



**Storage Platforms and Services Engineering**  
Citigroup Architecture & Technology Engineering

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# **Cisco MDS 9000 FCIP v1.0**

**GDSE-07015-RN**

**Release Notes**

**1.0**

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## 1 Version Control

| Version | Date       | Author          | Reviewed            | Comments              |
|---------|------------|-----------------|---------------------|-----------------------|
| 0.1     | 27-July-07 | Scott Torgerson | Chris Clayton       | Peer Review           |
| 0.5     | 27-July-07 | Scott Torgerson | Global Stakeholders | RFC                   |
| 1.0     | 17-Sept-07 | Scott Torgerson | Global Stakeholders | Release to Production |
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## 3 Contact

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## 4 Latest Versions

It is recommended that the latest version of the document be used from the GDSE website <http://gdse.ny.ssmc.com>. Newer versions may include expanded scope, or comments on issues discovered after deployment.

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## 6 Executive Summary

The original solution used by Citi for extending SAN traffic over the IP WAN was the McData IPS SAN Routers. Since McData has been purchased by Brocade Corporation they have announced that the IP SAN Routers will be EOL at the end of Q4 2007. As a result GDSE was looking for a replacement product to extend the SAN over the IP network. After evaluating and testing Cisco MDS FCIP it has been determined that it can and will act as the new SAN over IP solution for Citi.

This document which is phase I of this project certifies the Cisco MDS 9000 Series with the Multi-protocol Service Module (MPS-14/2) which will provide Citi with the ability to extend SAN traffic to great distances to any number of sites across the IP network. The Cisco MDS 9000 Multi-protocol Services Modules extend the reach of Fibre Channel SANs by using Fibre Channel over IP (FCIP). This provides new opportunities for Citi to implement secure enterprise-wide SAN strategies that are stable, interoperable, and scalable.

For phase I of this certification the MPS-14/2 was certified for all Citi approved Cisco MDS 9000 directors and switches. The MPS-14/2 provides the following functionality.

- Gigabit Ethernet line-rate performance with FCIP
- Full support of value added MDS 9000 Fibre Channel features such as Virtual SANs (VSAN), Inter VSAN routing, port bindings, High availability Port Channeling and VSAN Trunking TE\_Port functionality.
- Write Acceleration to improve synchronous and asynchronous disk write (data replication) performance over long distances.

Using Cisco FCIP Citi can connect local SANs to remote SANs in other locations across large geographical distances. Once connected the following project types could possibly look to take advantage of the Cisco MDS FCIP solution.

- EMC Asynchronous Data Replication (SRDF/A)
- Host initiator to remote pooled storage (Data Migrations)

**Note:** Although this phase of the project intended to certify FCIP compression, it was not certified because a bug was found. Please see the [Known Issues](#) section of this document for the Cisco Bug ID and more details about this issue.

## 7 GDSE Findings

### 7.1.1 Overall Product

The MDS FCIP product was found to be solid, reliable, and very robust in functionality. Because of this it has been determined that it will be the product to replace the McData IPS SAN Routers. However, there are a few areas that will still need to be tracked and followed through completion. These areas are as follows:

**Manageability** – There are (3) methods to manage the Cisco MDS FCIP solution which are the Command Line Interface (CLI), Device Manager, and Fabric Manager. Of these (3) methods, Fabric Manager appeared to be the best for managing MDS switches that were spread across multiple sites. During configuration and testing, GDSE turned in several Request For Enhancements (RFE) for Fabric Manager to Cisco that will be tracked. All of the RFE's will help improve the Cisco Fabric Manager and make it easier to use for the Citi Implementers and operators. The RFE's or Bug ID's that will be tracked are as follows:

- **CSCsi72663** - FM 3.1.2 bug that causes all the FCIP links to show up like normal FC links.
- **CSCsc17889** - fcping fails with FCIP/FC Write Acceleration enabled on Port Channels with more than one link or multiple equal cost paths.
- **CSCsi81010** - Global command to enable Enhanced Zoning by default in all newly created VSANs. A step should also be added to the setup script.
- **CSCsi82343** - Add/reorder steps to the FCIP Wizard to allow it to fully configure all GigE and FCIP requirements.
- **CSCsf21466** - Fix the real time performance monitoring within Fabric Manager (ISLs in real time) and Device Manager so that they show the correct performance of links that have compression enabled.

**Compression** – Compression was tested but we could not achieve line rate speeds when it was enabled. As a result GDSE did not certify compression in this phase of the project. There is an open bug ID with Cisco for this problem and it will be tracked by GDSE. If the problem is solved in the next version of SAN O.S. as expected, GDSE will certify compression in the next phase of this project.

- **CSCsh62126** - FCIP compression bug in 3.1.2. This is fixed in SAN O.S. 3.1.2(b).

**IVR** – GDSE does not consider IVR a best practice but it was tested because there are a few scenarios where it must be used. Although IVR performed fine functionally, GDSE logged the following problems which Cisco that will need to be tracked.

- **CSCsj81465** - After the upgrade from 3.1.2 to 3.1.2b IVR became inconsistent within one of the local VSANs. Development has a workaround and will fix this bug in SAN OS 3.2.
- **CSCsj62539** - Enhancement for the Fabric Manager fcping and End to End tests so that they can work with IVR Zones and devices.

### 7.1.2 SRDF/S and SRDF/A

Both SRDF/S and SRDF/A were tested with MDS FCIP. GDSE found that most best practices that were in place for SRDF across the McData IPS SAN Routers also applied to the Cisco MDS FCIP solution. Port Channeling functionality on the Cisco MDS FCIP solution also simplified zoning across the WAN as compared to the McData IPS SAN Routers which did not have this feature thereby requiring that zones be manually spread across the GE connection in order to obtain load balancing and good performance.

### 7.1.3 Comparison to the McData IPS

When looking at the area of performance the Cisco MDS FCIP solution stood up well against the McData IPS SAN Routers. With Jumbo Frames enabled the Cisco MDS FCIP solution outperformed the McData IPS solution by a large margin. Jumbo frames will be considered a GDSE best practice for any replication environments that are on dedicated network circuits.

Although the graph below shows that the Cisco MDS FCIP solution also outperformed the McData IPS solution when Jumbo frames were not enabled, this may have been do to the differences in the test environment. When the McData IPS was tested without Jumbo frames it was tested on DMX-2 arrays and there were only 9 4-way RAID-0 LUNs available for testing which may have limited the amount of I/O that could be put on the GigE test links. When the Cisco MDS FCIP solution was tested it was completed with DMX-3 Arrays and 30 4-way RAID-0 LUNs.

Since the line droop looks almost identical between the two solutions it is thought that without Jumbo Frames enabled, if the McData IPS was tested on DMX-3 with 30 LUNs that the two solutions would have performed about the same. But the Cisco MDS FCIP solutions with Jumbo Frames enabled highly outperformed the McData IPS Solution that was never tested using Jumbo frames. The graph below shows the comparison of the two solutions doing an SRDF/S Full Establish.

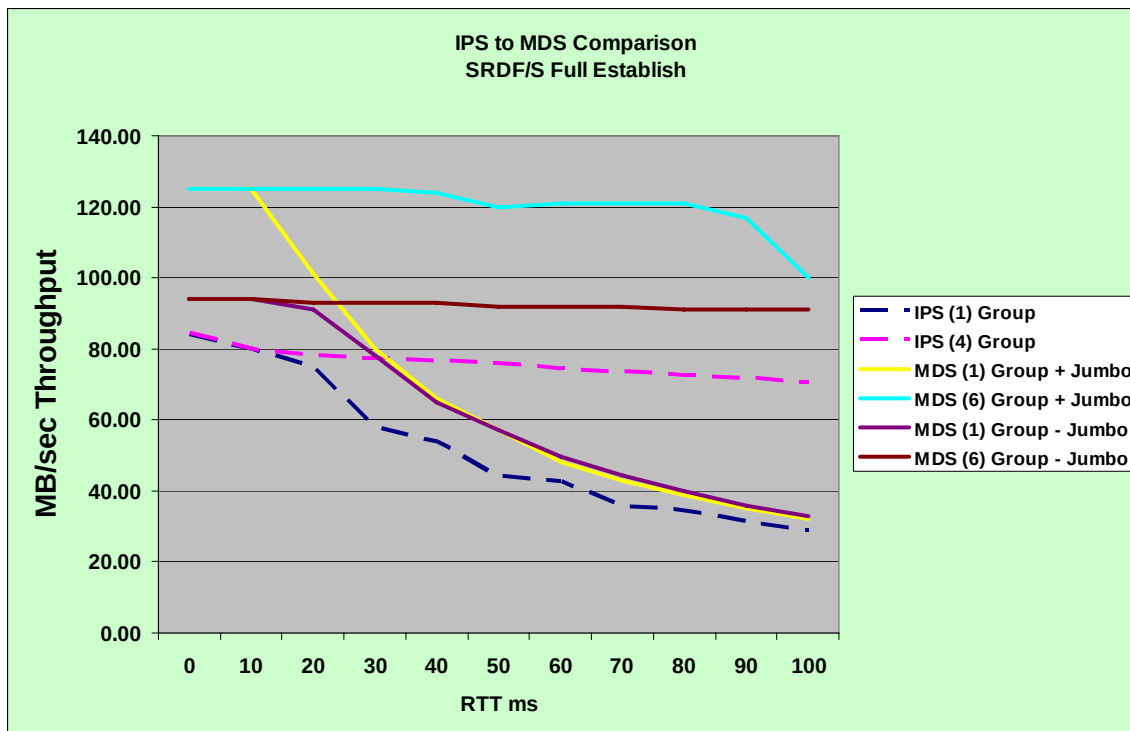


Figure 1 - Cisco MPS-14/2 Comparison to McData IPS

## 8 Component Certification Matrix

### 8.1 Certified Hardware, Component, and Functionality Matrix

| Component Matrix    |                                                                                                                 |
|---------------------|-----------------------------------------------------------------------------------------------------------------|
| MDS Director Models | MDS-9513, MDS-9509, MDS-9506                                                                                    |
| MDS Switch Models   | 9216i = No Certification <sup>1</sup><br>9222i = Future Certification <sup>2</sup>                              |
| FCIP Line Cards     | IPS-4 = No Certification<br>IPS-8 = No Certification<br>MPS-14/2 = Certified<br>MPS-18/4 = Future Certification |
| SAN O.S.            | 3.1(2)                                                                                                          |
| Fabric Manager      | 3.1(2)                                                                                                          |
| Device Manager      | 3.1(2)                                                                                                          |
| VSANs               | Certified                                                                                                       |
| IVR                 | Certified                                                                                                       |
| IVR with NAT        | Not Certified                                                                                                   |
| Compression         | <b>Not Certified</b> <sup>3</sup>                                                                               |
| Encryption          | Not Certified <sup>4</sup>                                                                                      |
| Write Acceleration  | Certified                                                                                                       |
| Jumbo Frames        | Certified for Dedicated Networks only                                                                           |

