Hewlett Packard Enterprise

HPE 3PAR StoreServ Storage: designed for mission-critical high availability

Modern Tier-1 storage for the new style of Business

Technical white paper

Contents

Executive summary

In the modern data center, the quest for predictability and order has given way to the need for flexibility and the ability to address the unexpected. New service delivery models like IT as a service (ITaaS) are driving new requirements around storage agility, efficiency, and resiliency.

The marketplace is filled with "me too" traditional SAN storage suppliers, but only HPE offers the industry's broadest experience delivering solutions and services to enable business continuity while maintaining flexibility of IT infrastructure. For example, HPE 3PAR StoreServ Storage features a modern, purpose-built architecture that spans from low to high and encompasses both traditional spinning media and all-flash capacity, delivering new innovations to storage that are far beyond traditional SAN storage environments. HPE 3PAR StoreServ Storage removes the last barrier to consolidation by delivering assured quality of service (QoS) levels without having to physically partition resources or maintain discreet storage silos.

HPE 3PAR StoreServ Storage is designed to help minimize operational impact by delivering planned resilience. Full hardware redundancy is built into the system, mitigating all single points of failure. When appropriately configured, HPE 3PAR StoreServ Storage is capable of greater than "five nines" or 99.999 percent availability from a hardware perspective. This is reinforced by autonomic and proactive error checking, and software features that deliver seamless failover/failback to help ensure complete system resilience, even when the unexpected happens.

A unique set of products power HPE 3PAR StoreServ Storage in delivering high availability (HA) and mission-critical resilience to multi-tenant cloud and ITaaS environments. HPE 3PAR Peer Persistence software keeps mission-critical applications running seamlessly, even in the event of a disaster, by enabling automated, transparent failover and failback, between both systems and sites. HPE 3PAR Persistent Cache removes performance impacts that can result from unplanned component failures, making it a must-have for maintaining service levels in the virtual data center. HPE 3PAR Persistent Ports allows non-disruptive upgrades on HPE 3PAR StoreServ Storage without relying on multi-pathing software and without initiating failover. HPE 3PAR Persistent Checksum ensures end-to-end data integrity, protecting against silent corruption from the host to the storage array. HPE 3PAR Priority Optimization software provides assurance of predictable and consistent service levels by providing storage controls that allow applications to get the right level of performance.

Achieving native HA

All HPE 3PAR StoreServ Storage models offer built-in, native hardware and software availability that combine to create massively available Tier-1 systems. Many enterprise, financial, and hosted service providers have standardized on HPE 3PAR StoreServ Storage at a global level to offer mission-critical ITaaS services. This technical white paper describes all of the HPE 3PAR StoreServ Storage hardware components and software features that natively support seamless, Tier-1 availability.

HPE 3PAR Architecture

The foundation for all HPE 3PAR StoreServ Storage systems, a single HPE 3PAR StoreServ Architecture combines superior open technologies with extensive innovations in hardware and software design. This architecture reduces class distinctions across storage tiers by offering a range of models to meet the needs of small to large enterprise data centers running key business applications, up through the enterprise-wide deployment of mission-critical applications and beyond. With a single architecture that meets mid-range to enterprise as well as all-flash storage demands, HPE 3PAR StoreServ Storage offers a common operating system, management experience, feature set, and Tier-1 data services across the entire product family.

The HPE 3PAR StoreServ Architecture features a high-speed, full-mesh backplane that joins multiple controller nodes (the high-performance data movement engines of the HPE 3PAR StoreServ Architecture) to form a cache-coherent, "mesh-active" cluster. This low-latency interconnect allows for tight coordination among the system's controller nodes. Within this architecture, controller nodes are paired via either Fibre Channel (FC) or SAS connections (depending on model) from each node in the pair to the dual-ported drive chassis (or drive enclosures) owned by each pair. In addition, each controller node may have one or more paths to hosts (either directly or over a network). The clustering of storage controller nodes enables HPE 3PAR StoreServ Storage to present to hosts a single-instance, highly available, self-optimizing, and high-performance storage system.

