

Best Practices in Virtual Environments

Questions? From your BS&A program, go to **Help>Contact Customer Support** and select **Request Support Phone Call** or **Email Support**. Or, you may call us at (855) 272-7638 and ask for the appropriate support department. Questions for our I.T. department may be submitted by phone (same number), or by emailing tech@basoftware.com.

Although BS&A Software strongly recommends a physical environment for our customers, we support the implementation of our software in virtual environments. This white paper will outline the best practices for planning and configuring virtual environments for use with BS&A Software .NET applications.

BS&A has extensively tested and approved both [VMware](#) and [HyperV](#) in our labs. This paper will outline the types of best practices and configurations that can be used to implement BS&A Software applications in a virtual environment while minimizing the inherent performance degradation normally associated with virtualization. Recommended hardware requirements/specifications for virtual environments can be found on the BS&A Software support page.

(<http://support.basoftware.com/References/Documents/HardwareNet.pdf>)

Basic DOs and DON'Ts

A note about Microsoft's support of virtual environments (including HyperV and VMware): Microsoft supports the use of its SQL Server product with the following notable qualifications:

Microsoft does not support "versions of SQL earlier than SQL Server 2005 (such as SQL Server 2000) running on any virtualization vendor or configuration." (*Microsoft Article ID:956893 - February 14, 2011 - Revision: 8.0*)

Further, they state that "Virtualization snapshots for Hyper-V or any virtualization vendor are not supported to use with SQL Server in a virtual machine. It is possible that you may not encounter any problems when using snapshots and SQL Server, but Microsoft will not provide technical support to SQL Server customers for a virtual machine that was restored from a snapshot." (*Microsoft Article ID:956893 - February 14, 2011 - Revision: 8.0*)

BSA Produces Large, Complex Databases

"BS&A Software produces some of the largest, most actively utilized databases in the local government space....Other than some forms of GIS, it is very rare to find an application as resource-intensive as those developed by BS&A. If not properly resourced, these applications will promptly slow to a crawl."

"The BS&A Software suite is a series of heavily used write-intensive SQL databases. While these performance-enhancing tips are true of both virtual and physical environments, it is particularly critical to understand the application(s) when virtualizing"

BS&A Software depends on the integrity of the data held in Microsoft SQL Server. Therefore, use of SQL 2005 or newer in virtual environments is strongly recommended. Reliance on VM snapshots for backup and recovery is discouraged. It is strongly recommended that alternative data protection methods be implemented.

What type of performance can be expected?

Through exhaustive and comprehensive testing, BS&A has found that a properly configured virtual environment should be able to achieve 75-80% of the speed of a comparable physical server. A simple method of benchmarking this would be to install the database on a local PC and compare standard operations between the local and the virtual environment. For example, a report that takes two minutes to run locally should take no longer than two and a half minutes on the virtual server.

BS&A Produces Large, Complex Databases

BS&A Software produces some of the largest, most actively utilized databases in the local government space. Our product line consists of more than 20 applications, all of which interact with each other reading and writing data to and from dozens of what can be very large tables. Other than some forms of GIS, it is very rare to find an application as resource-intensive as those developed by BS&A. If not properly resourced, these applications will promptly slow to a crawl.

Performance Tip #1... Disk I/O

The primary bottleneck that now slows any Microsoft SQL Server (virtual or physical) is disk I/O. Most BS&A Software applications are based on large write-intensive databases. Two general rules of thumb apply to such databases:

First, in such environments, best performance is achieved by utilizing separate spindles (physical disks) for the log files and the databases.

"Store transaction logs separate from data files. Do not stripe on the same disk as the data files. For large bandwidth demands on the I/O bus, use a different bus for the transaction log files." (*Physical Database Storage Design Article cc966414—Microsoft.com*)

"More / faster spindles are better for performance. Ensure that you have an adequate number of spindles to support your I/O requirements with an acceptable latency." (*Storage Top Ten Best Practices, Article ID cc966534—Microsoft.com*)

"Isolate log from data at the physical disk level. When this is not possible (i.e., consolidated SQL environments) consider I/O characteristics and group similar I/O characteristics (i.e., all logs) on common spindles." (*Storage Top Ten Best Practices, Article ID cc966534—Microsoft.com*)

"Combining heterogeneous workloads (workloads with very different I/O and latency characteristics) can have negative effects on overall performance (i.e., placing Exchange and SQL data on the same physical spindles)." (*Storage Top Ten Best Practices, Article ID cc966534—Microsoft.com*)

Second, understanding that BS&A Software is largely write-intensive, it is best to utilize RAID 1+0 or RAID 1 (rather than RAID 5 or 6). RAID 5 & 6 can have improved performance in an environment skewed toward reading data, but BS&A applications will run better in a RAID 1 environment (especially the database log files).

“Always place log files on RAID 1+0 (or RAID 1) disks. This provides better protection from hardware failure, and better write performance.” *(Storage Top Ten Best Practices, Article ID cc966534—Microsoft.com)*

Here is what VMWare has to say on the subject: “Storage configuration is critical to any successful database deployment... Your storage subsystem should provide sufficient I/O throughput as well as storage capacity to accommodate the cumulative needs of all virtual machines running on your ESX hosts.” *(Microsoft SQL Server and VMware Virtual Infrastructure Best Practices, VMWARE.COM)*

Furthermore: “Multiple heavily-used virtual machines concurrently accessing the same VMFS volume, or multiple VMFS volumes backed by the same LUNs, can cause decreased storage performance. Appropriately configured storage architectures can avoid this issue.” *(Microsoft SQL Server and VMware Virtual Infrastructure Best Practices, VMWARE.COM).*

The BS&A Software suite, in and of itself, is a series of heavily used write-intensive SQL databases. While these performance-enhancing tips are true of both virtual and physical environments, they are particularly critical in virtual environments. Best practices indicate that any Microsoft SQL database should be split (databases on one physical spindle, log files on another). Failure to do this will degrade performance. When both the database and the log files reside on the same physical disk, and that same disk is shared with other virtual machine(s), the performance degradation can be **extreme**.

