



White Paper

# Anthos on Bare Metal with NetApp

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## Abstract

This document outlines the configuration and validation of NetApp® ONTAP® storage platform with Google Cloud's Anthos on bare metal platform, using NetApp Trident, the open-source storage orchestrator for Kubernetes, to deploy and manage persistent storage for stateful application containers.

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# Introduction: Anthos on Bare Metal with NetApp

The relationship between NetApp and Google Cloud has been strong for several years, with NetApp first introducing cloud data services to Google Cloud with Cloud Volumes ONTAP and Cloud Volumes Service. This relationship was then expanded by validating NetApp's HCI platform for use with Google Cloud's Anthos on-prem, a hypervisor-based hybrid multi-cloud Kubernetes solution deployed on VMware vSphere, then coupled with Anthos Ready qualification of NetApp Trident, ONTAP, and the NFS protocol to provide dynamic persistent storage for containers.

With Anthos being made available to directly install on bare metal servers in a customer's environment, it adds an additional option for customers to extend the power of Google Cloud into their local data centers, without the need of a hypervisor. Additionally, by leveraging the best of breed capabilities from NetApp's ONTAP storage operating system and NetApp Trident, we can extend the capabilities of the platform to integrate persistent storage for containers.

This combination allows customers to realize the full potential of their own servers, storage, and networking combined with the support, service levels, monthly billing, and on-demand flexibility that Google Cloud provides. Because customers are using their own hardware, network, and storage; they have direct control over application scale, security, and network latency, as well as having the benefit of managed and containerized applications with Anthos on bare metal.

## Solution Overview: Anthos on Bare Metal with NetApp

### NetApp ONTAP on NetApp AFF/FAS

NetApp AFF is a robust all-flash storage platform that provides low-latency performance, integrated data protection, multiprotocol support, and nondisruptive operations. Powered by NetApp ONTAP data management software, NetApp AFF ensures nondisruptive operations, from maintenance to upgrades to complete replacement of your storage system.

NetApp ONTAP is a powerful storage software tool with capabilities such as intuitive GUI and REST APIs with automation integration, AI-informed predictive analytics, and corrective action, nondisruptive hardware upgrades, and cross-storage import.

ONTAP provides the following features:

- Unified storage system with simultaneous data access and management of NFS, CIFS, iSCSI, FC, FCoE, and FC-NVMe protocols.
- Different deployment models - on-premises on all-flash, hybrid and all-HDD hardware configurations, VM-based storage platform on a supported hypervisor as ONTAP Select, and in the cloud as Cloud Volumes ONTAP.
- Increased data storage efficiency on ONTAP systems with its support for automatic data tiering, inline data compression, deduplication, and compaction.
- Workload-based-QoS controlled storage.
- Seamless integration with public cloud for tiering and protection of data.

