PAC STORAGE

PAC Storage PS Gen1 Series

Technical Overview

This whitepaper provides an overview of the PS Gen1 Series' key features, hardware components, data services, and use cases to help you better understand the system.

Version 1.0

October, 2016

Table of Contents

PS Gen1 Series Features

Cloud-Integrated Unified Storage

The PS Gen1 Series unified storage is based on the block-level RAID technology with XFS file system and PAC Storage's self-developed cloud engine. From a user's perspective, block-based unified storage provides better performance and response time for block-based applications, such as database, exchange and virtualization. XFS file system allows users to easily scale their file shares to handle today's tremendous growth in unstructured data. Compared to other file systems, its main advantage is the support for large-capacity file sharing and smooth data flow, enabling user convenience.

In addition to block and file level, the PS Gen1 Series also supports RESTFul API for object storage at the frond-end and back-end (to cloud) and enables integration with third party cloud services with its complete features, including Cloud Cache, Cloud Backup, and Cloud Tiering. With Cloud Cache, all data is stored on cloud and users can choose to store all data or just the most accessed data on local storage. With Cloud Backup, snapshots are taken periodically according to schedule and uploaded to cloud so users can select specific images from different time points for data recovery. With Cloud Tiering, inactive data is moved to cloud for long term archive while the most accessed data will remain on local storage. These cloud features are offered to allow users to leverage cloud storage capacity and make use of off-site backup and disaster recovery.

Complete Product Line

PAC Storage is devoted to the planning of the PS Gen1 Series line to meet a wide of range of user requirements. With the current PS 2000, and 3000 systems to satisfy customer demands for performance and storage capacity.

For the PS storage and JBOD configuration, multiple form factors, including 2U12, 3U16, 2U24, and 4U24, are available and the converged host board supports multiple interface ports, including FC 16G x 2, FC 8G x 4, iSCSI 10G x 4, and FCoE 10G x 4. In general, with the converged host board, IT administrators who would like to upgrade the data host port connectivity from 10Gb/s iSCSi to 16Gb/s FC Channel can do so by substituting SFP+ or SFP transceivers and taking easy steps to switch the connection mode without changing the host board or controller. The converged host board offers flexibility for connections with different fiber-optic standards. It provides enterprises a whole new, convenient and versatile way to set up fiber-optic data storage systems that accommodate future data storage plans and enable cost savings for system upgrades.

| 10Gb/s iSCSI SFP+ | 16Gb/s Fibre | 12Gb/s SAS | Converged host board |

Host Board options in controller

Reliable Supercapacitor Backup with Flash Module

The traditional backup battery is replaced by an innovative Cache Backup Module methodology (CBM) which consists of a super capacitor and a flash backup module (FBM). Cached data is quickly distributed to a flash backup module for permanent storage with the support of the super capacitor in the event of a power outage. The main advantage of a super capacitor is its ultra-fast charging time. The super capacitor is charged within a few minutes and available to distribute power to the controller so cached data can be saved immediately and permanently in the flash backup module (FBM). In addition, the super capacitor has a long-life expectancy and therefore is highly reliable and requires minimum maintenance effort.
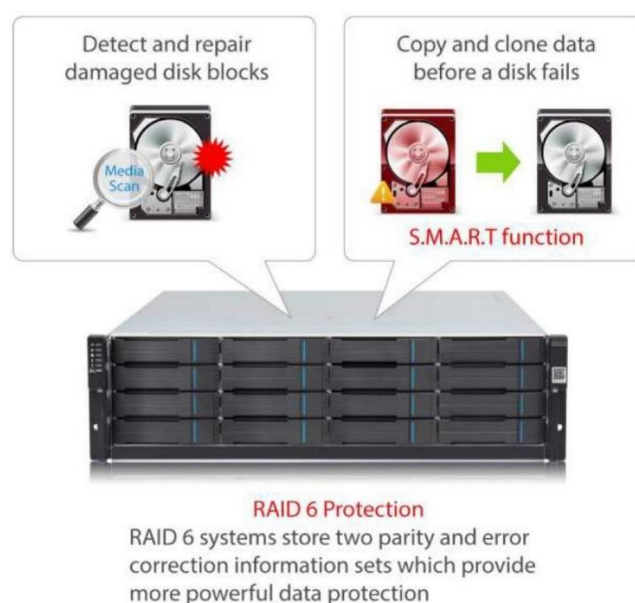

Supercapacitor Backup with Flash Module
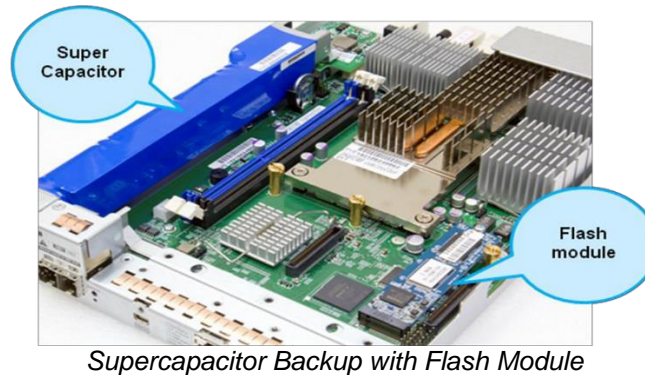
Built-in Intelligent Drive Recovery (IDR) Mechanism

IDR offers superior RAID protection and recovery compared to generic RAID, increasing data integrity and system efficiency while keeping your data secure against error and loss.

Working best in RAID 6, IDR uses spare drives to recreate data. Intelligent clone and replace prevents data loss by automatically recovering affected media. IDR clones faulty drives and is capable of specifically recovering bad sectors or blocks as needed. It automatically relocates potentially problematic data to readable sectors and blocks in the background without user intervention, providing a vital tool for preempting drive failure and preventing data issues.

