Overview

The new HP MSA 2040, a high-performance storage array designed for entry-level HP customers desiring 8 and/or 16Gb Fibre Channel, 1 and/or 10GbE iSCSI, or 6Gb/12Gb SAS connectivity with 4 host ports per controller. This next generation MSA 2040 Storage array provides an excellent value for customers needing performance balanced with price to support initiatives such as consolidation and virtualization.

The MSA 2040 delivers this performance by offering:

- New controller architecture with a new processor
- 4GB cache per controller
- Solid State drives (SSDs)
- Up to four (4) host ports per controller
- Two new MSA 2040 Controllers:
  - MSA 2040 SAN Controller
    - 8Gb/16Gb FC connectivity and/or
    - 1GbE/10GbE iSCSI
  - MSA 2040 SAS Controller
    - 6Gb/12Gb SAS connectivity

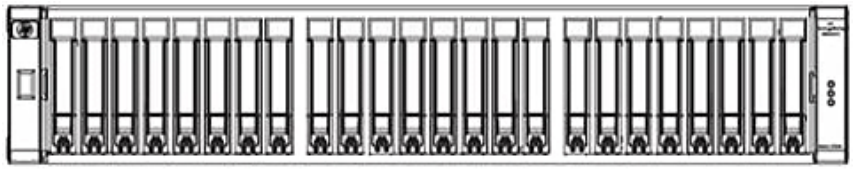
The HP MSA 2040 Storage System brings the performance benefits of SSDs to MSA array family customers. This array has been designed to maximize performance by using high performance drives across all applications sharing the array.
The HP MSA 2040 Storage arrays are positioned to provide an excellent value for customers needing increasing performance to support initiatives such as consolidation and virtualization.

The HP MSA 2040 Storage ships standard with a license for 64 Snapshots and Volume Copy for increased data protection. There is also an optional license for 512 snapshots. The HP MSA 2040 can also replicate data between arrays (P2000 G3 and/or MSA 2040 SAN Model only using FC or iSCSI protocol) with the optional Remote Snap feature.

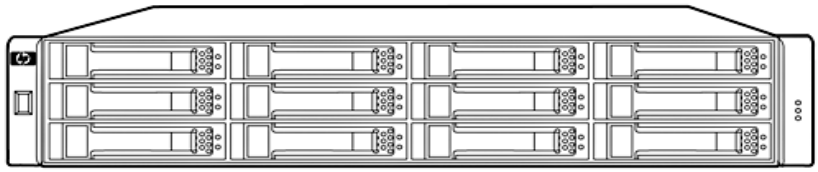
What's New in the MSA 2000 array family

- Adding 12Gb SAS Models -support up to Four 6Gb/12Gb SAS connections per controller.
- Adding support for 1GbE/10GbE iSCSI to MSA 2040 SAN Controller.
  - **NOTE:** Customers must upgrade their MSA 2040 controller firmware to GL101 or later for iSCSI functionality.
- Adding support for HP MSA 2040 SAN Controller to offer a combination of host interface protocols by mixing FC and iSCSI SFPs on the same controller. Please refer to the valid Configuration Table for Mixing SFPs in this doc.

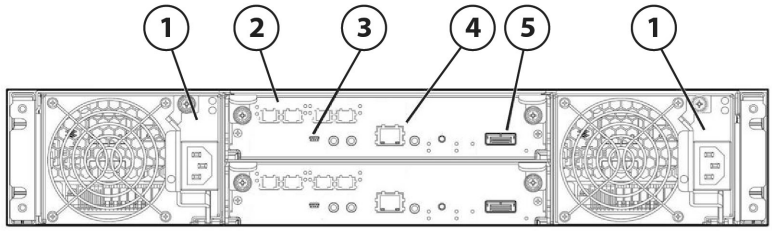
Overview



HP MSA 2040 Storage (SFF)

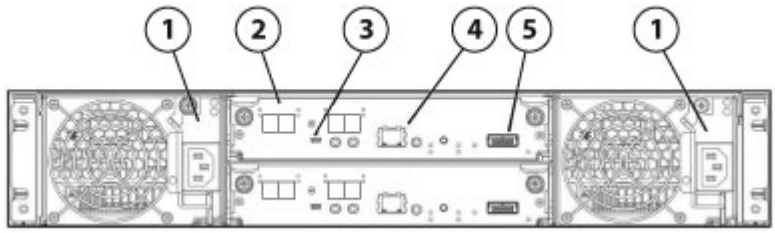


HP MSA 2040 Storage (LFF)



MSA 2040, 2 SAN controllers installed

1. Power supplies
2. 8 and/or 16Gb Fibre Channel, 1 and/or 10GbE iSCSI
3. CLI port (mini-USB)
4. Management Ethernet port
5. Expansion port



1. Power supplies
2. 6Gb/12Gb SAS ports
3. CLI port (mini-USB)
4. Management Ethernet port
5. Expansion port

Models

HP MSA 2040 Storage Models	**MSA 2040 Controller:**	
	HP MSA 2040 SAN Controller	C8R09A
	HP MSA 2040 SAS Controller	C8S53A
	MSA 2040 Pre-Configured Models:	
	HP MSA 2040 SAN Dual Controller LFF Storage	C8R14A
	(Includes LFF Array Chassis + two MSA 2040 SAN controllers) (no drives or SFPs are included)	
	HP MSA 2040 SAN Dual Controller SFF Storage	C8R15A
	(Includes SFF Array Chassis + two MSA 2040 SAN controllers) (no drives or SFPs are included)	
	HP MSA 2040 SAS Dual Controller LFF Storage	C8S54A
	(Includes SFF Array Chassis + two MSA 2040 SAS controllers) (no drives are included)	
	HP MSA 2040 SAS Dual Controller SFF Storage	C8S55A
	(Includes SFF Array Chassis + two MSA 2040 SAS controllers) (no drives are included)	
	MSA 2040 Array Bundles:	
	HP MSA 2040 SAN Dual Controller 24x900GB SAS 10K SFF HDD 21.6TB Bundle	C8R17A
	(Includes SFF Array Chassis + two MSA 2040 SAN controllers + 24 x 900 GB SFF SAS drives) (no SFPs are included)	
	HP MSA 2040 SAS Dual Controller w/24 900GB 6G SAS 10K SFF HDD 21.6TB Bundle	C8S57A
	(Includes SFF Array Chassis + two MSA 2040 SAS controllers + 24 x 900GB SFF SAS drives)	
	MSA 2040 Chassis:	
	MSA 2040 Controller-less Chassis (AC-powered)	
	HP MSA 2040 SFF Chassis	C8R10A
	(Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twenty four 2.5-in (SFF) drives)	
	HP MSA 2040 LFF Chassis	C8R12A
	(Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twelve 3.5-in (LFF) drives)	
	MSA 2040 Controller-less Chassis (DC-powered)	
	HP MSA 2040 SFF DC-power Chassis	C8R11A
	(Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twenty four 2.5-in (SFF) drives)	
	HP MSA 2040 LFF DC-power Chassis	C8R13A

Models

(Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twelve 3.5-in (LFF) drives)

Disk Enclosures:	
HP MSA 2040 LFF Disk Enclosure	C8R18A
HP D2700 Disk Enclosure	AJ941A
MSA 2040 Drives:	
Solid State Drives (SSDs) (SFF 2.5-inch)	
HP MSA 200GB 6G SAS Main End SFF(2.5in) Ent Mainstream 3yr Wty Solid State Drive	C8R19A
HP MSA 400GB 6G SAS Main End SFF(2.5in) Ent Mainstream 3yr Wty Solid State Drive	C8R20A
HP MSA 800GB 6G SAS Main End SFF(2.5in) Ent Mainstream 3yr Wty Solid State Drive	C8R21A
SAS Drives (SFF 2.5-inch)	
HP MSA 146GB 6G SAS 15K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	E2D54A
HP MSA 300GB 6G SAS 15K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	C8S61A
HP MSA 300GB 6G SAS 10K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	E2D55A
HP MSA 450GB 6G SAS 10K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	E2D56A
HP MSA 600GB 6G SAS 10K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	C8S58A
HP MSA 900GB 6G SAS 10K SFF(2.5-inch) Dual Port Ent 3yr Warranty Hard Drive	C8S59A
HP MSA 1TB 6G SAS 7.2K SFF (2.5-inch) Dual Port Midline 3yr Warranty Hard Drive	C8S62A
SAS Drives (LFF 3.5-inch)	
HP MSA 4TB 6G SAS 7.2K rpm LFF (3.5-inch) Midline 1yr Warranty Hard Drive	C8R26A
Small Form Factor Pluggable (SFPs) Transceivers:	
HP MSA 2040 8Gb Short Wave Fibre Channel SFP+ 4-pack Transceiver	C8R23A
HP MSA 2040 16Gb Short Wave Fibre Channel SFP+ 4-pack Transceiver	C8R24A
HP MSA 2040 10Gb Short Wave iSCSI SFP+ 4-pack Transceiver **NOTE:** Customers must upgrade their MSA 2040 controller firmware to GL101 or later for iSCSI functionality	C8R25A
HP MSA 2040 1Gb Short Wave iSCSI SFP+ 4-Pack Transceiver **NOTE:** Customers must upgrade their MSA 2040 controller firmware to GL101 or later for iSCSI functionality	C8S75A

All MSA 2040 models offer a common set of valuable features:

- New MSA 2040 controller architecture which maximizes performance
  - Four host ports per controller
    - MSA 2040 SAN controller supports 8Gb FC, 16Gb FC, 1Gb iSCSI or 10Gb iSCSI SFPs.
    - MSA 2040 SAS controller supports 6Gb and 12Gb SAS host connectivity.
  - 4 GB transportable read/write cache per controller.
  - Battery-free cache backup with super capacitors and compact flash
- MSA 2040 SAN Controller allows customers to create their own Combo Controller by mixing FC and iSCSI SFPs. Below are the valid configurations for mixing SFPs:

Configuration Table for mixing SFPs

Configuration	**Controller**	**Host Port 1 SFP[1]**	**Host Port 2 SFP[1]**	**Host Port 3 SFP[2]**	**Host Port 4 SFP[2]**
Table for mixing SFPs	Controller A	16Gb FC	16Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		8Gb FC	8Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		10Gb iSCSI	10Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		1Gb iSCSI	1Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
	Controller B	N/A	N/A	N/A	N/A
Dual Controller	Controller A	16Gb FC	16Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		8Gb FC	8Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		10Gb iSCSI	10Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI

Features

		1Gb iSCSI	1Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
	Controller B	Match Controller A	Match Controller A	Match Controller A	Match Controller A

[1] SFP in Host Port 1 must match SFP in Host Port 2
[1]SFP in Host Port 3 must match SFP in Host Port 4

All MSA 2040 models offer a common set of valuable features:

(**NOTE:** Customers must upgrade their MSA 2040 controller firmware to GL101 or later for iSCSI functionality)

- MSA 2040 supports SSD drives which allow IT managers to boost IOPS performance
- Ease of management featuring browser-based out-of-band access. This allows a department or small company to effectively handle growing storage requirements, with the aid of an intuitive GUI to administer the unit with a minimum of complexity. Ideal for local or remote installations.
- MSA 2040 comes standard with 64 controller-based snapshots and clone capability. Arrays also support an optional 512 snaps.
- Choose either a low-cost single controller array or start with a configured dual controller array model to fit the budget, high availability, and performance needs.
- All models feature a wide variety of drives: High-performance and high-speed SSD drives, enterprise-class SAS, and SAS Midline drives.
- MSA 2040 can have a maximum number of MSA 2040 LFF drive enclosures (7), a maximum number of D2700 SFF drive enclosures (7), or mix both sizes. The array can grow incrementally from a few drives to 96 LFF or 199 SFF drives.
- Vdisks can be spanned across multiple enclosures
  RAID levels 0, 1, 3, 5, 6, 10, 50
- Maximums vary by RAID levels: 2 drive max for RAID level 1; max of 16 drives for RAID levels 0, 3, 5, 6, and 10; max of 32 drives for RAID level 50
- 512 LUNs with LUN sizes greater than 40TB depending on the RAID configuration chosen. The maximum LUN size is 64TB
- Non-disruptive on-line controller code upgrade (requires dual controllers w/ multi-pathing software)
- Upgradable by design. Owners of a P2000 G3 array are able to do data-in-place controller upgrades to the new MSA 2040 array. This unique ability protects the earlier investments in drives, and JBODs. (Note: Certain limitation are applicable- please review MSA2040 Upgrade Technical Whitepaper before upgrading your P2000 G3 systems)

Follow us on twitter and be a part of the conversation, and get the latest MSA related news and information at:
http://www.twitter.com/MSAstorage

Features

Application Solutions

The HP MSA 2040 Storage is the ideal solution for customers running Oracle, Microsoft, SAP environments and those customers who are deploying virtual server technologies like VMware, Hyper-V, and Oracle Virtual Machine. The MSA 2040 delivers enterprise functionality that enhances virtual environments, simplifies management, and reduces costs. Easy to deploy, scale and maintain, HP MSA 2040 Arrays ensure that crucial business data remains available.
HP has developed best-in-class expertise in Oracle, Microsoft, SAP, and Virtualization Hypervisor technology through extensive testing with the HP MSA 2040, HP servers, and management software; high availability and disaster recovery solutions; and backup and recovery on the Oracle, Microsoft, and SAP application platforms. As a result, our customers can expect a wide range of operational and business benefits where they can:

- Deploy IT assets across multiple locations.
- Incrementally grow storage without interruption.
- Enable high availability and disaster recovery capabilities for critical applications.
- Deploy a remote disaster recovery site.

Learn more

To learn more about specific HP Storage Solutions that are built with Oracle, Microsoft, SAP and Virtualization environments in mind, visit the solution sites supporting each of these applications.
HP Storage for Oracle hyperlink to: http://www.hp.com/storage/oracle
HP Storage for Microsoft hyperlink to: http://www.hp.com/storage/microsoft
HP Storage for SAP hyperlink to: http://www.hp.com/storage/sap
HP Storage for VMware hyperlink to: http://www.hp.com/go/vmware/storage

Family Information

	MSA 2040
Capacity Minimum / with maximum additional drive enclosures	**LFF:** 48 TB (single LFF array-head -using 12 x 4TB LFF SAS MDL drives) 384 TB (by adding 7 LFF Disk Enclosures behind LFF Array & using 4TB LFF SAS MDL drives) **SFF:** 24 TB (single SFF array-head - using 24 x 1TB SFF SAS drives) 199 TB (by adding 7 SFF Disk Enclosures behind SFF Array & using 1TB SFF SAS drives) **NOTE:** maximum available storage capacity depends on the RAID level being implemented
Controller Cache	4 GB per controller
Total LUNs (LUN sizes are dependent on the disk and RAID configuration chosen)	512 maximum LUN size: 64TB
Host Interconnect	MSA 2040 SAN controller will support up to Four host connections with options of 16Gb, 8Gb FC and 10Gb, 1Gb iSCSI per controller. See table below for valid configurations MSA 2040 SAS controller will support up to Four 6Gb/12Gb SAS connections per controller

MSA 2040 SAN System	Controller	Host Port 1 SFP[1]	Host Port 2 SFP[1]	Host Port 3 SFP[2]	Host Port 4 SFP[2]
Single controller	Controller A	16Gb FC	16Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		8Gb FC	8Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		10Gb iSCSI	10Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		1Gb iSCSI	1Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
	Controller B	N/A	N/A	N/A	N/A
Dual Controller	Controller A	16Gb FC	16Gb FC	None	None

Family Information

				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		8Gb FC	8Gb FC	None	None
				16Gb FC	16Gb FC
				8Gb FC	8Gb FC
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		10Gb iSCSI	10Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
		1Gb iSCSI	1Gb iSCSI	None	None
				10Gb iSCSI	10Gb iSCSI
				1Gb iSCSI	1Gb iSCSI
	Controller B	Match Controller A	Match Controller A	Match Controller A	Match Controller A

[1] SFP in Host Port 1 must match SFP in Host Port 2
[2] SFP in Host Port 3 must match SFP in Host Port 4

(**NOTE:** Customers must upgrade their MSA 2040 controller firmware to GL101 or later for iSCSI functionality)

Maximum Drives w/ expansion	96 LFF/199 SFF
Maximum host supported	64
Standard Software:	Snapshot, 64 (snaps) Clone
Optional Software	Remote Snap Max Snapshot (512)

Product Technology

MSA 2040 SAN controller MSA 2040 SAN controller supports 8Gb FC, 16Gb FC, 1Gb iSCSI or 10Gb iSCSI SFPs.

MSA 2040 SAS controller MSA 2040 SAS controller supports 6Gb and 12Gb SAS host connectivity.

Modular Chassis 2U rack height. 12 Large Form Factor or 24 Small Form Factor drive bays, accommodating SSD, SAS and SAS Midline drives. Comes with space for one or two controllers, or MSA 2040 3.5-inch disk Enclosure I/O modules (LFF chassis only)

Drives available The MSA 2040 controllers support both the MSA 3.5-inch Large Form Factor (LFF) drives, and the MSA 2.5-inch Small Form Factor (SFF) drives.

- Solid State Drives (SSDs) deliver exceptional performance for applications requiring high random read IOPs performance
- Serial Attached SCSI (SAS) enterprise-class drives are designed for high demand, 24x7 usage.
- SAS Midline drives are usually reserved for archival of data as they are relatively inexpensive and are available in very large capacities.

Optional Disk Just as the user has a choice of chassis for the array head (LFF and SFF drive bays, AC or DC powered), so

Family Information

enclosures

also do they have a choice of expansion disk enclosures accommodating either drive size. Both the MSA 2040 and the D2700 disk enclosures can be hot-added to an operating array.

MSA 2040 3.5-inch Disk Enclosure. This 2U unit has twelve LFF (3.5-inch) drive bays and accepts for MSA dual-ported SAS and SAS MDL drives. The pre-configured HP MSA 2040 LFF Drive Enclosure (C8R18A) has two I/O modules and supports both single and dual controller arrays.

- This 3.5-inch MSA disk enclosure can be attached to MSA 2040 LFF or SFF array head.
- Each configured model ships standard with two .5m mini-SAS to mini-SAS cables for cascading to other MSA 2040 disk enclosures
- Up to seven MSA 2040 3.5-inch disk enclosures can be attached to a MSA 2040 Array.

D2700 2.5-inch Disk Enclosure. This 2U storage enclosure (AJ941A) is designed to support twenty five HP Storage or ProLiant 2.5-inch Universal form factor (SFF) 6Gb, SSD, SAS or SAS MDL hard drives. It ships standard with dual I/O modules installed.

- This 2.5-inch D2700 disk enclosure can be attached to a MSA 2040 (SFF or LFF) array head
- The D2700 enclosure ships with a two .5m miniSAS to miniSAS cable.
- Up to seven D2700 may be attached to the MSA 2040 array head, given total support for 199 SFF drives.

Scalability

The MSA 2040 SAN controllers are designed to allow an installation to begin with smaller capacity and be able to grow gradually as needed. The flexibility of SSD, SAS or SAS MDL drives technology, form factors, sizes, speeds, and costs per GB allows a system to easily fit in almost any budget.

