

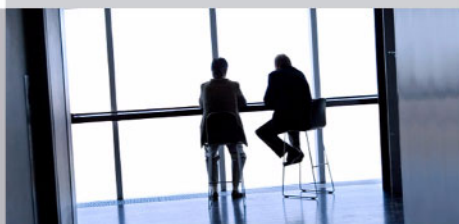


New Business Intelligence Solutions on the IBM System x3850 X5 Using XIV Storage



Redguides
for Business Leaders

Michael Lawson



- Fifth paper in the series on Business Intelligence solutions from IBM System x and IBM System Storage
- Tested reference configurations using refreshed IBM System x3850 X5 configurations with Microsoft SQL Server 2008 R2 BI
- IBM XIV System Storage benefits for Business Intelligence: Ease of use, performance, and data protection



Executive overview

Business Intelligence (BI) is defined as the technology used to extract useful information from the vast amount of data that a business has been collecting over time. The information extracted can then be used by decision makers to guide their business to success.

IBM® builds, tests, and publishes reference configurations to provide clients with guidelines when sizing their BI configurations. With the release of the new IBM eX5 servers with more processors and memory than ever before in an x86 platform, this IBM Redguide™ document shows you how you can get the most out of one of these high performance servers in a BI configuration. The IBM eX5 servers allow you to scale to new performance highs, process your cubes quickly, and get query results even faster than on previous generation M2 servers.

IBM has tested and is releasing new configurations built using these key components:

- ▶ IBM System x3850 X5
- ▶ IBM XIV® Storage System
- ▶ Microsoft® Windows® Server 2008 R2
- ▶ Microsoft SQL Server 2008 R2

This IBM Redguide is the fifth in a series that describes Business Intelligence reference configurations on the 4-socket and 8-socket IBM x3850 X5 platform using both Intel® Xeon X7500 series and Intel E7-8800 series processors. The first four papers covered reference configurations on IBM x3850 M2, IBM System x3850 X5, IBM System Storage® DS5000, IBM System Storage XIV and Microsoft Windows Server 2008 and SQL Server 2008 RTM and R2 editions.

Figure 1 shows the IBM System x3850 X5.



Figure 1 IBM System x3850 X5

This document provides updates to the fourth paper and sizing information for businesses that are planning to use the Microsoft Business Intelligence (BI) solution utilizing IBM System x3850 X5 server, IBM XIV Storage System, Microsoft Windows Server 2008 R2, and SQL.

We also show the performance improvements you can expect by upgrading from 4-socket x3850 X5 to 8-socket x3850 X5 and also from Intel Xeon® X7500 series processors to the Intel Xeon E7-8800 family of processors.

Table 1 provides a high level summary of the reference configurations discussed in this paper.

Table 1 Summary of the reference configurations for the system platforms

	1-node X7500	2-node X7500	1-node E7-8800
DW database size	1.7 TB	1.7 TB	1.7 TB
Server and storage	32 logical processors 64 GB memory 1 XIV, 79 TB usable	64 logical processors 128 GB memory 1 XIV, 79 TB usable	40 logical processors 64 GB memory 1 XIV, 79 TB usable
Cube building time	3 hours 25 minutes	2 hours 21 minutes	2 hours 48 minutes
Time % of 1-node X7500	100%	69%	82%

IBM offers a unique and compelling high end, modular, Intel Xeon X7500 and E7-8800 series processor based the IBM System x3850 X5 server running Windows Server 2008 R2 Enterprise. This server is a modular “building-block” server. The x3850 X5 can be configured with one or two chassis to build a scale-up server with up to 160 logical processors and 2 TB memory. The x3850 X5 can be configured with a 1U MAX5 memory drawer to build a 4-socket, 1.5 TB memory configuration. In conclusion, we show that the new eX5 servers and XIV storage process your data and derive intelligent information from it faster than you could ever do it before.

