Dell EMC PowerMax and VMAX All Flash: SRDF/Metro Overview and Best Practices

Abstract

SRDF/Metro significantly changes the traditional behavior of SRDF to better support critical applications in high availability environments. This document covers the SRDF/Metro enhancement for Dell EMC™ PowerMax, VMAX3™, and VMAX™ All Flash storage arrays.

September 2020

Revisions

Date	Description
September 2019	Content and template update
September 2020	Updates for PowerMaxOS Q3 2020 release

Acknowledgments

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Executive summary

Symmetrix Remote Data Facility (SRDF™) solutions provide disaster recovery and data mobility solutions for Dell EMC™ PowerMax, VMAX™, VMAX3™, and VMAX All Flash arrays. SRDF services are provided by the following operating environments:

- PowerMaxOS for PowerMax 2000 and PowerMax 8000
- HYPERMAX OS for VMAX All Flash VMAX 250F, VMAX 250FX, VMAX 450F, VMAX 450 FX, VMAX 850F, and VMAX 850 FX
- HYPERMAX OS for VMAX3 100K, 200K, and 400K arrays
- Enginuity for VMAX 10K, 20K, and 40K arrays

SRDF replicates data between 2, 3, or 4 arrays located in the same room, on the same campus, or thousands of kilometers apart.

- SRDF synchronous (SRDF/S) maintains a real-time copy at arrays located within 200 kilometers. Writes from the production host are acknowledged from the local array when they are written to cache at the remote array.
- SRDF asynchronous (SRDF/A) maintains a dependent-write consistent copy at arrays located at unlimited distances. Writes from the production host are acknowledged immediately by the local array, thus replication has no impact on host performance. Data at the remote array is typically only seconds behind the primary site.

HYPERMAX OS 5977.691.684 and Solutions Enabler/Unisphere for VMAX 8.1 introduced support for SRDF/Metro for VMAX3 and VMAX All Flash families of storage arrays. SRDF/Metro significantly changes the traditional behavior of SRDF to better support your critical applications in high availability environments.

With SRDF/Metro, the SRDF secondary device is read/write accessible to the host and takes on the external identity of the primary device (geometry, device WWN, and so on). By providing this external identity on the secondary device, both the primary and secondary devices may then appear as a single virtual device across the two SRDF paired arrays for presentation to a single host or host cluster.

With both devices being accessible, the host or hosts (in the case of a cluster) can read and write to both primary and secondary devices with SRDF/Metro ensuring that each copy remains current, consistent, and addressing any write conflicts which may occur between the paired SRDF devices. A single PowerMax, VMAX3, or VMAX All Flash Array may simultaneously support multiple SRDF groups configured for SRDF/Metro operations and multiple SRDF groups configured for non-SRDF/Metro operations.

The following features were introduced with the PowerMaxOS 5978 Q3 2020 Service Release (SR) and Solutions Enabler/Unisphere for PowerMax 9.2:

- SRDF/Metro Smart DR
- Support for 25 GbE SRDF
- SRDF/Metro Smart DR provides SRDF/Metro with a single asynchronous target R22 volume which may be populated from either the R1 or R2 volume of an SRDF/Metro paired solution. Adding the capability to use a single asynchronous target volume simplifies setup, maintenance capabilities, system requirements, and reduces the amount of disk space required for a single target system.

This release also added support for the 4 port 25 GbE SLiC and protocol driver for all SRDF replication and host connectivity (RE/SE). This hardware expands PowerMax support for next generation Ethernet-based SAN fabrics, continuing to provide maximum I/O performance and fabric capabilities to the platform.

PowerMaxOS 5978 Q2 2019 Service Release and Solutions Enabler/Unisphere for PowerMax 9.1 introduced support for SRDF/Metro® Online Device Expansion (ODE) and a new Unisphere interface for add/remove of SRDF/Metro devices based on the existing Storage Group add/remove device workflow. With Unisphere for PowerMax and Solutions Enabler 9.1 forward, we expanded our ODE support to include devices taking part in SRDF/Metro (Active) sessions; this new functionality is based on modifications to our existing Geometry Compatibility Mode (GCM) functionality for host visibility of devices. Unisphere 9.1 also provides new ease-of-use functionality by automating the addition of devices to a storage group which then adds corresponding SRDF paired devices for single hop, concurrent, and cascaded SRDF configurations.

Audience

These technical notes are intended for IT professionals who need to understand the SRDF/Metro enhancement for the PowerMax, VMAX3, and VMAX All Flash storage arrays. It is specifically targeted at Dell EMC customers and field technical staff who are either running SRDF/Metro or are considering SRDF/Metro as a viable replication or host availability solution.

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1 Introduction

SRDF synchronous (SRDF/S) mode maintains a real-time copy at arrays generally located within 200 kilometers (dependent upon application workload, network latency, and block size). Writes from the production host are acknowledged from the local array when they are written to cache at the remote array creating a real-time mirror of the primary devices.

SRDF disaster recovery solutions, including SRDF synchronous, traditionally use active, remote mirroring and dependent-write logic to create consistent copies of data. Dependent-write consistency ensures transactional consistency when the applications are restarted at the remote location.

An SRDF device is a logical device paired with another logical device that resides in a second array. The arrays are connected by SRDF links. R1 devices are the member of the device pair at the primary (production) site. R1 devices are generally read/write accessible to the host. R2 devices are the members of the device pair at the secondary (remote) site. During normal operations, host I/O writes to the R1 device are mirrored over the SRDF links to the R2 device.
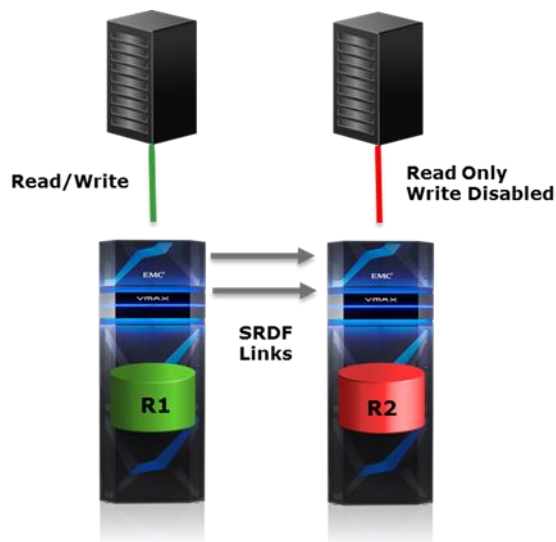
Figure 1   Traditional SRDF device pair states

Traditionally, data on R2 devices are not available to the host while the SRDF relationship is active. In SRDF synchronous mode, an R2 device is typically in read-only mode (write disabled) that allows a remote host to read from the R2 devices. In a typical open systems host environment, the production host has read/write access to the R1 device. A host connected to the R2 device has read-only access to the R2 device. To access the R2 device of a traditional synchronous relationship, a manual failover or swap operation must be performed to write enable the R2 site to accept host writes.

With the introduction of HYPERMAX OS 5977.691.684 and Solutions Enabler/Unisphere for VMAX 8.1, we have introduced support for SRDF/Metro for VMAX3 and VMAX All Flash families of storage arrays. SRDF/Metro significantly changes the traditional behavior of SRDF Synchronous mode with respect to the secondary or remote device availability to better support host applications in high-availability environments. With SRDF/Metro, the SRDF R2 device is also read/write accessible to the host and takes on the external identity of the primary R1 device (geometry, device WWN). By providing this external identity on the R2 device, both R1 and R2 devices may then appear as a single virtual device across the two SRDF paired arrays for host presentation. With both the R1 and R2 devices being accessible, the host or hosts (in the case of a cluster) can read and write to both R1 and R2 devices with SRDF/Metro ensuring that each copy

remains current, consistent, and addressing any write conflicts which may occur between the paired SRDF devices.
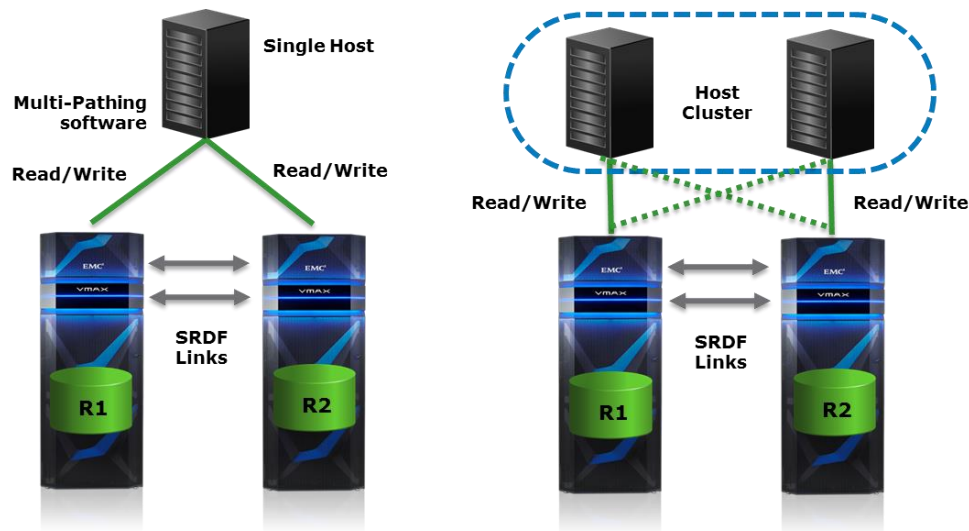
Figure 2   Single and clustered host configurations

The left example depicts a SRDF/Metro configuration with a stand-alone host which has visibility to both VMAX3 or VMAX All Flash arrays (R1 and R2 devices) using host multipathing software such as PowerPath, to enable parallel reads and writes to each array. This is enabled by federating the personality of the R1 device to ensure that the paired R2 device appears to the host as a single virtualized device. See the sections "Host Support Matrix" and "Best Practices for Host Multi-Pathing Software" for additional requirements in this area.

The right example depicts a clustered host environment where each cluster node has dedicated access to an individual VMAX array. In either case, writes to the R1 or R2 devices are synchronously copied to its SRDF paired device. Should a conflict occur between writes to paired SRDF/Metro devices, the conflicts will be internally resolved to ensure a consistent image between paired SRDF devices are maintained to the individual host or host cluster.

SRDF/Metro may be managed through Solutions Enabler SYMCLI or Unisphere for VMAX 8.1 or greater client software and requires a separate SRDF/Metro license to be installed on each VMAX3, VMAX All Flash, or PowerMax array to be managed.

1.1   Key differences

The key differences between SRDF/Metro and standard synchronous and asynchronous SRDF modes are:

- All SRDF device pairs that are in the same SRDF group and that are configured for SRDF/Metro must be managed together for all supported operations with the following exceptions:

  – If all the SRDF device pairs are not ready (NR) on the link, the user may perform a createpair operation to add additional devices to the SRDF group, provided that the new SRDF device pairs are created not ready (NR) on the link.
  – If all the SRDF device pairs are not ready (NR) on the link, the user may perform a deletepair operation on all or a subset of the SRDF devices in the SRDF group.

- An SRDF device pair taking part in an SRDF/Metro configuration may be brought to the following state:

    – Both sides of the SRDF device pair appear to the host(s) as the same device.
    – Both sides of the SRDF device pair are accessible to the host(s).

2 Configuring SRDF/Metro

The following sections describe the states through which a device pair in an SRDF/Metro configuration may transition during the configuration's life cycle and the external events and user actions which trigger these transitions.
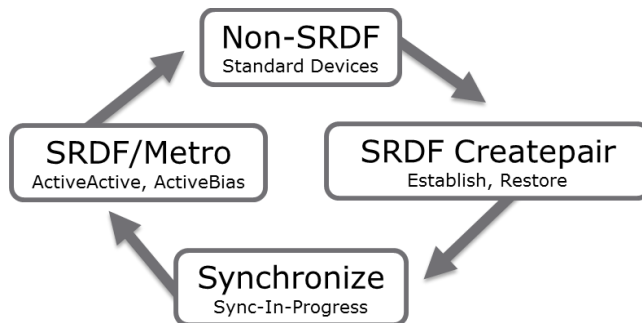

Figure 3   SRDF/Metro Device Life Cycle

The life cycle of an SRDF/Metro configuration typically begins and ends with an empty SRDF group and a set of non-SRDF devices. Since SRDF/Metro does not currently support concurrent or cascaded SRDF devices unless these devices are part of a supported SRDF/A configuration (see "Features and Functionality by Service Release" section for additional information), devices that will constitute the SRDF device pairs typically begin as non-SRDF devices. These devices may then return to a non-SRDF state following a deletepair operation, terminating the SRDF/Metro configuration.

2.1 Createpair operation

An SRDF createpair operation, with an appropriate SRDF/Metro option specified, places the new SRDF device pairs into an SRDF/Metro configuration. The user may perform the createpair operation to add devices into the SRDF group as long as the new SRDF devices created are not ready (NR) on the SRDF link with a suspended or partitioned state.

The SRDF device pairs may be made read/write (RW) on the SRDF link as a part of the createpair operation by specifying either establish or restore option. The createpair operation creates the SRDF device pairs and makes them read/write on the SRDF link. Alternately, the user may perform a createpair operation followed by an establish or restore operation to begin the device synchronization process between newly created device pairs. In either case, the resulting SRDF mode of operation will be Active for these devices to reflect an SRDF/Metro configuration.

2.2 Device pair synchronization

Once the devices in the SRDF group are made read/write (RW) on the SRDF link, invalid tracks begin synchronizing between the R1 and R2 devices, with the direction of synchronization defined by an establish or restore operation. The SRDF mode will remain Active with the device pair state becoming SyncInProg while the device pairs are synchronizing. During synchronization, the R1 side will remain accessible to the host while the R2 side remains inaccessible to the host.

An SRDF device pair will exit the SyncInProg SRDF pair state when either of the following occurs:

- All invalid tracks have been transferred between the R1 and the R2 for all SRDF device pairs in the SRDF group.
- Any SRDF device pair in the SRDF group becomes not ready (NR) on the SRDF link. This which will result in all SRDF device pairs of the SRDF/Metro group to become NR on the SRDF link. At this point, they simultaneously enter a suspended or partitioned SRDF link state.

2.3 Device pair operation

Once the initial synchronization has completed, the SRDF device pairs then reflect an ActiveActive or ActiveBias pair state and Active SRDF mode. The state of the device pair state depends upon the resiliency options configured for these devices which will be further described in the section "SRDF/Metro Resiliency".

SRDF/Metro devices transition to the ActiveActive or ActiveBias SRDF pair states when all the following has occurred:

- The external identity and other relevant SCSI state information have been copied from the R1 side of the SRDF device pairs to the R2 side.
- The R2 device in each pair has been set to identify itself using the information copied from the R1 side when queried by host I/O drivers.
- The R2 device has been made read/write (RW) accessible to the host(s).

At this point, the R2 devices with newly federated personalities from the R1 device may then be provisioned to a host or host cluster for use by an application. SRDF/Metro R2 devices should not be provisioned to a host until they enter an ActiveActive or ActiveBias pair state.

Going forward, host writes to either the R1 or R2 are synchronously copied to its paired SRDF device. Should a conflict occur between writes to paired SRDF/Metro devices, the conflict will be internally resolved to ensure a consistent image between paired SRDF/Metro devices is maintained to the individual host or host cluster.

2.4 FAST integration

Performance statistic exchange begins once the SRDF/Metro Active mode and ActiveActive or ActiveBias pair state have been achieved. Each side then incorporates the FAST statistics from the other side to ensure each side represents the workload as a whole (R1+R2 workload). Users may set the required service level objective (SLO) independently on both source and target SRDF/Metro paired arrays. There are currently no restrictions in this area as FAST data movement is transparent from SRDF/Metro.

3   SRDF/Metro resiliency

SRDF/Metro uses the SRDF link between the two sides of the SRDF device pair to ensure consistency of the data. If one or more SRDF device pairs become not ready (NR) on the SRDF link or all link connectivity is lost between VMAX3 or VMAX All Flash systems (suspended or partitioned states), SRDF/Metro selects one side of the SRDF device pair to remain accessible to the hosts, while making the other side of the SRDF device pair inaccessible.

SRDF/Metro supports two resiliency features to accommodate this behavior, bias and witness. While both of these features prevent data inconsistencies and split-brain complications between the two sides of the SRDF device pair. Split-brain complications are data or availability inconsistencies originating from the maintenance of two separate devices (with an overlap in scope) due to a failure caused by these systems not communicating or synchronizing their data.

The first resiliency feature, bias, is a function of the two VMAX3 or VMAX All Flash systems taking part in the SRDF/Metro configuration and is a required and integral component of the configuration. The second feature, witness, builds upon the base bias functionality by adding an optional SRDF/Metro component which allows a 3rd VMAX based (PowerMax, VMAX, VMAX3, or VMAX All Flash) or software based (Virtual Witness) node to act as an external arbitrator to ensure host accessibility in cases where bias alone would restrict access to one side of the SRDF/Metro device pairs. It is important to note that these resiliency features are only applicable to SRDF device pairs within an SRDF/Metro configuration.

Each witness may protect the full number of SRDF/Metro groups available on each array. There is a many to many relationship between SRDF/Metro paired arrays and witnesses for redundancy with each paired array able to be protected by multiple witnesses and each witness being able to protect multiple arrays. The current support for these relationships is outlined in the following table:

	Number of Arrays Supported	Array Pairs Supported	Number of SRDF/Metro groups protected per array pair
Physical Witness	32	16	250 - Number of Physical Witness RDF Groups
Virtual Witness	32	16	250

3.1   Understanding bias

As described previously, bias is an integral function of the two VMAX3 or VMAX All Flash arrays taking part in a SRDF/Metro configuration. The initial createpair operation places an SRDF device pair into an SRDF/Metro configuration and pre-configures the bias to the primary or R1 side of the device pair by default. From then on, the bias side is always represented within management interfaces, such as Solutions Enabler SYMCLI or Unisphere for VMAX, as the R1 and the non-bias side as the R2.

In the case of a failure causing the device pairs to become not ready (NR) on the link, SRDF/Metro responds by making the non-biased or R2 paired device inaccessible (not ready) to the host or host cluster. Bias can optionally be changed by the user once all SRDF device pairs in the SRDF group have reached ActiveActive or ActiveBias SRDF pair states. As noted previously, changing the bias to the R2 side effectively swaps the SRDF personalities of the two sides with the original R2 device pairs now being represented as the R1. Changing bias to the R1 side would be redundant as the R1 personality always follows the biased side.
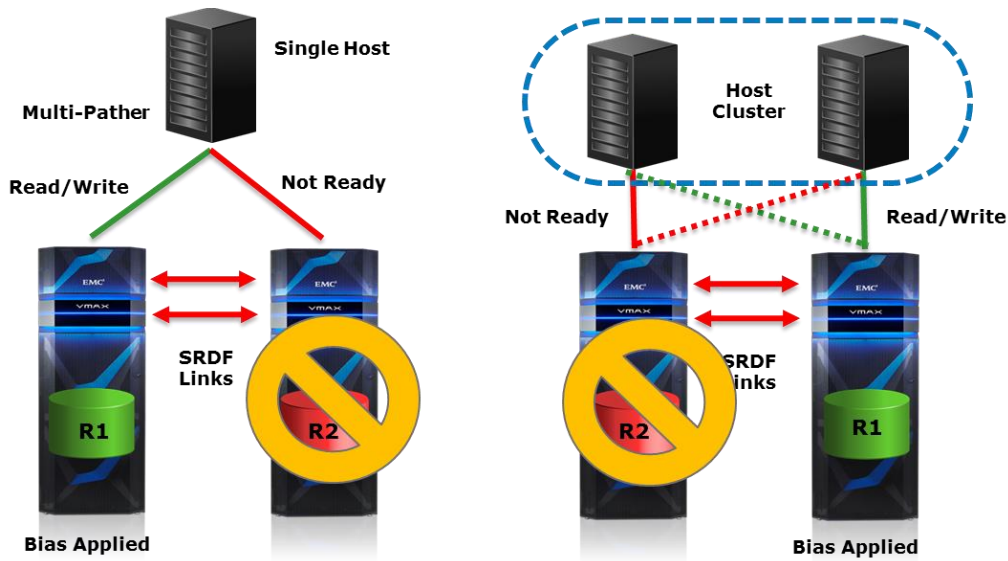
Figure 4   Bias Post Failure Examples

In both examples above, a failure has caused the SRDF/Metro device pairs to become not ready (NR) on the link, which resulted in the biased or R1 side remaining accessible (read/write) and the R2 or non-biased side becoming not ready (NR) to the host or host cluster. The left example represents a single host configuration with the default bias location after a user initiated suspend operation, while the right example depicts the resulting post failure configuration after a change in bias was made.

As noted previously, there are failure scenarios for which bias alone would not result in the ideal outcome for continued host accessibility. In the example below, a failure affecting the R1 or biased side would result in both the R1 and R2 (non-biased) sides becoming inaccessible to the host or cluster. For these scenarios, the optional and highly recommended redundant witness protection provides the best host accessibility outcome.
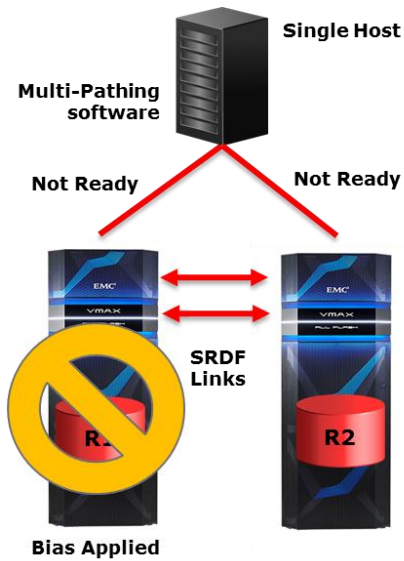

Figure 5   Undesirable Bias Outcome (with Bias Side Failure)

3.2 Understanding the array-based witness

As described previously, the optional witness functionality builds upon the base bias feature by adding an external arbitrator to ensure host accessibility in cases where bias alone would restrict access. Configuring a hardware witness functionality will require a third VMAX, VMAX3, VMAX All Flash, or PowerMax system with an applicable ePack installed and SRDF group connectivity to both the primary and secondary SRDF/Metro paired arrays.

Figure 6   Supported Hardware Witness Configurations

Once a VMAX witness system has been configured, it supersedes the previously described bias functionality unless a situation is encountered requiring specific knowledge of the biased system.

The VMAX or VMAX3 code requirements to support witness functionality are:

- VMAX systems with Enginuity 5876 and SRDF N-1 compatible ePack containing fix 82877.
- VMAX3 system with HYPERMAX OS 5977 Q1 2015 SR and ePack containing fix 82878.
- VMAX3 system with HYPERMAX OS 5977.691.684.

To configure a VMAX witness system, SRDF groups created with a new witness option must be made visible from the third VMAX, VMAX3, or VMAX All Flash system to both the primary and secondary VMAX3 systems. This requires SRDF remote adapters (RA's) to be configured on the witness system with appropriate network connectivity to both the primary and secondary arrays. Redundant links to the witness system are also recommended as a best practice in a production environment to address possible failures in connectivity.

Once this third system is visible to each of the SRDF/Metro paired VMAX3 or VMAX All Flash systems and the SRDF/Metro groups suspended and reestablished, the configuration enters a "Witness Protected" state. For this reason, it is also a best practice for the witness SRDF groups to be configured prior to establishing the SRDF/Metro device pairs and synchronizing devices.

Multiple VMAX witness systems may be configured in this manner for redundancy purposes. Should either connectivity or the primary witness system fail and no other alternative witness systems may be identified, SRDF/Metro resiliency defaults back to the bias functionality. See the section "Use Bias Option" and failure scenarios below for use in the event of scheduled maintenance of the witness system. Use of this option

prevents dial home events and escalations normally associated with an outage of SRDF/Metro in a witness configuration.

Note: Note that the SRDF personality of devices may also change as a result of a witness action (PowerMax, VMAX, or vWitness based) to better reflect the current availability of the resulting devices to the host. For example, should the witness determine that the current R2 devices remain host accessible and the R1 devices inaccessible, the current R2 devices will change to R1 as a result. Depending on access/availability, the previous R1 device will also change to R2's as in the case of a bias change.
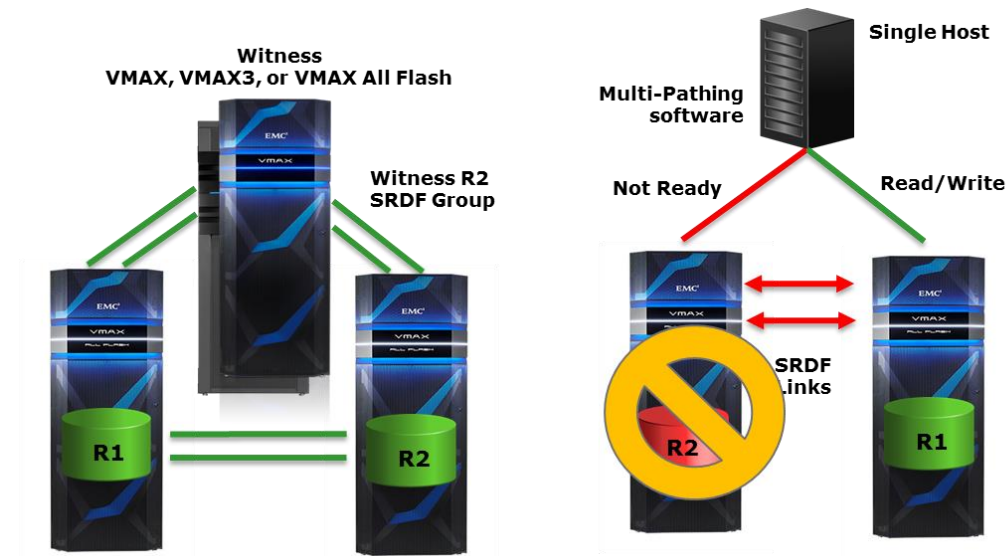

Figure 7   Desirable Witness Outcome (Bias Side Failure)

Using the undesirable bias outcome example described previously, a failure of the biased R1 side with a witness configured would now result in continued host accessibility of the non-biased R2 side:

The SRDF/Metro witness functionality covers a number of single and multiple failure and response scenarios.

