SUSE® Enterprise Storage on Ampere® eMAG

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Contents

1 Introduction

The objective of this guide is to present a step-by-step guide on how to implement SUSE Enterprise Storage (6) on the Ampere eMAG platform. It is suggested that the document be read in its entirety, along with the supplemental appendix information before attempting the process.

The deployment presented in this guide aligns with architectural best practices and will support the implementation of all currently supported protocols as identified in the SUSE Enterprise Storage documentation.

Upon completion of the steps in this document, a working SUSE Enterprise Storage (6) cluster will be operational as described in the SUSE Enterprise Storage Deployment Guide. (https://documentation.suse.com/ses/6/single-html/ses-deployment/#book-storage-deployment)

2 Target Audience

This reference guide is targeted at administrators who deploy software defined storage solutions within their data centers and make that storage available to end users. By following this document, as well as those referenced herein, the administrator should have a full view of the SUSE Enterprise Storage architecture, deployment and administrative tasks, with a specific set of recommendations for deployment of the hardware and networking platform.

3 Business Value

SUSE Enterprise Storage

SUSE Enterprise Storage delivers a highly scalable, resilient, self-healing storage system designed for large scale environments ranging from hundreds of Terabytes to Petabytes. This software defined storage product can reduce IT costs by leveraging industry standard servers to present unified storage servicing block, file, and object protocols. Having storage that can meet the current needs and requirements of the data center while supporting topologies and protocols demanded by new web-scale applications, enables administrators to support the ever-increasing storage requirements of the enterprise with ease.

Ampere eMAG

The Ampere eMAG server is an high performance, power efficient data center class platform featuring 32 Ampere-designed 64-bit Armv8 cores running up to 3.3 GHz. Designed for cloud data center workloads, the eMAG server is ideal scalable performance applications like the SUSE Enterprise Storage stack. The server processor has the following features: * 32 Ampere Armv8 64-bit CPU cores at 3.3 GHz Sustained - SBSA Level 3 * 32 KB L1 I-cache, 32KB L1 D-cache per core * Shared 256 KB L2 cache per 2 cores * 32MB globally shared L3 cache * 8x 72-bit DDR4-2667 channels * ECC, ChipKill, and DDR4 RAS features * Up to 16 DIMMs and 1TB/socket * 42 lanes of PCIE Gen 3, with 8 controllers * TDP: 75-125W

+ Also included in this configuration are the following key peripherals and infrastructure components that can be used to build a very high performance Ceph based storage cluster:

Micron

Enterprise IT and cloud managers want the fast, low latency and consistent performance of NVMe storage that won't break the budget. * The 7300 NVMe SSDs leverage the low power consumption and price-performance efficiencies of 3D NAND technology and deliver fast NVMe IOPS and GB/s for a wide array of workloads. * Built with the innovative 96-layer 3D TLC NAND, the 5300 series combines the latest in NAND technology and a proven architecture to provide performance upgrades now and a path forward for moving to an all-flash future. The 5300's high capacity, added security, and enhanced endurance enable strong performance.

NVIDIA

System Network Interface Card

MCX653105A-HDAT ConnectX-6 VPI Adapter is the world's first 200Gb/s capable HDR InfiniBand and Ethernet network adapter card, offering industry-leading performance, smart offloads and in-network computing, leading to the highest return on investment for high-performance computing, cloud, web 2.0, storage and machine learning applications.

Network Switch

Spectrum-2 MSN3700C is a 1U 32-port 100GbE spine that can also be used as a high density 10/25GbE leaf when used with splitter cables. SN3700C allows for maximum flexibility, with ports spanning from 1GbE to 100GbE and port density that enables full rack connectivity to any server at any speed, and a variety of blocking ratios. SN3700C ports are fully splittable to up to 128 x 10/25GbE ports.