Before installation or configuration of any FCIP hardware or components it should be validated by the FCIP implementer that all hardware and software types are list in the above certified hardware and component matrix. Any hardware or software versions not listed in the above matrix will not be supported by GDSE.

<sup>1</sup> There are no future GDSE plans to certify this hardware type.

<sup>2</sup> This hardware will be certified in phase II of this project once it is released by Cisco and then certified by EMC. The current target date for release by the vendor is Q3 2007.

<sup>3</sup> Compression will be certified in the next phase of this project. A bug was found and is discussed in compression section of the Best Practices of this document.

<sup>4</sup> Encryption will be certified in the next phase of this project once the compression bug is fixed.

## 9 Known Issues

### 9.1 *Compression will not Allow Line Rate Throughput*

**Impact** – Low

**Affects** – Compression

**Workaround** – There is no current work around so GDSE will not certify compression until it is fixed. According to the Cisco bug ID this problem will be fixed in SAN O.S. 3.1. 2(b)

**Description**

When compression was enabled throughput was running at 20-30MBps slower than line rate. When this was found in testing GDSE tried dropping one of the FCIP tunnels to make sure the pipe was full and even that did not get the throughput up to or near line rate. When this was logged with Cisco they immediately acknowledged that this was a known problem.

**Further Information**

Anyone needing more detail about this problem can reference Cisco Bug ID CSCsh62126.

### 9.2 *FCIP Links show up like Normal FC Links in Fabric Manager*

**Impact** – Low

**Affects** – Fabric Manager Display

**Workaround** – When this occurs the user should log out of Fabric Manager and then login again. This bug should be fixed in SAN O.S. 3.1.3.

**Description**

After a certain time passes (unknown amount) or after changes are made in Fabric Manager the FCIP links will suddenly change from dotted lines to solid line making the user think something has happened to the FCIP links.

**Further Information**

Anyone needing more detail about this problem can reference Cisco Bug ID CSCsi72663.

### 9.3 *Fcping fails with Write Acceleration on Port Channels.*

**Impact** – Low

**Affects** – Configuration

**Workaround** – Use fcping when Write Acceleration is not enabled.

**Description**

If the fcping command is run on a port channel that has write acceleration enabled, it will fail making a user believe connectivity is lost. This is because the

fcping frames are sourced from the supervisor and do not use a valid source/dest/oxid.

**Further Information**

Anyone needing more detail about this problem can reference Cisco Bug ID CSCsc17889.

**9.4 Fabric Manager End-To-End test fails with IVR enabled.**

**Impact** – Low

**Affects** – Configuration

**Workaround** – use fcping before write acceleration is enabled to check connectivity instead of the Fabric Manager End-To-End connectivity test for all IVR environments.

**Description**

After setting up IVR zones end-to-end connectivity check should be run before write acceleration is enabled. GDSE was not able to get end-to-end connectivity check to work while IVR was enabled.

**Further Information**

Anyone needing more detail about this problem can reference Cisco Bug ID CSCsj62539.

**9.5 Upgrading to SAN O.S. 3.1.2(b) segments fabrics when IVR is enabled**

**Impact** – High

**Affects** – All IVR configurations planning to upgrade

**Workaround** – Call Cisco. We were able to duplicate this problem and Cisco did create a workaround but this problem will not be fixed until SAN O.S. 3.2. Anyone that deploys an IVR configuration would need to wait to upgrade until GDSE certifies a version of SAN O.S. of 3.2 or higher.

**Description**

In an attempt to see if SAN O.S. 3.1.2(b) fixed the compression bug, GDSE upgraded this version with the intension of testing compression. This attempt failed because when the upgrade was completed the IVR configuration became inconsistent with one of the local VSANs.

**Further Information**

Anyone needing more detail about this problem can reference Cisco Bug ID CSCsj81465.

## 10 References

The GDSE documents are meant to be used as a best practices guideline and do not contain detailed scenarios of all use types. For complete details of the Cisco FCIP product that is not covered in this GDSE documentation set, please consult the vendor documents which have been placed on the GDSE website.

| Document                                                      | Location                                                                                                                                                                                                                                  |
|---------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cisco MDS FCIP v1.0 – Project Scope                           | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07015-PS.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07015-PS.pdf</a>                                       |
| Cisco MDS FCIP v1.0 – Solutions Guide                         | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07015-SG.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07015-SG.pdf</a>                                       |
| Cisco MDS FCIP v1.0 – Release Notes                           | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/releasenotes/07015-RN.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/releasenotes/07015-RN.pdf</a>                               |
| Cisco MDS FC Switch Certification Project Scope               | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07002-PS.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07002-PS.pdf</a>                                       |
| Cisco MDS FC Switch Certification Solutions Guide             | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07002-SG.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/stdsdocs/07002-SG.pdf</a>                                       |
| Cisco MDS FC Switch Certification Release Notes               | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/releasenotes/07002-RN.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/releasenotes/07002-RN.pdf</a>                               |
| Cisco MDS 9000 Fabric Manager Configuration Guide Release 3.X | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-FabricManagerGuide3.X.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-FabricManagerGuide3.X.pdf</a>     |
| Cisco MDS 9000 Installation Guide Release 3.X                 | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-InstallationGuide3.X.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-InstallationGuide3.X.pdf</a>       |
| Cisco MDS 9000 CLI Configuration Guide Release 3.X            | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-CLIGuide3.X.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-CLIGuide3.X.pdf</a>                         |
| Cisco MDS 9000 CLI Command Reference Release 3.X              | <a href="http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-CLICommand_Reference3.X.pdf">http://engineering.ti.citigroup.net/gdse/products/platforms/ciscomds/techinfo/MDS-CLICommand_Reference3.X.pdf</a> |

## 11 Appendices

### 11.1 Appendix A: Test Environment

All FCIP components used in testing were the same versions listed in the [Certified Component Matrix](#) of this Release Notes document. Along with the certified FCIP components, a pair of DMX-3's were used for SRDF/S and SRDF/A, a single Solaris server was used to drive I/O, and an Empirix Latency Simulator was used to interject latency and packet loss. Below is a diagram of the test environment that was used to test the Cisco MDS FCIP functionality.

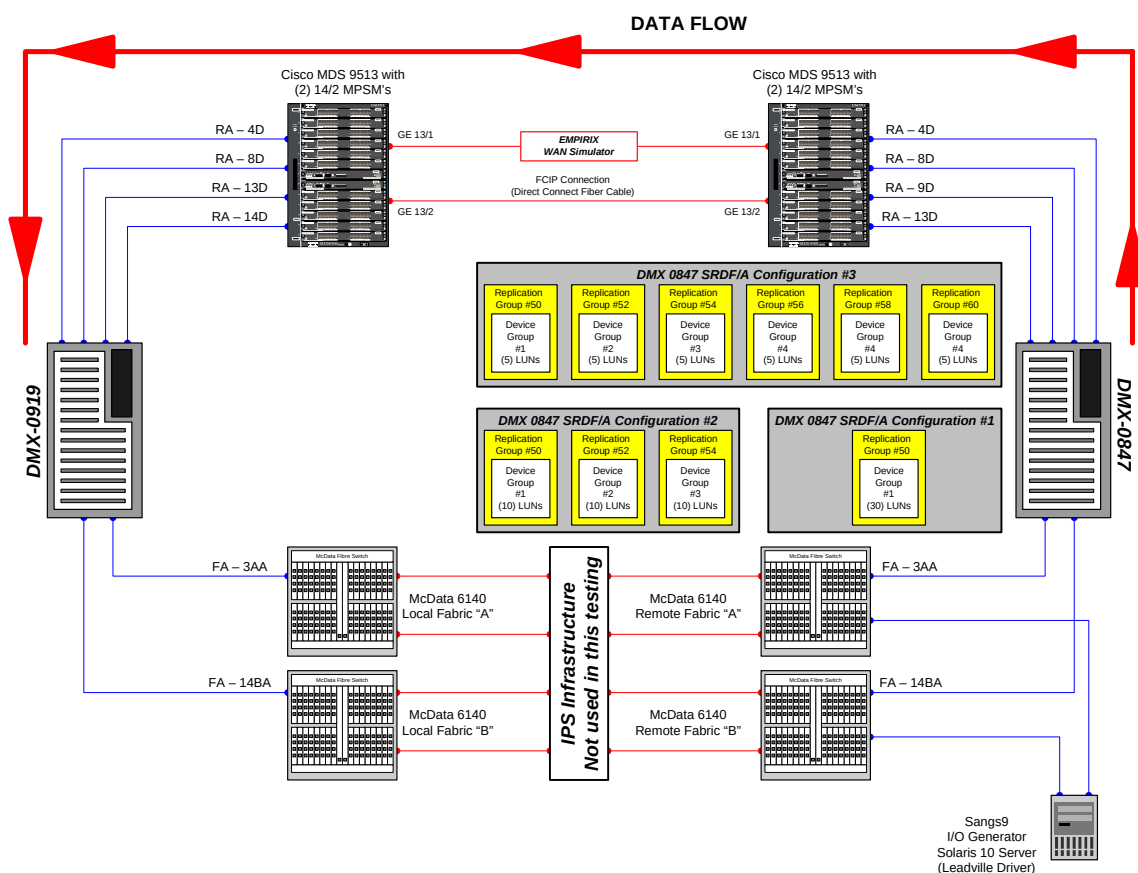


Figure 2 - Citi FCIP Test Environment

It is also important to note that the Cisco test labs duplicated this environment as close as possible and validated the Citi test results by running the same test plans.

