

Seradex White Paper

A Discussion of Issues in the Manufacturing OrderStream

Microsoft SQL Server High Performance for Your Business

Executive Summary

Microsoft SQL Server is the leading database product for small and large businesses. Microsoft SQL Server has been benchmarked at processing over 1 million sales orders per minute with 30,000 users and as a result, it can scale to handle very large business requirements.

This document will provide some tips to ensure you can maximize the performance of the database. There are many variables involved in optimizing the performance of SQL databases. These include:

- Server Hardware
- Network Configuration
- SQL Server Product Variations
- SQL Server Setup, Installation and Configuration
- SQL Database Design

Focus on these points for optimizing the performance of a Seradex ERP SQL database:

- Acquire the fastest hyperthreaded CPU available with the most L2 and L3 memory cache.
- Purchase a server with multiple CPU capabilities, but remember the performance increase per CPU drops off steeply as you add more CPU's.
- Put the maximum amount of RAM in the server. Memory affects many other subsystems of your SQL Server—for example, by caching more reads and writes to the disk subsystem.
- Use fast disk drives. A 15,000-rpm drive compared to a 10,000-rpm drive will provide a linear boost in performance.
- Utilize SAN, RAID1 or RAID10 Disk arrangements instead of RAID5
- Split the user database file and transaction log file on to separate disk volumes
- Use multiple disk controllers
- Your Seradex ERP SQL Server should be on a separate server. It should be the only application running on the server and be configured with default memory options. It should not be on a domain controller or a web server.
- SQL Server is available in three product editions and price points; Standard, Enterprise 32 Bit and Enterprise 64 Bit. A 64 Bit CPU offers significant performance improvements. Talk to Seradex about the best edition for your requirements.



Table of Contents

Executive Summary	1
SQL Server Editions	3
Server Hardware	3
CPU	3
Motherboard	4
CPU cache	4
Memory	4
Disk Input Output	5
Disk Storage Options	6
Network Infrastructure	6
Switches	7
Workstations	8
Cable	8
Appendix 1 - SQL Sizing	8
Appendix 2 - Sample Benchmark Values	10
Appendix 3 - Diagnosing Performance Issues	11

SQL Server Editions

There are several editions of Microsoft SQL Server available with varying features and performance levels.

	SQL Server 2000 Enterprise Edition 64 Bit	SQL Server 2000 Enterprise Edition 32 Bit	SQL Server 2000 Standard Edition
Cost	Highest	Medium	Lowest
Performance	Highest	Better	Good
Multiple CPU Support	>4	>4	4
Support for SAN	Yes	Yes	No
Support for Failover Cluster	8 Nodes	4 Nodes	No
Support Performance Increases from Multiple CPUs	Yes	Yes	No
Windows 2003 Datacenter Server	64GB	64GB	2GB
Windows 2003 Advanced Server	8GB	8GB	2GB
Windows 2003 Server	4GB	4GB	2GB

There is a wide array of pricing options for each edition from processor licenses to server and user licenses. For information on pricing refer to SQL Server Pricing

Server Hardware

CPU

A 10 percent increase in CPU speed yields a 7 percent boost in SQL Server's performance. Thus, a 3.3GHz CPU will perform about 7 percent better than a 2.9GHz CPU. This finding is consistent across different types of CPUs.

Many servers today can support multiple CPUs but the performance does not scale linearly. A second CPU adds about a 40 percent boost, the third and fourth CPUs about 16 percent increase for the Seradex ERP application.

An intriguing feature in Intel chips is hyperthreading. This feature allows one chip to process more than one instruction per cycle. Hyperthreading has been able to boost SQL Server performance by 35 percent.

