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Executive summary

The EMC® Symmetrix Remote Data Facility (SRDF®) family of remote mirroring software offers various levels of Symmetrix-based business continuance and disaster recovery solutions. The SRDF products offer the capability to maintain multiple, host-independent, mirrored copies of data. The Symmetrix systems can be in the same room, in different buildings within the same campus, or hundreds to thousands of kilometers apart.

SRDF remotely mirrors production or primary (source) site data to a secondary (target) site transparently to users, applications, databases, and host processors. The local SRDF device, known as the primary (R1) device, is configured in a partner relationship with a remote secondary (R2) device, forming an SRDF pair.

Enginuity™ level 5773 is the latest Enginuity release supporting the Symmetrix® Direct Matrix Architecture® DMX-3 and DMX-4 storage arrays, and contains features that provide increased storage utilization and optimization, enhanced replication capabilities, and greater interoperability and security, as well as multiple ease-of-use improvements.

One such feature of Enginuity level 5773 providing remote mirroring capabilities is cascaded SRDF, which supports a three-site disaster recovery configuration. The core benefit behind a “cascaded” configuration is its inherent capability to continue replicating with minimal user intervention from the secondary site to a tertiary site with SRDF/A in the event that the primary site goes down. This enables a faster recovery at the tertiary site, provided that is where the customer is looking to restart their operation.

By maintaining copies of data in different physical locations, SRDF enables you to perform the following operations with minimal impact on normal business processing:

- Disaster restart
- Disaster restart testing
- Recovery from planned outages
- Remote backup
- Data center migration
- Data replication and data mobility
Introduction and overview

Prior to Enginuity 5773, an SRDF device could be a primary device (R1 device) or a secondary device (R2 device); however it could not be in the dual role simultaneously. Cascaded SRDF is a new three-site disaster recovery configuration where data from a primary site is synchronously replicated to a secondary site, and then asynchronously replicated to a tertiary site.

Cascaded SRDF introduces a new SRDF R21 device. The R21 device assumes dual roles of primary (R1) and secondary (R2) device types simultaneously. Data received by this device as a secondary can automatically be transferred by this device as a primary (according to the available modes).

A basic cascaded SRDF configuration consists of a primary site (site A) replicating to a secondary site (site B) and then replicating the same data to a tertiary site (site C).

In the figure above, the secondary site B device is labeled R21. This device is the R2 mirror of the primary site A device, and the R1 mirror of the tertiary site C device. Primary site A and secondary site B have an SRDF pair state; secondary site B and tertiary site C have an SRDF pair state. These two pair states are separate from each other, but each must be considered when performing a control operation on the other pair.

The key benefits of cascaded SRDF:

- Sites can be geographically dispersed.
- Cascaded SRDF can span multiple SRDF groups and Symmetrix arrays.
- Faster recovery times at the tertiary site, which is enabled by the capability to continue replicating from the secondary site to the tertiary site if the primary site becomes unusable.
- Facilitate and assist customers in achieving less than a 2-hour recovery time objective.
- Zero data loss achievable up to the point of the primary site.
EMC foundation products and features

failure, fault or disaster event at the secondary B or tertiary C sites.

- Is tightly integrated with the TimeFinder® product family.
- Management capability provided with the current Storage Management Portfolio of products (using SMC and EMC ControlCenter®). Does not require the purchase of additional new management software products.

Available with Enginuity 5874, SRDF/Extended Distance Protection (EDP) is a new two-site disaster restart solution that enables customers to achieve no data loss at an out-of-region site at a lower cost. Using cascaded SRDF as the building block for this solution, combined with the use of the new diskless R21 data device at an intermediate (pass-through) site Symmetrix system, provides data pass-through to the out-of-region site using SRDF/A.

In addition, SRDF/EDP supports SRDF/Star for continuous remote data replication protection between the production site and the out-of-region site in the event that the intermediate (pass-through) site goes offline due to a disaster event.

The key benefits of SRDF/EDP to the customer:

- New long-distance replication solution with the ability to achieve zero RPO at the tertiary site.
- Lower cost alternative in which to achieve no data loss for out-of-region disaster restart.
- SRDF/Star differential relationship support between the extended distance site and the production site for failover operations with reverse SRDF/Asynchronous protection.

Audience

This technical note is intended for anyone who needs to understand cascaded SRDF or SRDF/EDP, functionality, best practices, and current restrictions. It is specifically targeted at EMC field technical staff and EMC customers who are either running cascaded SRDF or are considering cascaded SRDF as a viable long-distance replication solution.

EMC foundation products and features

Symmetrix Remote Data Facility

Symmetrix Remote Data Facility (SRDF) is a business continuity solution that provides a host-independent, mirrored data storage solution for
duplicating primary site data to one or more physically separated secondary Symmetrix systems. In basic terms, SRDF is a configuration of multiple Symmetrix systems whose purpose is to maintain multiple copies of logical volume data in more than one location.

SRDF replicates primary (source, R1) site data to a secondary (target, R2) site transparently to users, applications, databases, and host processors. The primary SRDF device is configured in a partner relationship with a secondary (R2) device, forming an SRDF pair. While the R2 device is mirrored with the R1 device, the R2 device is write-disabled to the remote host. After the R2 device synchronizes with its R1 device, the R2 device can be split from the R1 device at any time, making the R2 device fully accessible again to its host. After the split, the target (R2) device contains valid data and is available for performing business continuity tasks through its original device address.

SRDF requires the configuration of specific source Symmetrix volumes (R1s) to be mirrored to target Symmetrix volumes (R2s). If the primary site is no longer able to continue processing when SRDF is operating in synchronous mode, data at the secondary site is current up to the last I/O transaction. When primary systems are down, SRDF enables fast failover to the secondary copy of the data so that critical information becomes available in minutes. Business operations and related applications may resume full functionality with minimal interruption.

**SRDF/Extended Distance Protection**

SRDF/Extended Distance Protection (EDP) is a new two-site disaster restart solution that enables customers the ability to achieve no data loss at an out-of-region site at a lower cost. Using cascaded SRDF as the building block for this solution, combined with the use of the new diskless R21 data device at an intermediate (pass-through) site Symmetrix system, provides data pass-through to the out-of-region site using SRDF/A.

In addition, SRDF/EDP supports SRDF/Star for continuous remote data replication protection between the production site and the out-of-region site in the event that the intermediate (pass-through) site goes offline due to a disaster event.

As with cascaded SRDF, an SRDF/EDP configuration consists of a primary site (site A) replicating synchronously to a secondary site (site B) with SRDF/S, and then replicating the same data asynchronously to a tertiary site (site C) with SRDF/A.

A regular R21 has its own local mirrors so there are three full copies of data, one at each of the three sites. In contrast, the diskless R21 device has no local disk space allocated to store the user data, therefore it
EMC foundation products and features

reduces the cost of having disk storage in secondary Symmetrix.

The purpose of a diskless R21 device is to cascade data to the R2 device. When using a diskless R21 device, the changed tracks received on the R2 mirror are saved in cache until these tracks are sent to the R2 device. Once the data is sent to the R2 device and the receipt is acknowledged, the cache slot is freed and the data no longer exists on the R21 Symmetrix.

SRDF/EDP is for customers who are looking for a two-site DR solution with the ability to achieve a zero recovery point objective (RPO) in the event of a primary site failure. To date, customers looking to establish a two-site disaster recovery configuration with a zero RPO were bound by distance limitations due to latency and application performance (Synchronous Type Replication). Also, if the business called for an extended distance replication solution (Asynchronous Type Replication) they would have to compromise with some level of data loss (secs/mins).

In order to achieve the best of both worlds, some customers had to opt for three-site configurations such as concurrent SRDF or cascaded SRDF with SRDF/Star for the ability for extended distance replication and zero RPOs at the tertiary site, even though they really did not need three copies of their data. SRDF/EDP supports an RPO between the zero RPO of SRDF/S and seconds to minutes of SRDF/A, offering customers a more cost-effective, optimal solution to a three-site DR configuration.

SRDF/A Reserve Capacity enhancements

SRDF/A Reserve Capacity enhances SRDF/A’s ability to maintain an operational state when encountering network resource constraints that would have previously suspended SRDF/A operations. With SRDF/A Reserve Capacity functions enabled, additional resource allocation can be applied to address temporary workload peaks, periods of network congestion, or even transient network outages. The use of SRDF/A Reserve Capacity is fully supported with cascaded SRDF.