Beyond this basic advice, more advanced disk performance tuning is possible. Three proven methods to increase performance are:

- 1) **Disk partition alignment**, described at length in *Microsoft article 758814* [http://msdn.microsoft.com/en-us/library/dd758814\(SQL.100\).aspx](http://msdn.microsoft.com/en-us/library/dd758814(SQL.100).aspx)
- 2) **Replacing VMFS or virtual disks with Raw Device Mapping (RDM)**. A close reading of VMWare's best practices article on the subject reveals that they employed RDM in an effort to boost performance numbers. (*Microsoft SQL Server and VMware Virtual Infrastructure Best Practices, VMWare Article Revision: 20090313 Item: WP-087-ISV-01-01*) BS&A Software's own testing indicates this usually makes a noticeable difference in performance.
- 3) **High performance drives**: BS&A Software recommends the use of SAS drives with 6Gbps throughput. Internally, in its highest utilized environments, BS&A has implemented new SSD technology with great success. BS&A Software recommends (where feasible) the use of SSD technology.

Performance Tip #2... Memory Allocation

Given the many possible bottlenecks involved with disk I/O, BS&A Software strongly recommends sufficient RAM be allocated to any virtual machine running the database engine. It has been established that substantial performance gains can be made by minimizing disk I/O. Another method of doing this is by eliminating (as much as possible) the need to access the disk at all. Sufficient memory allocation is key in this effort.

Keep in mind that the free or "Express" version of SQL Server is limited to 1GB of RAM usage when buffering databases. Lack of utilized resources may not be an indicator of lack of need of resources. Upgrading to the Workgroup or Standard versions of MSSQL can open this bottleneck and provide for substantially increased performance. <http://www.microsoft.com/sqlserver/2008/en/us/editions.aspx>

Performance Tip#3... CPU

While SQL Server is licensed by the CPU (in many cases), these limitations do not apply to the multiple cores modern processors possess. SQL Server is inherently multi-threaded and will take advantage of being assigned multiple cores in a VM environment. It is recommended that more than one CPU/core be assigned to the virtual machines containing Microsoft SQL.

<http://www.microsoft.com/sqlserver/2008/en/us/editions.aspx>

Summary

BS&A desires that all of our customers have a pleasant experience running our software. A properly configured Virtual Server need not destroy employee productivity. In order to ensure the best possible overall performance system, administrators must be willing to allocate sufficient resources to Microsoft SQL. To that end, BS&A Software recommends the following when implementing the .NET software in VM environments:

- 1) Databases and log files are kept on separate physical volumes/disks
- 2) Volumes housing databases and/or log files are dedicated to the use of the database (no other VMs reside on those volumes)
- 3) High performance disk technologies are used wherever possible
- 4) Disparate database styles (i.e., MS Exchange) NEVER cohabitate with MSSQL on the same drives
- 5) VMWare RDMs are implemented wherever possible
- 6) Parent servers dedicate at least 2 CPU cores to MSSQL VMs
- 7) Sufficient RAM is allocated to reduce/minimize the need for excessive disk access
- 8) SQL 2005 or newer only; Workgroup or Standard Edition where possible
- 9) So-called snapshots of the virtual machine cannot be relied upon for data restoration or disaster recovery. Alternative database backup methods must be employed.
- 10) Optimize disk partitioning using industry-standard methods

Works cited or reviewed in the writing of this document

BS&A Software Hardware Recommendations, (<http://support.bsasoftware.com/References/Documents/HardwareNet.pdf>)

Microsoft Support Policy for SQL Databases Running in a Virtual Environment, Microsoft Article ID:956893 - February 14, 2011 - Revision: 8.0<http://support.microsoft.com/kb/956893>

Microsoft SQL Server Best Practices, Article ID 966412 <http://msdn.microsoft.com/library/cc966412>

Disk partition alignment, Microsoft article 758814 [http://msdn.microsoft.com/en-us/library/dd758814\(SQL.100\).aspx](http://msdn.microsoft.com/en-us/library/dd758814(SQL.100).aspx)

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Tuning Disk I/O in VMWare, VMWare Article kb1003469 http://kb.vmware.com/selfservice/microsites/search.do?language=en_US&cmd=displayKC&externalId=1003469

Memory Architecture, Microsoft MSDN article 187499 <http://technet.microsoft.com/en-us/library/ms187499.aspx>

SQL 2008 Edition Comparison, <http://www.microsoft.com/sqlserver/2008/en/us/editions.aspx>

Giving your virtual SQL server direct access to your storage array (techtarget.com), <http://itknowledgeexchange.techtarget.com/sql-server/giving-your-virtual-sql-server-direct-access-to-your-storage-array/>

Microsoft SQL Performance Solutions: (Superspeed.com), <http://www.superspeed.com/servers/ms-sql-performance.php>

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