AMD and Intel have released 64 bit CPUs. Hosted on a native 64-bit Windows Microsoft SQL Server 2000 Enterprise Edition (64-bit) offers major performance

advances compared to the 32 bit processors. Some recent impressive benchmarks include:

Benchmark	Results	Comments
Siebel	30,00 concurrent users resulting in 206,722 business transactions throughput/hour	The Siebel benchmark was run on a SQL Server 2000 (64-bit) backend running on the Itanium processor based Unisys ES7000 Orion 130 Enterprise Server.
SAP	2-tier SAP® Standard Application Sales and Distribution Benchmark	Itanium 2-based NEC Express5800/1032 occupies a top spot with 2,750 SD benchmark users with an average dialog response time of 1.85 seconds. The achieved throughput was 278,300 fully business processed order line items per hour and 835,000 dialog steps per hour.

Motherboard

Motherboards have very little impact on performance of the Seradex system. The high speed front bus offer minor improvements in SQL performance of less than 5%. The latest benchmarks show minor variations in performance due to motherboards – i.e. less than 5%.

CPU cache

There are two types of memory cache that affect SQL Performance

- L2 cache allows memory fetches at the full operating speed of the processor core. A CPU with a 2MB L2 cache offers 32 per-cent better performance than the same CPU with 512KB of L2 cache. Opt for the highest L2 cache on the fastest processor.
- L3 cache is located immediately adjacent to the CPU chip but isn't integrated with the CPU chip so it is much slower than L2 Cache. In testing, 4MB of L3 cache improved SQL Server performance by 39 percent compared to the same CPU with no L3 cache. Opt for the highest L3 cache on the fastest processor.

Memory

DDR RAM operates faster than the older style SDRAM and should be selected. The maximum supported RAM should be installed. RAM is limited by the combination of Windows Operating System and SQL Server Edition selected.

The Standard Edition of SQL Server can only use 2GB of memory no matter how much you have on the server. Keep in mind that memory is cheap but SQL Server Enterprise Edition is not, nor are the advanced versions of the server operating system that may be required to utilize all the memory you buy. Before starting down this road, make sure you understand the true cost of upgrading memory. SQL Server loves memory and it is often the cheapest way to get a performance boost.

If you have SQL Enterprise Edition running on Windows Advanced Server or Datacenter Edition with 4GB or more of RAM, you need to configure special memory management options at the operating system level.

Disk Input Output

In order to properly configure and tune disk input output (I/O), you must understand the fundamental types of redundant array of inexpensive disks (RAID), their benefits, and their drawbacks.

The most common types of hard disk configuration are redundant arrays of inexpensive disks (RAID). The common variations include RAID5, RAID1, and RAID10. In addition, many enterprises are now deploying storage area networks (SANs).

	Raid 5	Raid 1	Raid 10	SAN
Performance	Poor	Medium	High	Highest
Data Protection if Drive Fails	Good	Good	Good	Good
Cost	Low	Medium	High	Highest
Setup Effort	Medium	Low	Low	High
Can link to multiple servers?	No	No	No	Yes

Our testing has shown that RAID1 and RAID 10 both perform over 300 % better than RAID5. SAN performance, in terms of the total number of transactions processed per second, was better than RAID I and RAID 10. There is a wide variety of SANs available at many different price points so your mileage may vary.

Another important lesson is that more disk drives (aka spindles) equal better read performance. RAID1 and RAID 10 performance improved about 5 percent for each added spindle beyond the baseline configuration. Other tips to consider include:

- Add additional disk controllers to boost write performance.
- Disk write cache gives a big performance boost but require an uninterrupted power supply (UPS) on the server to prevent data loss in the event of a catastrophic failure.
- Place the log files on a separate dedicated RAID 1 disk array to boost performance. This allows SQL Server to utilize all disks for data and log files in parallel improving performance.
- Place the tempdb database on its own separate physical RAID 0 disk array.

As a high performance approach consider a server with multiple hot-swappable disk drives configured as:

- RAID 1 (2 drives, Mirrored) for Windows Operating System executables and Pagefile.sys
- RAID 10 (Multiple drives) for SQL Server Data files
- RAID 1 (2 drives, Mirrored) for SQL Server Log files

- RAID 0 (1 Drive) for tempdb files

Disk Storage Options

There are two technology platforms available for today's SAN - Fibre Channel and iSCSI. Fibre Channel can be implemented over either fiber optics or copper wire, but it requires a special switch. Particularly in smaller organizations, the additional cost and expertise required to connect a server to a Fibre Channel SAN can make the technology less attractive.