## 11.2 Appendix B: Test Plans

| Test                      | Equipment Types                                           | Test                                                                                   |
|---------------------------|-----------------------------------------------------------|----------------------------------------------------------------------------------------|
| <a href="#"><u>1</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Functional Testing – VSANs, Inter-VSAN Routing,<br>Port Channeling, and Port failures. |
| <a href="#"><u>2</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Functional Testing – Compression                                                       |
| <a href="#"><u>3</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Functional Testing – Fast Write                                                        |
| <a href="#"><u>4</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/S Full Establish,<br>No Jumbo Frames, (1) RDF Group         |
| <a href="#"><u>5</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/S Full Establish,<br>No Jumbo Frames, (6) RDF Groups        |
| <a href="#"><u>6</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/S Full Establish,<br>Jumbo Frames, (1) RDF Group            |
| <a href="#"><u>7</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/S Full Establish,<br>Jumbo Frames, (6) RDF Groups           |
| <a href="#"><u>8</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A 16K Rand Writes,<br>No Jumbo Frames, (1) RDF Group        |
| <a href="#"><u>9</u></a>  | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A 16K Rand Writes,<br>No Jumbo Frames, (6) RDF Groups       |
| <a href="#"><u>10</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A 16K Rand Writes,<br>Jumbo Frames, (1) RDF Group           |
| <a href="#"><u>11</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A 16K Rand Writes,<br>Jumbo Frames, (6) RDF Groups          |
| <a href="#"><u>12</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A Block<br>Comparison, No Jumbo Frames, (1) RDF Group       |
| <a href="#"><u>13</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A Block<br>Comparison, No Jumbo Frames, (6) RDF Groups      |
| <a href="#"><u>14</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A Block<br>Comparison, Jumbo Frames, (1) RDF Group          |
| <a href="#"><u>15</u></a> | (2) MDS-9513 with 14/2 Cards,<br>(2) DMX-3's, (1) Empirix | Performance Testing – SRDF/A Block<br>Comparison, Jumbo Frames, (6) RDF Groups         |

## 11.3 Appendix C: Test Results

### 11.3.1 Test #1 – Functional Testing – Configuration and Failure Tests

| Item | Test                                                                                                     | Expected Results / Explanation                                                                                                       | Actual Results | Pass/Fail | Notes                                                                                                                    |
|------|----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------|--------------------------------------------------------------------------------------------------------------------------|
| 1    | Install (1) MPS-14/2 in each MDS-9513 and direct connect one pair and run the other through the Empirix. | Cards should install while MDS remains running                                                                                       | As Expected    | Pass<br>✓ |                                                                                                                          |
| 2    | Plug in (4) DMX RA cables into each MDS-9513 into FC ports on the FC port blades                         | Cables will not come online on the MDS until ports are enabled.                                                                      | As Expected    | Pass<br>✓ | Used DMX-0847 and DMX-0919. Also used RAs 4D, 8D, 9D, and 13D                                                            |
| 3    | Enable all the FC ports where the RA ports were plugged in.                                              | Ports should come online                                                                                                             | As Expected    | Pass<br>✓ |                                                                                                                          |
| 4    | Enable FCIP without a license using the grace period                                                     | FCIP will enable. In production this should not be done. A real license should be entered.                                           | As Expected    | Pass<br>✓ |                                                                                                                          |
| 5    | On fabric Manager discover each MDS into fabric Manager                                                  | Both should show up in Fabric Manager                                                                                                | As Expected    | Pass<br>✓ |                                                                                                                          |
| 6    | Create the FCIP Tunnels/profiles                                                                         | Profiles should create without any issues                                                                                            | As Expected    | Pass<br>✓ | Created fcip2 and fcip3.                                                                                                 |
| 7    | Create static Routes to simulate intermediate network.                                                   | Routes should create without any issues                                                                                              | As Expected    | Pass<br>✓ |                                                                                                                          |
| 8    | Set the Round trip time.                                                                                 | Ips measure-rtt command should return value. Then when saving value Any I/O on the channel should stop briefly and then start again. | As Expected    | Pass<br>✓ | Used the “ips measure-rtt 10.10.20.50 interface Gig 13/1” and “ips measure-rtt 10.10.20.50 interface Gig 13/2” commands. |
| 9    | Create a Port Channel using both FCIP Tunnels.                                                           | Port Channel should create.                                                                                                          | As Expected    | Pass<br>✓ |                                                                                                                          |
| 10   | First the IVR configuration will be                                                                      | VSANs should create and show up without                                                                                              | As Expected    | Pass      | Created VSANs 500 and 501. Also used Static                                                                              |

| Item | Test                                                                                                                               | Expected Results / Explanation                                        | Actual Results | Pass/Fail   | Notes                                                                                                                                                         |
|------|------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | configured. To start this create a local VSAN on each MDS that holds the (4) FC ports where the RA's from each MDS are plugged in. | any issue.                                                            |                | ✓           | domain IDs.                                                                                                                                                   |
| 11   | Create transit VSAN.                                                                                                               | Transit VSAN should create without any issues                         | As Expected    | Pass<br>✓   | Created Transit VSAN 800                                                                                                                                      |
| 12   | Enable Enhanced zoning on all (3) VSANs                                                                                            | Should enable without any issues.                                     | As Expected    | Pass<br>✓   |                                                                                                                                                               |
| 13   | Add Transit VSAN to port Channel                                                                                                   | Port Channel should now contain VSAN 1 and VSAN 800                   | As Expected    | Pass<br>✓   |                                                                                                                                                               |
| 14   | Configure IVR Zoning using the IVR Wizard which would mean creating a single zone in the Zoneset and activating the ZoneSet.       | ZoneSet should activate without any problems.                         | As Expected    | Pass<br>✓   | Created RDF_A-Fabric Zoneset.                                                                                                                                 |
| 15   | Enable Cisco Fabric Services.                                                                                                      | Should enable without any issues                                      | As Expected    | Pass<br>✓   |                                                                                                                                                               |
| 16   | Create the (3) remaining RA-to-RA zones and refresh the ZoneSet.                                                                   | Refresh should work will all new zones added in.                      | As Expected    | Pass<br>✓   |                                                                                                                                                               |
| 17   | Check zoning connectivity using End-to-End Connectivity tool in Fabric Manager.                                                    | End-to-end Connectivity tool should run and come back with a success. | As Expected    | Failed<br>✗ | Could not get this work with IVR enabled. Logged a call with Cisco about this problem. I also used the fcping command to check connectivity as a work around. |
| 18   | Enable Write Acceleration                                                                                                          | Should enable without any issues.                                     | As Expected    | Pass<br>✓   |                                                                                                                                                               |
| 19   | Enable Jumbo Frames by setting MTU to 2300.                                                                                        | I/O will stop on each FCIP tunnel as MTU is changed.                  | As Expected    | Pass<br>✓   | In production Jumbo Frames would NOT be enabled on the shared Citi Network. They would only be enabled on dedicated                                           |

| Item | Test                                                                                     | Expected Results / Explanation                                                                                                           | Actual Results | Pass/Fail | Notes                                                                                                                                   |
|------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------------|
|      |                                                                                          |                                                                                                                                          |                |           | networks.                                                                                                                               |
| 20   | Enable IP ACLs on the GE ports. For this testing only create an ACL for all TCP traffic. | Stop and start each tunnel and both should come back up. If the links do not come back up it means that something is wrong with the ACL. | As Expected    | Pass<br>✓ |                                                                                                                                         |
| 21   | At this point with all FCIP tunnels up start an SRDF/S full establish.                   | Traffic should show up on the port channel.                                                                                              | As Expected    | Pass<br>✓ |                                                                                                                                         |
| 22   | Once traffic is flowing admin down one of the FCIP tunnels.                              | The other channel should stay up and data should continue to flow without impacting the SRDF link.                                       | As Expected    | Pass<br>✓ | Downed fcip3. I had to configure the link limbo times and transmit idle times on the SRDF group before the link would stay up for this. |
| 23   | Bring the tunnel back up and then disable one of the GE ports on an MDS itself           | One of the FCIP Tunnels should go down but the other should stay up and traffic should continue to flow.                                 | As Expected    | Pass<br>✓ |                                                                                                                                         |
| 24   | Once traffic is flowing again down one of the GE ports on the MDS itself                 | One tunnel in the port channel should drop but traffic should continue to flow across the other one.                                     | As Expected    | Pass<br>✓ | Downed GE13/1 on MDS-9500-01                                                                                                            |
| 25   | Bring the GE port back up on the MDS                                                     | Port channel should add the tunnel back in once it is up.                                                                                | As Expected    | Pass<br>✓ |                                                                                                                                         |
| 26   | In order to test Cross-Site VSANs undo all previous steps all the way back to step #10.  | MDS should be back to the point of only having VSAN #1.                                                                                  | As Expected    | Pass<br>✓ |                                                                                                                                         |
| 27   | Now create a cross-site VSAN selecting the DMX RA ports from each MDS.                   | Should have a VSAN that spans both MDS and has (8) DMX RA ports in it.                                                                   | As Expected    | Pass<br>✓ | Created VSAN 500 and used static domain IDs 200 and 202                                                                                 |
| 28   | Enable enhanced zoning on the new                                                        | Should enable without any issues.                                                                                                        | As Expected    | Pass      |                                                                                                                                         |