Broadcom

The high-port 9500-16i Tri-Mode, PCIe Gen 4.0 HBA is ideal for increased connectivity and maximum performance for enterprise data center flexibility. With increased bandwidth and IOPS performance compared to previous generations, the 9500-16i adapter delivers the performance and scalability needed by critical applications. * Connects up to 1024 SAS/SATA devices or 32 NVMe devices * Provides maximum connectivity and performance for high-end servers and applications * Support critical applications with the bandwidth of PCIe® 4.0 connectivity * Universal Bay Management (UBM) Ready

4 Hardware & Software

The recommended architecture for SUSE Enterprise Storage on Ampere eMAG leverages two models of Ampere servers. The role and functionality of each type of system within the SUSE Enterprise Storage environment will be explained in more detail in the architectural overview section.

STORAGE NODES:

- Ampere eMAG Core 2U Servers (Lenovo HR350A)

ADMIN, MONITOR, AND PROTOCOL GATEWAYS:

- Ampere eMAG 32 Core 1U Servers (Lenovo HR330A)

SWITCHES:

- NVIDIA Spectrum-2 MSN3700C 100Gb

SOFTWARE:

- SUSE Enterprise Storage (6)
- SUSE Linux Enterprise Server 15 SP1

TIP

Please note that limited use SUSE Linux Enterprise Server operating system subscriptions are provided with SUSE Enterprise Storage as part of the subscription entitlement

5 Requirements

Enterprise storage systems require reliability, manageability, and serviceability. The legacy storage players have established a high threshold for each of these areas and now expect the software defined storage solutions to offer the same. Focusing on these areas helps SUSE make open source technology enterprise consumable. When combined with highly reliable and manageable hardware from Ampere, the result is a solution that meets the customer's expectation.

5.1 Functional Requirements

A SUSE Enterprise Storage solution is:

- Simple to setup and deploy, within the documented guidelines of system hardware, networking and environmental prerequisites.
- Adaptable to the physical and logical constraints needed by the business, both initially and as needed over time for performance, security, and scalability concerns.
- Resilient to changes in physical infrastructure components, caused by failure or required maintenance.
- Capable of providing optimized object and block services to client access nodes, either directly or through gateway services.

6 Architectural Overview

This architecture overview section complements the SUSE Enterprise Storage Technical Overview (https://www.suse.com/docrep/documents/1mdg7eq2kz/suse_enterprise_storage_technical_overview_wp.pdf) document available online which presents the concepts behind software defined storage and Ceph as well as a quick start guide (non-platform specific).

6.1 Solution Architecture

SUSE Enterprise Storage provides unified block, file, and object access based on Ceph. Ceph is a distributed storage solution designed for scalability, reliability and performance. A critical component of Ceph is the RADOS object storage. RADOS enables a number of storage nodes to function together to store and retrieve data from the cluster using object storage techniques. The result is a storage solution that is abstracted from the hardware. Ceph supports both native and traditional client access. The native clients are aware of the storage topology and communicate directly with the storage daemons over the public network, resulting in horizontally scaling performance. Non-native protocols, such as ISCSI, S3, and NFS require the use of gateways. While these gateways may be thought of as a limiting factor, the ISCSI and S3 gateways can scale horizontally using load balancing techniques.