Note: To determine the actions necessary to properly recover SRDF/Metro from a specific failure scenario, please refer to the SRDF/Metro Recovery Knowledge Base (KB) article KB516522 (https://support.emc.com/kb/516522), engage Dell EMC support directly, or escalate to your local account or support team as the urgency of the situation dictates.

Depicted below are detailed single and multiple failure scenarios and the resulting responses which are covered by SRDF/Metro witness functionality:

S1	R1 side of device pair
S2	R2 side of device pair
W	Witness Array/vWitness
⇄	SRDF links
⇇⇉	SRDF links/IP connectivity*
✕	Failure/outage

* Depending on witness type

S1 and S2 remain accessible to host
S2 wins future failures
S1 calls home

S1 and S2 remain accessible to host
Move to bias mode
S1 and S2 call home

S1 failed
S2 remains accessible to host

S1 remains accessible to host
S2 suspends

S1 and S2 remain accessible to host
S1 wins future failures
S2 calls home

S2 failed
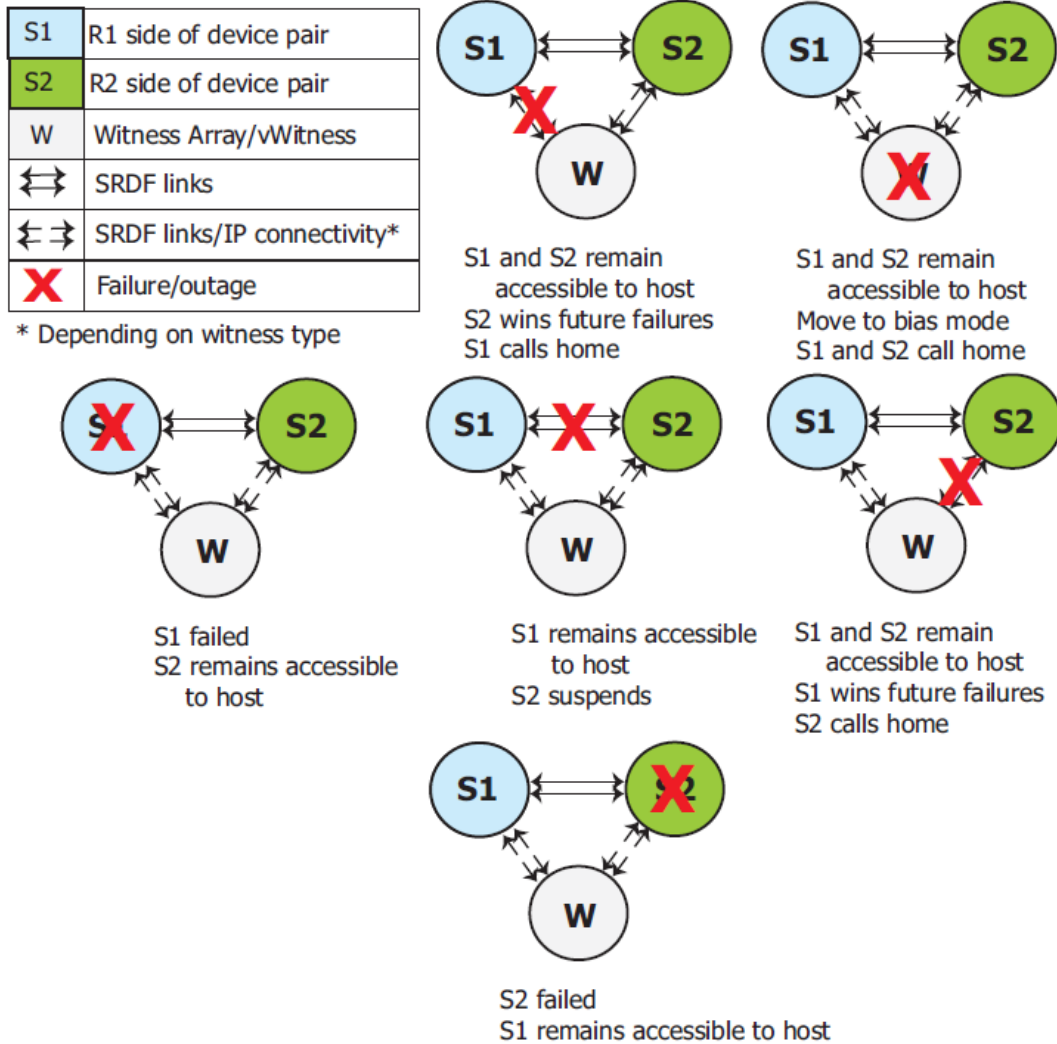S1 remains accessible to host

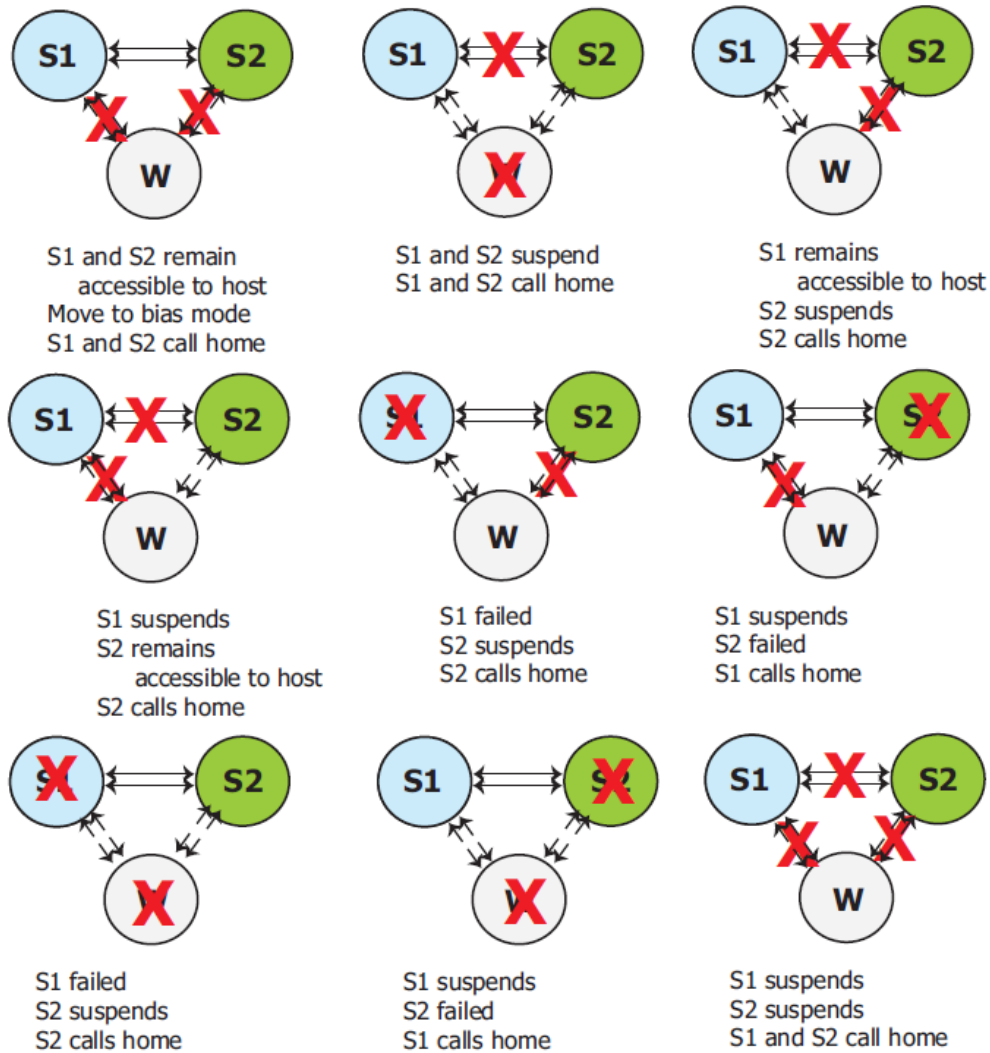Figure 8   Single Failure Witness Scenarios

Figure 9   Multiple Failure Witness Scenarios

3.3   Understanding the Virtual Witness (vWitness)

While the advantage of the previously described VMAX based witness solutions continues to be the high availability of the VMAX product and which is especially beneficial for the customers with existing VMAX systems, a disadvantage of this approach is the requirement for additional VMAX hardware for new customers. The SRDF/Metro Virtual Witness (vWitness) solution, in contrast, provides alternative witness functionality without requiring additional VMAX hardware. Operationally, virtual and physical witnesses are treated the same by HYPERMAX OS and SRDF/Metro. They each offer equivalent functionality and may be employed independently, simultaneously, and securely. If both array-based witness and vWitness are available, SRDF/Metro will prefer the array-based witness. It is important to note that a vWitness will only be used if an array-based witness is not available.

The benefits of a vWitness configuration are the following:

- Does not require additional VMAX hardware.
- Offers functional equivalence to existing array-based witness solutions.
- Connections are secured using TLS/SSL based IP connectivity.

- Virtual and array-based witness solutions may be used simultaneously.

In addition to the vWitness summary information presented below, a separate configuration document is available on support.emc.com entitled *VMAX vWitness Configuration Guide* and is focused exclusively on vWitness installation, configuration, and management. See this document for additional vWitness information.

The SRDF/Metro vWitness is available for VMAX storage arrays running HYPERMAX OS 5977 Q3 2016 Service Release and Solutions Enabler/Unisphere for VMAX 8.3 or later. The vWitness will be packaged as a VMware virtual appliance (vApp) for installation directly into the customer environment. This package will support Unisphere for VMAX or Solutions Enabler vApp kits with the Solutions Enabler kit being preferred due to its lower hardware requirements for those not requiring the full management capability of Unisphere for VMAX. Once installed, the vWitness will then be configured using the local Embedded Element Manager (EEM) installed on each pair of VMAX3 or VMAX All Flash arrays.
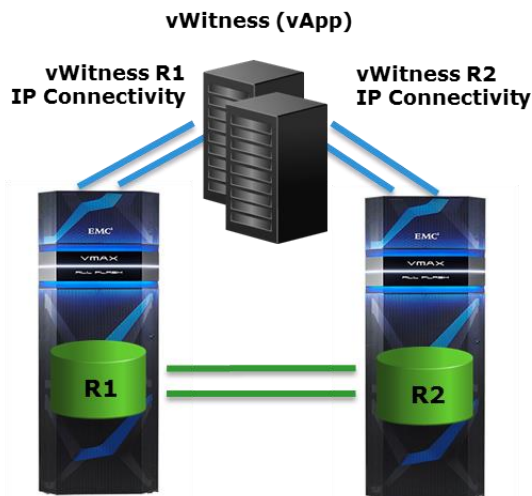

Figure 10   Supported Virtual Witness (vWitness) Configurations

The vWitness vApp will maintain multiple IP connections to redundant management guests located on both the primary and secondary SRDF/Metro managed arrays. These IP connections will use TLS/SSL to ensure secure connectivity between the vWitness and SRDF/Metro paired arrays.

Once IP connectivity has been established to the SRDF/Metro paired arrays, the vWitness(s) may then be configured and maintained using an embedded Solutions Enabler SYMCLI or Unisphere for VMAX 8.3 instance on each array. Using this vWitness management interface, the user may perform the following operations:

Add vWitness: Add a new vWitnesses to the configuration. This will not affect the current Witness protection if so configured. SRDF/Metro will learn about the new vWitness and attempt to connect.

Query vWitness: Query the configuration/state of the vWitnesses.

Suspend vWitness: This will make the vWitness temporally inactive. If the vWitness is servicing an active SRDF/Metro session, a force flag would need to be used. The SRDF/Metro session then becomes witness unprotected until a new witness (if available) is renegotiated what might take up to 5 seconds.

Remove vWitness: SRDF/Metro will be notified about the vWitness removal and break the connection to the removed vWitness. This operation is allowed as long as the vWitness being removed is not currently used by an active SRDF/Metro session.

Note: Note that the SRDF personality of devices may also change as a result of a Witness action (VMAX or vWitness based) to better reflect the current availability of the resulting devices to the host. For example, should the witness determine that the current R2 devices remain host accessible and the R1 devices inaccessible, the current R2 devices will change to R1 as a result. Depending on access/availability, the previous R1 device will also change to R2's as in the case of a bias change.

The requirements for a vWitness deployment are:

- VMware ESXi 4.0 or greater (for vApp):
- Solutions Enabler 8.3 vApp- Single Processor, 2 GB of Memory, Dual Disks: 16 GB of Disk Space + another 5 GB of Expandable Disk Space
- Unisphere for VMAX 8.3 vApp - Dual Core Processor, 16 GB of Memory, 120 GB of Disk Space
- IP Network connectivity between both SRDF/Metro arrays and VMware ESXi vApp host
- Embedded Element Manager (EEM) installed on each pair of VMAX3 or VMAX All Flash arrays for vApp configuration and management
- There are two daemons which support the vWitness functionality:
- storvwlsd (Witness Lock Service) on a vWitness vApp instance.
- storvwmd (Witness Manager) on a storage system (EEM).

3.4   PowerMaxOS / Solutions Enabler 9.0 (and greater) Witness Enhancements

Currently, whenever a witness-protected SRDF/Metro session is activated, which occurs as devices are made RW on the SRDF link, the arrays on the two sides of the session negotiate to determine the witness they will use. Under PowerMaxOS and later, the two sides of a witness-protected SRDF/Metro session also negotiate to determine the side better suited to continue servicing host IOs in the event of a failure. That side will then become the 'winner' side, reported as the R1. In general, the added negotiation between the two sides of the session will select the side that currently has a more available DR configuration or that has fewer array-level HW/SW issues as the 'winner' side. The behavior is the same for array as well as virtual witness options.

The witness selection criteria with this release and greater is the following (in priority order):

- Presence of Host-Array Connectivity
- Under the system WP limit
- Presence of a DR Leg
- Synced SRDF/A leg
- SRDF/A leg
- DR leg has link up
- DR leg has ready mirror
- Dead director criteria
- The side that is currently the bias side (R1)

The first of these criteria that one array has and the other does not stops the selection process. The side with the matched criteria is the preferred winner. The two sides repeat this selection process regularly for each

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SRDF/Metro session to ensure that the winner remains the one that is most preferable. This means that the winning side may change during the course of a session.

3.4.1   Bias implications

As a result, the traditional bias and set bias options will no longer be supported nor necessary for configurations supported by a PowerMaxOS or later witness. As such, when choosing to use a witness of based on the PowerMaxOS release or later to protect the SRDF/Metro configuration, the user is choosing to let the witness select the winner side in the event of a failure. Set bias operations will therefore only be supported for configurations with an ActiveBias (non-witness) SRDF pair state.

For suspend operations, the set bias option has been renamed to 'Keep' to specify which side will retain host accessibility (designated by the R1 SRDF personality). For example, suspending an SRDF/Metro session with set bias now becomes keep:

symrdf -sg <SgName> -sid <SymmID> -rdfg <GrpNum>

  [-bypass] [-noprompt] [-i <Interval>] [-c <Count>]

  [-v | -noecho] [-force] [-symforce]

  . . .

  suspend [-keep <R1 | R2 >]

Similar -keep syntax available with –g, –cg, -sg, -file options.

3.5   Use bias resiliency option

By default, SRDF/Metro uses witness resiliency where SRDF witness groups have been configured. On systems prior to PowerMaxOS, Witness resiliency may be overridden by the user by specifying a use_bias option each time links are established. This option forces the use of a ActiveBias pair state even where an ActiveActive state with witness protection may otherwise be achieved. Performing a subsequent establish operation without the use_bias option results in witness protection where available.

It is important to use this option during testing or when scheduled maintenance of the witness system is necessary. In the event of scheduled maintenance of the witness system, use of this option prevents dial home events and escalations normally associated with an outage of SRDF/Metro in a witness configuration as depicted in the witness system failure scenario below.
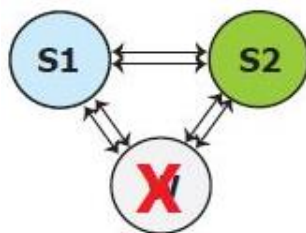
S1 and S2 remain
 accessible to host
Move to bias mode
S1 and S2 call home

Figure 11   Witness System Failure Scenario

3.6 Witness best practices for redundancy

The following are best practices for configuring a vWitness or Hardware-based witness:

- Configure multiple witnesses with two minimum for redundancy
- Utilize independent fault domains for each witness to include power and network domains
- Witnesses should <u>not</u> be placed in the same fault domains as the protected SRDF/Metro configuration
- Locate each witness within 40 ms network latency of paired arrays
- vWitness offers flexibility and redundancy due FC SAN separation of IP protocol
- Spread vWitness installations over multiple ESXi servers for redundancy
- Utilize a hardware-based witness for 3rd site DR topologies

Note: SRDF/Metro will always give priority to array-based witnesses first (code preference) followed by any vWitnesses configured in the environment. This is particularly important as an option for 3rd site DR topologies where the DR array may be used as a hardware-based witness followed by one or more vWitnesses to meet the redundancy recommendations above.

3.7 Witness behavior during failures and recovery

This section describes the behavior provided by a witness with respect to witness selection, redundancy, and availability decisions.

3.7.1 Witness selection and promotion

Activity between a pair of SRDF/Metro groups is known as a SRDF/Metro session. When a session starts, the R1 and R2 arrays negotiate which of the available witness instances to use to protect the session. Thus, an individual array could be using several witness instances simultaneously. In the same way, an individual witness instance may be monitoring several SRDF/Metro sessions simultaneously as described previously.

The SRDF/Metro paired array polls all of the witness instances in its definition list every second. Each witness then sends a reply. This enables the paired array to maintain a list of instances that are available and operational. If an array detects that an instance has not responded for 10 seconds, it checks whether the instance is in use by any SRDF/Metro session. If it is in use, the R1 and R2 arrays negotiate an alternative witness to use in its place. If there are no witnesses available, the session uses bias functionality as a fallback.

3.7.2 System failures

If either array detects that an SRDF/Metro session has failed (that is, the array has lost contact with the partner group either due to a failure of the SRDF link or in the partner array), the array will request a lock from the witness instance allocated to the SRDF/ Metro session. On the R1 side, the array sends this lock request to the witness instance for that session immediately. Typically, the R2 array waits 5 seconds before sending a similar lock request to the witness. This allows time for the R1 side to request the lock. In this manner, the R1 array has priority and acquires the lock during this 5 second period. The witness instance grants the lock in response to the first request it receives. The side that gains the lock remains available to the host while the other side becomes unavailable.

In addition to determining which witness instance to use, the arrays in each SRDF/Metro session also negotiate which of them is the preferred winner. In the event of a failure, the preferred winner is the side that has priority when requesting the lock from the witness instance; that is, the preferred winner is the R1 side.

When either side runs HYPERMAX OS 5977, SRDF/Metro uses the bias settings for the devices to determine the preferred winner. That is, the devices defined as the being on the bias side, if Device Bias were to be used, become the preferred winners.

3.7.3 System recovery

As described in this and related witness failure sections, there are a number of possible single, dual, and triple failures scenarios and outcomes covered by a witness in addition to other factors taken into account regarding the ability of a particular array to better service host I/Os. The recovery from a specific scenario may range from performing a simple establish operation, half swap operation, or may require other more detailed recovery steps.

Note: To determine the actions necessary to properly recover SRDF/Metro from a specific failure scenario, please refer to the SRDF/Metro Recovery Knowledge Base (KB) article KB516522 (https://support.emc.com/kb/516522), engage Dell EMC support directly, or escalate to your local account or support team as the urgency of the situation dictates.

4 Example host support matrix

The following support matrix example includes the hosts, host clusters, and Multipathing software supported with SRDF/Metro, HYPERMAX OS, and PowerMaxOS. This is provided as an example only with current support information available at the ELN link below.

Note: Go to the E-Lab Interoperability Navigator (ELN), which provides a web-based interoperability and solution search portal, for additional information, associated qualification footnotes, or changes to the support matrix provided below. It is recommended that each array configured for SRDF/Metro have the latest target code with the latest patches/ePacks applied.

Operating system	MultiPathing software	Native Cluster support	Third-Party Cluster support	iSCSI / FC support	Boot from SAN [1]	Example applications [2]
AIX 6.1	Native MPIO	Yes	No	FC only	Yes (with FC only)	AIX Native FS, AIX Native SCSI-2 Cluster (PowerHA), AIX Native SCSI-3 Cluster (GPFS, PowerHA)
AIX 6.1 - VIOS 2.x	Native MPIO	Yes	No	FC only	No	AIX Native FS, AIX Native SCSI-2 Cluster (PowerHA), AIX Native SCSI-3 Cluster (GPFS, PowerHA)
AIX 7.1	Native MPIO	Yes	No	FC only	No	AIX Native FS, AIX Native SCSI-2 Cluster (PowerHA), AIX Native SCSI-3 Cluster (GPFS, PowerHA)
AIX 7.1 - VIOS 2.x	Native MPIO	Yes	No	FC only	No	AIX Native FS, AIX Native SCSI-2 Cluster (PowerHA), AIX Native SCSI-3 Cluster (GPFS, PowerHA)
Citrix XenServer 6.2 and higher	DM-MPIO	Yes	No	FC, and iSCSI	Yes (with iSCSI only)	
ESXi 5.x [6]	NMP	Yes [8]	Yes	FC and iSCSI	Yes (with iSCSI only)	Windows over ESXi Native Clusters (single node and multi node)
ESXi 6.x [7]	NMP	Yes [8]	Yes	FC and iSCSI	No	Windows over ESXi Native Clusters (single node and multi node)
OEL 6.x UEK R3 and higher	DM-MPIO, PowerPath 6.x	No	Yes	FC only	No	Oracle RAC 12.1.0.2
OEL7.x UEK R3 and higher	DM-MPIO, PowerPath 6.x	No	No	FC only	No	
OVM 3.3.x	DM-MPIO, PowerPath 6.x	Yes	No	FC only	No	Native FS
RHEL 6.x	DM-MPIO	Yes	No	FC and iSCSI	No	Ext4 FS, GFS, RedHat Cluster Suite
RHEL 6.x	Veritas DMP 6.0.x or higher	Yes	No	FC and iSCSI	No	Ext4 FS, GFS, RedHat Cluster Suite
RHEL 6.x	PowerPath 5.x, 6.x	No	No	FC and iSCSI	No	Ext4 FS
RHEL 7.x	DM-MPIO	Yes	Yes	FC and iSCSI	Yes (with FC only)	Native LVM, VxVM, Native Filesystem, RedHat Cluster Suite, Pacemaker with RHEL 7.x based on VxFS ... RAC
RHEL 7.x	Veritas DMP 6.1.x or higher, InfoScale 7.0	Yes	Yes	FC and iSCSI	Yes (with FC only) (7.0)	Native LVM, VxVM, Native Filesystem, RedHat Cluster Suite ... RHEL 7.x based on VxFS Filesystem
RHEL 7.x	PowerPath 6.x	No	No	FC only	No	Ext4 FS, GFS, ASM, Oracle RAC
SLES 11 SP2, SP3, SP4	DM- MPIO, PowerPath 5.x, 6.x, Veritas DMP 6.0.x and higher, or InfoSacle 7.0	No	No	FC only	Yes (with FC only)	VxVM, ocfs2
SLES12	DM- MPIO, PowerPath 5.x, 6.x, Veritas DMP 6.0.x and higher, or InfoSacle 7.0	Yes	No	FC only	No	VxVM, ocfs2, HAE(High Availability Extension) Clusters over OCFS2 with Powerpath 6.x.
Solaris SPARC 10.x	PowerPath 5.x, 6.x	No	No	FC only	No	Native FS
Solaris SPARC 11.x	PowerPath 5.x, 6.x	No	No	FC only	No	Native FS
Solaris x86 10.x	PowerPath 5.x, 6.x	No	No	FC only	No	Native FS
Solaris x86 11.x	PowerPath 5.x, 6.x	No	No	FC only	No	Native FS
Windows 2008	MPIO [4]	No	No	FC only	No	
Windows 2008 R2	MPIO [4]	Yes [5]	No	FC and iSCSI [3]	No	Microsoft Failover Clusters, Standard Storage Resource
Windows 2008 Windows 2008 R2	PowerPath 5.x, 6.x	No	No	FC only	No	Native NTFS
Windows 2012	MPIO	No	No	FC only	Yes (with FC only)	Native NTFS
Windows 2012 R2	MPIO	Yes [5]	No	FC and iSCSI	Yes (with FC only)	Native NTFS, Microsoft Failover Clusters, Standard Storage Resource
Windows 2012 Windows 2012 R2	PowerPath 5.x, 6.x	No	No	FC only	No	

Figure 12   Example Interoperability Support Matrix

You can find the ELN at https://elabnavigator.EMC.com

5   Features and functionality by service release

The following SRDF/Metro features and functionality were introduced with the PowerMaxOS 5978 Q3 2020 SR, PowerMaxOS 5978 Q2 2019 SR, PowerMax OS 5978 Q2 2018, HYPERMAX OS Q3 2016 and HYPERMAX OS 5977.811.784 service releases. For additional information regarding these features, please refer to the SRDF/Metro support matrix located at: https://elabnavigator.EMC.com

5.1   PowerMaxOS 5978 Q3 2020 service release

The following features were introduced with the PowerMaxOS 5978 Q3 2020 Service Release (SR) and Solutions Enabler/Unisphere for PowerMax 9.2:

- SRDF/Metro Smart DR
- Support for 25 GbE SRDF
- SRDF/Metro Smart DR provides SRDF/Metro with a single asynchronous target R22 volume which may be populated from either the R1 or R2 volume of an SRDF/Metro paired solution. Adding the capability to use a single asynchronous target volume simplifies setup, maintenance capabilities, system requirements, and reduces the amount of disk space required for a single target system.
- This release also added support for the 4-port 25 Gb Ethernet I/O module and protocol driver for all SRDF replication and host connectivity (RE/SE). This hardware expands PowerMax support for next generation Ethernet-based SAN fabrics, continuing to provide maximum I/O performance and fabric capabilities to the platform.