SRDF/A Transmit Idle is a Reserve Capacity enhancement to EMC’s SRDF/A feature that provides SRDF/A with the capability of dynamically and transparently extending the Capture, Transmit, and Receive phases of the SRDF/A cycle while masking the effects of an “all SRDF links lost” event. Without the SRDF/A Transmit Idle enhancement, an “all SRDF links lost” event would normally result in the abnormal termination of SRDF/A. The SRDF/A Transmit Idle enhancement has been specifically designed to prevent this event from occurring.
Beginning with Enginuity version 5772, there is an additional option for managing the buffering of delta set data: SRDF/A Delta Set Extension (DSE). DSE provides a mechanism for augmenting the cache-based delta set buffering mechanism of SRDF/A with a disk-based buffering ability. This extended delta set buffering ability may allow SRDF/A to ride through larger and longer SRDF/A throughput imbalances than would be possible with cache-based delta set buffering alone.

You can configure DSE for any SRDF/A session and within any configuration in which SRDF/A is a participant, including SRDF/Star and concurrent SRDF. DSE is designed to preserve the major benefits of SRDF/A, including impact on host-write response time that is typically not measurable, the use of write folding to reduce remote link bandwidth requirements, and the options SRDF/A provides for managing consistency.

**Note:** Transmit Idle and DSE work together to maximize availability of replication operations while minimizing operational overhead.

### Solutions Enabler for open systems

The EMC Solutions Enabler kit contains all the base management software that provides a host with SYMAPI-shared libraries and the basic Symmetrix command line interface (SYMCLI). Other optional subcomponents in the Solutions Enabler (SYMCLI) series enable users to extend functionality of the Symmetrix systems. Three principle subcomponents are:

- Solutions Enabler SYMCLI SRDF, SRDF/CG, and SRDF/A
- Solutions Enabler SYMCLI TimeFinder/Mirror, TimeFinder/CG, TimeFinder/Snap, TimeFinder/Clone
- Solutions Enabler SYMCLI Storage Resource Management (SRM)

SYMCLI resides on a host system to monitor and perform control operations on Symmetrix storage arrays. SYMCLI commands are invoked from the host operating system command line or using scripts. SYMCLI commands invoke low-level HBA commands to specialized devices on the Symmetrix called “gatekeepers.” Gatekeepers are very small logical volumes configured upon disks in the Symmetrix that act as SCSI targets for the SYMCLI commands.

SYMCLI is used in single command line entries or in scripts to monitor and perform control operations on devices and data objects toward the management of the storage complex. It also monitors device configuration and status of devices that make up the storage environment. To reduce the number of inquiries from the host to the Symmetrix systems, configuration and status information is maintained...
Revised SRDF relationships for cascaded SRDF

in a host database file.

**Note:** Solutions Enabler references pertaining to the open systems cascaded SRDF interface are included in this document for introductory purposes only and are not intended to replace product specific documentation. For additional details on the cascaded SRDF open systems interface, refer to the *EMC Solutions Enabler Symmetrix SRDF Family CLI Product Guide* (available on Powerlink©).

**SRDF Host Component for z/OS**

SRDF Host Component is a z/OS subsystem for controlling SRDF processes and monitoring SRDF status by using commands executed from a host. SRDF Host Component for z/OS along with ResourcePak Base© for z/OS (API services module) is delivered when ordering a member of the SRDF product family.

User interfaces to the SRDF Host Component are provided with both TSO (ISPF) and batch commands. An optional interface is provided for EMC TimeFinder commands as well as SRDF commands to centralize commands for both replication products.

You can issue SRDF Host Component commands to both local and remote Symmetrix systems. Commands destined for remote Symmetrix systems are transmitted using local Symmetrix systems to remote Symmetrix systems using their SRDF links.

**Note:** SRDF Host Component references pertaining to the z/OS cascaded SRDF interface are included in this document for introductory purposes only and are not intended to replace product specific documentation. For additional details on the cascaded SRDF interface for z/OS, refer to the *EMC SRDF Host Component for z/OS Version 5.6 Product Guide* (available on Powerlink©).

Revised SRDF relationships for cascaded SRDF

The introduction of a cascaded SRDF relationship means that the commonly used mechanism of viewing an SRDF device as either a R1 device or a R2 device needs to change since the R21 device serves both purposes. Changing the way we view an SRDF device to be context-, or mirror-based, rather than device type-based will allow the customer to more easily understand the changes that have been made to Solutions Enabler and SRDF Host Component.
Throughout Solutions Enabler and SRDF Host Component interfaces, an R21 device may be viewed based on the relationship that is being queried or controlled. For example, when working with the R1->R21 relationship, the R21 device will be acting and will be managed as if it were an R2. When working with the R21->R2 relationship, the R21 will be acting and will be managed as if it were an R1 device.

When querying or controlling an R1 device that is participating in a cascaded SRDF relationship, the terms first hop and second hop will be used to R1 -> R21 and R21 -> R2 relationship, respectively. This is also true when controlling a R2 device that is participating in a cascaded SRDF relationship, but the first hop will represent the R2 -> R21 relationship and the second hop will represent the R21 -> R1 relationship.

When performing controls against one SRDF pair relationship, the state of the other SRDF pair relationship will determine whether the operation will be allowed. Controls are allowed from hosts connected to either the Symmetrix containing the R1 device, the Symmetrix containing the R21 device, or the Symmetrix containing the R2 device.

The open systems example below shows that the location of the hop-2 devices is dependent on the location of the controlling host. In this example, the controlling host is located at workload site A, therefore a control operation using a -hop2 specific reference will act on the devices in the Symmetrix at tertiary site C.

Conversely, when the controlling host is located at site C, as shown on the next example, a control operation using a -hop2 specific reference will act on the devices in the Symmetrix at primary site A.

While similar, references in SRDF Host Component for z/OS utilize a
Supported SRDF modes and general restrictions

Valid SRDF modes

SRDF currently supports the following modes of operation in a cascaded environment:

- **Synchronous mode (SRDF/S)** — Provides real-time mirroring of data between the primary Symmetrix system(s) and one or more secondary Symmetrix systems. Data is written simultaneously to the cache of both systems in real time before the application I/O is completed, thus ensuring the highest possible data availability. Data must be successfully stored in both the primary and secondary Symmetrix systems before a positive acknowledgment is sent to the primary host. This mode is used mainly for metropolitan area network distances less than 200 km.

- **Asynchronous mode (SRDF/A)** — Maintains a dependent-write consistent copy of data at all times across any distance with little or no measurable host application impact. Applications needing to replicate data across long distances historically have had limited options. SRDF/A delivers high-performance, extended distance replication and reduced telecommunication costs while leveraging existing management capabilities with no host performance impact.

- **Adaptive Copy mode** — Transfers data from source devices to target devices regardless of order or consistency, and without host performance impact. This is especially useful when transferring...
large amounts of data during data center migrations, consolidations, and in data mobility environments.

Similar to other advanced SRDF relationships, the modes supported for each hop of a cascaded SRDF configuration are based upon the current state of the device in question and the SRDF links.

A basic cascaded SRDF configuration consists of a primary site (site A) replicating synchronously to a secondary site (site B) with SRDF/S, and then replicating the same data asynchronously to a tertiary site (site C) with SRDF/A.

Notice that in the previous figure, the link from workload site A to secondary site B is in SRDF/S or synchronous mode and the link from secondary site B to tertiary site C is in SRDF/A or asynchronous mode.

While the configuration above represents a typical or best practice implementation of cascaded SRDF, other SRDF mode combinations are also valid as shown in the following diagram and associated table.

<table>
<thead>
<tr>
<th>HOP-1: Site A to Site B (R1 - R21)</th>
<th>HOP-2: Site B to Site C (R21 - R2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous ¹</td>
<td>Asynchronous ²</td>
</tr>
<tr>
<td>Adaptive Copy disk</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Adaptive Copy WP</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Adaptive Copy disk</td>
</tr>
<tr>
<td>Asynchronous</td>
<td>Adaptive Copy disk</td>
</tr>
<tr>
<td>Adaptive Copy WP</td>
<td>Adaptive Copy disk</td>
</tr>
<tr>
<td>Adaptive Copy disk</td>
<td>Adaptive Copy disk</td>
</tr>
</tbody>
</table>

¹ Recommended Hop-1 SRDF mode of operation
² Recommended Hop-2 SRDF mode of operation
Caution! Use of Adaptive Copy mode on the first leg will cause loss of consistency for SRDF/A operating on the second leg.

General limitations and restrictions (non-interface specific)

The following is a current list of general cascaded SRDF limitations and constraints:

- The secondary site B (where the R21 device resides) requires Enginuity 5773, Solutions Enabler 6.5, or SRDF Host Component 5.6. The primary/workload A and tertiary C sites systems can run on 5671, 5772, or 5773.
- Primary site A and tertiary site C Symmetrix will require Enginuity 5x71 or later to support SRDF/A Multi-Session Consistency (MSC).
- An R21 device cannot be paired with another R21 device.
- R21 devices cannot be BCV devices.
- R21 devices are only supported on GigE and Fiber RAs.
- PPRC devices cannot be R21 devices.
- R21 thin devices are not supported.
- The first hop will support all SRDF modes of operation, with the exception of SRDF/A if it is currently utilized on the second hop.
- The second hop will support either SRDF/A or Adaptive Copy Disk Mode, with the exception of SRDF/A if it is currently utilized on the first hop.
- Solutions Enabler or SRDF Host Component will continue to discover Symmetrix that are at most two hops away.
- There is no support for controlling or creating a single SRDF relationship containing both concurrent and cascaded components.

