Google Anthos

NetApp Solutions

NetApp
May 03, 2022

Table of Contents

Google Anthos

WP-7337: Anthos on Bare Metal

Alan Cowles and Nikhil M Kulkarni, NetApp

NetApp and Google Cloud have had a strong relationship for several years now, with NetApp first introducing cloud data services for Google Cloud with Cloud Volumes ONTAP and the Cloud Volumes Service. This relationship was then expanded by validating the NetApp HCI platform for use with Google Cloud Anthos on-premises, a hypervisor-based hybrid multi-cloud Kubernetes solution deployed on VMware vSphere. NetApp then passed Anthos Ready qualification for NetApp Trident, ONTAP, and the NFS protocol to provide dynamic persistent storage for containers.

Anthos can now be directly install on bare metal servers in a customer's environment, which adds an additional option for customers to extend Google Cloud into their local data centers without a hypervisor. Additionally, by leveraging the capabilities of NetApp ONTAP storage operating system and NetApp Trident, you can extend your platform's capabilities by integrating persistent storage for containers.

This combination allows you to realize the full potential of your servers, storage, and networking combined with the support, service levels, monthly billing, and on-demand flexibility that Google Cloud provides. Because you are using your own hardware, network, and storage, you 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.

Next: Solution overview.

Solution overview

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.

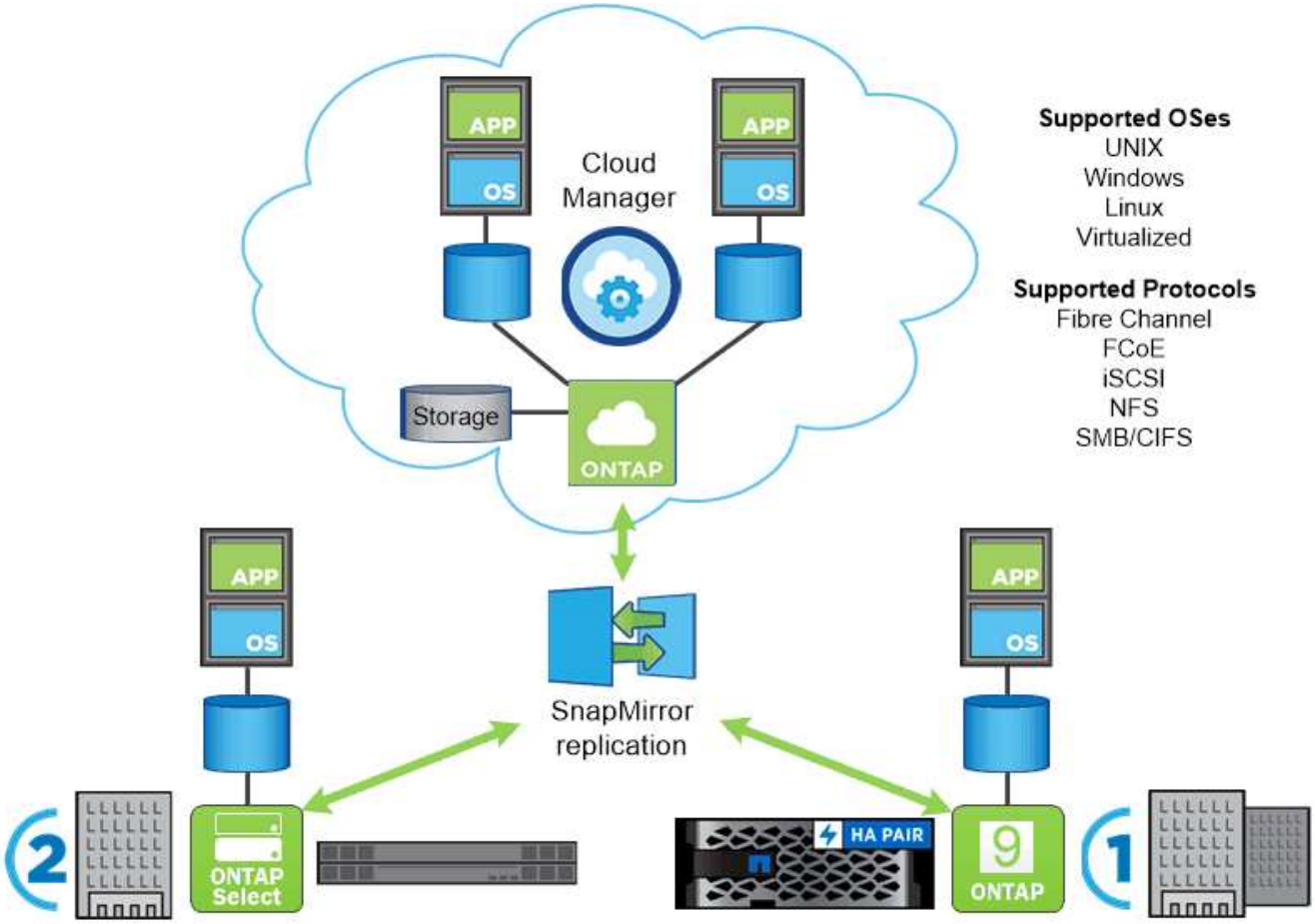
NetApp ONTAP is a powerful storage-software tool with capabilities such as an intuitive GUI, REST APIs with automation integration, AI-informed predictive analytics and corrective action, nondisruptive hardware upgrades, and cross-storage import.

