Bullet-proof Fibre Channel Remote Replication Solutions

Introduction

Fibre Channel (FC) is one of the most widely used protocols for Storage Area Networks (SAN) in data centers. The reason for FC's popularity includes its lossless nature, its ability to continually scale to higher speeds to meet the increasing bandwidth needs of storage applications and, most importantly, its reliability. FC reliability is critical to its users and a cornerstone of its widespread usage.

FC has been adopted extensively as the go-to technology to replicate, store, and back up large amounts of data to and from remote locations. Some of the main FC users are the financial services and healthcare industries, where compliance to federal laws and regulations (including among others Sarbanes Oxley and HIPAA in the US) means organizations must develop, deploy and periodically test disaster recovery (DR) and business continuity (BC) plans. These DR & BC plans need to ensure that no mission-critical data is lost, and that service is recovered and restored when the primary datacenter location is unavailable due to natural causes like hurricanes, and earthquakes, or due to other factors like power outages, vandalism, and terrorism.

These requirements are driving large organizations handling mission-critical data to deploy backup datacenters with remote replication technologies (for example DellEMC SRDF, Pure Storage ActiveCluster, NetApp MetroCluster™, Hitachi TrueCopy® [1]) to be placed up to hundreds of kilometers away from the primary datacenter. This approach has several advantages, such as both the primary and secondary datacenters not being located in the same fault zone, or having their power sourced from the same switching station. However, as with any major new SAN project, issues can arise throughout and following deployment.

Challenges Deploying FC over Remote Storage

Fibre Channel was originally designed to be a robust storage communications protocol for co-located storage devices. This design goal resulted in FC supporting loss detection, correction, and the ability of a FC peer to respond quickly. Also central to FC is the concept of a buffer credit system as a form of built-in flow control to prevent target devices from being overwhelmed and eliminating the need for re-transmission.

The overall time it takes a storage device to send a storage block and clear that storage block involves round trip delay, which is as follows:

Total Roundtrip Delay = Transmit Delay of FC Frame + Receive Processing Delay + Return Delay of Confirmation

Transmission delay is a critical component of overall delay. As a result, transmission delay has a direct effect on the throughput of the connection, and it is critical to optimize the buffer credit allocation proportional to the delay across the FC link. In general, more buffer credits are needed as link distance grows and also as interface speeds increase, e.g., 1Gbps to 32Gbps. Insufficient allocation of buffer credits causes bottlenecks in the data transfer and results in an effect called a "slow drain." For this reason, it is imperative to test long distance FC links **with delay** to make sure the buffer credit allocation mechanism is properly tuned.

Traditional Approach

This type of distance testing was traditionally accomplished using large fixed-length fiber spools, fiber pods or even the production network itself. To test for buffer credit allocation at different distances, multiple heavy and bulky spools were needed. This approach is not automatable since these spools are cumbersome, time consuming and expensive. They also need to be physically swapped out from one length to the other, requiring the test engineer to be onsite to do the physical swap. This slows down testing. However, using a modern and easy-to-use delay emulator like the Aukua Fibre Channel SAN Delay Emulator provides tremendous advantages over previous methods to the end user.

Traditional methods are cumbersome, expensive, not scalable, and cannot be automated.