Initial best practices for cascaded SRDF

As a new Enginuity feature, cascaded SRDF best practices are in the process of being developed based on our continued experiences with the product in the lab and well as with customers in the field. The list of cascaded SRDF best practices presented below is in no way definitive and will continue to develop based on these experiences.
A basic cascaded SRDF configuration is recommended and should consist of a primary site (site A) replicating synchronously to a secondary site (site B) with SRDF/S, and then replicating the same data asynchronously to a tertiary site (site C) with SRDF/A.

The first hop of a cascaded SRDF configuration should have Consistency Group (ConGroup) enabled in SRDF/S mode.

SRDF/A MSC should be enabled on the secondary leg with a host controlling cycle switching from primary, secondary or tertiary sites.

R21 will have local mirrors using Mirrored, RAID 5, or RAID 6, or it can be unprotected. However, unprotected R21 devices are not recommended due to possible impact on replication due to drive failures.

Separate SRDF directors configured to support the incoming and outgoing SRDF groups for the R21 device are highly recommended.

A R21 device cannot have one static and one dynamic SRDF mirror.

The use of SRDF/A Reserve Capacity is fully supported and recommended with cascaded SRDF.

For the second hop, the R21 device cannot be in a consistency group because SRDF synchronous mode is not supported on the second hop.

A “gold copy” BCV device at the tertiary site C is highly recommended should re-synchronization become necessary following a network or link outage.

Changes to open systems Solutions Enabler interface

The following sections pertaining to the open systems cascaded SRDF interface are included for introductory purposes only and are not intended to replace EMC product specific documentation.

For additional details on the cascaded SRDF open systems interface, refer to the EMC Solutions Enabler Symmetrix SRDF Family CLI Product Guide (available on Powerlink).

Initial packaging and licensing

The initial release of cascaded SRDF has been packaged with the 5773 Enginuity release and Solution Enabler 6.5. It requires a license at each site in a cascaded SRDF configuration. Other applicable SRDF family licenses for the cascaded SRDF implementation also will apply.
Establishing a cascaded SRDF configuration

Configuring cascaded replication is a two-step process, which can be performed in any order:

1. Create the initial R1 -> R2 pair between primary site A and secondary site B, or first hop
   (or) between secondary site B and tertiary site C (second hop), alternatively.

2. Set up the R1 -> R2 pair between secondary site B and tertiary site C, or second hop
   (or) between primary site A and secondary site B (first hop, alternatively).

These steps are accomplished using the `symconfigure` command with the `add mirror` option. The following examples show how to add a mirror from each site. Please refer to the EMC Solutions Enabler Symmetrix Array Controls CLI Product Guide for information about using the `symconfigure` command.

In the following examples, the device pairs in the cascaded replication are:

- 01A:140 (R1 workload site A and R21 secondary site B)
- 140:4F (R21 secondary site B and R2 tertiary site C)

From workload site A, the `add mirror` command would be as follows:

```
add rdf mirror to dev 01A ra_group=67, mirror_type = RDF1, remote_dev = 140, invalidate=R1, start_copy = YES, rdf_mode = sync;
```

From tertiary site C, the `add mirror` command would be as follows:

```
add rdf mirror to dev 4F ra_group=67, mirror_type = RDF2, remote_dev = 140, invalidate=R1, start_copy = YES, rdf_mode = acp_disk;
```
Changes to open systems Solutions Enabler interface

**Note:** For SRDF/EDP configurations, use `rdf_mode = acp_wp`.

**Note:** Both `add mirror` commands cannot be in the same command file.

**Adding SRDF hop-2 devices**

Cascaded SRDF introduces the ability to perform controls on SRDF devices that are two hops, or SRDF links, away.

The following new device types have been added to device groups and composite groups:

- Hop-2 BCV (logical device name 2BCVnnn)
- Hop-2 VDEV (logical device name 2VDEVnnn)
- Hop-2 TGT (logical device name 2TGTnnn)

For device groups, all `-hop2` devices must be associated using the same hop-1 and hop-2 SRDF groups. The SRDF group used to associate hop-2 devices must be the same one used to associate RBCVs, RTGTs, and other devices.
Device groups

To add hop-2 VDEV and TGT devices to a device group use the `symld` command syntax, as follows:

```
symld -g DgName [-sid SymmID] [-vdev | -tgt] [-hop2] [-rdfg GrpNum] [-remote_rdfg RemoteGrpNum]
add dev SymDevName [LdevName]
```

Use the `symbcv` command syntax to add hop-2 BCVs to a device group, as follows:

```
symbcv -g DgName [-sid SymmID] [-vdev | -tgt] [-hop2] [-rdfg GrpNum] [-remote_rdfg RemoteGrpNum]
associate dev SymDevName [LdevName]
```

The `symld` and `symbcv` commands with the `-hop2` parameter can be used for the following operations:

- Add/remove
- Addall rmall (symld)
- Move/moveall
- Copy/copyall
- Dg2cg

Composite groups

To add hop-2 VDEV and TGT devices to a composite group, use the `symcg` command syntax, as follows:

```
symcg -cg CgName [-sid SymmID] [-vdev | -hop2] [-tgt] [-rdfg GrpNum] [-remote_rdfg RemoteGrpNum]
add dev SymDevName [LdevName]
```

Use the `symbcv` command to add hop-2 BCVs to a composite group, as follows:

```
symbcv -cg CgName [-sid SymmID] [-vdev | -hop2] [-tgt] [-rdfg GrpNum] [-remote_rdfg RemoteGrpNum]
associate dev SymDevName [LdevName]
```

The `symcg` and the `symbcv` commands with the `-hop2` parameter can be used for the following operations:

- Associate/disassociate
- Associateall/rmall
- Move/moveall
Changes to open systems Solutions Enabler interface

- Copy/copyall

**RDF21 type groups**

Device groups and composite groups can be created to contain R21 devices as standards. These groups can be identified with a new SRDF group type: RDF21. The following syntax examples show creating an RDF21 device group and composite group:

```
symdi -type RDF21 create test_group_dg
symcg -type RDF21 create test_group_cg
```

The following restrictions apply to RDF21 groups:

- Composite groups cannot be PowerPath® groups
- Device groups must use the same SRDF groups
- The SRDF mirror types for an SRDF group must match

For example, the following figure shows an RDF21 group that will not be allowed because the device groups must use the same SRDF groups.

The next figure shows an allowed RDF21 group using the same SRDF groups.
Changes to open systems Solutions Enabler interface

