



FlexArray & V-Series Technical FAQ

TABLE OF CONTENTS

1	General Questions	6
	What is FlexArray?	6
	On which FAS models may FlexArray be added?	6
	What is a V-Series controller?	6
	How is a V-Series controller different than a FAS controller?	6
	What is the Difference between a FlexArray and a V-Series controller?	6
	Does V-Series support clustered Data ONTAP?	6
	Which version of Data ONTAP is required?	6
	Does FlexArray or V-Series require the use of FAS disks?	7
2	Technical Questions	7
	What is the purpose of a spare disk if no NetApp disks are being used with a V-Series or FlexArray implementation?	7
	How do array LUNs differ from FAS disks?	7
	How many array LUNs can be connected to a single FlexArray system?	8
	What array LUN sizes are supported by FlexArray?	8
	Are SnapLock compliance and SnapLock Enterprise supported on array LUNs?	8
	Can multiple arrays be connected to a single FlexArray-enabled system or a V-Series system?	8
	Are Fibre Channel switches required to attach to arrays?	8
	Which protocols are supported on a V-Series and FlexArray controllers?	8
	Which arrays and switches are supported by the V-Series controller?	8
	Can FlexArray be added to a running FAS system?	9
	Does FlexArray require any special hardware?	9
	Does FlexArray or V-Series support MetroCluster?	9
	Can you describe a V-Series or FlexArray licensed FAS back end and front end?	9
	Can I attach both third party storage array LUNs and NetApp disks to a V-Series or FlexArray licensed FAS controllers?	9
	Can I attach third party storage array LUNs to a FAS controller without the FlexArray license?	9
	Can I replace my FAS controller with a V-Series controller?	9
	Can I convert my FAS controller to a V-Series controller?	10
	What type of RAID protection is used on a V-Series or FlexArray licensed controller?	10
	What is the maximum array LUNs I can attach to a V-Series or FlexArray licensed controller?	10
	What is the maximum storage capacity I can attach to a V-Series or FlexArray licensed controller?	10
	Is there a special Data ONTAP version for V-Series?	10
	Can I dynamically add/remove third-party storage behind a V-Series system?	10
	Can I add NetApp disk shelves to a V-Series or FlexArray licensed system?	10

Are the licenses on V-Series different than FAS licenses?	11
Which licenses are required for V-Series?	11
If a storage array vendor starts supporting solid-state disks in its array, is the array supported with V-Series?	11
How do I get V-Series to support a new array that is not listed on the V-Series support matrix?	11
How do I know if I need a FlexArray licensed FAS controller or a V-Series controller?	11
Are there plans to unify the FAS and V-Series platforms?	11
How are third-party arrays qualified for V-Series/FlexArray support?	12
What are my options if a configuration is not listed on the support matrix?	12
Do the back-end storage arrays or switches need to be under a support contract?	12
How are V-Series/FlexArray and third-party arrays supported in a multivendor environment?	12
Can I add storage behind an existing V-Series deployment?	12
Is NetApp E-Series supported with V-Series or FlexArray?	12
Are there specific cabling and zoning models for attaching the V-Series controller to the storage array?	12
Can a single V-Series attach to multiple array LUN groups?	13
How do I decide when a single four-array-port LUN group is OK or when I need to have two or more four-port-array LUN groups on a single storage array?	13
Is there a minimum number of LUNs in a LUN group?	13
How do I calculate usable V-Series space given a fixed amount of storage array LUN capacity? How do I calculate required storage array capacity given the desired front-end use requirements?	14
How do I size a V-Series/FlexArray system?	14
How do I migrate existing data residing on third-party arrays being served to hosts and bring it under V-Series control and management?	14
What precautions should I take prior to doing system maintenance, including fabric or storage array maintenance?	15
What happens if I don't set the <code>fc-non-array-adapter-list</code> parameter correctly for my MP-HA system?	15
How many fiber paths should there be between a V-Series/FlexArray controller and an array or a LUN?	15
How many fabric HOPs can I have between the V-Series/FlexArray controller and the array?	16
How many array LUNs can I put on each initiator port pair?	16
Can a single V-Series/FlexArray initiator FC port attach to multiple storage array target ports?	16
Can multiple V-Series/FlexArray initiator FC ports attach to a single storage array target port?	16
Can I share storage array target ports with other hosts or with other V-Series/FlexArray controllers?	16
Are soft zoning and hard zoning both supported?	16
What are the minimum number and size of array LUNs supported for a V-Series/FlexArray deployment?	16
Should I install the root volume on an aggregate of NetApp disks or on storage array LUNs?	16
Is a minimum size for the root volume or for the storage array LUN needed for the root volume?	17
Why do I need a spare LUN on my V-Series controller?	17
Can I use an array LUN with an ID of 0 (LUN0)?	17

Can I mix different-size LUNs into the same NetApp aggregate?	17
How do you recommend that I size my storage array LUNs for a V-Series/FlexArray controller?	17
Does V-Series/FlexArray support back-end storage array thin provisioning?	17
Some storage arrays can dynamically grow an array LUN. Is growing an array LUN supported behind a V-Series controller?	17
Can I use Hitachi Dynamic Provisioning (HDP) for LUNs presented to a V-Series controller?	18
Can I use storage array-based replication and have a V-Series/FlexArray controller at the remote array site? ..	18
Is a crossed back end supported?	18
Are there special requirements for using HDS USP-V with a virtualized array behind the USP-V?	18
Is there added latency when installing a V-Series controller in front of a storage array?	18
Can I use SnapMirror between a V-Series/FlexArray controller with array LUNs and a V-Series/FlexArray controller or FAS with NetApp shelves?	18
Can I use SyncMirror on a V-Series/FlexArray controller between different types of storage arrays or different types of disks within the array?	19
Can I use SyncMirror on a V-Series/FlexArray controller between array LUNs and NetApp disks?	19
Can I get any storage array information from the V-Series/FlexArray controller?	19
Into which switch and switch port is my V-Series/FlexArray physically plugged?	19
What are checksums, and are they required?	19
Can I mix BCS and AZCS into the same aggregate?	19
How can I change the checksum type?	19
How does V-Series/FlexArray handle pathing assignments to array LUNs?	20
If my paths to LUNs are not balanced, what can I do?	20
Can I transparently replace a fabric behind a V-Series/FlexArray controller?	20
If a V-Series/FlexArray controller has multiple aggregates that are either built on third-party array LUNs or built on NetApp disks and one aggregate fails, what happens to Data ONTAP, the other aggregates, or the volumes?	20
What happens if I move the cable from one switch FC port to another FC port?	20
How do I replace the NVRAM on a V-Series/FlexArray controller? Are these steps the same as on a FAS controller?	20
Are the V-Series/FlexArray motherboard replacement steps the same as those for a FAS motherboard replacement?	21
Are there any performance or capacity overheads?	21
Can I use advanced storage features on the back-end array?	21
How do we migrate existing data from array LUNs into FlexArray?	21
Where can I get more detailed information about FlexArray?	21
3 Best Practice Questions	21
What is a simple set of best practices for a V-Series/FlexArray deployments?	21
If I replace my V-Series/FlexArray controller, is a data migration required?	22

Can I mix array LUNs from different storage arrays or array vendors within the same NetApp aggregate?	22
What storage array features can I use with a V-Series controller?	22
How should I respond to other storage array vendors who say the V-Series/FlexArray controller is not supported in front of their array or that attaching the V-Series/FlexArray controller will void the array warranty?.....	22

1 General Questions

What is FlexArray?

