White Paper

NetApp HCI for DevOps with NetApp Kubernetes Service

Amit Borulkar and Atul Bhalodia, NetApp
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Abstract

NetApp® Kubernetes Service (NKS) on NetApp HCI abstracts the operational overhead associated with deploying and managing the Kubernetes cluster, enabling organizations to adopt DevOps practices and build microservices-based applications and services in an agile manner.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Introduction

It's no secret that cloud technologies and DevOps adoption have skyrocketed in the past few years. Enterprises are adopting a cloud-native development and delivery paradigm to release new products and features to customers. DevOps practices, such as canary deployments and blue/green deployments, are becoming prevalent. Containers are playing a critical role in helping organizations adopt agile DevOps practices. Containers package an application and its dependencies together, which creates a single deployable unit and abstracts away the platform requirements from the application. Developers are enabled to write code and focus on solving business problems rather than ensuring compatibility between different platforms. From an operational perspective, it's crucial to make sure that the underlying infrastructure meets these demands.

Operations teams have to make sure that their base infrastructure is fully resilient and highly available and that it is agile and API-driven in nature. New compute, storage, and network resources should be provisioned and deprovisioned automatically without impacting existing workloads.

NKS abstracts away the operational concerns of running microservices workloads across both public clouds—Amazon Web Services (AWS), Azure, and Google Cloud Platform (GCP)—and in on-premises data centers. NKS enables deployment of Kubernetes clusters as a service, which allows customers to choose a region for deployment. NKS does the heavy lifting of provisioning the infrastructure resources such as virtual machines (VMs), connecting them to appropriate networks, provisioning the required storage, and deploying Kubernetes in a production-grade deployment. NKS also manages the Kubernetes cluster lifecycle, which allows the addition of worker nodes, patches, bug fixes, and Kubernetes cluster upgrade support. This process eliminates all the operational complexity for deploying and managing the Kubernetes cluster and at the same time ensures that the clusters meet the requirements of your workload.

NKS on NetApp HCI also enables your microservices to consume enterprise-grade persistent storage with storage efficiencies and data protection features. Depending on the requirements of the workload, both block-based and file-based storage can be dynamically provisioned to meet the application's demands. NKS on NetApp HCI leverages the rich data management features such as clones, NetApp Snapshot™ copies, and data protection features for persistent volumes in Kubernetes. NKS and cloud data services on NetApp HCI also enable optimized data transfer between different regions.

Kubernetes enables portability of applications across different environments. NetApp Cloud Services on NetApp HCI enables movement of data between public and private clouds, which provides a reliable hybrid cloud infrastructure platform for running your microservices workloads. This white paper explains how NetApp HCI and NKS deliver the benefits of Kubernetes and containers and enable a hybrid or multicloud infrastructure.

This white paper reflects the NKS, NetApp Cloud Volume, and NetApp Cloud Insights services that will be delivered on NetApp HCI. The products and functionality will be released in phases. This document is an overview of the value these services will provide when they are released.

Note: Preview releases of the services are for test purposes and should not be used for production workloads or normal operations.

1.1 NetApp HCI

NetApp HCI with NetApp Element® software and VMware vCenter are the foundation of a multicloud infrastructure. NetApp HCI is designed to deliver a cloudlike consumption experience with simplicity, dynamic scale, and operational efficiency. Each Element storage node added to a NetApp HCI environment provides a fixed number of IOPS and capacity, allowing predictable, plannable growth. NetApp HCI allows IT to scale storage and compute independently of each other. NetApp HCI is based on the VMware virtualization, which enables all the virtualization benefits—such as VMware Distributed Resource Scheduler (DRS) and VMware HA)—and also offers lower operational overhead. You can run and mix VMware ESXi-based VMs and containers on the same NetApp HCI infrastructure.

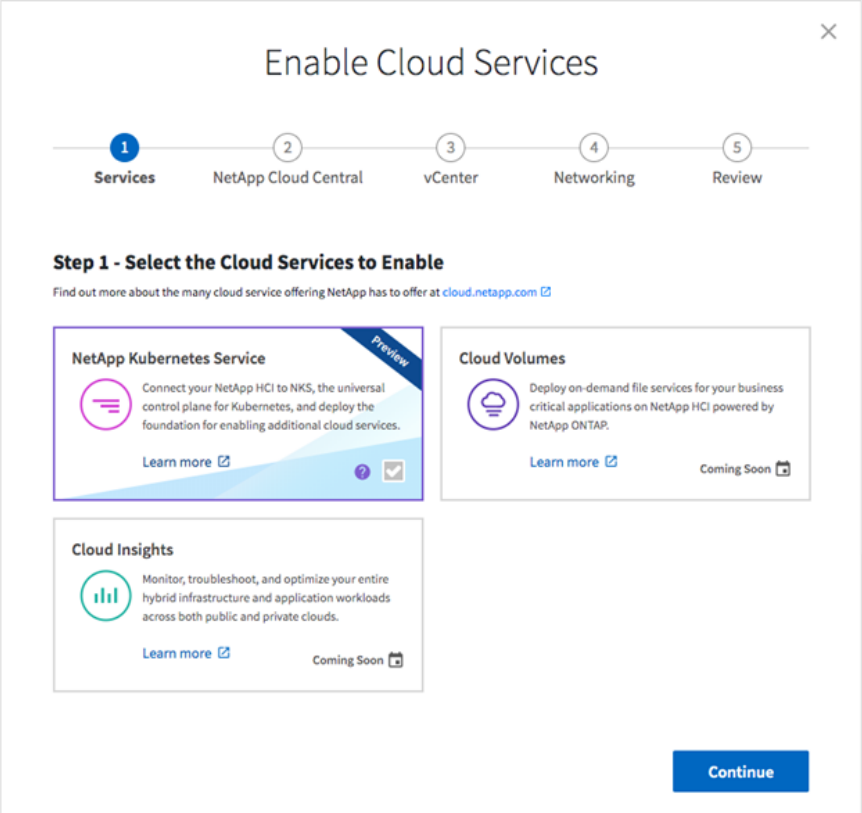
For more information about NetApp HCI, see the HCI product page.

