



CATE Storage and Backup Engineering
Citigroup Architecture & Technology Engineering

NetApp FAS2000 Series

CSBE-08043-RN

Release Notes

Version 3.3.1

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1 Version Control

Version	Date	Author	Reviewed	Comments
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0.2	19-DEC-2008	Tim Armstrong		RFC
1.0	30-DEC-2008	Tim Armstrong		Updated shelf firmware RFP
2.0	10-APR-2009	Tim Armstrong	Jackson Tan	Updated to include phase 2: certification of 2050HA
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3.3	28-JUL-2011	Richard Sopp	n/a	Add CSB-1107-02 issue
3.3.1	28-May-2014	Richard Sopp	Richard Sopp	Annual Review

2 Legal Notice

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3 Contact

Please address any comments or questions regarding the information contained in this document via email to the "CATE Storage and Backup Engineering" distribution list or alternatively to gdse@citi.com.

4 Latest Versions

It is recommended that the latest version of the document be used from the CATE Storage Engineering website <http://catecollaboration.citigroup.net/domains/platstor/gdse/products/default.aspx>. Newer versions may include certification on additional platforms, or comments on issues discovered after deployment.

5 Regional Reviewers

The purpose of this section is to list all the stakeholders who reviewed this document during the Request for Comment process.

Region	Reviewed by	Version reviewed
Asia Pacific	Tim Armstrong	3.1
EMEA	Jason Palmer	3.1
Japan	No response received	-
Latin America / Mexico	n/a	-
North America	No response received	-

5.1 - Regional stakeholder review

6 Table of Contents

1	Version Control	2
2	Legal Notice	2
3	Contact.....	2
4	Latest Versions	2
5	Regional Reviewers	3
6	Table of Contents.....	4
7	Introduction	5
7.1	Operating System dependencies	5
7.2	Summary of differences between FAS270C, FAS2040, FAS2020 and FAS2050	6
7.3	Comparing storage capacity	7
7.3.1	FAS2040 with DS4243 disk shelf	7
7.3.2	FAS2020 and FAS2050 with DS14 disk shelf	7
8	FAS2040 Best Practices & Recommended Configurations.....	8
8.1	NICs	8
8.2	Storage Capacities	8
8.3	SAS Stack and Shelf Firmware.....	9
8.4	RAID groups, Aggregates, Volumes and De-duplication	11
8.5	Tape Connectivity.....	12
8.6	Remote Management.....	13
8.7	Virtual Servers (vFilers).....	13
8.8	Snapvault / Snapmirror Concurrent Streams	13
8.9	Elevations.....	14
9	FAS2020/50 Best Practices & Recommended Configurations.....	15
9.1	NICs	15
9.2	Storage Capacities	15
9.3	FC Loop and Shelf Firmware	16
9.4	RAID groups, Aggregates, Volumes and De-duplication	17
9.5	Tape Connectivity.....	20
9.6	Remote Management.....	20
9.7	Virtual Servers (vFilers).....	21
9.8	Snapvault / Snapmirror Concurrent Streams	21
9.9	Shared chassis resources.....	22
9.9.1	FAS 2020 Component View	22
9.9.2	FAS 2020 Component Glossary and Quantities.....	22
9.9.3	FAS 2050 Component View	23
9.9.4	FAS 2050 Component Glossary and Quantities.....	23
10	Known Issues.....	25
11	Document version control	26
12	Appendices	27
12.1	FAS2040 Installation Test Plan.....	27
12.2	Degraded state test plan	29
12.3	Software / firmware upgrade test plan	31
12.4	Test Environment Lab Diagram	32

7 Introduction

The FAS2040 is the second generation FAS2000 series hardware platform from NetApp. It offers twice the performance characteristics of the first generation FAS2000 series hardware (FAS2020 and FAS2050), as well as SAS ports to support the new DS4243 disk shelves. It is also capable of supporting ONTAP 8.x whereas the first generation hardware is not.

As part of the certification project for the FAS2040 this document is being restructured to promote use of the FAS2040 for all new entry level system installations and discouraging the implementation of any new FAS2020 and FAS2050 systems due to the lack of support for ONTAP 8.x. FAS2020 and FAS2050 information is only maintained in this document for reference purposes only.

The scope of these release notes is to provide hardware related best practices for the use of the FAS2040 with ONTAP 8.x 7-mode, FAS2020 and FAS2050 with the ONTAP 7G operating system.

The FAS2000 series is targeted for small environments as a general file sharing NAS solution, supporting CIFS and NFS protocols.

7.1 Operating System dependencies

The following operating system version (ONTAP) dependencies apply when considering use of the FAS2000 series systems. The following table lists which hardware platform is supported on ONTAP 7G and the minimum version of the operating system required to support this hardware. The platform status column has been added to indicate which model should be used for new deployments (current) as opposed to first generation systems already deployed to production (restricted) in order to provide a recommendation for platform choice that protects hardware investment with the ability to support future releases of the ONTAP operating system. The platform status description aligns with the CTC (Citigroup Technology Catalogue) status for this hardware.

Platform	Platform Status	ONTAP 7G Supported	ONTAP 8.x Ready	Minimum ONTAP version (NetApp)	Minimum ONTAP version (Citi)
FAS2040	Current	Y	Y	7.3.2	7.3.3P3
FAS2020	Non-strategic	Y	N	7.2.5.1	7.2.5.1P6
FAS2050	Non-strategic	Y	N	7.2.5.1	7.2.5.1P6

7.1 - Hardware platform by Minimum Operating System Version Support Matrix

Operations teams with FAS2020 and FAS2050 systems deployed should engage their local NetApp account team representative to discuss hardware upgrade procedures and processes to the FAS2040 platform.

7.2 Summary of differences between FAS270C, FAS2040, FAS2020 and FAS2050

The main differences between the FAS270C, FAS2040HA, FAS2020HA and the FAS2050HA hardware are summarized in the following table. The values listed below are per cluster as most of the metrics relate to the specification of the overall chassis.

Feature	270C →	2020A →	2050A →	2040A
# CPU (# Cores ¹)	2 (2)	2 (2)	2(2)	2(4)
RAM	2GB	2GB	4GB	8GB
NV-MEM	256MB	256MB	512MB	512MB ²
FC ports	2 x 1Gb disk expansion 2 x 2Gb tape initiator or FCP target	4 x 1/2/4Gb initiator or target	4 x 1/2/4Gb initiator or target	4 x 1/2/4Gb initiator or target
SAS ports	n/a	n/a	n/a	2 x 12Gb QSFP
ACP ports	n/a	n/a	n/a	2
NIC ports	4 x 1Gb Ethernet (copper)	4 x 1Gb Ethernet (copper)	4 x 1Gb Ethernet (copper)	8 x 1Gb Ethernet (copper)
Height ³	3U	2U	4U	2U
Weight	77lb (35kg) (inc disks)	57lb (25.9kg) (exc disks)	91lb (41.3kg) (exc disks)	66lb (29.9kg) (inc disks)
AC Power ⁴	110-120V 4.3A 220-240V 2.07A	100-120V 2.23A 200-240V 1.18A	100-120V 2.37A 200-240V 1.24A	100-120V 4.53A 200-240V 2.28A
Thermal	1463 BTU/hr (inc disks)	1462 BTU/hr (exc disks)	1546 BTU/hr (exc disks)	1518 BTU/hr (inc disks)
Remote Management Ports	Serial Console	Serial Console BMC ⁵ (Baseboard Management Controller)	Serial Console BMC ⁴ (Baseboard Management Controller)	Serial Console BMC ⁴ (Baseboard Management Controller)
Support for Multipath-HA	Not Supported	Supported	Supported	Singlepath-HA only for DS4243
Internal Disks	14 Drive bays FC (Supported in Citi)	12 Drive bays SAS or SATA (Not supported in Citi)	20 Drive bays SAS or SATA (Not supported in Citi)	12 Drive bays SAS or SATA (Supported in Citi)
External storage	DS14	DS14	DS14 (DS4243 not supported in Citi)	DS4243 (DS14 not supported in Citi)

7.2 - Feature comparison

¹ Number of cores is the number in brackets.