ONTAP provides the following features:

- A unified storage system with simultaneous data access and management of NFS, CIFS, iSCSI, FC, FCoE, and FC-NVMe protocols.
- Different deployment models include on-premises on all-flash, hybrid, and all-HDD hardware configurations; VM-based storage platforms on a supported hypervisor such as ONTAP Select; and in the cloud as Cloud Volumes ONTAP.
- Increased data storage efficiency on ONTAP systems with support for automatic data tiering, inline data compression, deduplication, and compaction.
- Workload-based, QoS-controlled storage.
- Seamless integration with a public cloud for tiering and protection of data. ONTAP also provides robust data protection capabilities that sets it apart in any environment:

- **NetApp Snapshot copies.** A fast, point-in-time backup of 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.** Efficiently administration of non-rewritable data by writing it to special volumes that cannot be overwritten or erased for a designated period.
- **NetApp SnapVault.** Backs up data from multiple storage systems to a central Snapshot copy that serves as a backup to all designated systems.
- **NetApp SyncMirror.** Provides real-time, RAID-level mirroring of data to two different plexes of disks that are connected physically to the same controller.
- **NetApp SnapRestore.** Provides fast restoration of backed-up data on demand from Snapshot copies.
- **NetApp FlexClone.** Provides 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.

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



Across the NetApp data fabric, you can count on a common set of features and fast, efficient replication across platforms. You can use the same interface and the same data management tools.