Answer: FlexArray is a software license available on the FAS80x0 controllers that enables LUNs provided by a separate storage array to be used for Data ONTAP® aggregates. This allows customers to leverage their existing storage investments, while enabling the full suite of NetApp® storage efficiencies and industry-leading features.

On which FAS models may FlexArray be added?

Answer: FlexArray is supported on the FAS8020, FAS8040, FAS8060, and FAS8080. It is not supported on older platforms.

What is a V-Series controller?

Answer: V-Series is an open storage controller that enables you to attach to multivendor storage systems and extend Data ONTAP® features to third-party storage. The V-Series controller unifies NAS, IP, and FC SAN management in a single controller. V-Series is still supported but is no longer being sold now because it has been replaced by FlexArray which is a licensable feature offered on any FAS 8xxx running Data ONTAP 8.2.1.

How is a V-Series controller different than a FAS controller?

Answer: FAS and V-Series controllers are almost identical, with very few exceptions. V-Series and FAS controllers with FlexArray licensed, enable you to extend Data ONTAP capabilities to other vendors' storage arrays and to NetApp® disk shelves. FAS systems use only NetApp disk shelves and use NetApp RAID 4 or RAID-DP® technology for parity protection, unless they have a FlexArray license installed. With a FlexArray license installed, they are able to use third-party storage just as V-Series does. With V-Series and FlexArray licensed FAS storage arrays, the parity protection is performed on the third-party array.

What is the Difference between a FlexArray and a V-Series controller?

Answer: A V-Series controller is an open storage controller that acts as an initiator in front of third or first-party arrays. FlexArray is a license that enables V-Series functionality on a FAS 8xxx controller. A V-Series controller will already have a V-Series license installed on it and requires that license to act as an initiator. FlexArray is a license that may be added to a FAS 8xxx controller to allow that controller to act as an initiator and be able to virtualize third and first-party storage behind it.

One exception, there is no FlexArray support on All Flash FAS (AFF), you can't apply a FlexArray license to AFF.

Does V-Series support clustered Data ONTAP?

Answer: Yes, V-Series supports clustered Data ONTAP. A cluster may be a mix of V-Series HA pairs and FAS HA pairs. Some, all or none of the FAS HA pairs can have a FlexArray license and therefore third-party storage provisioned behind them. Consult the [NetApp Interoperability Matrix Tool \(IMT\)](#) for an up-to-date list of supported arrays.

Which version of Data ONTAP is required?

Answer: The FlexArray feature license requires Data ONTAP 8.2.1 and later. FlexArray can be enabled on the FAS8000 controller and future controllers. It will not work on legacy controllers running Data ONTAP 8.2 or earlier. Both 7-Mode and clustered Data ONTAP are supported.

Which arrays does V-Series and/or FlexArray support?

Answer: FlexArray supports third-party arrays from Hitachi Data Systems (HDS), EMC, HP, IBM, Fujitsu and first-party, NetApp branded E-Series arrays. For specific array models and supported firmware levels, consult the [NetApp Interoperability Matrix Tool \(IMT\)](#)

Does FlexArray or V-Series require the use of FAS disks?

Answer: No, neither V-Series or FlexArray require native NetApp disks, although both support using both native disks and also array sources LUNs. NetApp does recommend using FAS disks for the root volume. This provides for better diagnostic and support capabilities in the event of a fabric or array failure.

What does licensing look like on FlexArray now?

Answer: Licensing is:

On FAS 80XX platforms

- Node based FlexArray License
- Node based a la carte software license – applicable to FAS capacity as well 3rd party capacity

On FAS 82XX/90XX Platforms

- Node based FlexArray License
- Node based Premium/Base bundle for software – only applicable for 3rd party capacity
- Capacity based Premium/Base bundle for software – only applicable for FAS storage

On AFF/A series all flash arrays

- AFF/A series don't support FlexArray currently because currently there isn't a mechanism to ensure that only source flash arrays are used behind FlexArray.

2 Technical Questions

What is the purpose of a spare disk if no NetApp disks are being used with a V-Series or FlexArray implementation?

Answer: The spare disk is a bit of a misnomer since there is no way to use a spare to replace a broken disk in a RAID 0 array. The spare is actually being made available to the controller as a place to write a core file in the event of a problem. The core file contains the full contents of memory and current working threads and can be very useful in diagnosing certain classes of problems.

How do array LUNs differ from FAS disks?

Answer: Aside from the obvious physical differences, Data ONTAP treats them slightly differently. The most important difference is that Data ONTAP does not provide any additional RAID protection with array LUNs. The array must handle RAID protection.

The second difference follows as a result of the first. We cannot support replacing or removing an array LUN from an aggregate after it has been added. Because we are doing no additional RAID, we cannot rebuild a "failed" array LUN. For this reason, care should be taken when adding array LUNs.

A third difference is that FlashPool™ aggregates are only supported with FAS disks. Because we cannot mix FAS disks and array LUNs in a single aggregate, we cannot support Flash Pool aggregates with array LUNs.

How many array LUNs can be connected to a single FlexArray system?

Answer: The maximum number of array LUNs varies, depending on the FAS or V-Series platform. Each platform has a maximum number of disks supported. This number includes both FAS disks and array LUNs. The Hardware Universe shows these limits. For example, the FAS8020 supports 480 drives. This could be 254 FAS SAS drives and 226 array LUNs. Any combination is acceptable as long as the sum of array LUNs and FAS disks does not exceed 480.

The maximum number of array LUNs visible on a single FC initiator port is 254. Very large deployments will require additional FC ports.

What array LUN sizes are supported by FlexArray?