² In a clustered configuration the FAS2040 is physically fitted with 1GB of NV-MEM, however only 512MB is utilized (256MB per controller) with ONTAP 7.3.x. 512MB per node is used when the system is running ONTAP 8.x (due for certification at a later date)

³ Due to single chassis design the height remains the same for single and dual controllers

⁴ Line voltage for standalone systems dependent on local power distribution; cabinets are 200 to 240V only.

⁵ Note the Baseboard Management Controller is not supported for use in Citi. Please refer to section [9.6](#)

7.3 Comparing storage capacity

The following figures represent the maximum size configurations NetApp supports on these hardware platforms.



These figures differ with what NetApp supports in terms of the hardware capacity as CATE Storage Engineering does not support configuring the hardware at more than 75% total supported storage capacity. The values below are provided for comparison purposes only between the old and new models. For the storage capacity configuration supported by CATE Storage Engineering refer to section 0.

7.3.1 FAS2040 with DS4243 disk shelf

Refer to table [8.2](#) for the amount of raw storage supported on the FAS2040 platform given different drive types and sizes. The table compares the values supported by NetApp to the quantity of raw storage certified by CATE Storage and Backup Engineering which applies a standard rule of 75% of manufacturer's specification.

7.3.2 FAS2020 and FAS2050 with DS14 disk shelf

When comparing single controller and cluster configurations the following figures represent the storage supported by a single controller or a cluster. For example if you were considering deploying a FAS2020 cluster with external 300GB FC drives the maximum raw configuration supported by NetApp would be 16TB (8TB per storage controller in the two node cluster). Note the following table represents capacity excluding use of internal drive bays.

Capacity	270 →	2020 →	2050
Fiber Channel 144GB	8TB	8TB	12TB
Fiber Channel 300GB	16TB	16TB	24TB
Fiber Channel 450GB ⁶	16TB	24TB	36TB
SATA 500GB	16TB	28TB	42TB
SATA 1TB	16TB	56TB	84TB
Aggregate / Volume Maximum Size ⁷	8TB	8TB	16TB
RAID Group Maximum number of Disks ⁸	28 FC 16 ATA	16 FC 16 ATA	28 FC 16 ATA
Maximum backend FC Loops	1 (single) 2 (HA/dual)	2 (single) 4 (HA/dual)	2 (single) 4 (HA/dual)
Maximum disks per loop	56	56	84

7.3 - NetApp FAS2020 / FAS2050 supported raw storage capacity with DS14 enclosures

⁶ Supported only when using DS14mk2 FC and DS14mk4 FC shelves

⁷ Volume / aggregate size is calculated using base2 arithmetic. Please refer to section [9.4](#) for Aggregate recommendations

⁸ Please refer to section [9.4](#) for RAID group recommendations

8 FAS2040 Best Practices & Recommended Configurations

This section details best practices when configuring the FAS2040 with ONTAP 7G and ONTAP 8 7-mode.

8.1 NICs

Due to the integrated system board approach with no inclusion of expansion slots on FAS2040, the use of the onboard ports is only available option with the FAS2040 platform. The FAS2040 has twice the amount of onboard Gig-E interfaces as the FAS2020 and the FAS2050.

Network Interface Card Configuration (Gigabit Ethernet)	Slot and Port Assignments
	2040
Active / Passive 1Gb (single mode)	Single mode: e0a, e0c
Active / Passive 2Gb (single mode VIF over multi mode VIF) 2Gb	1) Multi mode: e0a, e0b 2) Multi mode: e0c, e0d 3) Single mode: 1) and 2)

8.1 – FAS2040 Gigabit Ethernet Port Assignment

8.2 Storage Capacities

The FAS2040 is only certified for use in Citi with the new DS4243 disk enclosure. While NetApp will support the FS2040 with the older DS14 shelf, it has not been certified by CATE Storage Engineering.

This section discusses all aspects of system configuration that relate to the backend storage. The following table presents the amount of raw storage supported on the FAS2040 platform given different drive types and sizes. The table compares the values supported by NetApp and compares that to the quantity of raw storage certified by CATE Storage Engineering which applies a standard rule of 75% of manufacturer's specification.

System Capacity (clustered [single path] configuration)		
Platform	2040	
Maximum Number of Disks ⁹	NetApp	Citi
All drive types & sizes (internal)	12	12
All drive types & sizes (external) ¹⁰	96	72
Storage Raw Maximum ¹¹		
SAS 300GB	28TB	21TB
SAS 450GB	42TB	31.5TB
SAS 600GB	56TB	42TB
BSAS (SATA) 1TB	96TB	72TB

⁹ Citi maximum number of drives value is derived as the integer result of ((NetApp Supported Drive Count / 24 drives in a DS4243 enclosure) * 0.75).

¹⁰ The NetApp Support site lists this figure as 124 external disks, which relates to a DS14 configuration. When using DS4243 shelves 96 drives is the maximum.

¹¹ Raw maximum is derived as the result of ((Disk Raw Capacity x Number of Drives) / 1024). Drive raw capacity is determined by the drive name and does not reflect overheads such as right-sizing.

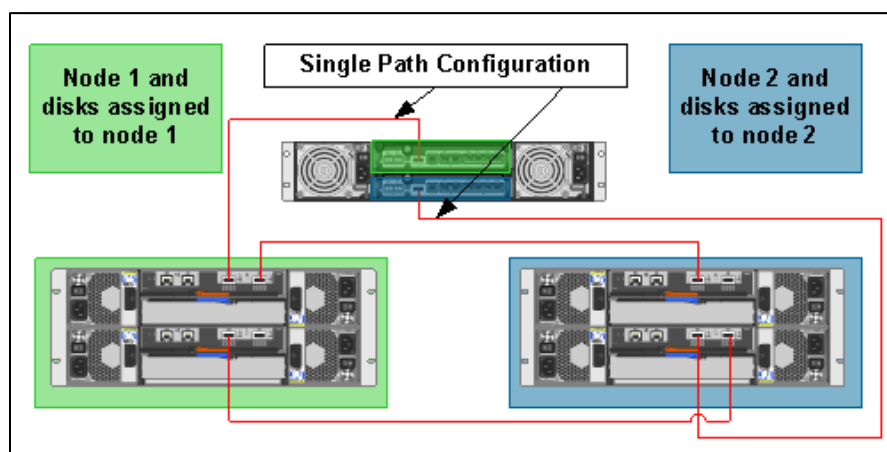
System Capacity (clustered [single path] configuration) - continued		
Platform	2040	
Maximum DS4243 shelf count ¹²		
All drive types & sizes	4	3
Maximum shelves per stack ¹³	4	3
Implied stack count ¹⁴	1	1
Maximum disks per stack	96	72
Aggregate Maximum Size with ONTAP 7.3	16TB	16TB

8.2 - Supported RAW storage capacities for FAS2040 series using DS4243 enclosures

8.3 SAS Stack and Shelf Firmware

The following tables provide best practice port assignments for the SAS stacks that connect the disk shelves to the storage controller. These port assignments apply consistently regardless of whether SAS or BSAS (SATA) drives are used.