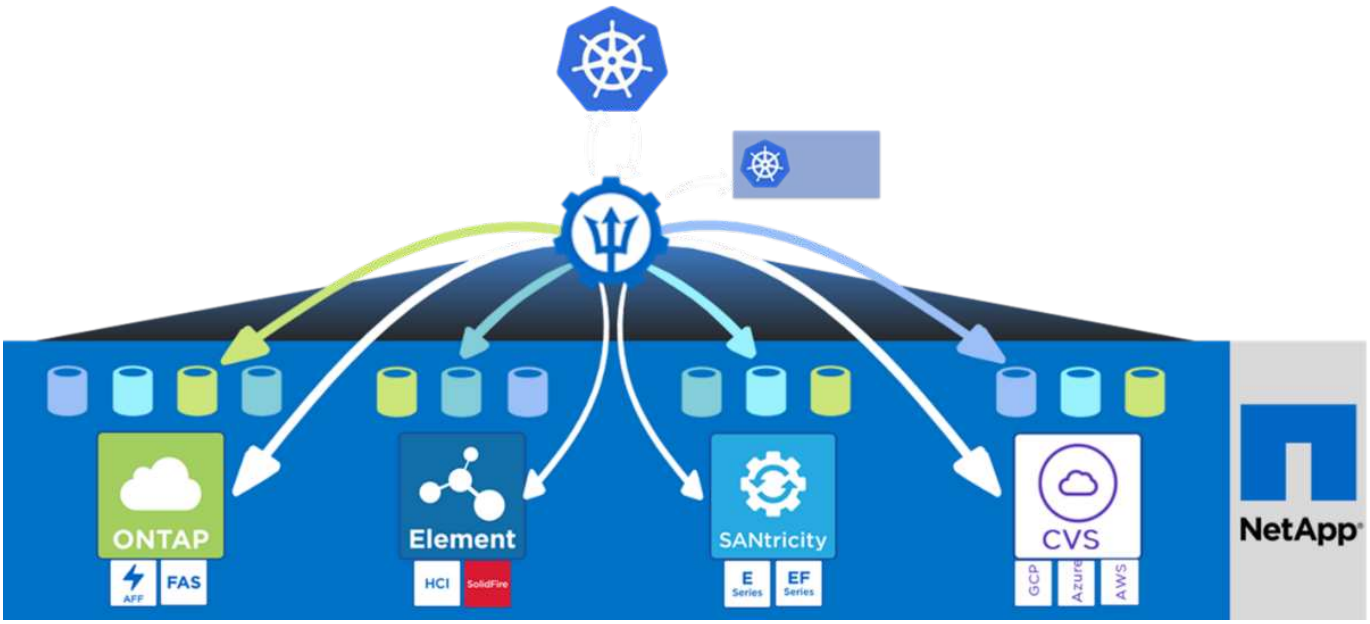
NetApp Trident

NetApp Trident is an open-source and fully supported storage orchestrator for containers and Kubernetes distributions, including Google Cloud Anthos. It works with the entire NetApp storage portfolio, including NetApp ONTAP software. Trident is fully CSI-compliant, and it accelerates the DevOps workflow by allowing you to provision and manage storage from your NetApp storage systems, without intervention from a storage administrator. Trident is deployed as an operator that 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.

Persistent volumes (PVs) are provisioned based on storage classes defined in the Kubernetes environment. They use 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 performance.

For more information about NetApp Trident, see the Trident page.

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.

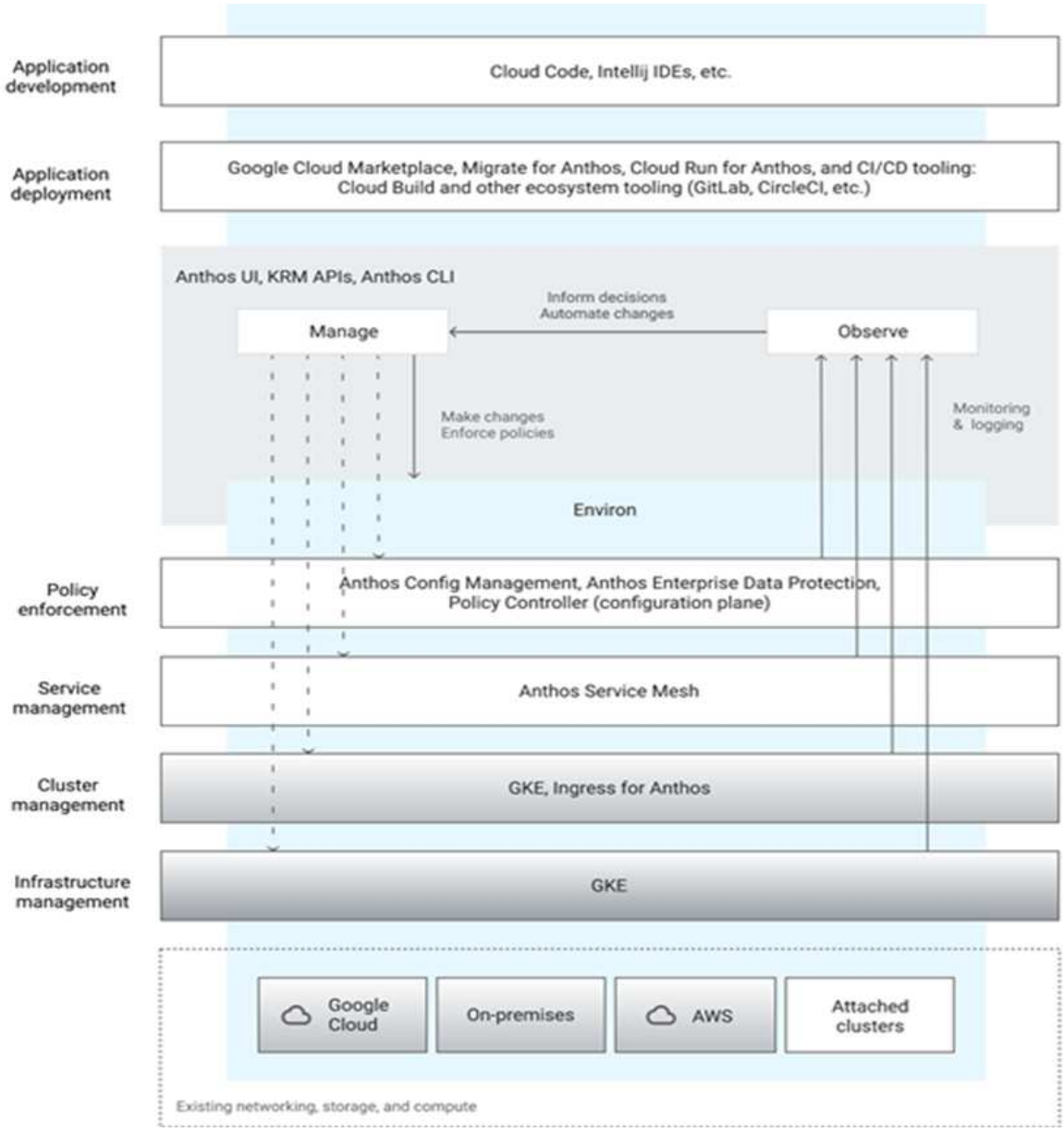
Anthos provides the following features:

- **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.

The following figure presents 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.** You can realize significant cost savings by using your own physical resources for application deployments instead of provisioning resources in the Google Cloud environment.
- **Develop then publish.** You can use on-premises deployments while applications are in development, which allows for the testing of applications in the privacy of your local data center before you make them publicly available in the cloud.
- **Better performance.** Intensive applications that demand low latency and the highest levels of performance can be run 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.

Next: Solution requirements.

Solution requirements

Hardware requirements

Compute: bring your own server

The hardware-agnostic capabilities of Anthos on bare metal allow you to select a compute platform optimized for your use-case. Therefore, your can match your existing infrastructure and reduce capital expenditure.

The following table lists the minimum number of compute hardware components that are required to implement this solution, although the hardware models used can vary based on customer requirements.

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

Storage: NetApp ONTAP

The following table lists the minimum number of storage hardware components needed to implement the solution, although the hardware models used can vary based on customer requirements.

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

Software requirements

The software versions identified in the following table were used by NetApp and our partners to validate the solution with NetApp, although the software components used can vary based on customer 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

This multi-OS environment shows the interoperability with supported OS versions of the of Anthos on bare metal solution. We anticipate that customers will 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.

Next: Deployment summary.

Deployment summary

For the initial validation of this 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 validation purposes.