HPE 3PAR Mesh-Active design allows each volume to be active on every controller in the system
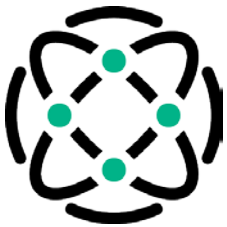
Native end-to-end error checking

HPE 3PAR StoreServ Storage offers automated end-to-end error checking during the journey of data frames through the system to the disk devices. These technologies have been put in place to always ensure that customer data frames does not get corrupted at any point in its journey through the array and where there may be corruption, detection is done promptly and handled appropriately. For example, the HPE 3PAR Thin Express ASIC comes with the Persistent Checksum feature that ensures end-to-end data protection, from host HBA to physical drives. In addition to this, Self-Monitoring Analysis and Reporting Technology (SMART) is used to provide predictive failure detection such that any disk device crossing certain SMART thresholds can be designated as a "predictive failure" by the storage node and identifying that device as in need of replacement before it actually fails.

Error checking includes, but is not exclusive to, the following layers within all HPE 3PAR StoreServ Storage systems:

- Cyclic redundancy checking (CRC) and parity checks on all internal CPU and serial buses

- Control cache and data cache error-correcting code (ECC) checks

- PCIe bus CRC checks

- HPE 3PAR Gen5 Thin Express ASIC Connection CRC checks

- Protocol FC/iSCSI/FCoE CRC checks at the frame level (hardware-accelerated via the systems' HPE 3PAR Gen5 Thin Express ASICs)

- Disk devices CRC at the block level, both when the data lands and during the lifecycle of the data on disk

- End-to-end T10-DIF error checking at host HBA, storage adapter, data cache and disk drives. This feature is also called HPE 3PAR Persistence Checksum

HPE 3PAR Persistence Checksum works on all customer data while all other above checks work on customer data, metadata and program code.

HPE 3PAR StoreServ Storage also issues logical error status block (LESB) alerts if a frame arriving in the storage interface has CRC errors beyond a certain threshold. This indicates that a cable or component between the host and storage device needs replacing or cleaning.

With HPE 3PAR Remote Copy software, proactive error detection is also extended to replicated data to help ensure that potential cascaded data issues are not experienced. Additionally, HPE 3PAR StoreServ replication with Remote Copy includes a link pre-integration test to verify the stability of Remote Copy replication links in advance of adding these links for use with Remote Copy over an IP network.

Native End-to-End Error Checking
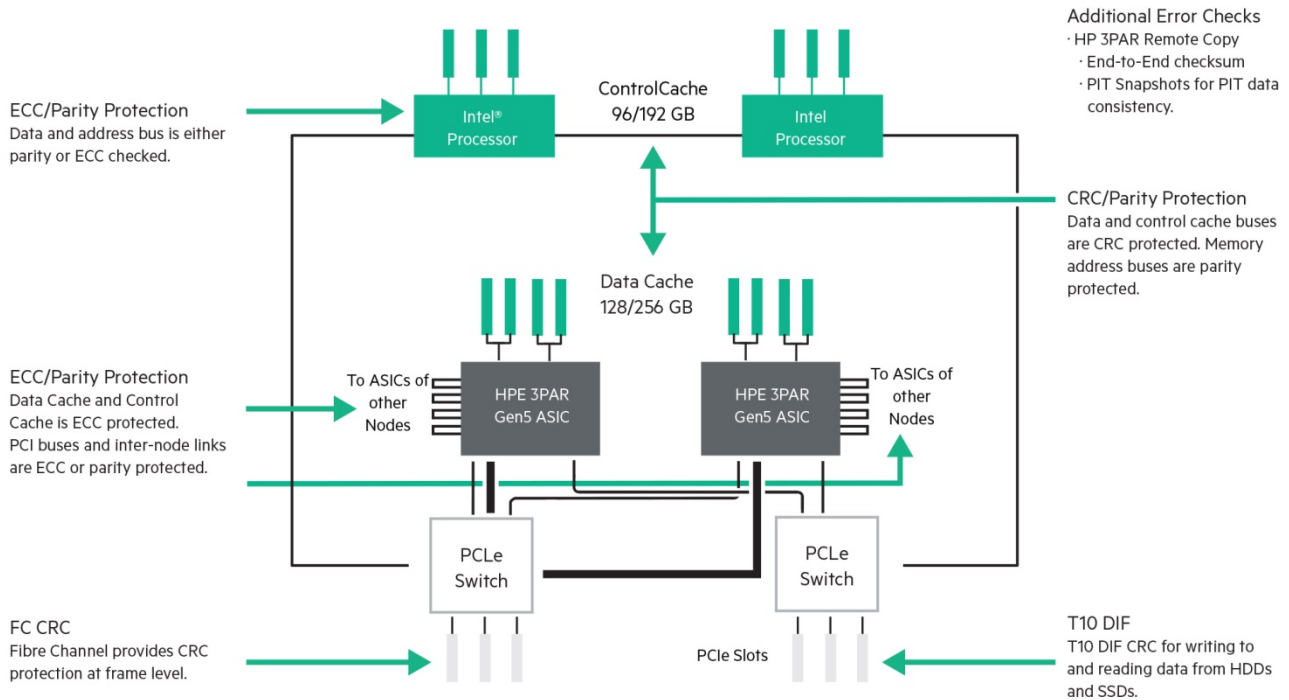
No single point of failure