- Large Form Factor configurations can scale up to 48 TB SAS MDL, expandable to 384 TB SAS MDL with the addition of a maximum of seven MSA 2040 3.5-inch Disk Enclosures.
- Small Form Factor configurations can scale from 28 TB SAS. With the addition of seven D2700 JBODs, the MSA 2040 storage can support 199 TB SAS.
- Users may configure a 24-drive MSA 2040 array head with 12-drive LFF MSA 2040 3.5-inch disk enclosures. This is an excellent method for a configuration that supports high-speed SFF SSDs or fast SFF enterprise-class SAS drives in the array head, combined with economical LFF drives staged for archival purposes, all in the same array.

Vdisks

Vdisks can span across multiple enclosures, where drives used in the Vdisk can be contained in different enclosures. The maximum number of drives that can be used in RAID 1 Vdisk is 2; RAID 0, 3, 5, 6, and 10 is 16; and for RAID 50 Vdisk is 32.

LUNs

The MSA 2040 of arrays supports 512 volumes and up to 512 snapshots in a system. All of these volumes can be mapped to LUNs. LUN sizes up to 64 TB depending on the disk and RAID configuration chosen. The array supports expansion and deletion of any LUN.

RAID 0, 1, 3, 5, 6, 10, 50

In addition to the usual RAID levels, the MSA 2040 features several important additional levels. RAID 6 is the highest level of RAID protection. It allocates two sets of parity data across drives and allows simultaneous write operations. It can withstand two simultaneous drive failures without downtime or data loss. RAID 10 is mirroring and striping without parity. It is the most popular of the multiple RAID levels, allowing large arrays with high performance in most cases and superior fault tolerance. RAID 50 combines the block striping and parity of RAID 5 with the straight block striping of RAID 0, yielding higher performance than RAID 5 through the addition of RAID 0, particularly during writes.

Performance

The performance figures provided here are for your reference as many variables exist between array configurations, workloads, hard drive types, vdisk setup parameters and host system setup.

HP has traditionally published a set of end-to-end MSA performance specifications which feed into HP Sizer tools which are based on conservative real-world configurations. For consistency, the MSA 2040 performance numbers have been documented in both Benchmark and End-to-End Performance tables.

Configuration details are provided for both test scenarios. These numbers are preliminary and subject to change without notice.

Benchmark Performance Results:

MSA 2040 Array Performance	HP MSA 2040 Converged SAN Controller with HDD	HP MSA 2040 Converged SAN Controller with SSD
Protocol (host connect)	16 Gb Fibre Channel	16 Gb Fibre Channel
MSA 2040 RAID 10 Performance Results[1]		
Random Reads IOPS	52,000	
Random Writes IOPS	25,500	
MSA 2040 RAID 1 SSD Performance Results[2]		
Random Reads IOPS		85,000
Random Writes IOPS		32,000
MSA 2040 RAID 5 Performance Results[3]		
IOMeter Sequential Reads MB/s[4]	6,310	
IOMeter Sequential Writes MB/s[4]	4,800	

Benchmark Setup Configurations

1). Dual Controller configuration, RAID: 10, block size: 8k, queue depth: 128 per LUN, (192) HDDs, 96 15k HDD + 96 10k HDD, 12 HDDs per vdisk, Win 2008 host: DL380pG8, (4) 16Gb FC direct connect to array

2). Dual Controller configuration, RAID: 1, block size: 8k, queue depth: 64 per LUN, (4) Enterprise Mainstream SSDs, 2 SSDs per vdisk, Win 2008 host: DL380pG8, (2) 16Gb FC direct connect to array

3). Dual Controller configuration, RAID: 5, block size: 256k, queue depth: 16 per LUN, (72) 10k 300GB HDD, 12 HDDs per vdisk, Win 2008 host: DL380pG8, (4) 16Gb FC direct connect to array

4). Sequential numbers are obtained using a single volume per vdisk and single sequential workload generated through the IOMeter performance software

End-to-End Performance Figures:

Guarantee Performance numbers are a guideline as established by tests using RAW I/O in an Operating System Agnostic test lab environment.

MSA 2040 Array	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAN Controller	HP MSA 2040 Converged SAS Controller	HP MSA 2040 Converged SAS Controller

Family Information

Performance	With HDD[5]	With SSD[6]	With HDD[5]	With SSD[6]	With HDD[5]	With SSD[6]	With HDD[5]	With SSD[6]
Protocol (host connect)[8]	16 Gb Fibre Channel	16 Gb Fibre Channel	10Gb iSCSI	10Gb iSCSI	1Gb iSCSI	1Gb iSCSI	12Gb8 SAS	12Gb8 SAS
MSA 2040 RAID 10 Performance Results ****NOTE:** RAID 1 was used for SSD testing								
Random Reads IOPS	49,000	75,000	48,800	82,000	45,800	76,300	48,500	86,400
Random Writes IOPS	27,200	29,500	27,400	31,500	27,900	31,300	28,600	32,200
Random Mix 60/40 IOPS	36,000	44,100	36,000	47,600	37,300	46,800	38,900	48,300
Sequential Reads MB/s[7]	4,680		2,990		860		4,720	
Sequential Writes MB/s[7]	2,260		1,860		840		1,730	
MSA 2040 RAID 5 Performance Results ****NOTE:** RAID 1 was used for SSD testing								
Random Reads IOPS	49,000	75,000	47,700	80,100	44,500	73,500	47,400	85,300
Random Writes IOPS	14,800	16,500	14,600	16,800	14,700	16,800	15,300	17,000
Random Mix 60/40 IOPS	23,000	29,000	24,200	29,800	23,700	29,400	24,900	30,100
Sequential Reads MB/s[7]	4,680		2,880		860		4,390	
Sequential Writes MB/s[7]	3,620		2,450		850		3,160	
MSA 2040 RAID 6 Performance Results ****NOTE:** RAID 1 was used for SSD testing								
Random Reads IOPS	49,000	75,000	47,600	80,000	44,400	72,700	47,400	84,100
Random Writes IOPS	11,350	13,600	11,000	14,000	11,400	13,700	11,500	13,900
Random Mix 60/40 IOPS	18,700	25,300	18,900	26,000	19,000	25,700	19,400	25,900
Sequential Reads MB/s[7]	4,600		2,990		860		4,430	

Sequential Writes MB/s[7]	3,500		2,470		790		2,870	
Refer to the paper titled "Upgrading to the HP MSA 2040", available in the Resource Library at: www.hp.com/go/msa2040.								

5). For MSA 2040 Hard Disk Drive (HDD) results, 146 GB 15K SAS drives were used in a dual controller configuration of 16 vdisks consisting of twelve disks per vdisk, 1.6 TB volumes, and 4 volumes per host. 4 hosts directly attached to the HP MSA 2040 array were used in this test configuration (results cannot be expected with a single host).

NOTE: MSA 2040 tests with 1Gb iSCSI used 8 hosts directly attached to the HP MSA 2040 array.

6). For MSA 2040 Solid State Drives (SSD) results, 200 GB Enterprise Mainstream SSDs were used in a dual controller configuration of 4 vdisks consisting of two disks per vdisk, 200 GB volumes, and 1 volume per host. 4 hosts directly attached to the HP MSA 2040 array were used in this test configuration (results cannot be expected with a single host).
NOTE: MSA 2040 tests with 1Gb iSCSI used 8 hosts directly attached to the HP MSA 2040 array.

7). Sequential tests results were achieved with 256K block sizes and random tests were based on 8K block sizes.

NOTE: For sequential workloads with a queue depth greater than 1, each sequential stream is targeted to operate on a separate LBA range. Other types of sequential workloads that target specific LBA ranges may achieve higher results

8). All SAS results were measured using 6Gb SAS Host Bus Adapters.

9). All Fibre Channel results were measured using 16Gb FC Host Bus Adapters. All SAS results were measured using 6Gb SAS Host Bus Adapters. All 10Gb iSCSI results were measured using 10Gb iSCSI Host Bus Adapters. All 1Gb iSCSI results were measured using 1Gb network interface controllers (NICs).

NOTE: Number and type of applications, drive type and number of drives, operating system used, and the number of hosts will affect overall performance. This table is provided strictly as a test-lab comparison.

NOTE: These numbers reflect a full array configuration with the maximum number of front-end ports, disks, and controllers. The test results shown for the HP MSA 2040 are designed to give a conservative reference point for comparisons.

DC-power chassis

HP is making the two models of controller-less chassis available with direct current (DC) power supplies. They each have the two empty bays where users can insert one or two MSA 2040 controller(s).
The 500 watt power supply is designed to operate over the input range of -40VDC to -75VDC.

MSA 2040 Controller-less Chassis (DC-powered)

HP MSA 2040 SFF DC-power Chassis C8R11A
(Will accept one or two MSA 2040 SAN or MSA 2040 SAS controllers and can accommodate up to twenty four 2.5-in (SFF) drives)

Family Information

	HP MSA 2040 LFF DC-power Chassis (Will accept one or two MSA 2040 SAN or MSA 2040 SAS controllers and can accommodate up to twelve 3.5-in (LFF) drives)	C8R13A
Configuration and Management Tools	HP Storage Management Utility (SMU). Management access, out-of-band: WEB GUI, CLI. Interface Types: USB, /100/1000 Ethernet. Protocols Supported SNMP, SMI-S, SSL, SSH, SMTP, FTP, HTTP, Telnet	
MSA 2040 Software and Documents Support CD	• All product documentation (CD can be used on ALL supported server Operating Systems.) • MSA Device Discovery Tool (Win and Linux) - reports MSA HW devices, and supported storage software • Host Software Bundles (Win and Linux for both ProLiant x86, ProLiant x64 and Integrity IA64servers) • CD updated quarterly on HP.com with sustaining firmware updates	
Hot Plug Expansion and Replacement Support	All MSA 2040 models support hot plug expansion and replacement of redundant controllers, enclosures, fans, power supplies, and I/O modules for simple, fast installation and maintenance. Hot add expansion of disk enclosures is also supported.	
Snapshot and Clone	All MSA 2040 arrays come standard with 64 snaps, 512 snaps available. This controller based functionality offers higher levels of data protection, enables an almost instant recovery from data failure or corruption and offers alternative development testing of 'offline' production data and the ability to backup snapped/cloned data.	