Together with HDD S.M.A.R.T (self-monitoring, analysis, and reporting technology), IDR offers smart media scan, which catches errors before they become a problem. Smart media scan takes into account I/O demand, suspending and resuming to avoid performance degradation. Media scan can also be scheduled manually or set to automatic mode.

RAID 6 Protection
RAID 6 systems store two parity and error correction information sets which provide more powerful data protection

Supporting Native Block-level and SMB 3.0

Continuous Failover

A simple parity error may sometimes cause a storage system to completely hang up, and system downtime is not allowed for today's mission-critical environment. Having two controllers working together will guarantee that at least one controller will survive the catastrophes and keeps the system working. The PS Gen1 Series Unified Storage supports both block-level failover and file-level (SMB3.0 transparent failover) in redundancy of dual controller design to ensure service continuous availability. During normal operation, each controller serves its own I/O requests from the host. If one controller fails, another existing controller will temporarily take over for the failed controller until it is replaced. The failover and failback processes are totally transparent to host and require only physical disconnect and reconnect efforts. Controllers are hot-replaceable and replacing a failed unit takes only a few minutes.

Controller Failover
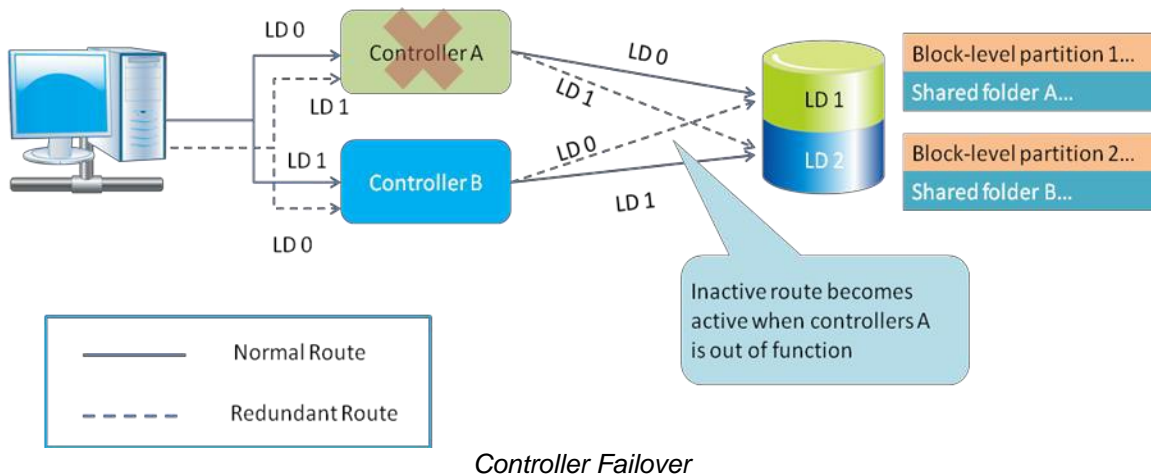
Embedded LDAP

The Lightweight Directory Access Protocol (LDAP) is a standard protocol for accessing and maintaining distributed directory services over network, and Microsoft Active Directory is a kind of directory service that works in Microsoft Windows OS. LDAP Server function is embedded into the PS Gen1 Series system, so you do not need to construct additional LDAP servers.

PAC Management Software
An Easy-to-use Interface for Management

PAC Management Software, the PS Gen1 Series management interface, simplifies data management by providing a single control center for centralized system management and resource monitoring. IT administrators are able to easily analyze and optimize system resources to improve ROI. One of innovative features of the PAC Management Software is its workflow automation GUI that integrates storage controls such as storage provision, scheduling backup as snapshot, and cloud into one easy and simple step-by-step procedure by grouping similar functions and settings into one streamlined page. This makes it much faster and easier to configure new systems while avoiding all the hassles of complicated navigations. Another advantage is Storage Resource Management (SRM) which allows IT personnel to analyze performance and capacity usage status to optimize system resources with quota management. Complete event notifications for system monitoring ensure users are fully informed of various events.

For the first time login to the PAC Management Software, you will see an Initial Setup Wizard which will guide you through the basic storage configurations.

Workflow can integrate storage controls into one easy and simple step-by-step procedure by grouping similar functions and settings into one streamlined page.

For the convenience of storage status monitoring, PAC Management Software provides analysis data of performance and capacity usage so users can easily locate the problem when any unplanned situations happen.
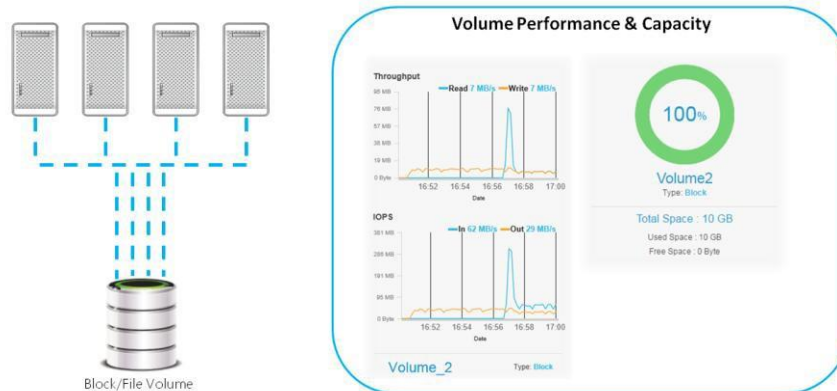
Performance Monitor

As for storage consumption analysis, the Storage Resource Management (SRM) function helps to collect the history records from disk array systems and displays them in trend charts. Users can easily plan storage usage ahead, make decisions, and even locate abnormal situations.

