Performance Evaluation of iSCSI based storage network with cluster mirroring.

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Abstract: With an increase in the amount of volume of data in networks, the traditional storage architecture is greatly challenged. Today, SAN (storage area network) emerges as the main technology of network storage. The main inter networking technology of SAN is the fibre channel. But now with increasing demand for mirroring solutions for small & medium sized businesses, the high implementation costs, lack of trained staff and poor interoperability of fibre channel have proposed iSCSI to be a cost effective and viable alternative of fibre channel. Mirroring provides excellent solution for disaster-recovery, high data availability and business continuity. Synchronous mirroring or asynchronous mirroring enables customers to have an instantaneous recovery and eliminate loss of access to storage during disasters. But the cluster mirroring can transform your existing server storage into high availability storage system. The cluster mirroring tries to reduce the response-time and provide high availability storage. In this paper, we explore the details of iSCSI and attempt to evaluate the performance of iSCSI SAN and show that it can be performed satisfactorily and economically, without requiring the costlier fibre channel option.

Keywords: SAN, iSCSI, SCVM, IP SAN.

I. Introduction

With the enormous amount of data being exchanged daily there is a definite need for storage repositories and the ability to retrieve data with a minimum amount of time delay. In real life application, more organizations are looking at the Storage area network (SANs) to address the mid to long term storage need of businesses from small and medium business (SMBs) to the large Enterprise. The SCVM (Storage Concentrator Virtual Machine) creates IP SAN storage as virtual machine using iSCSI [1, 2], providing the user with the ability to consolidate their virtual data center. The storage concentrators consolidate physical storage resources, and provision those resources into logical volumes. With the Virtual machine, the separation of physical storage from logical volumes offers increased flexibility in storage management and fault tolerance. The Storage Resources can be located internally, externally or on a network. SCVM s can be used to create an IP SAN [1, 2] within a virtual environment that eliminates the need for a separate IP SAN hardware appliance. It can also be used as a target for local replication and remote replication from IP SAN to SCVMs, as a primary or secondary IP SAN storage.

Backend storage for an achieve appliance, security appliance, as data flexible virtual appliance. Remote mirroring enables creating exact copies of the primary data at a site far away from the primary site, but connected to it via some kind of an underlying network. The mirroring process is invisible to the application servers and so does not affect the allocated resources for the application in any way.

Figure 1: IP SAN using DAS / RAID

II. Storage Area Networking (SAN)

Storage area network is a storage network specifically designed to interconnect high speed storage devices and servers, as show in Figure 2. This specific network can span a large number of systems and geographic locations. Unlike in NAS, SAN [7] is connected behind the servers where storage devices and clients/servers are on same local segment. SAN provides a block-level interface to clients as opposed to the file-level interface in NAS, which provides a faster mechanism to transfer data over the network, i.e., reading and writing of data.
occurs at block level or the transfer of raw data at physical level. An example of how data is transferred in actual SAN can be seen in Figure 2.

When a client on a network requests information from a storage device, the request is received by server, which in turn obtains the data from the storage device and sends it to the appropriate client over the network. Hence, the server has full control over the storage device and transfers the appropriate data requested by the client in the minimum possible amount of time. This particular block-level transfer provides a faster level of data transmission than to file-level transfers in NAS systems, since there is no overhead involved. Also, backups in the SAN network do not affect the rest of the LAN, since the back-up data passes only over the SAN, providing a LAN free back-up environment and less chances of network congestion occurred in frequent backups of data over the LAN. Hence for providing faster transmission of data over SAN, devices like SCSI are used to transfer block of data unlike other devices that are used for storage.

III. Internet Protocol Storage Area Network (IP SAN)

A common side effect of server consolidation projects or implementing a centralized Fibre Channel SAN is scores of unused disk arrays. Many organizations are reluctant to perform what they call forklift upgrades. This study explains why to migrate captured server disks (direct-attached external or RAID) to an IP SAN (Internet Protocol Storage Area Network) as [2, 12, 14]. To access the data on a given DAS/RAID, the desktop workstations must communicate with the application server attached to the storage volume using iSCSI command sets. The storage on an IP SAN with many application servers, place a dedicated 10/100/1000 Ethernet switch [10] behind the application servers. A storage volume sits on this dedicated 10/100/1000 Ethernet IP SAN. Each application server can use generic 10/100/1000 NIC cards with iSCSI software and/or dedicated SNIC hardware, as shown in the diagram below. In this environment, users can access stored data on any of the DAS/RAID via any of the other servers, including application servers. You can use logical volumes to segregate data.