Overview	The MSA 2040 arrays come integrated with web browser and CLI based software for storage and RAID management, setup, configuration, and troubleshooting. This reduces the cost of ownership by reducing the training and technical expertise necessary to install and maintain your HP storage solution. The SPOCK database provides interoperability information for thousands of components and millions of component combinations. It is available to all users at http://www.hp.com/storage/spock.
Server Compatibility **NOTE:** depends on protocol	Supports most HP ProLiant, BladeSystems and Integrity servers including • HP ProLiant DL, ML • HP c-Class Blade Servers • Integrity servers, IA64 • Compatibility must be confirmed at: http://www.hp.com/storage/spock
Industry Standard servers support	• Supports most multi-vendor industry standard 32-bit Intel and AMD based (x86) servers. HP requires the Third-Party Server to be logo'd and listed on the Microsoft Windows Server Catalog. • Refer to the Microsoft website: http://www.microsoft.com/windows/catalog/server/ • HP Division recommends that the Third-Party Server Vendor is an active member of TSANet. Refer to the TSANet website for details: www.tsanet.com • Non-HP servers will generally be supported if the HP storage stack is used. This includes supported HP branded HBAs and drivers, and supported FC switches.
OS Support **Fibre Channel ports**	Refer to the HP support statements for complete current OS version support: http://www.hp.com/storage/spock • Microsoft Windows Server 2012 IA32, x64, IA64 (Standard, Enterprise, Datacenter) • Microsoft Windows Server 2008 R2 x64 • Microsoft Windows Server x64 Hyper-V • VMware • HP-UX • Red Hat Linux (32/64) • SuSE SLES (32/64)
Web Browser support	• The MSA 2040 supports target based management, and include a Web interface and a telnet interface, and require a web browser for management. • The MSA 2040 requires Microsoft Internet Explorer, Mozilla Firefox, and Google Chrome.

VMware Site Recovery Manager(SRM)

VMware Site Recovery Manager (SRM)

VMware vCenter Site Recovery Manager (SRM) is an extension to VMware vCenter that delivers business-continuity and disaster-recovery solution that helps you plan, test, and execute the recovery of vCenter virtual machines. SRM can discover and manage replicated datastores, and automate migration of inventory from one vCenter to another. Site Recovery Manager integrates with the underlying replication product through a Storage Replication Adapter (SRA).

HP MSA 2040 Site Recovery Adapter (SRA)

The MSA 2040 SRA, a free-to-use plugin, is the program that integrates the VMware vCenter SRM with HP MSA 2040 arrays. It enables full-featured use of the VMware SRM. It is a host-software component installed on a Microsoft Windows Server that enables disaster recovery management (DRM) software on the host to communicate and control certain aspects of the replication feature in storage systems connected to the server. It allows the VMware SRM software to automatically coordinate virtual machine failover and failback between a protected data center and a disaster recovery site by employing a disaster recovery solution called Remote Snap. A perfect combination of the Remote Snap replication and VMware SRM provides an unfailing automated solution for implementing and testing the disaster recovery between sites located across geographies. It enables communication between the HP MSA Remote Snap replication functionality that is embedded in HP MSA 2040 systems. Users are required to acquire Remote Snap license for their local and remote HP MSA 2040 arrays to use the HP MSA SRA.

Site Recovery Manager Requirements/Dependencies:

- Requires vSphere 5.0/SRM 5.0 or 5.1
  - Not compatible with SRM 4.x
- Requires HP MSA 2040 /P2000 SRA 2.1 or later Plug-in (downloadable from Hp.com)
- SRM works with Remote Snap functionality
  - Requires purchase of MSA 2040 Remote Snap licenses (one for each site)

HP Insight Control Storage Module for vCenter

HP Insight Control Storage Module for vCenter

HP Insight Control Storage Module for vCenter is a component within the HP Insight Control plug-in for vCenter. It provides VMware administrators that are using VMware's vSphere management console (vCenter) with the ability to see how virtual machines are mapped to datastores and individual MSA 2040 volumes. By providing these clear relationships between VM's, datastores and storage, the VMware administrator's productivity increases, as does the ability to ensure quality of service. Roles for administrators can be defined on an individual basis, providing the ability to apply specific permissions for both view and control functions.

The HP Insight Control Storage Module for vCenter supports mixed array environments including MSA 2040, P2000, EVA, P4000, and the XP array series including the P9500.

When deployed with the MSA 2040 array, HP Insight Control Storage Module provides the following:

- Active Management functionality for the MSA 2040 array:
  - Create/Expand/Delete a Datastore
  - Create a Virtual Machine from a template
- Monitors the health and status of the MSA 2040
- Displays LUN / volume connections from VMs and ESX servers to the arrays and provides the location and attributes of the MSA 2040 within the SAN
- Identifies what storage features are available to allow administrators to match the features

Optional Software

available on the MSA 2040 to their requirements
- Provide a cluster-level view of the storage

HP Insight Control Storage Module for vCenter is downloadable from Software Depot:
https://h20392.www2.hp.com/portal/swdepot/displayProductInfo.do?productNumber=HPVPR

For more information on HP Insight Control Storage Module for vCenter visit: www.hp.com/go/vmware

vStorage API for Array Integration (VAAI)

The vStorage API for Array Integration (VAAI) is one of the storage application programming interface (API) sets in vSphere. VAAI is an API storage partners can leverage to enhance performance of virtual machine (VM) management operations by delegating these operations to the storage array. With hardware offload, ESX/ESXi hosts perform certain operations faster and consume less server CPU and memory resources, and also storage port and storage fabric bandwidth. VAAI includes high performance and scalable VM data path primitives.

Storage Hardware Primitives for VAAI

- Full Copy or Hardware Assisted Move
- Block Zeroing or Hardware Assisted Zeroing
- Hardware Assisted Locking or Atomic Test and Set (ATS)

Snapshot and Volume Copy Software for the MSA 2040

Product Features

Data Protection

- Snapshots create up to 512 point-in-time pictures of data
- Volume Copies create up to 128 point-in-time copies of data
- Recovery is instant - revert data from any previous Snapshot or Volume Copy
- Backup 'snapped' data to disk, virtual tape, or physical tape without a backup window
- A 64 snapshot license and Volume Copy are included with all MSA 2040 models.
- Support and updates are desired for bundled software functionalities (such as 64 LTU Snap and/or Volume Copy etc. in the MSA 2040 products) a combination HW + SW support care pack must be purchased.
- HP does not provide warranty assistance for software products included with our base hardware products. This would either be SupportPlus or SupportPlus24. The hardware warranty component of these services is accounted for in the pricing of the SP and SP24 care packs.

Data Testing

- Snap or clone data to test the performance of a software application on 'offline' production data
- Snap or clone data to test how a software patch or enhancement will function on 'offline; production dat0061

MSA 2040 Snapshot and Clone:

All MSA 2040 models come STANDARD with 64 snapshots and Volume Copy software.
512 Snapshot option is also available for additional cost.

HP MSA 512-Snapshot Software LTU	TC462A
HP MSA 512-Snapshot Software E-LTU	TC462AAE

HP MSA Remote Snap Software

- HP MSA Remote Snap Software is array based software that provides remote replication on the HP MSA 2040 Array products. HP Remote Snap is a form of asynchronous replication which consists of replication of block-level data from a volume on a local system to a volume that may be on the same system or on a second independent system. This second system may be collocated with the first system or may be located at a remote site.
- HP Remote Snap functionality is based on existing Snapshot technology offered by HP MSA SAN

Optional Software

Array products. Snapshots are used to track the data to be replicated as well as to determine the differences in data updated on the master volume, minimizing the amount of data to be transferred.

- HP Remote Snap replication technology provides the ability to accomplish key data management and protection capabilities. First, because Remote Snap uses snapshots as the underlying technology it creates multiple local recovery points which can be used for such tasks as to complement daily backups; second, replication provides the ability to access data in a remote site which could be used for dispersed operations; and third but definitely not least important replication allows for business continuance in the event of a failure on the primary site.
- In order to perform a replication, a snapshot of the volume to be replicated is taken, creating a point-in-time image of the data. This point-in-time image is then replicated to the destination volume by copying the data represented by the snapshot via a transport medium such as TCP/IP (iSCSI) or Fibre Channel. The amount of data transferred is minimized though the use of snapshots whenever possible.

