

HPE Primera Storage System

Note: HPE Primera has been replaced with the HPE Alletra product line. The HPE Primera Product Analysis is no longer receiving updates as of September, 2023.

The HPE Primera system is a high end storage system that evolved from the HPE 3PAR storage systems and primarily focuses on large scale enterprise use cases. With Primera, HPE created a storage system that puts emphasis on simplicity, performance, and reliability. Primera has been designed around the use of ASICs and flash devices in order to improve performance from previous 3PAR systems. To reduce complexity, HPE has focused on ease of use and claims a simple setup can be done in minutes. Primera is also integrated with HPE InfoSight in order to leverage AI and machine learning for predictive analytics.

As a high end system focused on enterprise use, HPE Primera competes against the Dell EMC PowerMax, Hitachi VSP 5000, PureStorage //X90, and IBM DS8900 arrays.

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Highlights

- Characteristics
 - Performance – HPE is very open about publishing performance data and has published vendor-tested numbers of 1.5M IOPs and 44 GB/s bandwidth. The SPC website should be consulted for the latest industry standard performance data.
 - Availability – Primera uses multiple controllers in a cluster arrangement and has the ability to failover in the case of a controller failure. Multiple redundancies of other components give the system high availability characteristics.
 - Replication for BC/DR – Remote copy for single or multi-volume copies (synchronous or asynchronous) and three-site DR and stretched cluster support is included as well as many-to-one data replication for consolidated data protection and archiving. Both periodic async (snapshot based) and continuous async are supported.
 - Deduplication, compression, and data packing to increase effective capacity.
 - Express Protect – direct backup to StoreOnce of snapshots
- Applications
 - Primera is targeted at performance demanding applications that use block I/O in the enterprise space.
 - The features of snapshot and remote replication are required by enterprise applications and the Primera system, with these advanced features included, make it a good choice for those applications.
- System environments
 - HPE Primera is a block storage system accessed using FC and iSCSI or NVMeoF in the future with standard drivers on host systems. There is a wide range of host operating systems supported.
- Deployment and Administration
 - A new browser-based GUI on the Primera allows customers to install the system themselves in under 20 minutes according to HPE. Upgrades can be performed in five minutes without disruption.
 - To manage more than one system requires the separate management server – SSMC (StoreServ Management Console)
 - An internal analytics engine is used to monitor and adapt the Primera operation to optimize performance and availability.
- InfoSight – SaaS analytics on storage system data
 - VM visibility
 - SRM type functions
 - Predictive failure and proactive service by HPE support

Overview of System

HPE Primera is a block storage system that evolved from HPE 3PAR systems. Primera features a scale-out block storage system and is available in three model levels – 630, 650, and 670. Each model is available in either an all flash or a hybrid configuration. The all flash models are designated by an “A” prefix. The hybrid configurations, in which the HPE nomenclature is “Converged flash system”, is designated by a “C” prefix. The Primera systems can scale from two to four nodes depending on the model. Internode communication is handled by the use of ASICs.

Unlike its 3PAR predecessor, Primera does not support file access along with its block support. Primera is built to support flash devices for high end performance, however hybrid flash and disk models are also available. HPE has added support for NVMe flash devices. Currently, Primera offers iSCSI and FC host connections, however, HPE has announced that NVMeoF will be supported in the future.

HPE has integrated its InfoSight SaaS based predictive analytics software with Primera to provide features such as VM visibility and predictive failure and proactive service. Along with this, HPE has further backed the reliability of their system with a 100% availability guarantee.

The Primera operating environment runs independently on every controller, and runs functions as independent services. These independent services, that HPE refers to as “containerized”, allow for updating and restarting without the need for an entire reboot of the system.

Along with its high-end performance, Primera makes its case as a true enterprise solution with a full set of advanced features. Primera offers thin provisioning, LUN snapshots, remote replication, and data reduction features.