Choose the display time interval of the SRM diagram

Hardware Overview

The PS Gen1 Series platform includes the mid-range PS 2000 and PS 3000 models and can be

configured as an all flash, as a hybrid system, or as any general purpose storage. The models share certain similarity in the form factor. All enclosures are designed to utilize 2.5" or 3.5" hard drives and drive capacity can be expanded by attaching expansion hard drive enclosures (JBODs), and feature high-availability hardware design with redundant and hot-swappable hardware components, such as dual controllers, power supplies and cooling fans, to eliminate single-point-of-failure. The main differences among the series are the computing power, memory capabilities and connectivity, designed to meet different operation requirements.

PS 2U24 Front View

PS 3U16 Front View

PS 2U12 Front View

Hardware Highlighted Features

Large Memory Size

The PS Gen1 Series supports up to 256 GB per system (128 GB per controller). Due to its large memory size, more data can be stored in temporary memory as read and write cache, enabling faster processing. In other words, compared to small capacity systems, it is expected to have better performance and quicker response time in application use cases. In addition, adopting larger memory size provides the system great ability to process multi-tasks. For example, operations can run more smoothly with larger memory capacity when block-and file-level services are enabled simultaneously.

Hardware Scalability

PS Gen1 Series supports high scalability and upgradability based on highly scalable hardware design. Various form factor options of JBOD expansion units are available that help users quickly and efficiently expand capacity without downtime. With 12Gb/s SAS connectivity to

compatible JBOD enclosures, drives and storage capacity can be expanded as easy as cascading up to 444* drives with a RAW capacity as large as 4,440TB*, and customers can save as much data as they want with no worries for capacity limit.

Available in PS Gen1 2024 and 3024 with 10TB Nearline SAS Drives
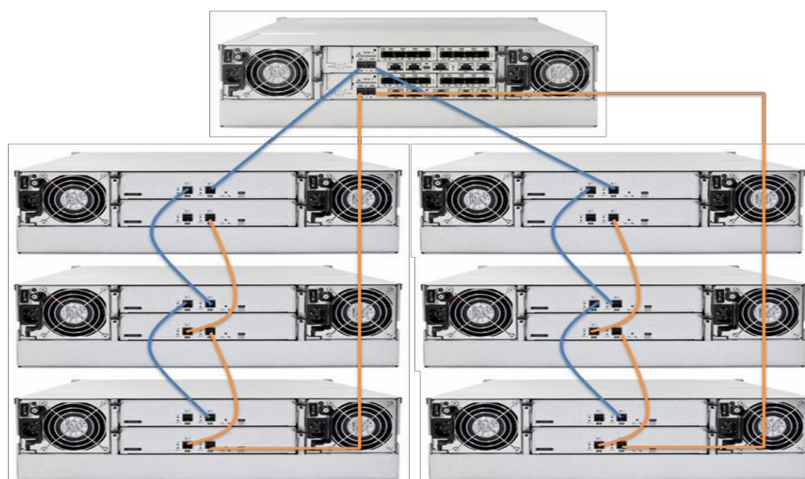
Redundant Cross Loop and Protection Against Single Point of Failure

Dual Host Board and Embedded On-Board Converged Host Board Design

The PS Gen1 Series features an optional dual host board design which vastly augments storage network speed and flexibility. Beyond wider bandwidth, it enables hybrid combinations of Fibre Channel (up to 16Gb/s), SAS (up to 12Gb/s), and iSCSI (up to 10Gb/s) for diverse connectivity. With its unique dual host board design and 12Gb/s SAS interfaces to internal SAS or SATA disk drives, these systems achieve a massive throughput to meet even highly demanding applications such as media editing. Below shows a dual host board design for one controller.

Dummy cover default included on HB2 if customer only buys one host-board or doesn't buy a host-board

Cable-less Modular Design

The PS Gen1 Series' completely cable-less and modular design eliminates problems associated with cable connections to offer a higher level of serviceability and hot-swappability. This design is for easy deployment and maintenance.

Cable-less Design
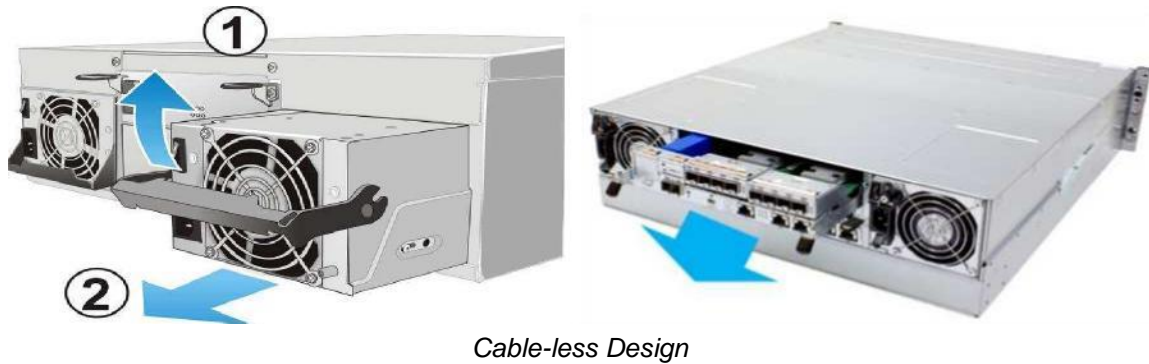
Data Service Overview

Rapidly growing data leads to burgeoning storage needs. As an ideal storage solution for business critical applications, the PS Gen1 Series not only provides necessary capacity and performance to accommodate data and process transactions but also offers comprehensive data services to provide cloud integration features and ensure storage operation efficiency, enhanced data protection, and serviceability.

