NVIDIA SuperPOD with DGX B300 Systems, NVIDIA Quantum-X800 InfiniBand switching and AC Power Reference Architecture

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Reference Architecture

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Tip

The NVIDIA SuperPOD with DGX B300 Systems, NVIDIA Quantum-X800 InfiniBand switching and AC Power Reference Architecture is also available as a PDF.

Chapter 1. Abstract

The NVIDIA DGX SuperPOD architecture has been designed to power the next-generation AI factories with unparalleled performance, scalability, and innovation that supports all customers in the enterprise, higher education, research, and the public sector. It is a physical twin of the main NVIDIA research and development system, meaning the company's infrastructure software, applications, and support are first tested and vetted on the same architecture.

This DGX SuperPOD Reference Architecture (RA) is based on DGX B300 systems powered by NVIDIA Blackwell Ultra GPUs. The RA discusses the components that define the scalable and modular architecture of DGX SuperPOD. DGX SuperPOD is built on the concept of scalable units (SU); each SU contains 72 DGX B300 systems, which enables rapid deployment of DGX SuperPOD of any size. The RA also includes details regarding the SU design and specifics of InfiniBand, Ethernet fabric topologies, storage system specifications, recommended rack layouts, and wiring guidelines.

This RA combines the latest NVIDIA technologies to help companies and industries develop their own AI factories. To achieve the most scalability, DGX SuperPOD is powered by several key NVIDIA technologies and solutions, including:

- NVIDIA DGX B300 system provides one of the most powerful computational building block for AI and HPC.
- NVIDIA XDR (800 Gbps) InfiniBand: High performance, low latency, and scalable network interconnect.
- NVIDIA NVLink® technology—networking technologies that connect GPUs at the NVLink layer to provide unprecedented performance for the most demanding communication patterns.
- NVIDIA Mission Control: a unified operations and orchestration software stack for managing AI factories.

The DGX SuperPOD architecture integrates NVIDIA software solutions including NVIDIA Mission Control, NVIDIA AI Enterprise, CUDA, and NVIDIA Magnum IO™. These technologies help keep the system running at the highest levels of availability, performance, and with NVIDIA Enterprise Support (NVEX), keeps all components and applications running smoothly.

This reference architecture (RA) discusses the components that define the scalable and modular architecture of DGX SuperPOD. The system is built on the concept of scalable units (SU), each containing 72 DGX B300 systems, which provides for rapid deployment of systems of multiple sizes. This RA includes details regarding the SU design and specifics of InfiniBand, NVLink network, Ethernet fabric topologies, storage system specifications, recommended rack layouts, and wiring guides.

This RA specifically focuses on the AC power supply version for more traditional data centers.

The NVIDIA DGX B300 is offered in a DC Busbar version as well as the more traditional AC Power supply version as do many of the fabric and other components.

More information on the NVIDIA DGX B300 power supply version and other AC powered components can be found at: https://www.nvidia.com/en-us/data-center/dgx-superpod/.

1.1. Scope of DGX SuperPOD

NVIDIA DGX SuperPOD is a product that is defined by this RA with specific bill of materials for both hardware and software. It is designed for single-tenant, multi-user enterprise environment.

The designed mode of operation for DGX SuperPOD is as follows:

- NVIS led installation and expert service for initial bring up and commissioning
- Customer-owned infrastructure-as-a-product, where the customer is responsible for day-to-day operation with premium support from NVIDIA Premium Technical Account Manager and optional continuous bring-up service.
- Functional and performance updates during the product lifecycle.
- Administration of the DGX SuperPOD with NVIDIA Mission Control software.
- User and application access using SLURM or NVIDIA Run:ai

For customers who wish to modify their DGX SuperPOD after delivery for additional capabilities such as general Kubernetes cluster access, or reconfiguration into a multi-tenant environment for enterprise private cloud or public cloud services, modifications are performed at customers' own discretion and risk. NVIDIA does not support these capabilities and performance with the DGX SuperPOD as a product. However, enterprise-level support will still be available for NVIDIA components (for both software and hardware) that are available in the DGX SuperPOD.

Chapter 2. Key Components of the DGX SuperPOD

The DGX SuperPOD architecture has been designed to maximize performance for state-of-the-art model training, scale to exaflops of performance, provide the highest performance to storage and support all customers in the enterprise, higher education, research, and the public sector. It is a digital twin of the main NVIDIA research and development system, meaning the company's software, applications, and support structure are first tested and vetted on the same architecture. By using SUs, system deployment times are reduced from months to weeks. Leveraging the DGX SuperPOD design reduces time-to-solution and time-to-market of next generation models and applications.

DGX SuperPOD is the integration of key NVIDIA components, as well as storage solutions from partners certified to work in the DGX SuperPOD environment.

2.1. NVIDIA DGX B300 System

The NVIDIA DGX B300 system (Figure 2.1) is an AI powerhouse that enables enterprises to expand the frontiers of business innovation and optimization. The DGX B300 system delivers breakthrough AI performance with the most powerful chips ever built, in an eight GPU configuration. The NVIDIA Blackwell Ultra GPU architecture provides the latest technologies that brings months of computational effort down to days and hours, on some of the largest AI/ML workloads.

Figure 2.1: DGX B300 system

Some of the key highlights of the DGX B300 system when compared to the DGX B200 system include:

- InfiniBand XDR or Spectrum-X 2.0 based compute fabric
- Alternative DC Busbar powered appliance design available, fully N+N redundant
- 72 petaFLOPS FP8 training and 144 petaFLOPS FP4 inference
- Fifth generation of NVIDIA NVLink.
- 1,440 GB of aggregated HBM3 memory

2.2. NVIDIA InfiniBand Technology

InfiniBand is a high-performance, low latency, RDMA capable networking technology, proven over 20 years in the harshest compute environments to provide the best inter-node network performance. InfiniBand continues to evolve and lead data center network performance.

NVIDIA InfiniBand XDR has a peak speed of 800 Gbps per direction with an extremely low port-to-port latency and is backwards compatible with the previous generations of InfiniBand specifications. InfiniBand is more than just peak bandwidth and low latency. InfiniBand provides additional features to optimize performance including Adaptive Routing (AR), collective communication with SHARP™, dynamic network healing with SHIELD™, and supports several network topologies.

NVIDIA InfiniBand NDR with a peak speed of 400 Gbps per direction with the same extremely low port-to-port latency is used for Storage Fabric for fast and reliably storage access to feed the data required for AI training.

2.3. NVIDIA Mission Control

The DGX SuperPOD Reference Architecture represents the best practices for building high-performance AI factories. There is flexibility in how these systems can be presented to customers and users. NVIDIA Mission Control software is used to manage all DGX SuperPOD with DGX B300 systems deployments.

NVIDIA Mission Control is a sophisticated full-stack software solution. As an essential part of the DGX SuperPOD experience, it optimizes developer workload performance and resiliency, ensures unmatched uptime with automated failure handling, and provides unified cluster-scale telemetry and manageability. Key features include full-stack resiliency, predictive maintenance, unified error reporting, data center optimizations, cluster health checks, and automated node management.

NVIDIA Mission Control software incorporates the same technology that NVIDIA uses to manage thousands of systems for our award-winning data scientists and provides an immediate path to an AI factory for organizations that need the best of the best.

DGX SuperPOD is to be deployed on-premises, meaning the customer owns and manages the hardware. This can be within a customer's data center or co-located at a commercial data center. In each case the customer owns the hardware, the service it provides, and is responsible for their cluster infrastructure as well as providing the building management system for integration.

2.4. Components

The hardware components of DGX SuperPOD are described in Table 2.1. The software components are shown in Table 2.2.