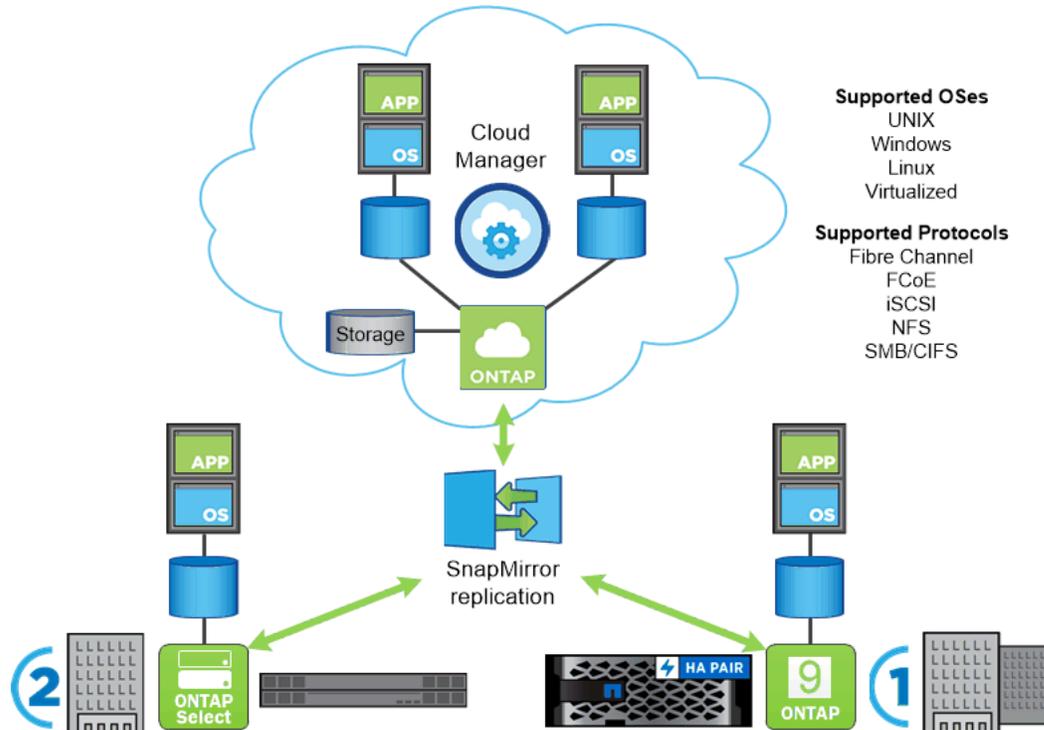
ONTAP also provides robust data protection capabilities that sets itself apart in any environment:

- **NetApp Snapshot™**. A fast point-in-time backup of the data using a minimal amount of disk space with no additional performance overhead.
- **NetApp SnapMirror®**. Mirrors the Snapshot copies of data from one storage system to another. ONTAP supports mirroring data to other physical platforms and cloud native services as well.
- **NetApp SnapLock®**. For efficiently administrating the non-rewritable data by writing it to special volumes that cannot be overwritten or erased for a designated period.

- **NetApp SnapVault®.** Backing up data from multiple storage systems to a central Snapshot copy that serves as a backup to all the designated systems.
- **NetApp SyncMirror®.** For real-time, RAID-level mirroring of data to two different plexes of disks that are connected physically to the same controller.
- **NetApp SnapRestore®.** Fast restoration of backed-up data on-demand from Snapshot copies.
- **NetApp FlexClone®.** Instantaneous provisioning of a fully readable and writeable copy of a NetApp volume based on a Snapshot copy.

For more information about ONTAP, see the [ONTAP 9 Documentation Center](#).

Figure 1) NetApp ONTAP is available on-premises, virtualized, or in the cloud.