HPE 3PAR StoreServ Storage components such as storage nodes, cache cards, disk- and host-facing host bus adapters (HBAs), power supplies, batteries, and disks feature 2N or better redundancy. As a result, system interruption does not occur as a result of failures with any of these components. The system's power domains are designed with redundancy to prevent power loss to back-end disk devices due to a drive enclosure power supply failure. HPE 3PAR StoreServ Storage systems offer up to four current load-balanced power distribution units (PDUs) per rack, providing a minimum of one and support for up to two separate data center power feeds to offer even more power redundancy and protection against events such as brownouts.

All storage nodes run a separate copy of HPE 3PAR Operating System (OS) software. The software is both statefully managed and self-healing in the case of a process's or processes' failure and restart, across all cache-coherent active/active storage controller nodes.

Zero downtime for maintenance and upgrade services

With HPE 3PAR StoreServ Storage, all maintenance and upgrade activities are performed online and completely non-disruptively. This includes hardware replacements and upgrades as well as HPE 3PAR Operating System software updates and patches. Component firmware at all levels can be upgraded dynamically (en masse or individually), including the disk firmware, as all disk devices in the HPE 3PAR StoreServ Storage system are dual-ported.

Intuitive functionality such as **checkupgrade** and **checkhealth** functionality helps confirm that an upgrade can be completed successfully and without risk when performed prior to an HPE 3PAR OS upgrade. These functions check firmware levels, system services, and system status in terms of any degraded or failed components that may need replacing. In addition, the health check can be executed on an ongoing basis to obtain comprehensive information on the health of
the system.

Proactive system monitoring and support services can also be used to remotely apply software upgrades and dynamically examine a system at the customer's request, helping ensure successful upgrade experiences when change control windows are limited.

Persistent Ports feature

When upgrading controller node software, the HPE 3PAR StoreServ system gives you the ability to upgrade one controller node at a time, pausing between nodes to confirm that multi-pathing is active. HPE 3PAR Persistent Ports is an OS feature that provides greater resiliency and decreases the need for host multi-pathing software.

By using HPE 3PAR Persistent Ports in SAN connect environments where the FC SAN switch to which the HPE 3PAR StoreServ Storage system is connected supports N_Port ID virtualization (NPIV) capability, you can perform software upgrades on a node-by-node basis without any reliance on host multi-pathing software, thereby avoiding any path failovers. The HPE 3PAR Persistent Ports feature also works with iSCSI and FCoE ports and allows non-disruptive and online upgrades to take place completely transparent to hosts.

In addition to enabling non-disruptive and online software upgrades, HPE 3PAR Persistent Ports also protects applications against any possible outage due to the loss of a controller node. Regardless of the cause for this loss—planned upgrade/maintenance, power failure, and others—the Persistent Ports feature allows seamless failover of all the ports on the impacted node to designated partner ports on a different node. This is seamless to hosts, which continue to use the original ports assigned while in reality IO is transparently re-routed through the partner port. This helps organizations maintain uninterrupted service levels for their applications running on HPE 3PAR StoreServ Storage and protects against any service level penalties that might apply. For Fibre Channel attached hosts, HPE 3PAR Persistent Port functionality also provides transparent and uninterrupted failover in response to "loss_sync" events, which may be triggered as the result of a failure between an array HBA and the switch.

Rapid recovery from failed disk devices

The most common hardware failure for storage arrays in general occurs in the disk devices themselves. In the event of a disk failure, it is imperative that rebuild takes place quickly and with little or no impact to system performance. HPE 3PAR StoreServ Storage systems utilize unique capacity virtualization technology to help ensure that all potentially impacted logical unit numbers (LUNs) associated with a physical disk device failure are rebuilt from a "degraded" mode to full parity protection in the fastest possible time.

On the HPE 3PAR StoreServ Storage system, all disk devices are virtualized into "chunklets." The system tracks utilization and writes allocation for each chunklet at all times. All disk devices have a number of "spare" chunklets that are reserved for sparing purposes.