The diagram below depicts a FAS2040HA (clustered) Filer in a single SAS stack configuration. Due to the small form factor density of the onboard controllers, each controller only has one SAS embedded SAS port. In addition there are no PCI expansion slots on the FAS2040 to add more SAS ports. This results in the FAS2040 only being able to support a single path HA configuration for the DS4243 shelf, compared to a dual path configuration if used with a DS14 shelf (CATE Storage and Backup engineering have no plans to certify the FAS2040 with the older DS14 shelf). The low SAS port count is a design tradeoff between supporting SAS functionality in a small form factor Filer and the dual path SAS connectivity found in mid-range and high-end NetApp NAS Filers.



8.1 - FAS2040 single path HA SAS configuration – rear elevation

- ¹² Maximum shelf count derived as a result of (Maximum Number of Disks / 24 drives per enclosure)
- ¹³ Maximum shelves per stack is not affected by the 75%, so there is no need to artificially limit the number of shelves in a stack to 75% of a given stacks shelf capacity.
- ¹⁴ Implied (maximum) stack count is derived as a result of (Maximum Shelves per Stack / Maximum DS4243 Shelf Count). Best practice is to keep the number of different SAS (includes SATA) stacks to a minimum. To a certain extent this is dictated by the number of available SAS ports / SAS HBAs and available PCI slots on the storage controller.

Due to the single path HA nature of this configuration, the following functional behavior is exhibited:

- Introduction of additional disk shelves into existing system will require downtime for a CIFS and NFS data serving perspective
- Connectivity issues with SAS cables may instigate a cluster failover as a secondary path is not available (only a redundant path is available via the other controller which requires a cluster failover to achieve ownership of disks)
- IOM3 modules are not hot swappable and will require downtime or a cluster failover event if the IOM3 module in the primary data path needs to be replaced
- The onboard SAS drives in the FAS2040 chassis are not interchangeable with the SAS drives in the DS4243 as the drive caddies are a different type and size

SAS stack for clustered / single-path HA configuration			
Configuration	Number of Stacks (cluster total)	Number of shelves per stack (cluster total)	Port / Slot Assignments
Node A of a clustered (HA) pair	1	3	0d
Node B of a clustered (HA) pair			0d

8.3 - FAS2040 SAS stack port configuration for Single-path HA

CATE Storage Engineering recommends the following minimum shelf and ACP firmware when implementing the FAS2040 for ONTAP 7G.

Shelf Type	F/W Type	Firmware File(s)	Reported Version
DS4243	ACP	/etc/acpp_fw/ACP-IOM3.0115.AFW /etc/acpp_fw/ACP-IOM3.0115.AFW.FVF	01.15 (use <code>storage show acp</code> to check)
DS4243	IOM3	/etc/shelf_fw/IOM3.0110.SFW /etc/shelf_fw/IOM3.0110.SFW.FVF	Rev '0110' (use <code>sasadmin expander_map</code> to check)

8.4 – FAS2040 Recommended minimum ACP and IOM3 firmware versions

8.4 RAID groups, Aggregates, Volumes and De-duplication

CATE Storage Engineering recommends the following best practices when implementing RAID group configurations. Note that RAID-4 is not supported by CATE Storage Engineering on this hardware platform.

Due to a number of system limitations, special consideration needs to be given to the FAS2040 disk configuration. The following guidelines are provided for the FAS2040:

- 3 hot spares allocated up front using the internal drives in the FAS2040
- All RAID groups must be configured RAID-DP
- All RAID groups must comply with limitations for RAID Group maximum number of disks.
- All Aggregates must comply with limitations for Aggregate maximum number of disks.

Disk Drive Type	Drive Capacity	RAID Group Maximum number of Disks	Aggregate Maximum number of Data Disks ¹⁵
SAS	300GB	28	61
	450GB	28	40
	600GB	28	29
BSAS (SATA)	1TB	16	19

8.5 – FAS2040 NetApp limits for Maximum # disk drives per Aggregate and RAID Group

Below shows the various configurations for the FAS2040 with up to 3 shelves of disks.

Shelves	# Disks Total ¹⁶	# Spares per Filer	Filer Aggregate	RAID Group	Data	Parity
0	12	3	filer1_aggr0	aggr0_rg0	1	2
		3	filer2_aggr0	aggr0_rg0	1	2
1	36	3	filer1_aggr1	aggr1_rg0	10	2
			filer1_aggr1	aggr1_rg1	10	2
2	60	3	filer2_aggr1	aggr1_rg0	10	2
			filer2_aggr1	aggr1_rg1	10	2
3	84	3	filer1_aggr2	aggr2_rg0	10	2
			filer1_aggr2	aggr2_rg1	10	2

8.6 - FAS2040 Recommended Disk Configurations with SAS disks

Note there is increased risk sharing a single DS4243 shelf between both controllers in a FAS2040A cluster. While the DS4243 has multiple levels of redundancy and a passive backplane, an external isolated catastrophic failure would impact the entire cluster rather than the just one controller. That is why the expansion pattern outlined above may appear unequal in the allocation of disks between controllers.

The smaller RAID groups in the above design also allow for the possibility of half populated shelves being installed. Plus all the data residing on the external shelves allows for greater flexibility in system expansion should

¹⁵ ONTAP 7.3.1 and above does not include parity disks in the calculation of aggregate capacity. It also performs the calculation in terms of the right sized value of the disk. The values in this table reflect exclusion of parity disk and right sized values.

¹⁶ Includes the 6 internal drives assigned to each controller (head) in the cluster (12 in total)

All volumes must be created as Flexvols to optimize the provisioning model of NetApp NAS Filers. The following table lists the recommended root volume size. The Citi recommended value is essentially triple the NetApp recommendation to allow enough space for log files.

Due to the limited capacity of the FAS2040, it is recommended that the root volume (vol0) and business data will reside on the same aggregate (aggr0).

Hardware model	NetApp recommended root vol size	Citi recommended root vol size
2040	16GB	48GB

8.7 - FAS2040 Recommended Root Volume Size

Data de-duplication (de-dupe) is supported for volumes on the FAS2040. De-dupe artificially restricts the maximum size of the volume on any given platform. The current size limitations for de-dupe enabled volumes in releases ONTAP 7.3.x for these platforms are:

Hardware model	NetApp Maximum De-dupe Vol Size
2040	3TB ¹⁷

8.8 - NetApp Recommended De-dupe Volume Size

8.5 Tape Connectivity

This section provides the best practice port assignments to use when considering attaching your Filer to a Fiber Channel attached backup infrastructure. Where supported by your infrastructure CATE Storage Engineering recommends you ensure these ports are set to a 4GB line speed. As the FAS2040 is certified for use with only SAS storage, both FC ports are available for use. It is recommended for tape connectivity, where possible, each FC port is connected to a separate FC switch to provide redundancy.