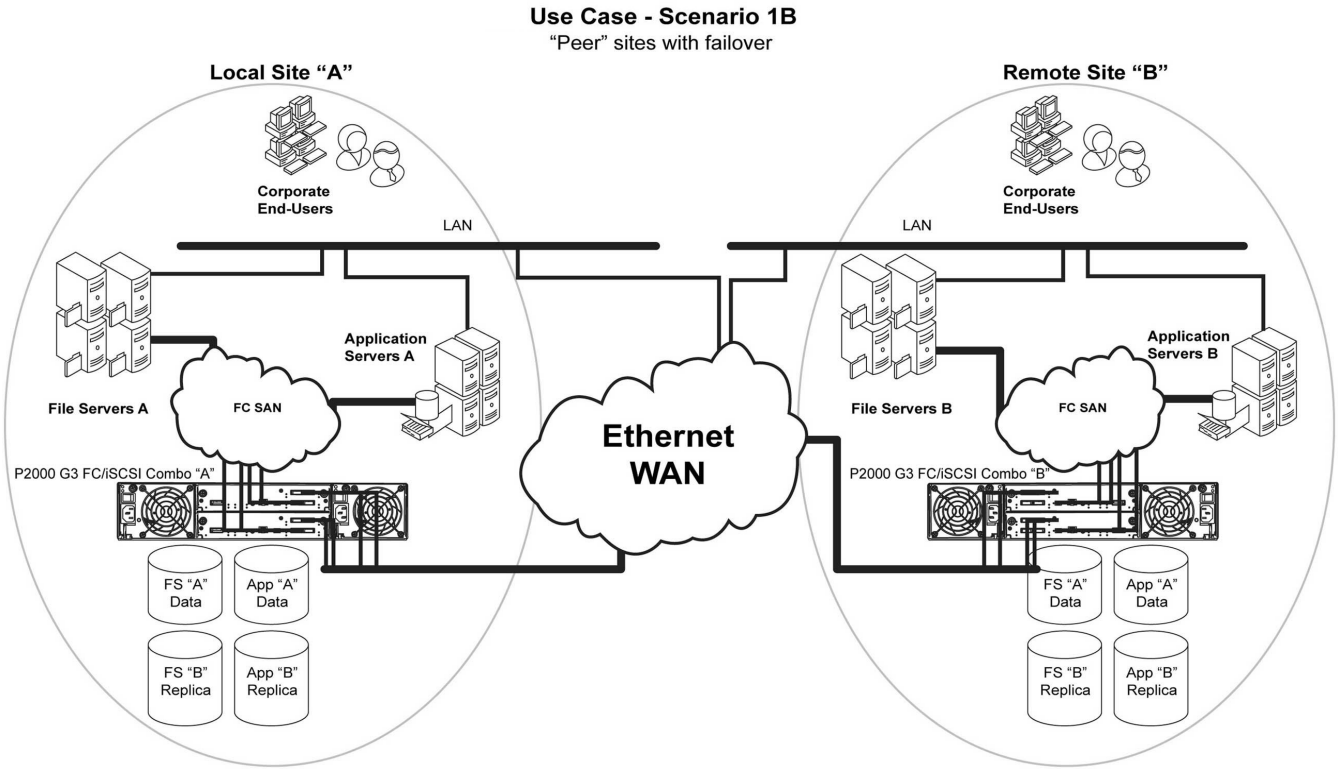
HP MSA Remote Snap Software LTU	TC463A
HP MSA Remote Snap Software E-LTU	TC463AAE

(**NOTE:** One license per array is required for replication. For example, if you have two MSA arrays performing replication (from Primary system to Remote System), you will need 2 licenses).

Product Features

- Storage based asynchronous snapshot replication
- Initial copy of data can be performed locally, reducing burden on wide area networks
- Support of both Ethernet and Fiber Channel interconnects provides flexible options to the application environments.
- Snapshot based replication technology means only changed data will be replicated to alternate site
- Many to 1 replication (up to 4 nodes) - primary use case is to replicate from "many" branch offices to the home office for the purpose of backing up data from the branches
- Single controller to single controller replication
- Advanced scheduler provides several options to IT administrators for business continuance
- Flexible architecture allows remote replication between MSA 2040 and/or P2000 G3 supported arrays. Protects existing investments and enhances business continuity planning objectives.
- Replication Wizard simplifies the task of setting up and establishing replication pairs from one unified, easy to use GUI.
- Snapshot based replication enables both local and remote recovery depending on the need. Snapshot replication isolates problems to a specific point in time which can be selected by the administrator. Additionally snapshot replication supports longer distance replication.
- Multiple relationships provide greater storage flexibility and utilization.
- Bundled 64 Snapshots and Volume Copy integration provides better efficiencies by combining the management and array technologies to create local copies.
- Fast application recovery with minimal or no transaction loss
- Creation of disaster tolerant copies of your critical business data
- No-single-point-of-failure solution to increase the availability of your customers data

Optional Software



Customer Benefits

Disaster Recovery

Replication technology has typically been used to address disaster recovery issues. Disaster recovery is still the driving business case behind replication. Remote replication can be implemented from the production site to one or more remote sites across a campus, across town, across a state or across the country. When a disaster strikes the primary location, the applications can be brought up at the remote site and continue processing against the replicated copies. When the primary site is back online, the replication can be reversed and when the data is resynchronized, processing can be switched back to the primary site and business can continue. In the past, if an e-mail system experienced a disaster it was an "oh well" moment. The loss of a day or more of e-mail was not considered important. Today, e-mail is a critical component of many companies' business plans and recovering e-mail after a disaster quickly and completely is required.

Maintenance

HP Remote Snap software can also be used to solve other business needs. For instance, E-mail servers may need periodic maintenance that can take hours to complete. With remote replication in place, the downtime can be minimal (as long as it takes to bring the remote peer of the primary e-mail server online). The primary server can be worked on (patches, hardware upgrades, etc.) and then brought back online and into production. A whole datacenter can be failed over to a remote site on purpose to perform maintenance on generators, air conditioning, etc. Replication can also be used to perform a datacenter move with minimal downtime (fail everything to the DR site, move the production datacenter to its new location then fail the DR site back to the new datacenter).

Storage Based

Optional Software

Data replication is performed at the storage subsystem controller level and is totally transparent to the host, alleviating unnecessary host cycles to perform the data mirroring functions. Unlike a fabric based or host based solution, the storage based solution dedicates its resources to managing the replication process between arrays, with minimal impact to applications, other data or devices on the SAN.

Bi-Directional

The bidirectional HP MSA 2040 Array solution addresses the growing need among businesses to ensure continuous availability of applications that are critical to daily business operations. HP MSA 2040 enables two sites in a remote replication connection to use each other as a destination to maintain replicated copies of online data. This maximizes resource utilization while enabling business continuance, even in the event of disaster.

Disaster Tolerance

The MSA 2040 Arrays utilize snapshot data online and in real time to a remote MSA 2040 through a local or extended storage area network (SAN). Additionally, data replication can be bidirectional, meaning that a storage array can be both a source and a destination. A particular LUN can be replicated in only one direction between the two storage arrays. Write I/O data sent to the source is replicated by HP MSA 2040 Array to the destination. A pair of properly configured HP MSA 2040 arrays is a replication solution that guarantees data integrity in the event of a storage system or site failure.

First initial copy

When a DR site is initially created a initial copy of the data from the source volume to the target volume must occur. The MSA 2040 array allows this first copy to take place locally. After completion the disks can me manually moved to the remote location. Subsequent changes will only remotely copy the changed blocks.

SAN Extensions

HP MSA 2040 Array provides the capability to replicate data over direct Fibre Channel. The distances supported over dark fiber are determined by the speed of the dark fiber connection and the technology used to communicate over the dark fiber.

Path failover (MPIO)

Multipath failover (MPIO) is supported on all operating systems

HP StoreEasy 3000 Gateway Storage

Add more value to your MSA 2040 array

HP MSA 2040 combined with HP StoreEasy 3830 Gateway Storage or StoreEasy 3830 Gateway Storage Blade enables you to consolidate block and file storage onto a single, high-performance system - giving your business the flexibility to meet changing business needs on-demand.

HP StoreEasy 3830 Storage delivers efficient, secure, and highly available file services that help address your changing file-serving needs. It reduces your cost of ownership by simplifying management, increasing resource utilization, centralizing growth, and protecting data. HP StoreEasy 3830 Storage leverages the Server Manager capabilities in Microsoft Windows Storage Server 2012 to provide a simple and consistent experience for managing block and file storage for multiple workloads centrally.

HP StoreEasy 3830 Gateway Storage - B7E00A
HP StoreEasy 3830 Gateway Storage Blade - B7E01A
NOTE: For more information visit: www.hp.com/go/StoreEasy

Service and Support, HP Care Pack, and Warranty Information

Warranty

Three-year limited warranty, parts exchange Next Business day delivery

Enclosures, Hard drives, and Options for the MSA 2040 carry their own warranty. Refer to HP's Limited Warranty Statement for more information.

The MSA 2040 has been designed with customer self-repairable parts to minimize repair time and provide greater flexibility in performing defective parts replacement. Please refer to HP's limited warranty Statement and parts replacement instructions for further details.

http://h18006.www1.hp.com/products/storageworks/warranty.html

Products included in various kits carry their own individual warranties.

NOTE: The warranty of the hard drive options purchased with the MSA 2040 models is different for SAS hard drives versus SAS MDL. SAS hard drive options have a three year warranty and SAS MDL.

Solid State Drives (SSD) Warranty

3/0/0 warranty; Customer Self Repair (CSR) subject to maximum usage and or maximum supported lifetime limitations, whichever occurs first. Maximum Supported Lifetime is the period in years set to equal the warranty for the device. Maximum usage limit is the maximum amount of data that can be written to the device before reaching the device's write endurance limit.

Service and Support

Services to accelerate time to results

HP Storage Services bring you a rich portfolio of consulting and support services designed to add value to our core storage products and solutions. We have the know-how and experience to put storage technology to work for you. We work closely with you as your strategic partner, leveraging our full services portfolio to make sure that everything works to optimize your enterprise.

Choose from services aligned to our storage product offerings and lifecycle. From mission-critical onsite services to innovative web-based remote support, you choose the precise level of attention and support your business demands.

Discover, plan, and design

Choose from a rich portfolio of services to make the most of HP MSA2040 Storage, so you can efficiently and affordably consolidate, manage, and extract value from unstructured data.

Start here to understand your data protection options. Next, develop a methodical plan and design the optimal HP MSA 2040 SAN Storage, that addresses your unique technology requirements.