Cloud Integration

The PS Gen1 Series integrates three cloud features that extend local storage with cloud capacity or make use of off-site backup and disaster recovery. These features include Cloud Cache, Cloud Backup, and Cloud Tiering. Currently the PS Gen1 Series supports integration with the following cloud service providers:

- Amazon S3

- Google Cloud Platform

- Microsoft Azure

- Alibaba AliCloud

- OpenStack Swift

Cloud Cache

Enable the Cloud Cache to establish a connection between a storage pool and a cloud bucket. Data will automatically be deduplicated, compressed (optional), and encrypted when migrated to the cloud. Cloud Cache is available in two options – fully cache or non-fully cache. If Fully Cache is active, the PS Gen1 Series will keep all data locally and flush all data to the cloud based on a scheduled snapshot. On the other hand, if Fully Cache is inactive (non-fully cache), the PS Gen1 Series will keep only frequently accessed data locally and flush all data to the cloud based on a scheduled snapshot. Regardless of whether Fully Cache is active or inactive, all data will be stored in the cloud and is recoverable based on the last flush period of the snapshot. Based on the operation mechanism of Cloud Cache and Cloud Fully Cache, Cloud Cache is suitable for email archiving or less frequently accessed database archiving and Cloud Fully Cache is suitable for less frequently accessed database or production data backup and disaster recovery.

Cloud Backup

In this mode, the cloud bucket is treated as a storage target for remote replication. After the PS Gen1 Series has established a connection pair between the pool and the bucket, it will periodically back up data snapshots to the cloud. The latest data will always be stored locally

and multi-point-in-time snapshots will be stored in the cloud. Users can directly access local data and as the cloud can store multiple snapshots, users can restore any version of snapshot from the cloud to a local or another remote site when a problem occurs at the local site. Because of its mechanism, Cloud Backup is suitable for frequently-accessed database or production data backup and disaster recovery.

Cloud Tier

With Cloud Tiering, PS Gen1 Series users can establish a connection between a pool and a cloud bucket to integrate cloud storage into a storage tier, keeping the frequently accessed data locally to ensure a high read/write speed while moving the less accessed data to the cloud. Less accessed data stored locally will be moved to the cloud according to its data access frequency record if the used storage pool capacity exceeds 80% (Threshold $\geqq$ 80%). Therefore, data will exist only either locally or in the cloud. If users need to retrieve less accessed data which is stored in the cloud, it will take time to access the data as it will be first decompressed (optional), unduplicated, and decrypted into its original format. In addition, data migration speed from cloud to the PS Gen1 Series system is based on Internet bandwidth. Due to its mechanism, Cloud Tiering is suitable for users who wish to leverage online scalability due to a steady capacity demand and can deal with slower cloud data access.

Data Reduction Technology: Deduplication & Compression

The PS Gen1 Series' cloud gateway engine can automatically de-duplicate and compress data (optional) before moving it out of on-premise storage, which significantly reduces footprint to cloud and lowers the cost charged by cloud service providers. In addition, the PS encrypts data with AES 256-bit algorithm for in-flight and at-rest data to ensure data security.

Data deduplication is a method of consolidating redundant copies of data. In the deduplication process, unique chunks of data are identified and stored during a process of analysis. As the analysis continues, other chunks are compared to the stored copy and whenever a match occurs, the redundant chunk is replaced with a small reference that points to the stored chunk.

The PS Gen1 Series uses GZIP, a format standard where the underlying compression algorithm is called Deflate, to operate compression and de-compression process in order to optimize bandwidth usage before delivering data over the Web. Compression helps speed up data transmission time and minimize cloud storage costs, and there are many types of data that can benefit from compression, such as archives for virtual machines file and static copies of databases.

Operation Efficiency

SSD Cache

Cache is a component that transparently stores data so that future requests for the data can be served more efficiently. It is fundamental to storage, especially for read-intensive applications.

Because the capacity of controller memory cache is limited, SSD Cache allows fast SSD to be used to extend the cache pool capacity of storage systems and stores frequently accessed data. While the capacity of SSD Cache has increased, the cache hit rate has also improved. With more hot data stored in the SSD Cache, future request for those data can be served more efficiently and the read performance dramatically improves.

SSD Cache
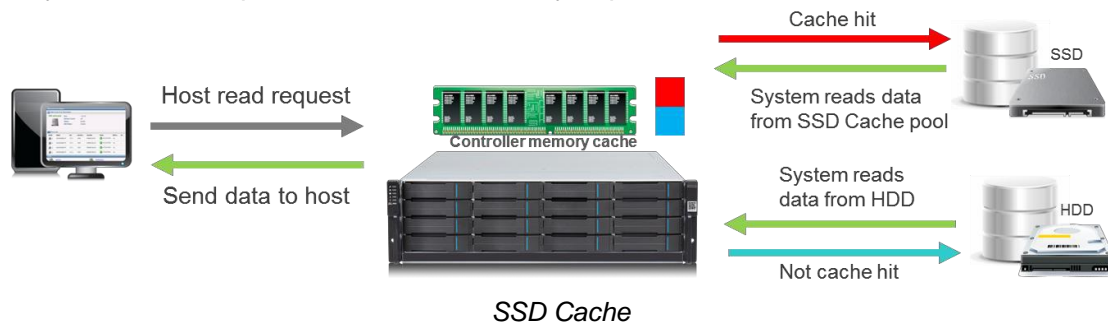
Automated Storage Tiering

Block-based automated tiering automatically migrates data between low and high performance drives. A maximum of four tiers can be deployed, with the highest tier (tier 0) featuring the highest performance level. The most frequently accessed data will be stored on the fastest storage tier. Users can greatly optimize storage performance and increase ROI when enabling this function.