Configuration FAS2040	Port / Slot Assignments
	Tape
Node A of a clustered (HA) pair	0a, 0b
Node B of a clustered (HA) pair	0a, 0b

8.9 - FAS2040 FC Loop Configuration for FC Tape

¹⁷ Note that the maximum recommended de-dupe volume size supported on the FAS2040 is lower than on other models. Please refer to the current ONTAP Solutions Guide for values for other NetApp models.

8.6 Remote Management

The FAS2040 is fitted with multiple interfaces: Network, Console and Baseboard Management Controller. The Baseboard Management Controller (BMC) is a remote management device that is built into the motherboard of the FAS2000 series storage systems. This is a new approach introduced by NetApp not available in other current FAS systems.

8.7 Virtual Servers (vFilers)

As of ONTAP v7.3, you can configure up to 16 usable vFilers on a single FAS2040 storage controller (up to 32 in a cluster). The maximum limits for number of vFilers are shown in the table below, and highlights the maximum value supported by NetApp and the value certified by CATE Storage Engineering.

Filer model	NetApp	Citi
FAS2040	16	12

8.10 - FAS2040 Supported vFiler quantities per storage controller

8.8 Flash Cache (formerly known as PAM II)

The FAS2040 does not support the new read only cache expansion card, Flash Cache (formerly known as PAM II) which was added with ONTAP 7.3.2 and above. There are no PCI expansion slots on this small form factor controller to accommodate any PCI expansion cards.

8.9 Snapvault / Snapmirror Concurrent Streams

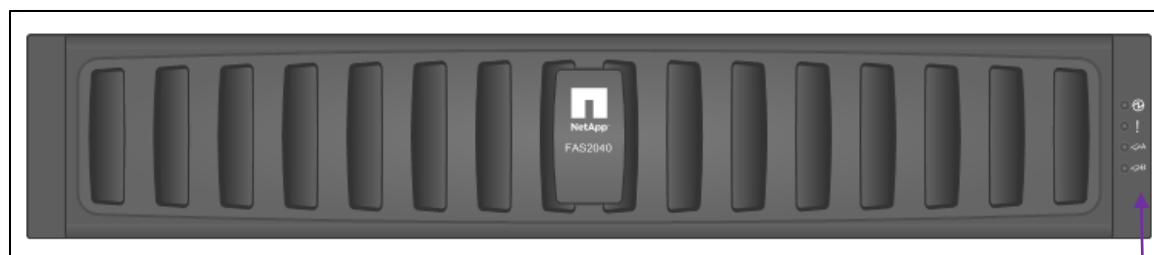
When the NearStore personality is enabled, Data ONTAP increases the support for concurrent destination streams on the FAS2040. The table below presents the concurrent stream count supported with ONTAP 7.3.x.

Configuration	Volume SnapMirror		Qtree SnapMirror		SnapVault	
	Src	Dest	Src	Dest	Src	Dest
FAS2040	50	50	64	64	64	64
FAS2040 with nearstore option	50	100	160	160	160	160

8.11 - FAS2040 Total number of simultaneous transfers supported per replication type

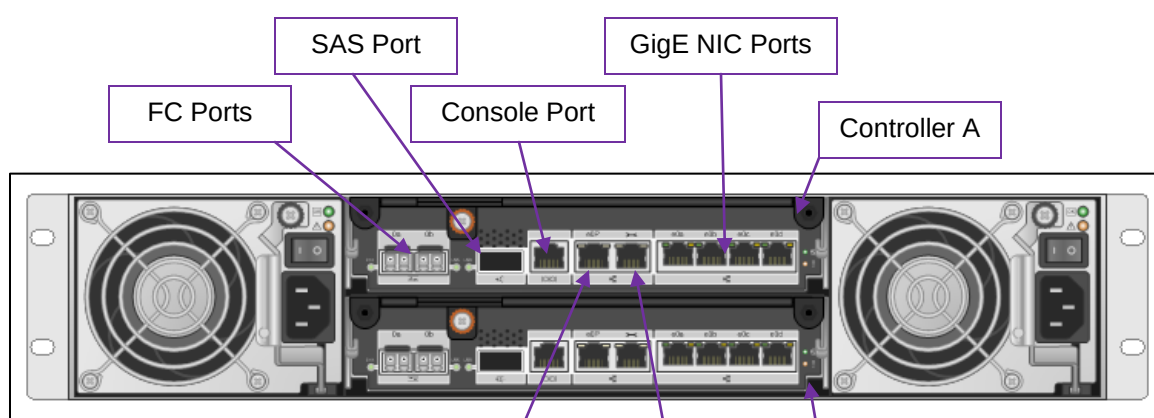
8.10 Elevations

The following diagrams depict the front and rear elevations of the FAS2040.



8.2 - FAS2040 Front Elevation

Status LEDs



8.3 - FAS2040 Rear Elevation

ACP Port (DS4243)

BMC Port

Item	Description	Quantity
PSU	Power Supply Unit	2 per chassis (shared)
PCM	Processor Control Module	2 per chassis (HA-Pair)
Status LED's	Status indicators for system	1 set per chassis
Serial Port	Serial Console Port	1 per PCM
BMC Port	Baseboard Management Controller Port	1 per PCM
FC Ports	1/2/4GB FC Initiator/Target Ports	2 per PCM
NIC Ports	10Base-T/100Base-TX/1000Base-T Ports	4 per PCM
SAS Port	Serial Attached SCSI Port	1 per PCM
ACP Port	Alternate Control Path Port	1 per PCM

8.12 - FAS2040 Component Glossary and Quantities

9 FAS2020/50 Best Practices & Recommended Configurations

This section details best practices when configuring first generation FAS2020 and FAS2050 with ONTAP 7G.

9.1 NICs

Due to the integrated system board approach with no inclusion of expansion slots on FAS2020, the use of the onboard ports is only available with the FAS2020 platform.

For systems that require more than 1Gb Ethernet connectivity with relatively small storage requirement, the expansion slot of the FAS2050 can be considered. By adding a quad port Ethernet card it would be possible to have 2 active and 2 passive ports on the FAS 2050. It should be noted that the inclusion of a quad port Ethernet card in the FAS2050 excludes the possibility of configuring with a quad port FC card. Please refer to Section [8.5 Tape Connectivity](#).

Network Interface Card Configuration (Gigabit Ethernet)	Slot and Port Assignments	
	2020	2050
Active / Passive (single mode) 1Gb	e0a, e0b	e0a, e0b
Active / Passive (single mode) 2Gb	N/A	e0a, e0b,e1a,e1b

9.1 - FAS2020/2050 Gigabit Ethernet Port Assignment

9.2 Storage Capacities

This section discusses all aspects of system configuration that relate to the backend storage. The following table presents the amount of raw storage supported on each hardware platform given different drive types and sizes. The table compares the values supported by NetApp and compares that to the quantity of raw storage certified by CATE Storage Engineering which applies a standard rule of 75% of manufacturer's specification. Note that for the FAS2050 the 75% rule was applied to the total number of disks supported of 104 (84 external and 20 internal) resulting in 70 external disks supported in Citi. Any variation from this will require prior approval from CATE Storage Engineering.