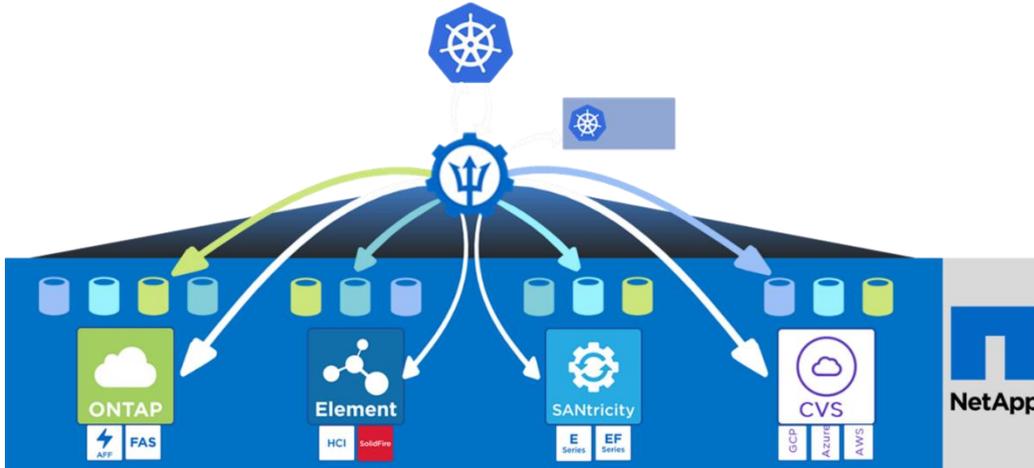


## NetApp Trident

NetApp Trident is an open-source and fully supported storage orchestrator for containers and Kubernetes distributions, including Google Cloud's Anthos. It works with the entire NetApp storage portfolio, including NetApp ONTAP software. Trident is fully CSI-compliant and provides the ability to accelerate the DevOps workflow by allowing customers to provision and manage storage from their NetApp storage systems, without requiring intervention from a storage administrator. Trident is deployed as an operator and communicates directly with the Kubernetes API endpoint to serve containers' storage requests in the form of persistent volume claims (PVCs), by creating and managing volumes on the NetApp storage system. These persistent volumes (PVs) are provisioned based on storage classes defined in the Kubernetes environment and uses storage backends (created by a storage administrator), which can be customized based on project needs, and storage system models to allow for any number of advanced storage features, such as: compression, specific disk types, or QoS levels that guarantee a certain performance.

For more information about NetApp Trident, see the [Trident](#) page.

Figure 2) Trident orchestrates storage from each system and service in the NetApp portfolio.



## Google Cloud's Anthos

Google Cloud's Anthos is a cloud-based Kubernetes data center solution that enables organizations to construct and manage modern hybrid-cloud infrastructures, while adopting agile workflows focused on application development. Anthos on bare metal extends the capability of Anthos to run on-premises directly on physical servers without a hypervisor layer and interoperate with Anthos GKE clusters in Google Cloud.

Adopting containers, service mesh, and other transformational technologies enables organizations to experience consistent application development cycles and production-ready workloads in local and cloud-based environments.

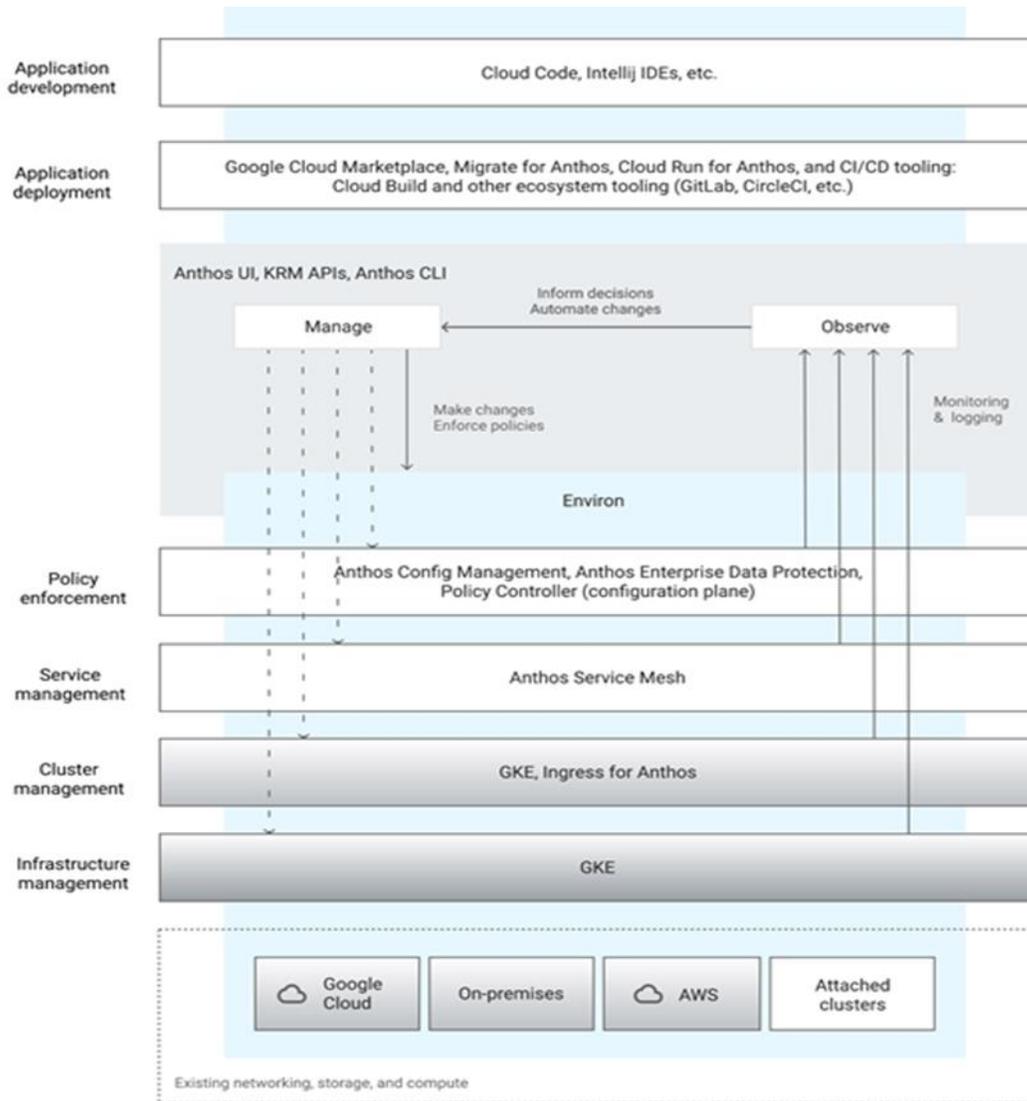
Anthos provides the following features:

- **Anthos configuration management.** Automates the policy and security of hybrid Kubernetes deployments.
- **Anthos Service Mesh.** Enhances application observability, security, and control with an Istio-powered service mesh.
- **Google Cloud Marketplace for Kubernetes applications.** A catalog of curated container applications available for easy deployment.
- **Migrate for Anthos.** Automatic migration of physical services and VMs from on-premises to the cloud.

Figure 3 depicts the Anthos solution and how a deployment in an on-premises data center interconnects with infrastructure in the cloud.

For more information about Anthos, see the [Anthos website](#).

Figure 3) Google Cloud's Anthos architecture.



## Anthos on Bare Metal

Anthos on bare metal is an extension of GKE that is deployed in a customer's private data center. An organization can deploy the same applications designed to run in containers in Google Cloud in Anthos clusters on-premises. Anthos on bare metal runs directly on physical servers with the user's choice of underlying Linux operating system, and provides customers with a full-fledged hybrid cloud environment with the capability to run at the core or edge of their data centers.

Anthos on bare metal offers the following benefits:

- **Hardware agnostic.** Customers can run Anthos on their choice of optimized hardware platform in their existing data centers.
- **Cost savings.** Customers can realize significant cost savings by utilizing their own physical resources for their application deployments instead of provisioning resources in their Google Cloud environment.

- **Develop then publish.** On-premises deployments can be used while applications are in development, which allows for testing of applications in the privacy of a local data center before being made publicly available in the cloud.
- **Better performance.** Intensive applications that demand the highest levels of performance and lowest latency can be satisfied by running them closer to the hardware.
- **Security requirements.** Customers with increased security concerns or sensitive data sets that cannot be stored in the public cloud are able to run their applications from the security of their own data centers, thereby meeting organizational requirements.
- **Management and operations.** Anthos on bare metal comes with a wide range of facilities that increase operational efficiency such as built-in networking, lifecycle management, diagnostics, health checks, logging, and monitoring.

## Solution Requirements: Anthos on Bare Metal with NetApp

### Hardware Requirements

#### Compute: Bring Your Own Server

Using the hardware agnostic capability of Anthos on bare metal, this solution provides flexibility to the customer to select the compute platform of their choice and efficiently optimize for their use-case. This widens the capability to use their existing infrastructure and reduce capital expenditure.

Table 1 lists the minimum number of compute hardware components that are required to implement this solution. The hardware models that are used in any implementation of the solution might vary based on customer requirements. The hardware models identified are those that were used to validate the solution with NetApp and our partners.

**Table 1) Hardware requirements – compute.**

Usage	Hardware and Model	Quantity
Admin nodes	Cisco UCS B200	3
Worker nodes	HP Proliant DL360	4

#### Storage: NetApp ONTAP

Table 2 lists the minimum number of storage hardware components that are required to implement the solution. The hardware models that are used in any implementation of the solution might vary based on customer requirements. The hardware models identified are those that were used to validate the solution with NetApp and our partners.