Figure 1: HPE Primera Storage System (Source: HPE)



Model Offering

HPE Primera has 3 models, the 630, the 650, and the 670, each of which has an all flash or a hybrid configuration. The 630 model is a 2U, 2 node system with 24 drives. The 650 and 670 systems are both 4U and can have either 2 or 4 nodes along with 48 drives.

Feature	A630 / C630	A650 / C650	A670 / C670
Controller Nodes	2	2, 4	2, 4
CPUs per Node	1	2	2
Max Capacity raw	250 TiB / 1000 TiB	800 TiB / 2400 TiB	1600 TiB / 4000 TiB
RAID Levels	6	6	6
Devices (max)	SSDs – 144 HDDs – 240	SSDs – 384 HDDs – 576	SSDs – 576 HDDs – 960
10k rpm	2.4 TB SAS	2.4 TB SAS	2.4 TB SAS
7,200 rpm	8 TB SAS	8 TB SAS	8 TB SAS
SSD	1.92, 3.84, 7.68, 15.36 TB SAS	1.92, 3.84, 7.68, 15.36 TB SAS	1.92, 3.84, 7.68, 15.36 TB SAS
Connectivity			
Total Connect	16	48	48
FC – 32 Gb/s	0 - 16	0 - 48	0 - 48
25GigE	0 - 16	0 - 48	0 - 48
NVMeoF	Not yet available	Not yet available	Not yet available

Table 1: HPE Primera Model Attributes

HPE Primera Hardware Architecture

HPE Primera systems consist of 2 or 4 nodes attached to a passive backplane in a 2U or 4U enclosure, depending on the model. Each node utilizes Intel Skylake CPUs, 1 in the 630 models and 2 in the 650 and 670 models. The Skylake CPUs are accompanied by up to four ASICs in each node to create a highly parallelized system.

In a 2U configuration Primera can hold up to 24 drives. In the 4U configuration up to 48 drives are available. All available drive slots are SAS or NVMe protocol through PCIe with dual connectors for SAS and PCIe connection.

HPE has equipped Primera with HPE's gen 6 ASICs – 1 per node in the 630 models and 4 per node in the 650 and 670 models. The ASICs can help prevent performance bottlenecks and slowing of the CPU. The ASICs are used to provide zero detect, SHA-256, X/OR, cluster communications, and data movement functionality.

HPE has stressed that Primera is built for storage class memory.

HPE Primera Controller

The Primera controller nodes contains up to two Intel Skylake CPUs and up to four ASICs and plugs into a passive backplane. The Primera controllers are part of what HPE describes as an “all-active architecture” in which all controllers and cache are active at the same time.

RAID Level Support

Primera utilizes RAID for redundancy, however unlike its 3PAR predecessor that offered many RAID configurations, Primera only offers RAID6. This change to a RAID6 only configuration was a design feature that HPE elected in order to simplify the configuration of protection groups. In Primera common provisioning groups (CPGs) are automatically configured and optimized for RAID6.

Volume Configuration

The HPE Primera OS divides physical devices into logical “chunklets” of 1GB for Primera from which RAID groups are created, which may then be allocated as a volume or LUN. As a result, data may be spread across more physical devices than RAID groups comprised of entire drives.

SSD Support

HPE offers support for an all solid state configuration in any of the three models. The solid state configurations are designated with an “A” prefix: A630, A650, and A670. Currently SAS and NVMe SSDs are supported, which offer performance benefits over HDDs.

Primera also utilizes SSDs in its hybrid, or “converged”, models: C630, C650, and C670. The hybrid models utilize solid state devices as the highest performance tier while using spinning disks as a lower tier and for archival purposes.

I/O Connectivity

Each Primera node has one management port and one service port along with two built-in 10 gigabit ethernet ports that are used for remote replication over IP. On the A630 and C630, each node contains two SAS ports and two PCIe slots. The nodes in the 650 and 670 models contain four SAS ports and 3 PCIe slots.