Pair states queries of a cascaded relationship

To display information about the second hop SRDF pair of a cascaded SRDF relationship, use the `--hop2` option with the `symrdf query` command. The following output is an example of a `symrdf query conrl --hop2` command. The bolded output is further described immediately after the display.

```
symrdf query -cg conrl -hop2

   Composite Group Name : conrl
   Composite Group Type  : RD6
   Number of Symmetric Units : 1
   Number of RDF (RA) Groups : 1
   RDF Consistency Mode  : NONE

 Symmetric ID     : 00019B0600016 (Microcode Version: 577)
 Hop-2 Symmetric ID : 00019B0601039 (Microcode Version: 577)
 Hop-2 Remote Symmetric ID : 00019B0602069 (Microcode Version: 577)
 RDF (RA) Group Number  : 121 (78)
 Hop-2 RDF (RA) Group Number  : 124 (7B)

 SOURCE (RL) View TARGET (RL) View NODES STATES
------------------------------- --------------------------------------------------
  ST   LI   ST   C  S
  ST   LI   ST   C  S
 Logical Sym T Rl Inv R2 Inv K T Rl Inv R2 Inv n s RDF Pair
 Device Dev E Tracks Tracks S Dev E Tracks Tracks MDA s p STATE

DEV003 01FF EW 0 0 NW 030A UD 0 0 A.. X - Consistent
DEV004 01FE EW 0 0 NW 030B UD 0 0 A.. X - Consistent
DEV001 020F FW 0 0 NW 02FD WD 0 0 A.. X - Consistent

 Symmetric ID     : 00019B0600016 (Microcode Version: 577)
 Hop-2 Symmetric ID : 00019B0601039 (Microcode Version: 577)
 Hop-2 Remote Symmetric ID : 00019B0602069 (Microcode Version: 577)
 RDF (RA) Group Number  : 121 (78)
 Hop-2 RDF (RA) Group Number  : 160 (9F)

 SOURCE (RL) View TARGET (RL) View NODES STATES
------------------------------- --------------------------------------------------
  ST   LI   ST   C  S
  ST   LI   ST   C  S
 Logical Sym T Rl Inv R2 Inv K T Rl Inv R2 Inv n s RDF Pair
 Device Dev E Tracks Tracks S Dev E Tracks Tracks MDA s p STATE

DEV003 00F8 EW 0 0 NW 0306 UD 0 0 A.. X - Consistent

Legend for NODES:

X (mode of Operation) : A - Async, S - Sync, E - Semi-sync, C - Adaptive Copy
(Nomine) : X = Enabled, . = Disabled
(Adaptive Copy) : D = Disk Mode, W = WR Mode, . = ACP off

Legend for STATES:

Consistency State) : X = Enabled, M = Mixed, . = Disabled, - = N/A

Some items to note in the preceding query:
Changes to open systems Solutions Enabler interface

- **Number of RDF (RA) Groups** — Represents the number of R1 -> R21 SRDF groups in the composite group.
- **Symmetrix ID** — Represents the Symmetrix ID of the R1 device.
- **Hop-2 Symmetrix ID** — Represents the Symmetrix ID of the R21 device.
- **Hop-2 Remote Symmetrix ID** — Represents the Symmetrix ID of the R2 device.
- **RDF (RA) Group Number** — Represents the SRDF group of the R1 device.
- **Hop-2 RDF (RA) Group Number** — Represents the SRDF group of the R21 device.
- **Total** — Sums the invalid tracks (and MB) across all displayed R21 -> R2 SRDF groups (sums all hop-2 invalid tracks).

**Note:** With an R1 -> R21 -> R2 configuration, issuing a query `-hop2` from an RDF1 CG indicates that the query should show the relationship of the R21 -> R2 device pairs. Thus the query will display the R21 device from the R1 mirror point of view.

To see both hops of the RDF1 or RDF2 CG that contains devices in a cascaded SRDF relationship, use the `symrdf -cg query` command with the `-hop2` and the `-detail` options.

**Note:** The `-detail` option is not supported for a device group.

Restrictions and limitations for open systems

The following restrictions and limitations apply to R21 devices:

- To set up a dynamic R21 device, the device must be both `dyn_rdf1` and `dyn_rdf2` capable. The following command will set this value:

  ```
  set dev xxx:[xxx] attribute = dyn_rdf;
  ```

- When adding the first device to an SRDF group with `-rdf_mode async`, all subsequent devices that are added to the SRDF group must also be added with `-rdf_mode async`.

- When a mode is not specified, it defaults to Synchronous mode.

- When adding the first device to an SRDF group with `-rdf_mode sync|semi|acp_wp|acp_disk`, subsequent devices cannot be added with `-rdf_mode async`.

- If the SRDF device is a part of a consistency group, the device
cannot have a mirror added to it to form an R21 device.

- Mirrors cannot be added to VDEVs, SAVE devices, DATA devices, thin devices, and WORM-enabled devices.
- When adding a mirror to a device, making the device an R21 device, the following two conditions must be met:
  1. The R21 device should be able to see its current SRDF partner, in other words, the links cannot be partitioned.
  2. The remote partner of the R21 cannot already be an R21 device.
- If adding a dynamic SRDF mirror for an R21 device, the second hop can only be in async or acp_disk mode (ac_wp for SRDF/EDP configurations).

Specific restrictions for Static SRDF configurations:

- Static SRDF configurations can only be configured in sync, ac_wp, or ac_disk mode.
- The static SRDF R21 -> R2 link has to be ac_disk mode (ac_wp for SRDF/EDP configurations).
- The start_copy option should be set to NO and invalidate set to NONE, if adding a remote mirror to a device leads to a concurrent SRDF configuration.

Note: Currently symconfigure contains a restriction that if invalidate is set to R1 or R2, then start_copy should be set to yes.

SRDF/EDP specific Solutions Enabler interface changes

The new SRDF/EDP functionality is based on a cascaded SRDF configuration, where a Symmetrix VMAX™ at a secondary site uses a new DLDEV (diskless R21) device to capture only the differential data that would be owed to the tertiary site in the event of a primary site failure. The data in the diskless R21 device helps these configurations to achieve a zero RPO. The new DLDEV device type does not consume storage space and is not a restartable copy of the user data. Therefore in this configuration, users only have two full copies of the data being protected, one at the primary and the other at the tertiary site.

EMC Solutions Enabler has been enhanced to support diskless devices. Support has been added to SYMCLI to allow the user to create diskless devices, report on diskless devices, create SRDF relationships with
diskless devices, and control the diskless devices and diskless SRDF relationships. The Solutions Enabler SRDF Consistency support has also been enhanced to support SRDF consistency groups and Star environments comprised of diskless cascaded SRDF devices.

The following changes have been made to the SYMCLI to support SRDF/EDP:

The add and remove SRDF mirror command has been extended to support add both static and dynamic SRDF mirrors to diskless devices. The procedure for setting up a diskless R21 device is generally no different from configuring a legacy R21 device.

The symdev list command will be enhanced to support a new -dldev parameter that can be used to display all configured diskless devices.

```
symdev [-sid SymmID] [-offline]
        [-v] [-resv] [-wwn] [-all]
```

**Note:** The -dldev flag can be specified in conjunction with the -R1, -R2, -R21, or -dynamic flags and will return the requested diskless SRDF or SRDF capable devices.

```
symdev list -sid 64 -dldev
```

```
0005 Not Visible ???:? NA:NA RDF1+DLDEV N/Grp'd RW 1031
```

The following changes have been made to the output of the symdev show command to support diskless devices:

- The Device Configuration field shows the device as being diskless.
- The Device SA Status always shows as N/A because diskless devices cannot be mapped to a host.
- The Mirror Set Type and Mirror Set DA Status only show information about SRDF mirrors.
- The Back End Disk Director Information section only shows information about SRDF mirrors.
- The Back End Disk Director Information section shows a new Mirror Number field for each displayed hyper.
- Each RDF Information section displays a new Diskless RDF Relationship field to indicate if the device is a diskless SRDF
device or in a SRDF relationship with a diskless SRDF device.

```bash
symdev show 01A -sid 56 (for a R21 diskless device)
```

```
Device Configuration : RDF21+DLDEV (Non-Exclusive Access)
Device Status : Ready (RW)
Device SA Status : N/A (N/A)
Mirror Set Type : [R2 Remote,R1 Remote,N/A,N/A]
Mirror Set DA Status : [RW,RW,N/A,N/A]
Mirror Set Inv. Tracks : [0,0,0,0]
```

```
Back End Disk Director Information
{
Hyper Type : R2 Remote
Hyper Status : Ready (RW)
Disk [Director, Interface, TID] : [N/A,N/A,N/A]
Disk Director Volume Number : N/A
Hyper Number : N/A
Mirror Number : 1

Hyper Type : R1 Remote
Hyper Status : Ready (RW)
Disk [Director, Interface, TID] : [N/A,N/A,N/A]
Disk Director Volume Number : N/A
Hyper Number : N/A
Mirror Number : 2
```

```
RDF Information
{
Device Symmetrix Name : 01A
RDF Type : R2
RDF (RA) Group Num : 8 (07)
Remote Device Symmetrix Name : 0120
Remote Symmetrix ID : 000190000000
R2 Device Is Larger Than The R1 Device : False
Paired with Diskless Device : False
Concurrent RDF Relationship : False
Cascaded RDF Relationship : True
...
RDF Information
{
Device Symmetrix Name : 01A
RDF Type : R1
RDF (RA) Group Num : 11 (0A)
Remote Device Symmetrix Name : 0234
Remote Symmetrix ID : 000190002615
R2 Device Is Larger Than The R1 Device : False
Paired with Diskless Device : False
Paired with a Concurrent RDF Device : False
Paired with a Cascaded RDF Device : False
...
```

**Note:** The Paired with Diskless Device fields show as “False” because this device is not paired with a diskless device but rather is the diskless device. The Paired with Diskless Device field is an indicator about the device type for the SRDF remote pair for this device.

```bash
symdev show 01A -sid 56 (for a non-SRDF diskless device)
```
SRDF/EDP specific Solutions Enabler interface changes

Device Configuration: DLDEV (Non-Exclusive Access)

Device Status: Ready (RW)
Device SA Status: N/A (N/A)
Mirror Set Type: [N/A,N/A,N/A,N/A]
Mirror Set DA Status: [N/A,N/A,N/A,N/A]
Mirror Set Inv. Tracks: [0,0,0,0]

Back End Disk Director Information:
- Hyper Type: N/A
- Hyper Status: N/A (N/A)
- Disk [Director, Interface, TID]: [N/A, N/A, N/A]
- Disk Director Volume Number: N/A
- Hyper Number: N/A
- Mirror Number: N/A
- Disk Capacity: N/A
- Disk Group Number: N/A

XML output has been changed to include the new displayed values and to display the new mirror number and Paired with a Diskless RDF Device fields.