Automated Storage Tiering
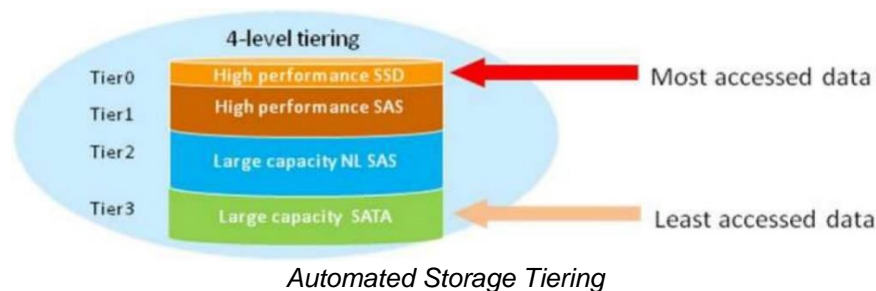
Thin Provisioning

Thin provisioning allows you to allocate a large amount of virtual capacity for a pool regardless of the physical capacity actually available. Actual space is used only when data writes occur. By automatically allocating system capacity to applications as needed, thin provisioning technology can significantly increase storage utilization. Thin provisioning also greatly simplifies capacity planning and management tasks.

Data Protection

Remote Replication

Remote replication capability allows users to create full data copies across storage systems, including in synchronous or asynchronous mode. If source data fails due to system malfunctions or disasters, users can leverage disk-based remote copy to restart services in a few minutes. If

the source needs to resume its role, it can be quickly synced with the remote copy while adjusting only for differentials.

To further ensure the integrity of remote data, remote replication allows users to protect remote copies with snapshot technology. Granular snapshot images can help restore corrupt remote copies in seconds when the resumption of business services is a top priority.

Remote Replication
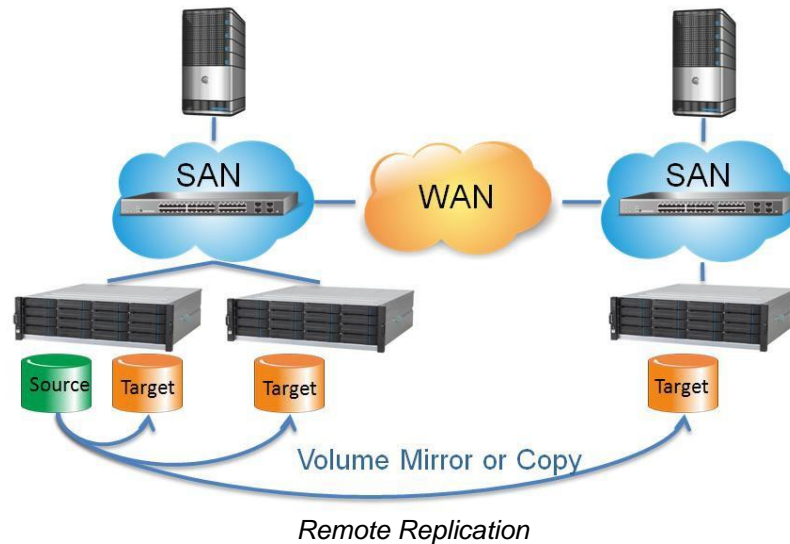
Snapshot

Snapshot functions provide instantaneous point-in-time copies of data that look and behave like complete backups without consuming equivalent disk space. The snapshot images are ideal for various applications including backup, testing or development, information analysis and data mining.

In the instant of snapshot creation, a point-in-time data image is taken without disrupting online applications. Based on the image, data changes will be copied to the snapshot volume when new writes occur. With copy-on-write design, PS Gen1 Series snapshot protects production data from accidental modifications, deletions, and corruptions with minimal capacity requirements and performance overhead. By accessing a snapshot copy as the desired recovery point, users can immediately restore system availability from data disruption.

File Replication (Rsync)

Remote replication via the rsync protocol allows users to create an identical backup copy of a PS Gen1 Series system (source) in a target device located at a physically distant place. When system failure occurs, the target can swiftly restore the data and network services to the previous state.

Data Security

Self-Encrypting Drives (SED)

SEDs have an encryption controller (ASIC) and an encryption key both embedded on the hard drive itself. SED encryption is automatic and transparent without performance degradation. A unique encryption key is generated randomly at the factory for each SED. The encryption is essentially fail-safe, meaning drives are extremely secure when installed in an array or when

removed so even if the physical drive is stolen or misplaced, the data thereon remains protected against intrusion.

Folder Encryption

The PS Gen1 Series supports comprehensive data protection mechanisms for the highest level of data integrity and availability. When folder encryption is enabled, this encrypted folder is password-protected with 256bit AES encryption. On the other hand, when this folder is unlocked, users can freely access files in the folder.

# Serviceability

Service Center

Service Center, a built-in service in the PAC Management Software, offers diverse services for the convenience of PAC Gen1 Series users. First, it helps simplify the process of replacing field-replaceable units (FRU). The GS system will proactive notify the service center when a hardware failure event occurs. Then, the service center will automatically create a support ticket and return merchandise authorization (RMA), and a technical support engineer will contact the user and send a required FRU to the user. Second, Service Center simplifies the process of bug reporting and feature requesting. You can describe your issue and requirements in a service request form created in the PAC Management Software, and the system will automatically create a support ticket. In general, Service Center greatly simplifies the manual and time-consuming process of getting technical support.

PS Gen1 Series Use Case

With best-in-class scalability, performance and availability, the PS Gen1 Series Unified Storage optimizes support for critical applications, cloud-ready infrastructure and data center consolidations, all through a single platform.

