1U Cable Management Arm for Ball Bearing Rail Kit

*Note: Each of the above node roles is detailed as singular configurations so that it is easier to figure out how to order the appropriate quantity for the desired cluster.*

### CaaS Platform

- [Product Documentation](#)

#### Bill of Materials - Software

Role	Quantity	Product Number	Product Name	Description
Software	1	Q9K53AAE	SUSE CaaS Platform, 1-2 Sockets 3yr 24x7	for each node of the deployment