Answer: The exact size will vary, depending on the version of Data ONTAP and controller models. For the FAS8080EX running Clustered Data ONTAP 8.3.2RC2 the minimum size array LUN is 1.05GB and the maximum size array LUN supported is 5856GB (6TB).

The maximum size array LUN supported on a FAS8080EX running ONTAP 9 has increased to 16TB

In general, it is best to have at least 16 LUNs, though more is certainly better. This makes sure that we are able to fully utilize available disk queues. For example, if you had 20TB of capacity, 20 1TB LUNs would be better than 5 4TB LUNs.

Are SnapLock compliance and SnapLock Enterprise supported on array LUNs?

Answer: Both SnapLock[®] Compliance and SnapLock Enterprise are supported with storage array LUNs in 7-mode.

There is no support for SnapLock Compliance in clustered Data ONTAP. SnapLock Enterprise will be supported in an upcoming major release of clustered Data ONTAP.

Can multiple arrays be connected to a single FlexArray-enabled system or a V-Series system?

Answer: Yes, you may connect multiple arrays. We do require that aggregates built with array LUNs use only LUNs from a single array, however. Be advised that additional FC initiator ports might be required. Consult the [FlexArray or V-Series best practices guide](#) for details.

Are Fibre Channel switches required to attach to arrays?

Answer: Yes, a SAN is required. This may be the customers existing SAN, provided the switches are listed on the [NetApp Interoperability Matrix Tool \(IMT\)](#) Brocade and Cisco® switches are generally supported. Direct attach to arrays is not supported.

FlexArray + E-Series is the single exception to this rule. FlexArray supports directly attaching E-Series backends. No other array is supported as direct attached.

Which protocols are supported on a V-Series and FlexArray controllers?

Answer: Like FAS controllers, V-Series and FlexArray licensed controllers support NFS, CIFS, FCP, FCoE, and iSCSI protocols along with other NetApp features such as Snapshot[™] copies, deduplication, replication, and so on, on the front end. This looks no different than any other FAS array.

Which arrays and switches are supported by the V-Series controller?

Answer: V-Series supports storage arrays from leading storage vendors such as EMC, HDS, IBM, HP, and NetApp E-Series. Switch support includes Brocade and Cisco. For details on the storage array and switch models and firmware supported, refer to the [NetApp Interoperability Matrix Tool \(IMT\)](#).

Can FlexArray be added to a running FAS system?

Answer: Yes. You do not have to purchase FlexArray when you purchase the initial FAS80x0 system. It can be purchased and installed at a later date.

Does FlexArray require any special hardware?

Answer: This depends largely on the size of the deployment and which protocols are being used on the FAS 8xxx. The onboard UTA2 controllers can be configured as FC initiators. If they are needed for FCoE, for example, then additional FC ports would be needed. These could be either a dedicated PCIe FC initiator card or additional PCIe-based UTA2 ports. Consult the [Hardware Universe](#) for the latest part numbers.

Does FlexArray or V-Series support MetroCluster?

Answer: Yes, both fabric and stretch MetroCluster are supported with FlexArray or V-Series. For fabric MetroCluster dedicated switches are required and limited to those that FMC/Fabric MCC supports. Consult the IMT for details on supported switches. Currently only E-Series is a supported backend for stretch MetroClusters.

Can you describe a V-Series or FlexArray licensed FAS back end and front end?

Answer: The back end refers to how the disk subsystem attaches to the V-Series/FlexArray controller. The V-Series/FlexArray back end includes all supported storage arrays, SAN fabrics, cabling, and building of the NetApp aggregate.

The front end refers to all hosts/clients attached to the controllers or NetApp feature set. There is no difference in the front-end feature set for FAS, FAS with FlexArray and V-Series controllers. For example, NFS protocol or SnapMirror[®] replication is a front-end feature and is descriptive for both FAS, FAS with FlexArray and V-Series. Front end describes everything from the aggregate forward.

Can I attach both third party storage array LUNs and NetApp disks to a V-Series or FlexArray licensed FAS controllers?

Answer: Yes. Starting with Data ONTAP 7.3 you can attach both third-party storage array LUNs and NetApp disks to a V-Series controller into separate storage aggregates.

FlexArray has offered both native and third-party support since its inception in Data ONTAP 8.2.1.

Can I attach third party storage array LUNs to a FAS controller without the FlexArray license?

Answer: No, unless you have FlexArray licensed, otherwise, FAS controllers only support NetApp disk shelves. V-Series or a FlexArray license is required to attach to third-party or first-party (E-Series) storage arrays.

Can I replace my FAS controller with a V-Series controller?

Answer: V-Series is no longer available for sale, so while it is technically possible to perform a head upgrade and sales upgrade, your option would be to purchase and install a FlexArray license to your existing FAS controller assuming it is a FAS 8xxx and is running Data ONTAP 8.2.1 or later in either 7-Mode or clustered Data ONTAP.

Can I convert my FAS controller to a V-Series controller?

Answer: No, you cannot convert a FAS controller to a V-Series controller. You can however, install a FlexArray license in order to gain all of the benefits of V-Series on a FAS controller assuming it is a FAS 8xxx and is running Data ONTAP 8.2.1 in either 7-mode or clustered Data ONTAP.

What type of RAID protection is used on a V-Series or FlexArray licensed controller?

Answer: V-Series creates storage pools with RAID 0 striping of array LUNs presented from other vendors' storage. The parity protection for these array LUNs is provided by the source storage array. Supported array RAID types are assigned by the array vendor and include the typical RAID types of RAID 1, RAID 5, and so on. Always consult the array integration guide for the latest information specific to the storage array being deployed behind the V-Series solution.

NetApp disk shelves are also supported with the V-Series platform or FlexArray licensed controllers and are protected using traditional Data ONTAP RAID 4 or RAID-DP.

What is the maximum array LUNs I can attach to a V-Series or FlexArray licensed controller?

Answer: Each V-Series/FlexArray controller can support a maximum number of back-end devices that is equivalent to the number of disks supported on a FAS system. The devices can be either array LUNs from storage arrays or NetApp disks. For example, the V3250 can support 720 devices for a standalone system or for an active-active system. These 720 devices can be all NetApp disks, all array LUNs, or any combination of disks and array LUNs that does not exceed 720. Refer to the [Hardware Universe](#) for the limits of each model.

What is the maximum storage capacity I can attach to a V-Series or FlexArray licensed controller?

Answer: Each V-Series/FlexArray controller has a maximum storage capacity that is equivalent to the the maximums for the equivalent FAS system (V-Series) or is the FAS system storage capacity. Those capacity maximums are published on the [Hardware Universe](#) for each model.