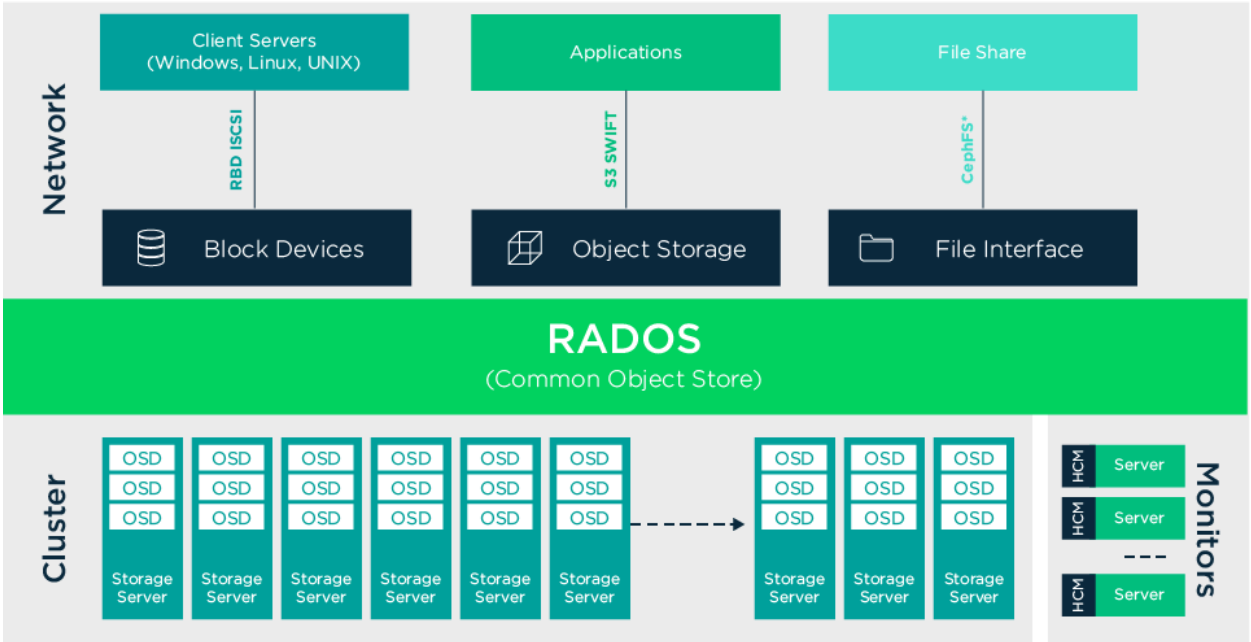

FIGURE 1: CEPH ARCHITECTURE

In addition to the required network infrastructure, the minimum SUSE Enterprise Storage cluster is comprised of a minimum of one administration server (physical or virtual), four object storage device nodes (OSDs), and three monitor nodes (MONs).

SPECIFIC TO THIS IMPLEMENTATION:

- One system is deployed as the administrative host server. The administration host is the Salt-master and hosts the SUSE Enterprise Storage Administration Interface, openATTIC, which is the central management system which supports the cluster.
- Three systems are deployed as monitor (MONs) nodes. Monitor nodes maintain information about the cluster health state, a map of the other monitor nodes and a CRUSH map. They also keep history of changes performed to the cluster.

- Additional servers may be deployed as iSCSI gateway nodes. iSCSI is a storage area network (SAN) protocol that allows clients (called initiators) to send SCSI command to SCSI storage devices (targets) on remote servers. This protocol is utilized for block-based connectivity to environments such as Microsoft Windows, VMware, and traditional UNIX. These systems may be scaled horizontally through client usage of multi-path technology.
- The RADOS gateway provides S3 and Swift based access methods to the cluster. These nodes are generally situated behind a load balancer infrastructure to provide redundancy and scalability. It is important to note that the load generated by the RADOS gateway can consume a significant amount of compute and memory resources making the minimum recommended configuration contain 6-8 CPU cores and 32GB of RAM.
- SUSE Enterprise Storage requires a minimum of four systems as storage nodes. The storage nodes contain individual storage devices that are each assigned an Object Storage Daemon (OSD). The OSD assigned to the device stores data and manages the data replication and rebalancing processes. OSDs also communicate with the monitor (MON) nodes and provide them with the state of the other OSDs.

6.2 Networking Architecture

A software-defined solution is only as reliable as its slowest and least redundant component. This makes it important to design and implement a robust, high performance storage network infrastructure. From a network perspective for Ceph, this translates into:

- Separation of cluster (backend) and client-facing (public) network traffic. This isolates Ceph OSD replication activities from Ceph clients. This may be achieved through separate physical networks or through use of VLANs.
- Redundancy and capacity in the form of bonded network interfaces connected to switches.

The following figure shows the logical layout of the traditional Ceph cluster implementation.