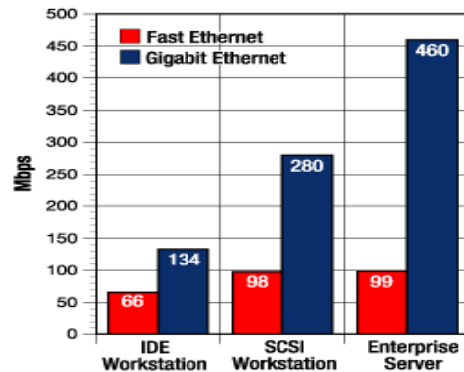
Connecting a SAN using iSCSI is as simple as adding a free iSCSI device driver to a server's Ethernet card. iSCSI can run over 10-gig Ethernet and you can achieve better performance from iSCSI than from 1-Gbps or even 4-Gbps Fibre Channel. iSCSI can be one-third the cost of Fibre Channel. In addition iSCSI can be located anywhere that has Internet service.

With iSCSI you can scale the storage capacity to 100's of Tbs with any type and brand of storage system. In addition, you can use any type of network (10,100,1000) and combine operating systems (MS, Linux, HP-UX, Solaris, AIX, Netware) within the SAN network. IP-SANs also include mechanisms for security, data replication, multi-pathing and high availability.

Network Infrastructure

Switches

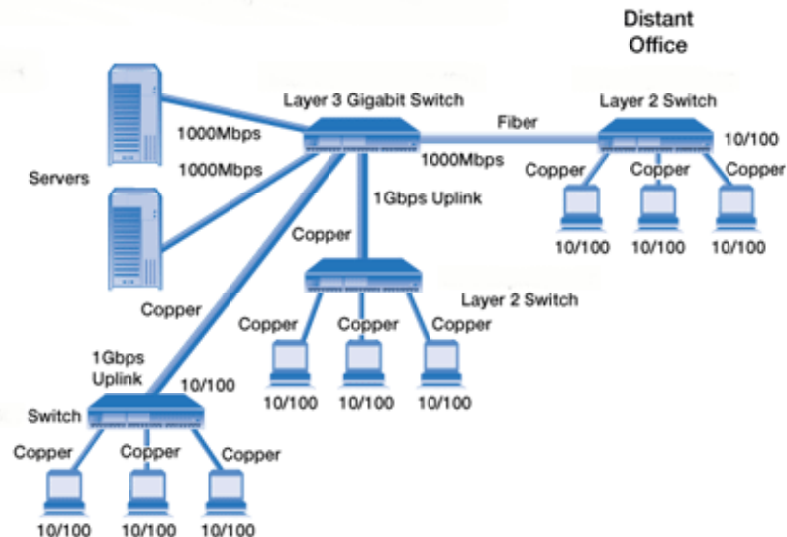
D-Link, Linksys, SMC and Netgear have switches that are in the sub-\$100 price range. Just like with 10/100 switches, Gigabit switches will interoperate with lower speed siblings on the same network, so you don't have to replace all your NICs if you don't want to. Auto-sensing ports — a key Gigabit switch feature — automatically determine the speed of the connected PC and deal with it appropriately. The graph below compares sustained network throughput:



Fast Ethernet vs. Gigabit Ethernet Sustained Throughput

In rapidly growing organizations, the demands of adding new 10/100 Mbps desktops will eventually outstrip network capacity, especially if users regularly need to move large files. With all desktop PCs running at 100 Mbps, users will experience slow response times and sluggish retrieval of files stored on the server. The Gigabit solution shown below will increase throughput to and from the server by a factor of 10 using the existing copper infrastructure. In addition, it will allow the organization to deploy new workgroups using copper or fiber cabling as required by distances or environmental factors

Sample Network Layout



Workstations

Until recently, Gigabit networking was a high-speed technology that came with a high price tag to match. However, like most technology advances, prices have come down and Gigabit networking products are now an affordable option.