Is there a special Data ONTAP version for V-Series?

Answer: No, both V-Series systems and FAS systems use the same Data ONTAP binaries. When downloading from the NetApp Support site you will be asked if your system is a V-Series system, but this is purely to track downloads. You will download the same executable for both V-Series and FAS systems.

Can I dynamically add/remove third-party storage behind a V-Series system?

Answer: Yes, with some caveats. Capacity may be added transparently to an existing aggregate, but it cannot be removed from that aggregate. If an array LUN does not belong to an aggregate, that is, it is labeled as a spare, it can be removed using the `disk remove -w` command to remove the SCSI reservation on the array LUN. The "[V-Series Best Practices Guide](#)" (TR-3461) discusses these issues in greater detail.

Since any change to a stable configuration introduces risk, NetApp recommends that these types of changes be implemented during maintenance windows.

Can I add NetApp disk shelves to a V-Series or FlexArray licensed system?

Answer: Yes, you can add NetApp disks shelves to a V-Series/FlexArray system just as you can with NetApp FAS systems. See the V-Series/FlexArray integration guide for requirements to set `fc-non-array-adapter-list` for FC ports used with NetApp storage. This parameter is not needed for SAS shelves.

Are the licenses on V-Series different than FAS licenses?

Answer: For Data ONTAP operating in 7-Mode, V-Series and FAS both offer the same sets of protocol and feature licenses. The actual system license on a V-Series controller is different than the FAS license and also includes a heterogeneous support license. A FAS license won't work on a V-Series controller. If you perform a FAS-to-V-Series upgrade, you have to replace the licenses. V-Series licenses are also hardware specific, a V-Series license for a v3050 will NOT work on a V6280.

As of Data ONTAP 8.1, clustered Data ONTAP licenses are not FAS or V specific.

FlexArray is simply another license that can be added to an existing FAS 8xxx controller if it is running at least Data ONTAP 8.2.1. It integrates seamlessly with any other licenses installed on that FAS controller.

Which licenses are required for V-Series?

Answer: V-Series controllers come with a V-Series license that enables the controller to attach to back-end storage array LUNs. Other protocol or feature licenses can be added. For example, FCP is a protocol license just like CIFS, NFS, and iSCSI and is used for front-end host or client attaching to the controllers.

If a storage array vendor starts supporting solid-state disks in its array, is the array supported with V-Series?

Answer: There is some support of SSDs on third-party/first-party arrays. A separate qualification is required, because we must enable the array vendor's implementation to work with Data ONTAP. Please consult the [NetApp Interoperability Matrix Tool \(IMT\)](#) to see if SSDs are supported on your array. Use typical V-Series/FlexArray best practices for separate NetApp aggregates based on array LUNs built on either SSD, FC, or SATA disks.

How do I get V-Series to support a new array that is not listed on the V-Series support matrix?

Answer: V-Series/FlexArray has an extensive support. We keep up with new storage arrays that are introduced and have an internal vetting process for arrays we plan to run through our qualification process. This qualification process and selection criteria is based largely on popularity of a given foreign array and market interest in deploying FlexArray virtualization in front of the specific array. If the array you would like to virtualize is not supported then please use the IMT help feature to inquire if a PVR might work to get the desired support, a secondary benefit of the IMT query/PVR process is that it signals market interest in a given solution.

How do I know if I need a FlexArray licensed FAS controller or a V-Series controller?

Answer: V-Series controllers are supported but no longer being sold, this is because FlexArray has been developed to replace V-Series hardware. FlexArray is a licensable feature which can be licensed to any FAS-8xxx system running 8.2.1 or later. You would need either an existing V-Series or to acquire a FlexArray license/licensed FAS 8xxx if you want to virtualize either third-party arrays or first-party arrays (E-Series).

Are there plans to unify the FAS and V-Series platforms?

Answer: Yes, that is why NetApp developed FlexArray as a licensable feature to replace V-Series as a specific hardware solution. NetApp has moved away from a hardware dependent model with V-series to a more flexible, software based model with FlexArray.

How are third-party arrays qualified for V-Series/FlexArray support?

Answer: If the business decision has been made to support an array, NetApp runs the array through an exhaustive qualification test. These tests are run for every supported FlexArray/V-Series controller, shipping version of Data ONTAP, and supported SAN switch. Tests are rerun for new microcode updates for each supported array and SAN switch.

What are my options if a configuration is not listed on the support matrix?

Answer: If you require a storage array, fabric, or microcode for V-Series/FlexArray support that is not listed on the [NetApp Interoperability Matrix Tool \(IMT\)](#), file a PVR with NetApp to request the additional support.

Do the back-end storage arrays or switches need to be under a support contract?

Answer: NetApp requires that all production equipment be on a vendor support contract.

How are V-Series/FlexArray and third-party arrays supported in a multivendor environment?

Answer: If the customer has a support contract with NetApp for our equipment, NetApp takes responsibility for troubleshooting and fault isolation of support issues that the customer believes involve NetApp. If the fault isolation determines that the other vendor's equipment is at fault, NetApp Technical Support will advise the customer to open a case with the other vendor and then continue to work with the customer and other vendor to jointly resolve the issue.

Can I add storage behind an existing V-Series deployment?

Answer: Yes, you can add additional storage behind a deployed V-Series controller. With any of these methods. Each method has its own set of risks, and you should follow proper procedures.

- Add array LUNs to an existing LUN group.
- Add a new array LUN group to an existing storage array.
- Add a new storage array to an existing V-Series deployment.
- Add NetApp shelves to existing loops.
- Add NetApp shelves to new loops.
- Making changes to a production system introduces risk. If changes must be made that risk disrupting data availability, we strongly recommend that they be made during a maintenance window or even while the system is offline.

Is NetApp E-Series supported with V-Series or FlexArray?

Answer: Yes. To find out details about supported configurations, consult the [NetApp Interoperability Matrix Tool \(IMT\)](#) and the [E-Series and EF-Series Systems Documentation Center](#). For additional information on configuring and managing the E-Series, consult the relevant E-Series documentation on the NetApp Support site. Also review [TR-4461i: NetApp Clustered Data ONTAP 8.3 FlexArray with E-Series Best Practices Configuration Guide](#).

Are there specific cabling and zoning models for attaching the V-Series controller to the storage array?