1.2 Cloud Services on NetApp HCI

Data persistence and availability is a bigger challenge when users have the option to use multiple cloud regions in public clouds and an on-premises data center. NetApp cloud services on NetApp HCI enable a cloudlike consumption model for provisioning resources in an intuitive and reliable manner while abstracting away all the complexities associated with the platform. Cloud services for NetApp HCI consist of the following services (Figure 1):

- NetApp Kubernetes Service on NetApp HCI (see section 2)
- NetApp Cloud Volumes on NetApp HCI
- NetApp Cloud Insights on NetApp HCI

Figure 1) Cloud services for NetApp HCI.



Cloud Volumes on NetApp HCI

Cloud Volumes on NetApp HCI enables users to consume file services through the NetApp Cloud Central portal. NetApp HCI is registered as a region, so new volumes can be provisioned on demand without accessing the storage clusters. Cloud Volumes delivers control, data protection, and storage efficiencies for data management with the flexibility of cloudlike consumption. Cloud Volumes is cloud-native data management software built on NetApp ONTAP® storage software, offering a superior universal storage platform that addresses cloud data needs. Having the same storage software in the cloud and on your premises brings the value of your data fabric delivered by NetApp without having to train IT staff in new methods to manage the data.

Cloud Insights on NetApp HCI

Cloud Insights is a NetApp SaaS offering for the hybrid infrastructure monitoring, troubleshooting, and cost-optimization tool. It provides views from a high-level overview to a fine-grain performance view of infrastructure assets, including Kubernetes clusters and NetApp HCI.

To learn more and start using Cloud Insights, see the Cloud Insights product page.

Cloud Insights Capabilities

Cloud Insights provides the following capabilities:

- Monitoring resources in AWS, Azure, Google Cloud Platform, and on-premises data centers
- Ability to configure the dashboard to display more than 50 different types of information
- End-to-end analytics
- Troubleshooting capabilities
- Ability to show the data path from container all the way to storage helps to diagnose performance and availability issues
- Risk analysis of systems
- Risk analysis of systems through Cloud Insight integration with NetApp Active IQ®
- Supports multiple tenants with granular RBAC, so the tenant's view is specific to the resources they own

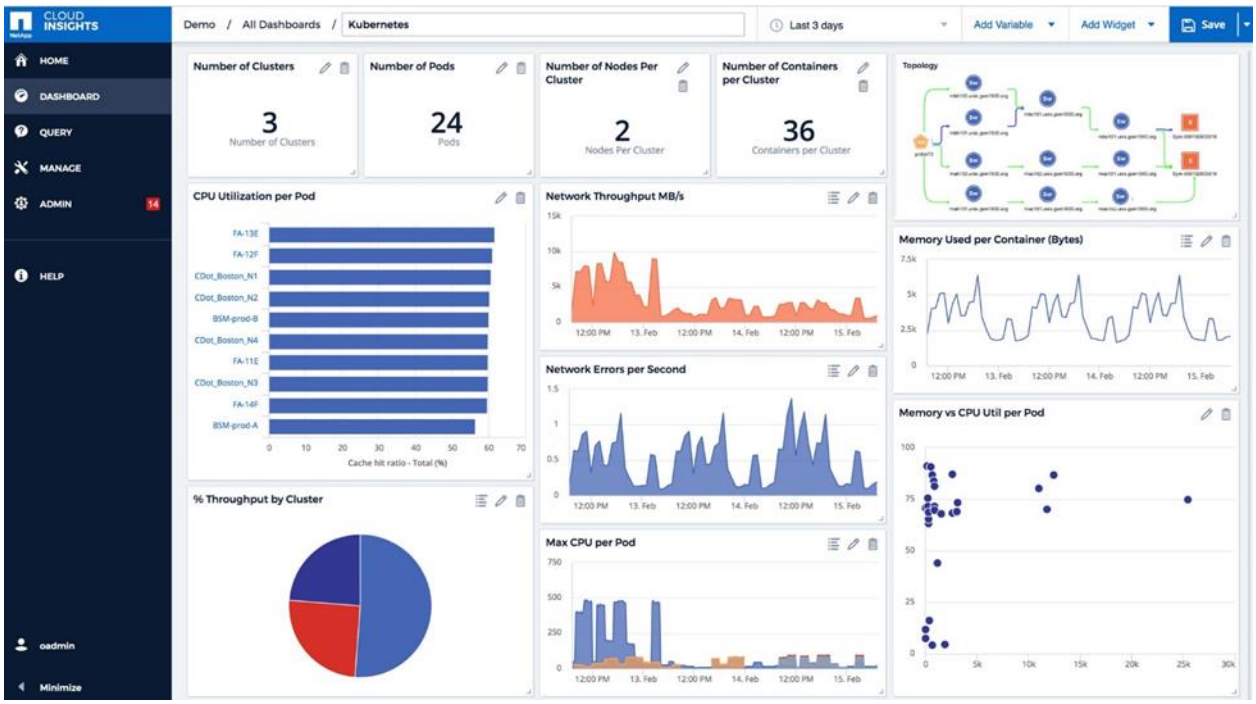
Cloud Insights Dashboard

You can configure the following information to be displayed in the Cloud Insights Kubernetes dashboard.