Table 2.1: DGX SuperPOD hardware components by NVIDIA

Component	NVIDIA Technology	Description
Compute nodes	NVIDIA DGX B300 system with eight Blackwell Ultra GPUs	The world's premier purpose-built AI systems featuring NVIDIA Blackwell Ultra GPUs, fifth-generation NVIDIA NVLink, and fourth-generation NVIDIA NVSwitch™ technologies.
Compute node transceiver and cable	NVIDIA OSFP twin port flat top transceiver, MMF passive fiber cable	Transceiver and cables for DGX nodes
Compute fabric	NVIDIA Quantum-X800 Q3400-RA 800 Gbps InfiniBand	Rail-optimized, non-blocking, twin-plane, fat tree topology for next-generation extreme-scale AI factory.
InfiniBand Storage fabric	NVIDIA Quantum QM9700 NDR 400 Gbps InfiniBand Switch	The fabric is optimized to match peak performance of the configured storage array
InfiniBand storage fabric switch transceiver and cable	NVIDIA QSFP single port flat top transceiver, MMF passive fiber cable	Transceiver and cables for InfiniBand switches
Ethernet Storage fabric	NVIDIA Spectrum-4 SN5610/SN5600D 800 Gbps Ethernet	Optional storage fabric for ethernet based storage solutions
Ethernet Storage fabric switch transceiver and cable	NVIDIA QSFP single port flat top transceiver 800GB (NIC side) and NVIDIA OSFP twin port finned (switch side) transceiver 1600GB MMF passive fiber cable	Transceiver and cables for Spectrum-4 switches
Storage InfiniBand fabric management	NVIDIA Unified Fabric Manager 3.5 Appliance, Enterprise Edition	NVIDIA UFM combines enhanced, real-time network telemetry with AI powered cyber intelligence and analytics to manage scale-out InfiniBand data centers
In-band management network	NVIDIA SN5610/SN5600D switch	64 port 800 Gbps and up to 256 ports of 200 Gbps Ethernet switch providing high port density with high performance

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Table 2.1 – continued from previous page

Component	NVIDIA Technology	Description
Ethernet In-band fabric switch transceiver and cable	NVIDIA QSFP single port flat top transceiver 400GB or NVIDIA OSFP twin port finned transceiver 800GB MMF passive fiber cable	Transceiver and cables for Spectrum-4 switches
Out-of-band (OOB) management network	NVIDIA SN2201(M) switch	48 port 1 Gbps Ethernet and 4 x 100 Gbps switch leveraging copper ports to minimize complexity

Table 2.2: DGX SuperPOD software components

Component	Description
NVIDIA Mission Control[1]	Simplified AI data center operations, cluster management, and workload orchestration with agility, resilience, and hyperscale efficiency for enterprises.
NVIDIA AI Enterprise	NVIDIA AI Enterprise is an end-to-end, cloud-native software platform that accelerates data science pipelines and streamlines development and deployment of production-grade co-pilots and other generative AI applications.
Magnum IO	Enables increased performance for AI and HPC
NVIDIA NGC	The NGC catalog provides a collection of GPU-optimized containers for AI and HPC
Slurm	A classic workload manager used to manage complex workloads in a multi-node, batch-style, compute environment

Note

NVIDIA Mission Control now includes Base Command Manager and Run:ai functionality. No separate purchase is needed. SuperPOD only supports multiteam environments through Base Command Manager; multitenancy is not supported with SuperPOD currently.

2.5. Design Requirements

DGX SuperPOD is designed to minimize system bottlenecks throughout the tightly coupled configuration to provide the best performance and application scalability. Each subsystem has been thoughtfully designed to meet this goal. In addition, the overall design remains flexible so that data center

[1] NVIDIA Mission Control includes Base Command Manager and Run:ai functionality. No separate purchase needed.

requirements can be tailored to better integrate into existing data centers.

2.5.1. System Design

DGX SuperPOD is optimized for a customers' particular workload of multi-node AI and HPC applications:

- A modular architecture based on SUs of 72 DGX B300 systems each.
- A fully tested system scales to 8 SUs, but larger deployments can be built based on customer requirements.
- Single rack that can support up to four DGX B300 systems per rack, enabling modification to accommodate different data center requirements if there is additional power and cooling capacity.
- Storage partner equipment that has been certified to work in DGX SuperPOD environments.
- Full system support, including compute, storage, network, and Mission Control software is provided by NVIDIA Enterprise Experience (NVEX).

2.5.2. Compute Fabric

- The compute fabric is rail-optimized, full-fat tree topology
- Managed Quantum-X800 switches are used throughout the design to provide better management of the fabric.

2.5.3. Storage Fabric (High Speed Storage)

The storage fabric provides high bandwidth to shared storage. It also has the following characteristics:

- It is independent of the compute fabric to maximize performance of both storage and application performance.
- Storage is provided over InfiniBand or RDMA over Converged Ethernet to provide maximum performance and minimize CPU overhead.
- It is flexible and can scale to meet specific capacity and bandwidth requirements.
- Connectivity to management nodes is required to provide storage access independent of compute nodes.

2.5.4. In-Band Management Network

- The in-band management network fabric is Ethernet-based and is used for node provisioning, data movement, Internet access, and other services that must be accessible by the users.
- The in-band management network connections for compute and management nodes operate at 200 Gbps and are bonded for resiliency.

2.5.5. Out-of-Band Management Network

The OOB management network connects all the base management controller (BMC) ports, as well as other devices that should be physically isolated from users. The Switch Management Network is a subset of the Out-Of-Band Network that provides additional security and resiliency.

2.5.6. Storage Requirements

The DGX SuperPOD compute architecture must be paired with a high-performance, balanced, storage system to maximize overall system performance. DGX SuperPOD is designed to use two separate storage systems, high-performance storage (HPS) and user storage, optimized for key operations of throughput, parallel I/O, as well as higher IOPS and metadata workloads.

2.5.7. High-Performance Storage

High-Performance Storage is provided via InfiniBand or high-speed Ethernet connected storage from a DGX SuperPOD certified storage partner, and is engineered and tested with the following attributes in mind:

- High-performance, resilient, POSIX-style file system optimized for multi-threaded read and write operations across multiple nodes.
- RDMA on InfiniBand or Ethernet support
- Local system RAM for transparent caching of data.
- Leverage local flash device transparently for read and write caching.

  The specific storage fabric topology, capacity, and components are determined by the DGX SuperPOD certified storage partner as part of the DGX SuperPOD design process.

2.5.8. User Storage

User Storage differs from High-Performance storage in that it exposes an NFS share on the in-band management fabric for multiple uses. It is typically used for "home directory" type usage (especially with clusters deployed with Slurm), administrative scratch space, and shared storage as needed by DGX SuperPOD components in a High Availability configuration (e.g., Base Command Manager), and log files.

With that in mind, User Storage has the following minimum requirements:

- 100 - 400Gbps Ethernet connectivity with 100G SerDes connectivity is required.
- Designed for high metadata performance, IOPS, and key enterprise features such as checkpointing. This is different than the HPS, which is optimized for parallel I/O and large capacity.
- Communicate over Ethernet, using NFS.

  User storage in a DGX SuperPOD is often satisfied with existing NFS servers already deployed, such that a new export is created and made accessible to the DGX SuperPOD's in-band management network. For the best performance, we require 100 Gb/s minimum bandwidth for the user storage.

Chapter 3. DGX SuperPOD Architecture

The DGX SuperPOD architecture is a combination of DGX systems, Ethernet networking, InfiniBand Networking, management nodes, and storage. Figure 3.1 the rack layout of a single SU. With DGX SuperPOD with DGX B300 systems, we utilize standard racks and with traditional power supplies and PDUs.