Introduction

The purpose of Business Intelligence (BI) is to take a company's historical and operational data, process it with analytics software and present the data in an easy-to-read and familiar format to enterprise users. The resulting data empowers users by aiding them in making better business decisions to help improve their company's bottom line. Examples of BI include using the retail sales trends by geographical areas over the past few years to decide which products go on the shelf, and using the results of various sales promotions offered historically to decide on future promotions.

IBM builds reference configurations and tests them to provide clients with guidelines when sizing their BI configurations. IBM uses a workload developed by Microsoft using their internal proprietary data. The workload used for testing the configurations listed in this paper includes BI cube building. Cube building is a processing step in the BI workflow that pre-aggregates the data warehouse data in a form suitable for fast retrieval when end users are performing business analytics. Building a cube can take many hours and is very dependent on the hardware resources provided and the specifications of the cube itself (for example, the amount and complexity of aggregation).

IT professionals need to know approximately how long their cubes will take to build, in order to plan effectively and have the cubes ready when their customers need them. See "Data warehouse profile" on page 8" when attempting to compare our workload with yours. The reference configurations have been tested by measuring how long it takes to build the cube.

The configurations are tested using the Microsoft BI software stack, providing assurance that the combined solution of software, server hardware, and data storage will provide the best return on investment in hardware and people resources.

The remainder of this guide is made up of three sections:

- ▶ Solution architecture
- ▶ Workload description
- ▶ Reference configurations

Solution architecture

Solution components include the high end IBM System x3850 X5, IBM XIV Storage System, and Microsoft Windows Server 2008 R2 and Microsoft SQL Server 2008 R2. This section introduces each of these components.

IBM System x3850 X5 server

The IBM System x3850 X5 server is the fifth generation of the Enterprise X- Architecture, delivering innovation with enhanced reliability and availability features to enable optimal performance for databases, enterprise applications, and virtualized environments.

Features of the x3850 X5 include:

- ▶ Increased performance with more processors and memory than ever before on x86.
- ▶ Intel Xeon E7-8800 series processors with up to 10-cores and Hyper-Threading.
- ▶ Intel Xeon X7500 series processors with up to 8-cores and Hyper-Threading.
- ▶ Up to eight sockets and 128 DIMMs with QPI scaling for larger databases, enterprise, and mission-critical workloads.

- ▶ Up to 64 DIMM slots per chassis delivering up to 1024 GB of high speed PC3-10600 double data rate (DDR3) memory.
- ▶ Memory reliability and availability with Memory ProteXion with Chipkill, memory mirroring, memory sparing, Intel SMI Lane Failover, SMI packet retry, and SMI Clock failover.
- ▶ Low-power cost-effective memory with Advanced Buffer eXecution chip.
- ▶ High performing databases and fast time to value for database workloads.
- ▶ Advanced networking capabilities with Emulex 10Gb Ethernet Adapter, including support for Fibre Channel over Ethernet (FCoE) as a future feature entitlement upgrade.
- ▶ Integrated Management Module (IMM) for enhanced systems management capabilities.
- ▶ Serial Attach SCSI (SAS) plus RAID to maximize throughput and ease installation of a RAID card.

Intel Xeon processors

First announced in 2010, the first generation of x3850 X5 was powered by the highly scalable Intel Xeon processor 7500 series. The Intel Xeon processor 7500 series features Intel Advanced Reliability Technology that provides automatic detection and correction of errors, dynamic reassignment of workloads across processors, interconnect error detection and recovery, and individual virtual machine recovery in virtualized environments.

New in 2011, the x3850 X5 has been updated to support the Intel Xeon E7 4000 and 8000 series of processors. These processors enhance the x3850 X5 to deliver scalable, reliable, powerful 64-bit multi-core servers offering industry-leading performance, expanded memory and I/O capacity, and advanced reliability ideal for the most demanding enterprise and mission-critical workloads, large-scale virtualization, and large-node HPC applications. The E7-4000 series processors offer up to 10 cores per processor at up to 2.4 GHz frequency. The X7500 series processors offered up to 10 cores per processor at up to 2.26 GHz. The higher frequency and increase in the number of cores results in a performance benefit of up to around 20% on a BI workload running on the x3850 with Microsoft SQL Server.

