MICROSOFT SQL SERVER

SAN considerations for your SQL Server environment

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SANs (Storage Area Networks) are playing an increasingly important role in SQL Server environments for several reasons. They include:

- The increasing size of the average database
- The increasing prevalence of clustered environments
- Performance advantages of SANs
- Storage efficiencies of SANs
- The increasing importance of recoverability or disaster recovery

The SANs sole function is to store data and offer high reliability and high performance access to this data. It is a network which provides high-speed, highly reliable transportation of data for multiple servers which generally connect through a high speed optical network called fibre. A SAN consists of many high performance hard drives (typically several hundred) aggregated together with high performance controllers and caching; these hard drives are virtualized so that the consumer does not know which hard drives a SQL Server or other device connected to the SAN will access. A SAN administrator will present blocks of storage to servers using the SAN and these blocks of storage can consist of a single hard drive, multiple hard drives or portions of hard drives in a logical unit called a LUN (Logical Unit Number).

SANS have several advantages over locally attached storage:

- There is a distance limitation for SCSI connections which the SAN fibre network overcomes.
- Most SANs provide features which allow you to clone, snapshot, or rapidly move data (replicate) from one location to another. File copies or bcp over your network simply are not scalable. This increases their usefulness for disaster recovery.
- SANs play well with clusters. Clusters share resources between the nodes that form the cluster.
- SANs will allow a cluster or a server to boot off a SAN.
- SANs offer increased utilization of storage. With locally attached storage large amounts of disk space can be wasted. With a SAN you can expand or contract the amount of disk space a server or cluster can access.
- SANs will also offload some of the processing from the host system to the SAN itself.

However SANs, due to their cost and complexity, only make sense in large enterprises. They are not a good choice in:

- small environments with relatively small databases
- companies with limited budgets - SANs are very expensive
- companies which only require disaster recovery on one or a few SQL Servers

Before you rush out and hit your procurement manager for a SAN or two, there are some considerations with using SANs with SQL Server.

Caching

One of the reasons SANs offer superior performance to locally attached storage is they typically offer significant caching. This is normally a good thing. But as a SAN provides storage services to multiple servers the available cache is also shared between multiple servers. So the large cache may not always be available to you. This is especially exacerbated if other IO intensive applications like Exchange are sharing the same cache as your SQL Server.

It is also possible that some file or database operations (like a checkpoint) can saturate the cache resulting in degraded read and write performance. Do benchmarking with your SAN vendor to ensure that your SAN cache will be adequate to provide optimal database performance.

LUNS

SAN administrators will carve up the SANs storage into LUNs and the servers will "see" one or more of these units as a partition or drive. Consider three 200 GB drives in the SAN. This could be theoretically divided up into two LUNS 300 GB each, and different SQL Servers could access each LUN. You may end up in situations where the drives will experience twice the IO from both two servers than if the drives were dedicated to a single server. Most SANs support Zoning, which allows the SAN administrator to dedicate entire disks in the SAN to your LUN in order to isolate the IO on this drive to your SQL Server.

Select the largest appropriate LUN possible as this will distribute the IO better over the multiple disks which comprise your LUN. Ultimately this will offer better IO performance.

Also try to ensure that your log files are on a separate LUN consisting of a dedicated disk. Log files typically are written sequential patterns, unlike data files. Having a LUN with drives shared with another application will not provide optimal IO performance. Your SAN administrator may not permit you to dedicate a separate disk or set of disks to your log files.,p> There are special considerations if you have a large number of LUNs dedicated to your Windows Server. Please consult this kb article for more information.

RAID

Some SAN vendors may attempt to convince you to use RAID 5 for all data files and log files. Before following their advice, test using a representative load to ensure that RAID 5 will offer best performance for tempdb, your log files and any write intensive filegroups you may have.

Host Components

Check to ensure that the hardware your SQL Server (your host) uses to connect to the SAN delivers optimal performance and that you have the correct, most up to date drives for them.

- Consider using multiple high speed host bus adapters (HBA) on the servers accessing your SAN. If you do use multiple HBAs ensure they are on different bus's to prevent bus saturation. As PCI slots have different bus speeds, see that the HBAs are plugged into the slots offering the highest speed.

- Use multi-pathing software to balance the IO across all HBAs.

- Consider aligning your NTFS volumes with the SAN track sectors. This can be done via the LUN offset on the SAN or through the Resource Kit DISKPAR tool to "sector" align the partition before you format it. What you want is 64 sectors equaling 32,768 bytes. By default you will have 63 sectors per track which will result in additional IO when reading blocks 4k and larger. Studies have shown improvements of 10 to 20 percent simply by properly configuring your partitions.

- Work with your SAN vendor to ensure your SAN solution delivers optimal performance for your SQL Server.

Summary

As you can see SANs are complex and delivering optimal performance of a SQL Server solution using a SAN is challenging. Benchmark your SQL Server to determine if bottlenecks exist with your SAN. Work with your SAN vendor to fine tune your solution and carefully consider and test any recommendations they may make.

About the Author: *Hilary Cotter has been involved in IT for more than 20 years as a Web and database consultant. Microsoft first awarded Cotter the Microsoft SQL Server MVP award in 2001. Cotter received his bachelor of applied science degree in mechanical engineering from the University of Toronto and studied economics at the University of Calgary and computer science at UC Berkeley. He is the author of a book on SQL Server transactional replication and is currently working on books on merge replication and Microsoft search technologies.*

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- Learn how to set up SQL Clusters on a SAN
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DATABASE ADMINISTRATOR

Storage area network (SAN) basics every SQL Server DBA must know

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Database administrators take SQL Server storage for granted all too often. The storage area network (SAN) is something a lot of DBAs need to learn more about. By understanding the concept of SANs, we can better manage a SQL Server environment and create the best possible system performance for dollars spent.