IV. Cluster Mirroring

The cluster mirroring [8, 12] implementation also makes use of the ability to have multiple logging implementations. The cluster log implementation is a fault-tolerant client/server logging system. It requires shared storage (which should be available, given the fact that the mirror volume is meant to be clustered). The mirroring system makes calls to the log, which are passed on to the server. The server then responds to the client, which passes the results back to the system. This may cause network traffic (which is inevitable), but it reduces disk traffic. The server is smart enough to know that if one machine has marked a region dirty, it need not mark it again for another machine. Other optimizations have been made as well. In this mirroring, master IP address ensures server access to storage volumes no matter which unit is active, always contains a group of volumes. The cluster mirroring technology to eliminate all points of failure across the management, storage and hardware engines [8, 9]. Cluster-Mirrors can be used for improving the uptime and availability of SAN.

For higher levels of availability, mirrored images maintained in Active/Active Cluster mirroring can provide a system with No Single Points of Failure, which is designed to improve the overall uptime of the storage system for organizations with 7x24x365 requirements. The user can protect from server hardware failure and reduce the planned or unplanned downtime. Cluster mirroring provides all of the advantages of storage consolidation in addition to clustering advantages. These advantages include centralized storage management, better storage utilization and lower storage management costs. No single point of failure operation is enabled by redundant connections to the SAN for the host systems, redundant SAN with redundant drive arrays and cabling, and data mirrored by the Intelligent Network System. In the event of a failure of any redundant component, the system will remain operational and will continue to deliver data to the attached servers. When the failed components have been repaired, the system will automatically resume fault tolerant operation and will be able to sustain another failure. If, because of the failure, the data in a mirror volume becomes out of sync, it will automatically be resynchronized when the failed component is restored to normal operation.

Figure 3: Internet Protocol Storage Area Networking (IP SAN)
1. Fail-Over

A Fail-Over [8, 9] is a high redundancy storage provisioning solution comprised of two storage volumes configured so that one is actively managing storage volumes and the other is in standby mode monitoring all fault condition. If the active storage volumes fails for any reasons, including loss of power, failure of a Gigabit Ethernet / FC port, loss of any storage connection, the inability to serve any volume, the inability to communicate with the host or the monitoring storage volume, then a Fail-Over event will be initiated. The standby unit is always ready to assume the active units duties when needed. If a component in either cluster member fails, Fail-Over automatically reassign the operations of the failed system to the surviving system. Fail-Over automatically redirects user requests from the failed system to good system.

2. Active-Active Clusters

A cluster consists of two Storage Concentrators work as Active-Active cluster [12]. In a Cluster system there is one primary and one Secondary Storage Concentrator. All host access the cluster through a single IP address. This allows all iSCSI target discovery to be accomplished with a single entry in the iSCSI initiator interface on the host. The session between the host and its discovered targets may be directed in the iSCSI initiator interface on the host. The balance of IO traffic between the two Storage Concentrators may be adjusted at any time using the Administrative Interface on the Primary Storage Concentrator.

3. Storage volume Fail-Over Benefits

- Two units provide redundant CPUs, power supplies, hard drives, port connections and operating system.
- All customer configuration data from the active Storage Concentrator is replicated to the standby unit.
- Both the active and standby units can initiate a Fail Over event.
- An administrator can set up a Fail-Over event as a test or to service the active Storage Concentrator.
- Redundant Storage Concentrators ensure storage volumes are continuously available.
- A master IP address ensures server access to storage volumes no matter which Storage Concentrator is active.

4. How does this benefit?

The benefits of using Cluster Mirroring are:

- Cluster Mirroring is designed to be a simple-to-administer solution that extends fail-over capability from within a data center to a remote site.
- Cluster Mirroring is also designed to provide replication of data from the primary site to a remote site, which helps to keep the data at the remote site current.
- The combination of failover and data replication aids in the recovery from disaster helping prevent loss of data in less time than otherwise possible.
- Replicates data from the primary site to the remote site to ensure that data there is completely up-to-date and available.
- If Site A goes down, Cluster Mirroring allows us to rapidly resume operations at a remote site minutes after a disaster.

IV. Performance analysis of IP SAN

The most important performance measures for the case of storage networks are average response time and network throughput. In this thesis the two parameters are employed to evaluate the iSCSI-based SAN. Average response time is the average time elapsed since the I/O request is sent by the initial device, until the I/O operations are finished by the destination device and the termination finishing message was sent back to the initial device by the destination device. Throughput is the maximum amount of I/O request processed by the storage subsystem per unit time. Average response time and throughput can be measured from different views, for example that of the users, OS, and disk controller, etc. For simplicity, in our experiment the two parameters are measured from the OS of the server. To confirm that whether the iSCSI technology is well suitable to implement the SAN, we have carefully designed two groups of experiments, one for the FC-SAN (group 1), the other for iSCSI-based SAN (group 2).