In our reference design, four DGX B300 fit within a single rack. The rack-level power consumption per rack is ~56kW. The rack layout can be adjusted to meet local data center requirements, such as maximum power per rack and rack layout between DGX systems and supporting equipment to meet local needs for power and cooling distribution.

This Reference Architecture is focused on traditional PDU and AC powered EIA racks. DGX SuperPOD with DGX B300 systems is also available for more dense DB Busbar solutions as well.

Figure 3.1 shows 72 x NVIDIA DGX B300 PS systems in standard racks each with three (3) 2U rack PDUs for maximum redundancy. Note that depending on your data center's capability, you might need to reduce the number of DGXs hosted on the same rack.

Figure 3.2 shows an example management rack configuration with networking switches, management servers, storage arrays, and UFM appliances. Sizes and quantities will vary depending upon models used. This example is for 1SU.

This reference architecture is focused on 8 SU units with 576 DGX nodes. DGX SuperPOD can scale to much larger configurations up to and beyond 72 SU with 2000+ DGX B300 nodes. See Table 3.1 for more information.

Table 3.1: Example Compute Fabric Components for DGX SuperPOD Counts

SU Count	Node Count	GPU Count	Cable Count			
			Leaf	Spine	Node-Leaf	Leaf-Spine
1	72	576	8	4	576	576
2	144	1152	16	8	1152	1152
4	288	2304	32	18	2304	2304
8	576	4608	64	36	4608	4608
18	1296	9216	144	72	10368	10368

Contact NVIDIA for information regarding DGX SuperPOD solutions of four scalable units or more.

Figure 3.1: DGX B300 in Racks

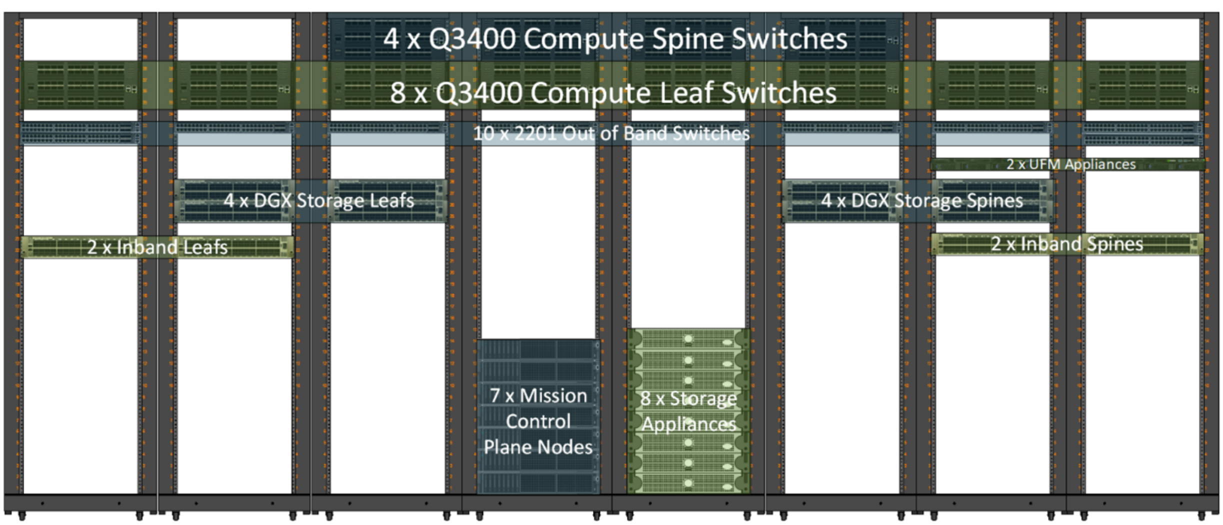

Figure 3.2: Management Equipment in Rack

Chapter 4. Network Fabrics

Building systems by SU provide the most efficient designs. However, if a different node count is required due to budgetary constraints, data center constraints, or other needs, the fabric should be designed to support the full SU, including leaf-spine switches and leaf-spine cables, and leave the portion of the fabric unused where these nodes would be located. This will ensure optimal traffic routing and ensure that performance is consistent across all portions of the fabric and the fabric's ability to scale to its planned size with minimal impact on existing infrastructure.

DGX SuperPOD configurations utilize four network fabrics:

- Compute Fabric
- Storage Fabric
- Ethernet Fabric with two network segments
    - Inband Network
    - Out-of-band Network

Figure 4.1 shows the ports on the back of the DGX B300 CPU tray and the connectivity provided. The compute fabric ports are on the edges of the compute tray and provide access to all eight GPUs. Each pair of in-band management and storage ports provide parallel pathways into the DGX B300 system for increased performance. The BMC port is used for BMC access. In addition, the BMC from both NVIDIA BlueField cards are connected to the out of band Network.

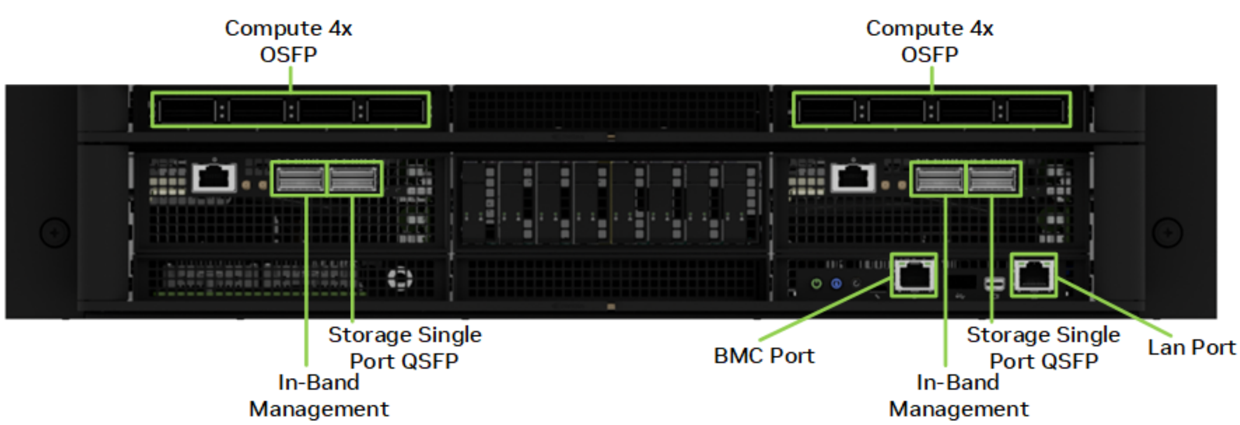

Figure 4.1: DGX B300 network ports

4.1. Compute Fabric

Figure 4.2 shows the compute fabric layout for the full 576-node DGX SuperPOD. Each group of 72 nodes is rail-aligned. Traffic per rail of the DGX B300 systems is always one hop away from the other 72 nodes in a SU. Traffic between SUs, or between rails, traverses the spine layer. UFM 3.5 nodes are connected to four (4) FNM ports on the Q3400 switches.