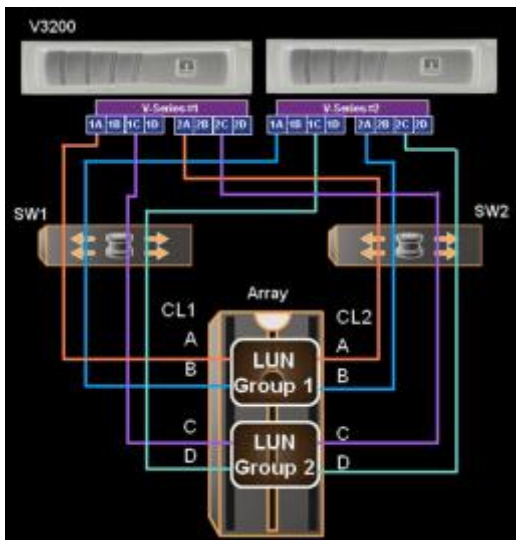
The recommended and most common way to attach a V-Series controller to a storage array is with a four-array-port LUN group. The array LUNs in the LUN group are assigned to the four array ports with the same LUN ID. Each V-Series controller has two dedicated paths to the array LUNs through different

SANs, and two HBA cards are installed in each V-Series controller. [TR-3461: V-Series Best Practices](#), covers these models in greater detail.

Can a single V-Series attach to multiple array LUN groups?

Answer: Yes, V-Series can also attach to multiple array LUN groups on some storage arrays. Multiple array LUN groups are not supported with all storage arrays. Refer to the V-Series support matrix to see if your storage array supports attaching multiple array LUN groups.

When attaching to multiple array LUN groups, use separate initiators for each array target port and verify proper one-to-one zoning for each path. Shown below are two storage array LUN groups behind a single V-Series controller in the supported configuration. Refer to [TR-3461](#) for further detail, including example diagrams.



How do I decide when a single four-array-port LUN group is OK or when I need to have two or more four-port-array LUN groups on a single storage array?

Answer: V-Series can support up to 254 array LUNs in a single array LUN group. The array LUNs can be built on any type of storage array disks. System design might vary greatly depending on factors such as the type of disks in the storage array, expected system performance, and size of the array LUNs. With large archival systems, using 254 LUNs on SATA-based disks with 1TB array LUNs is okay. For performance-type systems in which you have FC drives in the array, you might want to have fewer LUNs in each LUN group and reduce the size of the array LUNs for each LUN group. Using multiple LUN groups allows you spread a given aggregate's I/O across more ports in addition to more spindles.

Is there a minimum number of LUNs in a LUN group?

Answer: No, however, we advise at least 16 LUNs in a LUN group because we have seen specific cases of LUNs not being discovered on both HDS and 3Par when there were LUN groups with fewer than 16 LUNs.

How do I calculate usable V-Series space given a fixed amount of storage array LUN capacity? How do I calculate required storage array capacity given the desired front-end use requirements?

Answer: NetApp usable space for any given array LUN includes the NetApp WAFL[®] system and checksum overhead. WAFL overhead will be approximately 11% you will then need to calculate checksum overhead based on the checksum option selected. NetApp utilizes either Block Checksum (BCS) or Advanced Zone Checksum (AZCS) to verify data integrity on array LUNs. BCS is the default is the much more performant solution and should be used in the vast majority of cases. BCS has a 12.5% overhead. AZCS is not used except in cases where performance is not very important and maximizing effective capacity is critical. AZCS has an overhead of 1.5%

To summarize:

- WAFL + BCS overhead = ~23.5% overhead and high performance.
- WAFL + AZCS overhead = ~12.5% overhead but will negatively impact performance.

For example, a 100GB array LUN given to a V-Series controller will include WAFL overhead of 11% and 12.5% block checksum overhead, giving ~77GB of space. If using Zone checksums, you would have ~87.5GB. The actual amount that is “usable” will vary, depending on the efficiencies gained by dedupe, compression, or thin provisioning.

How do I size a V-Series/FlexArray system?

The two parts of system sizing are capacity and performance:

- How much space do you need for your applications?
- How many IOPs or MB/s do you need, or how fast do you need them?

The capacity question is something your NetApp or NetApp Certified Partner account team can assist with. In addition to the amount of space your data requires, overheads are needed for projected growth, Snapshot copies, and file system overheads. In some cases, especially when hosting server virtualization platforms like Citrix or VMware[®], NetApp dedupe can substantially reduce the amount of capacity required. Your account teams have tools to factor these savings into the overall system design. The performance part of the equation can be difficult to know, but your NetApp or NetApp Certified Partner account manager and systems engineers can help you figure this out using tools NetApp developed for this purpose. This data will provide the recommended model of V-Series controller required, as well as the recommended number of disk spindles required on the third-party array to support the required IOPS.

How do I migrate existing data residing on third-party arrays being served to hosts and bring it under V-Series control and management?

Answer: When installing a V-Series controller in front of a third-party storage array, the array LUNs presented to the V-Series controller must not contain any data. Any data on these array LUNs will be overwritten by the V-Series controller. If there is existing data on the storage array that needs to be migrated onto a V-Series controller, the steps are as follows.

- Assign the unused capacity to the V-Series controller. The unused capacity can come from either the array or from NetApp disks.
- Configure NetApp LUNs on the V-Series controller and provision these LUNs to the hosts or clients. The hosts or clients will also be attached to their existing/legacy array LUNs in addition to their NetApp LUNs.

You can now copy the existing data from the legacy array LUN to the NetApp LUN. Performing a front-end migration from the legacy storage to the new NetApp storage can vary depending on the type of

hosts or applications; for example, you might use application-based migration tools or host-based volume mirroring. Use the best process for your type of data and hosts.

Upon completion of the migration process, release the legacy LUNs from host usage and reassign them to the V-Series controller.

Repeat the process. In some cases, the storage array capacity might be fully used by existing hosts and you will need to add some extra capacity for swing space. You might consider using NetApp disk shelves for swing space. In other cases, the storage array capacity might be partially used and you can use the unused storage array capacity for the swing space to initially build V-Series.

As part of your design, you will want to wind up with a system that meets the overall best practices layouts.

What precautions should I take prior to doing system maintenance, including fabric or storage array maintenance?

Answer: A V-Series or FlexArray system includes the V-Series/FlexArray controllers, back-end fabric that connects the controller to the array, and the back-end storage array. If only a single path to the array LUNs is active, then removing the remaining path or the other array controller for maintenance will cause the system to panic.

- Prior to performing maintenance on the system, we recommend that you:
- Verify that there are two paths from the V-Series controller through the fabric to the array LUNs. Use commands such as `storage show disk -p sysconfig` and `sysconfig -a`
- Send out an AutoSupport™ (ASUP™) message prior to maintenance.