Primera does not have any built-in host ports, instead it uses host adaptors on each node. Primera supports the use of either 16 GB or 32 Gb/s 4-port fibre channel host bus adaptors. Each node must have at least one host adaptor, and each node in a pair must use the same type of adaptor.

Primera 650 and 670 models also offer optional SAS adapters to provide additional SAS ports for drive enclosure connectivity. The adapter must be installed in the third PCIe slot and an array with SAS adapters must have one SAS adapter per node.

SCM Cache

HPE has not released any information about Primera currently using SCM, however they have stated that it is a technology that they plan to utilize in the future.

Storage Provisioning

The HPE Primera system breaks storage down into “chunklets”, 32 MB regions and 16 KB pages. RAID groups are comprised using the chunklets distributed among the drives.

HPE Primera Custom ASIC

The 6th generation ASICs used in Primera are new for the Primera system and evolved from the 5th generation ASICs that were used in the latest HPE 3PAR systems. HPE has released few details about the new generation. The 630 models include one ASIC per node and the 650 and 670 models include four ASICs per node. The ASICs are designed to optimize internode concurrency and they feature a data integrity mechanism that HPE describes as “lockless”. The functions that the gen 6 ASICs provide in Primera are zero detect, SHA-256, X/OR, cluster communications, and data movement.

Evaluator Group Comments:

Using an ASIC is becoming increasingly uncommon in newer storage systems. The usage of the HPE Primera Gen6 ASIC enhances performance, while lowering cost for common functions. Functions within the ASIC are not easily or quickly changed, due to the design, test, prototype and production cycles for hardware elements so major advances typically come with each generation of the product.

Device Enclosures

Primera currently offers two choices of drive enclosures, which are optional due to the storage base including small form factor drive bays. The optional drive enclosures are a SFF drive enclosure with 24 drive bays in 2U and an LFF drive enclosure with 12 drive bays in 2U. The two options can be intermixed within an array. The maximum number of drive enclosures allowed is dependent on the model.



Model	A630	C630	A650	C650	A670	C670
Max Add-on Drive Enclosures	5	9	14	22	22	38
Total Number of Devices	144	240	384	576	576	960

Connectivity Options

Primera supports connectivity via Fibre Channel and iSCSI. HPE has stated that they plan on supporting NVMeoF in the future. There are 16 total host ports on the 630 models and 48 total host ports on the 650 and 670 models.

FC Connectivity

Primera systems provide up to 16 ports on the 630 and 48 ports on the 650 and 670. Each port supports 16GB or 32Gb/s Fibre Channel connectivity.

Dedicated Replication Ports

Primera features two built-in 10GbE ports per node that are dedicated to replication over IP.

HPE Primera Software Architecture

Primera Operating System Overview

Primera features a services-centric operating system with a multitude of capabilities including RAID, thin provisioning, QoS, replication, and more. The OS uses a containerized approach in which these features are implemented as independent services. This approach allows for faster and more frequent upgrades without the need to reboot the entire system. The embedded operating system runs independently on each of the controller nodes.

Host Operating System Support

Primera offers support for a wide array of host operating systems.

Those systems include:

- Citrix XenServer
- HP-UX
- IBM AIX
- Microsoft Windows Server, including Microsoft Hyper-V
- OpenVMS
- Oracle Linux
- Oracle Solaris
- VMware vSphere
- Red Hat Enterprise Linux
- Red Hat Enterprise Virtualization
- SUSE Linux Enterprise
- SUSE Linux Virtualization

Primera Software Features

HPE offers an extensive set of software functionality that is available within the Primera system. All of the software licenses are included with the array, with the exception of the Data Encryption LTU which requires a separate license.

Thin Provisioning

HPE features thin provisioning of LUNs to optimize efficiency across the Primera System.