IBM XIV Storage System

The IBM XIV Storage System is a revolutionary high-end disk storage system with enterprise-level consistent performance through massive parallelism, disk utilization, and unique caching mechanisms. It eliminates the complexity of storage administration and makes storage management easy.

Figure 2 on page 5 shows the XIV Storage System.



Figure 2 IBM XIV Storage System

The IBM XIV Storage System is characterized by the following set of features:

- ▶ iSCSI and Fibre Channel (FC) interfaces
- ▶ Multiple host access
- ▶ Management software, including graphic user interface (GUI) and command line interface (CLI)
- ▶ Volume cloning (snapshots)
- ▶ Thin provisioning
- ▶ Asynchronous and synchronous replication of a volume to a remote system
- ▶ Easy assignment and reassignment of storage capacity

Note: The term “storage capacity” refers to the total storage capacity, and does not take into account the amount of storage used for data redundancy or mirroring and other data-related tasks.

- ▶ Remote configuration management
- ▶ Notifications of events through email, SNMP, or SMS messages
- ▶ Truly no single-point-of-failure
- ▶ Fault tolerance, failure analysis, and self-healing algorithms
- ▶ Non-intrusive maintenance and upgrades

Microsoft Windows Server 2008 R2 and SQL Server 2008 R2

Microsoft SQL Server 2008 R2 running on Microsoft Windows Server 2008 R2 enables organizations to build comprehensive, enterprise-scale analytic solutions that deliver intelligence where customers want it.

Key features include:

- ▶ Windows and SQL Server 2008 R2 Datacenter Editions support up to 256 logical processors, a 4x increase from the previous product.
- ▶ PowerPivot offers self-service Business Intelligence, allowing business users to create BI solutions in Excel. Users can publish their solutions to SharePoint to collaborate with other users, while database professionals can continue to administer the data in the solutions.
- ▶ Master Data Services provides the capability to manage an organization's master data to become, through integration, the single source of master data across the organization.
- ▶ Data-tier application (DAC) provides a new way to develop, deploy, and manage the database objects used by an application.
- ▶ 64-bit native DBMS.
- ▶ Dynamic large memory support.
- ▶ High Availability through Failover Clustering, Database Mirroring, Log Shipping, and Replication.
- ▶ Database snapshots, a point in time, instantaneous, read-only copy of a database, which can be used for reporting and reverting back.
- ▶ Data compression for reduced on-disk space utilization, faster data retrieval, and faster backups and restores.
- ▶ Policy-Based Management for managing SQL Server instances throughout the enterprise.
- ▶ All other components needed to provide a comprehensive, low-cost business intelligence solution.

SQL Server 2008 R2 BI components

SQL Server 2008 R2 includes the SQL Relational Database Engine, Analysis Services, Integration Services, and Reporting Services. Together these components form a complete data warehousing and business intelligence solution.

Key features include:

- ▶ The Database Engine provides the services for the relational databases, which includes the operational databases and the data warehouses.
- ▶ Integration Services provides the means for Extracting, Transforming, and Loading (ETL) the data from the operational databases into the data warehouses.
- ▶ Analysis Services provides the means for creating, processing and serving On Line Analytical Processing (OLAP) cubes.
- ▶ Reporting Services provides a comprehensive reporting solution for SQL Server data stored in relational databases and cubes.

Figure 3 shows the various components in the BI Reference configuration and how the data flows between them. During the cube building process, Analysis Services (AS) requests data from the Data Warehouse (DW), aggregates it, and writes it into the Cube. The data flows (shown by the arrows) from the DW to the XIV, across the Fibre Channel network, into the x3850 X5 server where Database Engine (DE) is running. The DE passes the data to AS via

a high performance in-memory data transfer. AS, also running on the x3850 X5, sends the data across the Fibre Channel network, into the XIV, and from there into the Cube.