5.2   PowerMaxOS 5978 Q2 2019 service release

The following features were introduced with the PowerMaxOS 5978 Q2 2019 Service Release (SR) and Solutions Enabler/Unisphere for PowerMax 9.1:

- Support for SRDF/Metro Online Device Expansion (ODE)
- Unisphere for PowerMax SRDF add/remove using Storage Group management interface

With Unisphere for PowerMax and Solutions Enabler 9.1 forward, we expanded our ODE support to include devices taking part in SRDF/Metro (Active) sessions; this new functionality is based on modifications to our existing Geometry Compatibility Mode (GCM) functionality for host visibility of devices.

Unisphere 9.1 also provides new ease-of-use functionality by automating the addition of devices to a storage group which then adds corresponding SRDF paired devices for single hop, concurrent, and cascaded SRDF configurations.

5.3   PowerMaxOS 5978 Q2 2018 service release

The following features were introduced with the PowerMaxOS 5978 Q2 2018 service release:

- Add new or existing devices to Active SRDF/Metro session
- Move existing SRDF/S/ACP devices into Active SRDF/Metro session
- Enhanced SRDF/Metro Witness capability with SRDF/A leg awareness
- Allow SRDF/Metro session with GCM identified devices
- SRDF/Metro Mobility ID support with ALUA
- SYMCLI replaces –rdf_metro SE SYMCLI option with –metro
- Allow Suspending SRDF/Metro devices without Force option

5.4   HYPERMAX OS Q3 2016 service release

The following feature were introduced with the HYPERMAX OS Q3 2016 service release:

- Virtual Witness (vWitness) functionality as previously described
- SRDF/Metro Extended Disaster Recovery (DR) with SRDF/A support
- Provides an extra layer of data protection for continuous out of region asynchronous replication in the event of regional disaster
- Concurrent (R11) and Cascaded (R21) support
- Concurrent (R11) SRDF/A target must be on a VMAX running HYPERMAX OS 5977 Q32016SR or later
- Single Session SRDF/A Consistency only (no MSC)
- No changes to Unisphere or SYMCLI other than removing previous blocks on ACP_DISK and SRDF/A
- Adding New Devices to an Active SRDF/Metro solution (createpair -format)
- Adds more storage on application that is SRDF/Metro protected without losing Active protection

Note: Adding existing devices by createpair –format will <u>erase</u> all existing data on the specified local and remote devices.

Support Matrix Updates:

- Support for Powerpath/PPVE Clustering with AIX 6.1, 6.1 with VIOS, 7.1, and 7.1 with VIOS 2.x
- Red Hat Enterprise Linux 6.x, 7.x
- Windows 2012, Windows 2012 R2
- ESXi
- Support for SCSI-2 and SCSI-3 Group Reservations for PowerPath Cluster
- HP-UX with Native MPIO and PowerPath for ServiceGuard Cluster

5.5   HYPERMAX OS 5977.811.784 service release

The following features were introduced with the HYPERMAX OS 5977.811.784 release:

Support for cluster cross connections with single host, uniform clusters, and non-uniform clusters.

- For uniform clusters on ESXi, NMP should use the default round robin policy. See the KB article: https://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=2134684
- Support for SCSI-3 and SCSI-2 Clusters.
- Support for iSCSI with a limited set of hosts and MPIOs.
- Support for unMap and Writesame VAAI commands. SRDF/Metro now supports all VAAI commands with the exception of xCopy/ODX.
- FAST.X support was added to SRDF/Metro.
- Full ESXi support with HYPERMAX OS 5977.811.784.

6   SRDF/Metro device maintenance (add/move operations)

An SRDF createpair operation is used to add devices to an existing SRDF configuration while an SRDF movepair operation is used to move devices between existing SRDF configurations, retaining their incremental resynchronization capabilities. The HYPERMAX OS 5977.691.684 service release first introduced the ability to add new devices using a createpair command to an inactive or suspended SRDF/Metro configuration. To add new SRDF devices to an SRDF/Metro configuration in this manner, the -rdf_metro option is used with the createpair command (note –rdf_metro option has been truncated to –metro in Solutions Enabler 9.0 and beyond).

This ability was expanded with the HYPERMAX OS 5977.811.784 service release to allow the addition of net-new or unused devices to the SRDF/Metro configuration using a createpair –format command. Adding existing devices by createpair –format in this manner will erase all existing data on the specified local and remote devices.

With the PowerMaxOS 5978 release, we expanded on this base capability to allow the addition and movement of both net-new devices as well as those which contain existing application data to an active SRDF/Metro configuration. This will be accomplished by the addition of an –exempt option to both the createpair and movepair commands to signify that the target of the operation is an active SRDF/Metro configuration. The SRDF movepair operation, specifically, has not been supported in HYPERMAX OS releases previous to the PowerMaxOS 5978 release.

Note: For Smart DR environments, see procedures in the Smart DR subsection for Adding/Expanding Existing Devices.

6.1   Createpair –exempt

Given an SRDF/Metro session whose devices are currently in ActiveActive SRDF pair state, whose R1 side is in SRDF group 3 on array 123, and whose R2 side is in SRDF group 8 on array 456:

symrdf -sid 123 -rdfg 3 -file xx **createpair** -type R1 -metro **–exempt**

This createpair command requires and accomplishes the following:

- Creates new RDF pairs from the devices listed in file xx, placing them in the SRDF/Metro group
- -exempt option is required because the SRDF/Metro group is active and RW on the RDF link
- -exempt option indicates that data on the R1 side of the new RDF device pairs should be preserved and host accessibility should remain on the R1 side
- After creating the new device pairs in SRDF group 3, establish will be performed, setting them RW on the SRDF link with SyncInProg RDF pair state; they will eventually transition to the ActiveActive or ActiveBias pair states

See appendix C for a Unisphere for PowerMax example of the Createpair –Exempt operation described above.

6.2   Movepair –exempt

HYPERMAX OS releases prior to PowerMaxOS 5978 have not allowed movepair operations into or out of an SRDF/Metro group (while suspended or active). To support movepair operations with PowerMaxOS 5978 and later, the source SRDF group and devices must be Adaptive Copy or Synchronous modes (not SRDF/A).

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Target SRDF/Metro group may now be Active with device pair states of Suspended, SyncInProg, ActiveActive, or ActiveBias. As with any newly added SRDF/Metro devices, R1 devices will remain host accessible and R2 will remain inaccessible to the host until these devices reach active mode.

Note: The SRDF R1/R2 'polarity' of the source SRDF device pairs must match that of the target SRDF group. For example, R2 devices on one side of the link may not be moved into a group where the devices have R1 personalities. As with 'createpair –exempt', movepair can only be used if the active SRDF/Metro group does not contains exempt devices

The following command moves the existing SRDF pairs described in file xxx from SRDF group 10 on array 456 to the SRDF/Metro group 8:

symrdf -sid 456 -rdfg 10 -file xxx **movepair** -new_rdfg 8 **-exempt**

This movepair command requires and accomplishes the following:

- -exempt option is required because the device pairs already in the session are RW on the RDF link. The -exempt option would also be required if the R1 side of RDF group 10 was on array 456, since then the device pairs being added to the SRDF/Metro session would have reversed polarity relative to the device pairs already in the session, whose R1 side is on array 123
- The -exempt option indicates that data on the R1 side of the new RDF device pairs should be preserved and host accessibility should remain on the R1 side
- Prior to performing the movepair into the SRDF/Metro session, SE will suspend the device pairs being moved if they are RW on the RDF link
- After completing the movepair into the session, SE will perform an establish on the device pairs that were added, setting them RW on the RDF link with SyncInProg RDF pair state; they will eventually transition to the ActiveActive or ActiveBias pair states

See Appendix D for a Unisphere for PowerMax example of the Movepair –Exempt operation described above.

6.3   Understanding the consistency exempt status

Newly added exempt devices will synchronize R1->R2 invalid tracks under a new SRDF/Metro consistency 'exempt' status similar in concept to the previous SRDF/A consistency exempt functionality. The ActiveActive or ActiveBias SRDF pair state is reached for effected devices only after track synchronization for effected devices completes and volumes have been added to the SRDF/Metro session. Once synchronized, the 'exempt' status for these devices will be cleared and SRDF/Metro operations for all active devices will continue normally with external identify transfer and R2 host availability.

Consistency Exempt Operation Restrictions:

- Restore operations will be blocked while one or more devices in an SRDF/Metro group are in an 'exempt' status
- At least one device within the SRDF/Metro session must be non-exempt
- Management software will not allow all devices in the SRDF/Metro session to be removed with exempt deletepair or movepair
- If the devices added to the SRDF/Metro configuration are, or will be, concurrent SRDF devices, they must meet the criteria required of concurrent devices in an SRDF/Metro configuration:
- The non-Metro RDF mirror cannot be in Synchronous mode
- A device cannot have 2 Metro RDF mirrors

- The non-Metro RDF mirror of the SRDF/Metro devices must be an R1.
- The R1 device in an SRDF/Metro configuration can be an R11 device, but it cannot be an R21 device, and
- The R2 device in an SRDF/Metro configuration can be an R21 device, but it cannot be an R22 device
- A device cannot simultaneously be both RW on the RDF link on the Metro RDF mirror and the target of data copy from the non-Metro RDF mirror
- A device cannot be WD to the host if the device's Metro SRDF mirror is RW on the RDF link
- Additional Movepair Exempt support restrictions:
- The SRDF R1/R2 'polarity' of the source SRDF device pairs must match that of the target SRDF group.
- For example, R2 devices on one side of the link may not be moved into a group where the devices have R1 personalities
- As with '**createpair –exempt**', movepair can only be used if the active SRDF/Metro group does not contains exempt devices
- If any of the SRDF device pairs being added have the SyncInProg SRDF pair state, then the -symforce option is required
- Device pairs being added will be suspended during the movepair operation
- Source device pairs which have Suspended or SyncInProg SRDF pair states cannot have invalids owed from R2 to R1

Consistency Exempt Devices may be identified using the following Solutions Enabler SYMCLI commands:

- `symrdf list` and `symrdf list –v` indicates whether a device is exempt within a SRDF/Metro group
- `symrdf list -exempt` option includes only devices which are currently exempt within a group
- `symdev show` indicates whether a specific device is exempt
- `symrdf query` indicates devices within a group that are currently exempt

7 SRDF/Metro online device expansion (ODE operations)

This section covers the new SRDF/Metro Online Device Expansion (ODE) feature for PowerMaxOS 5978 and Solutions Enabler/Unisphere for PowerMax 9.1.

Note: For Smart DR environments, please see procedures in the Smart DR subsection for Adding/Expanding Existing Devices.

In Solutions Enabler 9.0 and 5978 code, we introduced support for Online Device Expansion (ODE) for SRDF devices taking part in Synchronous (SRDF/S), Asynchronous (SRDF/A), and Adaptive Copy (ACP_DISK) relationships. At that time, this did not include support for SRDF/Metro ODE. With Unisphere for PowerMax and Solutions Enabler 9.1, we expanded our ODE support to include devices taking part in SRDF/Metro (Active) sessions. This functionality is based on modifications to our existing Geometry Compatibility Mode (GCM) functionality for host visibility of devices.

This feature provides the following functionality:

- Adds support for devices in SRDF/Metro Active or Suspended pair states
- Expansion will not impact read/write operation performance to associated devices or applications
- Support for both Compatibility and Mobility IDs
- Supports SRDF/Metro R1/R2 topology with single a command/operation
- Support for devices which have an Async DR target will be supported
- If the expansion operation fails for either site, then both paired devices will expose the same (original) size

For SRDF/Metro DR (w/Async leg) support:

- Configuration with a 3rd site will require multiple steps rather than a single operation/command
- Need to expand DR site first and then expand SRDF/Metro pair
- It will be necessary to suspend DR during the expansion operation

See appendix E for an example of the SRDF/Metro ODE interface in Unisphere for PowerMax 9.1.

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8   SRDF/Metro Smart DR

Added with the PowerMaxOS 5978 Q3 2020 SR and Solutions Enabler/Unisphere for PowerMax 9.2, SRDF/Metro Smart DR provides SRDF/Metro with a single asynchronous target R22 volume which may be populated from either the R1 or R2 volume of an SRDF/Metro paired solution. Adding the capability to use a single asynchronous target volume simplifies setup, maintenance capabilities, system requirements, and reduces the amount of disk space required for a single target system.
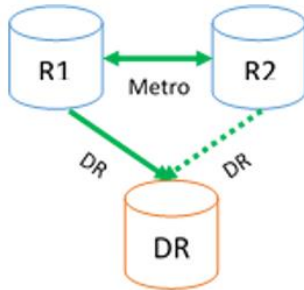
Figure 13   Single Smart DR asynchronous target volume

The Smart DR feature adds the following capabilities to SRDF/Metro:

- Metro Smart DR is a two-region high available (HA) disaster recovery (DR) solution
- Integrates SRDF/Metro (Metro) and SRDF/Async (SRDF/A) enabling HA DR for a Metro session
- Achieved by closely coupling the SRDF/A sessions on each side of a Metro pair to replicate to a single DR device
- Witness configuration is required for all Smart DR configurations
- Ensures that only a single SRDF/A session will be sending data to the DR site
- Will switch the data transfer to the other side ensuring that the dependent-write consistent copy of data on the DR site is maintained and stays as up to date

Note: See the Restrictions and Dependencies section below for specific Smart DR requirements.

8.1   Witness configuration

Metro Smart DR requires the use of a witness configuration; may use either an array based or virtual witness (vWitness). The following documents are available which contain setup instructions:

- *SRDF/Metro Technical Notes (this document)*: http://www.emc.com/collateral/technical-documentation/h14556-vmax3-srdf-metro-overview-and-best-practices-tech-note.pdf
- *SRDF/Metro vWitness Configuration Guide*: http://www.emc.com/collateral/TechnicalDocument/docu78903.pdf

8.2   Environment definition

Each Metro Smart DR environment is uniquely identified by an *Environment Name* which is composed of the 3 arrays (**MetroR1** array, **MetroR2** array, **DR** array) and associated SRDF groups and devices for each array. All arrays contain the same number and size of devices. All device pairings form a triangle across the three arrays taking part in the Smart DR environment. This environment name can be up to 16 characters long, is case-sensitive and may include alpha numeric characters and the dash ('-') and underscore ('_').

MetroR1 array contains:

- One Metro RDF group which is configured **to the MetroR2 array** (referred to as MetroR1_Metro_RDFG)
- One DR RDF group which is configured **to the DR array** (referred to as MetroR1_DR_RDFG)
- Devices which are concurrent RDF and are paired using MetroR1_Metro_RDFG and MetroR1_DR_RDFG

MetroR2 array contains:

- One Metro RDF group which is configured **to the MetroR1 array** (referred to as MetroR2_Metro_RDFG)
- One DR RDF group which is configured **to the DR arra**y (referred to as MetroR2_DR_RDFG)
- Devices which are concurrent RDF and are paired using MetroR2_Metro_RDFG and MetroR2_DR_RDFG

DR array contains:

- One DR RDF group which is configured **to the MetroR1 array** (referred to as DR_MetroR1_RDFG)

8.3   Smart DR setup

An environment setup operation is required to convert a Metro session and a DR session into a Smart DR environment which enables the ability to closely couple the SRDF/A sessions from each side of the Metro session when the DR site devices are in SRDF/A asynchronous mode. To set up a Smart DR environment, the user must use the new `symmdr environment –setup` command in Solutions Enabler 9.2 or similar Unisphere 9.2 interface steps as covered in greater detail within the associated Smart DR Unisphere Setup appendix below.

To perform a Smart DR setup operation, the user will need the following:

- The user must have an existing concurrent SRDF (CRDF) configuration which has one mirror that is a Metro session and one mirror that is either a SRDF/A session or in adaptive copy disk mode (**R2←R11→R2**).
- The user will name the Smart DR environment and supply an empty RDF group which is configured between the MetroR2 array and the DR array.
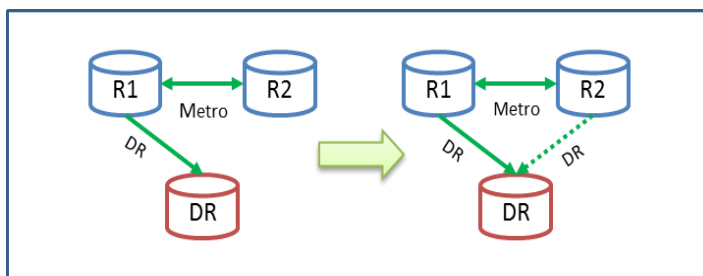
Figure 14   Concurrent (CRDF) conversion (R2←R11→R2) to Smart DR

Note: The setup operation will not change the state of the Metro or DR session. For example, if the SRDF pair state of the Metro session is ActiveActive and the SRDF mode of the DR session is Asynchronous and the SRDF pair state of the DR session is Consistent. Device states of these SRDF pairs should remain the same after the setup operation has completed.

In addition, the setup operation will adjust the newly created SRDF mirror from the MetroR2 array to the DR array so that it mimics the state of the existing DR states. For example, ensures that the minimum cycle time that exists on the MetroR1 to DR is the same minimum cycle time that exists on the Metro R2 to DR.
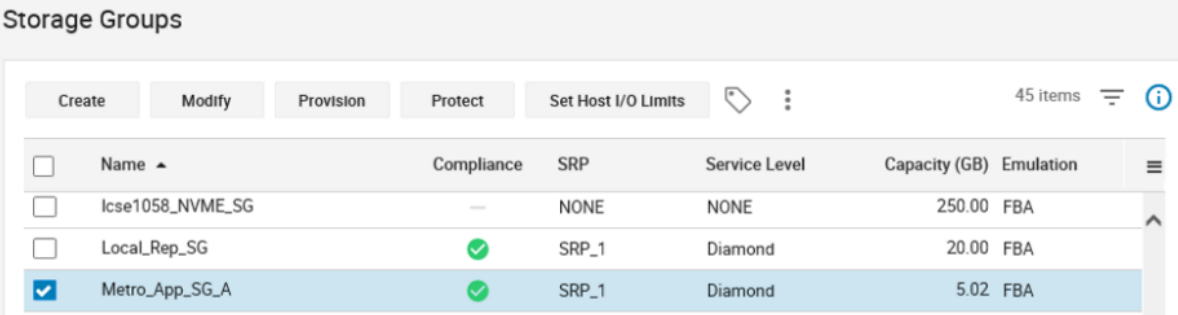
Example SYMCLI setup command:

```
symmdr –sid -56 –name metrodr1 –metro_rdfg 119 –dr_rdfg 76 env –setup
A MetroDR 'Environment Setup' operation is in progress for 'metrodr1'. Please
wait...
```

8.4   Converting SRDF/Metro with DR to Smart DR

A new feature of Unisphere 9.2 allows the user to convert an existing SRDF/Metro with DR environment to Smart DR (*Storage Groups -> Select SG -> More Options -> Convert to MetroDR/Smart DR*) under the following pre-conditions:

- The target Storage Group is protected with SRDF/Metro and has an Asynchronous SRDF session or Adaptive Copy Disk session
- The existing Async or ACP_Disk session must be from the R1 array (Concurrent)
- The Metro Session must be configured using a witness
- User Role must be at least StorageAdmin or RemoteRep

Figure 15   Unisphere Storage Group interface

The specific steps required in Unisphere 9.2 to perform this conversion is as follows:

- Log in to Unisphere.
- Select an Array
- Select Data Protection Menu option
- Select Storage Groups
- Select SRDF tab
- Select an SG suitable for Smart DR environment setup
- Click "More Options"
- Click "Convert to Smart DR"
- Enter a new, unique environment name
- Optionally, Select Manual to pick an SRDF group for DR
- Select SRDF Group
- Click Run Now or Add to Job List

8.5 Smart DR removal

To remove a Smart environment, users must use the `symmdr environment –remove` SYMCLI command. The final result will be a Concurrent (CRDF) or Cascaded (CRDF) topology which has one mirror that is a Metro session and one mirror that is either a SRDF/A session or adaptive copy disk mode. The user will be able to choose to keep a specific DR leg that originates from the MetroR1 side or the MetroR2 side.
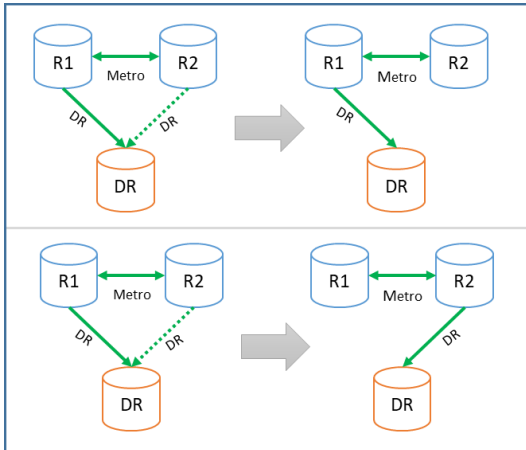
Figure 16   Removal of Smart DR to Concurrent (CRDF) or Cascaded (CRDF) topology

The resulting state of a successful remove operation will be as follows:

- State of the Metro session will not change
- Unless a force is required the state of the DR session will not change.
- If the DR mode is asynchronous at the time of the `symmdr env –remove`, the devices will remain enabled
- Remove command may require a –force option if the operation will result the state of the DR changing:
- DR mode is adaptive copy disk
- DR from the MetroR2 will be kept
- Metro session state is ActiveActive
- DR session state is Synchronized

8.6 Adding devices and Online Device Expansion (ODE)

The process of adding new devices or Online Devices Expansion (ODE) of existing devices is not directly supported within the Smart DR environment. To accomplish these functions, the user must remove the existing Smart DR environment temporarily, perform the associated operation, followed by a conversion back to the original Smart DR environment. This process is greatly simplified by using the removal and conversion automation previously described within Unisphere 9.2 and later.

The steps necessary to perform either of these functions are the following:

- The Smart DR environment must first be removed with a Remove operation described previously
- Devices may then be added or existing devices expanded using the normal SRDF/Metro procedures described in this document; please see examples provided in the appendices for these operations
- A Smart DR conversion operation as described previously is then performed to return to the Smart DR environment

8.7 Smart DR control operations

Smart DR control operations may be performed via Solutions Enabler SYMCLI 9.2 or Unisphere 9.2 and later. For SYMCLI. In addition to Unisphere, the **symmdr** command previously described will be used to perform a Smart DR setup, removal, recovery, and specific operations directed to the various Metro and DR components. The Unisphere protection wizard allows the complete creation of a Smart DR environment based on the R1 Storage Group being protected. This will include the setup of Metro and DR array storage groups as well as the creation of devices on these arrays which match the number and size of the initial R1 Storage Group. For Unisphere, please see examples of the Unisphere 9.2 protection wizard and control interface within the appendix F section of this document.

Note: Controlling the Smart DR environment via the `symrdf` command will not be allowed. The new `symmdr` command must be used for all SYMCLI oriented Smart DR control operations.

All control operations may be directed at:

- The Smart DR environment as a whole
- The Metro localized session
- The DR localized session

Note: Control operations which are targeted at the Smart DR environment, require all 3 arrays to be previously discovered and that the Metro, MetroR1 to DR, and MetroR2 to DR SRDF groups to be online.

Operations which are allowed on the Smart DR environment are categorized as follows:

- Setting up and Removing the Smart DR environment
- Monitoring the Smart DR environment
- Recovering the Smart DR environment

Control Operation Summary

- Environment Setup: An environment setup is required to put a Metro session and a DR session into a MetroDR environment which enables the ability to closely couple the SRDF/A sessions from each side of the Metro session when the DR is in Async mode. See detailed description above for additional information.
- Environment Recover: The recover command will transition the Metro Smart DR environment back to a known state.
- Environment Remove: The result will be a Concurrent RDF setup which has one session that is a Metro session and one session that is either a SRDF/A session or in adaptive copy disk mode.
- Metro Establish: An establish makes the devices in the Metro session RW on the SRDF link and initiates an incremental re-synchronization of data from the Metro R1 to the Metro R2. An establish makes the devices in the DR session RW on the SRDF link and initiates an incremental re-synchronization of data from the Metro to the DR. In the event the user chooses both sessions, the Metro session will be run first, followed by the DR session, two separate API calls will be made, one for each session.
- Metro Suspend: A suspend makes the devices in the Metro session NR on the SRDF link. By default the Metro R1 will remain accessible to the host, while the Metro R2 will become inaccessible to the host. A suspend makes the devices in the DR session NR on the SRDF link, stopping data synchronization between Metro session and DR.

- Metro Restore: A restore makes the devices in the Metro session RW on the SRDF link and initiates an incremental re-synchronization of data from the Metro R2 to the Metro R1.
- DR Split: A split makes the devices in the DR session NR on the SRDF link, stopping data synchronization between Metro session and DR.
- DR Restore: A restore makes the devices in the DR session RW on the SRDF link and initiates an incremental re-synchronization of data from the DR to the Metro R1.
- DR Failover: A failover makes the devices in the DR session NR on the SRDF link, stopping data synchronization between Metro session and DR and adjusts the DR to allow the application to be started on the DR side. Once the failover command completes successfully: The DR is Ready (RW).

  - If the failover command was issued when the DR state was not Partitioned or TransIdle:
  - When the MetroR1 is mapped to the host, the MetroR1 will be write disabled (WD)
  - The MetroR2 will be inaccessible to the host
  - The Metro state will be Suspended
  - If the failover command was issued when the DR state was Partitioned or TransIdle:
  - MetroR1, MetroR2, and the Metro states will not change

- DR Failback: A failback makes the devices in the DR session RW on the SRDF link and initiates an incremental re-synchronization of data from the DR to the Metro R1. It will also make the devices in the Metro session RW on the SRDF link, initiating an incremental re-synchronization of data from the Metro R1 to Metro R2.
- DR Update R1: An Update R1 makes the Metro R1 to DR devices RW on the SRDF link and initiates an update of the R1 with the new data that is on DR.
- DR Set Mode: A set mode acp_disk sets the DR mode to Adaptive copy disk mode. A set mode async sets the DR mode to Asynchronous mode.