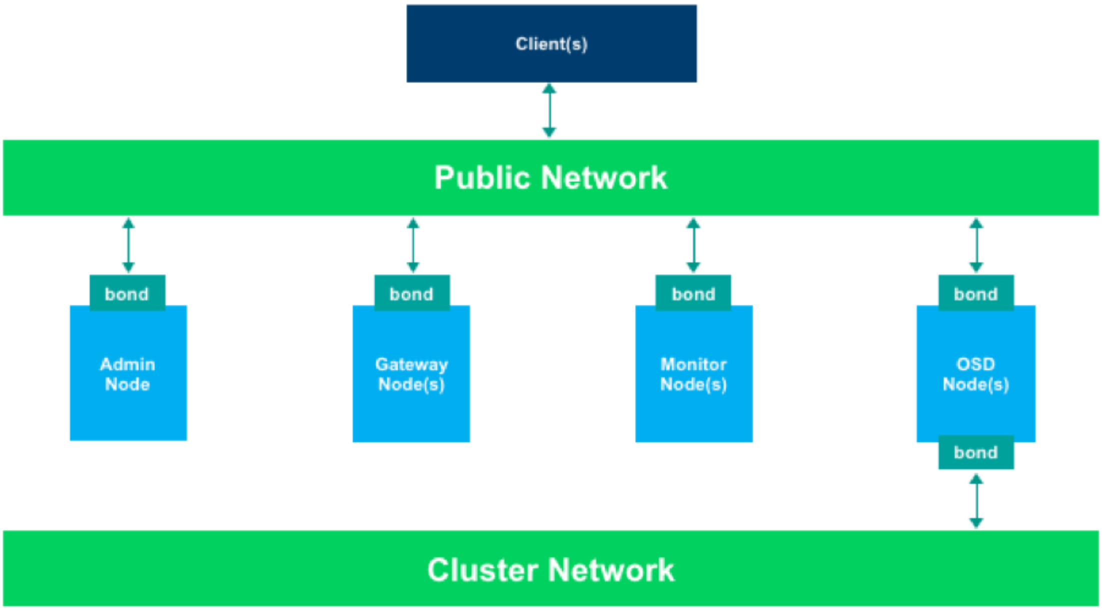

FIGURE 2: CEPH NETWORK ARCHITECTURE

7 Component Model

The preceding sections provided information on the both the overall Ampere hardware as well as an introduction to the Ceph software architecture. In this section, the focus is on the SUSE components: SUSE Linux Enterprise Server (SLES), SUSE Enterprise Storage (SES), and the Repository Mirroring Tool (RMT).

COMPONENT OVERVIEW (SUSE)

- SUSE Linux Enterprise Server - A world class secure, open source server operating system, equally adept at powering physical, virtual, or cloud-based mission-critical workloads. Service Pack 3 further raises the bar in helping organizations to accelerate innovation, enhance system reliability, meet tough security requirements and adapt to new technologies.

- Repository Mirroring Tool (RMT) for SLES - allows enterprise customers to optimize the management of SUSE Linux Enterprise (and extensions such as SUSE Enterprise Storage) software updates and subscription entitlements. It establishes a proxy system for SUSE Customer Center (SCC) with repository and registration targets.
- SUSE Enterprise Storage - Provided as an extension on top of SUSE Linux Enterprise Server, this intelligent software-defined storage solution, powered by Ceph technology with enterprise engineering and support from SUSE enables customers to transform enterprise infrastructure to reduce costs while providing unlimited scalability.

8 Deployment

This deployment section should be seen as a supplement online documentation. (https://www.suse.com/documentation/) Specifically, the SUSE Enterprise Storage (6) Deployment Guide (https://documentation.suse.com/ses/6/single-html/ses-deployment/#book-storage-deployment) as well as SUSE Linux Enterprise Server Administration Guide. (https://documentation.suse.com/sles/15-SP1/single-html/SLES-admin/#book-sle-admin) It is assumed that a Repository Mirroring Tool server exists within the environment. If not, please follow the information in Repository Mirroring Tool (RMT) for SLES (https://documentation.suse.com/sles/15-SP1/single-html/SLES-rmt/#book-rmt) to make one available. The emphasis is on specific design and configuration choices.