In addition to ASUP, collect outputs from `disk show -v`. These items are also documented in the “V-Series Maintenance Guide” located on <http://now.netapp.com>.

What happens if I don't set the `fc-non-array-adapter-list` parameter correctly for my MP-HA system?

Answer: This parameter is used only for MP-HA configurations with NetApp FC disks. Single-path configurations and SAS disks do not need to set `fc-non-array-adapter-list`. During boot, Data ONTAP will panic with an error message of this form:

sanown: received add for already known disk in process sanown_notify

How many fiber paths should there be between a V-Series/FlexArray controller and an array or a LUN?

Answer: A V-Series controller generally supports exactly two paths to any array LUN. The two paths must be on separate fabrics and to separate array controllers. The total number of paths would be twice the number of array LUN groups. Refer to the four-port LUN group illustration above, or [TR-3461: V-Series Best Practices](#).

When running clustered Data ONTAP 8.1, V-Series can support up to four paths per array LUN. Please consult [TR-3461: V-Series Best Practices](#) for details.

FlexArray also support up to four paths per array LUN.

How many fabric HOPs can I have between the V-Series/FlexArray controller and the array?

Answer: We support up to three hops between the storage array and the V-Series controller. A hop is an interswitch link between switches (ISL). So a V-Series–core–core–storage array is one hop (the ISL between the core switches).

How many array LUNs can I put on each initiator port pair?

Answer: V-Series can support 254 array LUNs behind any given controller initiator port. So each array four-port LUN group can have up to 254 LUNs presented to the V-Series controller.

Can a single V-Series/FlexArray initiator FC port attach to multiple storage array target ports?

Answer: Starting in Data ONTAP 8.2, a Data ONTAP FC initiator port can be attached to multiple target ports on separate storage arrays within the same family.

Can multiple V-Series/FlexArray initiator FC ports attach to a single storage array target port?

Answer: Starting with Data ONTAP 8.3, a maximum of two Data ONTAP FC initiator ports across nodes can be attached to a single target port on the storage array. This configuration is not supported with MetroCluster configurations. This configuration is supported for use with all storage arrays listed in the Interoperability Matrix as supported for the release and mode of Data ONTAP running on your system.

Can I share storage array target ports with other hosts or with other V-Series/FlexArray controllers?

Answer: Storage array target ports should be dedicated to the V-Series/FlexArray controller. Do not share the storage array target ports with other host ports or even with other V-Series/FlexArray initiator ports. Doing so can affect both reliability and performance.

Are soft zoning and hard zoning both supported?

Answer: Yes, you can use either hard zoning (port based) or soft zoning (wwpn based).

What are the minimum number and size of array LUNs supported for a V-Series/FlexArray deployment?

Answer: If NetApp disks are being used, no array LUNs are required. If no NetApp disks are used, an HA pair of V-Series controllers requires four array LUNs at a minimum: an array LUN for each to support the root aggregate and a second array LUN for each as a spare-core device. Additional array LUNs are needed to support the user data. Refer to the V-Series/FlexArray support matrix for the size requirements for the root volume and the spare array LUNs for each Data ONTAP release and platform.

Should I install the root volume on an aggregate of NetApp disks or on storage array LUNs?

Answer: If the V-Series controller is installed with both NetApp storage and with third-party storage arrays, we recommend that the root volume be installed on NetApp disks. If there are no NetApp disks installed, then use a single-array LUN for the root flexible volume. You will also need to provision a spare array

LUN per V-Series/FlexArray controller to collect cores in the event of a problem. Consult the Data ONTAP documentation on the NetApp Support site to determine the minimum array LUN size required for the spare array LUN.

Is a minimum size for the root volume or for the storage array LUN needed for the root volume?

Answer: Yes. The root volume size varies for each controller model, and the underlying array LUN used for the root volume should be properly sized. Consult the [Hardware Universe](#) on the NetApp Support site for details.

Why do I need a spare LUN on my V-Series controller?

Answer: A spare LUN is needed for the diagnostic purpose of capturing a core file. The spare LUN requirement can be either a LUN from the array (in an array-only configuration) or a NetApp disk if NetApp shelves are used with your V-Series controller.

Can I use an array LUN with an ID of 0 (LUN0)?

Answer: We recommend not using a LUN0. Start your array LUN assignments with 1 or some other non-0 number. If you currently have a LUN0 assigned, you don't need to make any changes unless instructed to by NetApp Support.

Can I mix different-size LUNs into the same NetApp aggregate?

Answer: We strongly recommend that all array LUNs within an aggregate be the same size for the most consistent performance over time.

How do you recommend that I size my storage array LUNs for a V-Series/FlexArray controller?

Answer: Current Data ONTAP versions support array LUNs up to 6TB. But array RAID group sizes and disk sizes vary, so one size does not fit all for array LUN sizing. A typical deployment takes an array RAID group and creates two, four, or six LUNs in the RAID group (one for each aggregate), which gives good overall design flexibility.

Let's use the example of an array 6+1 RAID group with 400GB drives. We need four NetApp aggregates. There is approximately 2400GB of space on the RAID group, creating four equal-sized LUNs of 600GB each.

Does V-Series/FlexArray support back-end storage array thin provisioning?

Answer: No, you cannot use storage array thin provisioning behind a V-Series controller. Data ONTAP requires access to the entire capacity of the array LUN. Using array thin provisioning results in system panics and data loss. You can use NetApp thin provisioning for front-end host or client use.

Some storage arrays can dynamically grow an array LUN. Is growing an array LUN supported behind a V-Series controller?

Answer: No. Advanced array features such as dynamic array LUN resizing is not supported behind a V-Series controller. However, our controllers do support storage resizing for hosts or clients attached to the V-Series/FlexArray controller.

Can I use Hitachi Dynamic Provisioning (HDP) for LUNs presented to a V-Series controller?

Answer: HDP is supported provided the pools are fully provisioned.

Overprovisioning dynamic provisioning pools (DP pools) that provide LUNs to a V-Series system is prohibited. Never assign more logical unit capacity than the total capacity of the DP pool. Consult your Hitachi documentation or the support provider for your array for additional information. If you are unsure about how to prevent overprovisioning of the DP pool, then use the standard RAID group type when creating logical units.

Can I use storage array–based replication and have a V-Series/FlexArray controller at the remote array site?

Answer: No, advanced storage array features such as storage array–based replication are not supported behind a V-Series/FlexArray controller. If you require replication, use NetApp replication tools.

All the V-Series/FlexArray implementation documents describe a layout in which ports from one side of a storage array controller are attached to one fabric. My SAN design is a cross in which a single storage array controller attaches to both fabrics.