| Item | Test                                                                                     | Expected Results / Explanation                                                                                                           | Actual Results | Pass/Fail | Notes                                                                                                                                                         |
|------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
|      | VSAN                                                                                     |                                                                                                                                          |                | ✓         |                                                                                                                                                               |
| 29   | Add new Cross-Site VSAN to the port channel                                              | Port channel should now contain VSAN 1 and 500                                                                                           | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 30   | Create cross-site zones and add (2) RAs to each zone                                     | Should be (4) zones                                                                                                                      | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 31   | Create and activate a ZoneSet                                                            | Zoneset should create and activate without any issues.                                                                                   | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 32   | Check zoning connectivity using End-to-End Connectivity tool in Fabric Manager.          | End-to-end Connectivity tool should run and come back with a success.                                                                    | As Expected    | Pass<br>✓ | Could not get this work with IVR enabled. Logged a call with Cisco about this problem. I also used the fcping command to check connectivity as a work around. |
| 33   | Enable Write Acceleration                                                                | Should enable without any issues.                                                                                                        | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 34   | Enable Jumbo Frames by setting MTU to 2300.                                              | I/O will stop on each FCIP tunnel as MTU is changed.                                                                                     | As Expected    | Pass<br>✓ | In production Jumbo Frames would NOT be enabled on the shared Citi Network. They would only be enabled on dedicated networks.                                 |
| 35   | Enable IP ACLs on the GE ports. For this testing only create an ACL for all TCP traffic. | Stop and start each tunnel and both should come back up. If the links do not come back up it means that something is wrong with the ACL. | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 36   | At this point with all FCIP tunnels up start an SRDF/S full establish.                   | Traffic should show up on the port channel.                                                                                              | As Expected    | Pass<br>✓ |                                                                                                                                                               |
| 37   | Once traffic is flowing admin down one of the FCIP tunnels.                              | The other channel should stay up and data should continue to flow without impacting the SRDF link.                                       | As Expected    | Pass<br>✓ | Downed fcip3.                                                                                                                                                 |

| Item | Test                                                                           | Expected Results / Explanation                                                                           | Actual Results | Pass/Fail | Notes                        |
|------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------|-----------|------------------------------|
| 38   | Bring the tunnel back up and then disable one of the GE ports on an MDS itself | One of the FCIP Tunnels should go down but the other should stay up and traffic should continue to flow. | As Expected    | Pass<br>✓ |                              |
| 39   | Once traffic is flowing again down one of the GE ports on the MDS itself       | One tunnel in the port channel should drop but traffic should continue to flow across the other one.     | As Expected    | Pass<br>✓ | Downed GE13/1 on MDS-9500-01 |
| 40   | Bring the GE port back up on the MDS                                           | Port channel should add the tunnel back in once it is up.                                                | As Expected    | Pass<br>✓ |                              |

### 11.3.2 Test #2 – Functional Testing - Compression

| Item | Test                                                                                                                             | Expected Results / Explanation                                                                                                                                                                                      | Actual Results | Pass/Fail   | Notes                                                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put them in synchronous mode. Then set MTU to 2300.                                         | I/O will stop momentarily on the Port channel while MTU changes.                                                                                                                                                    | As Expected    | Pass<br>✓   | Changing MTU size will stop I/O briefly but does not impact the host.                                                                                                                                                                                                  |
| 2    | Start SRDF/S full establish and validate that both FCIP tunnels are running at line rate and getting around 124 MBsec Throughput | Both FCIP tunnels show between 124 and 125 MBsec throughput.                                                                                                                                                        | As Expected    | Pass<br>✓   | This is to validate that we can push enough I/O with an establish once compression is turned on.                                                                                                                                                                       |
| 3    | Down one of the FCIP tunnels in the port channel.                                                                                | SRDF establish should keep going. Remaining interface should keep getting 124-125 MB/sec                                                                                                                            | As Expected    | Pass<br>✓   |                                                                                                                                                                                                                                                                        |
| 4    | On the FCIP tunnel that is still up change the min and max bandwidth to 500000 in fabric Manager (1/2 Gbsec Throughput)          | Link may suspend and have to restart full establish. Once sync starts again throughput should be around 62-63 MB/sec                                                                                                | As Expected    | Pass<br>✓   | Link did suspend. Restarted establish and throughput came back at around 63 MB/sec                                                                                                                                                                                     |
| 5    | Now enable compression and find out what the compression ratio of the data is.                                                   | Since we had put a bunch of tar files on the filesystems and then unmounted we were hoping for compression ratio of less than 4-1.                                                                                  | As Expected    | Pass<br>✓   | Link suspended again. Once establish was started again I checked the compression ration and it was about 2.25-1                                                                                                                                                        |
| 6    | Check the throughput numbers on the FCIP Tunnel now.                                                                             | Since we know that the DMX was able to get two FCIP tunnels @ 124MBsec each, and then we downed a channel and then cut the throughput of the channel in half, we would expect the throughput to be somewhere around |                | Failed<br>✗ | Since I was losing about 13MBsec on a ½ Gbsec tunnel I saw that without limiting the GE link I would be 26MBsec away from line rate. So I logged a call with Cisco and they informed me that this was a known bug that line rate throughput could not be achieved with |

| Item | Test | Expected Results / Explanation                                                                                                                                                                                                    | Actual Results | Pass/Fail | Notes                                                                     |
|------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------|
|      |      | 62-63MBsec throughput as long as compression was less than 4-1 which it was. The throughput of the FCIP tunnel was around 50 MBsec. I ran this several time and could never achieve max or line rate throughput on the interface. |                |           | compression turned on. The Cisco bug ID that they gave me was CSCsh62126. |

### 11.3.3 Test #3 – Functional Testing - Fastwrite

| Item | Test                                                                                                                                         | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                       |
|------|----------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put them in synchronous mode. Then set MTU to 2300.                                                     | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.                       |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix. <b>Disable Write Acceleration</b> on the remaining FCIP tunnel. | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                       |
| 3    | Start SRDF/S Full Establish of the RDF Groups with Empirix at 0 RTT and 0% packet Loss                                                       | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used group DG-50                                                                            |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, and RTT of 61-200000                                                             | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ |                                                                                             |
| 5    | <b>Enable Write Acceleration</b> and go through the same test                                                                                | We would expect that the throughput would be better and it was.  |                |           | This test shows that Write Acceleration should be used. See <a href="#">Figure 3 - Test</a> |

| Item | Test                                                  | Expected Results / Explanation | Actual Results | Pass/ Fail | Notes                                                    |
|------|-------------------------------------------------------|--------------------------------|----------------|------------|----------------------------------------------------------|
|      | of 0-200ms RTT and 0% packet Loss and record results. |                                |                |            | <a href="#">#3 Results</a> for the results or this test. |

#### 11.3.4 Test 4 – SRDF/S Full Establish, No Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/ Fail | Notes                                                                        |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|------------|------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put it in synchronous mode. Then set MTU to 1500.               | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓  | Changing MTU size will stop I/O briefly but does not impact the host.        |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓  | Downed fcip3 profile.                                                        |
| 3    | Start SRDF/S Full Establish of the RDF Group with Empirix at 0 RTT and 0% packet Loss                | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓  | Used group DG-50                                                             |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓  | See <a href="#">Figure 4 - Test #4 Results</a> for the results or this test. |
| 5    | Once all Testing is complete split the SRDF group.                                                   |                                                                  | As Expected    | Pass<br>✓  |                                                                              |

#### 11.3.5 Test #5 – SRDF/S Full Establish, No Jumbo Frames, (6) RDF Grp

| Item | Test                                                                                      | Expected Results / Explanation                                   | Actual Results | Pass/ Fail | Notes                                                                 |
|------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|------------|-----------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Groups and put them in synchronous mode. Then set MTU to 1500. | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓  | Changing MTU size will stop I/O briefly but does not impact the host. |
| 2    | Down the FCIP link in the port channel that                                               | Port Channel should stay up with a single                        | As Expected    | Pass       | Downed fcip3 profile.                                                 |

| Item | Test                                                                                                   | Expected Results / Explanation                        | Actual Results | Pass/Fail | Notes                                                                        |
|------|--------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------|-----------|------------------------------------------------------------------------------|
|      | does not go through the Empirix.                                                                       | FCIP tunnel.                                          |                | ✓         |                                                                              |
| 3    | Start SRDF/S Full Establish of the RDF Groups with Empirix at 0 RTT and 0% packet Loss, and RTT of 61. | Should be getting line rate throughput at this point. | As Expected    | Pass<br>✓ | Used group DG-50, DG-52, DG-54, DG-56, DG-58, and DG-60                      |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000   | I/O will stop when the RTT is changed.                | As Expected    | Pass<br>✓ | See <a href="#">Figure 5 - Test #5 Results</a> for the results or this test. |
| 5    | Once all Testing is complete split the SRDF group.                                                     |                                                       | As Expected    | Pass<br>✓ |                                                                              |

