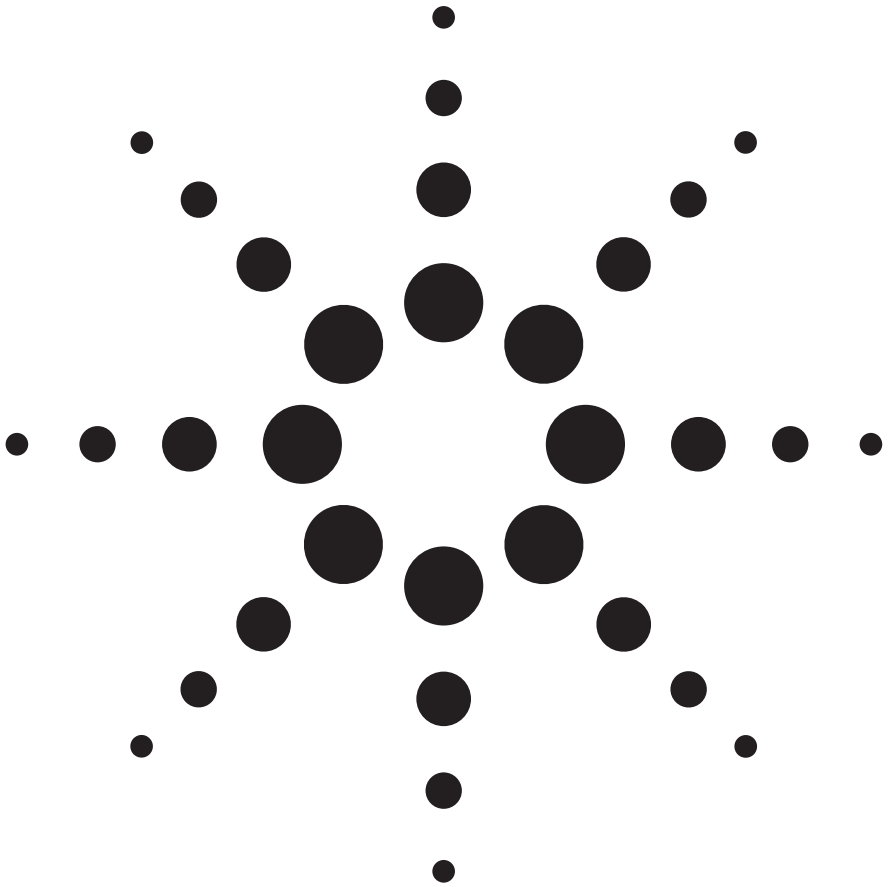
Emerging Test Solutions

Combined protocol analysis and traffic generation test platforms

White Paper



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Introduction

Storage Area Networks (SAN) architectures address the need for better scalability, flexibility, and availability of storage systems. They also contribute to managing the data center operational costs while efficiently adding storage capacity as required by the different functions within corporations. These significant benefits are fueling the adoption of SANs, and greater demands are now being placed on SANs.

One major demand is related to the need for connecting geographically dispersed SAN islands – for example, connecting backup centers to data centers. This change in SAN operations force network equipment manufacturers to develop new technologies to carry Fibre Channel traffic over IP, SONET/SDH or DWDM.

Another consideration is the sheer scale of the storage area networks in a data center. As users determine the viability of SANs, the SANs inevitably grow in size. Because information is a fundamental asset of today's companies, the storage infrastructure and applications are extensively tested to ensure reliable operation.

Even as the SANs grow in size, the market pressure is driving down the cost of the SAN component. According to a recent market report (Gartner) the cost of a unit of storage is dropping by 30% year over year.

All these factors are driving the system integration teams within equipment manufactures, OEMs and storage solutions providers to reconsider their current test strategy. The existing test strategies and environments, which were appropriate for low scale SAN infrastructures, need to be rethought to be able to keep up with the SAN's exponential growth to hundreds of ports, at the same time reducing the cost of test. There have been many innovations from test vendors in this area, from SAN test platforms which can mimic end devices to multi-function test platforms which reduce the capital expenditure required for test.

Traditional test environments

Testing SAN systems has been a major challenge for server, network device, storage manufacturers and storage solutions providers. The test needs vary across the different players in the market, depending on the product or the service they are delivering. However, the different categories of test can be classified under the “CRISP” acronym: Conformance, Robustness, Interoperability, Scalability and Performance.

The early days of SAN looked pretty much like the early days of LAN and WAN. Due to a lack of off-the-shelf test solutions, test teams developed proprietary test environments based on computers and storage devices. Real applications and proprietary test software were used to load the SAN infrastructure with traffic representative of multiple simultaneous applications. While this approach provides obvious benefits for interoperability tests, these solutions face road blocks when large scale SAN testing is required. The problem is also growing more complex as the SAN traffic grows and also goes outside the data centers through metropolitan and core networks.

The scalability challenge

Scalability is a major issue for system integration teams. Server and storage based test platforms do not scale very well. To validate configurations with several hundreds of ports, space and power become issues. Hundreds of kilowatts are required to run both the equipments and the air conditioning. Because of the low port density of traditional test solutions, tens of heavy weight racks filled with servers and storage are required.

The disaster simulation challenge

To test the robustness of SAN configuration, it is necessary to simulate errors, improper devices behaviors and events outside of the specifications (negative events). It is then necessary to analyze the impact of such behaviors on the rest of the infrastructure as well as determine how well the system will recover from such exceptions. Computers and storage devices have not been designed to reproduce, in a deterministic way, these behaviors. Simulating power issues with devices powering up and down can be harmful if not fatal for real servers and storage. Servers may not reboot properly or may need to have the operating system reinstalled.