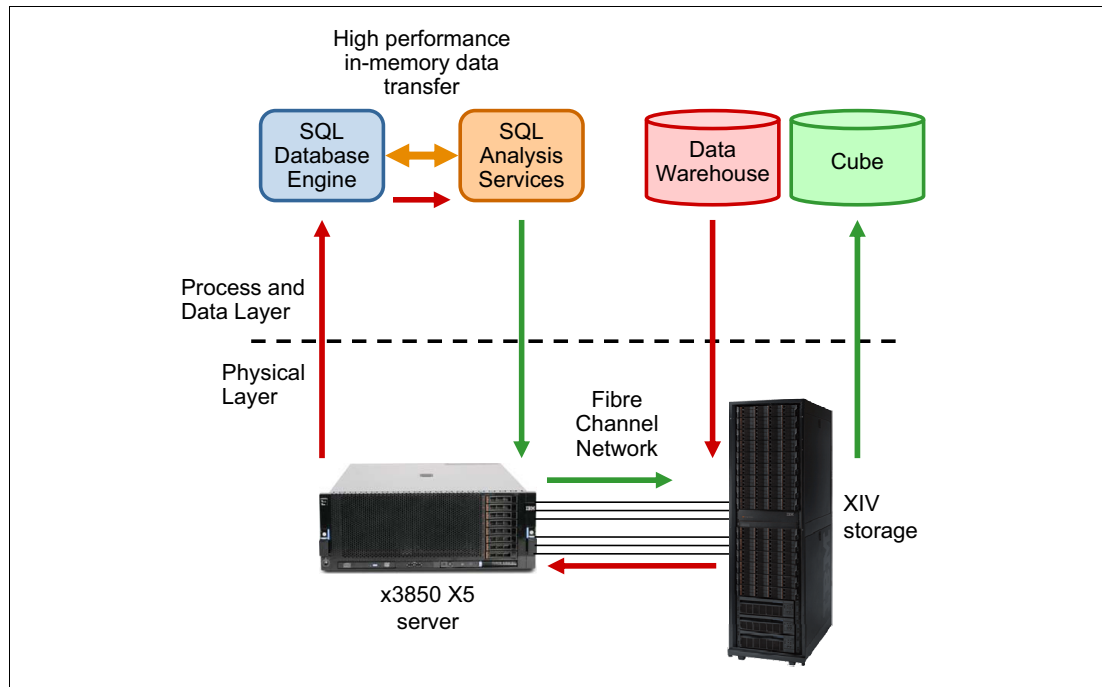


Figure 3 BI reference configuration architecture

Workload description

The cube building (also called cube processing) workload used to test these reference configurations comes from a data warehouse of Web Tracking information. The workload and the data warehouse come from Microsoft.

To aid in describing the cube-building workload, we first offer a brief explanation of several key BI concepts: dimensions, fact tables, measure groups, and cubes. Then, we provide a profile for the Data Warehouse (DW) and Cube design and processing used in these tests.

BI terminology

This section lists a few key terms used in Business Intelligence (BI).

Fact tables

Fact tables contain the individual transactions or events that are relevant to the business. For example, a retail business has a fact table of all of its product sales over time.

Dimensions

Dimensions are hierarchical entities that categorize and group fact table rows. For example, time is nearly always a dimension with a hierarchy of year, month, day, hour, minute, and second. Another dimension example is geographic location with a hierarchy of country, state, city, and zip code. A third dimension example is product with a hierarchy of product category, product subcategory, product code, and product model.

Measure and measure groups

A measure is a numeric attribute of a fact table that can be aggregated (for example, the sale amount in dollars of a transaction).

The sale amount could be summed for all the transactions in a particular day, giving the gross total sales for that day. A measure group is a specific combination of measures and dimensions.

Cubes

A cube is composed of measure groups, which, in turn, are composed of fact tables and dimensions. In order to quickly return queries from the cube, the cube also contains pre-aggregated measures from the fact tables along the related dimensions. For example, the cube might contain the total sales for each product in each city for each day. Then a query, asking for the total sales of all Bicycles sold in Seattle, WA, on January 15, 2009, could be quickly returned without having to scan through all the data and sum up the result. And a similar query requesting the same data for the entire month of January could be returned by summing up each of the (pre-aggregated) 31 days of January. This illustrates that not every possible pre-aggregation needs to be stored. Higher level aggregations can be created “on the fly” from lower level ones.