Is a crossed back end supported?

Answer: Crossed backend is not supported for Active/passive arrays but they are supported with AA/AAA(ALUA) arrays, please refer the IG guides for further details

Are there special requirements for using HDS USP-V with a virtualized array behind the USP-V?

Answer: It is a best practice to have the V-Series/FlexArray system use array LUNs directly from the array rather than be virtualized behind the USP-V. Otherwise, performance problems can easily occur. If a customer must use this configuration, then strict requirements need to be followed.

V-Series/FlexArray root volume and spare core volumes should be on USP internal disks or NetApp disks.

- Do not mix array LUN types when building the aggregates. For example, do not mix array LUNs based on either FC or SATA drives, and don't mix USP internal and virtualized LUNs into the same aggregate.
- Follow HDS recommendations for external storage array attachment and for queue depth settings on the arrays. The V-Series/FlexArray settings are the default settings.
- If the storage array behind the USP-V is on the V-Series support matrix, NetApp strongly recommends attaching directly to the back-end array and not using the USP-V.

Is there added latency when installing a V-Series controller in front of a storage array?

Answer: There is no additional write latency as data is written to NetApp cache and no read latency when the data is in NetApp cache. For reads coming from the back-end storage array, added read latency is in the microsecond range and can vary depending on type of back-end connectivity, disk type and speed, and controller cache size.

Can I use SnapMirror between a V-Series/FlexArray controller with array LUNs and a V-Series/FlexArray controller or FAS with NetApp shelves?

Answer: Yes, SnapMirror can be used between FAS and V-Series/FlexArray licensed systems.

Can I use SyncMirror on a V-Series/FlexArray controller between different types of storage arrays or different types of disks within the array?

Answer: SyncMirror[®] technology can be used for transparent data mirroring between similar storage array types and vendors only. SyncMirror is only supported when used with array LUNs from the same array family and with similar configurations. See the integration guides for which storage arrays are in the same family.

- Additional requirements include the following:
- You can't mix FC and SATA in the same aggregate.
- You can't mix 2gb and 4gb in the same aggregate.

RAID groups must be similarly configured on the array; there can be no mixed RAID levels.

Can I use SyncMirror on a V-Series/FlexArray controller between array LUNs and NetApp disks?

Answer: No. SyncMirror between aggregates built from array LUNs and aggregates built on NetApp disks is not supported and will not work. SyncMirror operates at the aggregate level.

Can I get any storage array information from the V-Series/FlexArray controller?

Answer: Data ONTAP has limited information available from the storage array and provides no detailed array LUN layout information. Commands are available to retrieve information about the array type, the array LUNs it is providing, and the paths through which they are connected.

Into which switch and switch port is my V-Series/FlexArray physically plugged?

Answer: A sysconfig-a for each NetApp port will be the switch port that is cabled into the V-Series controller.

Switch Port: EMBHNX00:110

- However, if you have fc-no-mgmt? set, you will not be able to see the switch per the following output: Switch Port: ??

What are checksums, and are they required?

Answer: A checksum is a form of data redundancy check, a simple measure for protecting the integrity of data through error detection. Checksums are required. The checksum type is assigned when the raw array LUN is assigned to the V-Series controller. BCS is the default and recommended type of checksum. Data ONTAP reserves 12.5% of the space in the array LUN for the BCS. All features are supported when using BCS-assigned LUNs. Starting in Data ONTAP 8.1.1, FAS and V-Series/FlexArray support Advanced Zone Checksums (AZCS). AZCS is optimized for high-capacity devices (>3TB). When used with array LUNs, AZCS is best for sequential workloads. High-performance random read workloads should be avoided when using array LUNs. No such issues exist with NetApp disks, however. AZCS uses ~1.56% of raw device capacity.

Can I mix BCS and AZCS into the same aggregate?

Answer: Aggregates can only contain either BCS or AZCS LUNs and cannot be intermixed.

How can I change the checksum type?

Answer: The array LUN must first be a spare array LUN before you change the checksum type. Data on the device will not be preserved. The device must be removed and then reassigned with the desired checksum type.

How does V-Series/FlexArray handle pathing assignments to array LUNs?

Answer: Each array LUN has two paths from the V-Series/FlexArray controller: an active path and a passive path. For tier 1 arrays, the total LUN path balancing is accomplished by splitting the primary path for half the LUNs. Tier 2 arrays follow the primary pathing as assigned from the array.

Starting with Data ONTAP 8.3, I/O requests to an array LUN can be distributed through all the available optimized paths to the LUN. The I/O requests are no longer sent over a single active optimized path. [Ref Link](#)

If my paths to LUNs are not balanced, what can I do?

Answer: Pathing assignments to back-end array LUNs should be balanced for best system performance. Tier 1 array paths are assigned equally to each controller path when the controller is booted or during a cluster takeover/giveback. Tier 2 array paths are assigned on the array, and the NetApp controller will follow the array pathing primary/alternate assignments.

Can I transparently replace a fabric behind a V-Series/FlexArray controller?

Answer: Yes, you can replace a fabric between the V-Series/FlexArray controller and a storage array provided there is fabric redundancy in your deployment. However, great care should be taken when performing tasks such as this on live systems. Replace the fabric during a maintenance window.

Removing a fabric will cause all pathing to use only the surviving fabric. Replace one fabric and then verify that proper zoning is in place and connections have been restored before replacing the other fabric.

If a V-Series/FlexArray controller has multiple aggregates that are either built on third-party array LUNs or built on NetApp disks and one aggregate fails, what happens to Data ONTAP, the other aggregates, or the volumes?

Answer: If Data ONTAP detects a data inconsistency, the controller will panic to preserve state and reboot. Only the affected aggregates will be inconsistent. Other aggregates will only be affected because of the system reboot. In an HA configuration, a storage failover will occur, and only limited interruption or no interruption will happen for unaffected aggregates.

What happens if I move the cable from one switch FC port to another FC port?

Answer: Moving the cable between the switch and the array with soft zoning will simply change the NetApp reported disk name: for example, Switch00:96.127L15 to Switch00:83.127L15. Notice the switch port change from 96 to 83. Moving the cable between the V-Series/FlexArray controller and the switch with soft zoning will simply change the NetApp reported switch port for each FC port, from, say, EMBHXX00:110 to EMBHXX00:97.

With hard zoning in place, you will have to rezone because of the new switch FC ports used. You should avoid making changes to a production system outside of a maintenance window.

How do I replace the NVRAM on a V-Series/FlexArray controller? Are these steps the same as on a FAS controller?