### 11.3.6 Test #6 – SRDF/S Full Establish, Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                        |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put it synchronous mode. Then set MTU to 2300.                  | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.        |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                        |
| 3    | Start SRDF/S Full Establish of the RDF Group with Empirix at 0 RTT and 0% packet Loss                | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used group DG-50                                                             |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | See <a href="#">Figure 6 - Test #6 Results</a> for the results or this test. |
| 5    | Once all Testing is complete split the                                                               |                                                                  | As Expected    | Pass      |                                                                              |

| Item | Test        | Expected Results / Explanation | Actual Results | Pass/Fail | Notes |
|------|-------------|--------------------------------|----------------|-----------|-------|
|      | SRDF group. |                                |                | ✓         |       |

### 11.3.7 Test #7 – SRDF/S Full Establish, Jumbo Frames, (6) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                        |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|------------------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Group and put them in synchronous mode. Then set MTU to 2300.             | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.        |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                        |
| 3    | Start SRDF/S Full Establish of the RDF Groups with Empirix at 0 RTT and 0% packet Loss               | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used group DG-50, DG-52, DG-54, DG-56, DG-58, and DG-60                      |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | See <a href="#">Figure 7 - Test #7 Results</a> for the results of this test. |
| 5    | Once all Testing is complete split the SRDF group.                                                   |                                                                  | As Expected    | Pass<br>✓ |                                                                              |

### 11.3.8 Test #8 – SRDF/A 16K Rand Writes, No Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                    | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                 |
|------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|-----------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put it in Asynchronous mode. Then set MTU to 1500. | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host. |
| 2    | Down the FCIP link in the port channel that does not go through                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                 |

| Item | Test                                                                                                 | Expected Results / Explanation                        | Actual Results | Pass/Fail | Notes                                                                                                                           |
|------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------------------------------------------------------------|
|      | the Empirix.                                                                                         |                                                       |                |           |                                                                                                                                 |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss    | Should be getting line rate throughput at this point. | As Expected    | Pass<br>✓ | Used RDF group DG-50                                                                                                            |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                | As Expected    | Pass<br>✓ | Used 16K Blocks and did Random Write data pattern. See <a href="#">Figure 8 - Test #8 Results</a> for the results or this test. |

### 11.3.9 Test #9 – SRDF/A 16K Rand Writes, No Jumbo Frames, (6) RDF Grp

| Item | Test                                                                                                                                                      | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                                                           |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|---------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Groups and put them in Asynchronous mode. Then set MTU to 1500.                                                                | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.                                                           |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                                                                              | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                                                           |
| 3    | Put all (6) RDF groups into a single consistency group. Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF groups DG-50, DG-52, DG-54, DG-56, DG-58, DG-60. Made a single consistency group called “multi”                        |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000                                                      | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | Used 16K Blocks and did Random Write data pattern. See <a href="#">Figure 9 - Test #9 Results</a> for the results or this test. |

### 11.3.10 Test #10 – SRDF/A 16K Rand Writes, Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                                                             |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and put it in Asynchronous mode. Then set MTU to 2300.              | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.                                                             |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                                                             |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss    | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF group DG-50                                                                                                              |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | Used 16K Blocks and did Random Write data pattern. See <a href="#">Figure 10 - Test #10 Results</a> for the results or this test. |

### 11.3.11 Test #11 – SRDF/A 16K Rand Writes, Jumbo Frames, (6) RDF Grp

| Item | Test                                                                                       | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                     |
|------|--------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|-------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Groups and set them to Asynchronous mode. Then set MTU to 2300. | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly but does not impact the host.                     |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.               | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                     |
| 3    | Put all (6) RDF groups into a single consistency group. Start SRDF/A I/O                   | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF groups DG-50, DG-52, DG-54, DG-56, DG-58, DG-60. Made a single consistency group |

| Item | Test                                                                                                 | Expected Results / Explanation         | Actual Results | Pass/ Fail | Notes                                                                                                                             |
|------|------------------------------------------------------------------------------------------------------|----------------------------------------|----------------|------------|-----------------------------------------------------------------------------------------------------------------------------------|
|      | using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss                     |                                        |                |            | called "multi"                                                                                                                    |
| 4    | Record each result of 0-200 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed. | As Expected    | Pass<br>✓  | Used 16K Blocks and did Random Write data pattern. See <a href="#">Figure 11 - Test #11 Results</a> for the results or this test. |

### 11.3.12 Test #12 – SRDF/A Block Compare, No Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/ Fail | Notes                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and set it to Asynchronous mode. Then set MTU to 1500.              | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓  | Changing MTU size will stop I/O briefly.                                                                                                           |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓  | Downed fcip3 profile.                                                                                                                              |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss    | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓  | Used RDF group DG-50                                                                                                                               |
| 4    | Record each result of 0-400 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓  | Used 8K, 16K, 32K and 64K Blocks and did Random Write data pattern. See <a href="#">Figure 12 - Test #12 Results</a> for the results or this test. |

### 11.3.13 Test #13 – SRDF/A Block Compare, No Jumbo Frames, (6) RDF Grp

| Item | Test | Expected Results / Explanation | Actual Results | Pass/ Fail | Notes |
|------|------|--------------------------------|----------------|------------|-------|
|------|------|--------------------------------|----------------|------------|-------|

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Group and set them to Asynchronous mode. Then set MTU to 1500.            | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly.                                                                                                           |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                                                                              |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss    | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF groups DG-50, DG-52, DG-54, DG-56, DG-58, DG-60. Made a single consistency group called "multi"                                           |
| 4    | Record each result of 0-400 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | Used 8K, 16K, 32K and 64K Blocks and did Random Write data pattern. See <a href="#">Figure 13 - Test #13 Results</a> for the results or this test. |

### 11.3.14 Test #14 – SRDF/A Block Compare, Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                              | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                    |
|------|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|------------------------------------------|
| 1    | Configure DMX with (1) RDF Group and set it to Asynchronous mode. Then set MTU to 2300.           | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly. |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                      | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                    |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF group DG-50                     |
| 4    | Record each result of                                                                             | I/O will stop when the                                           | As             | Pass      | Used 8K, 16K, 32K and                    |

| Item | Test                                                                           | Expected Results / Explanation | Actual Results | Pass/Fail | Notes                                                                                                                        |
|------|--------------------------------------------------------------------------------|--------------------------------|----------------|-----------|------------------------------------------------------------------------------------------------------------------------------|
|      | 0-400 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | RTT is changed.                | Expected       | ✓         | 64K Blocks and did Random Write data pattern. See <a href="#">Figure 14 - Test #14 Results</a> for the results or this test. |

### 11.3.15 Test #15 – SRDF/A Block Compare, Jumbo Frames, (1) RDF Grp

| Item | Test                                                                                                 | Expected Results / Explanation                                   | Actual Results | Pass/Fail | Notes                                                                                                                                              |
|------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|----------------|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Configure DMX with (6) RDF Group and set them to Asynchronous mode. Then set MTU to 2300.            | I/O will stop momentarily on the Port channel while MTU changes. | As Expected    | Pass<br>✓ | Changing MTU size will stop I/O briefly.                                                                                                           |
| 2    | Down the FCIP link in the port channel that does not go through the Empirix.                         | Port Channel should stay up with a single FCIP tunnel.           | As Expected    | Pass<br>✓ | Downed fcip3 profile.                                                                                                                              |
| 3    | Start SRDF/A I/O using IOrate tool against the RDF Group with Empirix at 0 RTT and 0% packet Loss    | Should be getting line rate throughput at this point.            | As Expected    | Pass<br>✓ | Used RDF groups DG-50, DG-52, DG-54, DG-56, DG-58, DG-60. Made a single consistency group called “multi”                                           |
| 4    | Record each result of 0-400 ms RTT for packet losses of 0%, 0.01%, 0.1% and 1%, and RTT of 61-300000 | I/O will stop when the RTT is changed.                           | As Expected    | Pass<br>✓ | Used 8K, 16K, 32K and 64K Blocks and did Random Write data pattern. See <a href="#">Figure 15 - Test #15 Results</a> for the results or this test. |

## 11.4 Appendix D: Test Result Graphs

Below are the results in graphs for some of the performance test plans. From these results it can be seen that Jumbo frames helps overall throughput numbers, and that multiple RDF groups (which is a current SRDF/A best practice) dramatically improves line droop.