Adaptive Data Reduction

HPE Primera adaptive data reduction includes both deduplication and compression. Zero detect and data packing features also add to the Primera data reduction features. Deduplication is done on a 16KB granularity for selected volumes designated as TDVV (thin deduped virtual volumes). A Primera ASIC is used to perform the hash code of the 16KB block, a bit for bit comparison of data, and zero detect. A feature called Express Indexing does the initial table lookup of the hash code for detection of duplicate blocks.

Data compression uses functions of the Intel processor or an FPGA depending on the workload along with software to reduce data stored. Data Packing uses 16KB containers to store data independent of block boundaries for greater efficiency. With the Adaptive Data Reduction feature, HPE guarantees a 4:1 data reduction.

HPE InfoSight

A core feature built into Primera is HPE InfoSight cloud analytics. InfoSight is built with AI to provide predictive analytics that are used to monitor and support the storage system. Commonly, support for storage systems offer solutions to problems after an issue has arisen. The goal of HPE InfoSight is to detect and prevent these problems before they occur. HPE achieves this by continuously collecting and analyzing millions of data points from across their systems. As InfoSight continues to record and analyze data it uses AI to learn from the system and predict potential issues that may occur. InfoSight can then take action to avoid issues and optimize performance. The addition of InfoSight can dramatically reduce the maintenance and support effort that is often required for a high end system such as Primera. This allows IT staff to focus their attention elsewhere, while InfoSight continues to monitor for issues.

Data Protection Software

Snapshots

A key data protection element for HPE Primera is its snapshot functionality. Snapshots are a commonly required feature for enterprise data storage and as a product that is focused on high end enterprise use, Primera is able to meet this requirement. Primera snapshots can be backed up directly to HPE StoreOnce.

Currently, HPE Primera offers several products that provide data protection. There is a point-in-time snapshot called “Virtual Copy”, along with the function for the creation of clone copies called “Full Copy”. In addition, both synchronous and asynchronous remote replication is provided in the Remote Copy product.

Full Copy

Full Copy creates a complete physical copy or a LUN. The copy may have a different RAID level than the base volume and may be of equal or greater size than the source. Full Copy includes a re-synchronize option that allows the physical copy to be updated only with changed blocks. The Full Copy feature is able to make clones from both traditional and thinly provisioned LUNs.

Virtual Copy

Virtual Copy is a copy-on-write snapshot technology where only blocks changed since the first snapshot was made are copied. A reserve area of space for snapshots is allocated when snapshots are enabled. Virtual Copy supports up to 500 snapshots per base volume. Snapshots may be either read-only or up to 256 may be read-write. A Virtual Copy may be rolled back so that a volume can be synchronized with a prior snapshot.

When a snapshot is first created, a pointer to all its data is recorded. When a new data block is written, the original block is copied to a separate snapshot data space and the snapshot points to this data space instead. Snapshots are also writeable by allowing new blocks to be written in the snapshot data space. Snapshots of snapshots are also supported.

Remote Copy

HPE Primera Remote Copy is a storage system-based set of data protection products available on the HPE Primera systems. Remote copy is also known as remote replication and remote mirroring. HPE Primera's remote copies may be configured with RAID 6 as the only supported RAID type. Remote Copy supports both synchronous and periodic asynchronous modes of operation along with support for multi-volume consistency groups. Volumes can be grouped together to maintain write ordering across the set of volumes. A notable change from the 3PAR systems is that Primera does not currently support asynchronous streaming capabilities.

The HPE Primera Remote Copy services provide several data replication mechanisms to provide disaster recovery protection. Typically, two HPE Primera arrays are utilized: a primary for production data, and a secondary system used at a disaster recovery site.

Connectivity for Remote Copy

Remote Copy is transport agnostic, enabling data to be transferred using different protocols over different networks. Replication over both FC and IP connections is supported. Additionally, Remote Copy supports line-trunking in order to utilize all configured network links. Data transfers are distributed across all links providing better performance and increased availability to tolerate a link failure.