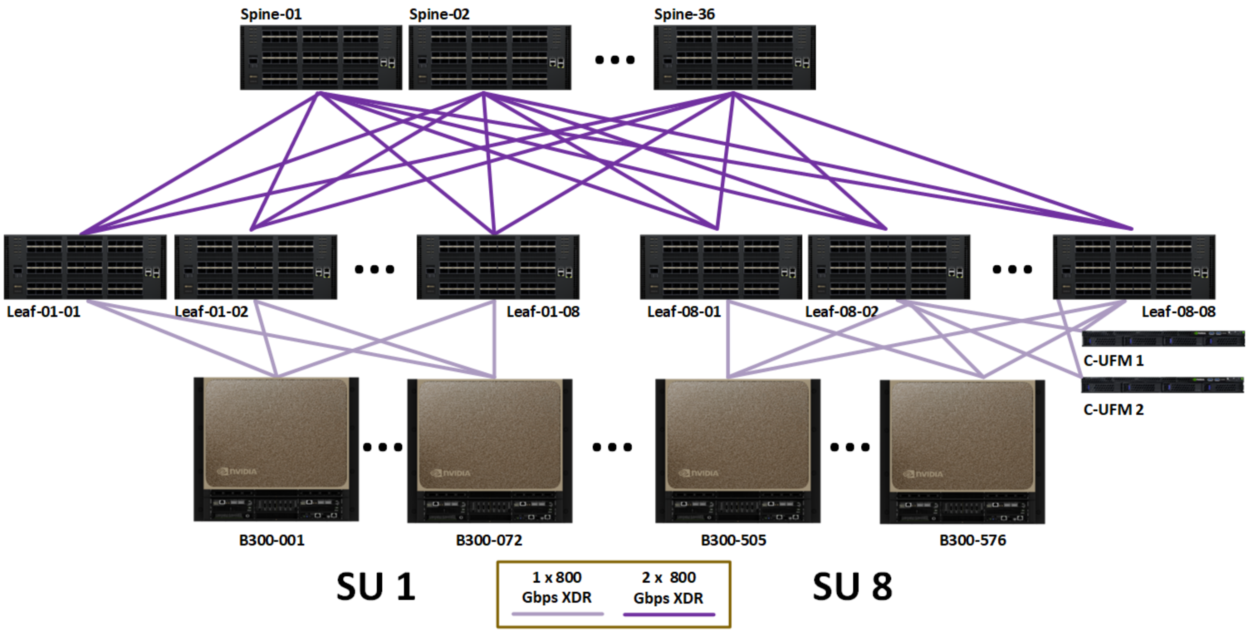

Figure 4.2: Compute fabric for full 576-node DGX SuperPOD

4.2. InfiniBand Storage Fabric

The storage fabric employs an InfiniBand network fabric that is essential to maximum bandwidth (Figure 4.3). This is because the I/O per-node for the DGX SuperPOD must exceed 80 GBps. High bandwidth- requirements with advanced fabric management features, such as congestion control and AR, provide significant benefits for the storage fabric.

There are two storage fabric options for NVIDIA DGX SuperPOD. The InfiniBand storage fabric uses MQM9700-NS2R (AC power) or *MQM9701-NS2R* (DC power) NDR switches (Figure 4.4). The high-speed storage devices are connected at a 1:1 port to uplink ratio. The DGX B300 system connections are slightly oversubscribed with a ratio near 4:3 with adjustments as needed to enable more storage flexibility regarding cost and performance.

4.3. Ethernet Storage Fabric

There are two storage fabric options for NVIDIA DGX SuperPOD. The Ethernet storage fabric employs a high-speed Ethernet network fabric that is essential to maximum bandwidth (Figure 4.5). This is because the I/O per-node for the DGX SuperPOD must exceed 80 GBps per SU. High bandwidth requirements with advanced fabric management features, provide significant benefits for the storage

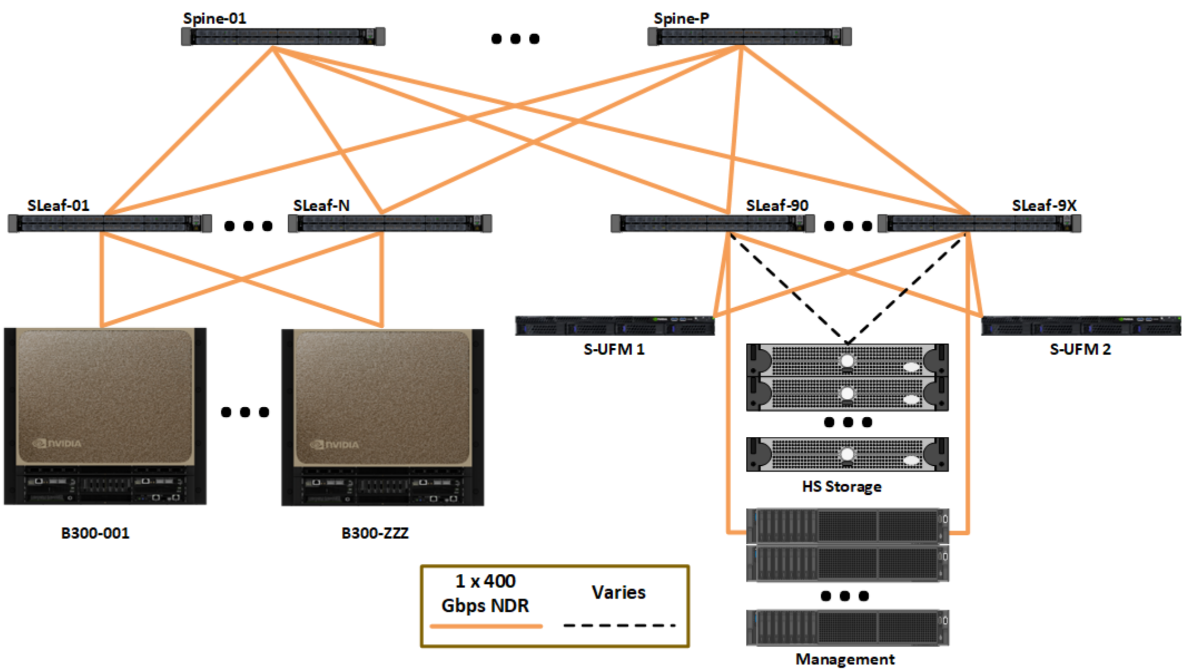

Figure 4.3: Storage fabric logical design

Figure 4.4: MQM9700-NS2F switch

fabric. Supported ethernet storage appliance leverages RoCE to provide best performance and minimizes CPU usage.

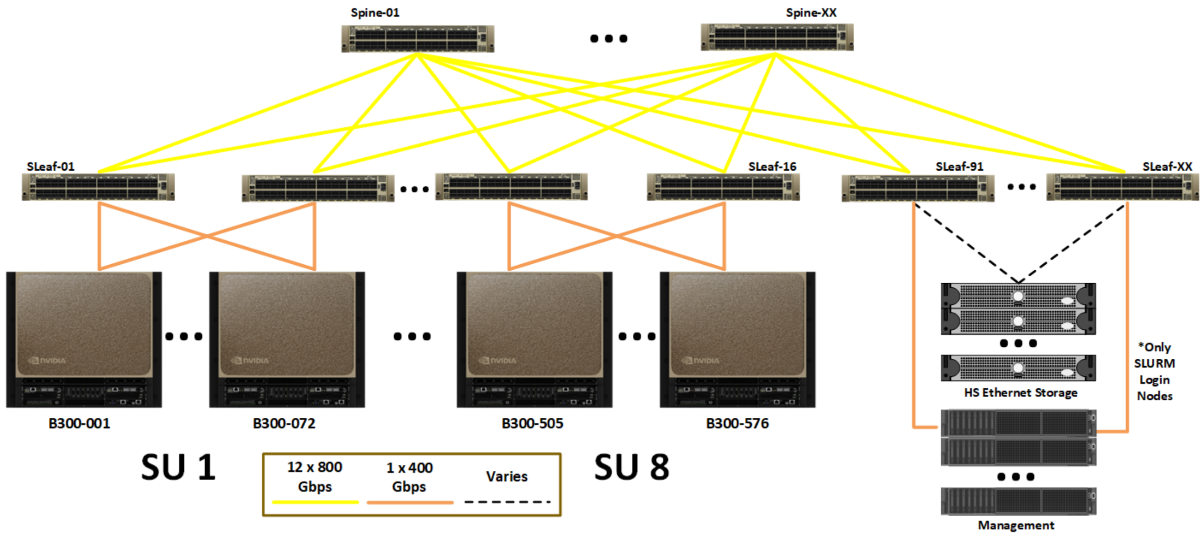

Figure 4.5: Ethernet Storage fabric logical design

The storage fabric uses SN5610 (AC power) or SN5600D (DC power) switches (Figure 4.6). The high-speed storage devices are connected at a 1:1 port to uplink ratio. The DGX B300 system connections are slightly oversubscribed with a ratio near 4:3 with adjustments as needed to enable more storage flexibility regarding cost and performance.