8.7.1   Solutions Enabler SYMCLI control operation syntax

The syntax of the SYMCLI `symmdr` command for operations targeted against the **Smart DR environment** as a whole:

symmdr -sid <SID> -name <Env> -metro_rdfg <RDFGroup> -dr_rdfg <RDFGroup>

    [-noecho] [-noprompt] [-i <Interval>] [-c <Count>]

  environment –setup

symmdr -sid <SID> -name <Env> -dr_rdfg <RDFGroup>

    [-noecho] [-noprompt] [-i <Interval>] [-c <Count>] [-force]

  environment –remove

symmdr -sid <ArrayID> -name <EnvironmentName> [-noecho] [-noprompt]

    [-i <Interval>] [-c <Count>]

  Recover

The syntax of the SYMCLI `symmdr` command for operations targeted against the ***SRDF/Metro session, specifically***:

symmdr -sid <SID> -name <Env> [-noecho] [-noprompt]

[-i <Interval>] [-c <Count>] [-force] [-symforce] **-metro**

establish

restore

suspend [-keep <R1 | R2>]

The syntax of the SYMCLI `symmdr` command for operations targeted against the ***DR session***, *specifically*:

symmdr -sid <SID> -name <Env> [-noecho] [-noprompt]

[-i <Interval>] [-c <Count>] [-force] [-symforce] **-dr**

establish

failback

failover

restore

split

suspend

update

set mode <acp_disk | async>

8.8   Monitoring Smart DR

As with control operations, Smart DR monitoring may be performed via Solutions Enabler SYMCLI 9.2 or Unisphere 9.2 and later. For SYMCLI, the **symmdr** command previously described will be used to monitor the environment as a whole or Metro and DR sessions directly. The Unisphere Smart DR interface allows monitoring at the environment, Metro, and DR levels and provides clear graphic information concerning the configuration and status of various Smart DR components such as the Metro, DR, or host connectivity status. For Unisphere, please see examples of the Unisphere 9.2 monitoring and control interface within the appendix G section of this document.

Some examples of the state and status information available for Smart DR include the following:

- **RDF Mode**: Active, Async, Adaptive Copy
- **Service State**: Active HA, Active, Inactive, Degraded
- **Link State**: Online, Offline, MetroR1_DR Offline, MetroR2_DR Offline
- **Witness State**: Available, Degraded, Failed
- **Mapped devices**: Mapped, Mixed, Not Mapped
- **Exempt devices**: Some Exempt, None Exempt
- **Paired devices**: Paired, Mixed, Not Paired
- **RDF Group**: Exists, Does Not Exist

> **Note:** A complete description of reported state and status information may be found in the Smart DR appendix of this document.

The **symmdr** command has a familiar status output format as other SYMCLI commands with list, show, and query options to monitor various level of detail. The reporting syntax of the **symmdr** command is the following:

```
symmdr -sid <SID> [-i <Interval>] [-c <Count>] list [-tb]
symmdr -sid < SID> -name <Env> [-i <Interval>] [-c <Count>] show [-detail]
symmdr -sid < SID> -name <Env>[-i <Interval>] [-c <Count>] query [-tb]
```

The query option output of the **symmdr** command is very important to providing an overview of the configuration and various state and status information regarding the Smart DR environment. The following are examples of the information provided in the output of the **symmdr query** command:

- The overall environment requires attention
- The state of both the Metro and DR sessions
- The DR is in Async mode, and the DR state is Consistent which indicates that the DR site has a dependent-write consistent copy of data
- If the DR Service state is 'Active HA' which would enable HyperMaxOS to switch the data transfer to the other side as required
- Ensures that the dependent-write consistent copy of data on the DR site stays as up to date as possible

Similarly, the Unisphere Smart DR interface allows monitoring at the environment, Metro, and DR levels and provides clear graphic information concerning the configuration and status of various Smart DR components such as the Metro, DR, or SRDF connectivity status:
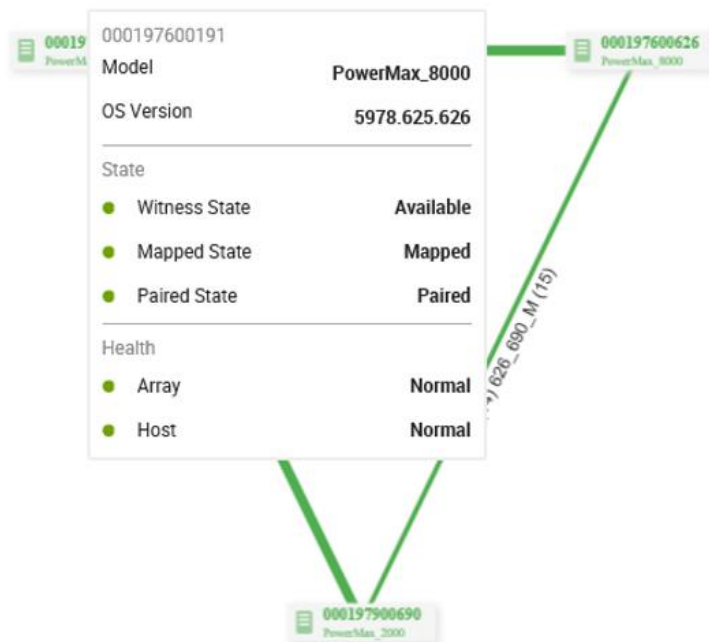
Figure 17   Unisphere Smart DR Graphical Configuration and Status

In addition to the above information, the query output also more includes specific information concerning a specific environment such as Metro and DR status:

- Environment status

  – Indicating the overall service state of the environment
  – Indicating whether a recovery is required
  – Indicating the MetroR1, MetroR2, DR array IDs

- Metro status

  – Invalids indicating how much data is owed to MetroR1 and/or MetroR2
  – Indicating the state of the Metro session
  – Indicating the Metro session service state
  – Indicating the availability of the Metro witness
  – Indicating whether the Metro SRDF group is offline

- DR status

  – Invalids indicating how much data is owed to Metro and/or DR
  – Indicating the state of the DR session
  – Indicating the SRDF mode
  – Indicating the DR session service state
  – Indicating whether the DR SRDF groups are offline

An example output of the `symmdr query` command is as follows; in this case, indicating that a recovery operation is needed:

symmdr -sid 044 –name Alaska **query**

Array ID: 000197900044

Name   : Alaska

Service State : Degraded – Run Recover

Capacity   : 104.7 GB

Exempt Devices: No

MetroR1: 000197900044

MetroR2: 000197900055

DR   : 000197900033

    MetroR1   MetroR2   MetroR1 <-> MetroR2

-------------------- -------------------- -----------------------

MetroR1 MetroR2   MetroR1 MetroR2

```
Invalids Invalids Flg Invalids Invalids Flg Flags        Done
(GB)    (GB)   HA (GB)    (GB)    HA  LW ES State      (%)
-------- -------- --- -------- -------- --- ----- ------------ ----
   0.0    20.9 ..    0.0     0.0 .X  .. .D Invalid        -
```

```
   Metro            DR                      Metro <-> DR
---------------- ---------------- ------------------------------------------------
Metro   DR     Metro   DR                       Cycle
Invalids Invalids Invalids Invalids Flags        Done Time
(GB)    (GB)    (GB)    (GB)    LM ES State      (%) (sec) DR Consistent Image Time
-------- -------- -------- -------- ----- ------------ ---- ----- -----------------------
   0.0    47.1     0.0     0.0 .A .D Invalid        -   15 -
```

Legend:

 Metro Flags:

   (H)ost Connectivity: . = Normal, X = Degraded

   (A)rray Health   : . = Normal, X = Degraded

 MetroR1 <-> MetroR2 Flags:

   (L)ink State   : . = Online, X = Offline

   (W)itness State   : . = Available, D = Degraded, X = Failed

   (E)xempt Devices : . = No Exempt Devices, X = Exempt Device

   (S)ervice State   : H = Active HA, A = Active, I = Inactive, D = Degraded

 Metro <-> DR Flags:

   (L)ink State   : . = Online, X = Offline, 1 = MetroR1_DR Offline, 2 = MetroR2_DR Offline

   (M)ode   : A = Async, D = Adaptive Copy

   (E)xempt   : . = No Exempt Devices, X = Exempt Devices

   (S)ervice State   : H = Active HA, A = Active, I = Inactive, D = Degraded

The `symmdr list` command may also be used to view a high-level status of <u>all</u> the Smart DR environments which have been configured on the specified array, and will identify:

- Environment name
- Capacity
- Indication identifying whether there are any consistency exempt devices
- Service state of the environment/session
- Metro session and service state
- Percentage of data resynchronization in progress for the Metro session
- DR session and service state
- Percentage of data resynchronization in progress for the DR session
- DR mode
- An example output of the `symmdr list` command is as follows; in this case, indicating that there are three Smart DR environment configured on the array:

symmdr list -sid 044

Array ID: 000197900044

```
        Environment              Metro              DR

------------------------------ -------------------- --------------------

             Flg Capacity         Flg Done           Flg Done

Environment Name  SE  (GB)      State      S  (%)  State       SM  (%)

---------------- --- --------- ----------- --- ---- ----------- --- ----

Alaska          ..      104.7 ActiveActive  H    - Consistent   HA    -

bermuda         ..      118.4 Suspended     I    - SyncInProg    AA   45

cayman          ..       16.1 ActiveActive  H    - Partitioned   IA    -
```


Legend:

 Environment Flags:

  (S)Service State : . = Normal, X = Environment Invalid, D = Degraded

  (E)xempt   : . = No Exempt Devices, X = Exempt Devices

 Metro Flags:

  (S)ervice State   : H = Active HA, A = Active, I = Inactive, D = Degraded

 DR Flags:

  (S)ervice State   : H = Active HA, A = Active, I = Inactive, D = Degraded

(M)ode   : A = Async, D = Adaptive Copy

If additional detail is required regarding a specific environment, the `symmdr show` command may be used to view additional details, and will identify:

- MetroR1, MetroR2 and DR arrays.
- SRDF groups between the MetroR1 and MetroR2 arrays.
- SRDF groups between the MetroR1 and DR arrays.
- SRDF groups between the MetroR2 and DR arrays.
- Indication identifying whether or not devices from each site are mapped to a host.
- Indication identifying consistency exempt devices on each site.
- If the RDF groups exist and if the RDF device pairs between them exist.
- Optionally, the devices on each array.

An example output of the `symmdr show` command is as follows; in this case, showing additional details concerning the Alaska named environment on the specified array:

symmdr show -sid 044 -name Alaska

Array ID: 000197900044

Name: Alaska

```
    MetroR1        Flags         DR        Flags       MetroR2        Flags

------------------------ -- ------------------------ -- ------------------------ --

RDFG  Array ID  RDFG ME RP RDFG  Array ID  RDFG ME RP RDFG  Array ID  RDFG ME RP

(<-)          (->)   (<-)         (->)    (<-)         (->)

---- ------------ ---- -- -- ---- ------------ ---- -- -- ---- ------------ ---- -- --

 115 000197900044   33 .. ..   28 000197900033   44 .. .M   76 000197900055  119 .. ..
```


Legend:

 (M)apped device(s) : . = Mapped, M = Mixed, X = Not Mapped

 (E)xempt device(s) : . = Not Exempt, X = Exempt

 (R)DF Group   : . = Exists, X = Does Not Exist

 (P)aired device(s) : . = Paired, M = Mixed, X = Not Paired

9 Best practices

This section describes specific boot from SAN and host multipathing best practices for use with SRDF/Metro configurations.

Note: Please note that all product, feature, script, or example code versions noted in the best practice sections below are specific to the operating system and multipathing software being referenced and not a general statement of support for PowerMax, VMAX, or the SRDF/Metro product.

Note: See the "Host Support Matrix" section of this document for guidance on host, operating system, host cluster, multipathing software, or related items currently supported by SRDF/Metro.

Note: Also check http://support.dellemc.com for additional specifics pertaining to host and operating system requirements to include additional Knowledge Base (KB) support articles which may be more current than the information provided below.

9.1 Boot from SAN support

SRDF/Metro with HYPERMAX OS 5977.811.784 supports booting directly from a SAN environment. With this release, boot drives may be configured on SRDF/Metro devices to support highly availability across SRDF/Metro sites.

See the section "Host Support Matrix" for additional information regarding specific operating systems and multipathing software supported.

Users should use the HBA BIOS (offline) or the HBA Management Utility (online) to configure the SAN-based boot devices. The BIOS or HBA management utility allows the user to specify primary and secondary paths for the boot drives. R1 side paths can be configured as the primary boot path and R2 side path as the secondary boot path. This will ensure reboots are seamless even when one of the sides is not available due to an outage.

See the following support documentation when configuring boot devices within an SRDF/Metro solution:

- For details on boot drive configuration please refer to your vendor-specific HBA management guide or BIOS guides.
- See the host connectivity guide for more additional information regarding Boot from SAN configuration guidelines: https://elabnavigator.EMC.com
- See the ELN for complete set of Boot from SAN supported host and host multipathing software with SRDF/Metro: https://elabnavigator.EMC.com

9.2 Host multipathing software

This section describes best practices for using multipathing software in SRDF/Metro configurations. See the SRDF/Metro Support Matrix for the latest operating system and multipathing software combinations.

In all host environments, it is best practice to not provision the secondary R2 devices to the host before activating SRDF/Metro. This allows the operating system and multipathing software to cleanly detect new paths to the R2 devices when SRDF/Metro reaches Active mode.

9.3   AIX native multipathing software

Best practice is to mask the R2 devices to host operating system once the SRDF/Metro reaches Active-Active or Active-Bias state. If the R2 device paths were masked and discovered before starting SRDF/Metro then some path cleanup and rescan would be required.

For Native Multipathing software on AIX operating systems, the best practice is to use the following setting for MPIO:

```
algorithm  = round_robin (you can choose other algorithm too)
check_cmd  = inquiry
queue_depth = 32
reserve_policy = PR_shared
```

9.4   AIX, GPFS, and PowerPath

Properly configuring multiple paths to the host with AIX 6.x and PowerPath requires additional steps to properly configured SRDF/Metro R2 devices:

1. After entering SRDF/Metro Active mode for the first time, R2 side paths are then masked to the host.
2. Cfgmgr (configuration command to scan and create the native device from R2 side).
3. Run 'emc_pp_configure.sh' script linked below to configure the new native device from V3 side into PowerPath. This script would copy the attributes of the pseudo device into the new native device and reconfigure the native devices back.

The latest emc_pp_configure.sh script may be obtained from the following link:

https://support.emc.com/search/?text=powerpath&facetResource=ST&facetProductId=1726

Note: This script MUST be used in order to properly use an SRDF/Metro R2 device in this environment. Failing to run the script following the configuration of the new native target devices can lead to data unavailability.

After SRDF/Metro enters Active mode for the first time, the SRDF/Metro R2 devices (appearing to the host as additional paths to the source devices) may then be masked by the user and made available to the host. After running cfgmgr to create the host native devices, the emc_pp_configure.sh script below must be run immediately following the completion of the cfgmgr command. The script will configure the new R2 devices into PowerPath by copying the attributes of the PowerPath hdiskpower pseudo devices into the new native devices and reconfigure the native devices.

9.5   Native Linux Multipathing Software (Linux Device Mapper)

After SRDF/Metro reaches active state:

- Mask the R2 devices to the host operating system
- Reload/rescan multipath (`multipath -r command`) to detect and add the new paths.

If SRDF/Metro was started without unmasking the R2 devices, run multipathing commands or scripts to remove the stale paths.

Use the default `/etc/multipath.conf` file. The following options are best practices to help the operating system and multipathing software to detect path changes efficiently:

```
Path_grouping_policy multibus
path_checker tur
features "1 queue_if_no_path"
path_selector "round-robin 0"
no_path_retry 10
```

9.6   IBM i (AS/400) operating system

The recommended best practice is to mask the R2 devices to the host operating system only when the SRDF/Metro reaches Active- Active or Active-Bias state.

The IBM® i operating system contains native multipath capability which will automatically detect and configure multiple paths to the storage devices.

Notes: Unisphere for VMAX cannot be used to configure SRDF/Metro for the IBM i host, however it (U4V) can be used to manage the SRDF/Metro configuration once it has been created using CLI commands.

9.7   PowerPath (version 5.7 and above)

Use default PowerPath multipath settings. When SRDF/Metro reaches active state:

- Mask the R2 devices to the host operating system and reload/rescan PowerPath. On Linux: `/usr/bin/rescan_scsi_bus.sh`.
- Detect and configure the new paths (powermt config).
- If the secondary site (R2 devices) was masked before SRDF/Metro was started:
- Use PowerPath commands/scripts to scan (on Linux: `/usr/bin/rescan_scsi_bus.sh -r`) and remove stale paths (`powermt check`)
- Rescan and update the paths (`powermt config`)

If an operational SRDF/Metro configuration is taken down (planned or unplanned) and then re-established, use the `powermt restore` command to detect path changes faster (otherwise it takes several minutes for PowerPath to detect path changes).

9.8   Windows 2012 with MPIO

Use default MPIO settings with the following parameters enabled:

- `PathVerifyEnabled` - Enable for optimal results with path discovery.
- `PathVerificationPeriod` - Set a time in seconds for automatic path detections.

Dell Technologies recommends setting it to lowest allowed value between 10 and 30 seconds.

9.9   Veritas dynamic multipathing

When SRDF/Metro reaches active state:

- Mask the R2 devices to the host operating system,
- Use the `rescan` command.

On Linux: `/usr/bin/rescan_scsi_bus.sh` followed by `vxdisk scandisks` to detect the new path (`vxdmpadm`) to verify that the new paths are added.

For better path discovery, set `dmp_restore_interval tunable` to 10 seconds.

For example: dmpadm settune dmp_restore_cycles=10

9.10   ESXi with native multipathing

When SRDF/Metro reaches active state:

- Mask the R2 devices to the host operating system
- Use the `rescan` command to detect new paths, or wait for NMP to detect paths automatically.

To reduce the delay in automatic detection, change to 30 seconds.

To set the path polling time, login to the host and go to `Configuration -> Advanced Settings -> Disk` and update the `Disk.PathEvalTime` field.

10 Restrictions and dependencies

The following restrictions and dependencies apply to SRDF/Metro configurations. For information regarding additional code-specific restrictions, please refer to the SRDF/Metro support matrix located at: https://elabnavigator.EMC.com.

- Both the R1 and R2 side must be running HYPERMAX OS 5977.691.684 or greater
- SRDF/Metro license must be installed on both arrays to be managed
- Only non-SRDF devices can become part of an SRDF/Metro configuration with HYPERMAX OS 5977.811.784 and earlier
- Concurrent and cascaded SRDF/A configurations are only supported with the HYPERMAX OS Q3 2016 SR and later
- Concurrent and cascaded SRDF/A configurations support Single Session Consistency only (no MSC)
- Concurrent (R11) SRDF/A target must be a VMAX running HYPERMAX OS 5977 Q3 2016 SR or later
- The R1 and R2 must be identical in size
- Devices cannot have Geometry Compatibility Mode (GCM) set on code prior to PowerMaxOS Q2 2018 SR
- Devices cannot have User Geometry set
- Online device expansion is not supported
- createpair -establish, establish, restore, and suspend operations must apply to all devices in the SRDF group
- Control of devices in an SRDF group which contains a mixture of R1s and R2s is not supported
- vWitness configurations require Embedded Element Management (EEM or eMgmt) on each SRDF/Metro paired array
- vWitness vApp requires VMware ESXi 4.0 or higher, and Solutions Enabler or Unisphere 8.3 or greater
- Consistency Exempt Status Restrictions:

  – Restore operations will be blocked while one or more devices in an SRDF/Metro group are in an 'exempt' status
  – At least one device within the SRDF/Metro session must be non-exempt
  – Management software will not allow all devices in the SRDF/Metro session to be removed with exempt deletepair or movepair
  – If the devices added to the SRDF/Metro configuration are, or will be, concurrent SRDF devices, they must meet the criteria required of concurrent devices in an SRDF/Metro configuration:

    > The non-Metro RDF mirror cannot be in Synchronous mode
    > A device cannot have 2 Metro RDF mirrors
    > The non-Metro RDF mirror of the SRDF/Metro devices must be an R1.
    > The R1 device in an SRDF/Metro configuration can be an R11 device, but it cannot be an R21 device, and
    > The R2 device in an SRDF/Metro configuration can be an R21 device, but it cannot be an R22 device
    > A device cannot simultaneously be both RW on the RDF link on the Metro RDF mirror and the target of data copy from the non-Metro RDF mirror
    > A device cannot be WD to the host if the device's Metro SRDF mirror is RW on the RDF link

- Other Movepair Exempt support restrictions:

  – The SRDF R1/R2 'polarity' of the source SRDF device pairs must match that of the target SRDF group.
  – For example, R2 devices on one side of the link may not be moved into a group where the devices have R1 personalities
  – As with '**createpair –exempt**', movepair can only be used if the active SRDF/Metro group does not contains exempt devices
  – If any of the SRDF device pairs being added have the SyncInProg SRDF pair state, then the -symforce option is required
  – Device pairs being added will be suspended during the movepair operation
  – Source device pairs which have Suspended or SyncInProg SRDF pair states cannot have invalids owed from R2 to R1

- Online Device Expansion (ODE) Restrictions:

  – Requires PowerMaxOS 5978 Q2 2019 SR and Solutions Enabler/Unisphere for PowerMax 9.1 or greater
  – SRDF N-X environments will not be supported (PowerMaxOS 5978 Q2 2019 SR or later only)
  – No device expansion will be allowed when SRDF/Metro pair is Partitioned
  – Expansion of a larger R2 is not supported, R1/R2 same initial sizes only
  – No support for NDM migrations or devices actively being migrated
  – For SRDF/Metro DR (w/Async leg) support:

    > Configuration with a 3rd site will require multiple steps rather than a single operation/command
    > Will need to expand DR site first and then expand SRDF/Metro pair
    > It will be necessary to suspend DR during the expansion operation

- Smart DR Restrictions:

  – Metro RDF, MetroR1 to DR RDF and MetroR2 to DR SRDF groups are online
  – All 3 Arrays must be PowerMaxOS 5978 Q3 2020 SR (Hickory) or greater
  – All 3 Arrays must be discoverable through SE and must be in the symapi_db.bin
  – All of the MetroR1 devices must be in the same SRDF/A session
  – All of the SRDF/A R1 devices on the MetroR1 array must be in the same Metro session
  – All of the MetroR2 devices must be in the same SRDF/A session
  – All of the SRDF/A R1 devices on the MetroR2 array must be in the same Metro session
  – The MetroR1, Metro R2, DR devices must be the same size
  – Online Device Expansion (ODE) is not supported. Remove/ODE/Setup is required
  – Devices cannot be: BCV, Encapsulated, RP, Data Domain, PPRC, CKD, Part of a STAR configuration, Part of a SQAR configuration, Enabled for MSC, Part of a Data Migration session

11   Conclusion

Symmetrix Remote Data Facility (SRDF) solutions provide disaster recovery and data mobility solutions for PowerMax, VMAX, VMAX3, and VMAX All Flash arrays. HYPERMAX OS 5977.691.684 and Solutions Enabler/Unisphere for VMAX 8.1 introduced support for SRDF/Metro for VMAX3 and VMAX All Flash storage arrays. SRDF/Metro significantly changes the traditional behavior of SRDF to better support your critical applications in high availability environments.

SRDF/Metro may be managed through Solutions Enabler SYMCLI or Unisphere for VMAX 8.1 or greater client software and requires a SRDF/Metro license on each PowerMax, VMAX3, or VMAX All Flash paired array.

With SRDF/Metro, the SRDF R2 device is read/write accessible to the host and takes on the external identity of the primary R1 device (geometry, device WWN). By providing this external identity on the R2 device, both R1 and R2 devices may then appear as a single virtual device across the two SRDF paired arrays for presentation to a single host or host cluster.

With both the R1 and R2 devices being accessible, the host or hosts (in the case of a cluster) can read and write to both R1 and R2 devices with SRDF/Metro ensuring that each copy remains current, consistent, and addressing any write conflicts which may occur between the paired SRDF devices. A single VMAX3 or VMAX All Flash may simultaneously support multiple SRDF groups configured for SRDF/Metro operations and multiple SRDF groups configured for non-SRDF/Metro operations.

Performance statistic exchange begins once the SRDF/Metro Active mode and ActiveActive or ActiveBias pair state have been achieved. Each side then incorporates the FAST statistics from the other side to ensure each side represents the workload as a whole (R1+R2 workload). Users may set the required service level objective (SLO) independently on both source and target SRDF/Metro paired arrays. There are currently no restrictions in this area as FAST data movement is transparent from SRDF/Metro.

SRDF/Metro uses the SRDF link between the two sides of the SRDF device pair to ensure consistency of the data. If one or more SRDF device pairs become not ready (NR) on the SRDF link or all link connectivity is lost between VMAX3 or VMAX All Flash systems (suspended or partitioned states), SRDF/Metro selects one side of the SRDF device pair to remain accessible to the hosts, while making the other side of the SRDF device pair inaccessible.

SRDF/Metro supports two resiliency features to accommodate this behavior, bias and witness. While both of these features prevent data inconsistencies and split-brain complications between the two sides of the SRDF device pair. Split-brain complications are data or availability inconsistencies originating from the maintenance of two separate devices (with an overlap in scope) due to a failure caused by these systems not communicating or synchronizing their data.

The first resiliency feature, bias, is a function of the two PowerMax, VMAX3, or VMAX All Flash systems taking part in the SRDF/Metro configuration and is a required and integral component of the configuration. The second feature, witness, builds upon the base bias functionality by adding an optional SRDF/Metro component which allows a 3rd VMAX based (VMAX, VMAX3, or VMAX All Flash) or software based (Virtual Witness) node to act as an external arbitrator to ensure host accessibility in cases where bias alone would restrict access to one side of the SRDF/Metro device pairs.