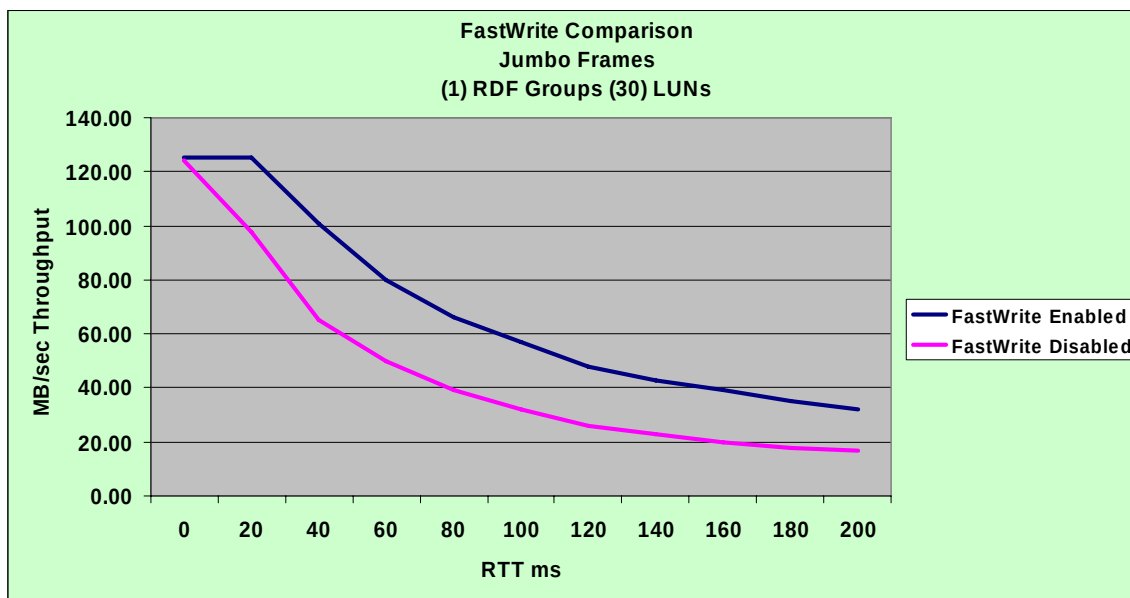


Figure 3 - Test #3 Results

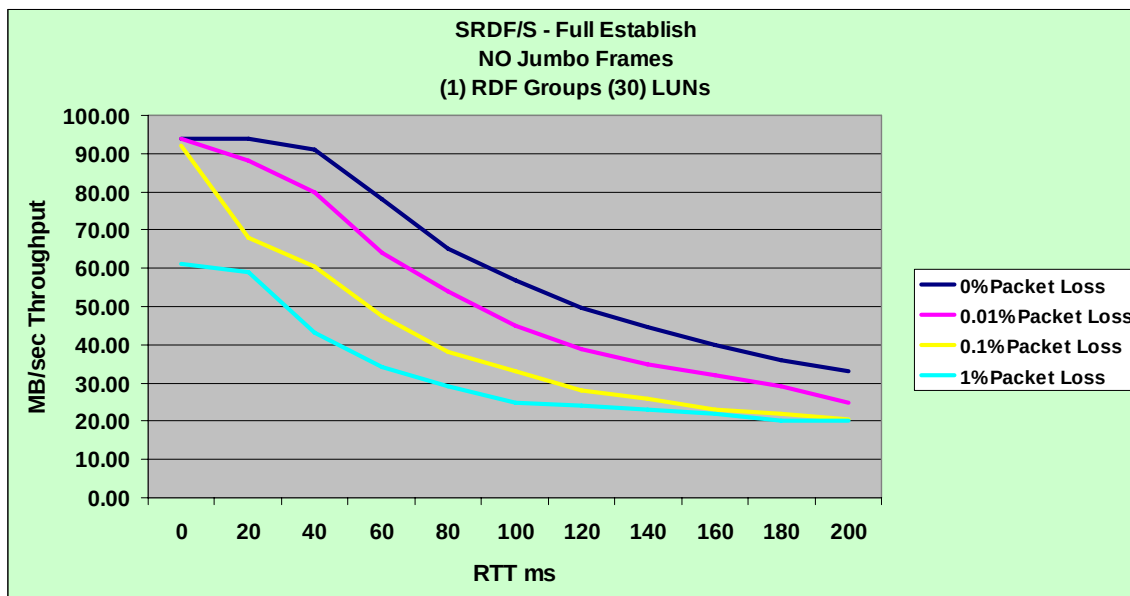


Figure 4 - Test #4 Results

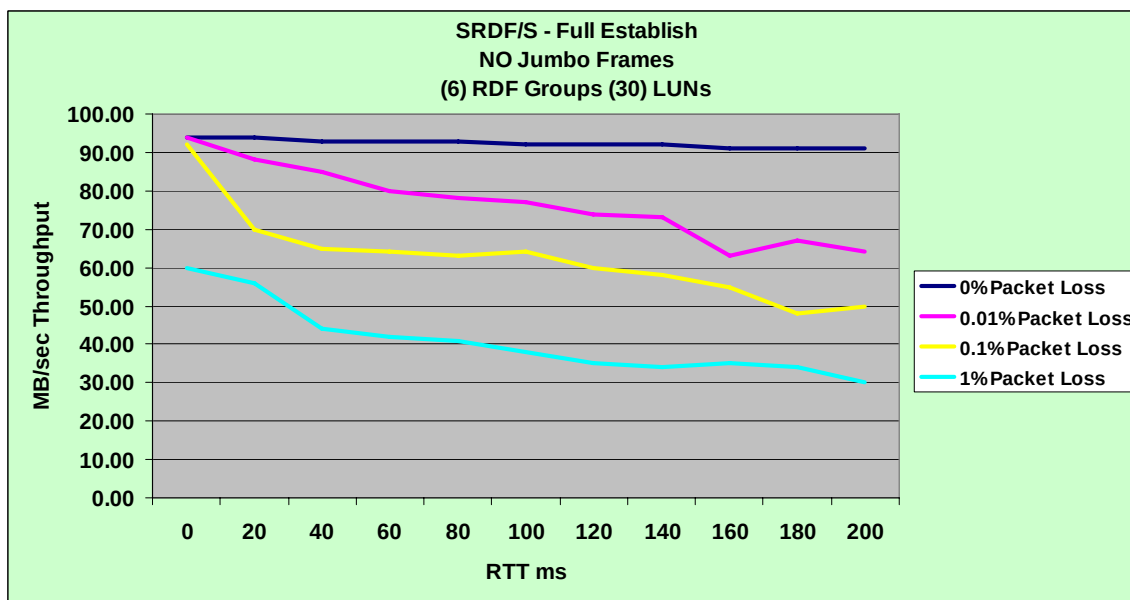


Figure 5 - Test #5 Results

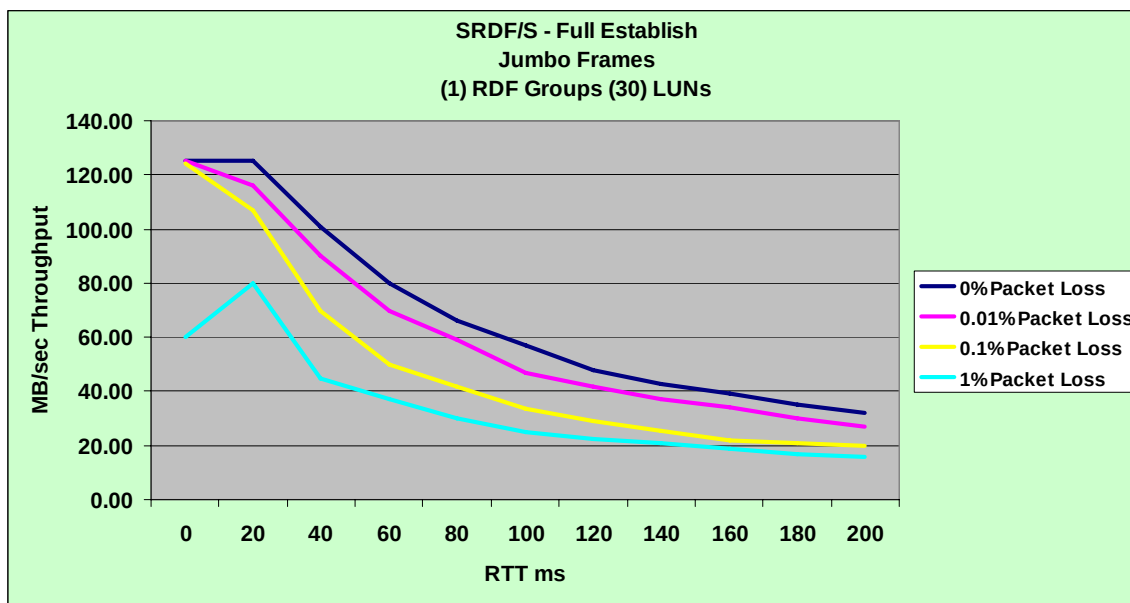


Figure 6 - Test #6 Results

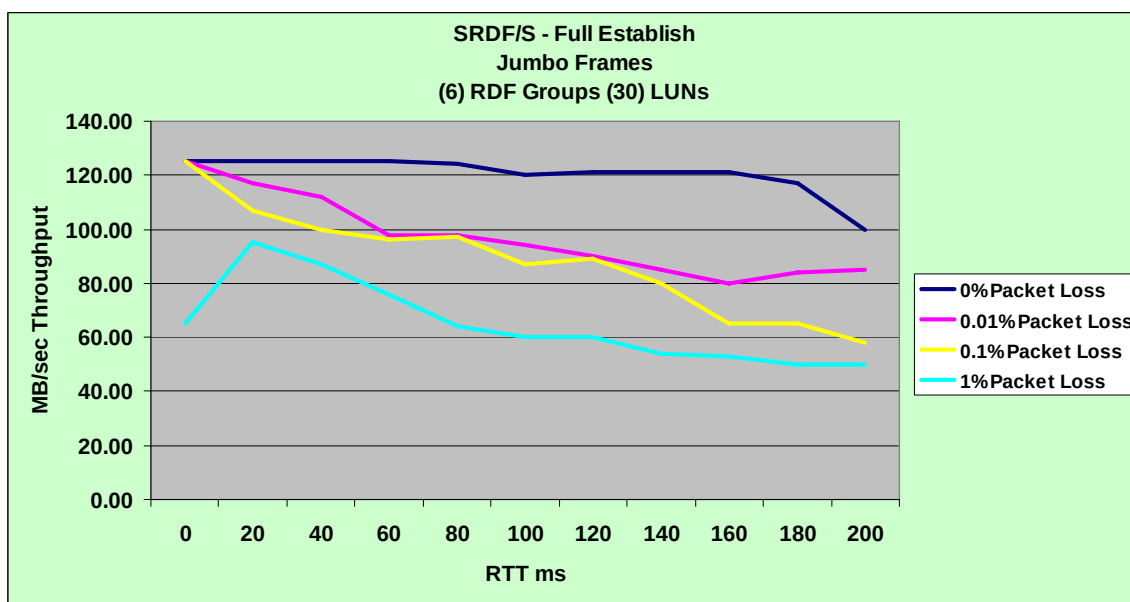