The system uses a global spare chunklet pool that spans all physical drives in the system instead of more limited and traditional hot-sparing concepts. This global pool is comprised of a specific amount of spare capacity, regardless of the size and type of disk devices in the system. If the system is upgraded, an embedded algorithm helps ensure that the global chunklet sparing pool grows in proportion to the capacity installed. If a disk device fails, an automated RAID rebuild occurs to spare chunklets distributed across all disk devices, resulting in an expedited and extremely rapid rebuild window. Traditional storage rebuild models involve a few disks in a disk RAID group rebuilding to a hot spare, which can take significantly longer for RAID rebuild and result in I/O hotspots.

The massive parallelism resulting from global sparing helps ensure limited impact on application performance. In addition, HPE 3PAR StoreServ Storage disk rebuilds are "thin-provisioning aware", so that only chunklets that have been written to are rebuilt. This also accelerates the rebuild time to full parity. For example, if a 4 TB disk fails but only 300 GB of written data resides on it, only 300 GB needs to be rebuilt to return any affected LUNs back to full RAID parity.

The system checks the Worldwide Name (WWN) of each replaced disk device to help ensure that the failed disk has not accidentally been re-inserted, thus help minimizing extended service times.

Traditional HA vs. HPE 3PAR StoreServ resiliency features
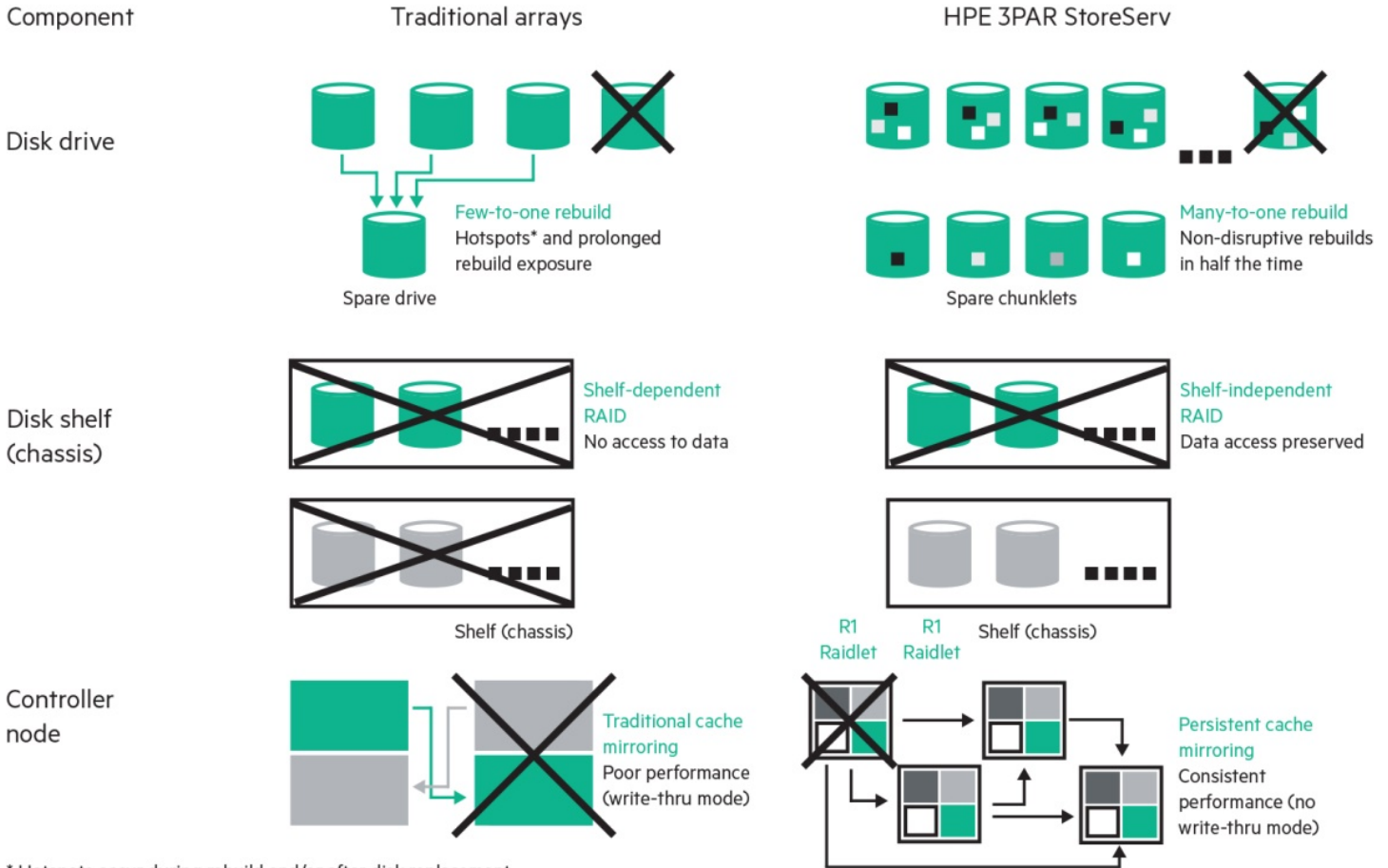
* Hotspots occur during rebuild and/or after disk replacement.