8.1 Network Deployment Overview

The following considerations for the network configuration should be attended to:

- Ensure that all network switches are updated with consistent firmware versions.
- Specific configuration for this deployment can be found in Appendix C: Network Switch Configuration & Appendix D: OS Networking Configuration
- Network IP addressing and IP ranges need proper planning. In optimal environments, a single storage subnet should be used for all SUSE Enterprise Storage nodes on the primary network, with a separate, single subnet for the cluster network. Depending on the size of the installation, ranges larger than /24 may be required. When planning the network, current as well as future growth should be taken into consideration.

- Setup DNS A records for all nodes. Decide on subnets and VLANs and configure the switch ports accordingly.
- Ensure that you have access to a valid, reliable NTP service, as this is a critical requirement for all nodes. If not, it is recommended to use the admin node.

Function	Hostname	Primary Network (VLAN)	Cluster Network (VLAN)
Admin	amp-admin.suse.lab	172.16.227.60	N/A
Monitor	amp-mon1.suse.lab	172.16.227.61	N/A
Monitor	amp-mon2.suse.lab	172.16.227.62	N/A
Monitor	amp-mon3.suse.lab	172.16.227.63	N/A
Gateway	amp-gw1.suse.lab	172.16.227.64	N/A
Gateway	amp-gw2.suse.lab	172.16.227.65	N/A
OSD	amp-osd1.suse.lab	172.16.227.59	172.16.220.59
OSD	amp-osd2.suse.lab	172.16.227.58	172.16.220.58
OSD	amp-osd3.suse.lab	172.16.227.57	172.16.220.57
OSD	amp-osd4.suse.lab	172.16.227.56	172.16.220.56
OSD	amp-osd5.suse.lab	172.16.227.55	172.16.220.55
OSD	amp-osd6.suse.lab	172.16.227.54	172.16.220.54
OSD	amp-osd7.suse.lab	172.16.227.53	172.16.220.52
OSD	amp-osd8.suse.lab	172.16.227.52	172.16.220.52
OSD	amp-osd9.suse.lab	172.16.227.51	172.16.220.51
OSD	amp-osd10.suse.lab	172.16.227.50	172.16.220.50

8.2 Operating System Installation

There are several key tasks to ensure are performed correctly during the operating system installation.

- During the SUSE Linux Enterprise installation, be sure and register the system with an update server. Ideally, this is a local RMT server which will reduce the time required for updates to be downloaded and applied to all nodes. By updating the nodes during installation, the system will deploy with the most up-to-date packages available, helping to ensure the best experience possible.
- To speed installation, on the System Role screen, it is suggested to select **Text Mode**. The resulting installation is a text mode server that is an appropriate base OS for SUSE Linux Enterprise Server.
- The next item is to ensure that the operating system is installed on the correct device. Especially on OSD nodes, the system may not choose the right drive by default. The proper way to ensure the right device is being used is to select **Create Partition Setup** on the Suggested Partitioning screen. This will then display a list of devices, allowing selection of the correct boot device. Next select **Edit Proposal Settings** and unselect the **Propose Separate Home Partition** checkbox.
- Do ensure that NTP is configured to point to a valid, physical NTP server. This is critical for SUSE Enterprise Storage to function properly, and failure to do so can result in an unhealthy or non-functional cluster.

8.3 SUSE Enterprise Storage Installation & Configuration

8.3.1 Software Deployment configuration (Deepsea and Salt)

Salt, along with DeepSea, is a stack of components that help deploy and manage server infrastructure. It is very scalable, fast, and relatively easy to get running.

There are three key Salt imperatives that need to be followed:

- The Salt Master is the host that controls the entire cluster deployment. Ceph itself should NOT be running on the master as all resources should be dedicated to Salt master services. In our scenario, we used the Admin host as the Salt master.
- Salt minions are nodes controlled by Salt master. OSD, monitor, and gateway nodes are all Salt minions in this installation.
- Salt minions need to correctly resolve the Salt master's host name over the network. This can be achieved through configuring unique host names per interface (e.g. osd1-cluster.suse.lab and osd1-public.suse.lab) in DNS and/or local /etc/hosts files.