Note: You can configure the dashboard to display more than 50 different types of information.

- A count of clusters, pods, and containers
- Topology
- CPU utilization per pod
- Network throughput
- Memory used per container, memory versus CPU usage, and so on

Figure 2) Cloud Insights Kubernetes dashboard.



1.3 Project Trident

Trident enables microservices and containerized applications to leverage enterprise-class storage services (such as QoS, storage efficiencies, and cloning) to meet the application's persistent storage demands.

Depending on an application's requirements, Trident can dynamically provision storage from:

- NetApp ONTAP data management software (NetApp AFF, FAS, ONTAP Select, and Cloud Volumes ONTAP)
- NetApp Element software (NetApp HCI and SolidFire®)
- NetApp SANtricity® software (NetApp E-Series and EF-Series)

Trident uses the storage class object that was introduced in Kubernetes 1.4 to dynamically provision persistent volumes (PVs) when a persistent volume claim (PVC) object is created. A storage class allows administrators to describe the classes of storage that they offer. A storage class might map to different QoS levels, backup policies, or other storage characteristics.

For more information, see the Trident documentation.

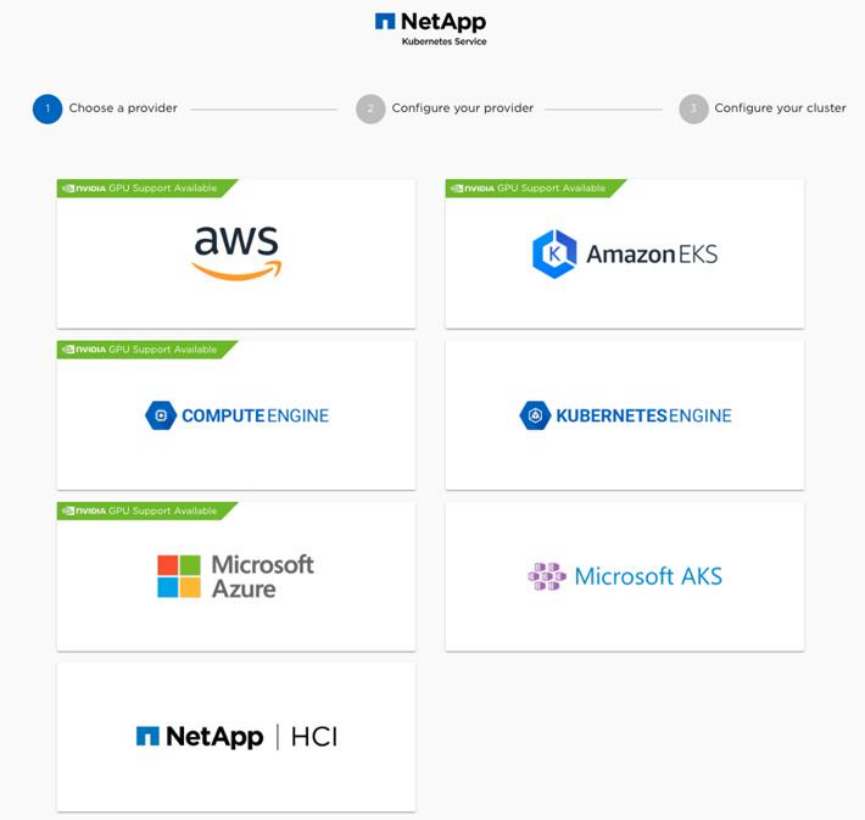
2 NetApp Kubernetes Service on NetApp HCI

NKS is a Cloud Native Computing Foundation certified Kubernetes distribution from NetApp. It enables a consistent and repeatable deployment experience for deploying Kubernetes clusters across multiple environments such as AWS, GCP, Azure, and NetApp HCI, enabling a true hybrid multicloud experience. It also enables customers to focus on developing applications and services in an agile manner to solve business needs while abstracting away the operational complexity for deploying and managing Kubernetes clusters.

NKS on NetApp HCI offers the following benefits:

- **Eliminates operational concerns.** NKS on NetApp HCI streamlines the mechanism for deploying all the associated virtual infrastructure for deploying Kubernetes. NKS creates a resource pool, associated VMs for Kubernetes masters and worker nodes, relevant networks, port groups, and datastores for provisioning a Kubernetes cluster. This mechanism abstracts away all the operational concerns related to a Kubernetes deployment. NetApp HCI cluster is registered as a region in `nks.netapp.io`. You can provision new Kubernetes clusters in an on-premises region by simply choosing the new NetApp HCI region.

Figure 3) NetApp HCI cloud region deploying Kubernetes.