Capacity	2020		2050	
System Capacity Maximum Number of Disks Multipath-HA and single head (dual path) configurations	NetApp	Citi	NetApp	Citi
Fiber Channel 144GB	56	42	84	70
Fiber Channel 300GB	56	42	84	70
Fiber Channel 450GB	56	42	84	70
SATA 500GB	56	42	84	70
SATA 1TB	56	42	84	70

System Capacity Raw Maximum Multipath-HA and single head (dual path) configurations	NetApp	Citi	NetApp	Citi
Fiber Channel 144GB	8TB	6TB	12TB	10TB
Fiber Channel 300GB	16TB	12TB	24TB	20TB
Fiber Channel 450GB	24TB	18TB	36TB	30TB
SATA 500GB	27TB	20TB	42TB	35TB
SATA 1TB	56TB	42TB	84TB	70TB
Maximum backend FC Loops	2 (single) 4 (HA/dual)	2 (single) 4 (HA/dual)	2 (single) 4 (HA/dual)	2 (single) 4 (HA/dual)
Maximum disks per loop	56	56	84	84
Aggregate / Volume Maximum Size ¹⁸	8TB	8TB	16TB	16TB

9.2 - FAS2020/2050 Supported RAW storage capacities

9.3 FC Loop and Shelf Firmware

The following tables provide best practice port assignments for the fiber channel loops that connect the disk shelves to the storage controller. These port assignments apply consistently regardless of whether FC or SATA drives are used.

For Fiber Channel drives CATE Storage Engineering recommends using the DS14mk4 disk shelves to achieve a backend 4GB line speed. When installing DS14mk4 shelves ensure the speed switch on the ESH module is set to 4Gb (by default these are shipped set at 2Gb). If you add a shelf configured at a lower speed to an existing loop running at 4Gb, the entire loop will reset to the speed of the shelf with the slowest configured line rate. This is why it is important to be consistent with your shelf configurations.

The redundant loop in the following tables is required for Multipath-HA implementations. As of Q2 2007 Multipath-HA is the recommended standard configuration for all NetApp NAS implementations.

Fiber Channel Loops for clustered configuration					
Configuration	Number of primary loops (per controller)	Port / Slot Assignments			
		Primary		Redundant	
		Local	Partner	Local	Partner
Node A of a clustered (HA) pair	1	0a	0b	0b	0a
Node B of a clustered (HA) pair	1	0b	0a	0a	0b

9.3 - FAS2020/2050 Fiber Channel Loop Configuration for HA-Pair with Multipath-HA

¹⁸ Note that the maximum aggregate size supported on the FAS 2020 is lower than on other models. Please refer to the current ONTAP Solutions Guide for values for other NetApp models.

CATE Storage Engineering recommends the following minimum shelf firmware when implementing the FAS2020 for ONTAP 7G.

Drive type	Shelf firmware	Sysconfig output
Fiber Channel (ESH4)	ESH4.1300.SFW	ESH4 Firmware rev: 13
SATA (AT-FCX)	AT-FCX.3700	AT-FCX Firmware rev: 37

9.4 - FAS2020/2050 Recommended minimum shelf firmware versions

9.4 RAID groups, Aggregates, Volumes and De-duplication

CATE Storage Engineering recommends the following best practices when implementing RAID group configurations. Note that RAID-4 is not supported by CATE Storage Engineering on this hardware platform.

Due to a number of system limitations, special consideration needs to be given to the FAS2020/FAS2050 disk configuration. The following guidelines are provided for the FAS2020 and FAS 2050:

- 1 hot spare with 28 or less disks per filer
- 2 hot spares allocated per filer for greater than 28 disks per filer (FAS 2050 only)
- All RAID groups must be configured RAID-DP
- All RAID groups must comply with limitations for RAID Group maximum number of disks.
- All Aggregates must comply with limitations for Aggregate maximum number of disks.
- Disks should be equally distributed (assigned) between each filer.

Disk Drive Type	Drive Capacity	RAID Group Maximum number of Disks ¹⁹		Aggregate Maximum number of Disks ²⁰	
		FAS2020	FAS2050	FAS2020	FAS2050
FC	144GB	16	28	45	104
	300GB	16	28	22	51
	450GB	15	28	15	35
SATA	500GB	14	28	14	33
	1TB	6	15	6	15

9.5 - FAS202/2050 NetApp limits for Maximum # disk drives per Aggregate and RAID

The following guidelines are provided for the FAS2050:

- 1 hot spare with less than 28 disks per filer
- 2 hot spares allocated per filer for greater than 28 disks per filer (FAS 2050 only)
- All RAID groups must be configured RAID-DP
- All RAID groups must comply with limitations for RAID Group maximum number of disks.
- All Aggregates must comply with limitations for Aggregate maximum number of disks.
- Disks should be equally distributed (assigned) between each filer.

¹⁹ Note that the RAID group maximum number of disks supported on the FAS 2020HA is lower than on other models. Please refer to the current ONTAP Solutions Guide for values for other NetApp models.

²⁰ To display aggregate capacities and usage, use the command `df -Ah`. If the used column in the resulting output shows 5.34 TB or less for each aggregate on the system, your system is within NetApp supported limits.

Below shows the various configurations for the FAS2020 / FAS2050 with up to 3/5 shelves of disks (Note: this does not apply when using 1TB drives due to the limitation of 6 disks per aggregate/RAID group).

Shelves	# Disks Total	# Disks per Filer	Configuration
1	14	7	1 Hot Spare 1 RAID group rg0: 6 disks (4 data, 2 parity) 1 Aggregate aggr0: rg0
2	28	14	1 Hot Spare 1 RAID group rg0: 13 disks (11 data, 2 parity) 1 Aggregate aggr0: rg0
3	42	21	1 Hot Spare 2 RAID groups rg0: 13 disks (11 data, 2 parity) rg1: 7 disks (5 data, 2 parity) 2 Aggregates aggr0: rg0 aggr1: rg1

9.6 - FAS2020 Recommended Disk Configurations with FC disks

Shelves	# Disks Total	# Disks per Filer	Configuration
1	14	7	1 Hot Spare 1 RAID group rg0: 6 disks (4 data, 2 parity) 1 Aggregate aggr0: rg0
2	28	14	1 Hot Spare 1 RAID group rg0: 13 disks (11 data, 2 parity) 1 Aggregate aggr0: rg0
3	28	21	1 Hot Spare 1 RAID groups rg0: 20 disks (18 data, 2 parity) 1 Aggregate aggr0: rg0
4	56	28	1 Hot Spares 2 RAID groups rg0: 20 disks (18 data, 2 parity) rg1: 7 disks (5 data, 2 parity) 2 Aggregates aggr0: rg0 aggr1: rg1
5	70	35	2 Hot Spares 2 RAID groups rg0: 20 disks (18 data, 2 parity) rg1: 13 disks (11 data, 2 parity) 2 Aggregates aggr0: rg0 aggr1: rg1

9.7 - FAS2050 Recommended Disk Configurations with FC disks

All volumes must be created as Flexvols to optimize the provisioning model of NetApp NAS Filers. The following table lists the recommended root volume size. The Citi recommended value is essentially triple the NetApp recommendation to allow enough space for log files. Due to the limited capacity of the FAS2020 and FAS2050, it is recommended that the root volume (vol0) and business data will reside on the same aggregate (aggr0).

Hardware model	NetApp recommended root vol size	Citi recommended root vol size
2020	10GB	30GB
2050	12GB	36GB

9.8 - FAS2020/2050 Recommended Root Volume Size

Data de-duplication (de-dupe) is supported for volumes on the FAS2020 and FAS2050. De-dupe artificially restricts the maximum size of the volume on any given platform. The current size limitations for de-dupe enabled volumes in releases 7.3.X for these platforms are:

Hardware model	NetApp Recommended De-dupe Vol Size
2020	1TB ²¹
2050	2TB ¹³

9.9 - FAS2020/2050 NetApp Recommended De-dupe Volume Size

²¹ Note that the maximum recommended de-dupe volume size supported on the FAS2020 and FAS2050 are lower than on other models. Please refer to the current ONTAP Solutions Guide for values for other NetApp models.