A cube can be queried efficiently by a decision maker to explore and plan new business actions. Cubes can be queried using the industry-standard MDX (Multidimensional Expressions) query language. Several products support MDX query, including Microsoft Reporting Services.

Reference database design

The Web Tracking database and application provided by Microsoft performs database mining of information captured during end-user web sessions. In this case, events that occur during the web sessions are recorded in terms of success or failure and the BI analytics are used to help reduce the failures. This section describes the profile of the data warehouse used in our testing. This data is provided here so customers can compare their database profile to the one used in testing the reference configurations listed in this paper.

Data warehouse profile

The data warehouse (DW) used in this test is 1.7 TB. It contains 26 dimension tables. The largest dimension has 77 million rows. There are 5 dimensions in the 100,000 to 300,000 row range, 3 dimensions in the 10,000 to 100,000 row range, and 3 dimensions in the 1,000 to 4,000 row range. The remaining dimensions have fewer than 1,000 rows.

There are three main fact tables. On average, about 12 dimension tables are referenced by the three fact tables. Each fact table appears in a standard star-schema configuration with the dimensions referenced. The largest fact table (row length 115) has 5 billion rows, the next largest fact table (row length 125) has 3.6 billion rows, and the third fact table (row length 95) has 2.4 billion rows, giving roughly 11 billion rows total. The fact tables are partitioned by date with a clustered index, using an integer surrogate key ($\text{key} = \text{YYYY} * 10,000 + \text{MM} * 100 + \text{DD}$), into 14 major partitions by month.

Between the three fact tables there are five non-unique, non-clustered indexes that are aligned on the same partitioning scheme as the clustered indexes. The arrangement is such that it can support the “sliding window” partition update scenario. There are 14 files, one for each of these months, so three partitions and their indexes reside in each file, one for each of the fact tables for that file’s month. The partitions (months) contain an uneven number of rows. The largest file is 190 GB and the smallest is 49 GB.

The number and size of the dimensions, along with the row lengths and number of rows given for each of the three fact tables, provides a point of reference for the volume and complexity of data processed in these reference configurations. Depending on how similar your own DW and cube definition are to this data warehouse profile, you might be able to extrapolate how your workload will perform on the reference configurations provided.

Cube design and processing

There are four measure groups. One measure group is created for each of the two largest fact tables. Two measure groups are created for the smallest fact table. The fact tables represent events. There are computed columns that define binary (0 or 1) attributes about these events (for example, success or failure). These binary attributes are counted and comprise the measures computed in the measure groups. Thus the cube provides visibility into the frequency of various outcomes related to the events. For example, the cube could support a query showing the percentage of successful events across some slice (dimension) of the fact data.

In these tests, when the cube is processed, all measure groups are processed at once. Processing the DW produced a cube approximately .58 TB in size.

Storage configuration

The XIV is extremely easy to use and provides excellent performance and data protection. When compared to conventional and previous generation storage systems, the XIV provides better value because ease of use translates into lower administrative costs, while providing equal or better performance and data protection.

XIV architecture

The ease of use and lower administrative costs come from the conceptually simple, but revolutionary XIV architecture. Each logical volume in the XIV is divided into multiple stripes of one megabyte. These stripes are distributed evenly across all disks in the system using a sophisticated pseudo-random distribution mechanism. Every data write is written simultaneously to two disks for redundancy. All you need to specify is the size of the logical volumes. The XIV architecture also makes it simple to resize volumes as the workload and storage needs change. This takes the hard work out of storage configuration.

Comparing conventional and previous generation storage systems

With conventional and previous generation storage systems, it is necessary to make many detailed decisions when configuring the storage system. Configuration choices include selecting the individual disk drives or the number of disk drives that make up a logical volume, whether or not to share disk drives between logical volumes, choosing the RAID level, choosing a preferred controller, selecting hot spare disks and the policy for their use. These decisions are made on the basis of capacity, data protection, and performance needs, which are competing objectives and thus result in making tradeoffs. After it is made, the configuration is difficult to change. This means significant time and effort must be expended up front when initially configuring the storage, and again any time the workload changes.