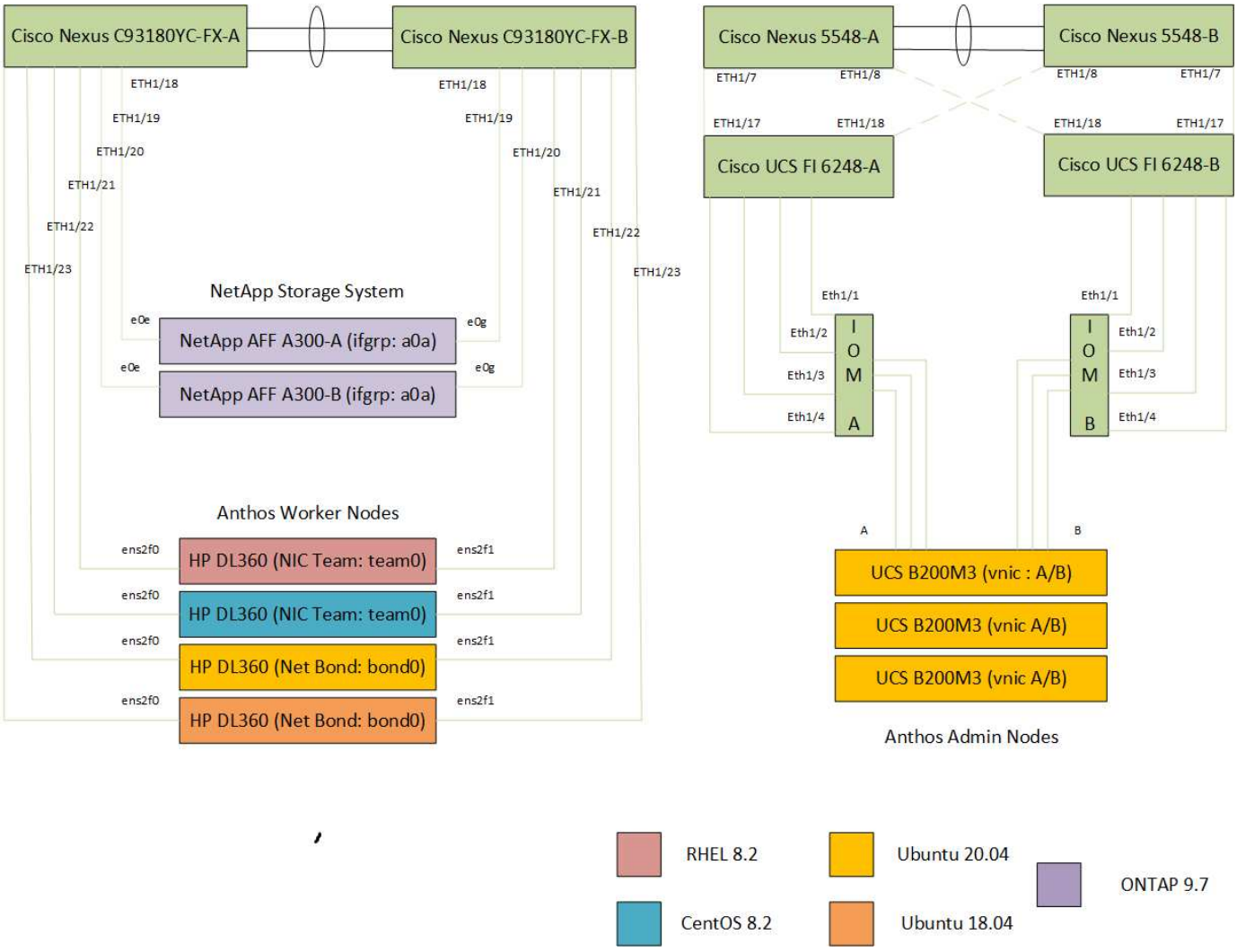
The Anthos on bare metal with NetApp solution was built as a highly available hybrid cluster with three Anthos control-plane nodes and four Anthos worker nodes.

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.

