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InfoWorld review: Dell iSCSI SAN sizzles with SSD, dynamic storage tiering

The Dell EqualLogic PS6010XVS with automated storage tiering leverages fast SAS or faster SSD storage depending on workload

DELL EQUALLOGIC PS-SERIES SANS HAVE long led the iSCSI pack with excellent performance, good management tools, 10G Ethernet support, and the ability to scale capacity and I/O simultaneously by stacking together appliances. The latest addition to the line offers more reasons to take a close look, with a high-performance solid-state drive (SSD) array, dynamic storage tiering, and tighter integration with VMware.

The new Dell EqualLogic PS6010XVS model differs from its 16-drive, 4U PS-series brethren only on the inside, where it houses eight 100GB Samsung SSDs and eight 450GB 15K RPM SAS drives, each run in their own RAID6 array. By itself, the SSD-SAS combination isn't terribly interesting — but what the new version of the EqualLogic firmware can do with it is.

[Use server virtualization to duplicate resources and create failover capabilities at a cost far below that of conventional solutions — without compromising reliability. Download InfoWorld's High-Availability Virtualization Deep Dive Report.]

Version 5 of the EqualLogic firmware brings a host of new features to the EqualLogic storage line, but the major benefit to the EqualLogic PS6010XVS is the dynamic storage tiering capability. In traditional tiered storage configurations, volumes are created on disparate storage technologies, SAS, SATA, and perhaps SSD, and data is placed on those volumes according to how heavily that info will be accessed. For example, databases might reside on the SAS or SSD arrays, while the cheaper SATA arrays house data that doesn't get much attention. Basically, admins make an educated guess as to the usage patterns of the data in their care and place it accordingly. Most times they're on the right track, but it's impossible to be sure that you have everything tuned correctly.

EqualLogic's new code keeps tabs on how data is being accessed at the block level and shifts heavily accessed portions to the SSD storage on the fly, increasing I/O substantially in some cases. As the workload shifts, it will return some blocks to SAS storage, other blocks to the SSD, and so forth. There's no more guesswork involved; it all happens automatically based on actual production workloads.

There's more to the Dell than tiered storage, including significant VMware-based virtualization performance improvements, but those features are not limited to the EqualLogic PS6010XVS. The release of the version 5 firmware brings those enhancements to the full line of Dell EqualLogic arrays (see the sidebar, "Lab test: New EqualLogic firmware takes a load off VMware").

In the lab: Dynamic SAS and SSD storage tiers

The EqualLogic PS6010XVS in our test was outfitted with a pair of 10G controllers and the fixed-configuration noted above, with eight 100GB SSDs and eight 450GB 15K RPM SAS drives. It was connected to a Dell PowerConnect 8024F 10G switch, as were a number of Dell servers running Windows Server 2008 R2 and VMware ESX 4.1.

The workloads placed on the EqualLogic PS6010XVS were driven by five Windows Server 2008 R2 virtual machines, all running continuous IOMeter workloads. I then added a Red Hat Enterprise Linux 5 virtual machine running a dd-based sequential read/write test that varied the number of processes to create a quasi-random workload.

Watching through the EqualLogic SAN HQ monitoring and trending software, it was apparent that the automated tiering was at work, as a graphical representation of the disk I/O shifted from being largely SAS-based to

Test Center Scorecard

	Management	Performance	Reliability	Scalability	Interoperability	Value	Overall Score
	20%	20%	20%	20%	10%	10%	
Dell EqualLogic PS6010XVS	9	10	9	9	10	8	9.2 EXCELLENT

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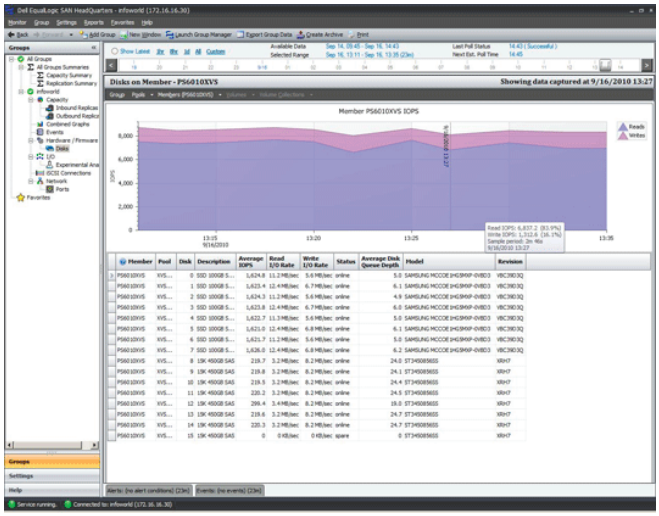

Dell EqualLogic SAN HQ is the central monitoring tool for EqualLogic arrays. Here it shows current status and performance statistics for the PS6010XVS's eight SSD and eight SAS drives..

increasingly SSD-based as the workloads continued to run. The response times increased and the latency decreased as the SSDs picked up more of the work, leaving the SAS drives to handle the data that was less utilized.