Deepsea consists of a series of Salt files to automate the deployment and management of a Ceph cluster. It consolidates the administrator's decision making in a single location around cluster assignment, role assignment and profile assignment. Deepsea collects each set of tasks into a goal or stage.

The following steps, performed in order, will be used for this reference implementation:

1. Install DeepSea on the Salt master which is the Admin node:

   ```
   zypper in deepsea
   ```

2. Start the salt-master service and enable:

   ```
   systemctl start salt-master.service
   systemctl enable salt-master.service
   ```

3. Install the salt-minion on all cluster nodes (including the Admin):

   ```
   zypper in salt-minion
   ```

4. Configure all minions to connect to the Salt master:

   Modify the entry for master in the */etc/salt/minion*

   ```
   master: sesadmin.domain.com
   ```

5. Start the salt-minion service and enable:

   ```
   systemctl start salt-minion.service
   systemctl enable salt-minion.service
   ```

6. List and accept all Salt keys on the Salt master: salt-key --accept-all and verify their acceptance:

```
salt-key --list-all
salt-key --accept-all
```

7. Select the nodes to participate in the cluster:

```
salt '*' grains.append deepsea default
```

8. If the OSD nodes were used in a prior installation, zap ALL the OSD disks (ceph-disk zap <DISK>)

9. At this point, the cluster can be deployed.

   a. Prepare the cluster:

   ```
   salt-run state.orch ceph.stage.prep
   ```

   b. Run the discover stage to collect data from all minions and create configuration fragments:

   ```
   salt-run state.orch ceph.stage.disovery
   ```

   c. A proposal for the storage layout needs to be generated at this time. For the hardware configuration used for this work, the following command was utilized:

   ```
   salt-run proposal.populate name=default target='amp-osd*'
   ```

   The result of the above command is a deployment proposal for the disks that places the RocksDB, Write-Ahead Log (WAL), and on the same device.

   d. A */srv/pillar/ceph/proposals/policy.cfg* file needs to be created to instruct Salt on the location and configuration files to use for the different components that make up the Ceph cluster (Salt master, admin, monitor, and OSDs).

      - See Appendix B for the *policy.cfg* file used in the installation.

   e. Next, proceed with the configuration stage to parse the *policy.cfg* file and merge the included files into the final form

   ```
   salt-run state.orch ceph.stage.configure
   ```

f. The last two steps manage the actual deployment.

Deploy monitors and ODS daemons first:

```
salt-run state.orch ceph.stage.deploy
```

Note

The command can take some time to complete, depending on the size of the cluster.

g. Check for successful completion via:

```
ceph -s
```

h. Finally, deploy the services-gateways (iSCSI, RADOS, and openATTIC to name a few):

```
salt-run state.orch ceph.stage.services
```

8.3.2 Post-deployment quick test

The steps below can be used (regardless of the deployment method) to validate the overall cluster health:

```
ceph status
ceph osd pool create test 1024
rados bench -p test 300 write --no-cleanup
rados bench -p test 300 seq
```

Once the tests are complete, you can remove the test pool via:

```
ceph tell mon.* injectargs --mon-allow-pool-delete=true
ceph osd pool delete test test --yes-i-really-really-mean-it
ceph tell mon.* injectargs --mon-allow-pool-delete=false
```

8.4 Deployment Considerations

Some final considerations before deploying your own version of a SUSE Enterprise Storage cluster, based on Ceph. As previously stated, please refer to the Administration and Deployment Guide.

- With the default replication setting of 3, remember that the client-facing network will have about half or less of the traffic of the backend network. This is especially true when component failures occur or rebalancing happens on the OSD nodes. For this reason, it is important not to under provision this critical cluster and service resource.
- It is important to maintain the minimum number of monitor nodes at three. As the cluster increases in size, it is best to increment in pairs, keeping the total number of Mon nodes as an odd number. However, only very large or very distributed clusters would likely need beyond the 3 MON nodes cited in this reference implementation. For performance reasons, it is recommended to use distinct nodes for the MON roles, so that the OSD nodes can be scaled as capacity requirements dictate.
- As described in this implementation guide and the SUSE Enterprise Storage documentation, a minimum of four OSD nodes is recommended, with the default replication setting of 3. This will ensure cluster operation, even with the loss of a complete OSD node. Generally speaking, performance of the overall cluster increases as more properly configured OSD nodes are added.