HP Backup Recovery Efficiency Analysis - Assessment of how efficiently backup components are being used as the amount of data to be backed up continues to grow exponentially via analysis intelligence and a snapshot of your current backup environment. http://h20195.www2.hp.com/v2/GetPDF.aspx/4AA3-8490ENW.pdf

HP Backup Recovery Impact Analysis - Focus placed on service requirements and design as the key to success for gaining a clear understanding of the role of increasingly diverse data protection strategies. http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA4-1175ENW.pdf

HP Backup Recovery Modernization - Initial discovery, interviews, reference architecture design, proposal content development, vendor grading, and final recommendations carried out so as to require minimal resources and locations on your part.
http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA4-1199ENW.pdf

Deploy and integrate

Implement HP MSA 2040 SAN Storage, correctly-right from the start-so you can count on reduced risk and accelerated deployment, while implementing a best-practice configuration from day one.

HP MSA/P2000 Family Disk Array Installation and Startup Service - Implement right from the start, as HP experts install, test, and configure your hardware and software onsite. We deliver a tailored storage deployment properly integrated into your environment.

HP Storage Data Migration Service - End-to-end data migration service providing seamless discovery, assessment, planning, and design, completely customizable to your organization's storage area network (SAN) or network attached storage (NAS) environment and using innovative software to help you migrate to HP storage quickly and efficiently
http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA3-0774ENW.pdf

HP Storage and Data Consultant Residency Services - Strategically augment your current storage and backup environment with HP resources who become your trusted advisors.
HP Proactive Select - A flexible way to purchase services to fit your environment with an extensive menu of HP Proactive Select event and technical services, such as onsite firmware upgrades, health checks, assessments, and education
http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA2-3842ENW.pdf

Operate and support

Choose the right support to maximize uptime, free up your resources, and achieve improved value-as you get the most out of the existing IT assets while accelerating time-to-revenue.

HP Proactive Care 24x7 - Hardware and software support services designed specifically for your technology with rapid access to Advanced Solution Centre Specialists plus firmware and software management and best practice advice
http://h20195.www2.hp.com/v2/GetPDF.aspx/4AA3-8855ENW.pdf

HP Proactive Care Personalized Support - An option-if you have HP Proactive Care- to bring increased personalization of the Proactive Care support experience through the assignment of an Account Service Manager (ASM) who provides IT best practice advice to help address IT issues and projects.
http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA4-3446ENW.pdf

HP Support Plus 24 - Support for environments where proactive help from HP is not required, with 24x7 hardware and software support onsite that includes third-party support with a maximum four-hour onsite response.
http://h20195.www2.hp.com/V2/GetPDF.aspx/5981-6638EN.pdf

HP Education Services - Comprehensive training for new, as well as experienced, storage administrators designed to expand your skills and keep you up to speed with the latest storage and virtualization technology from HP Storage.
http://education.hp.com/curr-storsan.htm

Optimized Care- delivers

Choose from three levels of operate and support care

Service and Support, HP Care Pack, and Warranty Information

best performance and stability through deployment and proactive management practices	**HP Proactive Care 24x7-**Plus, 20 credits per year per array **Additional options -** HP Proactive Care Personalized Support (once per Proactive Care support new environment), an additional day of HP Personalized Support, and 10 additional HP Proactive Select credits per year, per array
Standard Care-maintains high level of uptime, along with expert help to cut the cost and complexity of implementation and support	**HP Proactive Care 24x7-Plus, 10 credits per year per array** **Additional options -** HP Proactive Care Personalized Support (once per Proactive Care support new environment), an additional day of HP Personalized Support, and 10 additional HP Proactive Select credits per year, per array
Basic Care-Minimum recommended support	**HP Support Plus 24** - plus 10 HP Proactive Select credits per year, per array **Additional options -** 10 Proactive Select Credits per Year
Remote Support Automation	**HP Insight Remote Support-**Available at no additional cost to all warranty, HP Care Pack Service and service agreement customers, uses proven technology to deliver secure, reliable 24x7 remote monitoring, diagnosis and problem resolution. http://h20195.www2.hp.com/V2/GetPDF.aspx/4AA2-4676ENW.pdf http://h18004.www1.hp.com/products/servers/management/insight-remote-support/overview.html
For more information	www.hp.com/services/storage To learn more on HP Storage Services, please contact your HP sales representative or HP Authorized Channel Partner HP Care Pack Services are sold by HP and HP Authorized Service Partners: ● Services for customers purchasing from HP or an enterprise reseller are quoted using HP order configuration tools. ● Customers purchasing from a commercial reseller can find HP Care Pack Services at www.hp.com/go/lookuptool

Configure to Order Program Information

HP has a very successful Configure to Order program for the MSA 2040 family The MSA 2040 models and options may or may not be factory installed in a rack with add-on controllers, switches, MSA 2040 disk enclosures and hard drives. The MSA 2040 arrays may be integrated with ProLiant servers or as standalone storage.
Orders to be shipped through the CTO process must have a minimum of two drives of the same type (SSD, SAS or SAS MDL) ordered per controller.

Step 1 - MSA 2040 - Base Configuration

Select one chassis:

Model Name	SKUs
MSA 2040 Controller-less Chassis (AC-powered)	
HP MSA 2040 SFF Chassis (Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twenty four 2.5-in (SFF) drives)	C8R10A
HP MSA 2040 LFF Chassis (Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twelve 3.5-in (LFF) drives)	C8R12A
MSA 2040 Controller-less Chassis (DC-powered)	
HP MSA 2040 SFF DC-power Chassis (Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twenty four 2.5-in (SFF) drives)	C8R11A
HP MSA 2040 LFF DC-power Chassis (Will accept one or two MSA 2040 SAN or SAS controllers and can accommodate up to twelve 3.5-in (LFF) drives)	C8R13A

Step 2 - Options

Select each option with quantities specified.

Step 2a - MSA 2040 Controllers

Quantity	Description with Parts Shipped:	SKUs
1 or 2	HP MSA 2040 SAN Controller **NOTE:** for either the LFF or SFF MSA 2040 chassis or the two DC-powered chassis	C8R09A
1 or 2	HP MSA 2040 SAS Controller **NOTE:** for either the LFF or SFF MSA 2040 chassis or the two DC-powered chassis	C8S53A

Step 2b - SFPs

NOTE: MSA 2040 SAN Controller does not ship with any SFPs. Customer must select one of the following SFP options. Each MSA 2040 controller can be configured with 2 or 4 SFPs. MSA SFPs are for use only with MSA 2040 Controllers.

MSA Small Form Factor Pluggable (SFPs) Transceivers:

HP MSA 2040 8Gb Short Wave Fibre Channel SFP+ 4-Pack Transceiver (Includes four x 8Gb SW FC SFPs)	C8R23A

Configuration Information

HP MSA 2040 16Gb Short Wave Fibre Channel SFP+ 4-Pack Transceiver (Includes four x 16Gb SW FC SFPs)	C8R24A
HP MSA 2040 10Gb Short Wave iSCSI Channel SFP+ 4-Pack Transceiver (Includes four x 10Gb SW iSCSI SFPs)	C8R25A
HP MSA 2040 1Gb Short Wave iSCSI Channel SFP+ 4-Pack Transceiver (Includes four x 1Gb SW iSCSI SFPs)	C8S75A

Step 2c - SSD, SAS or SAS MDL Drive Options

NOTE: SAS MDL drives are designed for archival or reference data. They should not be used in a heavy or intense I/O environment. Those situations require the use of enterprise-class SSD or SAS drives. MSA 3.5-inch or 2.5-inch drives are for use only with MSA arrays.

MSA 2040 Drives:

Solid State Drives (SSDs) (SFF 2.5-inch)

HP MSA 200GB 6G ME SAS 2.5in Enterprise Mainstream 3yr Warranty Solid State Drive	C8R19A
HP MSA 400GB 6G ME SAS 2.5in Enterprise Mainstream 3yr Warranty Solid State Drive	C8R20A
HP MSA 800GB 6G ME SAS 2.5in Enterprise Mainstream 3yr Warranty Solid State Drive	C8R21A

SAS Drives (SFF 2.5-inch)

HP MSA 146GB 6G SAS 15K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	E2D54A
HP MSA 300GB 6G SAS 15K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	C8S61A
HP MSA 300GB 6G SAS 10K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	E2D55A
HP MSA 450GB 6G SAS 10K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	E2D56A
HP MSA 600GB 6G SAS 10K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	C8S58A
HP MSA 900GB 6G SAS 10K 2.5-inch Dual Port Enterprise 3yr Warranty Hard Drive	C8S59A
HP MSA 1TB 6G SAS 7.2K 2.5-inch Dual Port Midline 1yr Warranty Hard Drive	C8S62A

MSA Large Form Factor (LFF) SAS MDL DP drives for MSA 2040 Array and MSA 2040 3.5-inch Disk Enclosure

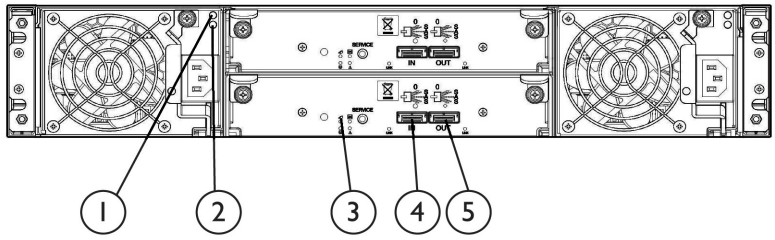
HP P2000 1TB 6G SAS 7.2K LFF (3.5-inch) Dual Port MDL Hard Drive	AP861A
HP P2000 2TB 6G SAS 7.2K LFF (3.5-inch) Dual Port MDL Hard Drive	AW555A
HP P2000 3TB 6G SAS 7.2K rpm (3.5-inch) Midline 1yr Warranty Hard Drive	QK703A
HP MSA 4TB 6G SAS 7.2K rpm LFF (3.5-inch) Midline 1yr Warranty Hard Drive	C8R26A
HP MSA 4TB 6G SAS 7.2K rpm LFF (3.5-inch) Midline 1yr Warranty Hard Drive	C8R26A