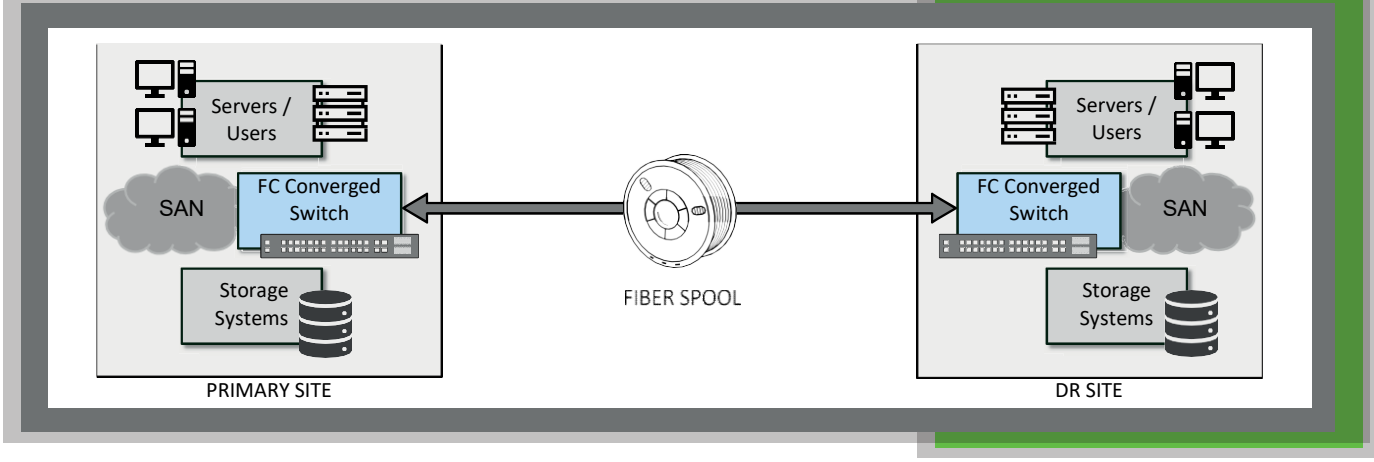

Figure 1: **Legacy Fibre Channel distance testing setup** which is cumbersome, not flexible or scalable, and limits automated testing

Aukua Approach

The Aukua Fibre Channel Delay Emulator solution is used in lieu of the fiber spools for a more flexible, repeatable and automated test methodology. They are usually placed in the Inter-Switch Links (ISL) between FC switches to emulate different fiber lengths. Another unique benefit of the Aukua FC Delay Emulator is that it can emulate other impairments in addition to latency!

A smarter approach!
The Aukua Fibre Channel SAN Delay Emulator is a more flexible, repeatable and automated test methodology.

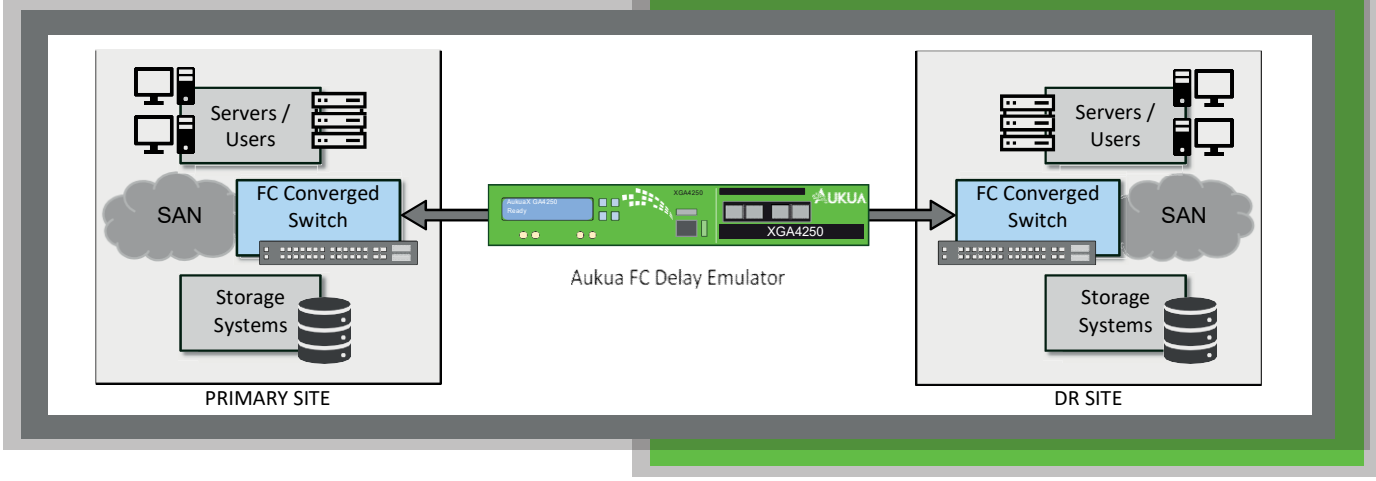

Figure 2: Fibre Channel distance emulation setup with the Aukua FC Delay Emulator

Testing Remote Replication Solutions

The Aukua FC Delay Emulator is used to emulate delay as well as other FC link impairments to test synchronous replications solutions such as DellEMC SRDF, NetApp MetroCluster™, Hitachi TrueCopy®[1] and others. Conduct more realistic vendor selection bake-offs, pre-deployment performance testing, Proof-of-Concept (PoC) testing as well as periodic regression or compliance testing. Here are some of the tests that can be performed with the Aukua solution:

Characterize Performance versus Maximum Distance

Very precise delay or latency can be applied to the FC traffic running over the ISL to emulate the distance between the primary and the secondary datacenters. Delay can be applied symmetrically or asymmetrically with nanosecond precision. Adding delay allows you to characterize throughput performance and to pinpoint the maximum distance (for example 100km, 200km, 400km, etc.) your remote replication software can tolerate as well as any margin that would be required. Armed with this information, the FC system can be tuned for optimal performance.