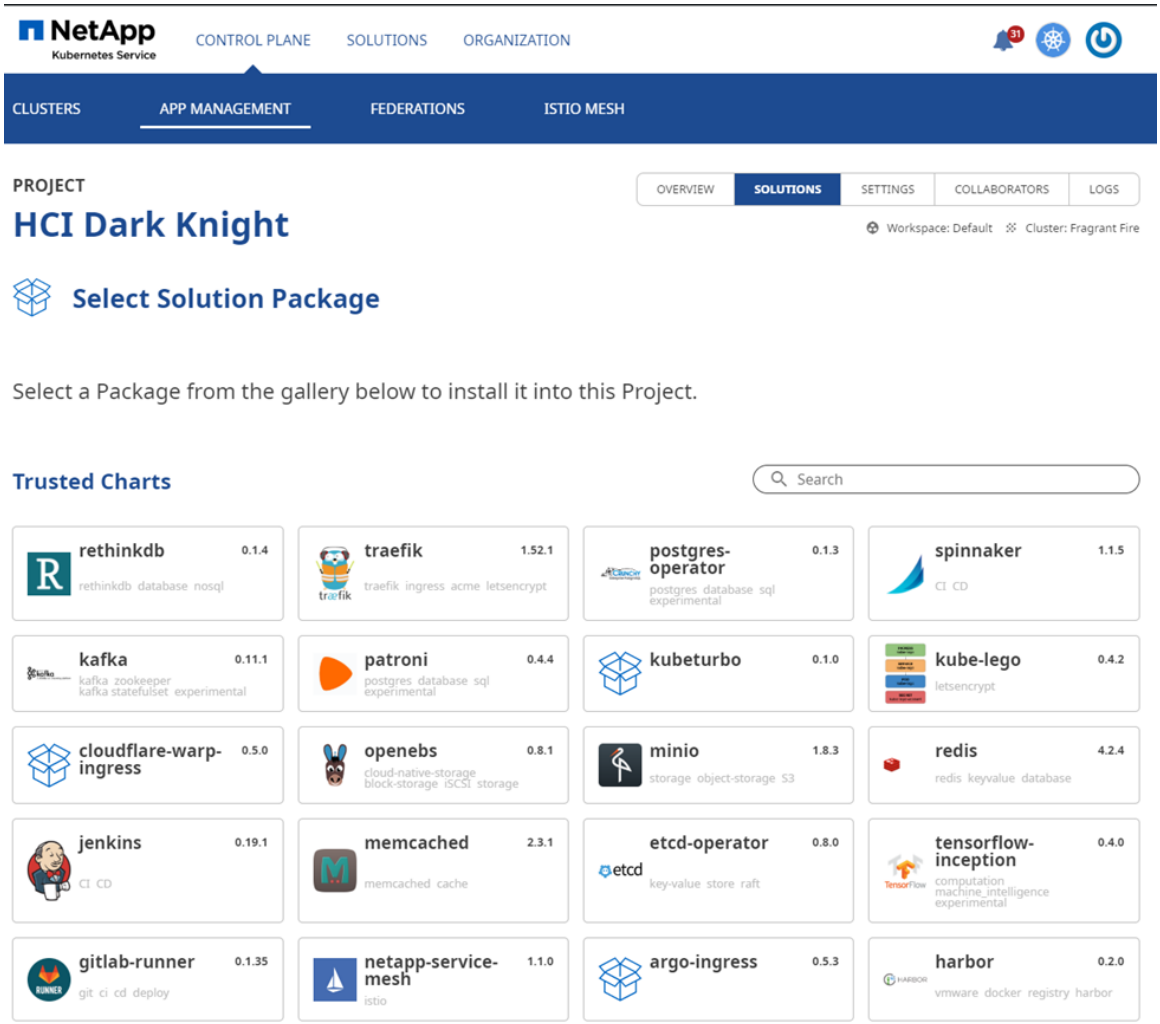


- **Supports agile workloads.** Depending on the microservices workload, you can create Kubernetes worker nodes with distinct flavors with different CPUs and memory characteristics. For example, you can provision worker nodes with more memory for in-memory database applications such as Redis. With just a few clicks, you can easily add new worker nodes to an existing cluster. NetApp Kubernetes Service also supports GPU-enabled worker nodes to support applications for medical imaging and artificial intelligence.
- **Manages cluster lifecycle.** One crucial aspect of managing the Kubernetes cluster is making sure that you meet conformance requirements (with respect to security vulnerabilities) and that the cluster is patched for the latest bug fixes. You need to make sure that these operational tasks do not impact the availability of the user applications and services. NKS alleviates this operational complexity by managing patches and upgrades to the Kubernetes cluster so that the operational teams can focus on building services on top of the cluster without worrying about the day-0/1 management of the Kubernetes cluster.
- **Manages users and group.** NKS supports the grouping of multiple members under the umbrella of an organization. Members are assigned roles and organized into teams. These organizations can be shared across multiple regions in different public clouds as well as different on-premises NetApp HCI clusters, thereby giving different teams in an organization a granular view of their respective clusters.

You can create members with distinct roles and privileges (such as a user with administrator role) with access to workspaces.