The following features were introduced with the PowerMaxOS 5978 Q3 2020 Service Release (SR) and Solutions Enabler/Unisphere for PowerMax 9.2:

- SRDF/Metro Smart DR
- Support for 25 GbE SRDF
- SRDF/Metro Smart DR provides SRDF/Metro with a single asynchronous target R22 volume which may be populated from either the R1 or R2 volume of an SRDF/Metro paired solution. Adding the capability to use a single asynchronous target volume simplifies setup, maintenance capabilities, system requirements, and reduces the amount of disk space required for a single target system.

This release also added support for the 4 port 25 Gb Ethernet I/O module and protocol driver for all SRDF replication and host connectivity (RE/SE). This hardware expands PowerMax support for next generation Ethernet-based SAN fabrics, continuing to provide maximum I/O performance and fabric capabilities to the platform.

A   Unisphere setup walkthrough

This appendix provides an example walkthrough of the SRDF/Metro interface with Unisphere for PowerMax 9.1.

The following operations are covered in the examples:

- Verify Unisphere and Arrays
- Create SRDF/Metro SRDF Group
- Optional Witness Configuration
- Identify Storage Group to be Protected
- Protect Storage Group via SRDF/Metro
- Display newly created SRDF/Metro Group

Verify Unisphere and Arrays (Local Source 0130/ Remote Target 0191)

The home screen below notes two systems, 0130 will be the primary (R1) system in the following examples while system 0191 will be the secondary (R2).

Double check on system 0130 for the next step.
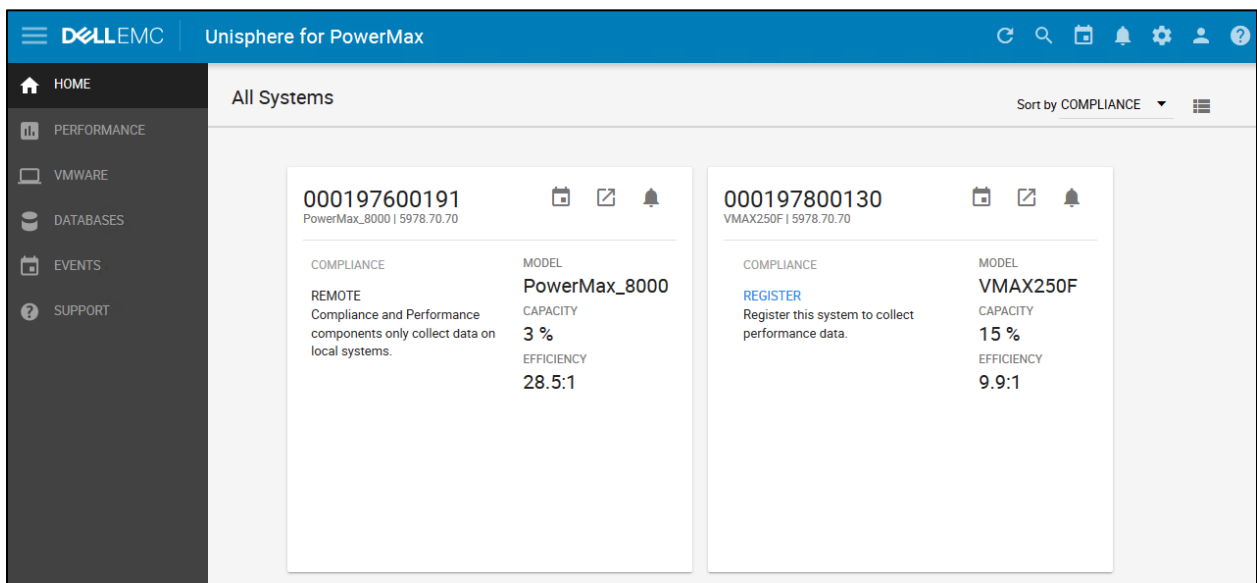
Create SRDF/Metro SRDF Group

Next, create a dynamic SRDF group for use with our SRDF/Metro configuration.

Choose Data Protection, SRDF Groups and follow the examples below to create the MetroRDFG group.
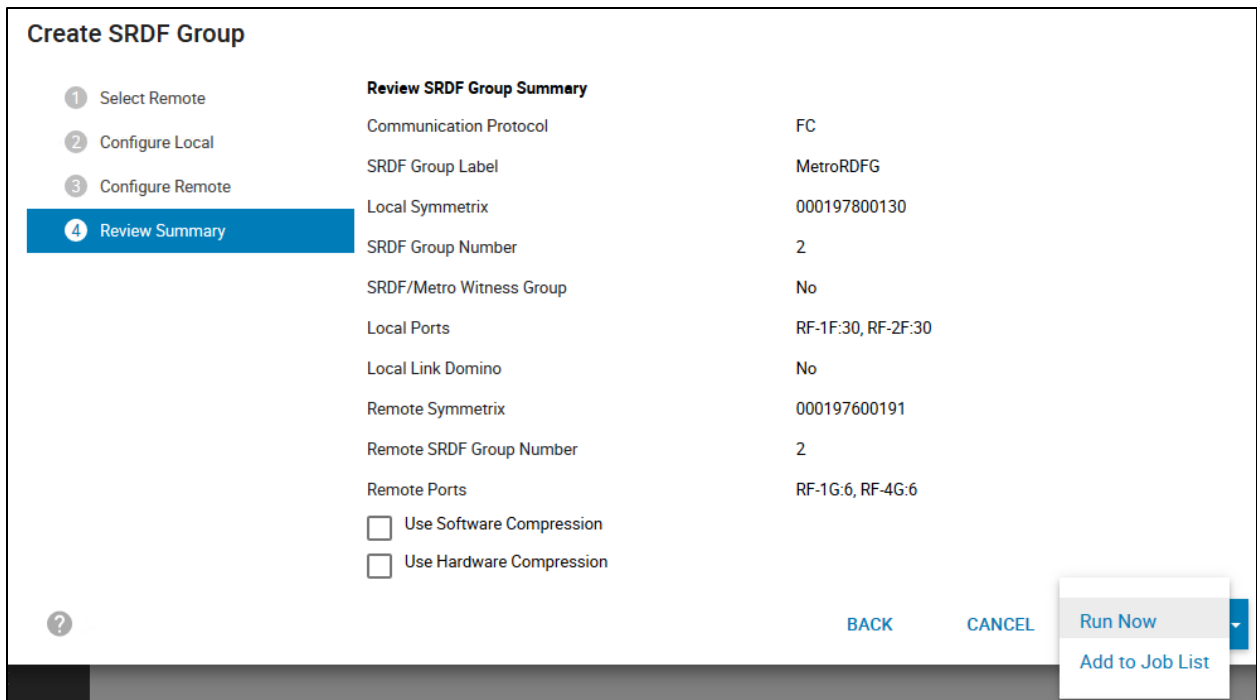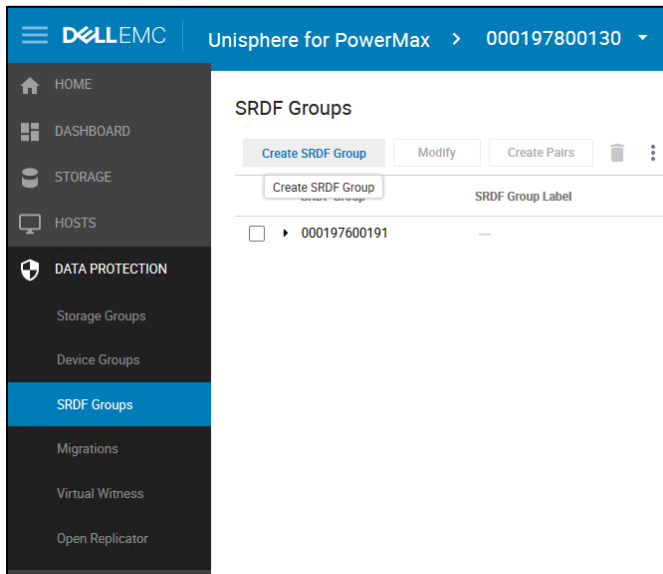
Optional Witness Configuration

Configuring a witness is not essential to the completion of this example; however, if the user would prefer to use either an array based or virtual witness (vWitness) the following documents are available which contain setup instructions:

SRDF/Metro vWitness Configuration Guide:
http://www.emc.com/collateral/TechnicalDocument/docu78903.pdf

Identify Storage Group to be Protected

To identify the example application storage group which we will protect under SRDF/Metro, chose Storage, Storage Groups… the MetroApp1 storage group will be used in the following SRDF/Metro examples.

Protect Storage Group via SRDF/Metro

To protect MetroApp1, select it and choose Protect from the options immediately above.
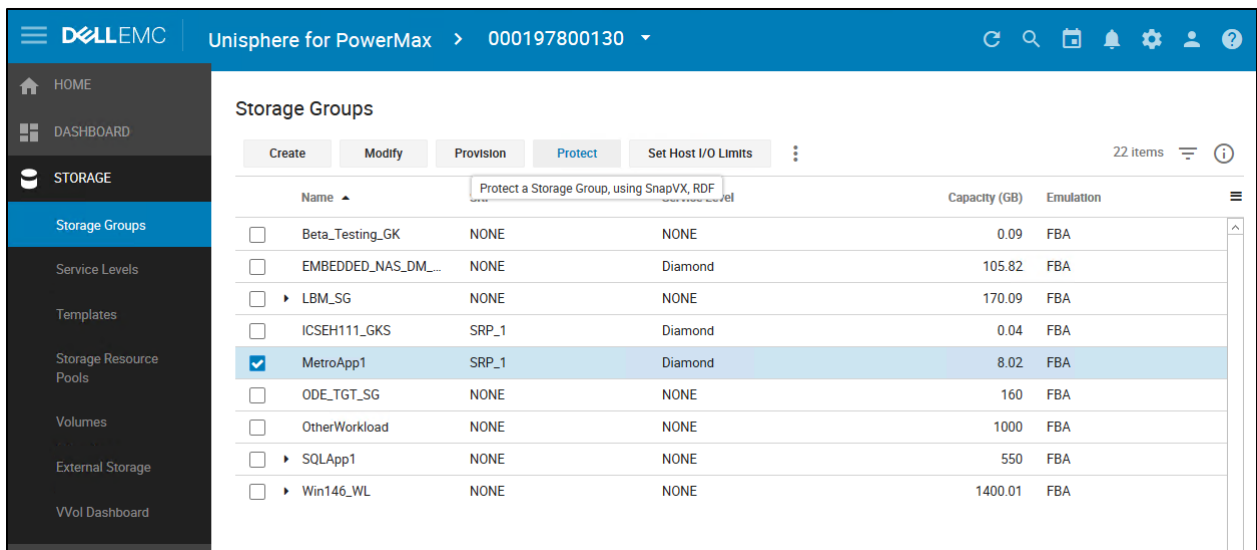
The following Protection Wizard will walk you through the process of creating the SRDF/Metro configuration based on the SRDF Group previously created. The example below will use bias protection; however, you may also have the option of Witness protection should you have created an optional witness in the previous step.
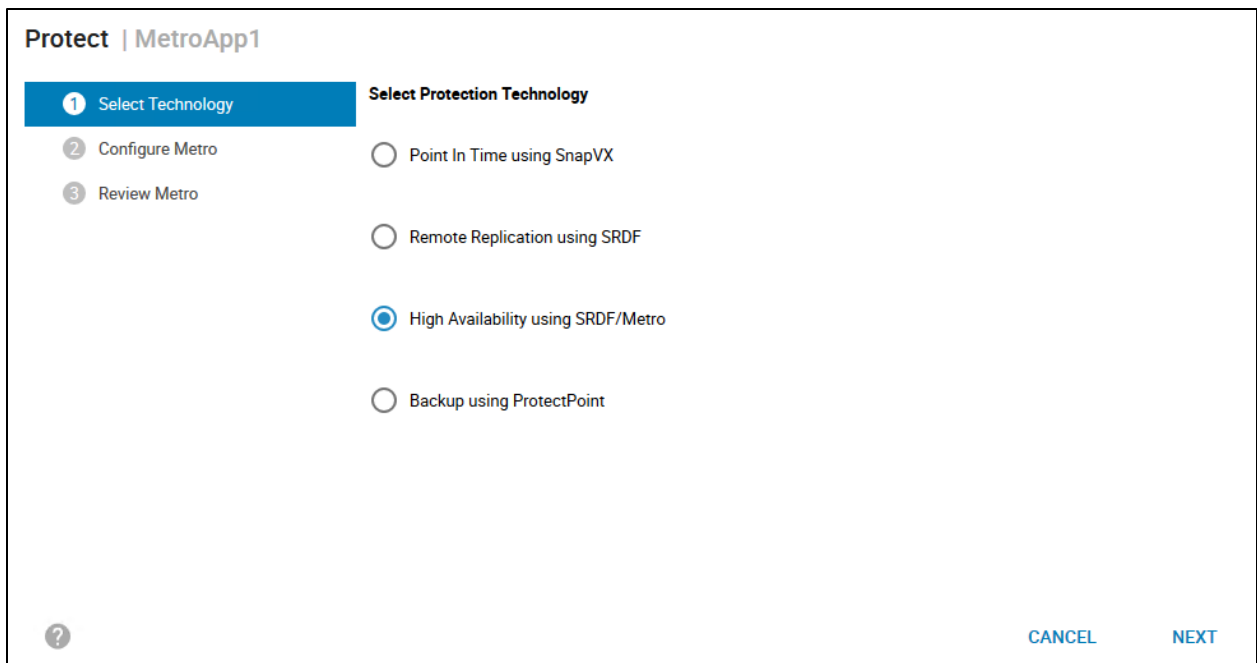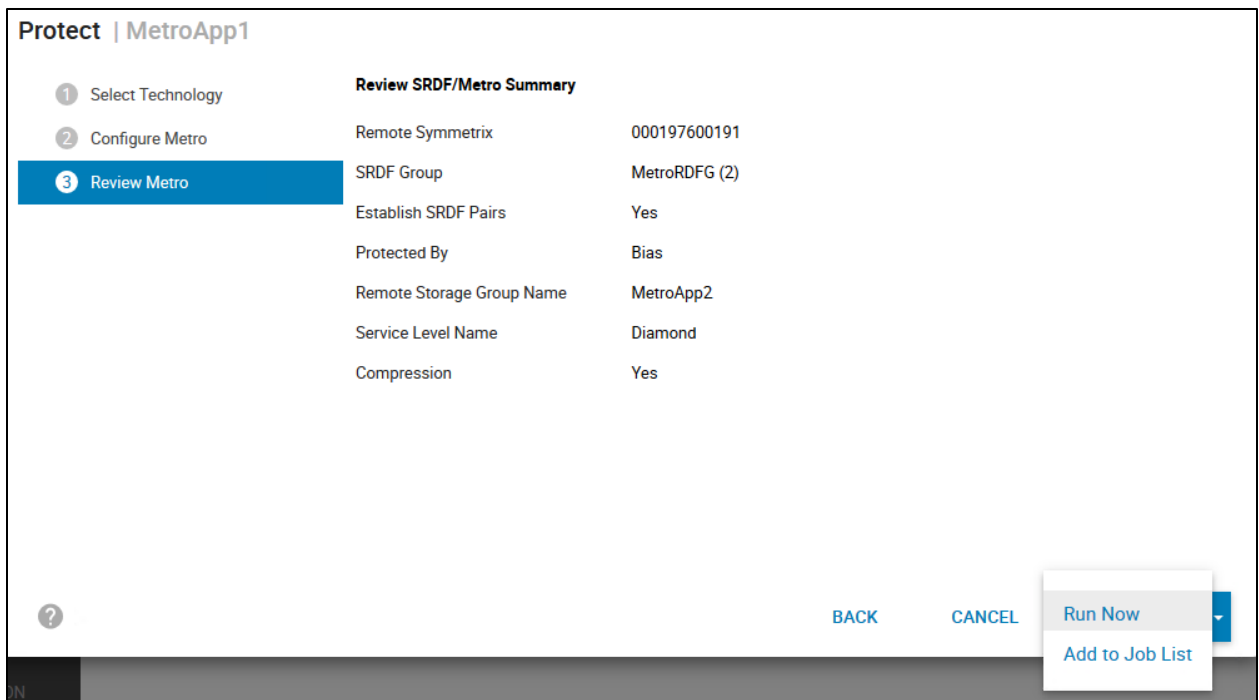
Display newly created SRDF/Metro Group

This display can be found by navigating to Data Protection, Storage Groups….
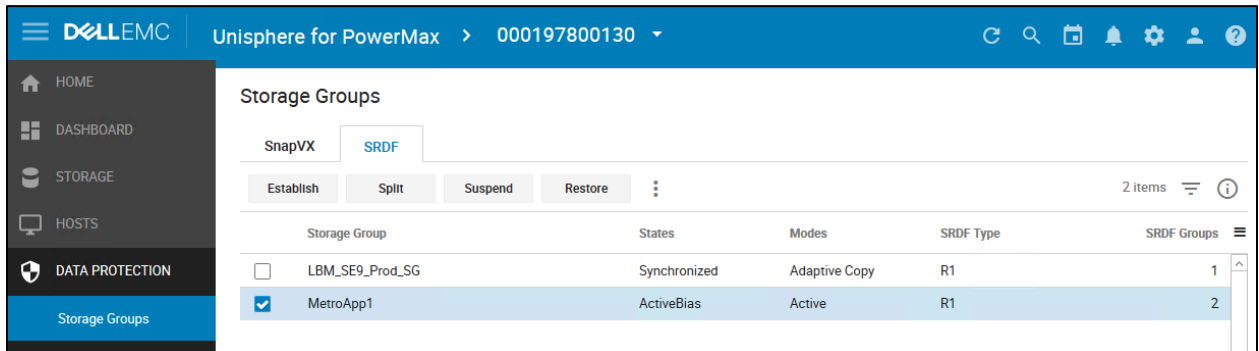
B Solutions Enabler SYMCLI Walkthrough

This appendix provides an example walkthrough of the SRDF/Metro interface with Unisphere for VMAX 8.1. The following operations will be covered in the examples provided:

- Verifying SYMCLI and Discovery
- Source SID 174 RA Configuration
- Remote SID 248 RA Configuration
- Local and Remote RA Group Configuration
- Adding Witness SRDF Groups
- Listing SRDF/Metro Related SRDF Groups
- Creating Storage Groups and Standard Devices
- Display Source Storage Group and Devices
- Display Target Storage Group and Devices
- Creatpair with –rdf_metro and Storage Groups
- Query newly created SRDF/Metro Group
- Show First Source R1 Device, External Identity
- Show First Source R1 Device, RDF Information
- Show First Target R2 Device, External Identity
- Show First Target R2 Device, RDF Information
- Verifying Modes, Changing Bias in Active Mode
- Changing Bias on Suspend
- Deletepair Example

```
symcli

Symmetrix Command Line Interface (SYMCLI) Version V8.1.0.0
```

```
symcfg discover

```

```
symcfg list

                                     Mcode     Cache      Num Phys   Num Symm

    SymmID       Attachment  Model    Version   Size (MB)  Devices    Devices


```

Figure 18   Verifying SYMCLI and Discovery

```
symcfg -sid 0174 list -ra all


   S Y M M E T R I X    R D F    D I R E C T O R S


          Remote        Local    Remote      Status

Ident Port SymmID       RA Grp   RA Grp  Dir      Port

----- ---- ------------ -------- -------- ---------------


RF-1E    5      -           -         - Online  PendOn

RF-2E    5 000196800248  1 (00)   1 (00) Online  Online

         5 000196800248  2 (01)   2 (01) Online  Online

RF-3E    5 000196800248  1 (00)   1 (00) Online  Online

         5 000196800248  2 (01)   2 (01) Online  Online

RF-4E    5      -           -         - Online  PendOn
```

Figure 19   Source SID 174 RA Configuration

```
symcfg –sid 248 list -ra all


      S Y M M E T R I X     R D F     D I R E C T O R S



          Remote          Local     Remote      Status

Ident Port SymmID          RA Grp    RA Grp   Dir      Port

----- ---- ------------  --------  -------- ----------------


RF-1F     5 000196800174   1 (00)    1 (00) Online   Online

          5 000196800174   2 (01)    2 (01) Online   Online

RF-2F     5 000196800174   1 (00)    1 (00) Online   Online

          5 000196800174   2 (01)    2 (01) Online   Online
```

Figure 20   Remote SID 248 RA Configuration

```
symcfg list -rdfg 2


Symmetrix ID : 000196800174


    Local              Remote                Group               RDFA Info

-------------- -------------------- ------------------------- ---------------

         LL                                    Flags   Dir Flags Cycle

 RA-Grp  (sec) RA-Grp  SymmID     T    Name     LPDS CHTM Cfg CSRM  time  Pri

-------------- -------------------- ------------------------- ----- ----- ---

  2 ( 1)    10   2 ( 1) 000196800248 D Metro_RDFG XX.. ..X. F-S -IS-    15  33


Symmetrix ID : 000196800248


    Local              Remote                Group               RDFA Info

-------------- -------------------- ------------------------- ---------------

         LL                                    Flags   Dir Flags Cycle

 RA-Grp  (sec) RA-Grp  SymmID     T    Name     LPDS CHTM Cfg CSRM  time  Pri

-------------- -------------------- ------------------------- ----- ----- ---

  2 ( 1)    10   2 ( 1) 000196800174 D Metro_RDFG XX.. ..X. F-S -IS-    15  33
```

Figure 21   Local & Remote RA Group Configuration

```
symrdf addgrp -sid 174 -rdfg  -remote_sid 584 -remote_rdfg 5

    -dir 2F:5,2F:5 -remote_dir 1F:5,2F:5 -label 584_174_W -witness
```

```
symrdf addgrp -sid 248 -rdfg 5 -remote_sid 584 -remote_rdfg 4          -
dir 1F:5,2F:5 -remote_dir 1E:5,2E:5 -label 584_248_W -witness
```

Figure 22   Adding Witness SRDF Groups

```
symcfg list –rdfg all -sid 174 –rdf_metro


 Local                 Remote                   Group                    RDF Metro

------------  --------------------  ----------------------------  ------------------

         LL                                            Flags   Dir    Witness

 RA-Grp  sec  RA-Grp  SymmID       ST     Name      LPDS CHTM Cfg CE S SymmID

------------  --------------------  ----------------------------  --  --------------

  2 ( 3)  10   4 ( 3) 000196800248 OD SRDF_Metro XX.. ..XX F-S WW N 000196700584

  5 ( 4)  10   4 ( 3) 000196700584 OW 584_174_W  XX.. ..X. F-S -- - -

…

     RDF (M)etro                        : X = Configured, . = Not Configured

  RDF Metro Flags    :

     (C)onfigured Type                  : W = Witness, B = Bias, - = N/A

     (E)ffective Type                   : W = Witness, B = Bias, - = N/A

     Witness (S)tatus                   : N = Normal, D = Degraded,

                                          F = Failed, - = N/A
```

Figure 23   Listing SRDF/Metro Related SRDF Groups

```
symsg –sid 174 create RDF1_SG

symsg –sid 248 create RDF2_SG
```

```
symconfigure -sid 174 -cmd "create dev count=10, size=2 GB, emulation=FBA,

          config=TDEV, sg=RDF1_SG;" commit



Adding devices to Storage Group..........................Done.

     New symdevs: 0006B:00074 [TDEVs]

   Terminating the configuration change session.............Done.
```

Figure 24   Creating Storage Groups and Standard Devices

```
symsg -sid 174 show RDF1_SG


Devices (10):

    {

    -----------------------------------------------------------------

    Sym                             Device                         Cap

    Dev     Pdev Name               Config          Attr  Sts    (MB)

    -----------------------------------------------------------------

    0006B  N/A                      TDEV                   RW     2049

    0006C  N/A                      TDEV                   RW     2049

    0006D  N/A                      TDEV                   RW     2049

    0006E  N/A                      TDEV                   RW     2049

    0006F  N/A                      TDEV                   RW     2049

    00070  N/A                      TDEV                   RW     2049

    00071  N/A                      TDEV                   RW     2049

    00072  N/A                      TDEV                   RW     2049

    00073  N/A                      TDEV                   RW     2049

    00074  N/A                      TDEV                   RW     2049

    }
```

Figure 25   Display Source Storage Group and Devices

```
symsg -sid 248 show RDF2_SG


 Devices (10):

    {

    ----------------------------------------------------------------

    Sym                             Device                      Cap

    Dev    Pdev Name                Config        Attr  Sts    (MB)

    ----------------------------------------------------------------

    00070  N/A                      TDEV                 RW     2049

    00071  N/A                      TDEV                 RW     2049

    00072  N/A                      TDEV                 RW     2049

    00073  N/A                      TDEV                 RW     2049

    00074  N/A                      TDEV                 RW     2049

    00075  N/A                      TDEV                 RW     2049

    00076  N/A                      TDEV                 RW     2049

    00077  N/A                      TDEV                 RW     2049

    00078  N/A                      TDEV                 RW     2049

    00079  N/A                      TDEV                 RW     2049

    }
```

Figure 26   Display Target Storage Group and Devices

```
symrdf createpair -rdf_metro -sid 174 -type R1 -rdfg 2

       -sg RDF1_SG -remote_sg RDF2_SG -establish



An RDF 'Create Pair' operation execution is

in progress for storage group 'RDF1_SG'. Please wait…

    Create RDF Pair in
(0174,002)..................................Started.

    Create RDF Pair in (0174,002)....................................Done.

    Mark target device(s) in (0174,002) for full copy from
source....Started.

    Devices: 006B-0074 in (0174,002)..............................Marked.

    Mark target device(s) in (0174,002) for full copy from source....Done.

    Merge track tables between source and target in
(0174,002).......Started.

    Devices: 006B-0074 in (0174,002)..............................Merged.

    Merge track tables between source and target in (0174,002).......Done.

    Resume RDF link(s) for device(s) in
(0174,002)..................Started.

    Read/Write Enable device(s) in (0174,002) on SA at target (R2)...Done.

The RDF 'Create Pair' operation successfully executed for

storage group 'RDF1_SG'.
```

Figure 27   Createpair with –rdf_metro and Storage Groups

```
symrdf -sid 174 -sg RDF1_SG -rdfg 2 query


        Source (R1) View              Target (R2) View      MODE

------------------------------    ---------------------- ---- ------------

           ST                   LI      ST

Standard      A                 N       A

Logical  Sym   T R1 Inv  R2 Inv  K Sym   T R1 Inv  R2 Inv       RDF Pair

Device   Dev   E Tracks  Tracks  S Dev   E Tracks  Tracks  MACE STATE

------------------------------- b ---------------------- ---- ------------


N/A      0006B RW      0       0 RW 00070 RW      0       0 T.X. ActiveActive

…

N/A      00074 RW      0       0 RW 00079 RW      0       0 T.X. ActiveActive


Legend for MODE:


 M(ode of Operation)    : A = Async, S = Sync, E = Semi-sync, C = Adaptive Copy

                       : M = Mixed, T = Active

 A(daptive Copy)        : D = Disk Mode, W = WP Mode, . = ACp off

 C(onsistency State)    : X = Enabled, . = Disabled, M = Mixed, - = N/A

 (Consistency) E(xempt): X = Enabled, . = Disabled, M = Mixed, - = N/A
```

Figure 28   Query Newly Created SRDF/Metro Group

```
symdev -sid 174 show 6B
…
Device External Identity
    {
    Device WWN        : 6000097000019680017453303030303642
    Front Director Paths (0): N/A
    Geometry          : Native
        {
        Sectors/Track      :       256
        Tracks/Cylinder    :        15
        Cylinders          :      1093
        512-byte Blocks    :   4197120
        MegaBytes          :      2049
        KiloBytes          :   2098560
        }
    }
…
```

Figure 29   Show First Source R1 Device, External Identity

```
symdev -sid 174 show 6B

…

RDF Information

        {

        Device Symmetrix Name                   : 0006B

        RDF Type                                : R1

        RDF (RA) Group Number                   :   2 (01)

        Remote Device Symmetrix Name            : 00070

        Remote Symmetrix ID                     : 000196800248

        RDF Mode                                : Active

        …

        Device Consistency State                : Enabled

        …

        Device RDF State                        : Ready            (RW)

        Remote Device RDF State                 : Ready            (RW)

        RDF Pair State (  R1 <===> R2 )         : ActiveActive

 …
```

Figure 30   Show First R1 Device, RDF Information

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```
symdev -sid 248 show 70

…

Device External Identity

        {

        Device WWN              : 60000970000196800174533030303642

        Front Director Paths (0): N/A

        Geometry                : Native

            {

            Sectors/Track        :          256

            Tracks/Cylinder      :           15

            Cylinders            :         1093

            512-byte Blocks      :      4197120

            MegaBytes            :         2049

            KiloBytes            :      2098560

            }

        }

…
```

Figure 31   Show First Target R2 Device, External Identity

```
symdev -sid 248 show 70

…

RDF Information

        {

        Device Symmetrix Name                   : 00070

        RDF Type                                : R2

        RDF (RA) Group Number                   :   2 (01)

        Remote Device Symmetrix Name            : 0006B

        Remote Symmetrix ID                     : 000196800174

        RDF Mode                                : Active

        …

        Device Consistency State                : Enabled

        …

        Device RDF State                        : Ready          (RW)

        Remote Device RDF State                 : Ready          (RW)

        RDF Pair State (  R1 <===> R2 )         : ActiveActive

        …
```

Figure 32   Show First Target R2 Device, RDF Information

```
symrdf -sid 085 -rdfg 86 verify -activeactive

symrdf -sid 085 -rdfg 86 verify -activebias [if -use_bias]

symrdf -sid 174 -sg RDF1_SG -rdfg 2 set bias R2


Execute an RDF Set 'Bias R2' operation for storage

group 'RDF1_SG' (y/[n]) ? y


An RDF Set 'Bias R2' operation execution is in

progress for storage group 'RDF1_SG'. Please wait...