New "business class" PCs and high-end workstations are now routinely equipped with Gigabit Network Interface Cards (NIC's). Be sure to get a Gigabit NIC installed on any new PC purchase. Older PC's can also benefit from a simple inexpensive retrofit of a 10/100/1000 NIC. SCSI Hard Drives in workstations offer about twice the network bandwidth compared to IDE drives.

Cable

Most of the Ethernet cable in use today is either Cat 5 or Cat5e. Generally speaking, Cat5e is a better choice than Cat5 for Gigabit Ethernet, though either one will work. Cat 6 is also an option (not a requirement) when it comes to Gigabit networks.

Appendix 1 - SQL Sizing

There are several SQL sizing tools available. In this example the Hewlett Packard tool available at HP SQL Server Sizing is used. Please use this tool to size for your transaction volumes.

This server was sized for a hypothetical company with the following requirements:

Assumptions	Values
Transactions per hour	20,000
Transactions per business day	160,000
Simultaneous Users	300
Database size	15.0 GB
Transaction log size	1.0 GB
Supported transaction growth	50%
Supported database capacity growth	50%
Solution options	Single Server with Direct Attach Storage

Network attachment	10/100/1000-T Gigabit Ethernet
--------------------	--------------------------------

HP Integrity rx5670 Server -

Processor:

2 Intel® Itanium® Processors - 1.5GHz with 6MB L3 cache

Memory Subsystem:

2048-MB RAM

Microsoft Windows Server 2003
Reserved for Applications
Available for SQL Server 2000

306 MB
100 MB
1642 MB

Performance Estimates

Transaction Latency (ms) 36.55
Processor Utilization 0.62%
Database Reads/sec 23
Database Writes/sec 7
Database Read Latency (ms) 8.92

Note the processor usage is less than 1 %!

2 x Gigabit Ethernet 10/100/1000- PCI-X Adapters

NIC Subsystem:

Hard Drives The following Volumes are configured on Local Storage:

Contents	RAID Level	Hot Pluggable SCSI	Fill %	Qty
Installation	Mirrored (RAID 1)	36.x - GB 10,000 rpm	13.90%	2
Transaction Log	Mirrored (RAID 1)	36.x - GB 10,000 rpm	2.80%	2
Database	Mirrored (RAID 1)	36.x - GB 10,000 rpm	41.70%	2

Appendix 2 - Sample Benchmark Values

Here are some recent benchmark results from TPC.Org based on orders /minute – these volumes are an indication of the performance of SQL Server.