- **Enables out-of-the-box, enterprise-grade persistent storage.** NKS on NetApp HCI enables different storage classes that correspond to different quality-of-service (QoS) levels. For example, a relational database, such as an Oracle database, might have a different set of storage requirements from a NoSQL database such as MongoDB or an in-memory datastore such as Redis. Based on the requirements, applications running on Kubernetes clusters on NetApp HCI can consume different types of storage services. For example, machine learning applications that require a single namespace with billions of files can consume storage from a NetApp FlexGroup volume by using the FlexGroup driver from Trident.
- **Provides helm chart and solutions.** NKS provides a set of curated helm charts for deploying applications on a Kubernetes cluster. These charts allow a distributed application with different Kubernetes objects such as replica sets, pods, and services to be deployed as a single unit. Helm charts also enable version management of your applications, version upgrades, and rollbacks. NKS supports integrating your private and public GitHub repositories with the Kubernetes cluster to manage builds and rollouts of your applications. NKS also supports the ability to import your own or trusted helm charts of your homegrown applications to be managed through the NKS management portal, as shown in Figure 4.

Figure 4) NKS management portal.



2.1 Hardware Requirements

Table 1 lists the hardware components that are required to deploy NKS on NetApp HCI. The hardware components that are used in any particular implementation of the solution might vary based on customer requirements.

Table 1) Minimum hardware requirements.

Layer	Product Family	Number of Nodes	Details
Compute	NetApp H-Series	4	–
Network	Mellanox SN2010	2	Mellanox switches
Storage	NetApp S-Series	4	6 x 960GB Encrypting/nonencrypting

Note: Any equivalent data switch with 10x 25GbE also works.

2.2 Software Requirements

Table 2 lists the software components that are required to implement the solution. The software components that are used in any particular implementation of the solution might vary based on customer requirements.

Table 2) Software requirements.

Layer	Software	Version (or Other Information)
Storage	NetApp Element Software	11.3
	NetApp Trident	19.04
	Mnode version	2.1
Virtualization	VMWare ESXi	6.5U1 or later
Operating system	Debian	–
Container orchestration	Kubernetes	1.14.1
Network	Onyx	3.7.1134

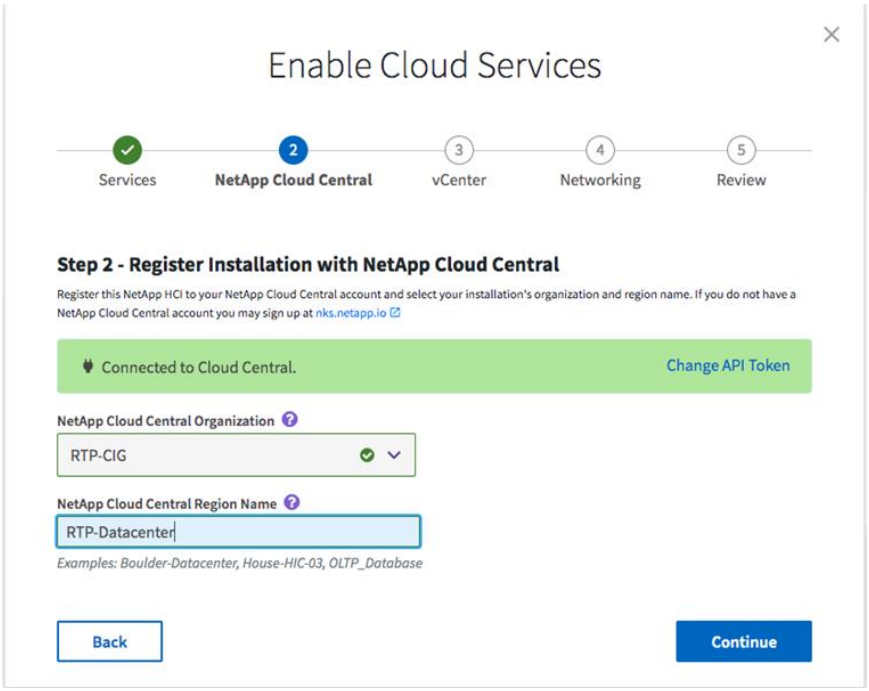
Note: NKS on NetApp HCI requires outbound internet connectivity on port 443 to access NetApp Cloud Central and pull the relevant software components to deploy NetApp Cloud Services on HCI.