The RDF Set 'Bias R2' operation successfully executed

for storage group 'RDF1_SG'.
```

Figure 33   Verifying Modes, Changing Bias in Active Mode

```
symrdf -sid 174 -sg RDF1_SG -rdfg 2 suspend -bias R2 -force


Execute an RDF 'Suspend' operation for storage

group 'rdf1_sg' (y/[n]) ? y


An RDF 'Suspend' operation execution is

in progress for storage group 'rdf1_sg'. Please wait...


    Suspend RDF link(s) for device(s) in
(0174,002)..................Done.


The RDF 'Suspend' operation successfully executed for

storage group 'rdf1_sg'.
```

Figure 34   Changing Bias on Suspend

```
symrdf -sid 174 -sg RDF1_SG -rdfg 2 suspend

symrdf deletepair -sid 174 -type R1 -rdfg 2 -sg RDF1_SG …
```

Figure 35   Deletepair Example

C   Unisphere Createpair –exempt specific steps

This appendix provides an example walkthrough of the SRDF/Metro interface with Unisphere for PowerMax 9.0. The following operations are covered in the examples:

- Create new Devices on Source and Target Arrays
- Verify SRDF/Metro Group is currently Active
- Perform Createpair –Exempt operation with active SRDF/Metro Group
- Display updated SRDF/Metro Group with Newly Added Devices

Create new Devices on Source and Target Arrays

In this section, we will create new source and target volumes which will be added the the active SRDF/Metro group. Navigate to the Storage, Volumes section and follow the create wizard to create appropriate primary side devices (R1). You will then select the secondary array (0191) and do the same to create the secondary devices (R2).
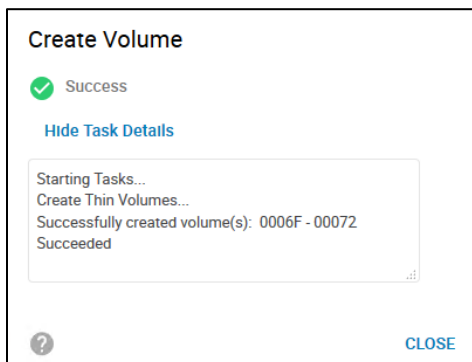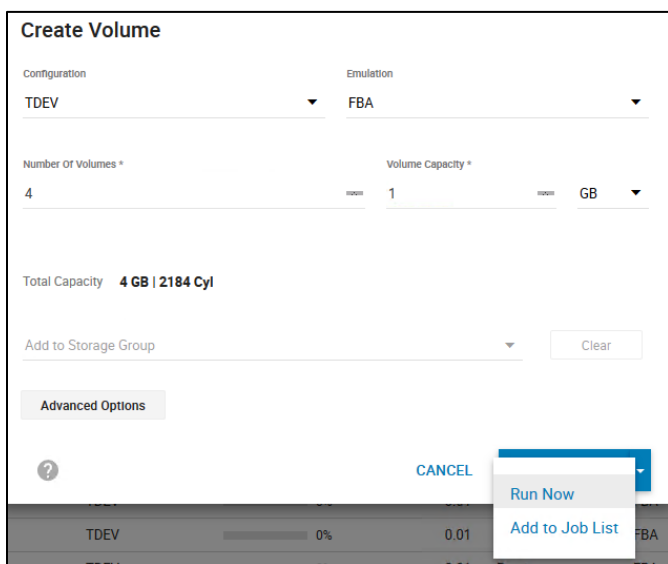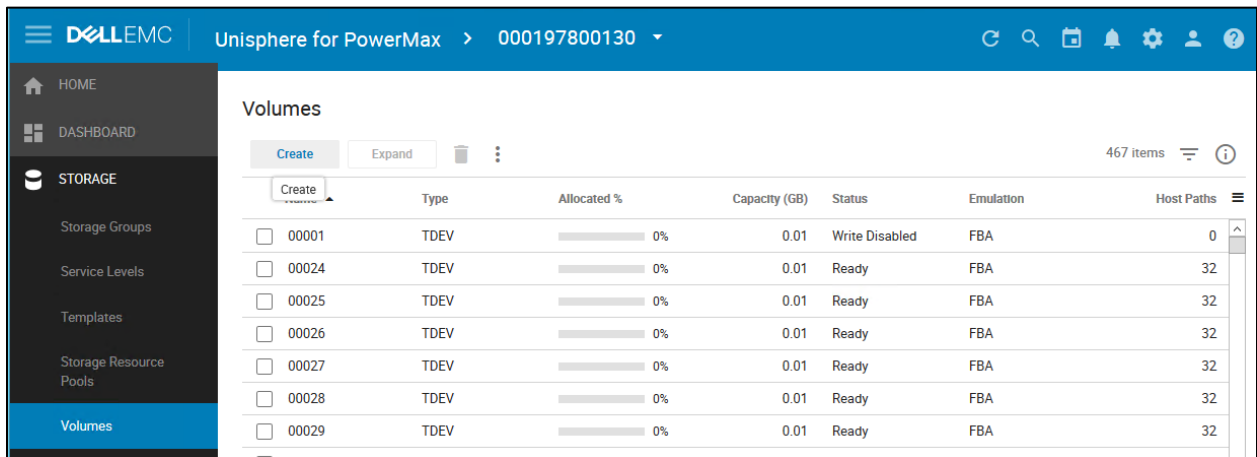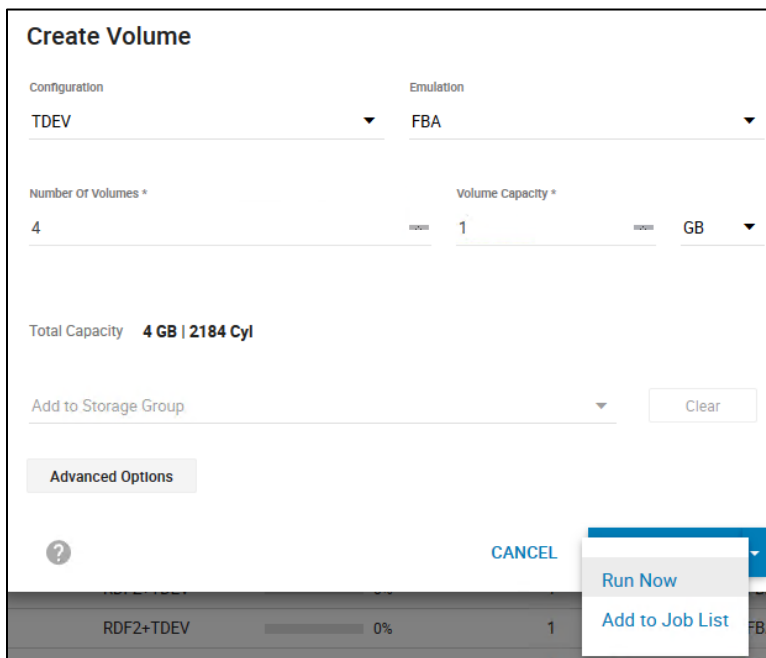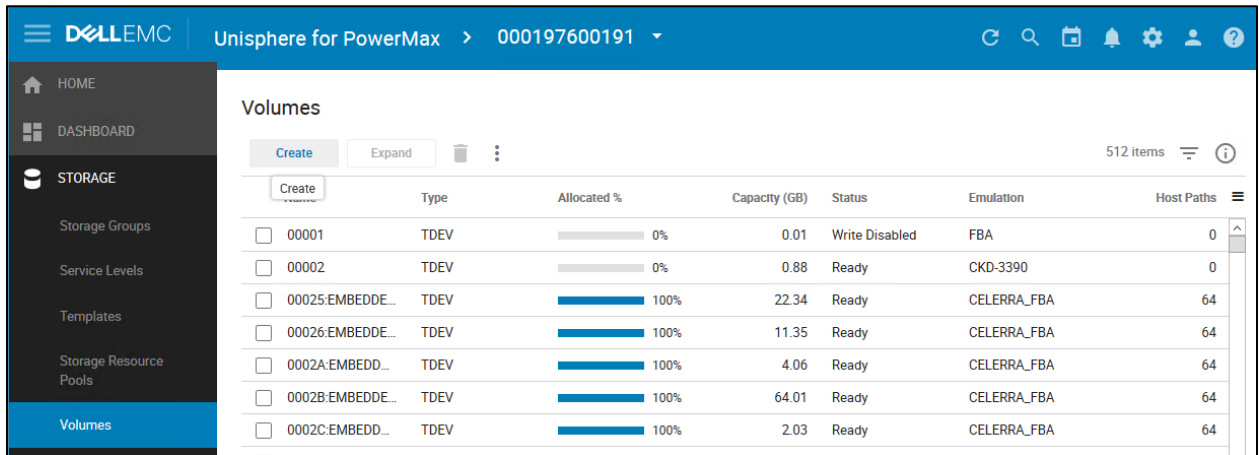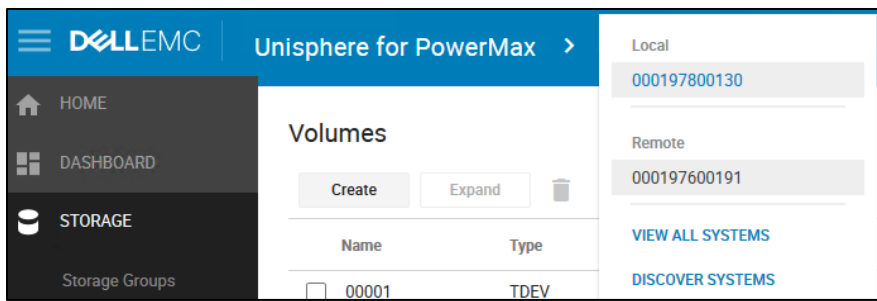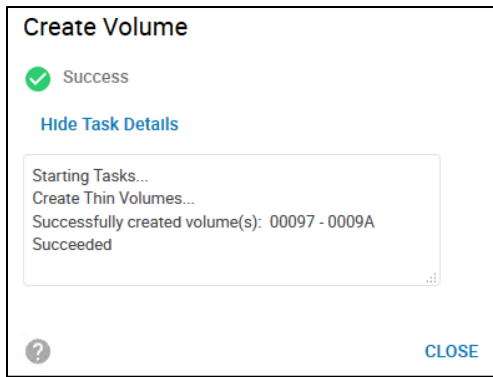
Verify SRDF/Metro Group is currently Active

On the primary array (0130), choose Data Protection, Storage Groups, SRDF, to verify that the MetroApp1 storage group mode is active.
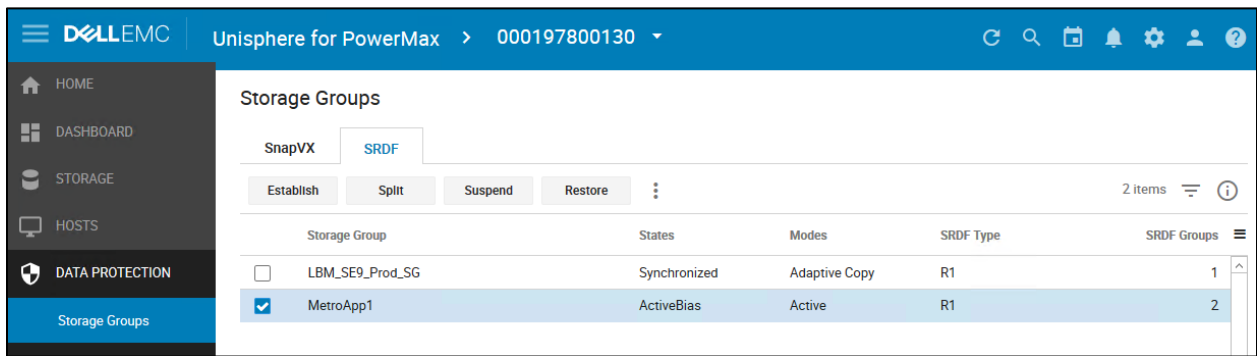
Perform Createpair –Exempt operation with active SRDF/Metro Group

To add the previously created devices to the SRDF/Metro active configuration, choose Data Protection, SRDF Groups, select the MetroRDFG group, then the Create Pairs option above to enter the appropriate wizard to add new devices to the chosen SRDF group.
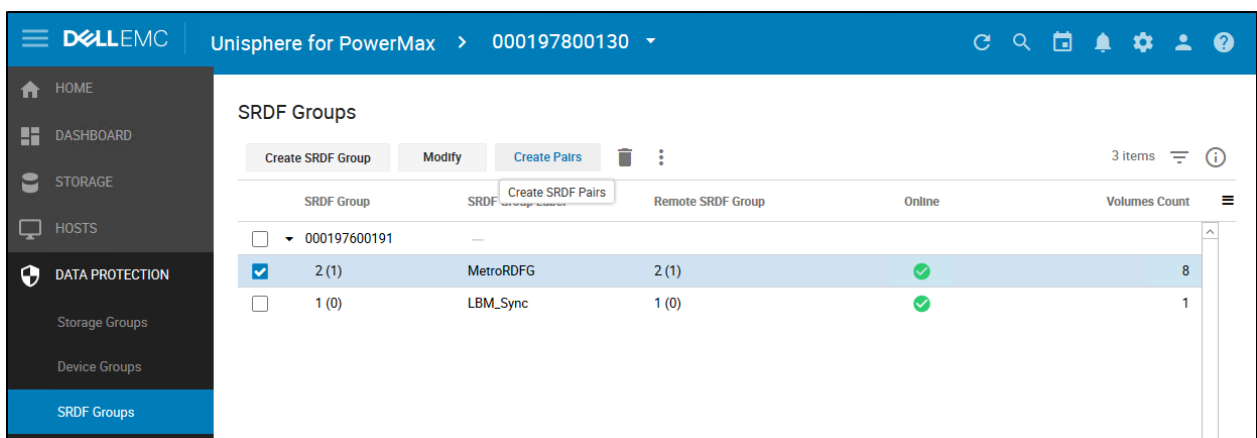
Create Pairs

1 Select SRDF Mode
2 Select Local Volumes
3 Select Remote Volumes
4 Review Pair Summary

Mirror Type

R1 ▼

SRDF Mode

Active ▼

Find Volumes

1 Find Volumes
2 Select Volumes

Find Volumes that match the following criteria

Capacity equal to

Volume ID

6F-72

Volume Identifier Name

Volume Configuration

TDEV ▼

Emulation

Any ▼

☑ Is Not In Use

Capacity Type

GB ▼

CANCEL   NEXT

Find Volumes

1 Find Volumes
2 Select Volumes

Available Volumes

4 items ☰

	Name ▲	Configuration	Capacity (GB)	Emulation	SRDF Group Nu...	☰
☑	0006F	TDEV	1	FBA	N/A	
☑	00070	TDEV	1	FBA	N/A	
☑	00071	TDEV	1	FBA	N/A	
☑	00072	TDEV	1	FBA	N/A	

BACK   CANCEL   OK

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Create Pairs

1 Select SRDF Mode

2 Select Local Volumes

3 Select Remote Volumes

4 Review Pair Summary

Local Volumes

☐ Automatic Selection

Select Volumes

4 VOLUMES SELECTED

☑ Add to Storage Group

🔍 Select Storage Group

ICSEH111_GKS

LBM_GK_SG

Beta_Testing_GK

✓ MetroApp1

BACK   CANCEL   NEXT

Find Remote Volumes

1 Find Volumes

2 Select Volumes

Find Volumes that match the following criteria

Capacity equal to   ≈

Capacity Type

GB ▼

Volume ID

97-9A

Volume Identifier Name

Volume Configuration

TDEV   ▼

Emulation

Any   ▼

☑ Is Not In Use

CANCEL   NEXT

DELLTechnologies

Find Remote Volumes

1 Find Volumes

2 Select Volumes

Available Volumes

4 items

Name ▲	Configuration	Capacity (GB)	Emulation	SRDF Group Nu...
☑ 00097	TDEV	1	FBA	N/A
☑ 00098	TDEV	1	FBA	N/A
☑ 00099	TDEV	1	FBA	N/A
☑ 0009A	TDEV	1	FBA	N/A

BACK   CANCEL   OK

Create Pairs

1 Select SRDF Mode

2 Select Local Volumes

3 Select Remote Volumes

4 Review Pair Summary

Remote Volumes

☐ Automatic Selection

Select Volumes

4 VOLUMES SELECTED

☑ Add to Storage Group

🔍 Select Storage Group

    ICSEH111_GKS

    LBM_GK_SG

    Beta_Testing_GK

✓ MetroApp1

BACK   CANCEL   NEXT

Create Pairs

1. Select SRDF Mode
2. Select Local Volumes
3. Select Remote Volumes
4. **Sort Pairs**
5. Review Pair Summary

Local		Remote	
Volume: 00070	Capacity Cyls: 546	Volume: 00097	Capacity Cyls: 546
Volume: 00071	Capacity Cyls: 546	Volume: 00098	Capacity Cyls: 546
Volume: 0006F	Capacity Cyls: 546	Volume: 00099	Capacity Cyls: 546
Volume: 00072	Capacity Cyls: 546	Volume: 0009A	Capacity Cyls: 546

BACK   CANCEL   NEXT

Create Pairs

1. Select SRDF Mode
2. Select Local Volumes
3. Select Remote Volumes
4. Sort Pairs
5. **Review Pair Summary**

SRDF Group Number	2
Mirror Type	R1
SRDF Mode	Active
Local Volumes	**4 VOLUMES**
Add Pairs to Local Storage Group	Yes
Selected Local Storage Group	MetroApp1
Remote Volumes	**4 VOLUMES**
Add Pairs to Remote Storage Group	Yes
Selected Remote Storage Group	MetroApp1
Exempt	Yes

BACK   CANCEL   Run Now
                   Add to Job List

DELLTechnologies
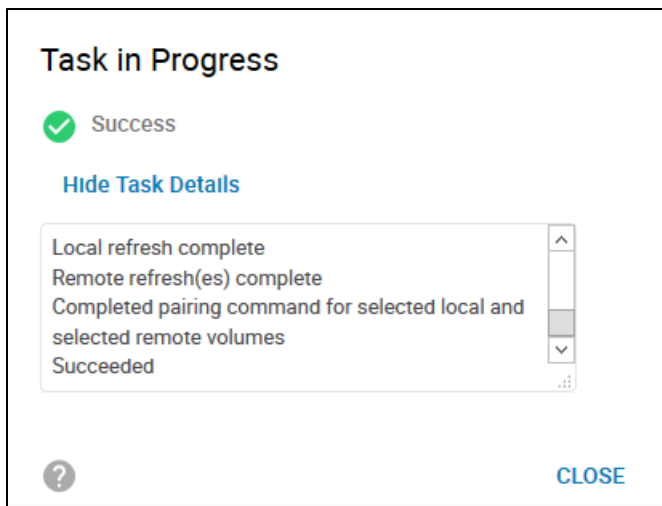
Display updated SRDF/Metro Group with Newly Added Devices

To verify the devices were added successfully, navigate to Storage, Storage Groups, choose MetroApp1 and verify that it now contains the additional devices.
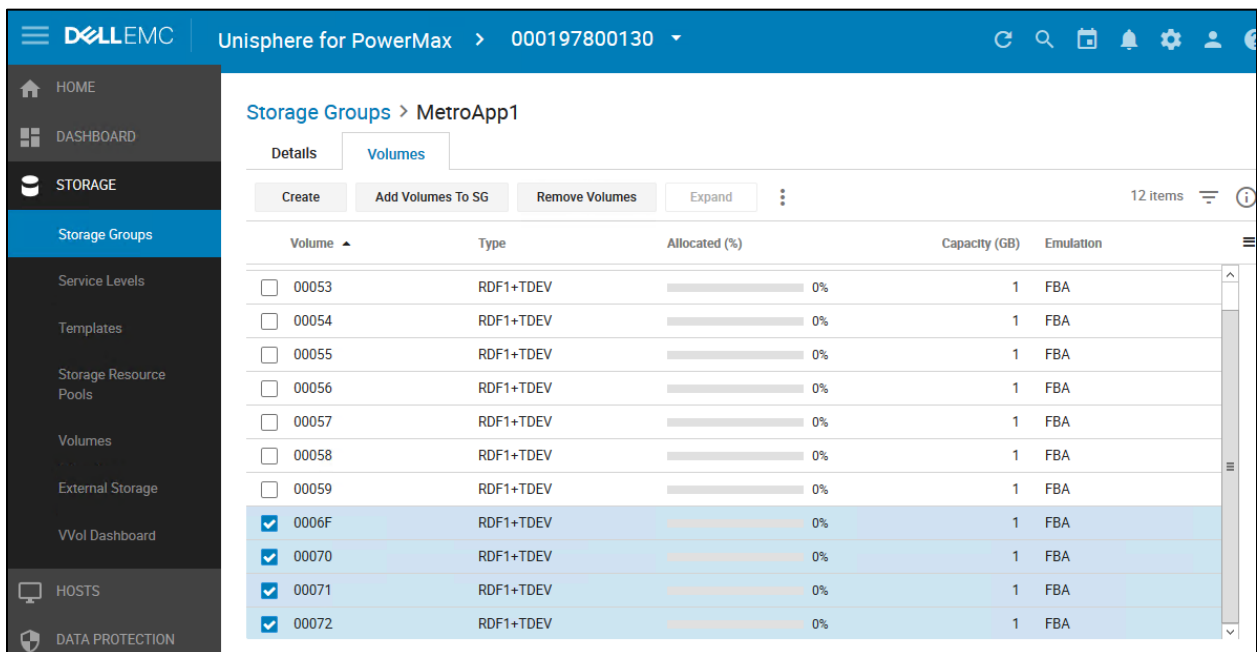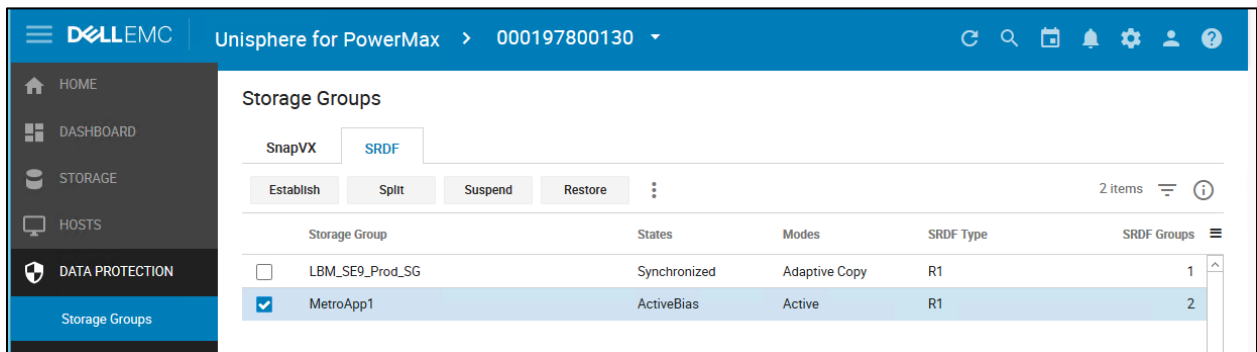
D   Unisphere Movepair –Exempt Specific Steps

This appendix provides an example walkthrough of the SRDF/Metro interface with Unisphere for PowerMax 9.0. The following operations are covered in the examples:

- Identify SRDF/S Group between Source and Target arrays
- Identify subset of devices within SRDF/S Group to be Moved
- Verify SRDF/Metro Group is currently Active
- Perform a Movepair –Exempt operation to active SRDF/Metro Group
- Display updated SRDF/Metro Group for Newly Added Devices

Identify SRDF/S Group between Source and Target arrays

For this example, we will be using an existing SRDF synchronous SRDF group (SyncRDFG) and associated storage group (SyncApp1). Choose Data Protection, Storage Groups, SRDF for the following display:
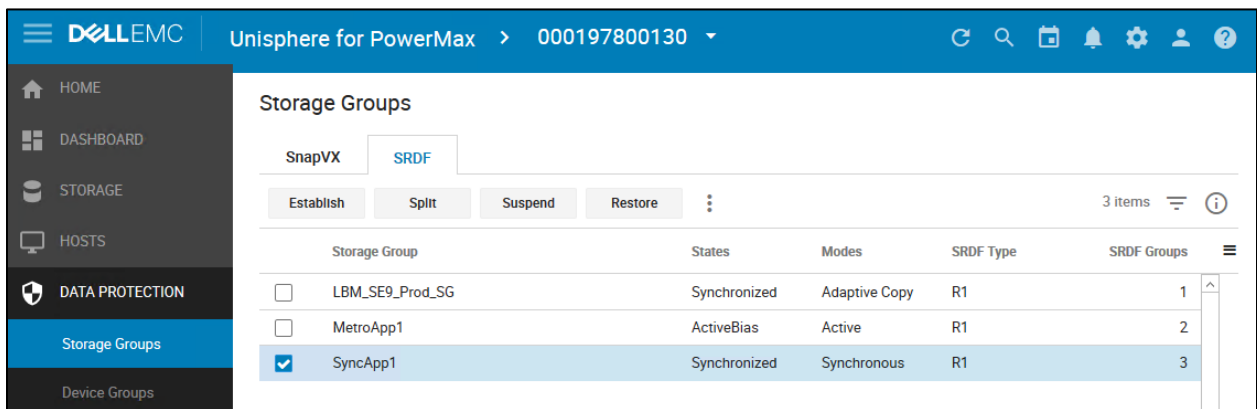
Identify subset of devices within SRDF/S Group to be Moved

Within the SyncApp1 storage group, identify one or more devices to be moved to the SRDF/Metro active group. The movepair operation will be accomplished in a later step; we are simply identifying candidate devices in this step.
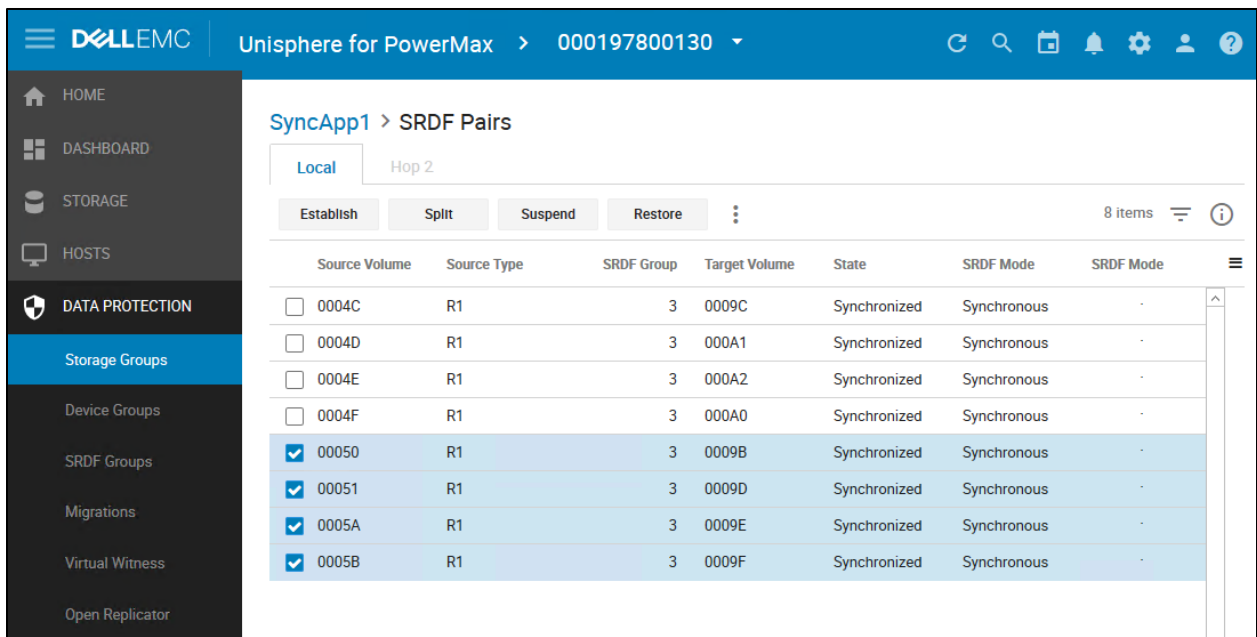
Verify SRDF/Metro Group is currently Active

On the primary array (0130), choose Data Protection, Storage Groups, SRDF, to verify that the MetroApp1 storage group mode is active.
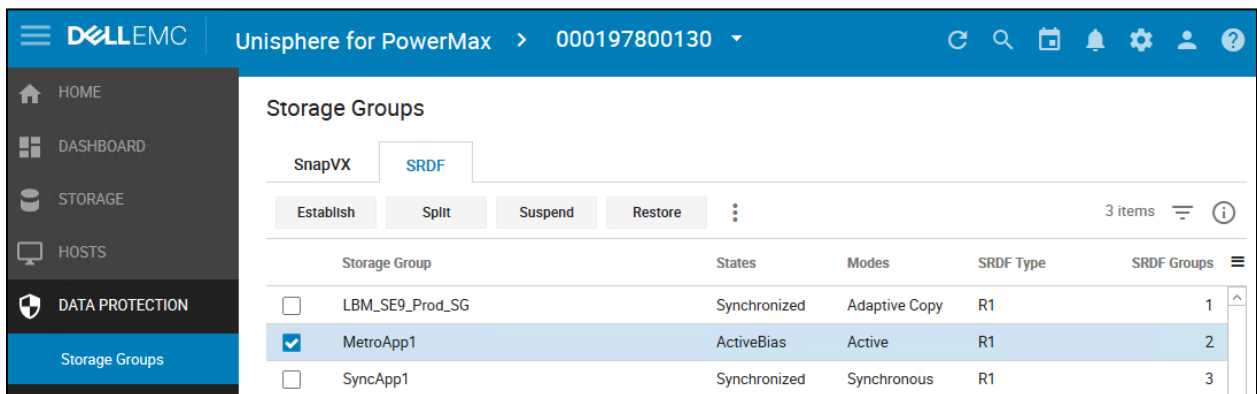
Perform a Movepair –Exempt operation to active SRDF/Metro Group

To move the previously identified devices to the SRDF/Metro active configuration, choose Data Protection, Storage Groups, double click on the SyncApp1 group, select the devices previously identified, then the from the vertical dot dropdown, choose the Move option above to enter the appropriate wizard to add move devices between SRDF groups.
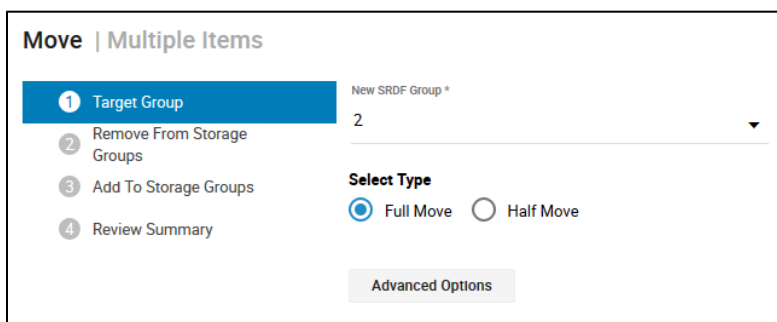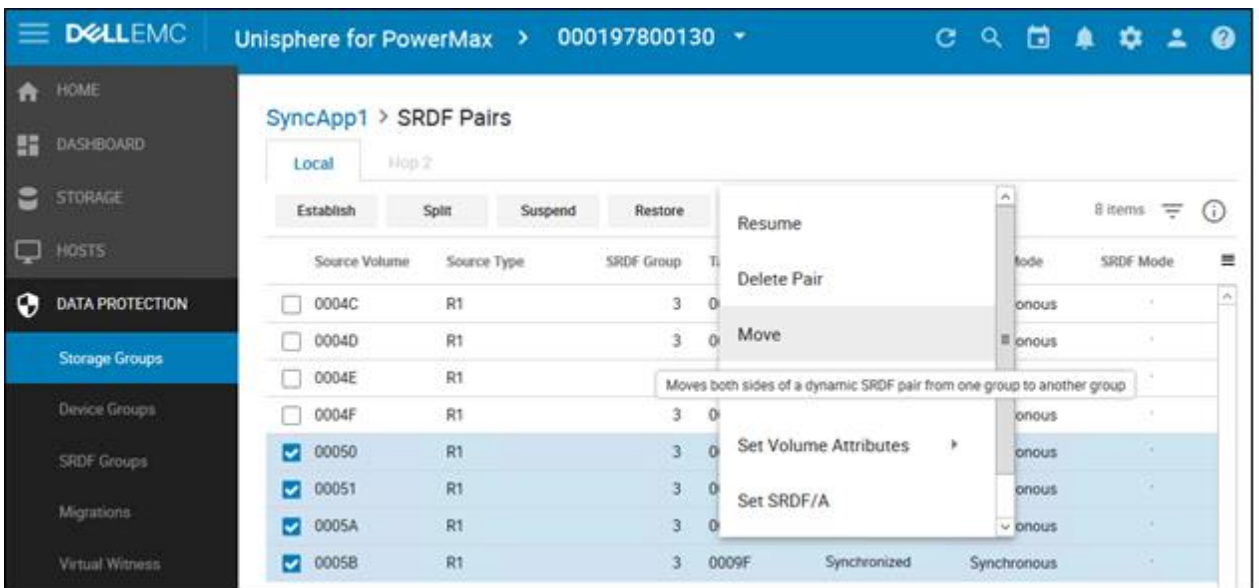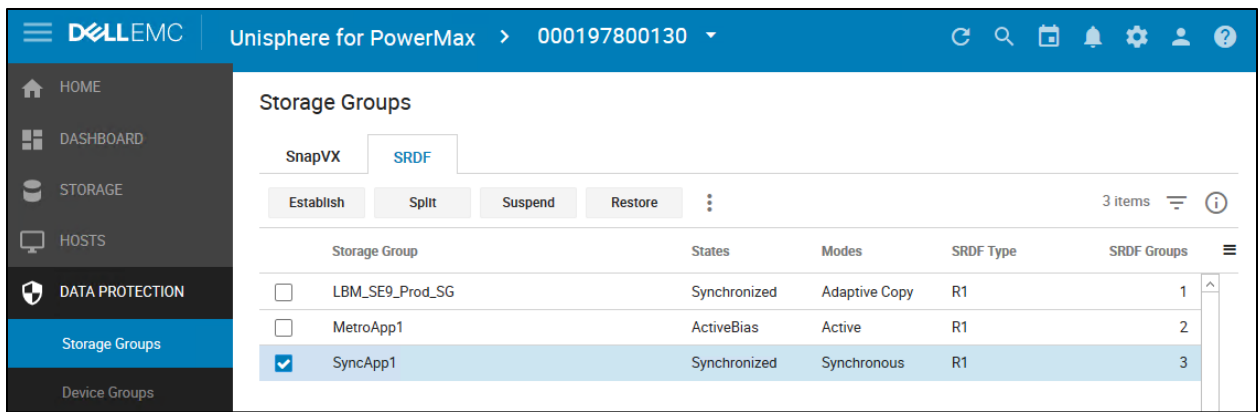
Move | Multiple Items

1. Target Group
2. **Remove From Storage Groups**
3. Add To Storage Groups
4. Review Summary

☑ Remove From Local Storage Group

🔍 Enter the name of the storage group to filter...

✓ SyncApp1

☑ Remove From Remote Storage Group

🔍 Enter the name of the storage group to filter...

✓ SyncApp1

BACK   CANCEL   **NEXT**

Move | Multiple Items

1. Target Group
2. Remove From Storage Groups
3. **Add To Storage Groups**
4. Review Summary

☐ Add To Local Storage Group

☐ Add To Remote Storage Group

BACK   CANCEL   NEXT

DELLTechnologies

Move | Multiple Items

① Target Group	
② Remove From Storage Groups	
③ Add To Storage Groups	
④ Review Summary	

Current SRDF Group	3
Target SRDF Group	2
Move Type	Full Move
Remove From Local Storage Group	Yes
Selected Local Storage Group(s)	SyncApp1
Remove From Remote Storage Group	Yes
Selected Remote Storage Group(s)	SyncApp1
Add To Local Storage Group	No
Add To Remote Storage Group	No
Selected Remote Storage Group(s)	
Bypass	No
Force	No
SymForce	No
Star	No

BACK   CANCEL   Run Now

Add to Job List

Task in Progress

✅ Success

Hide Task Details