Media & Entertainment

In the media asset industry, companies can be categorized into video production, TV stations and network streams. Video production services include most advertising productions, film post-processing and animation productions. TV stations contain local or nationwide TV stations. Network streams are a new media category usually used in network television.

PS Gen1 3000 Series

Reference Architecture
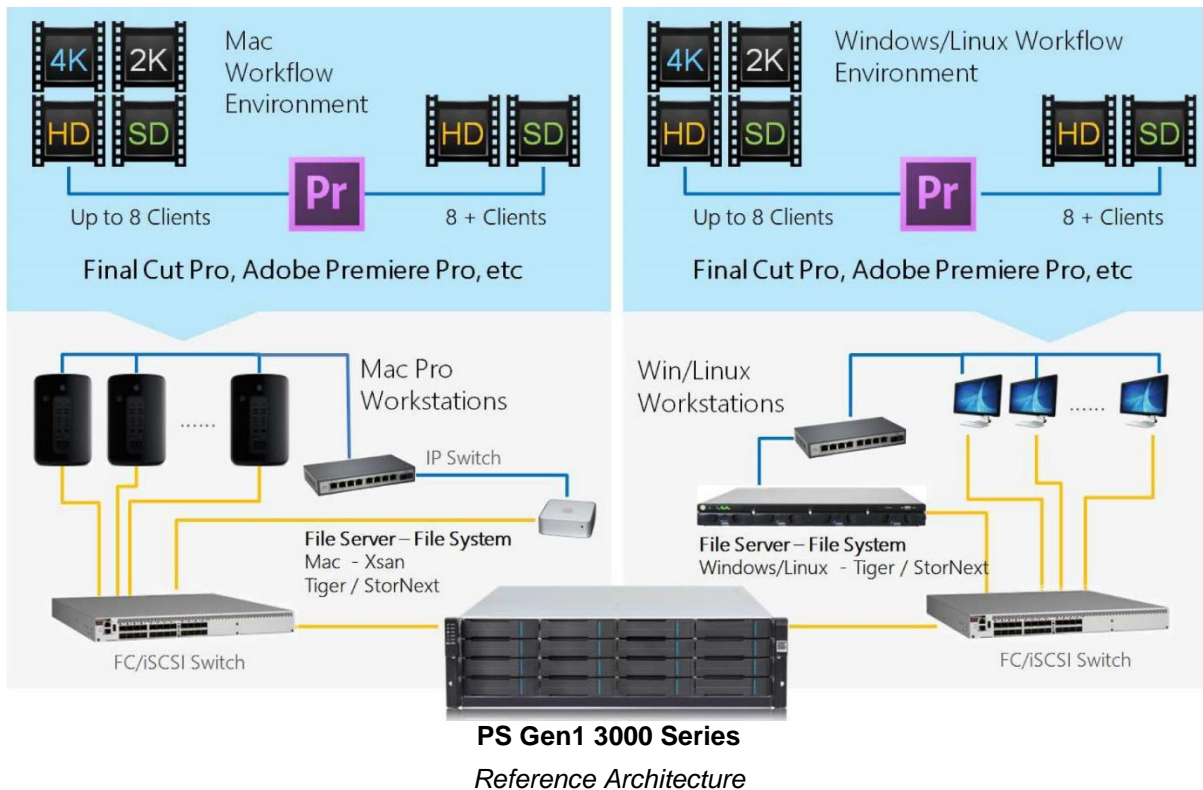
Major M&E applications of the PS Gen1 Series can be divided into the following two categories. Users can configure the system according to their requirements.

NAS Network Architecture Solution

The NAS network architecture solution meets the needs of mass multiple streams broadcasting and editing. Unified storage with full-IP network provides convenience and compatibility to most network structures.
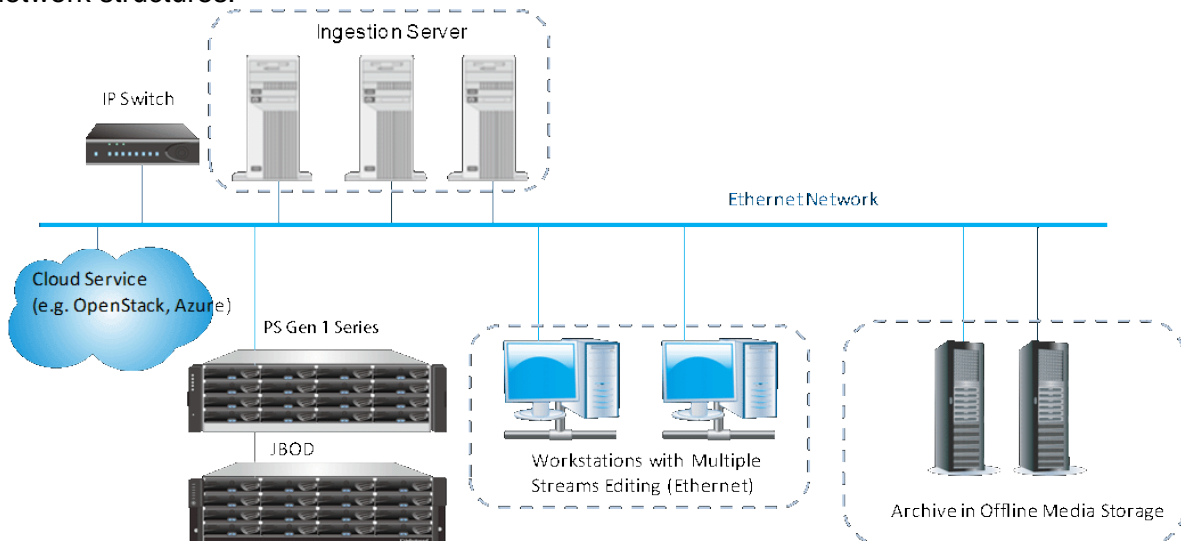