**Table 2) Hardware requirements – storage.**

Hardware	Model	Quantity
NetApp AFF	NetApp AFF A300	2 (1 HA pair)

### Software Requirements

The software components that are used in any implementation of the solution might vary based on customer requirements. The software versions identified are those that were used to validate the solution with NetApp, and our partners.

**Table 3) Software requirements.**

Software	Purpose	Version
Ubuntu	OS on 3 Admins	20.04
	OS on Worker4	20.04
	OS on Worker3	18.04
CentOS	OS on Worker2	8.2
Red Hat Enterprise Linux	OS on Worker1	8.1
Anthos on bare metal	Container Orchestration	1.6.0
NetApp ONTAP	Storage OS	9.7P8
NetApp Trident	Container Storage Management	20.10

**Note:** The multi-OS environment shows interoperability of the solution with the supported OS versions of Anthos on bare metal. We anticipate customers to standardize on one or a subset of operating systems for deployment.

For Anthos on bare metal hardware and software requirements, see the [Anthos on bare metal documentation](#) page.

## Deployment Summary: Anthos on Bare Metal with NetApp

For the initial Anthos-ready platform and storage validation of the Anthos on bare metal with NetApp solution, NetApp partnered with World Wide Technology (WWT) to establish an environment at WWT's Advanced Technology Center (ATC). Anthos was deployed on a bare metal infrastructure using the `bmctl` tool provided by Google Cloud. The following section details the deployment used for the validation purposes.

The Anthos on bare metal with NetApp solution was built as a highly available hybrid cluster with three Anthos control plane nodes, and four Anthos worker nodes.

The control plane nodes used were Cisco UCS B200M3 Blade Servers, hosted in a chassis and configured with a single virtual network interface card (vNIC) on each, which allowed for A/B failover at the Cisco UCS platform level for fault tolerance. The Cisco UCS chassis connected upstream to a pair of Cisco UCS 6248 Fabric Interconnects providing disparate paths for the separation of traffic along fabric A and fabric B. Those fabric interconnects connected upstream to a pair of Cisco Nexus 5548 data center switches that tied back to the core network at WWT.

The worker nodes were HP Proliant DL360 nodes, each running one of the supported Linux distributions for Anthos on bare metal: Red Hat Enterprise Linux 8.2, CentOS 8.2, Ubuntu 20.04 LTS, and Ubuntu 18.04 LTS respectively. The Red Hat Enterprise Linux 8 and CentOS 8 nodes were configured with NIC teams running in LACP mode and cabled to two Nexus 9k C93180YC-FX switches for fault tolerance. The Ubuntu servers were configured for network bonding in LACP mode and cabled to the same pair of Nexus 9k switches for fault tolerance.

The NetApp AFF A300 storage system running ONTAP 9.7 software was installed and connected physically to the same pair of Nexus 9k switches as the Anthos worker nodes. These network uplinks were aggregated into an interface group (a0a) and the appropriate data network VLAN was tagged to allow the worker nodes to interact with the storage system. A storage virtual machine (SVM) was created with data LIFs supporting the NFS protocol and dedicated to storage operations for Trident to provide persistent storage to the containers deployed in the Anthos on bare metal cluster. These persistent volumes were provided by NetApp Trident 20.10, the latest release of the NetApp open source, fully supported, storage orchestrator for Kubernetes.

Figure 4 depicts a physical cabling diagram of the solution to the top of rack data center switches.

Figure 4) Physical cabling diagram of Anthos on bare metal solution.