MSA Large Form Factor (LFF) SAS DP drives for MSA 2040 Array and MSA 2040 3.5-inch Disk Enclosure

HP P2000 300GB 6G SAS 15K rpm LFF Dual Port Enterprise Hard Drive	AP858A
HP P2000 450GB 6G SAS 15K rpm LFF Dual Port Enterprise Hard Drive	AP859A
HP P2000 600GB 6G SAS 15K rpm LFF Dual Port Enterprise Hard Drive	AP860A

Configuration Information

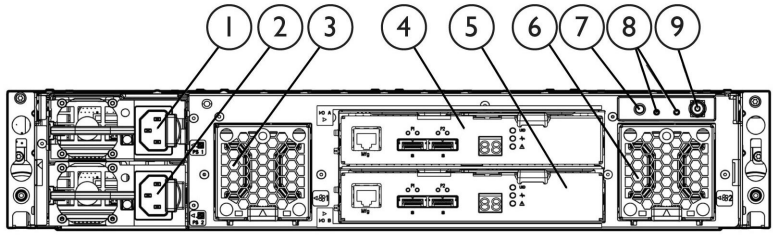
Step 2d - Drive Enclosure Options



MSA 2040 Dual I/O 3.5-inch 12 Disk Enclosure

Rear Panel components

1. Power Indicator
2. Fault Indicator
3. Unit Locator
4. SAS In Port
5. SAS Out Port



HP D2700 Disk Enclosure

Rear Panel components

1. Power Supply 1
2. Power Supply 2
3. Fan 1
4. I/O Module A
5. I/O Module B
6. Fan 2
7. Rear UID push button
8. Enclosure LEDs
9. Power on/standby button

Use either disk enclosure with Large or Small Form Factor, single or dual controller array heads. Each ships with two .5m mini-SAS to mini-SAS cables.

Configuration Information

HP MSA 2040 LFF Disk Enclosure	C8R18A
HP D2700 Disk Enclosure	AJ941A

Step 2e - SAS Cable Options

miniSAS to miniSAS Cables:

Connecting MSA 2040 Controller to a JBOD if a longer cable is desired.

HP External Mini SAS 1m Cable ALL	407337-B21
HP External Mini SAS 2m Cable	407339-B21

Step 3 - Other MSA 2040 Options

Choose optional AC Power Cords (2 required)

NOTE: Two PDU cables: one 142263-008 (Black) and one 1422633-013 (Grey), ship standard with all AC-powered enclosures.

HP ProLiant 12 ft Power Cord	227099-001
Power Cord, (Australia/China/New Zealand)	227098-001
Power Cord, (Central Europe)	157215-001
Power Cord, (United Kingdom/Hong Kong)	157216-001
Power Cord, (Switzerland)	157219-001
Power Cord, (Italy)	157217-001
Power Cord, (Denmark)	157218-001
Power Cord, (Japan)	139867-001
Power Cord, (South East Asia/India)	157220-001

Step 4a - Choose Supported Options For Fibre Channel Infrastructure

Fibre Channel Host Bus Adapters - X86 servers	Model	SKUs
	C-class HBA	
	HP QMH2572 8Gb Fibre Channel Host Bus Adapter for BladeSystem c-Class	651281-B21
	HP LPe1205A 8Gb Fibre Channel Host Bus Adapter for BladeSystem c-Class	659818-B21
	FC HBAs	
	HP StoreFabric SN1000Q 16GB 1-port PCIe Fibre Channel Host Bus Adapter	QW971A
	HP StoreFabric SN1000Q 16GB 2-port PCIe Fibre Channel Host Bus Adapter	QW972A
	HP SN1000E 16Gb 1-port PCIe Fibre Channel Host Bus Adapter	QR558A
	HP SN1000E 16Gb 2-port PCIe Fibre Channel Host Bus Adapter	QR559A
	FC switches	
	HP SN8000B Family (16Gb)	
	HP SN3000B Fibre Channel Switch (16Gb)	
	HP SN6000B Fibre Channel Switch (16Gb)	
	HP StoreFabric SN6500B 16Gb 96/96 Power Pack+ FC Switch	
	HP StoreFabric SN6500B 16Gb 96/96 FC Switch	

	HP StoreFabric SN6500B 16Gb 96/48 Power Pack+ FC Switch HP StoreFabric SN6500B 16Gb 96/48 FC Switch	
	BladeSystem c-Class Fibre Channel Mezzanine HBAs	
	QLogic QMH2562 8Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	451871-B21
	Emulex LPe1205 8Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	456972-B21
	Emulex LPe1105 4Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	403621-B21
	QLogic QMH2462 4Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	403619-B21
	HP BLc Brocade 804 8Gb Fibre Channel Host Bus Adapter	590647-B21
	Fibre Channel HBAs	
	NOTE: Please visit www.hp.com/go/fchba for product details and www.hp.com/storage/spock for compatibility details.	
	Brocade Fibre Channel HBAs	
	HP 81B 8Gb 1-port PCIe Fibre Channel Host Bus Adapter	AP769B
	HP 82B 8Gb 2-port PCIe Fibre Channel Host Bus Adapter	AP770B
	Emulex Fibre Channel HBAs	
	HP 81E 8Gb 1-port PCIe Fibre Channel Host Bus Adapter	AJ762B
	HP 82E 8Gb 2-port PCIe Fibre Channel Host Bus Adapter	AJ763B
	QLogic Fibre Channel HBAs	
	HP 81Q 8Gb 1-port PCIe Fibre Channel Host Bus Adapter	AK344A
	HP 82Q 8Gb 2-port PCIe Fibre Channel Host Bus Adapter	AJ764A
Fibre Channel Host Bus Adapters - Integrity servers	**Integrity**	
	HP 4Gb 1-port PCI-X 2.0 Fibre Channel Host Bus Adapter	AB378B
	HP 4Gb 2-port PCI-X 2.0 Fibre Channel Host Bus Adapter	AB379B
	HP 4Gb 2-port PCIe Fibre Channel Host Bus Adapter	AD300A
	HP 4Gb 1-port PCIe Fibre Channel Host Bus Adapter	AD299A
	HP 4Gb 2-port PCIe Fibre Channel Host Bus Adapter	AD355A
	HP PCIe 1-port 4Gb and 1-port 1000BT Adapter	AD221A
	HP PCIe 2-port 4Gb and 2-port 1000BT Adapter	AD222A
	HP PCIe 2-port 4Gb and 2-port 1000BSX Adapter	AD393A
	HP PCI-X 1-port 4Gb FC and 1-port 1000BT Adapter	AD193A
	HP PCI-X 2-port 4Gb FC and 2-port 1000BT Adapter	AD194A
	HP PCI Express 1-port 8Gb Fibre Channel SR (QLogic) Adapter	AH400A
	HP PCI Express 2-port 8Gb Fibre Channel SR (QLogic) Adapter	AH401A
	HP 8Gb 1-port PCIe Fibre Channel Host Bus Adapter	AH402A
	HP 8Gb 2-port PCIe Fibre Channel Host Bus Adapter	AH403A
	Integrity server blades	
	Emulex LPe1105 4Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	403621-B21
	QLogic QMH2462 4Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	403619-B21
	QLogic QMH2562 8Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	451871-B21
	Emulex LPe1205 8Gb Fibre Channel Host Bus Adapter for c-Class BladeSystem	456972-B21

Configuration Information

Fibre Channel Switches	HP 8/8 Base (0) e-port SAN Switch	AM866B
	HP 8/8 (8) Full Fabric Ports Enabled SAN Switch	AM867B
	HP 8/24 Base (16) Full Fabric Ports Enabled SAN Switch	AM868B
	HP 8/80 Power Pack+ (48) Full Fabric Ports Enabled SAN Switch	AM872B
	HP 8/80 Base (48) Full Fabric Ports Enabled SAN Switch	AM871B
	HP 1606 FCIP 16-pt Enabled 8Gb FC 6-pt Enabled 1GbE Power Pack+ Switch	AP864B
	HP 1606 FCIP 16-pt Enabled 8Gb FC 6-pt Enabled 1GbE Full Switch	AP863B
	HP 1606 FCIP 4-pt Enabled 8Gb FC 2-pt Enabled 1GbE Base Switch	AP862B
	HP 2408 FCoE 24-pt 10GbE 8-pt 8Gb FC Base Converged Network Switch	AP801B
	HP 2408 FCoE 24-10GbE 8-8Gb FC Power Pack+ Converged Network Switch	AP802B
	Brocade 8/12c SAN Switch for BladeSystem c-Class	AJ820B
	Brocade 8/24c SAN Switch for BladeSystem c-Class	AJ821B
	Brocade 8/24c Power Pack+ SAN Switch for BladeSystem c-Class	AJ822B
	HP SN6000 Stackable 8Gb 24-port Single Power Fibre Channel Switch **NOTE:** 20 device ports active/4 stacking (ISL) ports active	AW575B
	HP SN6000 Stackable 8Gb 24-port Dual Power Fibre Channel Switch **NOTE:** 20 device ports active/4 stacking (ISL) ports active	AW576B
	HP SN6000 Stackable 12-port Single Power FC Switch **NOTE:** 8 device ports/4 stacking (ISL) ports active, upgradeable to 20 device ports active	BK780B
	Cisco MDS 9124 8-ports Active Fabric Switch	AG646A
	Cisco MDS 9124 16-ports Active Fabric Switch	AG647A
	HP MDS 9124 24-ports Active Fabric Switch	AG648A
	Cisco MDS 8/12c Fabric Switch for HP BladeSystem c-Class	AW563A
	Cisco MDS 8/24c Fabric Switch for HP BladeSystem c-Class	AW564A
	Cisco MDS 9222i Multiservice with 0 SFP Transceiver Modular Fabric Switch	AG851B
	HP SN6000C 8Gb 16-port Fibre Channel Switch	AW585A
	HP SN6000C 8Gb 32-port Fibre Channel Switch	AW586A
PremierFlexOM4 type cables	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 1m Cable	QK732A
	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 2m Cable	QK733A
	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 5m Cable	QK734A
	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 15m Cable	QK735A
	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 30m Cable	QK736A
	HP Premier Flex LC/LC Multi-mode OM4 2 fiber 50m Cable	QK737A
OM3 FC LC-LC cables	HP LC to LC Multi-mode OM3 2-Fiber 0.5m 1-Pack Fiber Optic Cable	AJ833A
	HP LC to LC Multi-mode OM3 2-Fiber 1.0m 1-Pack Fiber Optic Cable	AJ834A
	HP LC to LC Multi-mode OM3 2-Fiber 2.0m 1-Pack Fiber Optic Cable	AJ835A
	HP LC to LC Multi-mode OM3 2-Fiber 5.0m 1-Pack Fiber Optic Cable	AJ836A
	HP LC to LC Multi-mode OM3 2-Fiber 15.0m 1-Pack Fiber Optic Cable	AJ837A