Unified Architecture Solution

This solution offers those media groups with some high-resolution video retouching and multiple small stream editing. Hybrid architecture provides high flexibility to fit users' environments.
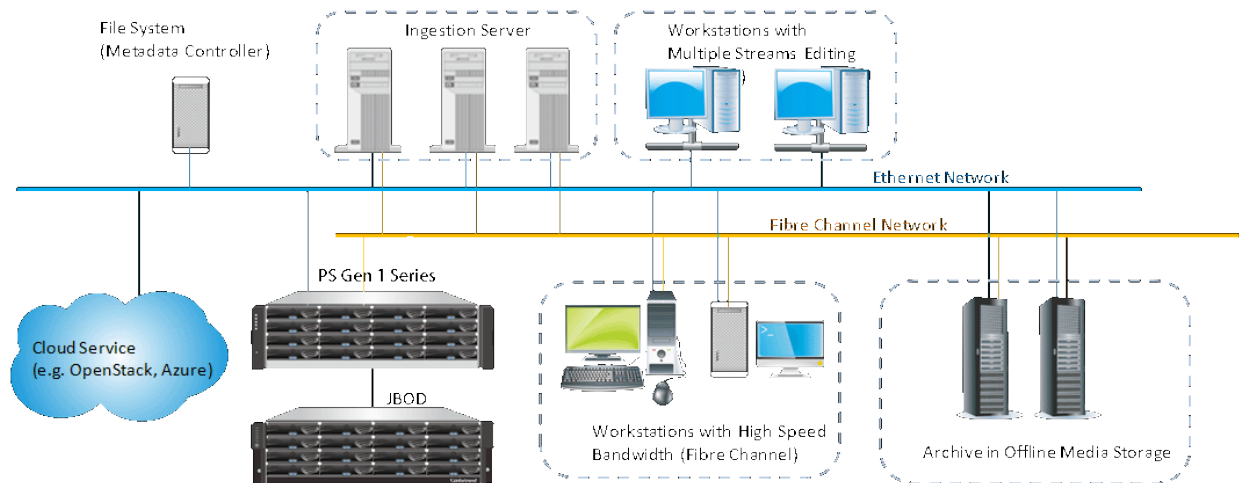
Mail Solution

Mail server is a disk-intensive application. The PS Gen1 Series supports high expansion scalability and can be scaled up to 444 drives, flexibly compatible with different types of drives. Configuration of the system should take mailbox capacity and future growth, performance requirements, number of databases and database size into consideration. Since a larger database size and a higher number of databases may impact performance, it is recommended to follow mail server guidelines when configuring the system.
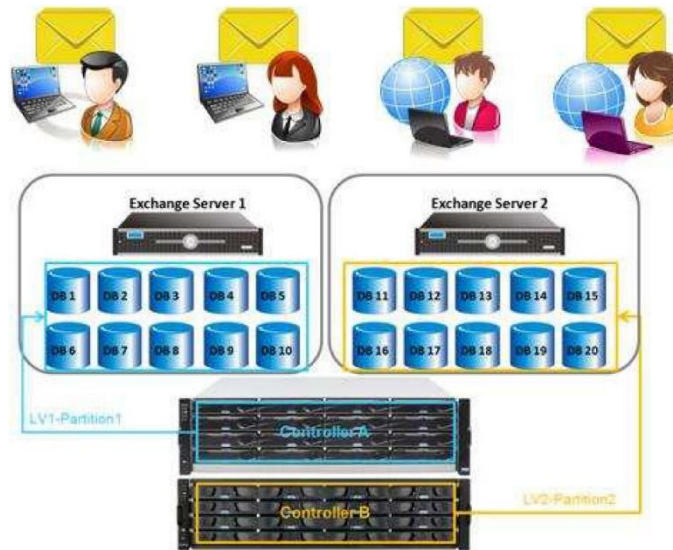
Database

Data can be of various levels of importance at the time when they are created and their value may change with time. Capacity demand will also grow. Furthermore, users' access patterns on the data are different and they may also expect different read/write performances. The PS Gen1 Series supports storage tiering and SSD cache, with which frequently accessed data and log files are moved to SSD storage to take advantage of SSD's low latency and infrequently accessed data (cold data) is migrated to 15K SAS, 10K SAS, or NL-SAS to make use of the large low-cost capacity.

# Virtual Desktop Infrastructure

Most businesses employ a mix of professional talents, such as sales, marketing, finance, call

center workers, etc. In a traditional IT infrastructure, computer resource management is always a nightmare for IT staff as they try to meet the variety of requirements of the different types of workforce in a business environment. The PS Gen1 Series unified storage integrates SAN and NAS features in one enclosure, providing easy folder sharing and better protection for user data and profile for all VDI users, making VDI deployment simple.

VDI Solution

Easy Folder Sharing for All VDI Users

The PS Gen1 Series can help not only build a VDI infrastructure but also provide features of file sharing. Shared folders are the basic directories, transferring data to VDI users over TCP/IP using the CIFS for Windows, NFS for Linux/ UNIX, or AFP for Apple OS X, where users can securely and easily share documents with other colleagues in the same company. In addition, based on each type of employee's requirement, IT staff can set up folder permissions for them.
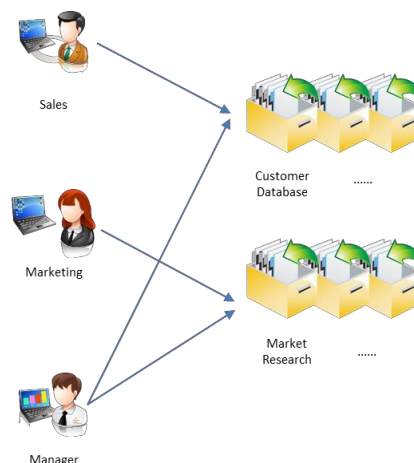

Easy to set up folder permission for different user groups

Optimizing VDI Data Management

The PS Gen1 Series unified storage along with well-organized planning will greatly simplify VDI data management.