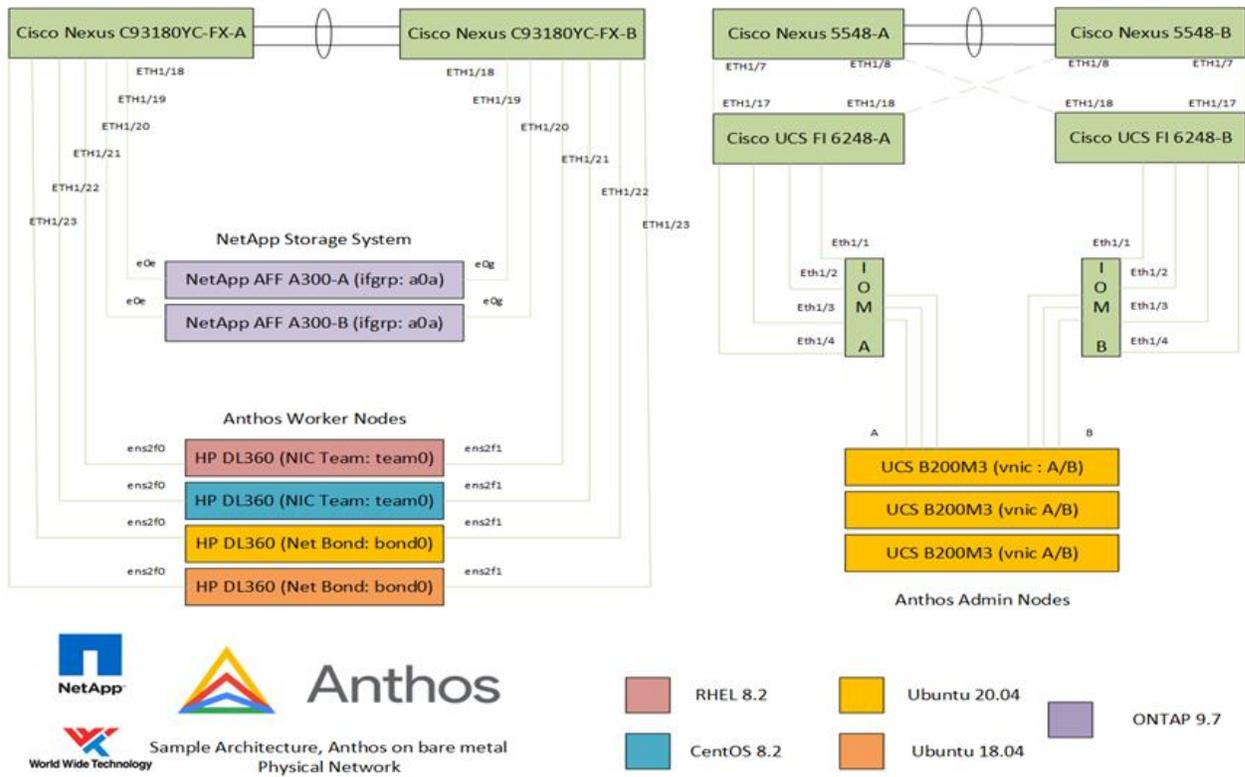
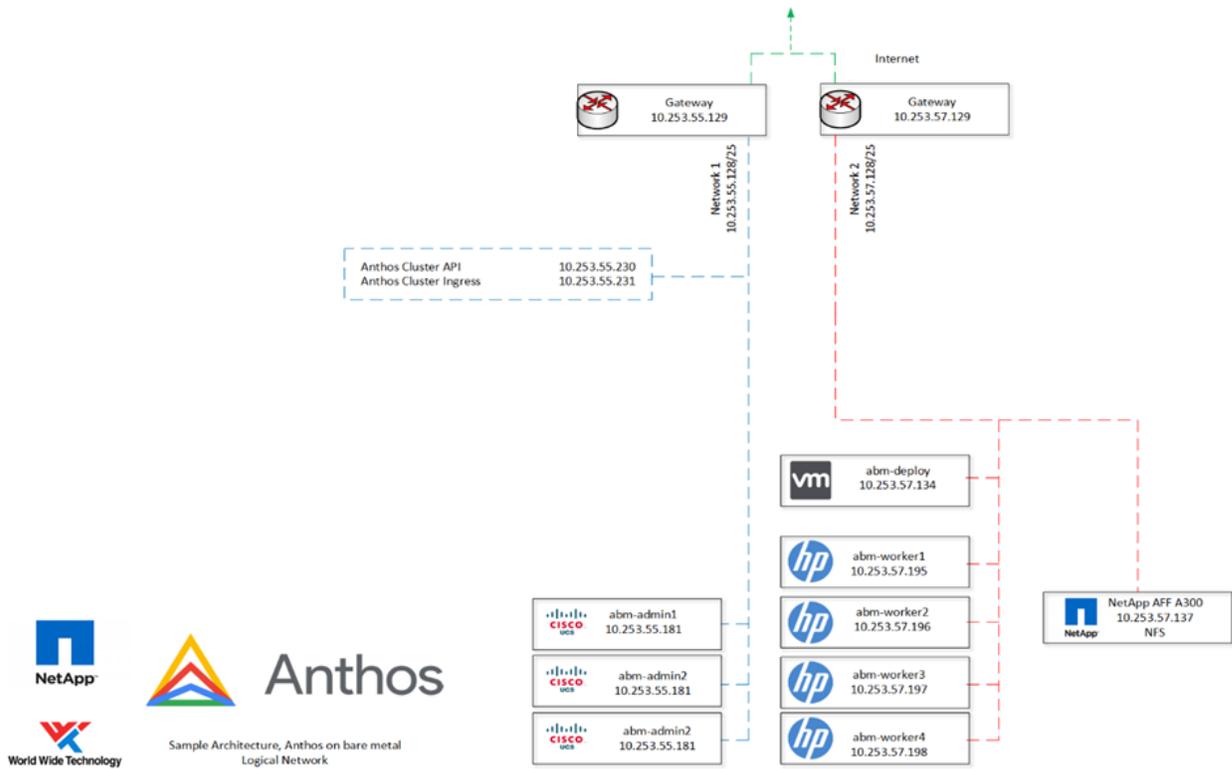