Remote copy is supported in two basic modes:

- Synchronous
- Asynchronous

Synchronous Mode provides real-time mirroring and provides the highest level of data currency by writing data simultaneously to the cache of both systems before the primary storage system acknowledges the write completion back to the host. As with competing offerings, synchronous mirroring is limited by speed-of-light signaling, effectively restricting usage to metropolitan areas of less than 100 km.

Asynchronous Periodic Mode supports unlimited distances and is similar to other asynchronous replication products in that it replicates only changes since a point in time by taking periodic point in time copies, or snapshots, determining the differences through the bit map and then replicating only the changed blocks. Asynchronous Periodic Mode captures and mirrors to the remote site only the data that has changed since the last update. When a block is marked as changed between the base volume and the point-in-time copy, the block is marked in the bit map, and then replicated to the remote site during the next scheduled synchronization period.

Write order consistency is maintained for consistency groups that are replicated asynchronously.

Operation of Asynchronous Replication

1. Initial Copy: After initiation, the source volume creates an initial copy-on-write snapshot at the primary site. This snapshot is the initial snapshot, which is labeled “A”. This copy is used to replicate to the remote site, and the snapshot is saved to be used for comparison with the next synchronization point.

2. Resynchronization: This is the replication phase that occurs based on the interval established:

- i) Before the synchronization begins, the source volumes have a snapshot created at the same time. This set is labeled “B”
- ii) The replication software also creates a set of snapshots at the target system. The set of snapshots at the target volume are consistent with the “A” snapshot taken at the source site.
- iii) The asynchronous replication compares the differences between the two local snapshots A and B.
- iv) The differences or delta’s are calculated via changes in the bit map used to track the copies.
- v) These differences are then remotely copied to the secondary site.

3. Cycle Completion: After the changed set has been replicated to the remote site, the replication software removes the local and remote initial snapshots (labeled “AS”), and renames the local “B” snapshot to “A”. This completes the cycle, and the process may begin again.

Continuous Asynchronous Mode allows I/Os to continue to the local Primera as they are replicated to the remote system. The RPO is limited to one minute by a delay or completion response to the host system as replicated I/Os to the remote system are delayed. Continuous asynchronous has performance advantages for replication over synchronous and a narrower potential for I/Os not being completed in the case of a disruption.

Consistency Groups

Consistency groups are supported with Asynchronous Periodic Mode, Continuous Asynchronous, and Synchronous Mode, which ensures that all data on the marked logical volumes are consistent to a specific point in time. The IT administrator can define consistency groups regardless of the host which the volumes are mapped to, providing consistency across multiple hosts and applications.

Many-to-One Remote Copy

HPE Primera Remote Copy supports many-to-one replication from several Primera systems to a single, centralized system. Many-to-one is supported for both synchronous and asynchronous replication. Many-to-one replication is commonly utilized in distributed enterprise scenarios where several smaller remote offices are replicating back to central site or all replications are going to a single, dedicated off-site disaster recovery center.

One-to-Many Remote Copy

HPE Primera Remote Copy supports one-to-many replication where a single Primera system can replicate data to several Primera systems. One-to-many is supported for both synchronous and asynchronous replication.

Synchronous Long Distance Remote Copy

HPE Primera Remote Copy includes a three-site DR configuration for Primera systems. Customers can copy synchronously between arrays to a synchronous DR site within synchronous copy range. Copies can also be made simultaneously to a longer distance asynchronous DR site. No professional services engagement is required to implement.

There are two recovery scenarios if the primary site fails,

- The synchronous DR site becomes the new primary site while the asynchronous DR site remains an asynchronous DR site with respect to the new primary.
- The asynchronous site can be made the new primary and can “push” copies asynchronously to the synchronous DR site, maintaining a DR capability.

Synchronous copy supports FC protocol communication between sites. Asynchronous copy supports IP and FCIP communication. All thin provisioning capabilities are also supported.

Express Protect

Snapshots can be directly copied from Primera to HPE StoreOnce using the Express Protect feature. Express Protect is a direct backup (called Flat Backup by HP) from Primera and is invoked by application APIs (via agents) or VMware.