```
(0130,002)...................
Started.
    Resume RDF link(s) for device(s) in
(0130,002)...................
Done.
```

CLOSE

Display updated SRDF/Metro Group for Newly Added Devices

From Data Protection, SRDF Groups, double click on the MetroRDFG group to enter the device list for that group and verify that the moved devices are now present in the active SRDF/Metro group.

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E   Unisphere Online Device expansion (ODE) steps

This appendix provides an example walkthrough of the SRDF/Metro Online Device Expansion (ODE) interface with Unisphere for PowerMax 9.1. The following operations are covered in the examples:

- Select an SRDF/Metro protected Storage Group from the Storage Group tab, choose Volumes
- Select the desired volume from the available devices to be expanded, select Expand
- On the volume expansion dialog, enter the desired new volume size, select Run
- Verify the paired R1 device has been expanded from the Primary array Storage Group interface, Volumes List
- Verify the paired R2 device has been expanded from the Secondary array Storage Group interface, Volumes List

Select an SRDF/Metro protected Storage Group from the Storage Group tab and choose Volumes

Select a volume (001C6 in this example) from the available devices to be expanded, select Expand

On the volume expansion dialog, enter the desired new volume size (0.5 to 1 GB in this example), Select Run:

Task in Progress

✅ Success

Hide Task Details

Starting Tasks...
Expand Volume(s) 001C6 with Remote Volume(s) 0019C to 1GB...
Successfully expanded remote volume(s) 0019C
Succeeded

❓   CLOSE
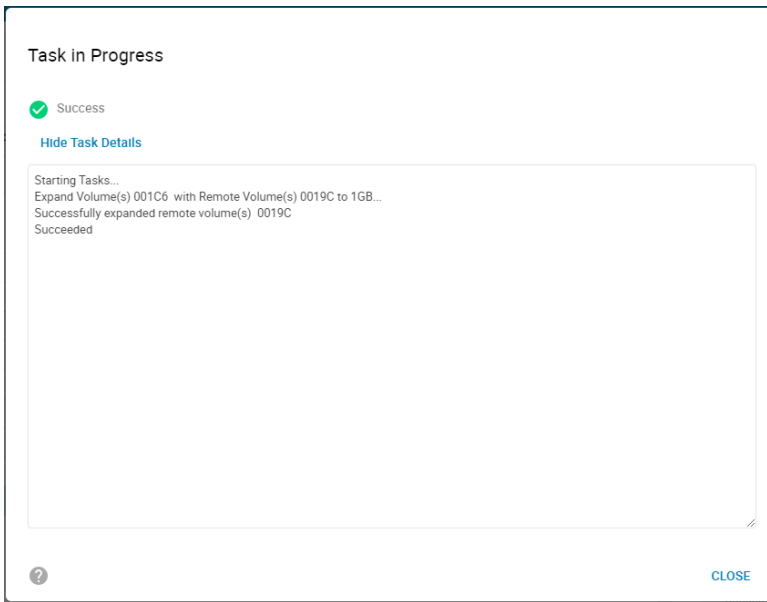
Verify the paired R1 device (001C6 below) has been expanded:

Verify the paired R2 device (0019C below) has been expanded

Unisphere Online Device expansion (ODE) steps

F   Unisphere Smart DR walkthrough

This appendix provides an example walkthrough of the SRDF/Metro Smart DR interface with Unisphere for PowerMax 9.2.

The following operations are covered in the examples to follow:

- Addressing SRDF group and witness configuration pre-requisites
- Creation of a new Smart DR environment via the Unisphere Protection Wizard
- Provisioning the paired Metro and DR storage groups, created by the Protection Wizard
- Exploring the Smart DR management interface for control and monitoring

Creation of a new Smart DR environment via the Unisphere Protection Wizard:

In this section, we will use the Smart DR Protection Wizard in Unisphere to protect a Storage Group and create the associated devices, storage groups, environment, and associated Metro and DR configurations.

Note: Metro Smart DR requires the use of a witness configuration; may use either an array based or virtual witness (vWitness). The following documents are available which contain setup instructions:

- *SRDF/Metro Technical Notes (this document)*: http://www.emc.com/collateral/technical-documentation/h14556-vmax3-srdf-metro-overview-and-best-practices-tech-note.pdf
- *SRDF/Metro vWitness Configuration Guide*: http://www.emc.com/collateral/TechnicalDocument/docu78903.pdf

Prior to starting the Unisphere Smart DR Protection Wizard, three dynamic SRDF groups for use with our SRDF/Metro Smart DR configuration must be created between all three of these arrays in the following manner:

- MetroR1 array contains:

  – One Metro SRDF group which is configured to the MetroR2 array (referred to as MetroR1_Metro_RDFG)
  – One DR SRDF group which is configured to the DR array (referred to as MetroR1_DR_RDFG)

- MetroR2 array contains:

  – One Metro SRDF group which is configured to the MetroR1 array (referred to as MetroR2_Metro_RDFG)
  – One DR SRDF group which is configured to the DR array (referred to as MetroR2_DR_RDFG)

- DR array contains:

  – One DR RDF group which is configured to the MetroR1 array (referred to as DR_MetroR1_RDFG)

In the Unisphere dashboard below, we will be using the 0191 array at the MetroR1, the 0626 array as the paired MetroR2, and the 0690 array as DR:

For each required SRDF group above, choose Data Protection, SRDF Groups and follow the examples below to create an the required SRDF groups:

The following provides and example of the Unisphere Smart DR Protection Wizard, where we will protect the existing Metro_App_SG_A Storage group and configure the associated Smart DR environment:

Protect | Metro_App_SG_A

① Select Technology
② Configure Metro Session
③ Configure DR Session
④ Review MetroDR

Select Protection Technology

○ Create a snapshot using SnapVX

○ Add Snapshot Policy

○ Setup remote replication using SRDF

○ Setup high availability using SRDF/Metro

◉ Setup high availability with DR using SRDF/MetroDR

CANCEL   NEXT

testjb   NONE   NONE   5.01 FBA   VIEW ALL DETAILS

Protect | Metro_App_SG_A

① Select Technology
② Configure Metro Session
③ Configure DR Session
④ Review MetroDR

Review SRDF/MetroDR Summary

MetroDR Environment Name *

Metro_App_SG_A

Metro R2 Array ID	000197600626
Metro SRDF Group	Automatic Selection
Establish Metro Pairs	Yes
Metro R2 Storage Group Name	Metro_App_SG_B
Metro R2 Storage Group SL	Diamond
DR Array ID	000197900690
Metro R1 to DR SRDF Group	Automatic Selection
Establish DR Pairs	Yes
Metro R2 to DR SRDF Group	Automatic Selection
DR Storage Group Name	Metro_App_SG_C
DR Storage Group SL	Diamond
DR Compression	Yes
DR SRDF Mode	Asynchronous

BACK   CANCEL   Run Now ▼

Run Now
Add to Job List

testjb   NONE   NONE   5.01 FBA

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Protect | Metro_App_SG_A

① Select Technology
② Configure Metro Session
③ **Configure DR Session**
④ Review MetroDR

DR Array ID
000197900690   ▼   Scan

DR SRDF Mode *
Asynchronous   ▼

Metro R1 DR SRDF Group
◉ Automatic   ○ Manual

Metro R2 DR SRDF Group
◉ Automatic   ○ Manual

Remote Storage Group Name *
Metro_App_SG_C

Remote Service Level
Diamond   ▼

☑ Establish SRDF Pairs

BACK   CANCEL   NEXT

Task in Progress

✅ Success

Hide Task Details