Answer: Replacing NVRAM on a V-Series controller follows the same process as on a FAS controller. After the NVRAM is replaced and before booting the controller, the failed controller must be booted to maintenance mode and the array LUN ownership must be reassigned from the old SYS_ID to the new SYS_ID. This change of ownership command can only be issued from the surviving V-Series node. If you run this change of ownership command from the failed node while in maintenance mode, you will panic the surviving controller.

Are the V-Series/FlexArray motherboard replacement steps the same as those for a FAS motherboard replacement?

Answer: Replacing the motherboard on a V-Series/FlexArray controller is similar to replacing one on a FAS controller and follows the same process as on a FAS controller. However, there are some differences due to the back-end fabric and the array host groups. A new motherboard will come with new WWPNs. The array could be attached to a V-Series/FlexArray controller using FC ports from the motherboard or from expansion slot FC ports. If you are using expansion slot cards as FC initiator ports, no back-end changes are needed after a motherboard replacement. If your array is attached using motherboard FC ports, you will have to boot the controller to maintenance mode and then change the fabric zoning and array host group configuration prior to booting the V-Series controller.

Are there any performance or capacity overheads?

Answer: Performance may be accelerated, given that we are essentially putting an additional memory and flash-based cache in front of the existing array. If the data being requested is in memory or has been stored in FlashCache™, the latency would be greatly reduced. If the data is not in cache and must be requested from the array, additional latency is generally measured in microseconds. Dedupe-aware cache, however, greatly reduces the odds that a requested block is not in cache.

With respect to capacity, there are file system and checksum overheads, but these overheads are generally quickly returned when NetApp storage efficiency technologies are enabled. Snapshot™ copies, deduplication, thin provisioning, FlexClone® volumes, and compression can all combine to provide many times the available physical storage as logically provisioned storage. These file system and checksum overheads are covered in the FlexArray best practices guide.

Can I use advanced storage features on the back-end array?

Answer: Some features are supported, and others are not:

- Supported features: storage pooling (if pools are fully provisioned), disk-based encryption, SSDs
- Unsupported features: thin provisioning, array-based replication, array-based Snapshot copies If there is a specific feature about which you have a question, visit the NetApp Communities website and ask.

How do we migrate existing data from array LUNs into FlexArray?

Answer: The process for migration of data is similar to that for FAS. If the back-end array has unused array LUNs, then that data can be migrated to those array LUNs. If the array is full, and no new LUNs could be created, then you must first migrate array data to some other location (that is, FAS disks), re-provision the now free space on the array, build aggregates from the array LUNs, and move the data onto those aggregates.

Where can I get more detailed information about FlexArray?

Answer: The FlexArray storage virtualization best practice guide contains detailed deployment guidelines and examples. The [NetApp Communities website](#) also contains questions others have asked and enables you to directly ask the NetApp FlexArray experts questions.

3 Best Practice Questions

What is a simple set of best practices for a V-Series/FlexArray deployments?

Answer: V-Series/FlexArray can be installed with one or more storage arrays and also with NetApp disk shelves. Detailed requirements and best practices can be found in the “V-Series Best Practices Guide,”

the V-Series support matrix, and Data ONTAP documentation. A simple set of best practices includes the following items:

- Use a NetApp shelf for the root volumes.
- Use a four-array port LUN group described below.
- Use dedicated storage array ports. Sharing storage array ports can adversely affect performance.
- Use a single-initiator-to-single-target configuration and zoning.
- Use dedicated array RAID groups.
- Have a spare LUN assigned. If using a NetApp shelf, the spare disk meets this requirement.
- Avoid making changes to configurations once they are built. Changes to a stable system introduce the risk of disruption.
- Follow proper procedures when performing any maintenance on the V-Series controller, the back-end fabric, or the storage array.
- After installing a new system, properly test for path redundancy and cluster function.

If I replace my V-Series/FlexArray controller, is a data migration required?

Answer: A V-Series controller replacement does not require a data migration. The data remains on the array LUNs. These array LUNs are simply reassigned to the new V-Series controller. If you use on-board FC ports, you may need to update fabric zones and array host group properties.

Can I mix array LUNs from different storage arrays or array vendors within the same NetApp aggregate?

Answer: You can mix different array vendor LUNs in the same aggregate, but it is neither supported or recommended. Each aggregate should be made from array LUNs of the same array family: the same size and same type of underlying array disk types. Make sure you build your aggregates properly, because Data ONTAP does not prevent you from mixing array LUN sizes, types, and so on.

Also, you cannot remove a single array LUN from an aggregate. Be careful when adding array LUNs to aggregates because if you add the wrong type, you will need to migrate the data to another aggregate and then destroy the mixed aggregate.

What storage array features can I use with a V-Series controller?

Answer: Advanced storage array features are not generally supported with V-Series/FlexArray controllers. The V-Series/FlexArray is considered the storage controller and the array LUNs are considered the storage capacity to support the controller. Storage array features that typically are under question and not supported are (1) array thin provisioning, (2) dynamic resizing of the array LUNs, (3) array-based replication and attaching V-Series at remote sites, and (4) array-based transparent movement of LUNs.

Of course features such as Dedupe, compression, resizing and any other NetApp advanced features are supported on the aggregates, volumes and LUNs that the V-Series/FlexArray builds and presents through their front ends from storage aggregated from backend array LUNs.

How should I respond to other storage array vendors who say the V-Series/FlexArray controller is not supported in front of their array or that attaching the V-Series/FlexArray controller will void the array warranty?

Answer: This objection is often raised by EMC in the selling process against V-Series/FlexArray and it is not true in practice. There are dozens of V-Series/FlexArray systems in production environments with

both CX/VNX and DMX/VMAX arrays, and EMC has not invalidated the warranty on any of these systems.

If this sales tactic is encountered, simply ask the customer to ask EMC personnel if they are not honoring their warranty for current production installations running with V-Series/FlexArray and EMC arrays. Customer references can be provided to validate the support EMC continues to provide for these customers in conjunction with their warranty.

V-Series/FlexArray supports any storage array listed on its support matrix in the same manner. This is outlined in our support policy and in our FAQ; it is also described in our published support matrix. We have more than 5000 systems running in over 2500 installations, and the support process is the same for each.

4 FlexArray enhancements in ONTAP 9.1

What FlexArray resiliency enhancements are included with ONTAP 9.1 ?

Answer: Resiliency enhancements in ONTAP 9.1 include the following:

- Consistent I/O failover timing in case of path failures
- Temporary suspension of I/O for a tunable period of time in case of all-path fail conditions
- Automatic path quiescence in case of intermittent path failures