Additional Data Protection

HPE Recovery Manager Central

Currently, RMC is not integrated with Primera, although HPE has stated that it has plans to do so in the future.

Encryption

HPE Primera supports encryption of data at rest by use of Self Encrypting Drives. To enable encryption, an LTU data encryption license is required. Once license is required for each encrypted array. Encryption can be enabled at any time with no disruption to data, however once turned on it may not be turned off.

Primera offers a local key manager that is included with the OS. Primera also offers support for KMIP external key management.

Primera does not feature encryption of data in flight for replication.

Reliability, Availability, Serviceability Features

The following summarizes the RAS capabilities:

- Redundant hot-plug cooling fans and power supplies are standard on all models
- RAID protection of device storage
- Multiple copies of the Primera operating system provides software redundancy (one copy per controller node)
- Redundant, hot-pluggable controller nodes can be scaled non-disruptively and are equipped with battery backup and dedicated drive backup for cache
- Three year parts warranty
- HPE Timeless Storage evergreen program
- Online replacement of failed parts
- HPE InfoSight predictive analytics
- Service centric OS allows frequent nondisruptive upgrades
- HPE 100% availability guarantee

Peer Persistence - Stretched Clusters or Clustered High Availability

HPE Primera systems have the ability to allow other Primera systems to act as peer across metropolitan distances (typically less than 100 KM) with Peer Persistence software. Peer Persistence implements what is known as stretched clusters to provide a high availability business continuance solution. With stretched clusters, failover and failback can be seamless and transparent to hosts. Peer Persistence utilizes the asymmetric logical unit access (ALUA) capability of the StoreServ systems to allow logical devices to have different characteristics and independent access. 3-site stretched cluster support is available with Peer Persistence.

The logical volumes are kept in synchronization at each site for the stretched cluster by use of redundant fabrics as described in the following diagram.

HPE 100% Availability Guarantee

HPE is dedicated to providing 100% data availability with their Primera systems and they have created a guarantee program to support this. The 100% availability guarantee offers assurance to eligible Primera customers that if they experience any qualifying outage, then HPE will provide credits towards a new Primera system or upgrade.

The requirements to be considered eligible for the availability guarantee are as follows:

- Purchase of an HPE Primera array
- Purchase of the standard HPE Proactive care support or higher support contract
- Activating HPE InfoSight
- Applying patches within 10 days of receiving notice from InfoSight
- Upgrading OS and firmware releases within 30 days of receiving notice from InfoSight

The guarantee covers the first three years of life for new Primera arrays and credits are based on the severity of the outage. In order to be considered a qualifying outage, the outage must be the fault of the primera system and not external factors such as environmental factors, additional or misconfigured hardware and software, or network failures.

Management

Management and Deployment

HPE Primera offers a new browser based GUI and has stressed that Primera is intended to be simple and efficient to use, referencing their Nimble Products as a comparison. HPE has claimed that Primera systems can be self installed in under 20 minutes.

StoreServ Management Console

For management of more than a single system, StoreServe Management Console is required. SSMC is built on HPE OneView as a common foundation with similar look and feel. Basic elements in a dashboard presents the status from a complete system view down to individual volumes, a Smart Search facility for searching for resources and events across the system, and a System Reporter providing information about the system in report formats. Information used by SSMC is acquired both in real-time and from historical and log data stored on the array.

The management console allows for role-based access and reporting information. Customization of individual dashboards is not currently available.