```
   Set environment attributes ...................................
Started.
    MetroR1_ArrayID: 000197600191, Metro_RDFG : 0010, DR_RDFG    : 0002
    MetroR2_ArrayID: 000197600626, Metro_RDFG : 0011, DR_RDFG    : 0015
    DR_ArrayID    : 000197900690, MetroR1_RDFG: 0002, MetroR2_RDFG: 0014
    DR Mode       : Asynchronous, MetroDR Devs: 10
   Set environment attributes ...................................
Done.
    Create RDF Pair(s) (MetroR2,DR)...............................
Started.
    Create RDF Pair(s) (MetroR2,DR)...............................
Done.
    Set HA Data Repl (Metro,DR)...................................
Started.
    Set HA Data Repl (Metro,DR)...................................
Done.
Starting refresh of entities
Calculating refresh entities
Refresh entities calculated, starting refresh
Refresh complete
Succeeded
```

CLOSE

Metro Smart DR requires that all storage groups in a Metro Smart DR solution be provisioned. Provision both the Metro_App_B and Metro_App_C newly created storage groups from the Storage->Storage Group-> Provision workflow of the appropriate arrays (MetroR2 and DR):
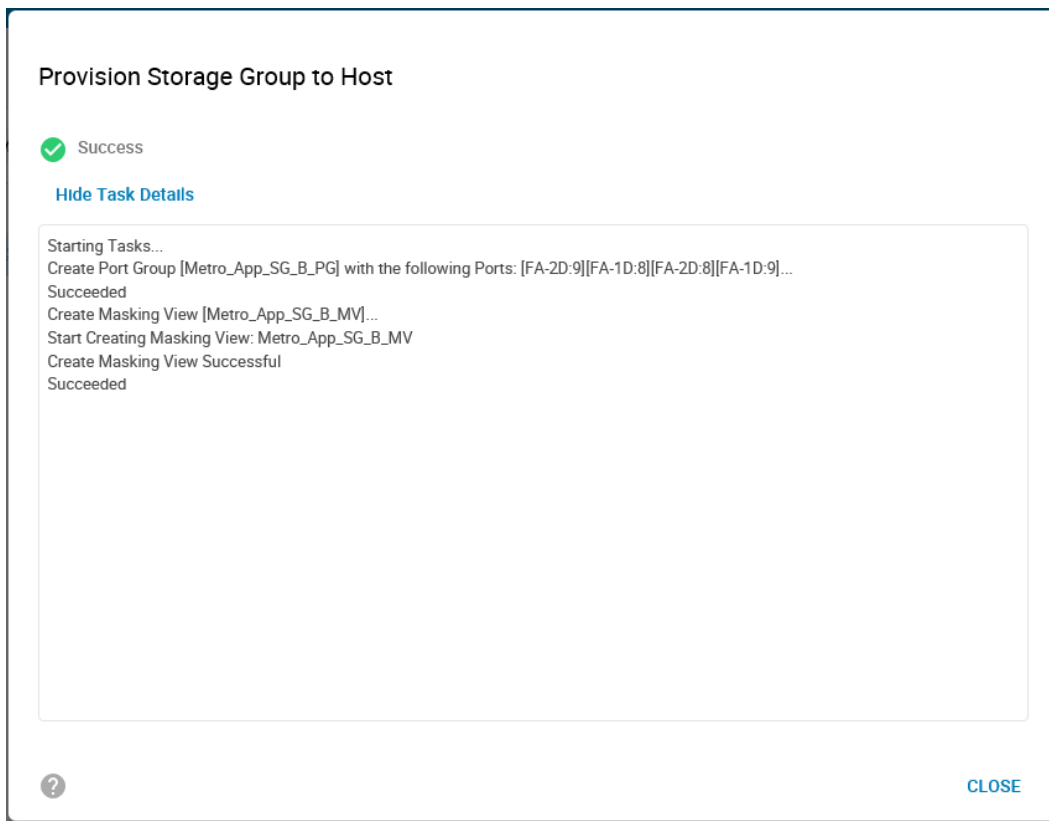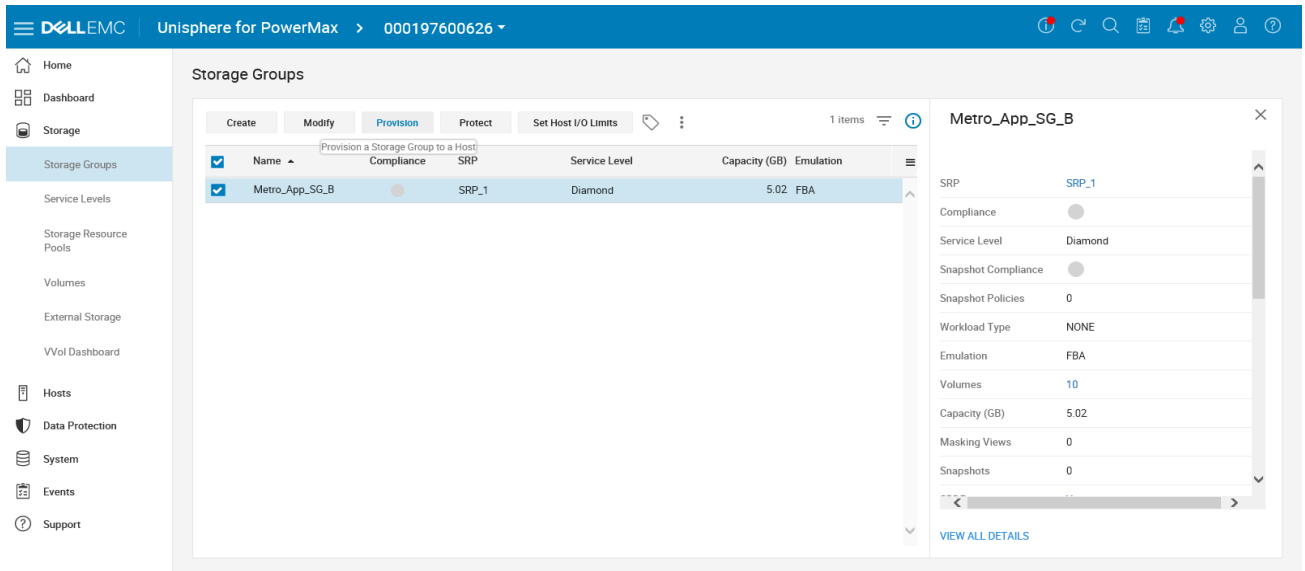
Provision Storage

1. Hosts
2. Ports
3. Summary

Review & Finish

Masking View *	Storage Group	Host	Port Group
Metro_App_SG_B_MV	Metro_App_SG_B	Cluster_1	Metro_App_SG_B_PG

☐ Enable Compliance Alerts

System Suitability Check not available, the system is not registered to collect performance data.

BACK   CANCEL   ADD TO JOB LIST ▼

≡ **DELL**EMC | Unisphere for PowerMax › 000197900690 ▼

- Home
- Dashboard
- Storage
  - Storage Groups
  - Service Levels
  - Storage Resource Pools
  - Volumes
  - External Storage
  - VVol Dashboard
- Hosts
- Data Protection
- System
- Events
- Support

Storage Groups

Create | Modify | Provision | Protect | Set Host I/O Limits

Provision a Storage Group to a Host

3 items

	Name ▲	Compliance	SRP	Service Level	Capacity (GB)	Emulation
☑	Metro_App_SG_C	○	SRP_1	Diamond	5.02	FBA
☐	RemoteRep_R1_...	○	SRP_1	Diamond	20.00	FBA
☐	WM_T60	○	SRP_1	Diamond	1,024.01	FBA

Metro_App_SG_C

SRP	SRP_1
Compliance	○
Service Level	Diamond
Snapshot Compliance	○
Snapshot Policies	0
Workload Type	NONE
Emulation	FBA
Volumes	10
Capacity (GB)	5.02
Masking Views	0
Snapshots	0

VIEW ALL DETAILS

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Provision Storage

① Hosts
② Ports
③ Summary

Review & Finish

Masking View *	Storage Group	Host	Port Group
Metro_App_SG_C_MV	Metro_App_SG_C	Cluster_1	Metro_App_SG_C_PG

☐ Enable Compliance Alerts

System Suitability Check not available, the system is not registered to collect performance data.

BACK   CANCEL   ADD TO JOB LIST ▾

Run Now
Add to Job List

Provision Storage Group to Host

✔ Success

Hide Task Details

Starting Tasks...
Create Port Group [Metro_App_SG_C_PG] with the following Ports: [FA-1D:5][FA-2D:5][FA-1D:4][FA-2D:4]...
Succeeded
Create Masking View [Metro_App_SG_C_MV]...
Start Creating Masking View: Metro_App_SG_C_MV
Create Masking View Successful
Succeeded

CLOSE

The following is the resulting Smart DR environment management interface which provides configuration information, control, and monitoring:

G   Smart DR State and status reference tables

This appendix provides an a complete reference for Smart DR state and status information for the Smart DR environment, Metro, and DR areas of the configuration:

Environment State and Status Tables:

Flag	Description
Normal	Indicates the MetroDR environment is not invalid or degraded

Invalid	The Metro and/or DR state: Unknown
	
	With the exception of the following:
	• Metro state: Unknown
	  ○ querying from the DR array and
	    ▪ DR Link State: Offline
	• DR state: Unknown
	  ○ querying from the MetroR2 array and
	    ▪ Metro Link State: Offline and
	    ▪ DR Link State: MetroR2_DR Offline

Degraded	The MetroDR environment service state is degraded if • Host Connectivity: Degraded • Array Health: Degraded • Metro Service State: Degraded • Metro Link State: Offline • DR Service State: Degraded • DR Link State: Offline, MetroR1_DR Offline, MetroR2_DR Offline • MetroR1 devices or MetroR2 devices are not mapped

Flag	Description

Run Recover	**'symmdr query' only**
	
	Indicates that the MetroDR environment is in a state that requires attention. Running 'symmdr recover' will put the MetroDR environment back to a known state.
	
	A MetroDR environment may get into this state if a 'symmdr' command does not complete successfully, if an RDF link failure occurs, or some other fault occurs.
	
	A MetroDR environment could require a recover because of one of the following:
	
	• A failed environment setup/remove command.
	  ○ Environment Valid: Environment Not Valid
	  ○ Metro State: Unknown
	  ○ DR State: Unknown
	• A failed Metro establish command.
	  ○ Metro State: Invalid
	• A failed DR establish command
	  ○ DR State: Invalid
	• An RDF link failure causes the SRDF/A session to drop
	  ○ DR State: Invalid

Flag	Description
Manual Recovery	**'symmdr query' only** Indicates that the MetroDR environment is in a state that needs attention. Manual intervention will be needed to address the issue. The resolution will require something other than the use of the 'symmdr' command. All 'symmdr' controls are allowed when Manual Recovery is indicated because of the following: • Host Connectivity: Degraded • Array Health: Degraded • MetroR1 devices Mapped: Mixed, Not Mapped • MetroR2 devices Mapped: Mixed, Not Mapped Some 'symmdr' controls are allowed when Manual Recovery is indicated because of the following (see States and Allowable operations section below): • Witness state: Degraded or Failed • Metro Link State: Offline • DR Link State: Offline, MetroR1_DR Offline, MetroR2_DR Offline

Mapped State and Status Table:

Flag	Description
Mapped	When listed at the RDF Group level: • Indicates all the devices on the associated Array are mapped. When listed at the device level: • Indicates the device on the associated Array is mapped.
Mixed	When listed at the RDF Group level: • Indicates some devices on the associated Array are mapped. When listed at the device level: • This indication will not be set
Not Mapped	When listed at the RDF Group level: • Indicates none of the devices on the associated Array are mapped. When listed at the device level: • Indicates the device on the associated Array is not mapped.

Consistency Exempt State and Status Table:

Flag	Description
No Exempt Devices	'symmdr show' When listed at the RDF Group level: • Indicates all the devices on the associated Array are not exempt. When listed at the device level: • Indicates the device on the associated Array is not exempt. 'symmdr list' or 'symmdr query' • Indicates all device in the MetroDR environment are not exempt.
Exempt Devices	'symmdr show' When listed at the RDF Group level: • Indicates some devices on the associated Array are Exempt. When listed at the device level: • Indicates the device on the associated Array is exempt 'symmdr list' or 'symmdr query' • Indicates at least one device in the MetroDR environment is exempt.

Metro State and Status Tables:

Flag	Description
Active HA	• Metro State: ActiveActive o Witness State: Available
Active	• Metro State: SyncInProg
Inactive	• Metro State: Suspended, Partitioned
Degraded	• Metro State: ActiveBias • Metro State: ActiveActive o Witness State: Degraded • Metro State: SyncInProg o Witness State: Failed • Metro State: Invalid

State	Description

ActiveActive	The R1 and the R2 are in the default RDF/Metro configuration which uses a witness.
	• Percent Done: 100% (The background copy is complete)
	• RDF Device Link Status: Ready (RW)
	• MetroR1, host accessible
	   ○ Device RDF State: Ready (RW)
	   ○ Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   ○ Device Status: Ready (RW)
	• The MetroR2, host accessible
	   ○ Device RDF State: Ready (RW)
	   ○ Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   ○ Device Status: Ready (RW)

State	Description

ActiveBias	The R1 and the R2 are in the default RDF/Metro configuration which uses a witness, however, the witness is not available (it is in a failed stated).
	• Percent Done: 100% (The background copy is complete)
	• RDF Device Link Status: Ready (RW)
	• MetroR1, host accessible
	   ○ Device RDF State: Ready (RW)
	   ○ Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   ○ Device Status: Ready (RW)
	• The MetroR2, host accessible
	   ○ Device RDF State: Ready (RW)
	   ○ Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   ○ Device Status: Ready (RW)

State	Description

SyncInProg	Synchronization is currently in progress between the R1 and the R2 devices.
	• Percent Done: not 100% (The background copy is not complete)
	• The copy direction could be R1→R2 or R1←R2.
	• RDF Device Link Status: Ready (RW)
	• MetroR1, host accessible
	  o Device RDF State: Ready (RW)
	  o Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  o Device Status: Ready (RW)
	• The MetroR2, not host accessible
	  o Device RDF State: Write Disabled (WD)
	  o Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  o Device Status: Not Ready (NR)

State	Description

Suspended	Synchronization is currently suspended between the R1 and the R2 devices.
	• Host writes accumulate as data owed to the R2
	• RDF Device Link Status: Not Ready (NR)
	• MetroR1, host accessible
	  o Device RDF State: Ready (RW)
	  o Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  o Device Status: Ready (RW)
	• The MetroR2, not host accessible
	  o Device RDF State: Write Disabled (WD)
	  o Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  o Device Status: Not Ready (NR)
	•

State	Description

Partitioned	The RDF group between the 2 Metro arrays is offline.
	
	• Host writes accumulate as data owed to the R2
	• RDF Device Link Status: Not Ready (NR)
	• MetroR1, host accessible
	  ○ Device RDF State: Ready (RW)
	  ○ Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  ○ Device Status: Ready (RW)
	• The MetroR2, not host accessible
	  ○ Device RDF State: Write Disabled (WD)
	  ○ Device SA Status:
	    ▪ If mapped, Ready (RW)
	    ▪ If unmapped, N/A
	  ○ Device Status: Not Ready (NR)
	•

Flag	Description
Unknown	If the environment is not valid, the Metro session state will be marked as Unknown. If querying from the DR array and DR Link State: Offline, the Metro session state will be Unknown.
Invalid	The state does not match one of the above.

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DR State and Status Table:

Flag	Description

Active	DR: mode Async
	
	• DR State: SyncInProg
	  o DR Link Status: Online
	• DR State: Consistent
	  o Metro State: Suspended, Partitioned
	  o – or-
	  o Metro State: SyncInProg
	    ▪ DR Link Status: Online
	  o – or-
	  o Metro State: ActiveActive, ActiveBias
	    ▪ DR Link Status: Online
	    ▪ Metro:
	      • Metro Invalids: 0
	      • DR Invalids: 0
	    ▪ DR:
	      • Metro Invalids: 0
	      • DR Invalids: 0
	    ▪ SRDF/A session transmit cycle between the MetroR2 and DR does not yet contain all I/Os required to take over the data transfer if necessary
	DR mode: Acp_disk
	• DR State: SyncInProg, Synchronized

Flag	Description
Inactive	DR mode: Async • DR State: Suspended, Split, Failed Over, R1 Updated, R1 UpdInProg or Partitioned DR mode: Acp_disk • DR state: Suspended, Split, Failed Over, R1 Updated, R1 UpdInProg or Partitioned

Degraded	DR mode Async
	• DR State: Invalid, TransIdle
	• DR Link State: MetroR2_DR Offline
	  o DR State: SyncInProg, Consistent
	  o Metro State: SyncInProg, ActiveActive, ActiveBias
	• DR Link State: Online
	  o DR State: SyncInProg, Consistent
	  o Metro State: SyncInProg, ActiveActive, ActiveBias
	  o Recovery: Run Recovery
	    ▪ To make the MetroR2 to DR RW on the RDF link
	DR mode: Acp_disk
	• DR State: Invalid

State	Description

Synchronized	Acp_disk only
	The background copy between the Metro and DR is complete.
	• Percent Done: 100% (The background copy is complete)
	• RDF Device Link Status: Ready (RW)
	• MetroR1, host accessible
	   o Device RDF State: Ready (RW)
	   o Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   o Device Status: Ready (RW)
	• The DR, not host accessible
	   o Device RDF State: Write Disabled (WD)
	   o Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   o Device Status: Write Disabled (WD)
	• The MetroR2 device states are dependent on the Metro session State

State	Description

Consistent	Async only
	The consistent state signifies the normal state of operation for device pairs operating in asynchronous mode.
	• Indicates that there is a dependent-write consistent copy of data on the DR site.
	• DR:
	   o Metro: Metro Invalids and
	   o DR: Metro Invalids
	      ▪ can be non zerio, representing a restore is in progress
	• RDF Device Link Status: Ready (RW)
	• MetroR1, host accessible
	   o Device RDF State: Ready (RW)
	   o Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   o Device Status: Ready (RW)
	• The DR, not host accessible
	   o Device RDF State: Write Disabled (WD)
	   o Device SA Status:
	      ▪ If mapped, Ready (RW)
	      ▪ If unmapped, N/A
	   o Device Status: Write Disabled (WD)
	• The MetroR2 device states are dependent on the Metro session State

State	Description
TransIdle	Async only The SRDF/A session is active but it cannot send data in the transmit cycle over the RDF link because the RDF link is offline. • There may be a dependent-write consistent copy of data on the DR devices • The background copy may not be complete • RDF Device Link Status: Not Ready (NR) • MetroR1, host accessible o Device RDF State: Ready (RW) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Ready (RW) • The DR, not host accessible o Device RDF State: Write Disabled (WD) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Write Disabled (WD) • The MetroR2 device state are dependent on the Metro session State

State	Description
SyncInProg	Synchronization is currently in progress between the Metro and the DR devices. • Percent Done: not 100% (The background copy is not complete) • In Adaptive copy mode, the copy direction could be Metro→DR or Metro←DR. • In Async mode, the copy direction is Metro→DR • RDF Device Link Status: Ready (RW) • MetroR1, host accessible o Device RDF State: Ready (RW) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Ready (RW) • The DR, not host accessible o Device RDF State: Write Disabled (WD) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Write Disabled (WD) • The MetroR2 device states are dependent on the Metro session State

State	Description
Suspended	Synchronization is currently suspended between the Metro and the DR devices. • Host writes accumulate and can be seen as invalids o DR: ▪ Metro: DR Invalids • RDF Device Link Status: Not Ready (NR) • MetroR1, host accessible o Device RDF State: Ready (RW) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Ready (RW) • The DR, not host accessible o Device RDF State: Write Disabled (WD) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Write Disabled (WD) • The MetroR2 device states are dependent on the Metro session State

State	Description
Split	Synchronization is currently suspended between the Metro and the DR devices. • Host writes accumulate and can be seen as invalids o DR: ▪ Metro: DR Invalids • RDF Device Link Status: Not Ready (NR) • MetroR1, host accessible o Device RDF State: Ready (RW) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Ready (RW) • The DR, host accessible o Device RDF State: Ready (RW) o Device SA Status: ▪ If mapped, Ready (RW) ▪ If unmapped, N/A o Device Status: Ready (RW) • The MetroR2 state is dependent on the Metro session State

State	Description

Failed Over	Synchronization is currently suspended between the Metro and the DR devices.
	• Host writes accumulate and can be seen as invalids
	    o DR:
	        ▪ DR: Metro Invalids
	• RDF Device Link Status: Not Ready (NR)
	• The DR, host accessible
	    o Device RDF State: Ready (RW)
	    o Device SA Status:
	        ▪ If mapped, Ready (RW)
	        ▪ If unmapped, N/A
	    o Device RA State: Ready (RW)
	
	If a failover command was issued when the DR state is not Partitioned or TransIdle
	• The Metro session is suspended
	    o RDF Device Link Status: Not Ready (NR)
	• MetroR1, not host accessible
	    o Device RDF State: Ready (RW)
	    o Device SA Status:
	        ▪ If mapped, Write Disabled (WD)
	        ▪ If unmapped, N/A
	    o Device Status: Write Disabled (WD)
	• The MetroR2, not host accessible
	    o Device RDF State: Write Disabled (WD)
	    o Device SA Status:
	        ▪ If mapped, Ready (RW)
	        ▪ If unmapped, N/A
	    o Device Status: Not Ready (NR)
	
	If a failover command was issued when the DR state is Partitioned or TransIdle
	• The Metro state will not change
	• the MetroR1 device state and MetroR2 device state will not change with regard to their accessibility to the host

State	Description

R1 Updated	The MetroR1 was updated from DR
	• The Metro session is suspended
	• RDF Device Link Status: Ready (RW)
	• MetroR1, not host accessible
	    o Device RDF State: Ready (RW)
	    o Device SA Status:
	        ▪ If mapped, Write Disabled (WD)
	        ▪ If unmapped, N/A
	    o Device Status: Write Disabled (WD)
	• The DR, host accessible
	    o Device RDF State: Ready (RW)
	    o Device SA Status:
	        ▪ If mapped, Ready (RW)
	        ▪ If unmapped, N/A
	    o Device Status: Ready (RW)
	• The MetroR2 is not accessible to the host

State	Description

R1 UpdInProg	The MetroR1 is being updated from DR
	• The Metro session is suspended
	• RDF Device Link Status: Ready (RW)
	• MetroR1, not host accessible
	    ○ Device RDF State: Ready (RW)
	    ○ Device SA Status:
	        ■ If mapped, Write Disabled (WD)
	        ■ If unmapped, N/A
	    ○ Device Status: Write Disabled (WD)
	• The DR, host accessible
	    ○ Device RDF State: Ready (RW)
	    ○ Device SA Status:
	        ■ If mapped, Ready (RW)
	        ■ If unmapped, N/A
	    ○ Device Status: Ready (RW)
	• The MetroR2 is not accessible to the host

State	Description

Partitioned	If the DR mode is Async the SRDF/A session is inactive.
	
	The RDF group between MetroR1 and DR is offline.
	
	• RDF Device Link Status: Not Ready (NR)
	• MetroR1, if host accessible
	    ○ Device RDF State: Ready (RW)
	    ○ Device SA Status:
	        ■ If mapped, Ready (RW)
	        ■ If unmapped, N/A
	    ○ Device Status: Ready (RW)
	• MetroR1, if not host accessible
	    ○ Device RDF State: Ready (RW)
	    ○ Device SA Status:
	        ■ If mapped, Write Disabled (WD)
	        ■ If unmapped, N/A
	    ○ Device Status: Write Disabled (WD)
	• The DR, if host accessible
	    ○ Device RDF State: Ready (RW)
	    ○ Device SA Status:
	        ■ If mapped, Ready (RW)
	        ■ If unmapped, N/A
	    ○ Device Status: Ready (RW)
	• The DR, if not host accessible
	    ○ Device RDF State: Write Disabled (WD)
	    ○ Device SA Status:
	        ■ If mapped, Ready (RW)
	        ■ If unmapped, N/A
	    ○ Device Status: Write Disabled (WD)
	• The MetroR2 is either accessible to the host or not accessible to the host

Flag	Description
Unknown	If the environment is not valid, the DR state will be marked as Unknown. If querying from the MetroR2 array and the MetroR2_Metro_RDFG and MetroR2_DR_RDFG are offline, the DR mode is Unknown the DR state will be marked as Unknown.
Invalid	The state does not match one of the above.

State	Description
Async	Asynchronous mode In asynchronous mode (SRDF/A), data is transferred from the source (Metro) site in predefined timed cycles or delta sets to ensure that data at the remote (DR) site is dependent write consistent. The array acknowledges all writes to the source (Metro) devices as if they were local devices. Host writes accumulate on the source (Metro) side until the cycle time is reached and are then transferred to the target (DR) device in one delta set. Write operations to the target device are confirmed when the SRDF/A cycle is is transferred to the DR site. Because the writes are transferred in cycles, any duplicate tracks written to can be eliminated through ordered write processing, which transfers only the changed tracks within any single cycle. The point-in-time copy of the data at the DR site is slightly behind that on the Metro site. SRDF/A has little or no impact on performance at the Metro site as long as the SRDF links contain sufficient bandwidth and the DR array is capable of accepting the data as quickly as it is being sent across the SRDF links.

State	Description
Acp_disk	Adaptive Copy Disk mode. Adaptive copy mode is designed to transfer large amounts of data without loss of performance. Adaptive copy mode allows the Metro and DR devices to be more than one I/O out of synchronization. Unlike the asynchronous mode, adaptive copy mode does not guarantee a dependent-write consistent copy of data on DR devices. NOTE: Adaptive Copy will be seen in the following situations • If querying from the DR array and the DR state is not TransIdle, and the DR Link State is offline • If querying from the MetroR2 array and the DR state is not TransIdle and the DR Link State is offline and the Metro Link State is offline

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Link State and Status Tables:

Flag	Description
Online	Indicates the RDF link is online
Offline	Indicates the RDF link is offline

Flag	Description
Online	• the MetroR1 to DR RDF link is online and • The MetroR2 to DR RDF link is online
Offline	• the MetroR1 to DR RDF link is offline and • The MetroR2 to DR RDF link is offline
MetroR1 DR Offline	• the MetroR1 to DR RDF link is offline and • the MetroR2 to DR RDF link is online
MetroR2 DR Offline	• the MetroR1 to DR RDF link is online and • the MetroR2 to DR RDF link is offline

Witness State and Status Tables:

Flag	Description
Available	A witness is configured from both the MetroR1 array and the MetroR2 array, alive and eligible to be used as a witness.
Degraded	Metro State: SyncInProg and • A witness is either not configured from both the MetroR1 array and MetroR2 array or at least one side is not alive or is not eligible to be used as a witness. Metro State: ActiveActive and • A witness is configured from both the MetroR1 array and MetroR2 array, however, one side is no longer alive or eligible to be used as a witness.

Flag	Description
Failed	Metro State: ActiveBias and • A witness is either not configured from both the MetroR1 array and MetroR2 array or both sides are no longer alive or eligible to be used as a witness. Metro State: Suspended and • A witness is either not configured from both the MetroR1 array and MetroR2 array or at least one side is not alive or is not eligible to be used as a witness.
N/A	If witness cannot be validated from both MetroR1 and MetroR2 arrays.

Host Connectivity State and Status Table:

Flag	Description
N/A	Metro State: Suspended or Partitioned, Unknown
Normal	Metro State: ActiveActive, ActiveBias, SyncInProg • Indicates that HyperMaxOS has identified that the host connectivity is normal
Degraded	Metro State: ActiveActive, ActiveBias, SyncInProg • Indicates that HyperMaxOS has identified that the host connectivity is degraded

Array Health State and Status Table:

Flag	Description
N/A	Metro State: Unknown
Normal	Indicates that HyperMaxOS has identified that the array health is normal
Degraded	Indicates that HyperMaxOS has identified that the array health is degraded

H   Technical support and resources

Dell.com/support is focused on meeting customer needs with proven services and support.

Storage and data protection technical white papers and videos provide expertise that helps to ensure customer success with Dell EMC storage and data protection products.

H.1   Related resources

The following documents provide additional information regarding topics covered in these technical notes. Reference information and product documentation can be found at delltechnologies.com and dell.com/support, including:

- **Dell EMC SRDF/Metro vWitness Configuration Guide** – Setup and configuration of the SRDF/Metro Virtual Witness feature.
- **Dell EMC Solutions Enabler 9.2 Release Notes** - Describes new features and any known limitations.
- **Dell EMC Solutions Enabler Installation Guide** - Provides host-specific installation instructions.
- **Dell EMC Solutions Enabler CLI Command Reference** - Documents the SYMCLI commands, daemons, error codes and option file parameters provided with the Solutions Enabler man pages.
- **Dell EMC VMAX All Flash Family Product Guide** - Describes the VMAX All Flash platform and software products available.
- **Dell EMC VMAX3 Family Product Guide** - Describes the VMAX3 platform and software products available.
- **Dell EMC Solutions Enabler Array Management CLI User Guide** - Describes how to configure array control, management, and migration operations using SYMCLI commands.
- **Dell EMC Solutions Enabler TimeFinder Family CLI User Guide** - Describes how to configure and manage TimeFinder environments using SYMCLI commands.
- **Dell EMC Solutions Enabler SRM CLI User Guide** - Provides Storage Resource Management (SRM) information related to various data objects and data handling facilities.
- **Dell EMC VMAX Family Security Configuration Guide** - Describes how to configure VMAX Family security settings.
- **Dell EMC Solutions Enabler 9.2 SRDF Family CLI User Guide**
- **Dell EMC VMAX All Flash Family Documentation Set** - Contains documentation related to the VMAX 450F, VMAX 450 FX, VMAX 850F, and VMAX 850 FX arrays.
- **Dell EMC VMAX3 Family Documentation Set** - Contains documentation related to the VMAX 100K, 200K, and 400K arrays.
- **Dell EMC VMAX Family (10K, 20K, 40K) Documentation Set** - Contains documentation related to the VMAX 10K, 20K, and 40K arrays.
- **Dell EMC VMAX All Flash Family with HYPERMAX OS Release Notes** - Detail new features and any known limitations.
- **Dell EMC VMAX3 Family with HYPERMAX OS Release Notes** - Detail new features and any known limitations.
- **Dell EMC VMAX Family Viewer for Desktop and iPad®** - Illustrates system hardware, incrementally scalable system configurations, and available host connectivity offered for VMAX arrays.
- **E-Lab™ Interoperability Navigator (ELN)** - Provides a web-based interoperability and solution search portal. You can find the ELN at https://elabnavigator.EMC.com.

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- **SolVe Desktop** - Provides links to documentation, procedures for common tasks, and connectivity information for 2-site and 3-site SRDF configurations. To download the SolVe Desktop tool, go to Online Support at https://support.EMC.com and search for SolVe Desktop. Download the SolVe Desktop and load the VMAX Family and DMX procedure generator.