9.5 Tape Connectivity

This section provides the best practice port assignments to use when considering attaching your Filer to a Fiber Channel attached backup infrastructure. Where supported by your infrastructure CATE Storage Engineering recommends you ensure these ports are set to a 4GB line speed.



When using a FAS2050HA and wishing to connect to Fiber Channel tape infrastructure it is recommended that a tape HBA expansion card is utilized.

If you wish to connect a FAS2020 or FAS2050 without HBA expansion to backup infrastructure via Fiber Channel, then the number of available Fiber Channel loops available for disk will decrease to 1 loop per controller which will therefore not allow Multipath HA to be configured (each Filer would need to be configured in Dual Path mode).

Fiber Channel Loops for clustered configuration						
Configuration	Number of primary loops (per controller)	Port / Slot Assignments				
		Primary Disk Path		Redundant Disk Path		FC Tape Path
		Local	Partner	Local	Partner	Local
Node A of a clustered (HA) pair	1	0a	0b	0b	0a	1a,1b
Node B of a clustered (HA) pair	1	0b	0a	0a	0b	1a,1b

9.10 - FAS2050 FC Loop Configuration for FC Tape with expansion HBA

Configuration FAS2020 or FAS2050 without HBA	Number of primary loops (per controller)	Port / Slot Assignments		
		Disk		Tape
		Local	Partner	Local
Node A of a clustered (HA) pair	1	0a	0b	0b
Node B of a clustered (HA) pair	1	0b	0a	0a

9.11 - FAS2020/2050 FC Loop Configuration for FC Tape and no HBA

9.6 Remote Management

The FAS2020 and FAS2050 are fitted with multiple interfaces: Network, Console and Baseboard Management Controller. The Baseboard Management Controller (BMC) is a remote management device that is built into the motherboard of the FAS2000 series storage systems. This is a new approach introduced by NetApp not available in other current FAS systems.

9.7 Virtual Servers (vFilers)

As of ONTAP v7.2, you can configure up to 65 usable vFilers on a single storage controller (up to 130 in a cluster), depending on the memory capacity of the hosting filer. The maximum limits for number of vFilers are shown in the table below, and highlights the maximum value supported by NetApp and the value certified by CATE Storage Engineering. For the FAS2020 the second row in this table is the relevant entry while for FAS2050, the third row in this table is the relevant entry.

Filer memory	NetApp	Citi
1GB or more (FAS2020)	26	20
2GB or more (FAS2050)	65	49

9.12 - FAS2020/2050 Supported vFiler quantities per storage controller

9.8 Flash Cache (formerly known as PAM II)

The FAS2020 and FAS2050 do not support the new read only cache expansion card, Flash Cache (formerly known as PAM II) which was added with ONTAP 7.3.2 and above. While there are no PCI expansion slots on the FAS2020 to accommodate any PCI expansion cards, there is one slot on the FAS2050. However NetApp does not support the use of Flash Cache on this hardware platform.

9.9 Snapvault / Snapmirror Concurrent Streams

When the NearStore personality is enabled, Data ONTAP increases the support for concurrent destination streams on FAS2000 systems. With a NearStore personality license, the FAS2020 can support up to 16 concurrent destination streams and FAS2050 can support up to 32 concurrent destination streams. The limit on maximum concurrent streams is the same whether for single controller or active-active configurations.

Configuration	volcopy command		Volume SnapMirror		Qtree SnapMirror		SnapVault	
	Src	Dest	Src	Dest	Src	Dest	Src	Dest
FAS2020	8	8	8	8	16	16	16	16
FAS2020 with nearstore option	8	8	8	8	40	40	40	40
FAS2050	8	8	8	8	32	32	32	32
FAS2050 with nearstore option	8	16	8	16	80	80	80	80

9.13 - FAS2020/2050 Total number of simultaneous transfers supported per replication type

9.10 Shared chassis resources

9.10.1 FAS 2020 Component View

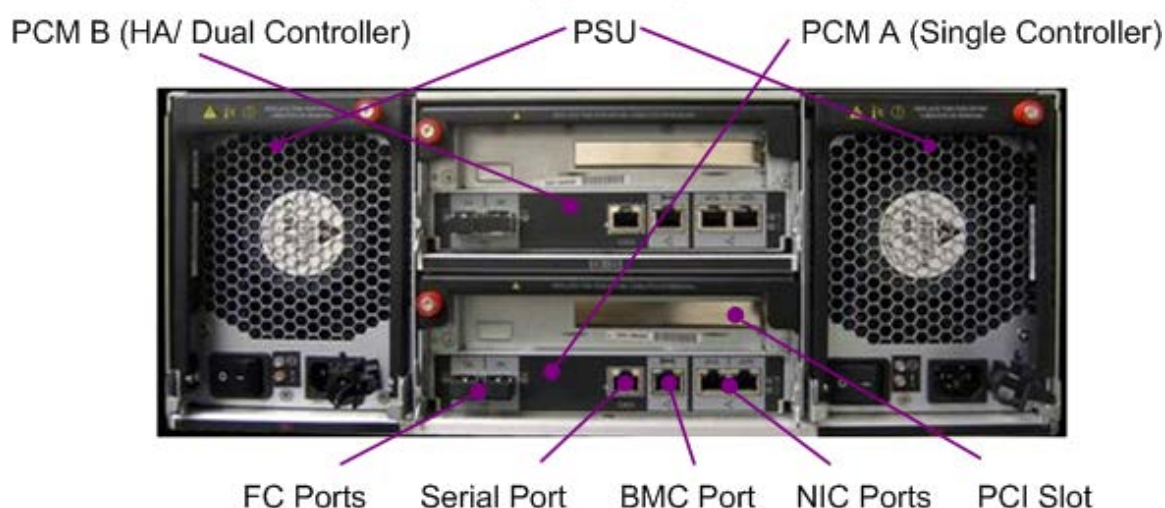
Item	Description	Quantity
PSU	Power Supply Unit	2 per chassis (shared)
PCM	Processor Control Module	2 per chassis (HA-Pair)
Status LED's	Status indicators for system	1 set per chassis
Serial Port	Serial Console Port	1 per PCM
BMC Port	Baseboard Management Controller Port	1 per PCM
FC Ports	1/2/4GB FC Initiator/Target Ports	2 per PCM
NIC Ports	10Base-T/100Base-TX/1000Base-T Ports	2 per PCM

9.10.2 FAS 2020 Component Glossary and Quantities

Front View



Rear View



9.10.3 FAS 2050 Component View

Item	Description	Quantity
PSU	Power Supply Unit	2 per chassis (shared)
PCM	Processor Control Module	2 per chassis (HA-Pair)
Status LED's	Status indicators for system	1 set per chassis
Serial Port	Serial Console Port	1 per PCM
BMC Port	Baseboard Management Controller Port	1 per PCM
FC Ports	1/2/4GB FC Initiator/Target Ports	2 per PCM
NIC Ports	10Base-T/100Base-TX/1000Base-T Ports	2 per PCM
PCI Slot	Modular I/O slot for FC/ GigE expansion	1 per PCM

9.10.4 FAS 2050 Component Glossary and Quantities

There are various aspects of the shared chassis that act independently of the Filer (PCM) itself. In the FAS 2020 and FAS 2050 there are two power supply units (PSUs).