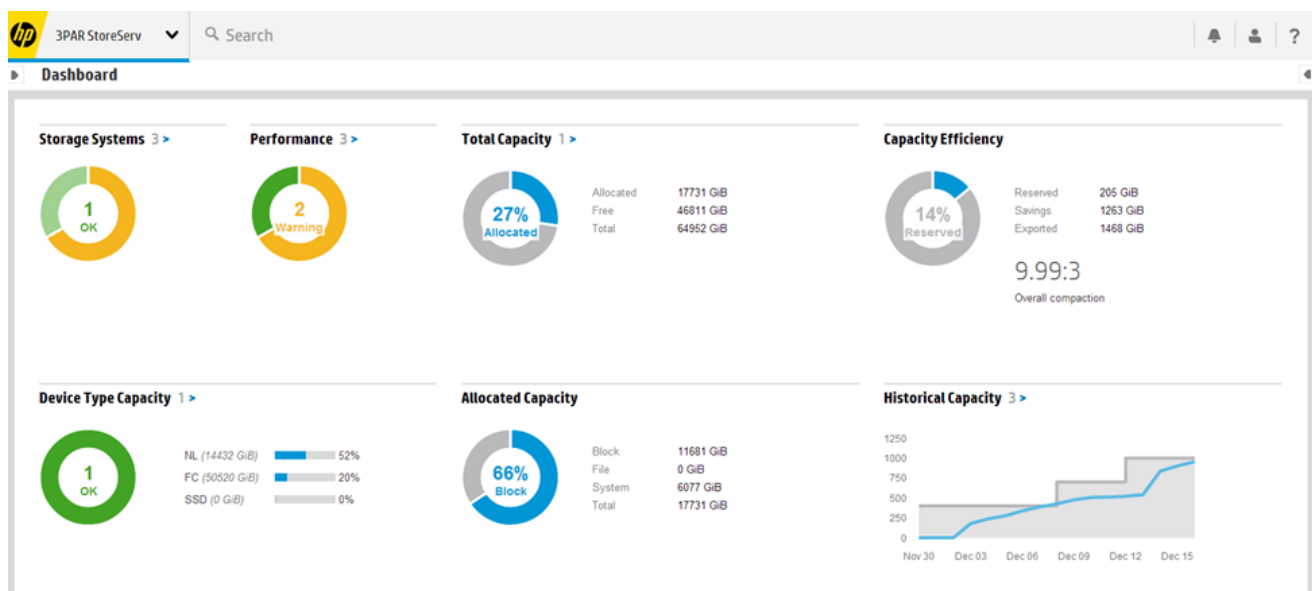


Figure 2: StoreServ Management Console



Performance

HPE's self reported performance claim that the Primera system is capable of 1.5M IOPS along with bandwidth of 44 GB/s for the maximum four node system. The Storage Performance Council website www.storageperformance.org should be consulted for the latest information. Performance tests greater than one year old may not reflect advances made with the latest updates to the product.

Evaluator Group Comments

Strengths:

The HPE Primera System improves upon the success of the HPE 3PAR systems as a high-performance SAN solution and creates a competitive offering in the enterprise level market. As all-flash systems, NVMe, and SCM continue to make their mark as high performance storage technologies, Primera positions itself as a smart and necessary evolution from HPE 3PAR. Primera benefits from many configuration options including three models each with all-flash and hybrid options.

In addition to improving upon performance, HPE also made an effort to create Primera as a simple and highly reliable system. Primera achieves this with a quick install time, as well as simplified management and support with the use of HPE InfoSight. InfoSight can utilize AI to relieve IT end users of many of the complexities involved with monitoring enterprise storage systems. In addition to InfoSight, HPE helps provide peace of mind for IT organizations by offering a 100% availability guarantee.

The addition of many advanced features is a strength for Primera as well. Enterprise users find many of these features, such as snapshots and remote copy, to be extremely useful.

Overall, Primera combines high performance technologies, and an array of advanced features to create a competitive enterprise storage offering for HPE moving forward.

Perceived Challenges:

While Primera seeks to be the solution for high performance enterprise storage, it currently does not yet fulfill all of its promises since Primera is still missing NVMe over fabrics support. Additionally, the positioning of Primera is somewhat unclear do to overlap with the previous generation 3PAR models as well as newer Alletra systems that were announced not long after the introduction of Primera.

More detailed information is available at www.evaluatorgroup.com

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