Flexible and resilient enterprise RAID levels

HPE 3PAR StoreServ Storage supports the following RAID levels: RAID 0, 1, 5, and 6 (multi-parity).

For RAID 5, the following RAID set sizes are supported concurrently (2 + 1 through 8 + 1, inclusively).

For RAID 6, the following RAID set sizes are supported concurrently (4 + 2, 6 + 2, 8 + 2, 10 + 2, and 14 + 2 inclusively), regardless of the disk device types installed.

For RAID 1, multiple mirror depths are supported on a LUN by LUN basis. From traditional RAID 1 (data + mirror) to mirror depth 4 (data + mirror + mirror + mirror), represents an unprecedented availability. With this RAID level, 75 percent of the disk devices in the system can be lost, yet any LUN configured with mirror depth 4 will still be online and accessible by hosts and applications.

HPE 3PAR StoreServ Storage supports the ability of administrators to change RAID level, RAID stripe size, device type, and availability level on the fly. In addition, based on user-specified policies, the system allows new storage resources to be dynamically shared as necessary—for example, additional storage controller nodes and disk devices. This helps ensure that the right applications receive the right levels of protection, HA, and performance, which is especially important when consolidating existing or rolling out new applications in an always-on infrastructure.

Automated bypass control and hot-plugging mode

HPE 3PAR StoreServ Storage supports switching intelligence to automate isolation of disk devices and drive enclosure SAS adapters from the SAS backend to which they are connected once a specific error threshold is reached. This process isolates the faulty component and protects other devices on that backend from other potential failures.

In addition, when a faulty disk or component is to be replaced, it is automatically placed into "hot-plug" mode. There is a visible LED on all devices to indicate this mode and reduces the risk of replacing the wrong device. Hot-plug mode also fences and isolates power to the component that needs to be replaced, which keeps power spikes from happening as a result of the component being removed or replaced.

Once the replaced or upgraded component is swapped out or added, the replacement routine automatically performs a series of checks to validate the new component. If required, the firmware on the new component can also be automatically and non-disruptively upgraded prior to activation.

Drive enclosure availability

The default provisioning for all HPE 3PAR StoreServ Storage systems includes high availability across drive enclosures for every LUN provisioned (This is the HA-cage or HA-enclosure mode.). This default protects from and helps ensure data availability in the event of the loss of an entire disk chassis or enclosure. Even in the event of an entire disk enclosure loss, the hosts do not lose access to the provisioned LUNs and applications still stay online. Since not all data may be of the same importance, this functionality is dynamically configurable per LUN. The minimum disk availability is magazine level. As the system scales, the availability level per LUN can be non-disruptively changed to disk-shelf availability as desired.

No cache data loss in any scenario

The protection of customer data is the number one priority on HPE 3PAR StoreServ Storage. HPE 3PAR StoreServ Storage supports redundant batteries to help ensure that the contents of write cache are written to specific and secure disks if a site power failure occurs. There is no pinning of data in cache, which puts data at risk when power is not restored in a specified period of time. Because cache data is written to disk, there is no limit with regard to the time to data recovery for cases where power is down for an extended period. Once power is restored, the cached data that was written to the secure disks is restored to its original location as part of the power-fail recovery process.

Persistent Cache feature

All storage arrays grow (no matter how efficient they are) as a result of increasing amounts of data and the need to keep that data secure and active for compliance purposes.

Unlike many competitive arrays that can only scale to two storage controller nodes or storage processors, HPE 3PAR StoreServ Storage can scale non-disruptively from two to eight cache-coherent active/active storage controller nodes (depending on model). As soon as the system detects that four or more storage controller nodes are installed, a resilience feature called Persistent Cache is autonomically enabled.