```
symdev show ae -sid 109 (for an R1 diskless device)
<?xml version="1.0" standalone="yes" ?>
...
<Dev_Info>
  ...
  <configuration>RDF1+DLDEV</configuration>
  ...
  <Back_End>
    ...
    <Hyper>
      ...
      <mirror_number>2</mirror_number>
    ...
    <RDF>
      ...
      <RDF_Info>
        ...
        <paired_with_diskless>False</paired_with_diskless>
      ...
    ...
    ...
  ...
```

The SRDF feature has been enhanced to support diskless SRDF devices. Since a diskless SRDF device does not have any local mirrors, appropriate controls have been restricted. Configuring a diskless R1, R2, R11, or R22 device is not recommended unless it is an intermediate stage of creating a diskless R21 device.

The following change will be made to the symrdf list command:

Filtering has been enhanced to support listing diskless SRDF devices. A new -diskless_rdf flag will be added and can be used to list all devices that are diskless SRDF devices or have an SRDF relationship with a diskless SRDF device.

-diskless_rdf can be used in conjunction with -R1, -R2, -R21, or -dynamic flags and will return the requested diskless SRDF or SRDF.
SRDF/EDP specific Solutions Enabler interface changes

capable devices.

The new `symrdf list` syntax is as follows:

```bash
symrdf [-sid SymmID] [-i Interval] [-c Count] [-offline] [-v] ... [-diskless_rdf] ...
```

SRDF control operations can be issued against CGs, DGs, and files that contain both diskless and legacy cascaded device types. The processing for SRDF pairs containing diskless devices is no different from the processing for SRDF pairs containing legacy cascaded devices; however, some new restrictions apply when you are controlling a cascaded SRDF relationship that is comprised of diskless devices. These are:

- Set mode ASYNC issued against a device in a SRDF group that consists of mixed diskless legacy cascaded devices is not allowed.

- With an R1 → R21 → R2 configuration where the R21 is diskless, only the following combinations of SRDF modes are allowed with all other combinations restricted:

<table>
<thead>
<tr>
<th>R1 → R21</th>
<th>R21 → R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synchronous</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Adaptive Copy – DISK</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Adaptive Copy – WP</td>
<td>Asynchronous</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Adaptive Copy – WP</td>
</tr>
<tr>
<td>Adaptive Copy – DISK</td>
<td>Adaptive Copy – WP</td>
</tr>
<tr>
<td>Adaptive Copy – WP</td>
<td>Adaptive Copy – WP</td>
</tr>
</tbody>
</table>

The `createpair`, `deletepair`, `swap_personality`, `movepair`, and `failover -establish` actions can be used to create and manage diskless SRDF device relationships. Please see the “Current limitations and restrictions” sections for additional information.
The following types of MSC and SRDF-ECA Consistency enabling will be allowed with SRDF/EDP:

<table>
<thead>
<tr>
<th>R1 → R21</th>
<th>R21 → R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRDF-ECA</td>
<td>-none-</td>
</tr>
<tr>
<td>SRDF-ECA</td>
<td>MSC</td>
</tr>
<tr>
<td>-none-</td>
<td>MSC</td>
</tr>
</tbody>
</table>

The symconfigure CLI has been modified to support creation, configuration, convert, and delete of diskless device and SRDF diskless device.

- DLDEV
- RDF1+DLDEV
- RDF2+DLDEV
- RDF21+DLDEV

To create a diskless device the user can use the existing create/configure dev command with one of the following config values.

- DLDEV
- RDF1+DLDEV
- RDF2+DLDEV

Other applicable Solutions Enabler SYMCLI considerations for SRDF/EDP:

- Symreplicate will be changed to return an error if a diskless SRDF is found in the configuration.
- SymRecover has been enhanced to support diskless SRDF configurations at the R21 site.
  
  For control site operations, when the R21 is diskless, the --cascaded_monitor_both_hops flag is required. Monitoring only a single hop of a diskless relationship is not supported.
  
  When restarting, the R21 → R2 leg will be recovered before recovering the R1 → R21 leg. This is required to adhere to the Enginuity limitation that the R1 → R21 relationship cannot be RW on the link when the R21 → R2 relationship is NR on the link.
  
  When recovering the R21 → R2 relationship, the restart_sync_type will always be adaptive copy write pending (ADCOPY_WP) if the R21 is a diskless device.
- Users cannot directly create RDF21 devices. They will have to use the “ADD RDF MIRROR” symconfigure command or the
SRDF/EDP specific Solutions Enabler interface changes

SYMRDF CREATEPAIR TYPE=DLDEV command to create R21 diskless devices.

- When creating diskless SRDF devices both the local and remote devices cannot be R21 devices.
- The disk group number and the mvs_ssid attributes are not applicable when creating diskless devices.
- The create pair action will be blocked if it results in a R1 R21 R2 relationship where the R1 and the R2 are diskless devices.
- Diskless SRDF is supported in conjunction with the SRDF/A Delta Set Extension feature.

Requirements and dependencies

SRDF/EDP and associated diskless devices are supported only on the Symmetrix VMAX hardware platforms with Enginuity 5874 and later. However, only the Symmetrix that contains the diskless R21 device is required to be Enginuity 5874. The primary and the tertiary site systems are required to be in a Enginuity code level 5773 or 5874. Customers are reminded that if a failover action will result in the primary or tertiary site being configured as a new “secondary” site (where diskless R21s are configured), then Enginuity 5874 will be required to run on those sites as well. Please see the “Current limitations and restrictions” sections for additional information.

Current limitations and restrictions

The following is a current list of SRDF/EDP limitations and constraints:

- A diskless device cannot be mapped to the host. Therefore, no host will be able to directly access a diskless device for I/O (read or write).
- Diskless SRDF devices are only supported on GIGE and Fiber RAs
- A diskless device cannot use hot sparing or dynamic sparing.
- All Symmetrix replication technologies other than SRDF (TimeFinder, Snap, Clone, and ORS) will be blocked from working in conjunction with diskless devices as either the source or the target of the operation.
- A diskless SRDF device cannot be paired with a thin SRDF device.
- A diskless SRDF device cannot be used in a R2 larger than R1 configuration.
Changes to the SRDF Host Component z/OS interface

The following sections pertaining to the z/OS cascaded SRDF interface are included for introductory purposes only and are not intended to replace EMC product specific documentation.

For additional details on the cascaded SRDF interface for z/OS, refer to the EMC SRDF Host Component for z/OS Version 5.6 Product Guide (available on Powerlink).

Initial packaging and licensing

Cascaded SRDF will be packaged with the 5773 Enginuity release and SRDF Host Component version 5.6. It will require a license at all sites in a cascaded SRDF configuration. Other applicable SRDF family licenses for the cascaded SRDF implementation also will apply.

SRDF Host Component change summary

Throughout SRDF Host Component version 5.6 and later versions, an

- The software implementation of DLDEVs will run only on the VMAX hardware platform with the Enginuity 5874 code level and later.
- Only the secondary site (where the DLDEV resides) will be required to be at the Enginuity 5874 code level to support a diskless R21 device.
- The primary and the tertiary site systems are required to be in a Enginuity code level 5773 or 5874.
- Primary or tertiary site systems with Enginuity code level 5773 will require an e-pack in order to connect to a SRDF/EDP system.
- Since local replication cannot be performed on a diskless device, Gold copies will not be allowed at a diskless R21 site.
- Diskless devices may not be added to the TGT, RTGT, or 2-Hop TGT device list.
- When creating a metadevice using diskless devices all the members of the meta must be diskless. You cannot mix diskless and legacy cascaded devices in a single meta.
- Either the local or the remote device can be diskless, however, both the local and the remote SRDF device cannot be diskless.
- Cannot add a mix of diskless and traditional cascaded SRDF devices in an SRDF group with devices in Async mode.
R21 device may be viewed based on the relationship that is being queried or controlled. For example, when working with the R1->R21 (read as R1 to R21) relationship, the R21 device will be acting, and will be managed, as if it were an R2. When working with the R21->R2 relationship, the R21 will be acting, and will be managed, as if it were an R1 device.

Configuring a cascaded SRDF configuration is a two-step process: (1) Establish R1->R2 pairs between primary site A and secondary site B (or secondary site B and tertiary site C) and (2) establish R1->R21 pairs between primary site A and secondary site B (or R21->R2 between secondary site B and tertiary site C).

Cascaded SRDF changes the way we view an SRDF volume to be context-, or mirror-based, rather than device-based. SRDF Host Component now supports configuring both cascaded and concurrent SRDF environments using the standard SRDF Host Component SC command syntax. The following example assumes that the synchronous SRDF relationship to the secondary DMX has already been established:

```
SC VOL,RMT(GK,localRDFGRP#,bunkerRDFGRP#),
CREATEPAIR(ADCOPY-DISK),start-bunkersymdv-end-
bunkersymdev#,B-site-start-symdev#
```

There have been relatively few SRDF Host Component changes required to implement cascaded SRDF; the SRDF commands needed to do multiple hops have been available in the command syntax and were used for SRDF/SAR in legacy releases. The only real change in command syntax added for cascaded SRDF support was related to describing the SRDF/A MSC session, since it is now controlled remotely. The syntax has been changed as follows:

```
MSC_INCLUDE_SESSION=ccuu,(localrdfgrp,remoterdfgrp)
```

All other changes within Enginuity allow concurrent SRDF for a R2 device and all associated operations that this entails.
Establishing a cascaded SRDF configuration

Once the required SRDF groups have been established, setting up cascaded replication is a two-step process, which can be performed in any order:

1. Create the initial R1 -> R2 pair between primary site A and secondary site B, or first hop
   (or) between secondary site B and tertiary site C (second hop), alternatively.

2. Set up the R1 -> R2 pair between secondary site B and tertiary site C, or second hop
   (or) between primary site A and secondary site B (first hop, alternatively).

In the following examples we will create the required SRDF groups, and device pairing, and perform various queries to determine the state of the environment.
The first step required to configure a legacy cascaded SRDF environment is to create an SRDF group from primary site A to secondary site B for the first hop.

The next step is to create an SRDF group between secondary site B and tertiary site C for the second hop.
Changes to the SRDF Host Component z/OS interface

EMCM 001  SRDF-HC : (24) 4SQ RDPGRF, RMT(9E00,04), RA(54)  EMCM 001  SRDF-HC DISPLAY FOR (24) 4SQ RDPGRF, RMT(9E00,04), RA(54)  871
MY SERIAL # MY MICROCODE
-------------------------
00190100849  5773-43

MY GRP OML FC OS GRP OS SERIAL OS MICROCODE SYNCHDIR FEATURE
------------- ------- ---------- ------------- ------- ------------
LABEL TYPE AUTO-LINKS-RECOVERY LINKS-DOMINO MSC_GROUP
----------------- ------- ---------- ------------- ------- --------------
54 Y F 64 00190300344 5772-83 G(R1=R2) TSTCAS2 DYNAMIC AUTO-LINKS-RECOVERY LINKS-DOMINO:NO

MY DIR# OS R# ST ----MY REM---- ----IN COUNT---- ----OUT COUNT----
28 3F 02 5006048AD52D5C47 0000000000030298 000000000000000000000000 0000000000000000000

END OF DISPLAY

Once the first and second hop SRDF groups have been created, performing an **SQ LINK** command will result in the following:

EMCM 001  SRDF-HC : (87) 4SQ LINK, 9E00  EMCM 001  SRDF-HC DISPLAY FOR (87) 4SQ LINK, 9E00 123
CUU_DIR RA P CONN_STATUS_ TMS:TS I/O-RATE HHD:MM:SS TOTAL-1/0
9E00 28 RP 1 Y ONLINE 00:00 0 000:00:00:00 3,567,296 9E00 38 RP 1 Y ONLINE 00:00 0 000:00:00:00 9,735,327
END OF DISPLAY

4SQ L, RMT(9E00,04)  EMCM 001  SRDF-HC : (88) 4SQ LINK, RMT(9E00,04)  EMCM 001  SRDF-HC DISPLAY FOR (88) 4SQ LINK, RMT(9E00,04) 132
CUU_DIR RA P CONN_STATUS_ TMS:TS I/O-RATE HHD:MM:SS TOTAL-1/0
9E00 28 RP 1 Y ONLINE 00:00 0 000:00:00:00 52,057,031
9E00 38 RP 1 Y ONLINE 00:00 0 000:00:00:00 12,104,811
END OF DISPLAY

4SQ L, RMT(9E00,04,54)  EMCM 001  SRDF-HC : (89) 4SQ LINK, RMT(9E00,04,54)  EMCM 001  SRDF-HC DISPLAY FOR (89) 4SQ LINK, RMT(9E00,04,54) 135
CUU_DIR RA P CONN_STATUS_ TMS:TS I/O-RATE HHD:MM:SS TOTAL-1/0
9E00 31 RP 1 Y ONLINE 00:00 0 000:00:00:00 142,110,994
9E00 40 RP 1 Y ONLINE 00:00 0 000:00:00:00 235,424,978
END OF DISPLAY
Once the SRDF groups have been created and verified, our next step is to identify volumes to be paired between primary site A and secondary site B for the first hop:

```
EMCMN001 SRDF-KC : (26) &SQ VOL,9E00,8,50
EMCQV001 SRDF-KC DISPLAY FOR (26) &SQ VOL,9E00,8,50 053
DV_ADDR | _SYM_ | [TOTAL] | [SY] | [DCB] | [CNTLUNIT] | [RL] | [R2] | [SY] | [CH|DEV] | [RDEV GP] | [VOLSER] | CYLS | [STAT] | [OPN] | [STATUS] | [MR] | [INVTRK] | [INTVRK] %
9E30 30 0050  OFFLIN 3339 OFFL 0 R/W
9E31 31 0051  OFFLIN 3339 OFFL 0 R/W
9E32 32 0052  OFFLIN 3339 OFFL 0 R/W
9E33 33 0053  OFFLIN 3339 OFFL 0 R/W
9E34 34 0054  OFFLIN 3339 OFFL 0 R/W
9E35 35 0055  OFFLIN 3339 OFFL 0 R/W
9E36 36 0056  OFFLIN 3339 OFFL 0 R/W
9E37 37 0057  OFFLIN 3339 OFFL 0 R/W
END OF DISPLAY
EMCMN001 SRDF-KC : (27) &SQ VOL,RMT(9E00,04),8,B0
EMCQV001 SRDF-KC DISPLAY FOR (27) &SQ VOL,RMT(9E00,04),8,B0 057
DV_ADDR | _SYM_ | [TOTAL] | [SY] | [DCB] | [CNTLUNIT] | [RL] | [R2] | [SY] | [CH|DEV] | [RDEV GP] | [VOLSER] | CYLS | [STAT] | [OPN] | [STATUS] | [MR] | [INVTRK] | [INTVRK] %
4290 90 00B0  OFFLIN 3339 OFFL 0 R/W
4291 91 00B1  OFFLIN 3339 OFFL 0 R/W
4292 92 00B2  OFFLIN 3339 OFFL 0 R/W
4293 93 00B3  OFFLIN 3339 OFFL 0 R/W
4294 94 00B4  OFFLIN 3339 OFFL 0 R/W
4295 95 00B5  OFFLIN 3339 OFFL 0 R/W
4296 96 00B6  OFFLIN 3339 OFFL 0 R/W
4297 97 00B7  OFFLIN 3339 OFFL 0 R/W
END OF DISPLAY
```

Once the volumes to be paired have been identified, the next step is to create device pairs between primary site A and secondary site B for the first hop.

```
EMCMN001 SRDF-KC : (29) &SC VOL,LC,LCL(9E00,04),CREATEPAIR,50-57,B0
EMCMQ441I COMMAND HAS FINISHED FOR BOX 000190103387 (CMD:29)
EMCMQ441I REQUESTED DEVICES 110
0050-0057
EMCMQ421I ELIGIBLE DEVICES 119
0050-0057
EMCMQ431I COMPLETED DEVICES 120
0050-0057
EMCMQ407I COMMAND COMPLETED (CMD:29)
```
Once the first hop has been completed, our next step is to identify volumes to be paired between secondary site B and tertiary site C for the second hop:

Once the second hop volumes have been chosen, the next step is to create device pairs between secondary site B and tertiary site C for the first hop. However, performing a typical CREATEPAIR will result in an error. **Important!** CREATEPAIR will default to synchronous mode, which is not a valid mode for the second hop of a cascaded SRDF relationship:

```
EMCMN001 SRDF-HC : (34) &SC VOL,RMT(9E00,04,54),CREATEPAIR,B0,B7,A0
EMCCV501 CREATEPAIR 00B0-00A0(0008) R1 OF R21 IN WRONG RDF MODE
000190100849/00B0/00B0
EMCGM101I COMMAND ABORTED  (CMD:34)
```
With this restriction in mind, the next step would then be to create device pairs between secondary site B and tertiary site C for the second hop, specifying Adaptive Copy disk as the mode of operation.
Performing a concurrent SRDF **SQ VOL** for comparison purposes results in the following output:

```
EMCMN001I SRDF-HC : (94) &SQ VOL, 9A00,16
EMCQ700I SRDF-HC DISPLAY FOR (94) &SQ VOL, 9A00,16 010

DV_ADDR | _SYM_ | TOTAL | DCB | CNTRLUNIT | R1 | R2 | SY
SYS CH | DEV | RDEV | GP | VOLSER | CYLS | STAT | OPN | STATUS | MR | INTRKR | INTRKR | %
9A00 00 0020 0020 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
9A01 01 0021 0021 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0021 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A02 02 0022 0022 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0022 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A03 03 0023 0023 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0023 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A04 04 0024 0024 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0024 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A05 05 0025 0025 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0025 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A06 06 0026 0026 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0026 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A07 07 0027 0027 14 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0027 04 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A08 08 0028 0028 15 OFFLIN 1113 OFFL 0 R/W-SY R1 0 0 **
9A09 09 0029 0029 15 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
0029 05 OFFLIN 1113 OFFL 0 R/W-AS L1 0 0 **
9A0A 0A 002A 002A 15 OFFLIN 1113 OFFL 0 R/W-SY L1 0 0 **
END OF DISPLAY
```

There have also been changes to RMT in the **SQ VOL** command to address access to the second hop:

```
EMCMN001I SRDF-HC : (37) &SQ VOL, RMT(9E00, 04.54), 8, A0
EMCQV001I SRDF-HC DISPLAY FOR (37) &SQ VOL, RMT(9E00, 04.54), 8, A0 279

DV_ADDR | _SYM_ | TOTAL | DCB | CNTRLUNIT | R1 | R2 | SY
SYS CH | DEV | RDEV | GP | VOLSER | CYLS | STAT | OPN | STATUS | MR | INTRKR | INTRKR | %
9A80 80 00A0 00B0 64 OFFLIN 3339 OFFL 0 N/R L2 28,668 46
9A81 81 00A1 00B1 64 OFFLIN 3339 OFFL 0 N/R R2 28,855 42
9A82 82 00A2 00B2 64 OFFLIN 3339 OFFL 0 N/R L2 29,955 40
9A83 83 00A3 00B3 64 OFFLIN 3339 OFFL 0 N/R L2 29,819 40
9A84 84 00A4 00B4 64 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
9A85 85 00A5 00B5 64 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
9A86 86 00A6 00B6 64 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
9A87 87 00A7 00B7 64 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
END OF DISPLAY
```
Changes to the SRDF Host Component z/OS interface

The SRDF/A hop may now be activated and the second hop queried to validate the expected mode of operation results (note the –C immediately after the SRDF group number indicates that the group is participating in a cascaded relationship):

```
EMCN001 I SRDF-HC : (6) &SC SRDFA,RMT(9E00,04,54),ACT
EMCGM07I COMMAND COMPLETED (CMD:6)
EMCN001 I SRDF-HC : (7) &SQ SRDFA,RMT(9E00,04,54)
EMCGR001 I SRDF-HC DISPLAY FOR (7) &SQ SRDFA,RMT(9E00,04,54) 717
MY SERIAL # MY MICROCODE
------------- ------------
000190100849 5773-46

MY GRP CNL PC OS GRP OS SERIAL OS MICROCODE SYNCHDIR FEATURE
-------- --- ----- ------ ----- ------ ------------
LABEL TYPE AUTO-LINKS-RECOVERY LINKS_DOMINO MSC_GROUP
-------- --- ----- ------ ------ --------------- ---------------
54-C Y F 64 000190300344 5772-83 G(R1>R2) SRDFA ACTIVE
TSTCAS2 DYNAMIC AUTO-LINKS-RECOVERY LINKS-DOMINO:NO

PRIMARY SIDB: CYCLE NUMBER 1 MIN CYCLE TIME 59
SECONDARY CONSISTENT ( Y ) TOLERANCE ( N )
CAPTURE CYCLE SIZE 0 TRANSMIT CYCLE SIZE 0
AVERAGE CYCLE TIME 0 AVERAGE CYCLE SIZE 0
TIME SINCE LAST CYCLE SWITCH 11 DURATION OF LAST CYCLE 0
MAX THROTTLE TIME 65,535 MAX CACHE PERCENTAGE 98
HA WRITES 109,603 RPTD HA WRITES 4,539
HA DUP. SLOTS 1 SECONDARY DELAY 11
LAST CYCLE SIZE 0 DROP PRIORITY 1
CLEANUP RUNNING ( N ) MSC WINDOW IS OPEN ( N )
SRDF/A TRANSMIT IDLE ( Y ) SRDF/A DSE ACTIVE ( N )
MSC ACTIVE ( N )
```

END OF DISPLAY
Similarly, the output of the *SQ VOL* command also has been changed to indicate a cascaded SRDF relationship (*CAS* in the status field indicates a cascaded SRDF relationship):