9 Conclusion

The Ampere eMAG servers provides a strong capacity-oriented platform for enterprise, HPC or Cloud Ceph-based storage cluster. In addition to the strong raw performance demonstrated by this configuration as characterized in industry standard benchmarks like the IO500 workload, the Ampere systems provide a very compelling value proposition when combining its high performance the with the ultra-efficient power profile and the lighter than expected acquisition cost of the cluster! These features combined with the access flexibility and reliability of SUSE Enterprise Storage and industry leading support from Ampere allows any business to proceed confidently with a solution that addresses many storage use cases driven by the exponential growth in storage capacity and performance currently facing the industry.

10 Appendix A: Bill of Materials

Role	Qty	Component	Notes
Admin, monitor, and protocol gateways	6	Ampere 1U Servers (Lenovo HR330A)	Configuration: • 1x Ampere eMAG 8180 32Core 3.3GHz • 32GB DRAM (4x8 DIMM 2667) • 2x Micron 7300 PRO NVMe M.2 480GB • 1x NVIDIA MCX653105A-HDAT ConnectX-6 VPI Adapter
OSD Nodes	10	Ampere 2U Servers (Lenovo HR350A)	Configuration: • 1x Ampere eMAG 8180 32Core 3.3GHz • 128GB DRAM (8x16 DIMM 2667) • 2x Micron 240GB NVMe M.2 • 4x Micron 7300 PRO NVMe M.2 480GB • 1x Broadcom BRCM 9500-16i HBA • 1x NVIDIA MCX653105A-HDAT ConnectX-6 VPI Adapter
Network Switch	2	NVIDIA Spectrum-2 MSN3700C Switch	Updated with latest OS image

11 Appendix B: policy.cfg

```
cluster-ceph/cluster/*.sls
role-master/cluster/amp-admin*.sls
role-admin/cluster/amp-admin*.sls
role-mon/cluster/amp-mon*.sls
role-mgr/cluster/amp-mon*.sls
role-storage/cluster/amp-osd*.sls
role-mds/cluster/amp-[mo]*.sls
role-grafana/cluster/amp-admin*.sls
role-prometheus/cluster/amp-admin*.sls
config/stack/default/global.yml
config/stack/default/ceph/cluster.yml
```