The Persistent Cache feature helps ensure that no storage controller node is placed into performance-limiting "cache write thru" mode as a result of a losing its partner in the node pair. Any node that loses its adjacent node can dynamically form a mirrored cache relationship with another storage controller node. This helps ensure that most efficient performance requirements are met and service levels remain unaffected during the failure or maintenance of a storage controller node.

Note
Other vendors that only scale to two storage controller nodes support a feature that enables the customer to keep mirrored cache mode enabled on a single storage controller in case of the loss or maintenance of the other storage controller node. For an enterprise storage customer, this represents an extreme risk to data as the system will now have a single point of failure. This creates the potential for data loss should the surviving controller node fail. Other vendors will quote mean time between failures (MTBF) of the second storage controller node as being such that the risk of a second error on the surviving storage controller node is minimal. However, if the risk value is not zero, there is usually a risk of dual failure and hence data loss. The biggest risk when running with a single point of failure is not component failure, but user error.

Persistent Checksum

HPE 3PAR Persistent Checksum addresses media and transmission errors that can be caused by any component in the I/O stack and provides additional protection above CRC transmissions for Fibre Channel protocol. Persistent Checksum is application independent and offers elaborate host OS support. When using supported HBAs, T10-DIF2 tags are added and verified on all customer data packets which are also checked and verified in the HPE 3PAR StoreServ Storage sub-systems like data cache and disk drives. When using unsupported HBAs T10-DIF tags are added and verified on the back-end HBAs and/or array target ports, storage data cache and disk drives, making the data secure all the way from the hosts right to the drives.

Agile QoS management on HPE 3PAR StoreServ Storage

HPE 3PAR Priority Optimization software for HPE 3PAR StoreServ Storage systems implements and manages a priority policy per Virtual Volume set (VVset) proxy for an application, or per virtual domain that serves as a proxy for a tenant. HPE 3PAR Priority Optimization software enables end users to take full control of performances via min goals and max limits for IOPS and bandwidth, along with the ability to set latency goals for volume sets as low as 500 microseconds for the most important applications. If these goals are not met, the system automatically adjusts the service levels of lower-priority applications and workloads in order to help assure that necessary QoS levels for your highest priority applications are frequently maintained.

With the combination of Priority Optimization software and HPE 3PAR Virtual Domains, you can specify these thresholds to protect individual tenants as well—for example, to prevent a single tenant from monopolizing resources. These capabilities removes the last barrier to consolidation by allowing you to deliver assured QoS levels without having to physically partition resources or maintain discreet storage silos.

HPE 3PAR Priority Optimization software is flexible and easy to configure and monitor, and it requires minimal supervision from storage system administrators. In contrast, some competitive QoS implementations require that you assign a workload to a predefined priority level or that the array be logically partitioned to reserve part of the system resources to a particular workload. These solutions are inflexible and don't allow real-time enforcement. HPE 3PAR Priority Optimization software is resident on the storage system and runs completely on the HPE 3PAR StoreServ Storage system. There are no host-based components to install.

High availability across sites using Peer Persistence

HPE 3PAR Peer Persistence software enables HPE 3PAR StoreServ Storage systems located within a metropolitan distance to act as peers to each other for delivering a high-availability, transparent failover solution for the connected VMware® vSphere, Microsoft® Hyper-V, Microsoft Windows® clusters, Red Hat® Enterprise Linux® (RHEL), and HPE-UX. HPE 3PAR Peer Persistence software allows an array-level HA solution between two sites or data centers where failover and failback remains completely transparent to the hosts and applications running on those hosts.

Unlike traditional disaster recovery models where the hosts (and applications) must be restarted upon failover, HPE 3PAR Peer Persistence software allows hosts to remain online serving their business applications, even when the serving of the I/O workload migrates transparently from the primary array to the secondary array, resulting in zero downtime.

In an HPE 3PAR Peer Persistence configuration, a host cluster would be deployed across two sites and an HPE 3PAR StoreServ Storage system would be deployed at each site. All hosts in the cluster would be connected to both of the HPE 3PAR StoreServ Storage systems. These HPE 3PAR StoreServ systems present the same set of VVs and VLUNs with same volume WWN to the hosts in that cluster. The VVs are synchronously replicated at the block level so that each HPE 3PAR StoreServ Storage system has a synchronous copy of the volume. A given volume would be primary on a given HPE 3PAR StoreServ Storage system at any one time. Using Asymmetric Logical Unit Access (ALUA), HPE 3PAR Peer Persistence presents the paths from the primary array (HPE 3PAR StoreServ Storage system on which the VV is primary) as "active/optimized" and the paths from the secondary array as "standby" paths. Issuing a switchover command on the array results in the relationship of the arrays to swap, and this is reflected back to the host by swapping the state of the paths from active to standby and vice versa. Under this configuration, both HPE 3PAR StoreServ Storage systems can be actively serving I/O under normal operation (albeit on separate volumes).