```
EMCMN001I SRDF-HC : (41) &SQ VOL,RMT(9E00,04),8,B0
EMQV001I SRDF-HC DISPLAY FOR (41) &SQ VOL,RMT(9E00,04),8,B0 667
DV_ADDR| _SYM_ | | | TOTAL|SYS | DBC|CNTNLUNIT| | R1 | R2 | SY
SYS CH|DEV RDEV GP|VOLSER| CYLS|STAT|OPEN|STATUS |MR|INVTRK|INVTRK| %
4290 90 00B0 0050 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A0 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4291 91 00B1 0051 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A1 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4292 92 00B2 0052 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A2 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4293 93 00B3 0053 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A3 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4294 94 00B4 0054 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A4 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4295 95 00B5 0055 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A5 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4296 96 00B6 0056 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A6 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
4297 97 00B7 0057 44 OFFLIN 3339 OFFL 0 N/R L2 0 0 **
  00A7 54 OFFLIN 3339 OFFL 0 CAS-AS L1 0 **
END OF DISPLAY
```

**Restrictions and limitations for z/OS**

The following restrictions and limitations apply to R21 devices:

- R21 devices are supported only at 5773 code.
- A and C Symmetrix systems can be at older code levels. **Note:** Failover operations that result in R21 devices being configured in the original A or C sites will require Enginuity 5773 to be running on the Symmetrix systems at those sites.
- R21 is only supported on GigE and Fibre RA (no ESCON).
- R21 can only be paired with R1 and R2 devices.
- You cannot chain R1->R21->R21->R2.
- R21 cannot be a BCV device.
- R21 cannot be a PPRC or XRC device.
- R21 device cannot have one static and one dynamic SRDF mirror.
- The R21 devices must be both static or both dynamic.
Mainframe Enabler 7.0 (SRDF Host Component 7.0) changes

With Mainframe Enabler 7.0 (SRDF Host Component 7.0), configuring a cascaded SRDF or SRDF/EDP configuration is now a one-step process: Establish R1, R2, to R2 triples between primary, secondary, and tertiary sites. This is accomplished by utilizing the new composite commands available in SRDF Host Component 7.0. The following commands have been added:

- **CASCRE**  
  Creates a cascaded configuration

- **CASSUSP**
  Suspends pairs in a cascaded configuration – Issued from R1 only

- **CASRSUM**
  Resumes pairs in a cascaded configuration – Issued from R1 only

- **CASDEL**
  Terminates all relationships in a cascaded configuration

- **CASSWAP**
  Performs SRDF personality swap on both device pairs
  - Must be used for diskless R2
  - Requires devices to be suspended first

The syntax for these new composite commands is as follows:

- \#SC VOL,LCL(cuu,rdfgroup#1,rdfgroup#2),CASCRE(flag-list),r1dv-r1dv,r21dv,r2dv
- \#SC VOL,LCL(cuu,rdfgroup#1),CASSWAP(flag-list),r1dv-r1dv
- \#SC VOL,LCL(cuu,rdfgroup#1),CASDEL(flag-list),r1dv-r1dv
- \#SC VOL,LCL(cuu,rdfgroup#1),CASRSUSP,r1dv-r1dv
- \#SC VOL,LCL(cuu,rdfgroup#1),CASRSUM,r1dv-r1dv

For example, Host Component 7.0 now supports configuring SRDF/EDP environments by using the new parameters for the SRDF Host Component SC command syntax. The following shows the syntax for creating the SRDF/EDP volume triplets needed to establish the SRDF/EDP environment.

- \#SC VOL,LCL(cuu,rdfgroup#1,rdfgroup#2), CASCRE(flag-list)r1dv-r1dv,r21dv,r2dv

Other considerations for use of the new composite commands:

- Cannot be issued from secondary site B.
- Default states for cascaded SRDF are sync (A→B) and AD Copy Disk (B→C).
- Default states for SRDF/EDP are sync (A→B) and AD Copy Write Pending (B→C).
- Specifying ADCOPY_DISK or ADCOPY flags on CASCRE will affect the A→B leg.
Mainframe Enabler 7.0 (SRDF Host Component 7.0) changes

- These modes are implicit for a B→C link.

There have been relatively few host component changes required to implement SRDF/EDP. The SRDF commands have been updated with new parameters to create, delete, resume, suspend and swap. All other changes are done within Enginuity to allow concurrent SRDF for a R2 device and all associated operations that this entails.

Requirements and dependencies

SRDF/EDP and associated diskless devices are supported only on the Symmetrix VMAX hardware platforms with Enginuity 5874 and later. However, only the Symmetrix that contains the diskless R21 device is required to be Enginuity 5874. The primary and the tertiary site systems are required to be in a Enginuity code level 5773 or 5874. Customers are reminded that if a failover action will result in the primary or tertiary site being configured as a new “secondary” site (where diskless R21s are configured), then Enginuity 5874 will be required to run on those sites as well. Please see the “Current limitations and restrictions” sections for additional information.

Current limitations and restrictions

The following is a current list of SRDF/EDP limitations and constraints:

- The secondary site (where the R21 device resides) requires Enginuity 5874 and SRDF Host Component 5.7.
- The primary and tertiary sites systems can run on 5773, or 5874.
- Symmetrix Sites A and C will require Enginuity 5x73 or later to support SRDF/A MSC.
- R21 devices cannot be BCV devices.
- R21 devices are supported only on GIGE and Fiber RAs.
- PPRC devices cannot be R21 devices.
- XRC devices cannot be R21 devices.
- R21 thin devices are not supported.
- The first hop will support all SRDF modes of operation, with the exception of SRDF/A if it is currently utilized on the second hop.
- The second hop will support either SRDF/A or Adaptive Copy Write Pending Mode, with the exception of SRDF/A if it is currently utilized on the first hop. The second hop will not support SRDF/S.
Cascaded SRDF/Star support for open systems and z/OS

- There is no mix of dynamic and static SRDF relationships for SRDF/EDP devices.
- There is no mix of SRDF/EDP R21 devices and legacy cascaded R21 devices.
- ResourcePak Base and Host Component will continue to discover Symmetrix arrays that are at most an additional two hops away.

Cascaded SRDF/Star support for open systems and z/OS

The following sections pertaining to the cascaded SRDF/Star are included for introductory purposes only and are not intended to replace EMC product specific documentation.

For additional details on the cascaded SRDF open systems SRDF/Star interface, refer to the EMC Solutions Enabler Symmetrix SRDF Family CLI Product Guide.

For additional details on the cascaded SRDF z/OS SRDF/Star interface, refer to the EMC SRDF Host Component for z/OS Product Guide (available on Powerlink).

Cascaded SRDF/Star introduction

SRDF/Star is a data protection and failure recovery solution that covers three geographically dispersed data centers in a triangular topology. SRDF/Star configures its three sites to protect business data against a primary/workload site failure or a regional disaster, using concurrent SRDF capability to mirror the same production data synchronously to one remote site and asynchronously to another remote site:

- The primary site of the SRDF/Star topology is the data center where the production workload is running.
- The secondary site is the sync target site usually located in the same region as the primary site. The production data is mirrored to this site using synchronous replication.
- The async target site is a secondary site in a distant location. The production data is mirrored to this site using asynchronous replication.

In the event of a primary site failure, there would be no data loss because of the synchronous replication to the sync target site. In the event of a regional disruption that made both the workload site and the sync target site unusable, SRDF/Star’s concurrent SRDF setup ensures that there
would be only a minimal data loss because of the asynchronous replication to the more distant async target site.

A major benefit of using SRDF/Star for failure recovery is that you can quickly establish communication and protection between the two remote sites, either of which can become the new primary site. SRDF/Star allows you to incrementally establish an asynchronous session between the two remote sites, thus avoiding a full and time-consuming resynchronization to re-enable disaster recovery protection between them. Incremental resynchronization (replicating only the data differences between the synchronous and asynchronous secondary sites) dramatically reduces the time required to establish remote mirroring and protection for a new primary site following a failure of the original primary site.

Another SRDF/Star benefit is that it allows the coordination of consistency groups to the secondary sites, meaning that devices within a consistency group act in unison to preserve dependent-write consistency of a database that may be distributed across multiple SRDF systems. SRDF/Star also allows you to determine which secondary site (sync or async) has the most current data in the event of a rolling disaster that affects the workload site. With a rolling disaster, there is no guarantee that the sync secondary site will be more current than the async secondary site. The capability to display where the most current data is located helps determine which site’s data should be used for failure recovery.

A cascaded SRDF/Star configuration has an SRDF/S (Synchronous) relationship between the primary site and the regionally located target site, and an SRDF/A (Asynchronous) relationship between the primary site and the extended distance target site.

The following figure illustrates, at a high level, a cascaded SRDF/Star configuration under normal operation with the primary site located at site A.
Summary and conclusion

The Symmetrix Remote Data Facility (SRDF) family of replication software offers various levels of Symmetrix-based business continuance and disaster recovery solutions. The SRDF products offer the capability to maintain multiple, host-independent, mirrored copies of data. The Symmetrix systems can be in the same room, in different buildings within the same campus, or hundreds to thousands of kilometers apart.

SRDF replicates production or primary (source) site data to a secondary (target) site transparently to users, applications, databases, and host processors. The primary (R1) device is configured in a remotely mirrored relationship with a secondary (R2) device, forming an SRDF pair.

Enginuity level 5773 is the latest Enginuity release supporting the Symmetrix Direct Matrix Architecture DMX-3 and DMX-4 storage arrays, and contains new features that provide increased storage utilization and optimization, enhanced replication capabilities, and greater interoperability and security, as well as multiple ease-of-use improvements.

One such feature providing new replication capabilities is cascaded SRDF, which supports a three-site disaster recovery configuration. The core benefit behind a “cascaded” configuration is its inherent capability to continue replicating with minimal user intervention from the secondary site B to a tertiary site C with SRDF/A in the event that the primary site A becomes unusable. This enables a faster recovery at the tertiary site C, provided that is where the customer is looking to restart their operation.

Prior to Enginuity 5773, an SRDF device could be a primary device (R1 device) or a secondary device (R2 device); however it could not be in the dual role simultaneously. Cascaded SRDF is a new three-site disaster recovery configuration where data from a primary site is synchronously replicated to a secondary site B, and then asynchronously replicated to a tertiary site C.

Cascaded SRDF introduces a new SRDF R21 device. The R21 device will assume dual roles of primary (R1) and secondary (R2) device types simultaneously. Data received by this device as a secondary can automatically be transferred by this device as a primary (according to the possible modes).

The introduction of a cascaded SRDF relationship means that the commonly used mechanism of viewing an SRDF device as either a R1
device or a R2 device needs to change since the R21 device serves both purposes. Changing the way we view an SRDF device to be context-based rather than device type-based will allow the customer to more easily understand the changes that have been made to Solutions Enabler.

Throughout Solutions Enabler and SRDF Host Component interfaces, an R21 device may be viewed based on the relationship that is being queried or controlled. For example, when working with the R1->R21 relationship, the R21 device will be acting and will be managed as if it were a R2. When working with the R21-> R2 relationship, the R21 will be acting and will be managed as if it were an R1 device.

When performing controls against one SRDF pair relationship, the state of the other SRDF pair relationship will determine whether the operation will be allowed. Controls are allowed from hosts connected to either the Symmetrix containing the R1 device, the Symmetrix containing the R21 device, or the Symmetrix containing the R2 device.

Similar to other advanced SRDF relationships, the modes supported for each hop of a cascaded SRDF configuration are based upon the current state of the device in question and SRDF links. A basic cascaded SRDF configuration consists of a primary or workload site (site A) replicating synchronously to a secondary site (site B) with SRDF/S, and then replicating the same data asynchronously to a tertiary site (site C) with SRDF/A. While this configuration represents a typical or best practice implementation of cascaded SRDF, other SRDF mode combinations are also valid. For example, cascaded SRDF is also supported in open systems and z/OS SRDF/Star environments.

SRDF/Extended Distance Protection (SRDF/EDP) is a new long distance disaster recovery solution that is supported with Enginuity 5874. SRDF/EDP is intended to be used in a cascaded SRDF environment that requires a no-data-loss failover capability at the tertiary site. SRDF/EDP is based on a new type of device, a diskless device, which does not consume any local storage. As the device has no local disk space allocated to store the user data, it reduces the cost of dedicating disk storage for the purpose of remote data replication in a secondary site Symmetrix.