They provide power to both controllers and have integrated fans for cooling. The PSUs have their own environmental monitoring devices and will shutdown of their own accord if something goes wrong internal to the PSU. The PSUs manage their own thermal environment (internal redundant fans) and monitor their own voltages. If anything goes wrong and the PSU is unable to deliver power properly, it will shut down like it does today in existing NetApp hardware platforms.

10 Known Issues

Bug #	Description	Workaround / resolution / notes
CSB-1107-02	NetApp has identified some 1TB, 750GB, 500GB and 250GB SATA disk drives that are not reporting unrecoverable errors within the allowable time limits, resulting in command timeout error messages. Too many command timeouts may cause Data ONTAP to mark the disk as failed. Storage systems in which these drives are densely populated into a single raid group have a higher probability of experiencing multiple disk failures when the above condition occurs. For the FAS20x0 series the affected drives are: NETAPP X280_SMOOST25SSS (Part #SP-280B-R5) 250GB, NETAPP X282_SMOOST50SSS (Part #X/SP-282A-R5) 500GB, NETAPP X298_SMOOS01TSSS (Part #X/SP-298A-R5) 1TB Note: 750GB SATA drives were never released by CATE	Upgrade the disk firmware on systems running these drive types to version NA02. Obtain the following firmware files from the NetApp support site: X280_SMOOST25SSS.NA02.LOD X282_SMOOST50SSS.NA02.LOD X298_SMOOS01TSSS.NA02.LOD Instructions for downloading and installing the latest drive firmware pack from NetApp can be found at http://now.netapp.com/NOW/cgi-bin/diskfwmustread.cgi/download/tools/diskfw/bin/all Instructions for downloading and installing the latest NetApp disk qualification package can be found at http://now.netapp.com/NOW/download/tools/diskqual/ NetApp strongly recommends upgrading to firmware NA02 immediately. The firmware upgrade is a non-disruptive operation and can be performed in the background. It does not require a system reboot.

11 Document version control

This section contains a detailed list of the updates made during each document release. The version control table in Section 1 is purely an overview.

Version	Changes
0.1	Initial release for peer review
0.2	Updated with feedback from stakeholder review
1.0	Updated disk recommended minimum disk shelf firmware version
2.0	Updated FAS2000 Release notes with FAS2050HA details
3.0	- Restructured document into legacy section (FAS2020 and FAS2050) and current section (FAS2040) - Added no support for ONTAP 8.0 statement for FAS2020 and FAS2050 to section 7 - Removed phased certification / project explanation from section 7 - Added test plan and appendices
3.1	- Removed duplicate table from section 7.3.1 - Updated tape connectivity in table 8.9 to use two redundant paths by defaults - Revised aggregate and RAID group layout recommendations in table 8.6 - Updated deduplication volume maximum sizes for FAS2020 and FAS2050 as of ONTAP 7.3 (see table 9.9) - Updated simultaneous transfer actions for FAS2020 and FAS2050 with the introduction of ONTAP 7.3 in table 9.13
3.2	- Aligned platform status description in table 7.1 with the status of hardware platform in the CTC - Updated NV-MEM capacity on the FAS2040 HA in table 7.2 due to differences in usually capacity between ONTAP 7.3.x and ONTAP 8.x - Updated values in table 8.5 regarding maximum number of data drives in an aggregate to exclude right size values and parity drives - Added clarification that Flash Cache (PAM II) is not supported on this platform
3.3	- Updated document definition from GDSE to CSBE - Added known issue to section 10 regarding Customer Support Bulletin 1107-02 and firmware requirements for 250GB, 500GB and 1TB SATA drives
3.3.1	- Annual review - Removed references to ONTAP GX (as GX is End Of Life) - Removed future tense references to ONTAP 8 certification for FAS2040 - Clarified ONTAP 7G and ONTAP8 supported platforms - Removed restrictions regarding the use of the BMC port now ONTAP 8.1.x is released

12 Appendices

12.1 FAS2040 Installation Test Plan

This section describes the steps used in testing the setup and install of a FAS2040.

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.0	FAS2040 Installation					
1.1	Basic System Configuration					
1.1.1	System Setup	Run through ONTAP setup process, includes: Initial setup Network configuration Join A/D domain Create aggregates Create volumes Create CIFS shares and NFS exports	System configured within a reasonable period of time by an appropriately qualified member of staff	As expected	Pass	
1.1.2	Boot time – Cold	Halt and physically power off system Power on system and record time in which file services appear on the network	System cold boots within an acceptable period of time	As expected	Pass	
1.1.3	Boot time - Warm	Reboot the system and record time in which file services appear on the network	System warm boots within an acceptable period of time	As expected	Pass	
1.2	Storage Configuration					
1.2.1	Define Aggregate	Using the 300GB internal drives create an aggregate using 5 drives, keeping 1 disk as spare, configured as RAID DP	Aggregate created in a comparable time with other NetApp platforms and system reports event	As expected	Pass	

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.2.3	Hot add fully populated SAS shelf	Hot add a DS4243 with SAS drives installed to an existing stack while FAS2040 is running	Shelf add requires cluster failover due to single path config, addition of new shelf reported in console, new disks appear as spares, shelf ID takes affect with the 30 second rule. Client I/O interrupted with cluster failover. Creation of aggregates and flex volumes works as normal	As expected	Pass	Acceptance criteria was updated after stakeholder test plan review and prior to start of testing based on a NetApp briefing regarding the FAS2040 single path config. Testing showed hot shelf add was possible without cluster failover is SAS connections were changed within the 10 second SAS port timeout window. This procedure will unlikely be operationally viable
1.2.4	Extend Aggregate	Extend existing aggregate by adding disks in an additional RAID group for the DS4243, configured as RAID DP	Aggregate extended in a comparable time with other NetApp platforms and system reports event	As expected	Pass	
1.2.5	Create flex volume	Create a flexible volume on the extended aggregate. Share it out to Windows client, mount share, expand and shrink the volume	Volume created in a comparable time with other NetApp platforms. Client continues to access storage during volume resize events without impact	As expected	Pass	
1.2.6	Add a FAS2040 with a DS4243 and 1TB SATA drives and 600GB SAS drives to OM 3.8.1	Add host to OM and allow appropriate time for all sampled metrics to be updated as required	FAS2040 is identified correctly DS4243 and IOM3 are not identified as the current release of OM does not identify any NetApp shelves or IO modules. Disk size, model and firmware are reporting correctly. Disks are only listed in the all disks report as no canned report exists for this size disks FAS2040 performance data available in performance advisor	As expected	Pass	

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.2.7	Console Port connectivity test	Connect terminal server device to FAS2040 console port and confirm connectivity	Able to issue commands using the console port and see the command output	As expected	Pass	

12.2 Degraded state test plan

This section describes the steps used in testing various degraded state scenarios with the hardware.