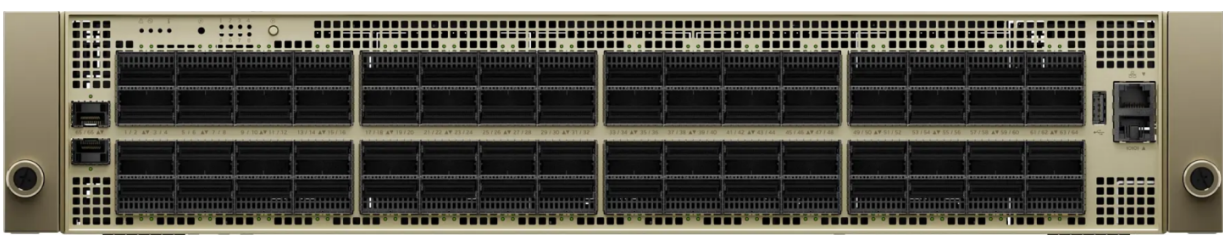

Figure 4.6: NVIDIA Spectrum SN5610 Ethernet Switch

4.4. Network Segmentation of the Ethernet Fabric

The ethernet fabric is segmented into these segments on the DGX SuperPOD:

- In-band Network
- Out-of-Band Management Network

In this reference design, the entire ethernet fabric (except for potential dedicated storage and compute fabric), is built on a common physical network, and segregated with VXLAN and EVPN to achieve network isolation between control traffic and admin traffic. VTEPs for different network segments terminate on the leaf switches (either SN2201 or SN5610D) for the access to different networks.

In the following, we introduce these networks in detail.

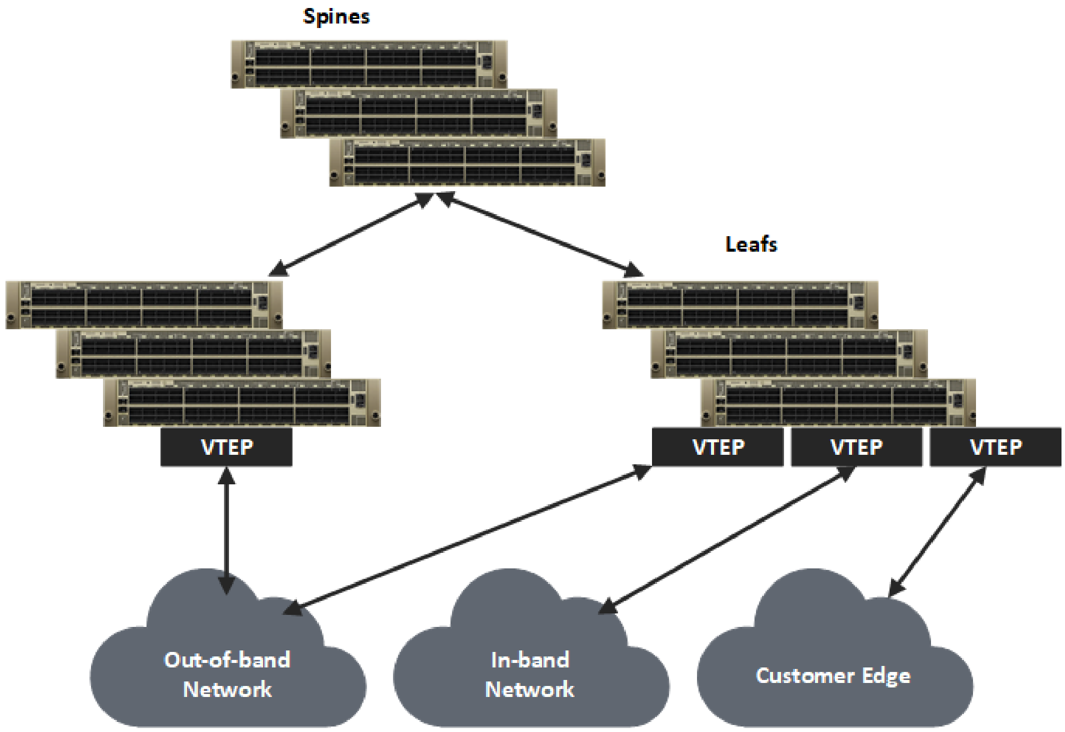

Figure 4.7: Network Segmentation diagram

4.4.1. In-band Management Network

The in-band management network provides several key functions:

- Connects all the services that manage the cluster.
- Enables access to the lower-speed, NFS tier of storage.
- Provides uplink (border) connectivity for the in-cluster services such as Mission Control, Base Command Manager, Slurm, and Kubernetes to other services outside of the cluster such as the NGC registry, code repositories, and data sources.
- Provides end user access to the Slurm head nodes and Kubernetes services.

The in-band management network uses SN5610 switches (Figure 4.6 and Figure 4.8).

4.4.2. Out-of-Band Management Network

Figure 4.9 shows the OOB Ethernet fabric. It connects the management ports of all devices including DGX B300 compute trays including system BMCs and BlueField-3 BMCs, switches, and management servers, storage, networking gear, rack PDUs, and all other devices. These are separated onto their own network. There is no use-case where a non-privileged user needs direct access to these ports and are secured using logical network separation.

The OOB network carries all IPMI related control traffic and serves as the network for fabric management of the compute InfiniBand fabric and compute fabric.