Disaster tolerant solutions with HPE 3PAR Remote Copy software

HPE 3PAR StoreServ Storage offers the most complete set of Disaster Recovery (DR) solutions in the industry. With a rich set of features, HPE 3PAR Remote Copy software is a uniquely easy, efficient, and flexible replication technology that allows you to protect and share data from any application. Choose between four different replication options from the same license—and across mid-range, enterprise-flash, and all-flash arrays of any model.

Implemented over a native IP network (through the built-in GigE interface available on all nodes) and native Fibre Channel, users may flexibly choose one of four different data replication modes: **Asynchronous Streaming** or **Asynchronous Periodic** (for asynchronous replication), **Synchronous, Synchronous Long Distance**—to design a solution that meets their solution requirements from the perspective of recovery-point objectives (RPOs) and recovery-time objectives (RTOs).

With all four of these modes, HPE 3PAR Remote Copy software allows data to be mirrored between any two HPE 3PAR StoreServ Storage systems of any model, reducing the incompatibilities and complexities associated with trying to mirror between traditional vendors' mid-range, enterprise, or all-flash arrays. Source and target volumes may also be flexibly and uniquely configured to meet user's needs (for example, different RAID levels, thick or thin volumes or different drive types, and others). HPE 3PAR Remote Copy is "thin aware" in that it is able to replicate both thin and thick volumes by using TPVV target volumes to provide the same cost savings associated with thin-provisioned source volumes created with HPE 3PAR Thin Provisioning software.

Synchronous mode solutions are suitable for data centers within metro distances and have a recovery point objective of zero seconds. When combined with HPE 3PAR Peer Persistence these solutions also enables recovery time objective of zero seconds.

For asynchronous replication solutions, network bandwidth is efficiently utilized with **Asynchronous Periodic** mode. Changed data within an HPE 3PAR Remote Copy Volume Group is transferred only once—no matter how many times it may have changed—between synchronization intervals. Additionally, efficiencies in the initial copy creation of the target volumes that do not require replication of "zero" data across the replication network (regardless of target volume type, thick or thin) result in a faster initial synchronization and better network utilization. With support for replication over long distances, HPE 3PAR Remote Copy **Asynchronous Streaming** assures data protection against disasters by providing an RPO in seconds, whereas HPE 3PAR Remote Copy Asynchronous Periodic mode ensures RPO in minutes over extended distances. Asynchronous Streaming is suitable for customers that want near zero RPO without the additional host latency associated with the synchronous mode of replication.

Synchronous Long Distance mode delivers a disaster recovery solution across long distances with a potential for zero data loss RPO and an RTO of minutes. This is achieved with a replication configuration that uses three sites (3DC) to simultaneously replicate a virtual volume from the primary array in synchronous mode to an HPE 3PAR StoreServ Storage array located at a synchronous site (within a metropolitan area) and in asynchronous periodic mode to an HPE 3PAR StoreServ Storage array located at an asynchronous site (across a long distance). In addition to the HPE 3PAR Remote Copy connections from the primary array to the two backup arrays, a passive asynchronous periodic link is configured from the synchronous array to the disaster recovery array. Under the Synchronous Long Distance mode algorithm, the synchronous site intelligently tracks the delta set of I/Os that have been acknowledged to the host but which have not yet been replicated to the asynchronous site. In the event that a disaster takes the primary storage array down, the user has the flexibility to recover either from the synchronous site or the asynchronous site.

Flat backup for end-to-end availability and data protection

HPE 3PAR Peer Motion software enables the seamless movement of data between HPE 3PAR StoreServ Storage systems of any model, enabling one-click workload balancing. Up to four systems can be pooled into the same federation to support up to 60 PB of usable capacity and 10 Million IOPS. Multi-array, bi-directional, non-disruptive data mobility across systems enables you to load balance at will, refresh technology seamlessly, reduce costs of asset lifecycle management, and lower technology refresh CAPEX.

