WHITE PAPER

The Untold Story – Advantages of NFS for Virtualization

No one doubts the benefits of virtualization for data center consolidation and efficiency. But there are still debates about the best way to deploy virtualization in conjunction with storage environments. For example, the main choices for connecting virtual machines to storage include Fibre Channel, iSCSI, and NFS.

Each of these technologies offers its own unique advantages. And while there appears to be a short-term lead for Fibre Channel and iSCSI deployments, NFS is slowly but surely gaining steam as a more easily managed infrastructure.

Why? NFS has a rich history of dealing with many clients simultaneously accessing a single storage system. And virtual environments are exactly that…many virtual machines vying for access to a single system.

Running VMs on NFS also provides a number of architectural advantages starting with the fact that virtual machines use files to store their image information, such as VMware's use of .vmdk files. Since network attached storage systems are built from the ground up for file management, the administrative time and resources to oversee a large number of virtual machine files is far less than what is required to manually assign and place those files on individual logical unit numbers (LUNs).

Some industry observers counter that NFS does not have the same performance characteristics of block level approaches. But this sweeping generalization is often based on out-dated information and without looking at modern NFS implementations.

New offerings such as scalable caching appliances now allow customers to extract more performance out of their existing NAS and NFS infrastructure than ever before. In fact, there are environments where NFS can perform as fast if not faster than other storage solutions based on Fibre Channel or iSCSI.

Let's take a closer look at the reasons why NFS is set to deliver more value for virtualization environments based on typical administrative tasks that include:

- Maintaining overall infrastructure

- Provisioning virtual disks
- Managing virtual disks
- Protecting/Recovering virtual disks
- Optimizing performance for virtual disks

Maintaining overall infrastructure

With consolidation topping the list of virtualization objectives, the ability to maintain a simpler overall infrastructure is an equally compelling factor. By deploying NAS and NFS storage solutions — as opposed to Fibre Channel-based approaches, administrators can forgo many of the complexities associated with maintaining separate Fibre Channel adapters, switches, and storage systems. NAS and NFS, in contrast, provide a unified Ethernet-based storage infrastructure.

The necessity of Fibre Channel adapters is also one of the biggest problems in virtual environments. This is because rack mounted servers often have a limited number of slots available for adapter cards. On the other hand, an Ethernet and IP-based solution avoids excessive adapters and can make effective use of embedded Gigabit Ethernet ports on the motherboard.

Provisioning virtual disks

When provisioning virtual disks with NFS, it is very easy to add new data stores quickly, simply by mounting a file system. There is no need to create or provision LUNs as is the case with Fibre Channel or iSCSI datastores.

Further, some NFS systems allow for expanding and decreasing NFS volumes on the fly, and incorporate thin provisioning features by default, saving valuable disk space.

In addition, users can easily provision new virtual disks from an NFS snapshot, allowing rapid deployment of new virtual disks from a copy/snapshot of an existing virtual disk.

Managing virtual disks

Managing virtual disks is typically easier with the file-management tools of NAS systems compared to manual handling of files within a LUN. For example, users can group virtual disks into folders or sub-folders and easily organize thousands of virtual disks.

Managing datastores between virtual servers is also far simpler with NFS. With Fibre Channel or iSCSI, sharing datastores requires manually matching LUN IDs. With VMware as an example, this is due to VMFS using the SCSI DISK ID from the LUN as an identifier. If this is not synchronized across ESX hosts, one of the hosts will see the VMFS volume as a snapshot. Use of shared NFS datastores does not require this level of synchronization.

Protecting/Recovering virtual disks

Protecting and recovering virtual disks can become a significant task for administrators. With a limited number of virtual machines, managing snapshots with host-based tools is practical and reasonable, but as the number of virtual machines increases, the need for more powerful tools escalates. Typically the most powerful snapshot tools are based at the storage subsystem because the snapshot processing is close to the data and does not require traversing the network.

Because NFS systems are designed specifically for file-centric environments, they can be particularly useful for file level snapshot and restore capabilities. For example, they typically include the option to handle single file restore compared to volume-level restore capabilities of block-based approaches. The latter requires significantly more overhead in terms of time and storage resources for file-level recovery.

Optimizing performance for virtual disks

Performance remains one of the key concerns when deploying large NFS-based virtual environments. Contrary to popular belief, there are cases when NFS-based virtualization deployments can perform as well or better than block-based alternatives.

The first aspect of improving performance with NFS is the ability to remove the need for a host-based file system. Many users find that the host-based approach is not the most efficient for packaging virtual disk information and that it can add overhead. Removing the host-based file system container and offloading that to the storage system clears the bottlenecks of a host-based file system. This sets the stage for separating functions between the host and storage system, such as snapshots. A frequent snapshot schedule can cause undue overhead when it is host-based, and can often be delivered more efficiently when implemented on the storage system.

Another critical aspect of performance with virtualization is the maximum number of outstanding I/Os allowed for LUNs. With block-based approaches this maximum number can artificially cap performance because it must be shared across all of the virtual machines using the LUN. While the maximum LUN queue depth varies by host bus adapter and manufacturer, enabling the maximum number of outstanding I/Os (e.g. 256) can lead to considerable latency.

With NFS, there is no such I/O limitation. Consequently, increasing the bandwidth and connectivity between the virtual machines and the datastore will continue to improve I/O performance.

Additional Options to Boost Virtualization Performance with NFS

While NFS has long been a “functionality and simplicity” favorite with storage managers, there have been concerns about performance compared to alternative block-based solutions for virtualization. Recognizing the benefits of storage-based

file systems and removing I/O queue limitations helps level the playing field. That said, there are new solutions that further enhance the performance of NFS solutions for virtualization.

Centralized storage caching is one of the emerging new technologies that enable the placement of a shared, high-capacity, high-speed cache in the network to offload I/O requests from slower disk-based systems and deliver that data 10-50x faster from memory. These scalable caching appliances complement existing NFS-based storage solutions by enhancing the systems with consolidated performance, offsetting the bottlenecks that can result when too many virtual machines are trying to access the same storage system.

Because virtual environments tend to drive small block sizes and random I/O, the caching appliances adeptly handle these traffic patterns with ultra low latency and very high I/O operations per second. This minimizes the I/O wait times for virtual machines, further boosting client CPU utilization and increasing overall application performance.

Conclusions

Architecting data center infrastructure is never a "one size fits all" endeavor. Understandably, some environments will be more suited to one storage infrastructure for virtualization. But increasingly the proliferation of virtual machines and the associated virtual disks present more file-related management issues than anything else. Given this trend, the industry needs to take a close look at offering customers best-of-breed solutions across both block and file-level storage architectures. Given the long history of NAS and NFS in managing large file-stores, the availability of performance-driven NFS solutions that make use of these capabilities will spur continued customer adoption.

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