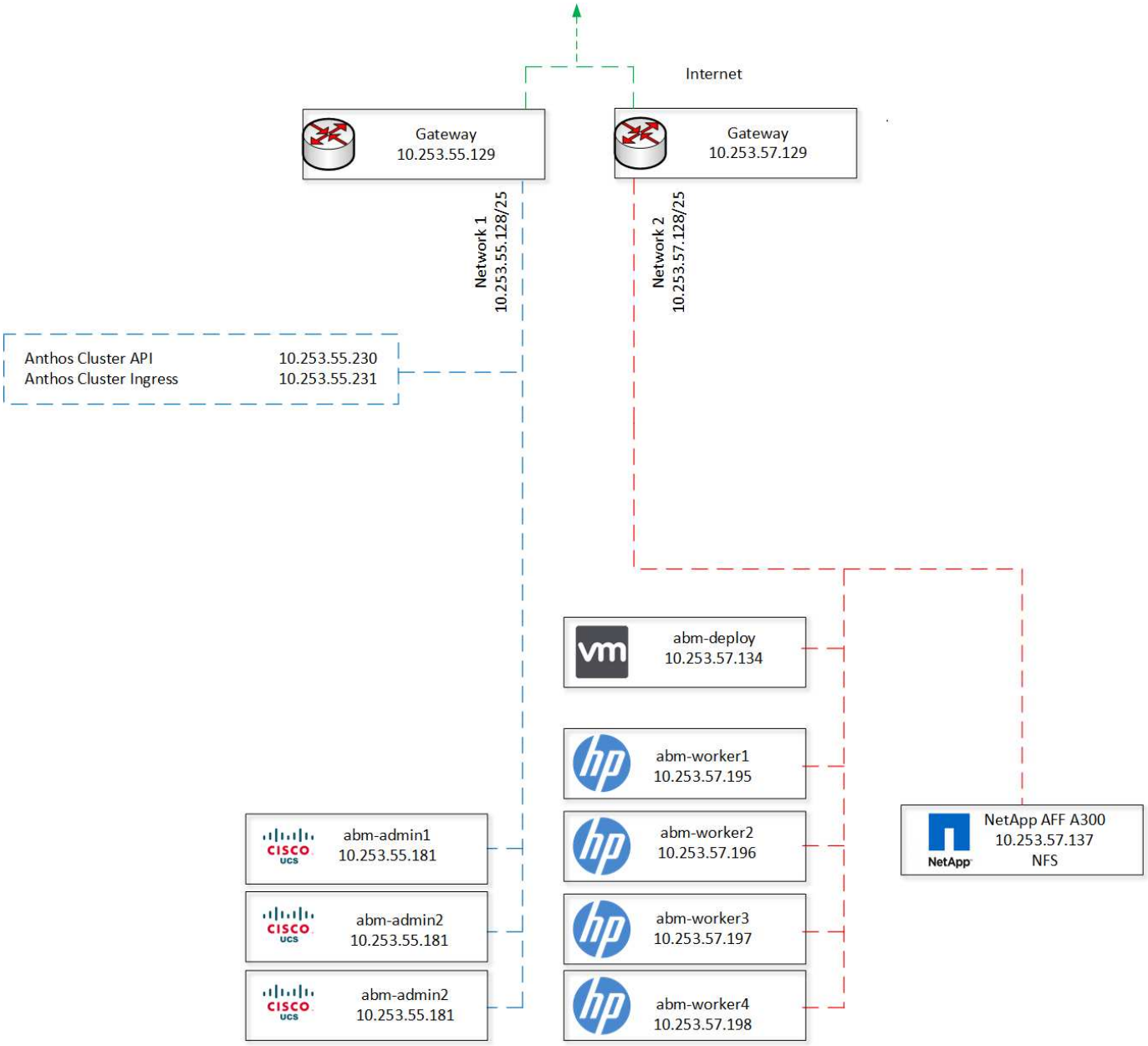
The worker nodes were HP Proliant DL360 nodes, each running one of the supported Linux distributions for Anthos on bare metal: Red Hat Enterprise Linux 8.2, CentOS 8.2, Ubuntu 20.04 LTS, or Ubuntu 18.04 LTS. The Red Hat Enterprise Linux 8 and CentOS 8 nodes were configured with NIC teams running in LACP 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 fully supported NetApp open-source storage orchestrator for Kubernetes.

The following figure depicts a physical cabling diagram of the solution to the top of rack data center switches.



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



Next: Solution validation.

Solution validation

The current deployment of this solution was put through two rigorous validation processes using tools provided by the Google Cloud team. These validations include a subset of the following tests:

- Partner validation of the Anthos-ready platform:
  - Confirm that all Anthos on bare metal platform services are installed and running.
  - Scale down the physical Anthos on bare metal cluster from four worker nodes to three and then back to four.
  - Create and delete a custom namespace.
  - Create a deployment of the Nginx web server, scaling that deployment by increasing the number of replicas.

    - Create an ingress for the Nginx application and verify connectivity by curling the index.html.
    - Successfully clean up all test suite activities and return the cluster to a pretest state.
- Partner validation of Anthos-ready storage:
    - Create a deployment with a persistent volume claim.
    - Use NetApp Trident to provision and attach the requested persistent volume from NetApp ONTAP.
    - Validate the detach and reattach capability of persistent volumes.
    - Validate multi-attach read-only access of persistent volumes from other pods on the node.
    - Validate the offline volume resize operation.
    - Verify that the persistent volume survives a cluster-scaling operation.

Next: Conclusion.

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.

Next: Where to find additional information.

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