In the experiment, the I/O meter is used to measure the throughput and average response time in different block sizes of the I/O request. The values of the experiment are shown in table, and the corresponding curves of throughput and average response time dependence on the block size are shown in diagrams.
Table: 1 Comparison between iSCSI based IP SAN and FC SAN

<table>
<thead>
<tr>
<th>Block size</th>
<th>Throughput(I/O/s) in T time (ms)</th>
<th>Throughput(MB/s) in T time (ms)</th>
<th>Average Response Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FC</td>
<td>iSCSI</td>
<td>FC</td>
</tr>
<tr>
<td>1KB</td>
<td>252.2162</td>
<td>1538.791</td>
<td>0.237378</td>
</tr>
<tr>
<td>2KB</td>
<td>252.4374</td>
<td>1584.010</td>
<td>0.39518</td>
</tr>
<tr>
<td>4KB</td>
<td>228.699</td>
<td>1201.280</td>
<td>0.797651</td>
</tr>
<tr>
<td>8KB</td>
<td>205.5713</td>
<td>940.3271</td>
<td>1.51461</td>
</tr>
<tr>
<td>16KB</td>
<td>178.5502</td>
<td>582.0236</td>
<td>2.707053</td>
</tr>
<tr>
<td>32KB</td>
<td>150.2857</td>
<td>379.0472</td>
<td>4.630789</td>
</tr>
<tr>
<td>64KB</td>
<td>123.0156</td>
<td>253.0086</td>
<td>7.651026</td>
</tr>
<tr>
<td>128KB</td>
<td>96.7213</td>
<td>149.1703</td>
<td>12.12765</td>
</tr>
<tr>
<td>256KB</td>
<td>75.7641</td>
<td>100.0032</td>
<td>19.18439</td>
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<tr>
<td>512KB</td>
<td>49.1250</td>
<td>56.6249</td>
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</tr>
<tr>
<td>1024KB</td>
<td>29.0069</td>
<td>30.7123</td>
<td>30.07939</td>
</tr>
</tbody>
</table>

Figure 5(a): Throughput-IOPS

Figure 5(b): Throughput-MBPS

Figure 5(c): Average Response Time

Figures 5(a), 5(b) show the effect of block size on the throughput. As seen from Figure 5(b), when block size is increased, the throughput (MB/s) increases (but the I/O/s decreases). Most importantly, the throughput iSCSI is bigger than that of FC. As can be seen in figure 5(a), when the block size is small (smaller than 64K), the throughput of the iSCSI is obviously larger than that of the FC. In most cases, the write/read request initiated by the application is decomposed into small I/O requests with block size of 4K-64K. Thus, from the point of throughput the iSCSI is fit for implementing the storage networks. When the block size is larger than 64K, the difference of throughput decreases. Currently the performance of the storage subsystem is becoming more and more depending on the disk controller. When the block size is 1024K, the throughput of the iSCSI and the FC is similar. It can be understood easily that, in the experiment, to create similar experiment environment, the maximum throughput of the two disk subsystems is similar; and that when the block size is 1024K, the throughput of the storage subsystem has reached the maximum throughput of the disk subsystems. In fact, after the throughput reached the maximum, increasing block size does not guarantee increased throughput but decreases the throughput instead.

V. Conclusion

In this thesis, we evaluate whether iSCSI is more suitable to implement the SAN, we analyze and compare iSCSI SAN and FC SAN with respect to several component of a network protocol which impacts the performance of the network. A Storage Concentrator and cluster mirroring enabled IP SAN delivers all the benefits of a traditional Fibre Channel SAN at a fraction of the cost, complexity and effort. By reducing management overhead, enabling clustering, strategic data protection and disaster recovery efforts, optimizing the use of existing and future storage. Cluster mirroring mixture model significantly increases the return on the overall storage applications. This work presents how we can way out to of diagnose of problems occurred in IP SAN, Cluster mirroring with composition of different technology SCVM. This works provide the optimal solution for improving reliability, high availability, management and high performance. A Storage Concentrator and cluster mirroring enabled IP SAN delivers all the benefits of a traditional Fibre Channel SAN at a fraction of the cost, complexity and effort. By reducing management overhead, enabling clustering, strategic data protection and disaster recovery efforts, optimizing the use of existing and future storage. Cluster mirroring mixture model significantly increases the return on the overall storage application for SMBs.
References