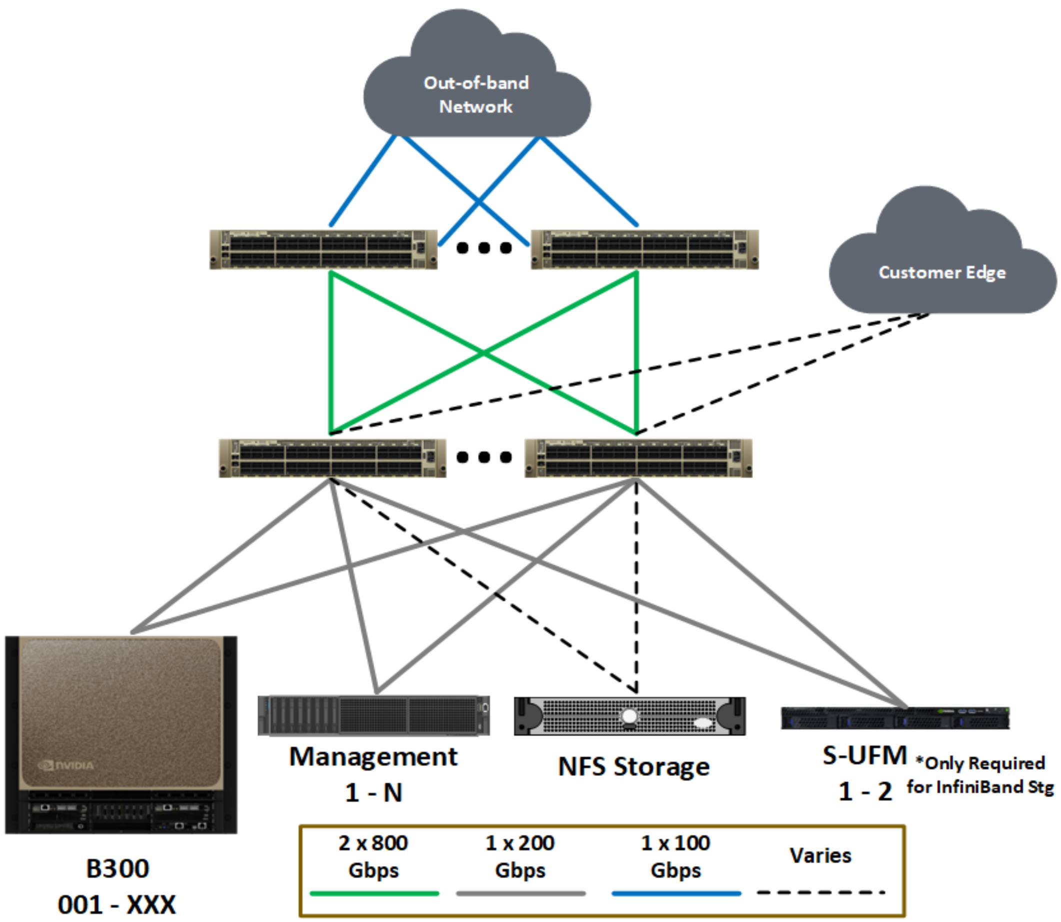

Figure 4.8: In-band Ethernet network

The OOB network is physically rolled up into the aggregation layer (spine layer) of each SU as a dedicated VXLAN. The OOB management network use SN2201 switches, shown in Figure 4.10.

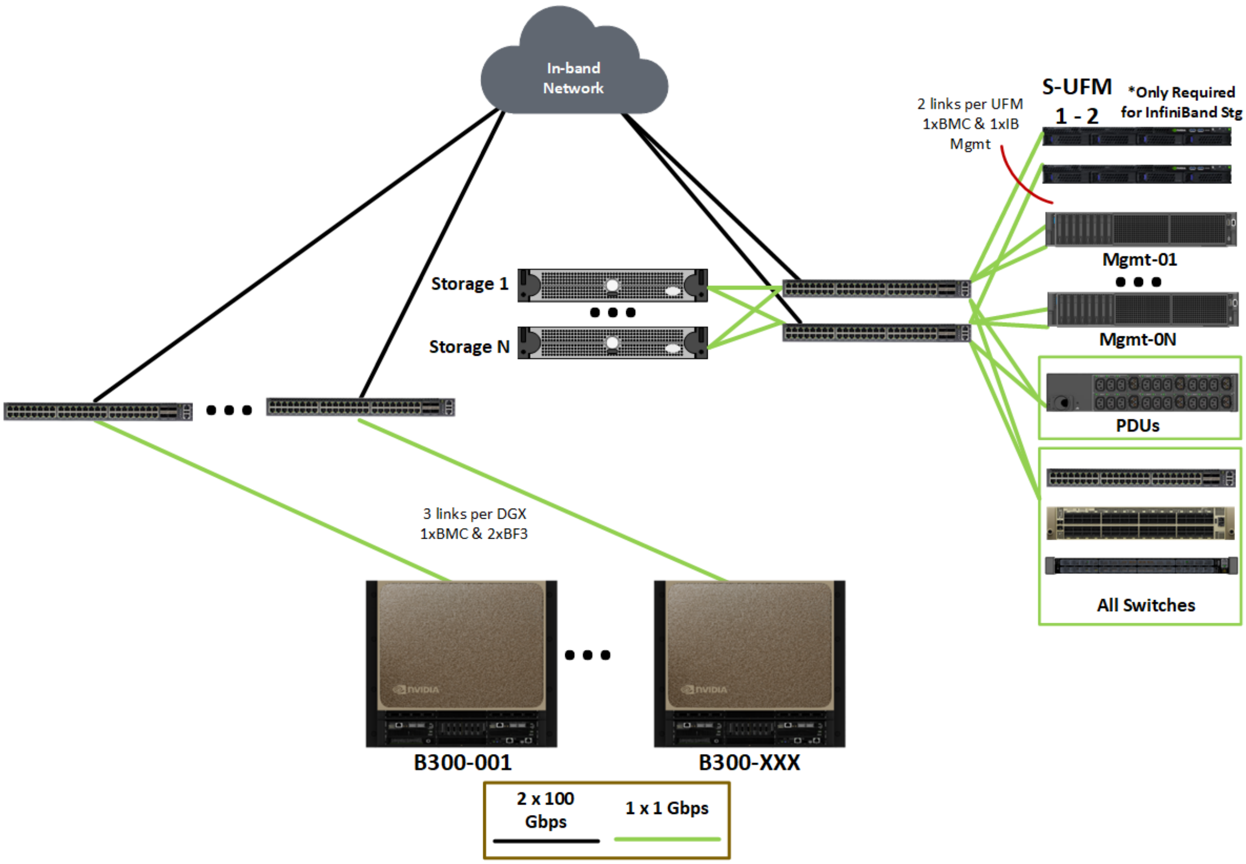

Figure 4.9: Logical OOB management network layout

The OOB management network uses SN2201 (AC or DC) switches (Figure 4.10).

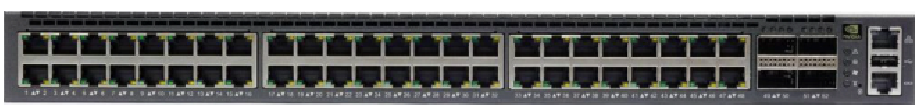

Figure 4.10: SN2201 switch

4.5. Customer Edge Connectivity

For connecting DGX SuperPOD to customer edge for uplink and customer corporate network access, we recommend at least 2x 100GbE links with DR1 single-mode connectivity to cope with the growing demand on high-speed data transfer into and from DGX SuperPOD.

For route handover, we prepare BGP protocol to peer with customer's network. Routes to/from in-band and out-of-band are announced.

Customers, who cannot provide DR1-based connectivity, are encouraged to use a pair of dedicated border leaf switches to enhance the connectivity (not as part of the SuperPOD).

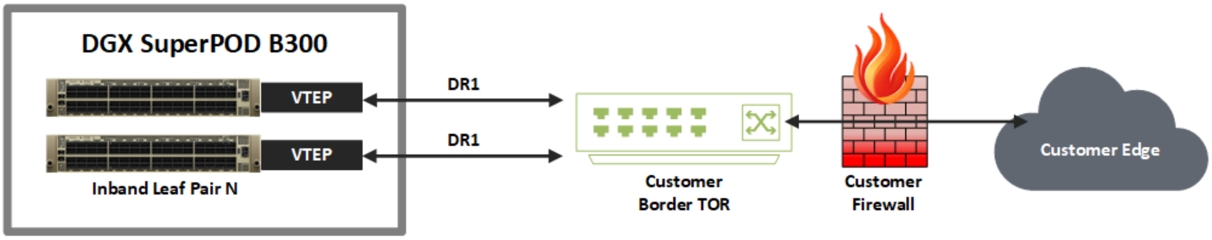

Figure 4.11: Customer Edge Example

4.6. User Storage Connectivity

For the operation with DGX SuperPOD, customers are required to provide an NFS-based home storage / configuration storage, to be integrated with NVIDIA Mission Control.

SuperPOD with DGX B300 supports storage integration with single-mode DR1 (or compatible 100G SerDes) connectivity for user storage. User storage is connected to the leaf-layer SN5610.

If customer provided User Storage does not support DR1 connectivity, we recommend they implement border TORs that would be able to connect to the SN5610.