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.3	Degraded state testing					
1.3.1	Circuit / PSU failure #1	Simulate power failure by removing power to PSU1, once test is complete reinstate power	ONTAP reports degraded PSU state and the flex volumes on the shelf continue to serve data	As expected	Pass	
1.3.2	Circuit / PSU failure #2	Simulate power failure by removing power to PSU2, once test is complete reinstate power	ONTAP reports degraded PSU state and the flex volumes on the shelf continue to serve data	As expected	Pass	
1.3.3	Power failure (hard)	Perform hard power outage of all supplies to the FAS2040. Wait 15 minutes and perform cold boot of system.	ONTAP reports system stability state at power up. No irrecoverable WAFL errors expected.	As expected	Pass	
1.3.4	Disk failure (soft)	Using ONTAP command fail one of the internal data drives on the FAS2040	RAID rebuild initiates and completes with ONTAP reporting system status. No data is lost.	As expected	Pass	
1.3.5	Disk failure (hard)	Remove one of the internal data drives on the FAS2040	RAID rebuild initiates and completes with ONTAP reporting system status. No data is lost.	As expected	Pass	

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.3.6	Fan Failure	Defeat fan operation on FAS2040 for one of the fans. NetApp to advise best process to achieve this.	ONTAP reports degraded fan state and the flex volumes on the shelf continue to serve data	As expected	Pass	Place filer under load with multiple iometer jobs running for Windows client.
1.4	Clustering testing					
1.4.1	Planned cluster failover	Using CF takeover initiate a cluster failover between controllers	ONTAP reports cluster failover. Client experiences minor SMB impact as experienced on other NetApp platforms and no data corruption occurs	As expected	Pass	Have a client loop running I/O to a CIFS share – recording the time between each loop: see script section in Appendix
1.4.2	Unplanned cluster failover	As it is not possible to force unplanned cluster failover by degrading power supply (as its shared), use the halt command to shutdown a node	ONTAP reports cluster failover. Client experiences minor SMB impact as experienced on other NetApp platforms and no data corruption occurs	As expected	Pass	Have a client loop running I/O to a CIFS share – recording the time between each loop: see script section in Appendix
1.4.3	Planned cluster failback	Using CF giveback initiate a cluster failback between controllers	ONTAP reports cluster failback. Client experiences minor SMB impact as experienced on other NetApp platforms and no data corruption occurs	As expected	Pass	Have a client loop running I/O to a CIFS share – recording the time between each loop: see script section in Appendix

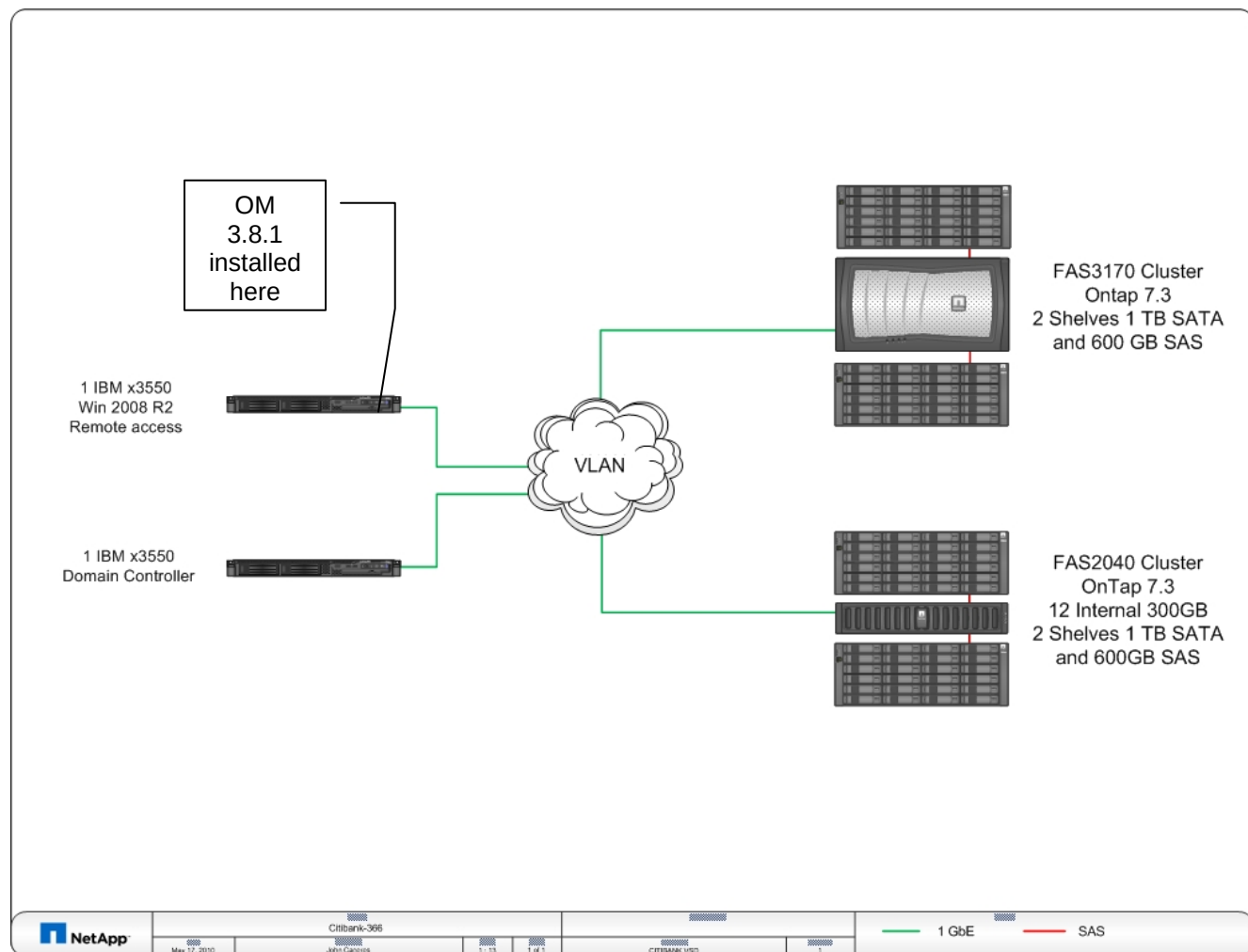
12.3 Software / firmware upgrade test plan

This section describes the steps used in testing various firmware and software upgrades with the hardware.

Test #	Test Conditions	Action / Test Procedure	Expected Results / Acceptance Criteria	Actual Results / Observed Results	Pass / Fail	Notes
1.5	Firmware upgrade					
1.5.1	System board	Using NetApp procedures and best practices upgrade the system board firmware on the FAS2040	Firmware can be upgraded while cluster is in failed over state. During cluster failover client experiences minor SMB impact as experienced on other NetApp platforms and no data corruption occurs	As expected	Pass	
1.5.2	Internal drives	Using NetApp procedures and best practices upgrade the internal disk drive firmware on the FAS2040	Firmware is upgraded while device is on line and serving data under load. ONTAP reports the upgrade	N/A	Post-poned	Rescheduled for later testing once first firmware upgrade is available for this drive type
1.6	ONTAP upgrade					
1.6.1	Upgrade ONTAP to the latest P release	Upgrade the version of ONTAP on the FAS2040 HA device to the latest P release of 7.3.3. Version of ONTAP installed on the FAS2040 should be of a version that allows for upgrade to the current level. Use the software update -d command Manual download and reboot steps involving cluster failover and giveback. Repeat process for other cluster node.	During cluster failover client experiences minor SMB impact as experienced on other NetApp platforms and no data corruption occurs	As expected	Pass	

12.4 Test Environment Lab Diagram

This section contains reference diagrams that describe the logical representation of the lab environment used to execute this test plan. The diagram below also shows a FAS3170 which is involved in concurrent DS4243 testing under a separate project.



12.1 - Lab Network