Selecting your RAID level and storage tier

When requesting storage from your SAN admin or Windows admin, tell them what RAID level and storage tier you need. That's important because the RAID level determines just how much read and write I/O you need, as well as the amount of redundancy you require. For definitions of the various RAID levels that SAN arrays support, check out this tip I wrote on optimizing disk configuration in SQL Server. It's important that a DBA is involved in the decision process for RAID level volumes -- after all, you know the data within the system much better than any storage engineer does.

Knowing the storage tier that your data will be in (assuming that your storage administrator has set up tiered storage) will make you the storage administrator's best friend. Most databases fall into Tier 1 storage. Tier 1 storage is the fastest, most expensive storage in the system. Lots of Fibre Channel drives, probably 146 Gig or 300 Gig in size, go behind the database to make it run well. Tier 2 storage will usually be larger Fibre Channel drives. This storage is not as expensive and not as fast as they are allocating more data per spindle. Tier 3 storage is the least expensive storage. It is usually made up of very large, very inexpensive disks such as 750 SATA drives.

Note: This tiered layout is by no means a standard. Talk to your storage administrator and see what sort of layout he used.

If you know the system doesn't need to be ultra fast – it will only be used by a small number of people – then you might want to put the system onto Tier 2 storage. The storage won't be as fast as Tier 1, but you'll have built the system for a lot less money and left the Tier 1 storage for systems that need the blazing fast speed.

If you are going to use SATA drives for your database, be very careful. SATA drives perform great in desktop computers, but when you start placing several requests to them at a time, you won't get the performance you're looking for.

Don't be afraid to mix and match storage tiers in a single database system. If you have one drive that needs fast storage and a second drive that needs slower storage for archive data, then request storage from two different tiers. This way, you can get the storage you need and the storage admin can balance storage needs across the entire environment.

Redundancy is critical

When moving your local storage to a storage area network, redundancy -- both within the SAN array as well as the Fibre Channel – is critical to keeping your SQL Server up and running. Within the storage array itself, there should be several hot spare hard drives. For Fibre Channel drives, it's recommended to have one hot spare for every 30 Fibre Channel drives in the system (one

hot spare per two shelves). For SATA drives, it's recommended to have one hot spare for every 15 drives (one hot spare per shelf). While this does reduce the amount of total usable storage within the array, it will allow your array to recover automatically from a disk failure.

Within the Fibre Channel fabric itself, all production systems should have two HBAs, with each HBA connected to a different Fibre Channel network. Then each Fibre network should be connected to the storage array. The Fibre networks should not be connected to each other. To remain redundant you have to keep them disconnected from each other. Connecting the networks will turn them into a single Fibre network. This will cause the entire Fibre network to go offline in the event that a single Fibre switch goes offline. When you look at your Fibre network, remember this: If a single Fibre switch goes offline, all Fibre switches connected to it will go offline. So be sure to keep those redundant networks separate.

Backups are no less important

Just because the databases are stored on the SAN, backups are just as important as always. While the SAN environment is very redundant and multiple drive failures are rare, they are still possible. And so is data corruption or accidental data deletion by a user.

However, because you are storing your data on a SAN, you have an option called snapshots. Snapshots in the SAN world are different from snapshots in the database world. In the SAN world, a snapshot means taking an exact duplicate of the LUN, which is presented to the host. Vendors do this slightly differently, so be sure to read up on what you're getting before you decide to use this method. When using SAN snapshots, make sure the storage array supports consistency groups. An array uses consistency groups to ensure that all the disks are in a consistent state when backed up. This is extremely important in the database world because if the files are out of sync, you won't be able to reattach them.

More on SANs and SQL Server performance:

- SQL Server backups using SAN snapshots
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You also need to know in what state the backup will be restored. There are basically two options: crash recoverable and crash restartable. A crash recoverable backup looks to the SQL Server as if the power cable was pulled from the system, then a backup was taken. A crash restartable backup looks to the SQL Server as if the SQL Server was stopped, then the backup was taken. A crash restartable restore has a much better chance of restoring than a crash recoverable database.

The SAN is not a magical device

Many IT folks treat SANs as if they are the solution to every problem. I've heard time and time again, "Just stick it on the SAN, that'll fix the performance problem." While this can be the case, it's not the right technique. The SAN is a powerful tool, but you need to manage it correctly. Unless you are spending huge amounts of money on your SAN, it's not going to self-diagnose or self-heal (except for failed hard drives). It's not going to find the parts that are overused and move the data somewhere else. That needs to be done manually. Be wary of SANs that claim to do this automatically, as they may end up spending more time cleaning themselves up than actually serving I/O requests. I've heard horror stories of SANs running at peak capacity, and when you look into the system, it's spending 80% of the time trying to optimize itself and only 20% of the time serving I/O requests.

As a DBA, be aware of all these things when working with your SAN array. SQL Server MVP Hilary Cotter has an excellent tip on SAN considerations, which goes over several other items.

Work with your storage engineer. He's there to work with you, not against you. After all, you both have the same goal: to get the systems up and running the best you can with the budget you've been given.

ABOUT THE AUTHOR:

Denny Cherry has over a decade of experience managing SQL Server, including MySpace.com's more than 175-million-user installation, one of the largest in the world. Denny's areas of expertise include system architecture, performance tuning, replication and troubleshooting. He uses these skills in his role as a senior database administrator and architect at Awareness Technologies. Denny is a longtime member of PASS and Quest Software's Association of SQL Server Experts and has written numerous technical articles on SQL Server management.
Check out his blog: SQL Server with Mr. Denny

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