Hardware	New Orders / Minute	Database	Server Operating System	Date Submitted	Price / New Order / Minute US\$
HP Integrity Superdome 64P c/s	1,082,203	SQL Server 2005 Enterprise 64bit	Windows 2003 Datacenter 64-bit	06/07/05	\$5.38
HP Integrity Superdome	786,646	SQL Server 2000 Enterprise 64-bit	Windows 2003 Datacenter 64-bit	08/27/03	\$6.49
HP Integrity Superdome	707,102	SQL Server 2000 Enterprise 64-bit	Windows 2003 Datacenter	05/20/03	\$7.16
HP ProLiant DL585-G1 64GB/2.2GHz Dual Core /4P	187,296	SQL Server 2000 Enterprise	Windows 2003 Enterprise	04/21/05	\$2.04
HP ProLiant DL760G2/64GB/3.0GHz/8P	143,367	SQL Server 2000 Enterprise	Windows 2003 Enterprise	12/10/04	\$3.96
HP rx5670	121,065	SQL Server 2000 Enterprise 64-bit	Windows 2003 Enterprise	04/24/03	\$4.49
HP ProLiant DL585 32GB/2.4GHz/4P	115,110	SQL Server 2000 Enterprise	Windows 2003 Enterprise	10/15/04	\$2.62
ProLiant BL45p - 4P	108,574	SQL Server 2000 Enterprise	Windows 2003 Enterprise	06/24/05	\$3.34
HP rx5670	87,741	SQL Server 2000 Enterprise 64-bit	Windows 2003 Enterprise	12/16/02	\$5.03
HP ProLiant DL580G2/2.8GHz-4P	84,712	SQL Server 2000 Enterprise	Windows 2003 Enterprise	09/08/03	\$3.83
HP ProLiant ML370G4/16GB/3.2GHz-2MB/2P	74,298	SQL Server 2000 Enterprise	Windows 2003 Enterprise	02/11/05	\$2.40
HP ProLiant DL385-G1 16GB/2.6GHz/2P	71,413	SQL Server 2000 Enterprise	Windows 2003 Enterprise	02/11/05	\$2.15
HP ProLiant ML370-G4-1M 3.6Ghz 2P	68,010	SQL Server 2000 Enterprise	Windows 2003 Enterprise	11/01/04	\$1.80
HP ProLiant ML370-G3-2M/3.20GHz-2P	60,364	SQL Server 2000 Enterprise	Windows 2003 Enterprise	03/02/04	\$3.51
HP ProLiant ML370-G3-1M 2P	54,096	SQL Server 2000 Enterprise	Windows 2003 Enterprise	10/13/03	\$3.77
HP ProLiant DL380G3-2P	43,230	SQL Server 2000 Enterprise	Windows 2003 Enterprise	05/29/03	\$3.71
HP ProLiant ML350G4p - 1P	42,432	SQL Server 2000 Enterprise	Windows 2003 Enterprise	03/28/05	\$1.96
HP ProLiant DL380-G3-1M/3.20GHz/1P-12GB	33,873	SQL Server 2000 Enterprise	Windows 2003 Enterprise	12/17/03	\$2.40
HP ProLiant ML350-G3-1M/2.80GHz-1P/8GB	28,711	SQL Server 2000 Enterprise	Windows 2003 Enterprise	03/02/04	\$2.14
HP ProLiant ML 370G3-2P	26,725	SQL Server 2000 Enterprise	Windows 2003 Standard	01/08/03	\$3.72
HP ProLiant ML350G3-1P	19,526	SQL Server 2000	Windows 2003 Standard	05/12/03	\$2.25
HP ProLiant ML350T03 X3.06/533/512K SA641	17,810	SQL Server 2000 Standard	Windows 2003 Standard	10/19/04	\$1.57

Appendix 3 - Diagnosing Performance Issues

Before you can fix performance problems, you need to know what's causing them. Fortunately SQL Server has some very good diagnostic tools built in and some more that are available for free download from Microsoft's web site. For the most part these tools are fairly simple to use. The hard part is understanding the results they generate.

CPU

Turn on the Processor: % log in System Monitor. This is a tool that comes with Windows and is already installed on your server for a typical 24 hour period. If this frequently exceeds 80% for several minutes at a time you may want to add more or faster processors.

Memory

The simplest measure is to log the SQL Server Buffer Manager: Cache Hit Ratio for a typical 24-hour period so you get the big picture:

- Average Cache Hit Ratio should be in the high nineties. 99% is OK below 98% indicates more RAM should be added
- Memory: Pages\Sec It is normal for this reading to spike very high for brief periods, but it should average 20 or below over a typical 24 hour period.

Disk I/O

Disk I/O can also be measured with System Monitor. Take measurements for each individual physical array. The totals for all disks mean very little. Disk configuration on a database server is a complex subject. There aren't any quick generalities that are useful here. If System Monitor indicates a serious I/O problem, you probably need to consult with an expert. However, remember that the disks may be spinning because your application is not adequately indexed. Take care of that first and the disk problem might disappear.

Physical Disk: %: Disk time should be under 60% except for an occasional brief spike

Physical Disk: Avg. Disk Queue Length: should be below 2 per physical disk in an array (i.e. a 5 disk RAID array is good for a queue length of 10)

Seradex Inc.
4460 Harvester Rd.
Burlington, ON
L7L 4X2
Tel: 905-332-5051
mcorker@seradex.com