The measurement challenge

Most SAN systems have embedded measurements and monitoring functions that can be used by the SAN management applications. Most of these measurements are statistical and do not provide the same level of visibility as dedicated measurement tools such as protocol analyzers and SAN test platforms.

Detecting the symptoms of a failure and retrieving the root cause of functional problems are more challenging as the number of ports in a SAN increase, having access to traffic history on multiple nodes before a crash is essential. The ideal test configuration would provide analysis and time correlation of every flow of traffic on each node of the fabric.

The cost challenge

The size of the SAN is growing, if the traditional test method is used, the cost of test will increase as well. The challenge for the test and integration teams is to find a test method that will allow the testing of large scale SANs while at the same time reducing the cost of test.

In data centers, due to cost control measures, data center staff is always being asked to do more with less. This includes reducing spending on infrastructure components and most certainly test equipment. The trend now is to buy less expensive tools, or to buy tools that can be used in multiple situations.

The performance measurement issue

Another challenge is to ensure that the performance of storage systems will meet expectations, and that peaks of activity can be supported by the infrastructure. The traffic generated by servers is typically based on software, thus the servers may not be able to deterministically reproduce peak conditions to fully load the network over a long period of time. The inherent limitations of the operating system and the drivers will reduce its traffic generation capabilities.

Test coverage

Fibre Channel is the dominant network technology used in SAN. The Fibre Channel network equipment provides different services: Data transport, Switching and Routing, and Fabric Services, such as Name Services, State Change Notification and Fabric Zoning. Thus, testing SAN networks does not consist just of validating proper data flows between devices. It is also important to characterize the performance of fabric services, routing and zoning mechanisms. These tests will help identify the best fabric topology. The size of the fabric usually has a significant impact on the performance of such mechanisms; testing them is important for large-scale systems.

Emerging test and measurement solutions

Test and measurement tools manufacturers have introduced platforms dedicated to SAN equipment and fabric testing and validation. These products can be classified in three categories.

1. SAN test platforms. The SAN testers are test platforms that can replace real servers and disks. The platform simulates multiple active devices generating and receiving traffic on the network. Their capability to emulate devices help network equipment manufacturers and system integrators save investment in expensive servers and storage equipment used for test.

Because these platforms have been designed for test automation, the productivity of test software engineers is increased, and the capabilities of such platforms go beyond what can be done on real servers. The different services of the fabric can be stimulated and stressed and a wide range of errors can be generated to verify the entire fabric robustness.

The scalability of such platforms provide significant added value for large size fabric testing. The platforms can control and synchronize the behavior of hundreds of devices, and can help deterministically generate traffic situations that would have been extremely difficult to reproduce with real devices.

2. Passive monitoring tools. These tools, such as protocol analyzers, help test engineers gain a better visibility of the storage traffic exchanged between real storage devices and servers. They usually provide SAN performance measurements based on the real time analysis of Fibre Channel frames. They also have trace capabilities that help analyze the traffic history before an event such as a crash or a device failure. These tools also help verify if the behavior of some devices are compliant with the existing standards. These tools are used during the development, deployment and maintenance phases of SAN fabrics.

For large scale system testing, when visibility over hundreds of nodes is required, protocol analysis solution by itself suffer from a high price per port (compared to low cost servers blades) and that cost is added to the rest of the test environment, (protocol analyzer do not substitute to the existing devices, and are transparent to the fabric operation). However, protocol analyzers when used in conjunction with SAN testers help provide additional insight on the operations of the devices.

3. Traffic jammers. Since disaster recovery and fabric robustness test is a key component of the entire test strategy, it is necessary to deterministically inject errors during normal fabric operations. Traffic jammers can be placed between end devices and the fabric (or within the fabric) and inject errors into healthy storage traffic, creating frame errors, payload destruction, sequences errors and link resets. These devices can be programmed to reproduce different types of disruptions.

With the extended simulation capabilities of the SAN testers, some of the testing traditionally done with a jammer can now be done using the SAN tester. Thus the need for the jammers is reduced. However, there are certainly scenarios where the extended stimuli generated by these devices can help extend the test coverage.

Multi-function test platforms

Even with the large test capabilities of SAN test platforms, real servers and devices are still needed for interoperability testing. The high diversity of configurations, drivers, operating systems versions, HBA models and firmware makes it difficult for the SAN testers to exactly emulate the behavior of real devices. However, for large scale storage configuration test, the right combination of real devices, SAN testers and protocol analysis tools represent the best approach to create a scalable test environment that will create realistic and peak traffic situations on the fabric. While real applications are running on servers and storage devices, hardware assisted traffic generation and real-time measurements can be done on the SAN test platform. When debug situations arise, the protocol analysis capabilities can be used to accelerate the identification of the root cause of elusive problems.

Typically, SAN testers and the protocol analyzers have been different test tools, manufactured by different vendors and are completely independent. A problem with this model is that purchase of the tools has to account for the peak usage. For example, at the early phases of testing or functional validation, stimuli is required to understand the response of the equipment to different types of stimuli, both positive and negative, thus more SAN testers are required. Towards the end of the testing the equipment is now fairly mature, thus not as many SAN tester ports are required for stimuli. Rather, more analyzers are required to monitor and trouble shoot when errors occur. So this means, in the initial stages of the project, analyzers may sit idle and in the final stages of the project SAN tester ports may sit idle.

To address this issue and to reduce the cost of testing, test vendors are now providing multi-functional test modules. A multi-functional test module typically allows the user to control its use, it can be configured either as a SAN test module, or a protocol analyzer module at run time. This has the benefit of being able to address a diverse set of tests at the same time reducing the total cost of test for the organization.

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Printed in USA, January 19, 2006
5989-4654EN

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