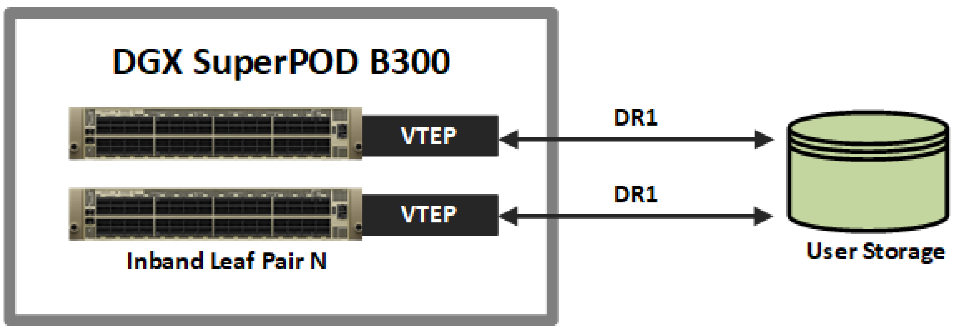

Figure 4.12: User Storage Example

Chapter 5. High Performance Storage Architecture

Data, lots of data, is the key to the development of accurate deep learning (DL) models. Data volume continues to grow exponentially, and data used to train individual models continues to grow as well. Data format, not just volume can play a key factor in the rate at which data is accessed so storage system performance must scale commensurately.

The key I/O operation in DL training is re-read. It is not just that data is read, but it must be reused repeatedly due to the iterative nature of DL training. Pure read performance still is important as some model types can train in a fraction of an epoch (ex: some recommender models) and inference of existing can be highly I/O intensive, much more so than training. Write performance can also be important. As DL models grow and time-to-train, writing checkpoints is necessary for fault tolerance. The size of checkpoint files can be terabytes in size and while not written frequently are typically written synchronously than blocks and block forward progress of DL models.

Ideally, data is cached during the first read of the dataset, so data does not have to be retrieved across the network. Shared filesystems typically use RAM as the first layer of cache. Reading files from cache can be an order of magnitude faster than from remote storage. In addition, the DGX B300 system provides local NVMe storage that can also be used for caching or staging data.

DGX SuperPOD is designed to support all workloads, but the storage performance required to maximize training performance can vary depending on the type of model and dataset. The guidelines in Table 5.1 and Table 5.2 are provided to help determine the I/O levels required for different types of models.

Table 5.1: Storage performance requirements

Level	Work Description	Dataset Size
Standard	Multiple concurrent LLM or fine-tuning training jobs and periodic checkpoints, where the compute requirements dominate the data I/O requirements significantly.	Most datasets can fit within the local compute systems' memory cache during training. The datasets are single modality, and models have millions of parameters.
Enhanced	Multiple concurrent multimodal training jobs and periodic checkpoints, where the data I/O performance is an important factor for end-to-end training time.	Datasets are too large to fit into local compute systems' memory cache requiring more I/O during training, not enough to obviate the need for frequent I/O. The datasets have multiple modalities and models have billions (or higher) of parameters.

Table 5.2: Guidelines for storage performance

Performance Characteristic	Good (GBps)	Better (GBps)
Single SU aggregate system read	80	250
Single SU aggregate system write	40	124
8 SU aggregate system read	640	2000
8 SU aggregate system write	320	992

High-speed storage provides a shared view of an organization's data to all nodes. It must be optimized for small, random I/O patterns, and provide high peak node performance and high aggregate filesystem performance to meet the variety of workloads an organization may encounter. High-speed storage should support both efficient multi-threaded reads and writes from a single system, but most DL workloads will be read-dominant.

Use cases in automotive and other computer vision-related tasks, where high-resolution images are used for training (and in some cases are uncompressed) involve datasets that easily exceed 30 TB in size. In these cases, 4 GBps per GPU of read performance is required.

While NLP and LLM cases often do not require as much read performance for training, peak performance for reads and writes are needed for creating and reading checkpoint files. This is a synchronous operation, and training stops during this phase. If you are looking for best end-to-end training performance, do not ignore I/O operations for checkpoints. Consider at least ½ of the read performance as recommended write performance for LLM and large model use cases.

The preceding metrics assume a variety of workloads, datasets, and need for training locally and directly from the high-speed storage system. It is best to characterize workloads and organizational needs before finalizing performance and capacity requirements.

Chapter 6. Management Servers

For DGX SuperPOD with DGX B300 systems, we provide two means of cluster access for end users (AI practitioners):

- With SLURM – best fit for pretraining-type of workflow, with bare-metal or containerized access to the compute infrastructure.
- With Kubernetes and NVIDIA Run:ai.

To support the operations, monitoring, and installation of the DGX SuperPOD, a set of management servers is required.

6.1. Management Server Quantities and Connectivity

These nodes are used for the following purposes:

- Base Command Manager in High Availability (HA): 2 Nodes, connects to Inband and OOB
- K8s Management Server: 3 Nodes, connects to Inband and storage
- SLURM Login Nodes, 2 Nodes, connects to Inband and storage
- All devices connect to OOB with 1GbE for IPMI/Redfish as well.

Table 6.1: Control Plane Node Form Factor Requirement

System	Power Supply, Form Factor
B300 PDU	AC, EIA
B300 Busbar	DC, MGX

Chapter 7. DGX SuperPOD Software

DGX SuperPOD is an integrated hardware and software solution. The included software (Figure 7.1) is optimized for AI from top to bottom. From the accelerated frameworks and workflow management to system management and low-level operating system (OS) optimizations, every part of the stack is designed to maximize the performance and value of DGX SuperPOD.

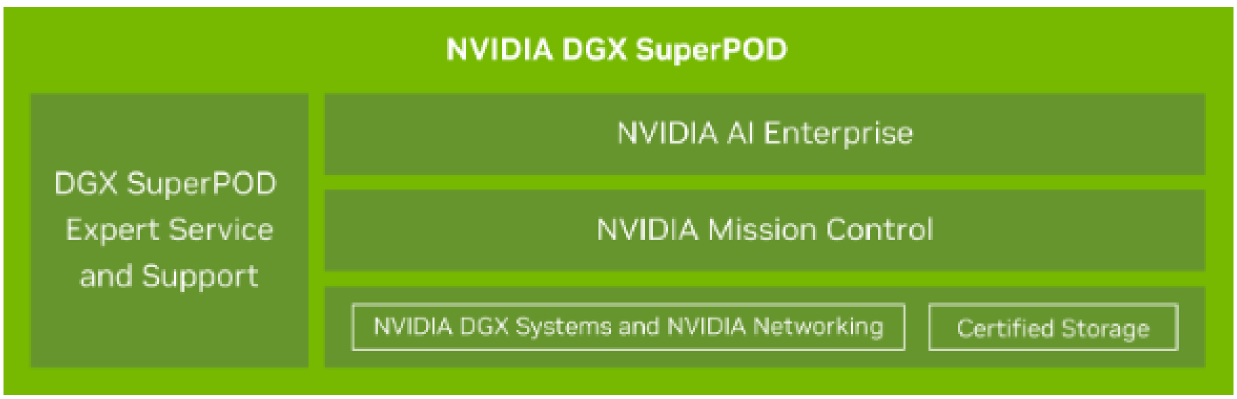

Figure 7.1: DGX SuperPOD high-level software architecture

7.1. NVIDIA Mission Control

NVIDIA Mission Control is the standard for every DGX SuperPOD with DGX B300. It streamlines AI operations, from workloads to infrastructure, with world-class expertise delivered as software powering AI data centers, bringing instant agility for inference and training while providing full-stack intelligence for infrastructure resilience. Every enterprise can run AI with hyperscale efficiency, simplifying and accelerating AI experimentation.