12 Appendix C: Network Switch Configuration

The switch uplinks are configured with a LAG. The load generation nodes are blade servers connected with 16 10Gb ethernet ports bonded in two LACP bonds, one to each upstream switch. The cluster network carries back end and is VLAN 220.

```
##
## Active saved database "c3-mellanox-s3700"
## Generated at 2020/07/13 20:53:19 +0000
## Hostname: switch-6bdea0
## Product release: 3.9.0914
##

##
## Running-config temporary prefix mode setting
##
no cli default prefix-modes enable

##
## Interface Ethernet configuration
##
   interface port-channel 28
   interface port-channel 30
   fae interface ethernet 1/1 speed 100G no-autoneg
   fae interface ethernet 1/2 speed 100G no-autoneg
   fae interface ethernet 1/3 speed 100G no-autoneg
   fae interface ethernet 1/4 speed 100G no-autoneg
   fae interface ethernet 1/5 speed 100G no-autoneg
   fae interface ethernet 1/6 speed 100G no-autoneg
   fae interface ethernet 1/7 speed 100G no-autoneg
   fae interface ethernet 1/8 speed 100G no-autoneg
   fae interface ethernet 1/9 speed 100G no-autoneg
   fae interface ethernet 1/10 speed 100G no-autoneg
   fae interface ethernet 1/11 speed 100G no-autoneg
   fae interface ethernet 1/12 speed 100G no-autoneg
   fae interface ethernet 1/13 speed 100G no-autoneg
   fae interface ethernet 1/14 speed 100G no-autoneg
   fae interface ethernet 1/15 speed 100G no-autoneg
   fae interface ethernet 1/16 speed 100G no-autoneg
   fae interface ethernet 1/30 speed 100G no-autoneg
   interface ethernet 1/1-1/16 mtu 9216 force
   interface ethernet 1/28-1/30 mtu 9216 force
   interface port-channel 28 mtu 9216 force
   interface ethernet 1/1-1/16 switchport mode hybrid
   interface ethernet 1/28-1/29 channel-group 28 mode on
   interface ethernet 1/30-1/32 switchport mode hybrid
```

```
   interface port-channel 28 switchport mode hybrid
   interface port-channel 28 description uplink LACP

##
## LAG configuration
##
   lacp
   interface port-channel 28 lacp-individual enable force
   port-channel load-balance ethernet source-destination-mac

##
## VLAN configuration
##
   vlan 197
   vlan 220-2227
   interface ethernet 1/1-1/16 switchport access vlan 197
   interface ethernet 1/1-1/16 switchport hybrid allowed-vlan all
   interface ethernet 1/30-1/32 switchport hybrid allowed-vlan all
   interface port-channel 28 switchport hybrid allowed-vlan all
   vlan 197 name "pxe"
   vlan 220 name "storage"
   vlan 227 name "storage2"
```

13 Appendix D: OS Networking Configuration

Each host is configured with an active passive bond. This alleviates the need for switch based configuration to support the bonding and still provides sufficient bandwidth for all IO requests

```
/etc/sysconfig/network # cat ifcfg-eth0
BOOTPROTO='dhcp'
STARTMODE='auto'
#
/etc/sysconfig/network # cat ifcfg-vlan227
BOOTPROTO='static'
BROADCAST=''
ETHERDEVICE='eth0'
ETHTOOL_OPTIONS=''
IPADDR='172.16.227.50/24'
MTU=''
NAME=''
NETWORK=''
REMOTE_IPADDR=''
STARTMODE='auto'
VLAN_ID='227'
```

```
#
/etc/sysconfig/network # cat ifcfg-vlan220
BOOTPROTO='static'
BROADCAST=''
ETHERDEVICE='eth0'
ETHTOOL_OPTIONS=''
IPADDR='172.16.220.50/24'
MTU=''
NAME=''
NETWORK=''
REMOTE_IPADDR=''
STARTMODE='auto'
VLAN_ID='220'
```

14 Resources

SUSE Enterprise Storage Technical Overview https://www.suse.com/docrep/documents/1mdg7e-q2kz/suse_enterprise_storage_technical_overview_wp.pdf

SUSE Enterprise Storage (6) Deployment Guide https://documentation.suse.com/ses/6/single-html/ses-deployment/#book-storage-deployment

SUSE Linux Enterprise Server 15 SP1 Administration Guide https://documentation.suse.com/sles/15-SP1/single-html/SLES-admin/#book-sle-admin

Repository Mirroring Tool https://documentation.suse.com/sles/15-SP1/single-html/SLES-rmt/#book-rmt

Armv8 https://developer.arm.com/architectures/cpu-architecture/a-profile

Ampere https://amperecomputing.com/emag/

Micron Operating system and storage drives https://www.micron.com/products/ssd/product-lines/5300 https://www.micron.com/products/ssd/product-lines/7300

Broadcom HBA BRCM 9500-16i HBA https://www.broadcom.com/products/storage/host-bus-adapters/sas-nvme-9500-16i

NVIDIA System Network Interface Card MCX653105A-HDAT ConnectX-6 VPI Adapter https://store.mellanox.com/products/mellanox-mcx653105a-hdat-sp-single-pack-connectx-6-vpi-adapter-card-hdr-ib-and-200gbe-single-port-qsfp56-pcie4-0-x16-tall-bracket.html and Network Switch Spectrum-2 MSN3700C https://www.mellanox.com/products/ethernet-switches/sn3000