Figure 5 presents a logical view of the solution as deployed and validated on the hardware in the lab at the NetApp partner WWT.

Figure 5) Logical data center diagram of Anthos on bare metal solution.



## Solution Validation: Anthos on Bare Metal with NetApp

The current deployment of Anthos on bare metal with NetApp has been run through two rigorous validation processes using tools provided by the team at Google Cloud. These validations include a subset of the following tests:

- Anthos-ready platform partner validation:
  - a. Confirm that all Anthos on bare metal platform services are installed and running.
  - b. Scale down the physical Anthos on bare metal cluster from four worker nodes to three, and then back to four.
  - c. Create and delete a custom namespace.
  - d. Create a deployment of the Nginx web server, scaling that deployment by increasing the number of replicas.
  - e. Create an ingress for the Nginx application and verify connectivity by curling the index.html.
  - f. Successfully clean up all test suite activities and return the cluster to a pretest state.
- Anthos-ready storage partner validation:
  - a. Create a deployment with a persistent volume claim.
  - b. Use NetApp Trident to provision and attach the requested persistent volume from NetApp ONTAP.
  - c. Validate the detach/reattach capability of persistent volumes.
  - d. Validate multiattach read-only access of persistent volumes from other pods on the node.
  - e. Validate offline volume resize operation.
  - f. Verify that the persistent volume survives a cluster scaling operation.

## Conclusion

Anthos on bare metal with NetApp provides a robust platform to run container-based workloads efficiently by allowing for the customization of deployed infrastructure. Customers can use the server infrastructure and supported operating system of their choice, or even deploy the solution within their existing infrastructure. The power and flexibility of these environments increases greatly through the integration of NetApp ONTAP and NetApp Trident, supporting stateful application workloads by efficiently provisioning and managing persistent storage for containers. By extending the potential of Google Cloud into their data center powered by NetApp, a customer can realize the benefits of a fully supported, highly available, easily scalable, and fully managed Kubernetes solution for development and production of their application workloads.

## 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 ONTAP Documentation Center  
<https://docs.netapp.com/ontap-9/index.jsp>
- NetApp Trident  
<https://netapp-trident.readthedocs.io/en/stable-v20.10/>
- Google Cloud's Anthos  
<https://cloud.google.com/anthos>
- Anthos on bare metal  
<https://cloud.google.com/anthos/gke/docs/bare-metal>

## Version History

Version	Date	Document Version History
Version 1.0	Nov 2020	Initial release

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