Typically a virtual desktop consists of OS, applications, user data (created from daily work including document, spreadsheets, and so on). OS and applications files are frequently accessed by all users, and they do not grow rapidly in capacity. On the other hand, user data are not accessed frequently but the capacity grows over a period of time. Therefore, it is better to manage them separately.

Traditional SAN Storage has to back up all VMDK files and this is time-consuming and costly. However, the PS Gen2 Series provides efficient management solutions. Along with a reasonable backup plan and 3rd party tools, the PS Gen2 Series can help only back up valuable user data and profiles and save backup time.
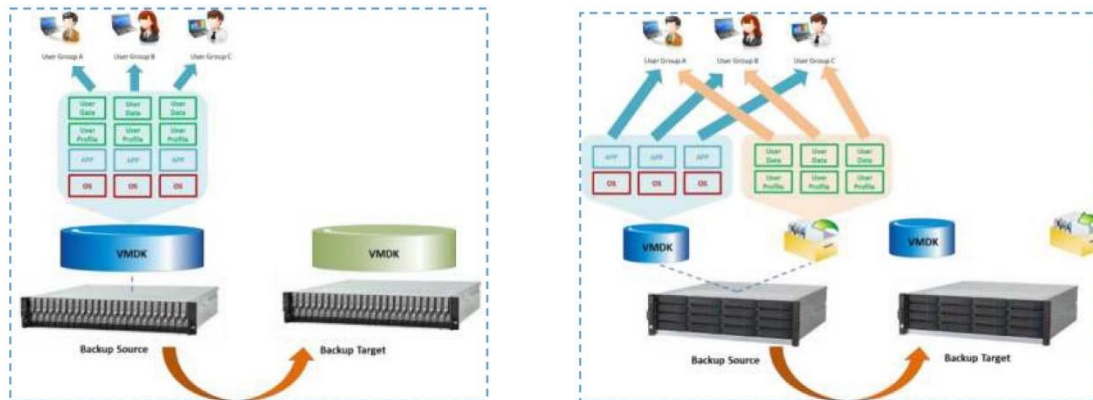
Traditional SAN Storage vs. PS Gen1 Series Unified Storage

Data Center Virtualization

The PS Gen1 Series has been designed to seamlessly integrate with a virtualization environment, offering user-friendly GUI for efficient operations and delivering all flash and hybrid storage solutions to sustain heavier workload demands and loads. In addition, the PS Gen2 Series consolidates SAN and NAS in a single system so users can easily share folders among virtual machine users and set folder permissions based on requirements.
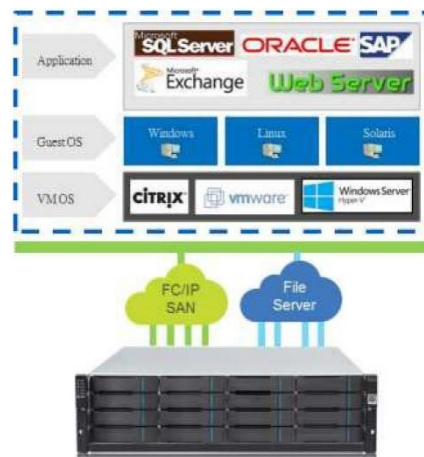
Data Center Virtualization Solution

D2C / D2D2C Backup

Data backup to cloud storage is the trend of the future. With the Fully Cache and Cloud Backup features, the PS Gen1 Series enables Disk to Cloud (D2C) backup and Disk to Disk to Cloud (D2D2C) with the remote replication function of the PS Gen1 Series. In the case of a disaster,

data on the cloud can be restored from a local or remote site to thereby ensure organizations' application programs can continue to provide services without interruption. To guarantee data security both in-flight and at-rest, the PS Gen1 Series will encrypt the data using the AES 256-bit algorithm before transmitting the data to cloud. Also to reduce bandwidth usage and increase storage efficiency, the PS Gen1 Series provides data deduplication and compression.

Appendix

PS Gen1 Family Hardware Specifications

	PS 2000	PS 3000
Form Factor	2U12 / 3U16 / 2U24 / 4U24	2U12 / 3U16 / 2U24 / 4U24
Controller	Dual Redundant Controller (S/R)	
CPU Platform	Intel Broadwell-DE 2C / 4C	Intel Broadwell-DE 4C
Cache Memory (per controller)	Default: 8GB, upgradeable to 64GB (2x32GB)	Default: 8GB, upgradeable to 128GB (4x32GB)
Cache Backup	Super Capacitor + Flash Module	
SAS Expansion Ports (Per controller)	1 x 12Gb/s SAS wide port	2 x 12Gb/s SAS wide port
Number of Host Boards	2	2
Onboard GbE Ports (per controller)	4 x 1Gb/s	2 x 1Gb/s + 2 x 10Gb/s (RJ45)
Optional Host Boards (per host board)	2 x 16Gb/s FC ports, 4 x 8Gb/s FC ports 4 x 10Gb/s iSCSI (SFP+) ports 2 x 10Gb/s iSCSI (RJ45) ports 4 x 10Gb/s FCoE Ports 2 x 12Gb/s SAS ports	
Drive Interface	12G SAS	
Maximum Number of Drives	444	