	HP LC to LC Multi-mode OM3 2-Fiber 30.0m 1-Pack Fiber Optic Cable	AJ838A
	HP LC to LC Multi-mode OM3 2-Fiber 50.0m 1-Pack Fiber Optic Cable	AJ839A

Step 4b - Choose Supported Options For SAS Infrastructure

Mini-SAS to Mini-SAS HD cables	HP 1.0m External Mini SAS High Density to Mini SAS Cable	716189-B21
	HP 2.0m External Mini SAS High Density to Mini SAS Cable	716191-B21
	HP 4.0m External Mini SAS High Density to Mini SAS Cable	716193-B21
	HP Modular Smart Array SC08e 2-ports Ext PCIe x8 SAS Host Bus Adapter	614988-B21
	HP H221 Host Bus Adapter	650931-B21
	HP Smart Array P712m/256 6Gb 2-ports Int/2-ports Ext Mezzanine SAS Controller	488348-B21
	HP Smart Array P711m/1G 6Gb FBWC 4-ports Ext Mezzanine SAS Controller	513778-B21
	HP Smart Array P721m/2G FBWC 4-ports Ext Mezzanine SAS Controller	650072-B21
	HP Smart Array P721m/512 4-ports Ext Mezzanine SAS Controller	655636-B21
	HP 6Gb SAS Switch Single Pack for HP BladeSystem c-Class	BK763A
	HP 6Gb SAS Switch Dual Pack for HP BladeSystem c-Class	BK764A
	HP External Mini SAS 2m Cable	407339-B21
	HP Ext Mini SAS 4m cable - (only be used when connecting a SAS HBA or 6GB SAS switch to a SAS Controller. Connecting it to a disk enclosure is not supported)	432238-B21

Step 4c - Choose Supported Options For 10GbE Infrastructure

- verify that the cable/transceiver is supported with the connecting device (i.e. switch or NIC/iSCSI HBA)

Copper Cable	HP BladeSystem c-Class Small Form-Factor Pluggable .5m 10GbE Copper Cable	487649-B21
	HP BladeSystem c-Class Small Form-Factor Pluggable 1m 10GbE Copper Cable	487652-B21
	HP BladeSystem c-Class Small Form-Factor Pluggable 3m 10GbE Copper Cable	487655-B21
	HP BladeSystem c-Class Small Form-Factor Pluggable 5m 10GbE Copper Cable	537963-B21
	HP BladeSystem c-Class Small Form-Factor Pluggable 7m 10GbE Copper Cable	487658-B21
DAC Cable	HP X242 10G SFP+ to SFP+ 1m Direct Attach Copper Cable	J9281B
	HP X242 10G SFP+ to SFP+ 3m Direct Attach Copper Cable	J9283B
	HP X242 10G SFP+ to SFP+ 7m Direct Attach Copper Cable	J9285B
	HP X240 10G SFP+ to SFP+ 0.65m Direct Attach Copper Cable	JD095C
	HP X240 10G SFP+ to SFP+ 1.2m Direct Attach Copper Cable	JD096C
	HP X240 10G SFP+ to SFP+ 3m Direct Attach Copper Cable	JD097C
	HP X240 10G SFP+ to SFP+ 5m Direct Attach Copper Cable	JG081C
	HP X240 10G SFP+ SFP+ 7m Direct Attach Copper Cable	JC784C
NIC	HP NC524SFP Dual Port 10GbE Module	489892-B21
	HP NC550SFP Dual Port 10GbE Server Adapter	581201-B21
	HP NC532m Dual Port 10GbE Multifunction BL-c Adapter	467799-B21
	HP NC550m 10Gb 2-port PCIe x8 Flex-10 Ethernet Adapter	581204-B21

Step 5 - Choose Rack Options

Please refer to the HP Infrastructure products page for more information on HP racks and rack options or the HP 10000 G2 Series Rack QuickSpec.
http://h18004.www1.hp.com/products/servers/platforms/rackandpower.html
http://h18000.www1.hp.com/products/quickspecs/12402_div/12402_div.HTML

Technical Specifications

MSA 2040	**POWER REQUIREMENTS**	
	Input Power Requirements (typical-running I/O) SFF/LFF arrays	• 110VAC 3.32A, 344-390 W; 220VAC 1.61A,374-432W
	Max Input Power	100-240 VAC, 50/60 Hz., 4.5-1.9A; 48-60 VDC 10.4A/8.3A
	Heat Dissipation	1622 BTU/hr
	TEMPERATURE AND HUMIDITY RANGES	
	Operating Temperature	41°F to 104°F (5°C to 40°C)
	Shipping Temperature	-40°F to 158°F (-40°C to 70°C)
	Operating Humidity	10% to 90% RH @ 104°F (40°C) non-condensing
	Non-Operating Humidity	Up to 93% RH @ 104°F (40°C)
	DECLARED ACOUSTIC NOISE LEVELS	
	Sound Power	A weighted sound power LWAd=6,75 B
	Sound Pressure	A weighted sound pressure LpAm - 55dB
	SHOCK AND VIBRATION	
	Shock, Operational	3G's for 11 milliseconds
	Shock, Non-Operational	15G 11ms half sine
	Vibration, Operational	5-500Hz, 0.14 Grms shaped
	Vibration, Non-Operational	3-365-3Hz, 1.22 Grms,z-axis,0.85 Grms, X&Y axis shaped spectrum
	PHYSICAL	
	Height	3.5 in/ 8.9 cm
	Depth (excluding cables) (back of ear to back of controller handle)	MSA 2040 SFF 24-bay array: 19.5 in / 49.5 cm MSA 2040 LFF 12-bay array: 22.5in. / 57.2 cm
	Width (body only)	17.6 in / 44.7 cm (w/ ears 19 in / 48.26 cm)
	Chassis Weight (no controllers)	MSA 2040 LFF chassis: 31 lbs. (DC-pwr model: 32.6 lbs) MSA 2040 SFF chassis: 29.1 lbs (DC-pwr model: 30.7lbs)

Technical Specifications

MSA 2040 Controllers:	**User Interface**	Status and activity provided via management interfaces. Status Indicators on front of Controller
	RAID Support	0, 1, 3, 5, 6, 10, 50
	Cache Memory	4GB Read/Write. ECC protection with backup to Flash memory (indefinite backup)
	Cache Backup	ECC protection with back up to flash memory (indefinite backup)
	Upgradeable Firmware	yes
	Disk Drive and Enclosure Protocol Support	6 Gb SAS - Serial Attached SCSI
	Host Ports	FC: 4 x 8Gb Fibre Channel (per controller) FC: 4 x 16Gb Fibre Channel (per controller) iSCSI: 4 x 10GbE iSCSI (per controller) iSCSI: 4 x 1GbE iSCSI (per controller)
		SAS: 4 x 12 Gb mini-SAS HD using SAS 3.0 SFF-8644 connect interface (per controller)
	Expansion Port	SAS (SFF8088) 4x lane 6 Gb SAS
	Weight, controller	MSA 2040 SAN Controllers 4.8 lbs.

MSA 2040 Regulatory Info	**Safety**	UL 60950-1 (USA)
		CAN/CSA-C22.2 No.60950-1-03 (Canada)
		EN 60950-1 (European Union)
		GS mark (Germany)
		IEC 60950-1 (International)
		CCC Mark (power supply only, China PRC)
	Electromagnetic Compatibility	VCCI:2008-04 Class A (Japan)
		FCC 15:109(g) Class A (USA)
		ICES-003:2004 Class A (Canada)
		EN55022 : (European Union Class A); CISPR 22 (International Class A)
		EN61000-3-2 : (Harmonics) (European Union)
		EN61000-3-3 : (Flicker) (European Union)
		EN 55024 (European Union, Immunity, Class A);CISPR 24 (International Immunity, Class A)
		AS/NZS CISPR 22, Class A (Australia, New Zealand)
		CNS 13438 Taiwan, Class A (Taiwan)
		KN22 Class A (Emissions Class A); KN24 (Immunity) (S Korea)
	RoHS and WEEE	RoHS-6/6 Compliance, China RoHS, WEEE
	Country Approvals	United States ,Australia/New Zealand, Canada, China (PRC), European Union, Germany (GS Mark), Japan, South Korea, Taiwan