3 Enable NetApp Kubernetes Service on NetApp HCI

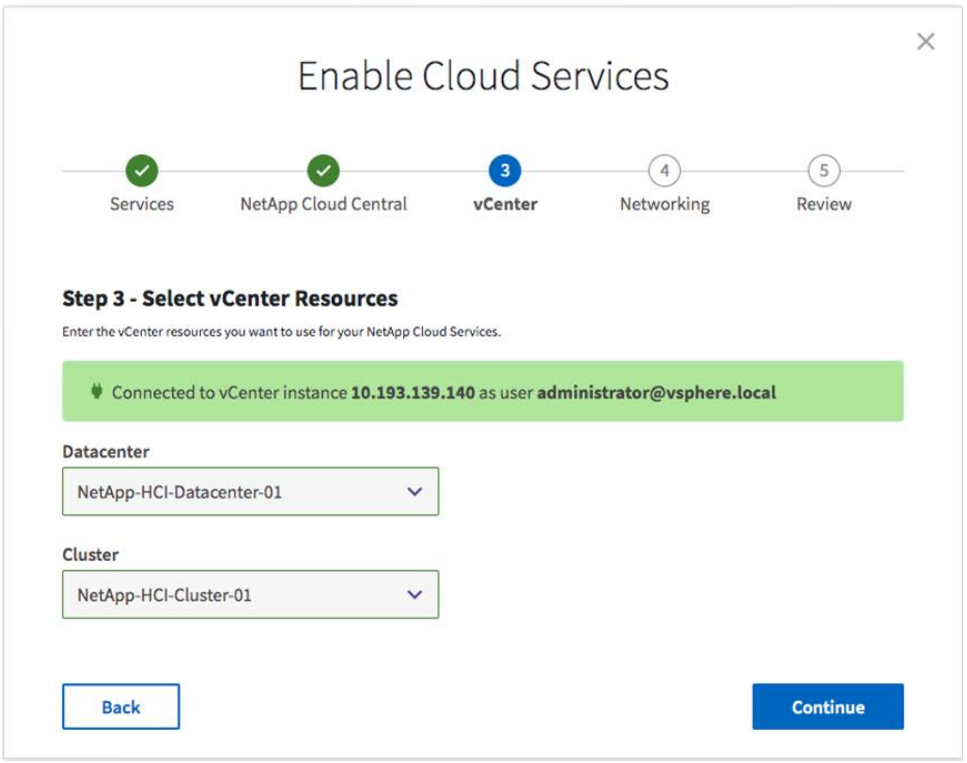
After the base infrastructure for NetApp HCI is provisioned through NetApp Deployment Engine, the NetApp hybrid cloud control plane connects the on-premises NetApp HCI as a cloud region for NKS through five intuitive steps.

Note: Make sure that the mnode service is updated and meets the version requirements for NetApp Cloud Services on NetApp HCI.

1. Select NKS from the list of NetApp Cloud Services to enable on the NetApp HCI platform.
2. Register NetApp HCI with NetApp Cloud Central through `nks.netapp.io`. Obtain a token to authorize NKS API Services on NetApp HCI.



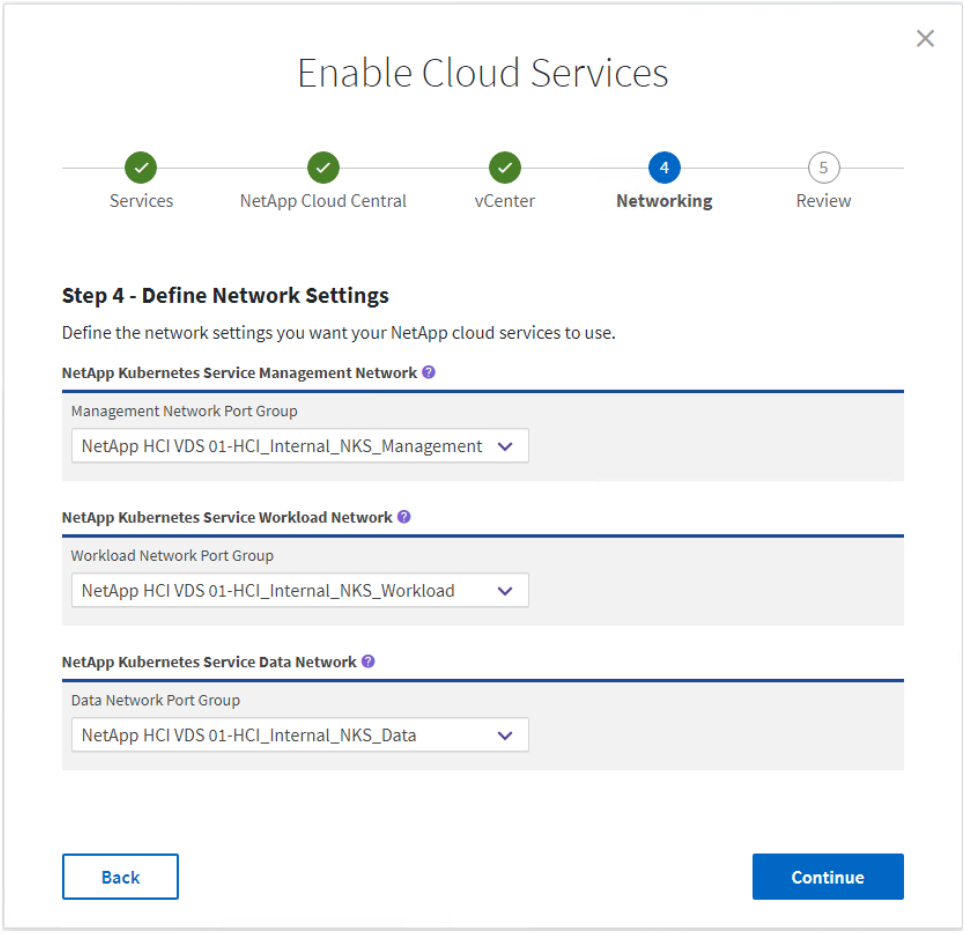
NKS on NetApp HCI deploys the virtual infrastructure associated with a production-grade Kubernetes deployment.



Note: You can provide a user with specific user roles, as described in the prerequisite document, instead of a vCenter Administrator user.

Note: Each vSphere cluster is registered as a cloud region to deploy NKS cluster.