NVIDIA Mission Control includes NVIDIA Base Command Manager and NVIDIA Run:ai functionality as part of integrated software delivery across configuration, validation, and operations.

7.2. NVIDIA Base Command Manager

NVIDIA Base Command Manager offers fast deployment and basic end-to-end management for heterogeneous AI and HPC clusters. It automates provisioning and administration of DGX SuperPOD from hundreds to thousands of nodes.

7.3. NVIDIA Run:ai

NVIDIA Run:ai is cloud native AI workload and GPU orchestration platform that simplifies and accelerates AI and machine learning with DGX SuperPOD through dynamic resource allocation, comprehensive AI lifecycle support, strategic resource management and advanced scheduling. Run:ai maximizes GPU efficiency and workload capacity. Its policy engine, open architecture, and visibility into AI workloads foster strategic alignment with business objectives.

7.4. NVIDIA NGC

NVIDIA NGC provides software to meet the needs of data scientists, developers, and researchers with various levels of AI expertise.

Software hosted on NGC undergoes scans against an aggregated set of common vulnerabilities and exposures (CVEs), crypto, and private keys.

Software from the NGC catalog is tested and ensured to scale to multiple GPUs and in some cases, to scale to multi-node, ensuring users maximize the use of their DGX SuperPOD.

7.5. NVIDIA AI Enterprise

NVIDIA AI Enterprise is the end-to-end software platform that brings generative AI into reach for every enterprise, providing the fastest and most efficient runtime for generative AI foundation models developed with the NVIDIA DGX platform. With production-grade security, stability, and manageability, it streamlines the development of generative AI solutions. NVIDIA AI Enterprise is included with DGX SuperPOD for enterprise developers to access pretrained models, optimized frameworks, microservices, accelerated libraries, and enterprise support.

Chapter 8. Summary

DGX SuperPOD with NVIDIA DGX B300 systems is the next generation of data center scale architecture to meet the demanding and growing needs of AI training. This RA document for DGX SuperPOD represents the architecture used by NVIDIA for our own AI model and HPC research and development. DGX SuperPOD continues to build upon its high-performance roots to enable training of the largest NLP models, support the expansive needs of training models for automotive applications, and scaling-up recommender models for greater accuracy and faster turn-around-time.

DGX SuperPOD represents a complete system of not just hardware but all the necessary software to accelerate time-to-deployment, streamline system management, proactively identify system issues. The combination of all these components keeps systems running reliably, with maximum performance, and enables users to push the bounds of state-of-the-art. The platform is designed to both support the workloads of today and grow to support tomorrow's applications.

Chapter 9. Major Components

Major components for the DGX SuperPOD configuration are listed in Table 9.1. These are representative of the configuration and must be finalized based on actual design.

Table 9.1: Major components of the 8 SU, 576-node DGX SuperPOD (AC Version)

Count	Component	Recommended Model
DGX Compute and Racks		
576	DGX B300	DGXB300-AC
144	19" Standard AC, AIE for DGX Nodes	Legrand NVIDPD13 or equivalent
48	19" Standard AC, AIE for Switches and Management	Legrand NVIDPD13 or equivalent
432	DGX rPDU for Standard Rack	Raritan (PX3-5091R-P1Q2R1A5) or Equiv
96	Mgmt Vertical PDU	Raritan (PX3-5747V-V2) or equivalent
7	AC Powered x86 Control Nodes for Mission Control	Dell validated control plane nodes
Compute Fabric		
64	IB XDR (Q3400-RA) - Compute Leafs - AC	920-9B36F-00RX-8S0
36	IB XDR (Q3400-RA) - Compute Spines - AC	920-9B36F-00RX-8S0
4608	Transceivers on DGX	980-9IATO-00XM00
2034	Twin port OSFP Transceivers on Leaf <-> DGX	980-9IAH1-00XM00
4608	Twin port OSFP Transceivers on Leaf <-> Spine	980-9IAH1-00XM00
4608	DGX-Leaf Cable	980-9I570-00N030
4608	Leaf-Spine Cable	980-9I570-00N030
Ethernet Storage Fabric		
16	SP4 (SN5610) - Storage Leafs DGX Side - AC	920-9N42F-00RI-3C1
4	SP4 (SN5610) - Storage Leafs Storage Side - AC	920-9N42F-00RI-3C1
12	SP4 (SN5610) - Storage Spines - AC	920-9N42F-00RI-3C1

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Table 9.1 – continued from previous page

Count	Component	Recommended Model
1152	400G Transceiver (for BF3240)	980-9I693-F4NS00
8	400G Transceiver (for Control Plane Nodes)	980-9I693-F4NS00
576	Twin port OSFP Transceivers on Leaf <-> Spine	980-9I510-F4NS00
1152	DGX-Leaf Cable	980-9I570-00N030
1120	Leaf-Spine Cable	980-9I570-00N030
InfiniBand Storage Fabric		
16	NDR Switches, Storage Leaf DGX Side	920-9B210-00FN-0M0
8	NDR Switches, Storage Leaf Storage Side	920-9B210-00FN-0M0
8	NDR Switches, storage spines	920-9B210-00FN-0M0
512	400G Transceiver (for BF3240)	980-9I693-00NS00
8	400G Transceiver (for Control Plane Nodes and UFM)	980-9I51S-00NS00
324	Twin port OSFP Transceivers on Leaf <-> DGX/storage/Mgmt	980-9I510-00NS00
512	Twin port OSFP Transceivers on Leaf <-> Spine	980-9I510-00NS00
2	UFM Appliance 3.5	920-9B020-00RA-0D0
2	UFM <-> Inband Transceiver	980-9I693-F4NS00
648	Leaf Cable	980-9I570-00N030
512	Leaf-Spine Cable	980-9I570-00N030
Inband Fabric		
6	SP4 (SN5610) - Inband Leafs	920-9N42F-00RI-3C1
2	SP4 (SN5610) - Inband Spines	920-9N42F-00RI-3C1
1152	400G Transceiver (for BF3240)	980-9I693-F4NS00
24	400G Transceiver (for Control Plane Nodes)	980-9I51S-F4NS00
294	Twin port OSFP Transceivers on Leaf <-> DGX, Management	980-9I510-F4NS00
48	Twin port OSFP Transceivers on Leaf <-> Spine	980-9I510-F4NS00
589	DGX, Mgmt - Leaf Cable	980-9I557-00N030
48	Leaf-Spine Cable	980-9I570-00N030
10	800G Transceivers (between leaf -> NFS & Uplink)	980-9I30H-F4NM00
20	DR4 -> 4x DR1 Fabric Splitter Leaf->NFS, SN2201, Uplink	NV08M31P2X1BHM020
4	100G DR1 (Uplink, NFS -> SP4)	Customer provided

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Table 9.1 – continued from previous page

Count	Component	Recommended Model
32	DR1 Storage	980-9I042-00C000
Out of Band Management		
69	SN2201	920-9N110-00R1-0C0
3290	Total RJ45 Count	Cat6
138	100G DR1 Transceiver (SN2201 @OOB)	980-9I042-00C000
36	800G optics (SN5610 Inband Spines -> SN2201)	980-9I30H-F4NM00

For the reference design, we assumed the following storage and management requirement:

- 7 Control Plane Nodes with 4 OSFP (CX7/CX8) connectors each
- 32x 100GbE ports for Home / NFS Storage
- 256x 400GbE/NDR ports for High Performance Storage
- 258x 1 GbE OOB ports for High Performance Storage and Home Storage
- 2x 1GbE Inband ports for High Performance Storage

Chapter 10. Notices

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