Validate Link Failover & Error Detection/Correction

The Aukua FC Delay Emulator also provides the ability to accurately inject bit error ratios from 1e-12 to 1e-3. The bit errors created are true bit errors corresponding to the rate selected and not a statistical approximation. Typically, the primary and secondary datacenters have dual metro links, i.e., ISLs connected between them for redundancy. By injecting bit errors on just one of the ISL's thereby creating an impaired fabric, failover mechanisms can be tested to ensure there are no unexpected issues or surprises during the cutover, and no data loss occurrs.

In addition, intermittent loss of signal (LOS), fiber cuts, fiber pulls, or link flapping can also be emulated using the Aukua solution. Finally, operation and limits of any forward error correction (FEC) deployed on the ISL's can also be tested reliably and repeatably in your lab.

Prove Advanced Features

Advanced and/or proprietary features such as the recently defined Fabric Performance Impact Notifications (FPIN), which address issues such as link integrity, congestion due to oversubscription, congestion due to credit stalls, slow drain detection and remediation, can also be effectively tested under real world impairment conditions using the Aukua FC Delay Emulator. Being able to inject these impairments in a controlled and repeatable method is key to proving these new advanced features work as advertised, prior to deployment.

Benefits of using Aukua's FC SAN Delay Emulator

1

COST & CONVENIENCE

The Aukua FC Delay Emulator allows for faster changes in distances to be tested resulting in easier operation, quick change in test scenarios, and reduced labor. This greatly reduces overall testing costs. The engineer performing the tests can dynamically change delay and impairment conditions in real-time with nanosecond precision from the comfort of their chair.

2

REALISTIC METHODOLOGY

With the Aukua FC Delay Emulator, any distance from as little as few hundred feet to thousands of kilometers can be emulated. And real-world network links don't just add latency. They also experience other impairments like bit errors and link failures, which is not practical in testing that utilizes spools of fiber. All of this is possible with the Aukua FC Delay Emulator, providing broader and more accurate test coverage. More realistic testing means results you can count on before deployment or in the event of a fail-over scenario.

3

PORTABLE & SCALABLE

Given the Aukua FC Delay Emulator comes in a small 1RU appliance weighing about 10 lbs. (7 kg), testing can be performed at a wider variety of locations including your customer's lab, proof-of-concept (POC) lab, trade shows, interoperability plug-fests, etc., and not just on your own premises. Previously, this was cumbersome having to swap out fiber spools every time they wanted to emulate a different distance, or prohibitively bulky and expensive to ship between locations.

4

AUTOMATED & REPEATABLE

The Aukua FC Delay Emulator is completely controlled through a modern HTML5 (web-browser based) graphical user interfaces. In addition, the Emulator supports a RestFUL API through which the operation can be controlled via scripting (For example in Python, C++, TCL, or any other programming language of choice). This allows the Emulator to be placed and controlled in a regression testbed for fully automated and repeatable testing.

Summary

Remote storage replication systems connected over Fibre Channel (FC) are stretched to their limits when deployed in a metro or dark fiber environment that is subject to additional latency and impairments. The remote systems and attached storage infrastructure need to be tuned for the additional latency as well as tested for their resiliency. In the past, these tests were performed using archaic, rigid and expensive methods like fiber spools or pods.

Today, with the increase in metro deployments as well as continued compliance requirements for Disaster Recovery & Business Continuity plans, there is a renewed need from storage system vendors, system integrators and end users for reliable, precise, and compact FC SAN delay and impairment emulation solutions. The Aukua Fibre Channel SAN Delay Emulator addresses all these needs, while reducing costs and increasing end-customer confidence. And it's for these reasons, leading companies around the world rely on Aukua Systems to achieve their business goals.

[1] All company names, trademarks and brand names are the property of their respective owners. All company, product and service names used in this paper are for example purposes only. Use of these names, trademarks and brands does not imply endorsement.

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