3. Specify the required networks/port groups to use for NKS user workloads:
   a. User workload traffic
   b. Storage network
   c. NKS management network traffic

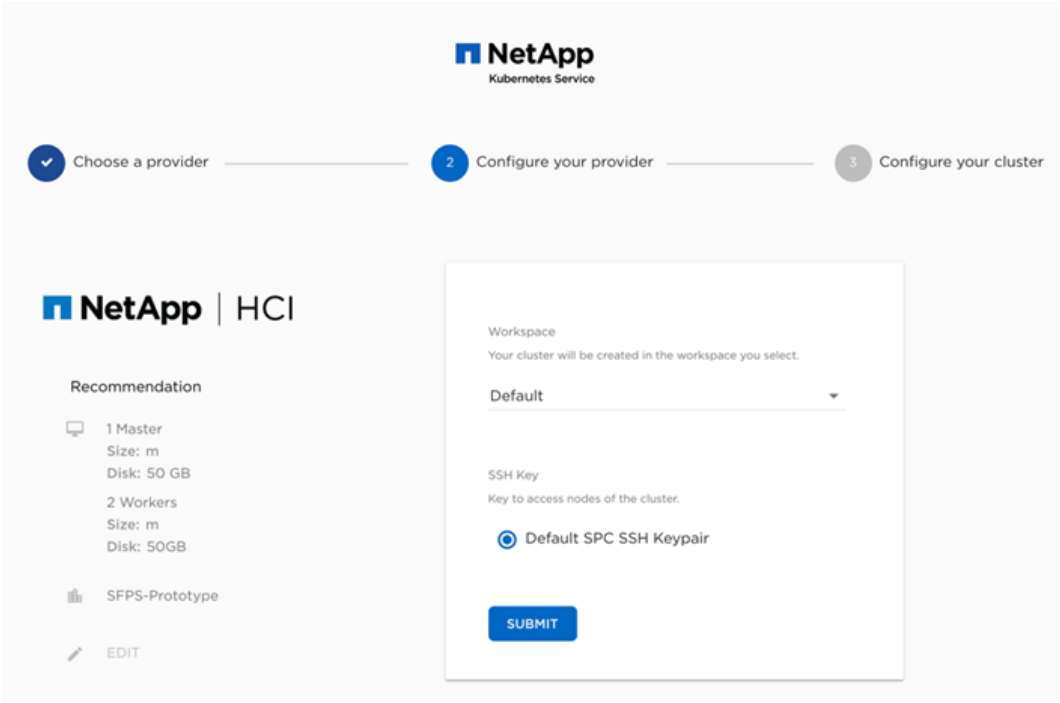


4. Review the configuration details and enable NKS on NetApp HCI.

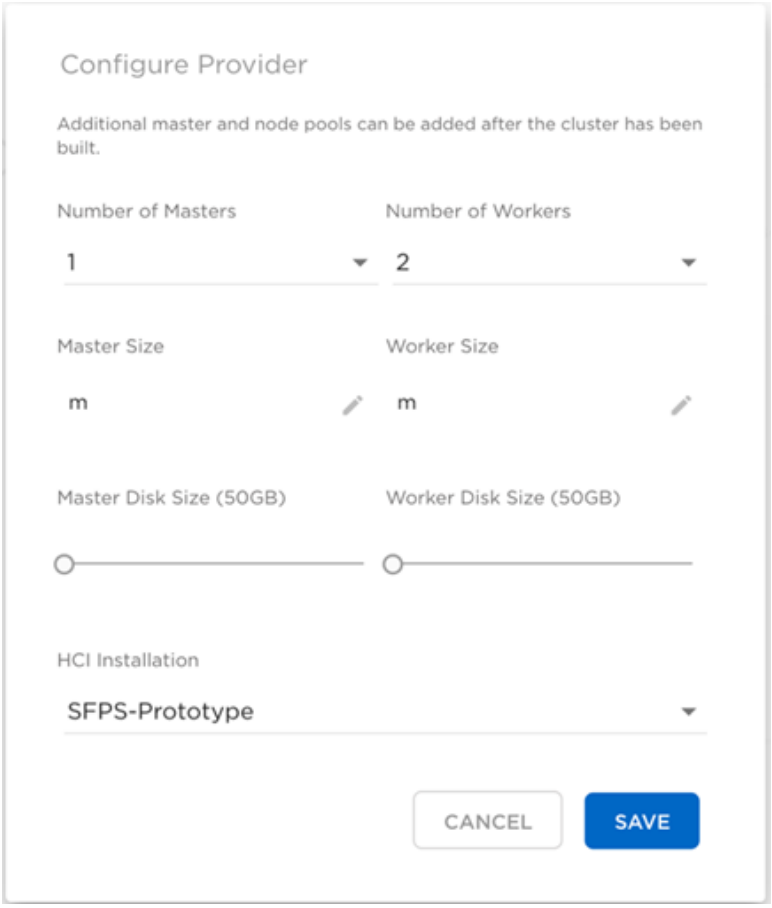
3.1 Provision Kubernetes Clusters on NetApp HCI

NKS enables the same cloudlike, automated, intuitive, and simple deployment experience for provisioning a Kubernetes cluster on NetApp HCI. Provisioning a Kubernetes cluster for user workloads is a three-step intuitive process:

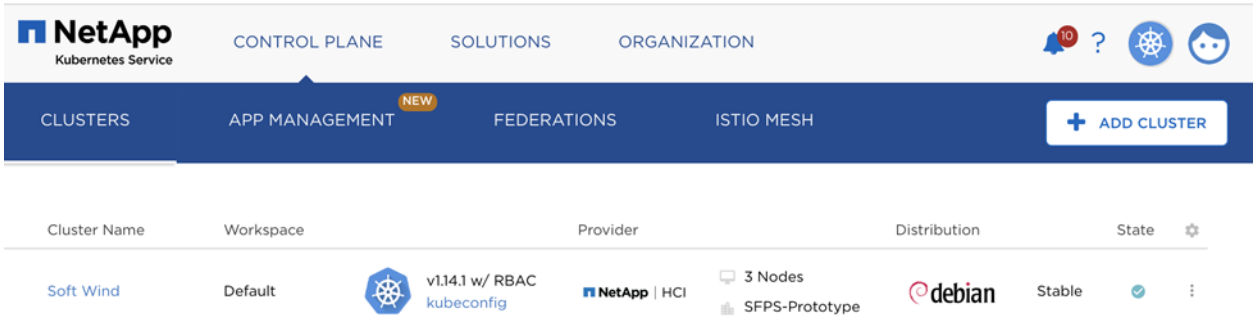
1. Log in to the NKS portal, click Create the Cluster, and select the registered NetApp HCI region.



2. Create a cluster with the required specifications. You can customize the worker node profile and the type of VM based on the workload.



3. Make any additional customizations, such as changing the cluster name, and complete the deployment.



The NKS portal provides a link to download the `kubeconfig` configuration file to connect to the cluster and deploy your workloads.

4 Sample Application

After you successfully deploy the Kubernetes cluster, run the microservices workloads. You can perform a functional validation by running the Elasticsearch, Fluentd, and Kibana (EFK) stack as a helm chart. The EFK stack aggregates logs from different components or log generators and provides a web-based UI to view and filter the collection of logs. An example of a distributed data-intensive application is when multiple services interact with each other, exchange traffic through the network, and need to store data persistently.

1. Download and export the `kubeconfig` from the newly deployed Kubernetes cluster.

```
export KUBECONFIG=/home/amit/kubeconfig
```

Note: Make sure that you have the `kubectl` binary downloaded and installed in the relevant path.

2. Verify that the nodes are in `Ready` status.

```
#kubectl get nodes
NAME                      STATUS   ROLES    AGE   VERSION
net7drlnfj-master-1       Ready    master   18d   v1.14.1
net7drlnfj-pool-1-2bjfz   Ready    <none>   18d   v1.14.1
net7drlnfj-pool-1-5frxj   Ready    <none>   18d   v1.14.1
```

3. Deploy the EFK stack application by using a curated helm start, or customize a helm chart for the EFK stack based on your requirements.
4. Install the helm chart by running the `standard helm install` command.

```
helm install --name efk-nks .
```

5. Verify that the application is deployed and that the relevant Kubernetes components have been set up.

```
helm ls
NAME    REVISION        UPDATED                         STATUS          CHART
        APP VERSION     NAMESPACE
efk-nks 1               Fri Jun  7 08:58:38 2019       DEPLOYED        elasticsearch-fluentd-kibana-
        default
```

6. Verify the pods and services associated with the EFK stack.

```
kubectl get pods
NAME                                READY   STATUS    RESTARTS   AGE
efk-nks-kibana-d57946b48-w4tgf      1/1     Running   0          3d
nginx-7db9fccd9b-v8czq              1/1     Running   1          3d16h
```

```
[root@trident-ab download]# kubectl get svc
NAME                      TYPE        CLUSTER-IP    EXTERNAL-IP   PORT(S)    AGE
efk-nks-elasticsearch     ClusterIP   10.3.0.12     <none>        9200/TCP   3d
efk-nks-kibana            ClusterIP   10.3.0.226    <none>        5601/TCP   3d
kubernetes                ClusterIP   10.3.0.1      <none>        443/TCP    18d
```

7. Verify that the associated PV was also created.

```
kubectl get pvc
NAME             STATUS   VOLUME                          CAPACITY      ACCESS MODES
STORAGECLASS       AGE
basic            Bound    default-basic-42335             1073741824    RWO            solidfire-
bronze   3d15h
elastic-search   Bound    default-elastic-search-51cd7    10737418240   RWO            solidfire-
bronze   6s
```

5 Conclusion

NKS enables organizations to adopt DevOps methodologies to operate in an agile manner by reducing the operational overhead associated with running and managing Kubernetes clusters. NKS, in conjunction with cloud services on NetApp HCI, enables a seamless hybrid or multicloud experience to move an application and its associated data in an optimized manner.

Where to Find Additional Information

To learn more about the information that is described in this document, review the following documents and/or websites:

- NetApp Kubernetes Service
  https://cloud.netapp.com/kubernetes-service
- NetApp Cloud Central
  https://cloud.netapp.com/home
- NetApp HCI product page
  https://www.netapp.com/us/products/converged-systems/hyper-converged-infrastructure.aspx
- NetApp HCI Datasheet
  https://www.netapp.com/us/media/ds-3881.pdf
- Project Trident documentation
  https://netapp-trident.readthedocs.io/en/stable-v19.04/
- NetApp Product Documentation
  https://docs.netapp.com

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Version History

Version	Date	Document Version History
Version 1.0	June 2019	Initial release.

Refer to the Interoperability Matrix Tool (IMT) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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