Figure 7 - Test #7 Results

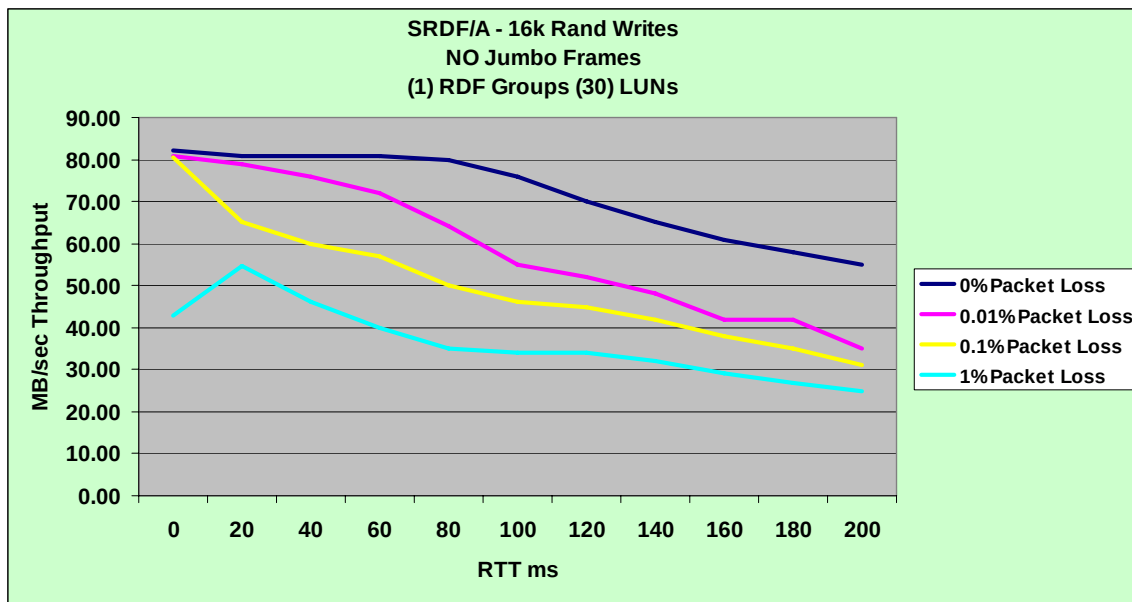


Figure 8 - Test #8 Results

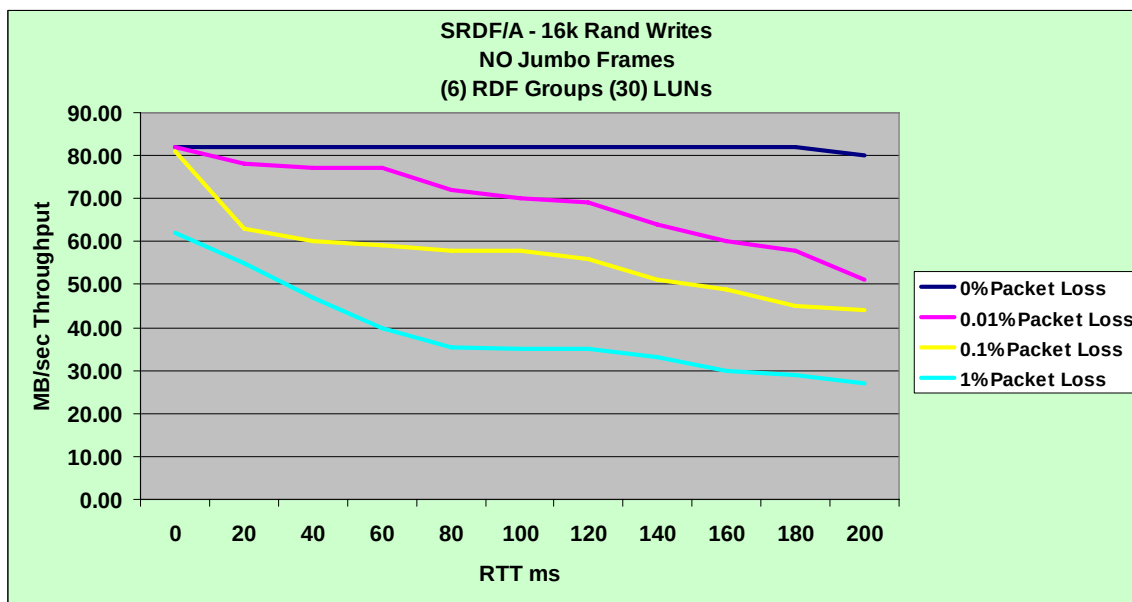


Figure 9 - Test #9 Results

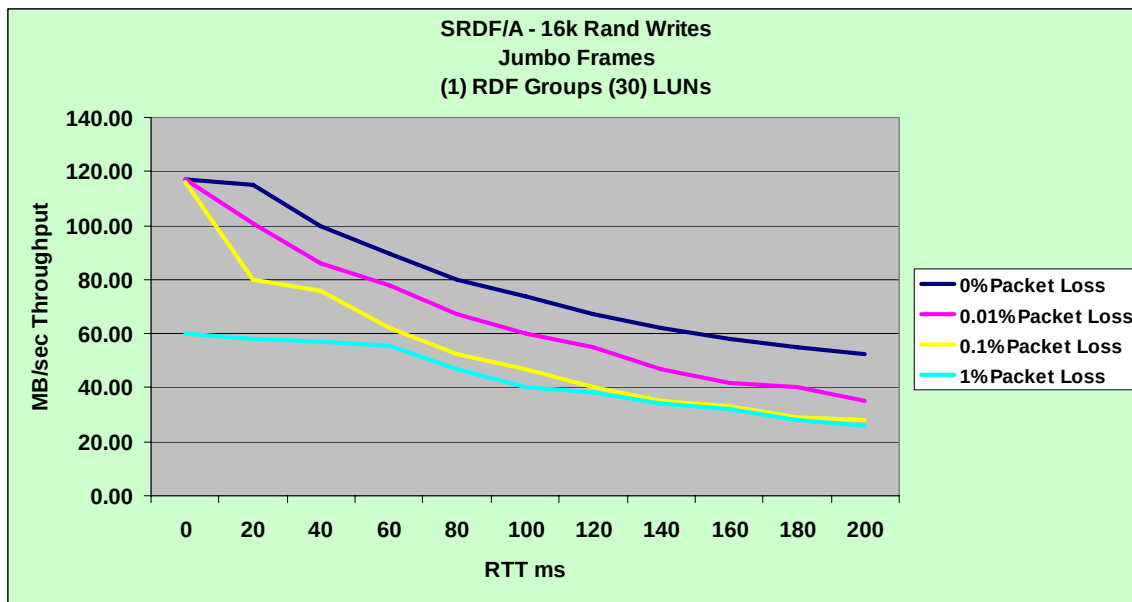


Figure 10 - Test #10 Results

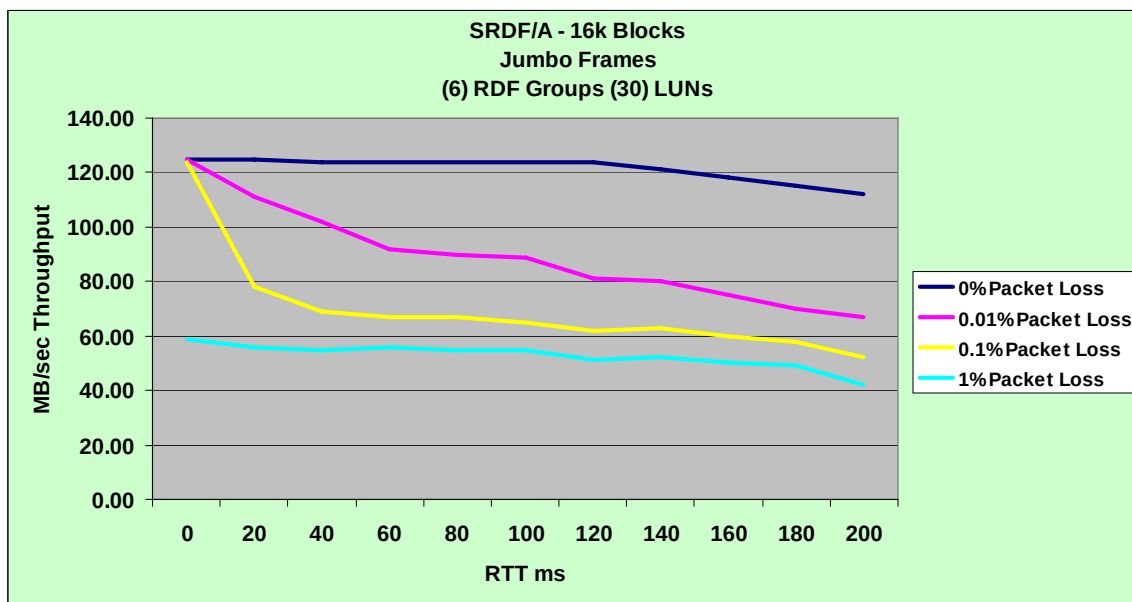