This shift doesn't happen immediately. It generally takes anywhere from 15 minutes to several hours for the automated tiering to kick in — partly to prevent data from bouncing between the SAS and SSD drives, but also to ensure that the workload is going to last long enough to benefit from the SSD's performance.

One workload that can benefit greatly from storage tiering is VDI (virtual desktop infrastructure). In implementations where many virtual desktops are built from a base desktop image — i.e., all the desktop virtual machines are thin clones of the original — the base image gets quite a workout, while the thin clones themselves mostly sit idle. During times of heavy reads — such as the morning when all the users log into their VDI sessions — the EqualLogic PS6010XVS will move the blocks containing the heavily accessed portions of the base image to the SSD storage, which can greatly increase access times and speed up the whole process.

Another aspect of the EqualLogic PS6010XVS can come in handy in some workloads: The SSDs can also be used for write caching if they're not loaded with data moved from the SAS tier. In heavy write scenarios, writes to the array are cached on the SSDs and pushed down to disk later, offering a significant write performance boost when necessary. This decision is made by the controller firmware based on an assortment of factors, such as how hard each side of the array is working and how much free space is available.

With all this caching at the controller and disk level, the high performance of the SAS and SSD disks themselves, and the 10G Ethernet interfaces, the EqualLogic PS6010XVS simply flies. It wasn't uncommon for loaded sequential reads run from a VMware virtual machine to hit 150MBps, with writes peaking at around 250MBps. Naturally those numbers fall off dramatically without the caching.

Pulling the plug: Redundant controllers and hot spares

During a period of intense utilization on the array, I walked around behind it and yanked out the active controller. Other than the management interface showing that the controller had vanished, nothing else noticed. There were no problems with the active workloads or any other ill effects. Reseating the controller simply brought it back up in the management interface, and everything else carried on normally.

It should also be noted that firmware updates to the EqualLogic PS6010XVS can be carried out without any downtime, as the first controller to be updated will reboot without dropping clients and take on the full load while the secondary completes its update.

How does a split array like the EqualLogic PS6010XVS address the potential problem of disk failure? In a normal array with identical drives, one or two drives would be designated as spares and called into action if a primary drive failed. The SAS side of the EqualLogic PS6010XVS is no different, with one of the eight drives designated as a hot spare. However, there is no hot spare SSD, as all eight are present in the RAID6 array. Thus, an SSD failure will not be able to pull a spare SSD into the mix. Instead, the controller will bring the hot spare SAS drive into the SSD array.

Substituting the SAS drive will necessarily degrade the performance of the SSD array, but also protect the integrity of the data stored on the SSD. When the failed SSD is replaced, the SAS replacement dumps all of its content to the new SSD and resumes its position as a hot spare, so the SSD array will once again be up to full speed. Given the price and higher reliability of the SSD, this scenario is acceptable, but it's wise to keep a cold spare SSD on hand.

The EqualLogic PS6010XVS represents yet another impressive product from Dell. The only downside is the relatively small capacity of the solution. Of the raw 4.4TB capacity, you'll see 500GB of SSD storage and roughly 2TB in SAS storage available for general use. The decision to go with the 450GB SAS drives was made to keep the ratio of SAS to SSD storage around 4:1, helping to maximize the performance enhancements of the SSD. That positions the EqualLogic PS6010XVS not as a general-purpose array, but one that would be best utilized for highly transactional workloads and heavily loaded virtual servers. As with all EqualLogic arrays, the EqualLogic PS6010XVS will fall right into place alongside other EqualLogic units and can be managed from within the same group.

— Paul Venezia

Dell EqualLogic PS6010XVS iSCSI SAN	
Cost	$55,000 fixed configuration with eight 100GB SSDs and eight 450GB 15K RPM SAS drives, both arrays configured in RAID6
Operating systems supported	Windows Server 2000/2003/2008/2008 R2, VMware ESX Server, Citrix XenServer, Red Hat Enterprise Linux, Novell Suse Linux Enterprise Server, Oracle Solaris, IBM AIX, HP-UX, Mac OS X, Novell NetWare