HPE 3PAR Peer Motion Software is a non-disruptive, do-it-yourself (DIY) data mobility tool for enterprise block storage that does not require any external appliance to be included in the data path, nor does it introduce any additional overhead on the host resources. Unlike traditional block migration approaches, the HPE 3PAR Peer Motion Software enables non-disruptive data mobility of storage volumes between any HPE 3PAR StoreServ system that is part of a storage federation, and without complex planning or dependency on extra tools.

Federated multi-array, bi-directional data mobility between HPE 3PAR StoreServ Storage systems is easy to implement and manage via the HPE 3PAR StoreServ Management Console (SSMC). Simple predefined workflows have been implemented within SSMC that give you the ability to move data—for example, moving all volumes associated with a host from one HPE 3PAR StoreServ Storage system to another or moving individual volumes for workload balancing purposes—all with just a single click.

Federation and non-disruptive data migration with HPE 3PAR Peer Motion software

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Customer-configurable priority for snapshot promotion

HPE 3PAR StoreServ Storage supports thousands of reservation less and QoS-aware snapshots (up to 500 per parent LUN). These snapshots are stateful, non-fragmenting, and "thin-aware"—meaning they are non-duplicative with respect to writes. In addition, any snapshot in the tree can be restored and promoted at any time while newer and earlier point-in-time (PIT) snapshots still remain valid. These snapshot features provide continued and active data consistency at all times, which is a must for all enterprise customers implementing a Tier-1 business solution.

When a LUN must be restored for any reason (corrupt database, file system resizing, and others), support for customizable prioritization order for snapshot promotes to the parent LUN that enable a restore to the desired recovery point as quickly as possible. This helps ensure that the customer can generally restore crash-consistent or application-consistent snapshots obtained by HPE 3PAR Recovery Manager products to a precise recovery point at all times.

Universal management interface and software functionality

HPE 3PAR StoreServ Storage supports a converged operating system (the HPE 3PAR OS) across all models, meaning that generations of HPE 3PAR StoreServ Storage systems—regardless of size, model, or deployment timeframe—can all be managed from the same interface. All software functionality is identical across all HPE 3PAR StoreServ models, which means that any administrator only needs one set of storage skills when managing HPE 3PAR StoreServ Storage.

In addition to a simple management interface, the use of HPE 3PAR OS across the entire family drastically reduces the risk of provisioning or management errors when utilizing different HPE 3PAR StoreServ models.

Proactive support services and remote operations

HPE 3PAR StoreServ Storage has a dedicated service processor server that is used mainly for the outbound transfer of specific array-based information required by HPE Services. This information includes system status, configuration, performance metrics, environmental information, alerts, and notification debug logs. No customer data is ever sent over these links.

The data sent is used by HPE Services teams to proactively monitor the array and contact the customer if potential issues are discovered. This results in the customer being proactively warned about a potential problem before the issue can occur. Once the customer is advised of the issue, parts are dispatched and non-disruptively replaced by trained HPE service personnel at the customer's convenience.

If the service processor stops transferring information for any reason, HPE customer support centers will receive an alert. The service processor is also the firmware database repository for all current and previous firmware levels (including HPE 3PAR OS, disk device, and disk chassis [AKA "enclosure"] firmware).

If remote access is needed for any reason, the customer can configure inbound access for OS upgrades, patches, and engineering access.

If the customer's data center does not permit "phone home" devices, then all alerts and notifications, are sent to the customer's internal support team. The customer can then notify HPE Services of any suspected issue over the phone or via the Web.

Automated proactive utilization monitoring

In addition to and concurrent with automated remote monitoring, alerting, and notification, HPE 3PAR StoreServ Storage also supports a complimentary support service for customers known as Over-Subscribed System Alerts (OSSA). This automated monitoring tool performs proactive utilization checks on key system elements using data that resides at HPE. This data is collected periodically from HPE 3PAR StoreServ Storage systems and sent to HPE. The intent is to provide clients with valuable information to keep their HPE 3PAR StoreServ Storage systems running more effectively at all times.

In addition, optional HPE 3PAR System Reporter software enables customers to set thresholds and alerts for performance on system components and even configure a custom set of alerts. New metrics are added dynamically as needed.

Current metrics include:

1. Storage node controller CPU utilization

2. Disk IOPS (per device type, to highlight potential spindle-bound applications and overloaded systems)

3. Number of host initiators per port (guards against over-subscription and non-tested configurations)

4. Total host initiators per system

5. PCIe bus bandwidth

6. Port bandwidth (per host- and disk-facing system ports)

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