Figure 11 - Test #11 Results

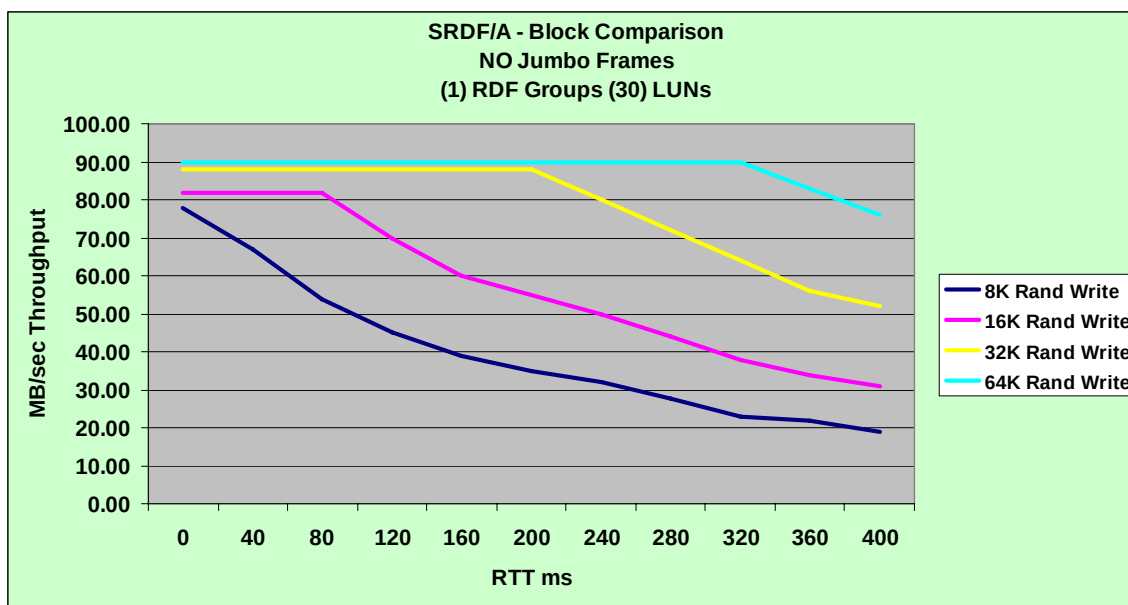


Figure 12 - Test #12 Results

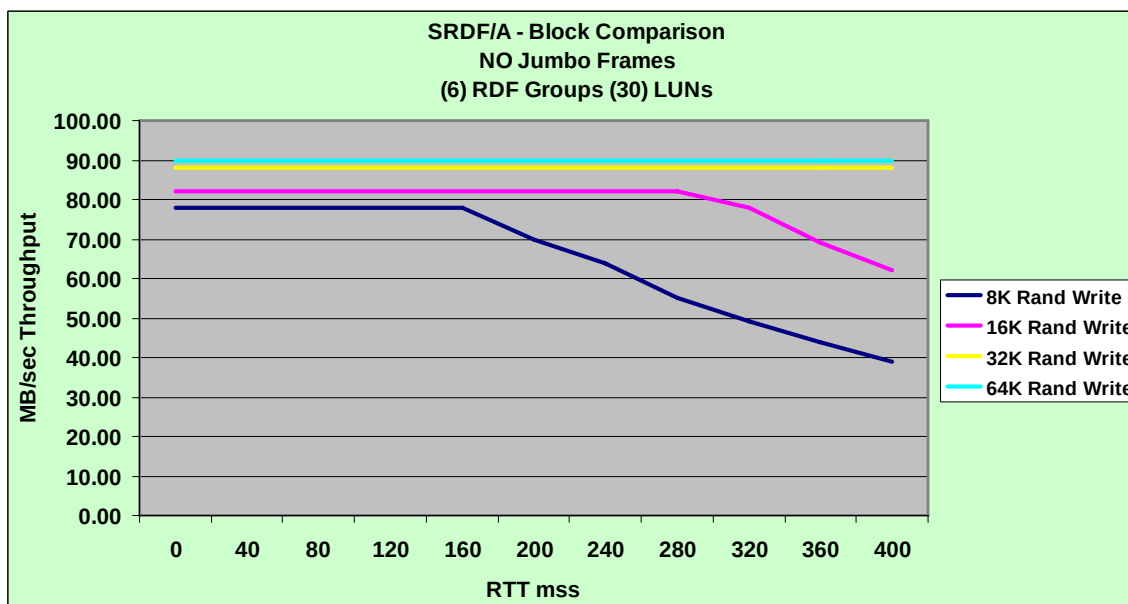


Figure 13 - Test #13 Results

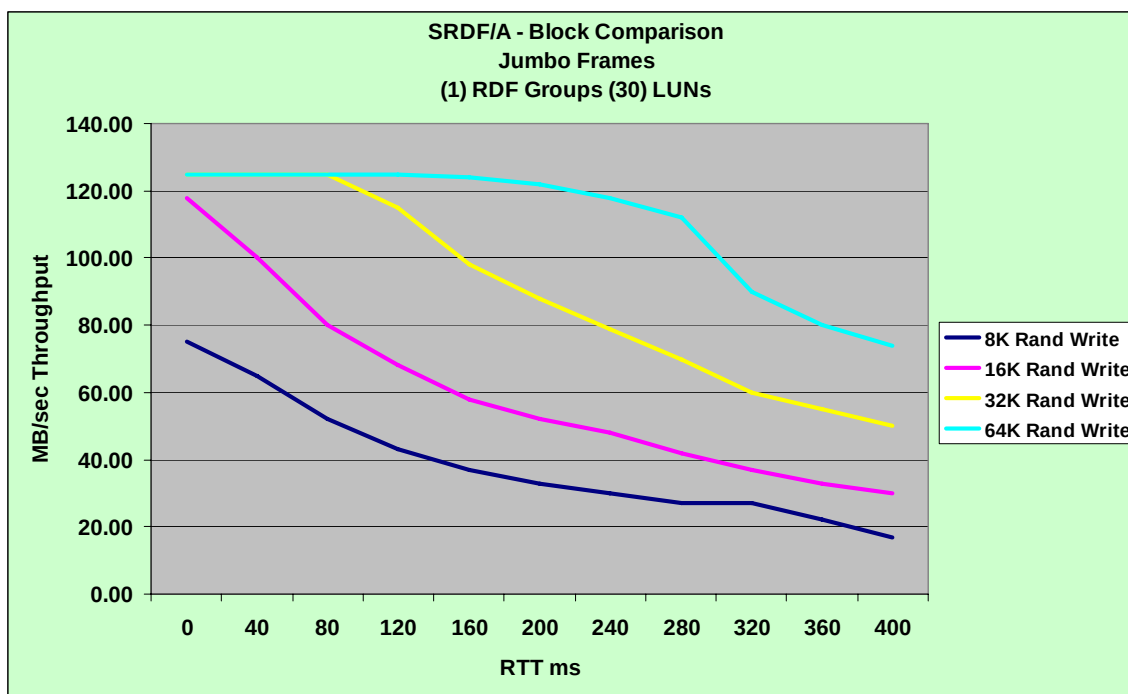


Figure 14 - Test #14 Results

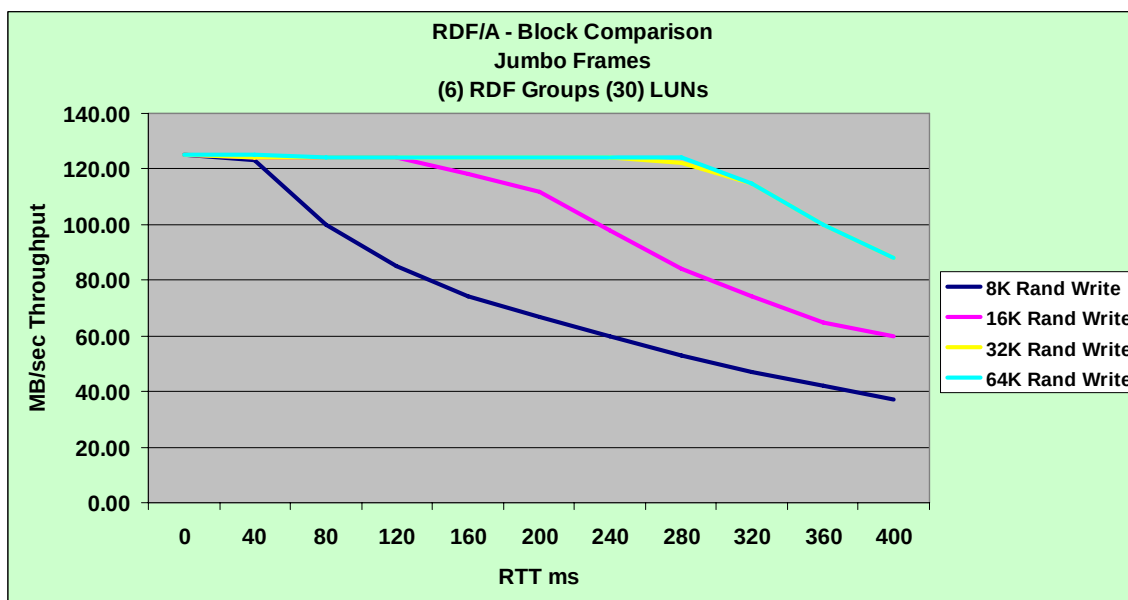


Figure 15 - Test #15 Results