The time and effort required to change the configuration is even greater when large amounts of existing data must be moved. A degree of risk to the data is involved, so it is prudent to back up the data prior to reorganizing the configuration, adding to the expense of any change operation.

XIV ease of use

Creating volumes on XIV only requires specifying the size of the volume; no placement information or RAID setting is needed. Therefore, it is simple to create the volumes. Another benefit is that the volumes are available for use instantly, without any performance impact. There is no waiting time while the volumes are initialized. On conventional storage systems, it can sometimes take many hours to initialize a large volume. During this time the volume might not be available or the initialization process might affect performance.

It is also simple to grow and shrink volumes, and volume size does not affect disk performance. Again, the XIV compares favorably with conventional storage. Some conventional storage systems do not allow resizing volumes, or only allow growth, or impose a performance penalty on the volume after it is resized.

XIV performance

The XIV performed well on this cube-building workload because of the XIV architecture; all 180 1-TB disk drives were used by all data volumes, providing sufficient IOs per second and sufficient bandwidth. In the lab, the XIV performed flawlessly and was extremely easy to use.

XIV data protection

Because the XIV always writes data to two locations, the risk of data loss is much lower than RAID5, the most common data protection choice with conventional storage. Availability is better in failure scenarios because rebuild time is much longer with RAID5 than with the XIV method, which is very similar to RAID10 (mirroring).

Reference configurations

In this section, we provide the tested reference configurations, including the parameter settings used (see “Appendix” on page 14) and the overall elapsed time taken to build the cube in each configuration.

Data warehouse scaling results

In this section, we document new results based on a software optimization and two new hardware configurations. The software optimization was to change the cube building process, as follows: In the tests conducted in the previous redguides in this series, the four measure groups, which make up the cube, were processed in sequence. In the tests described in this redguide, all four measure groups were processed in parallel. This makes it harder to tune the cube-building process because all the measure groups are being processed at once. But it does result in an overall shorter elapsed time to build the entire cube.

All tests were conducted on the Data Warehouse, as described in Table 2.

Table 2 Data Warehouse specifications

Item	Specification
Data warehouse	
Size	1.7 TB 93% space used 11 billion fact rows
Cube size	.58 TB
IBM XIV Storage	
Total drives	180
DW-data	4 TB, 1.7 TB used
SQL Server TempDB data	1 TB, 0.6 TB used
SQL Server logs	500 GB, 116GB used
OLAP Cube	1 TB, .6 TB used
OLAP Temp and Log	500 GB, 115 GB used

Table 3 summarizes the two new hardware configuration results by comparing them to the Standard configuration result.

Table 3 Comparison of standard configuration with new configuration

	Standard	2-node X7500	1-node X7500
Cube Building Time	3 hours 25 minutes	2 hours 21 minutes	2 hours 48 minutes
Time % of Standard	100%	69%	82%
Server	One x3850 X5 server with: <ul style="list-style-type: none"> ▶ Four 8-core 2.26 GHz X7500 processors ▶ 64 GB memory ▶ Four Emulex FC HBA ports 	One x3850 X5 server with: <ul style="list-style-type: none"> ▶ Eight 8-core 2.26 GHz X7500 processors ▶ 128 GB memory ▶ Four Emulex FC HBA ports 	One x3850 X5 server with: <ul style="list-style-type: none"> ▶ Four 10-core 2.40 GHz E7-8800 processors ▶ 64 GB memory ▶ Four Emulex FC HBA ports

The hardware configurations are Standard, 2-node X7500 and 1-node E7-8800. The Standard configuration result is provided for comparison and only has the software optimization (in other words, processing all measure groups at once).

Scaling results

In this section, we discuss two scaling results: the 2-node X7500 result and the 1-node E7-8800 result, comparing each to the Standard (1-node X7500 configuration) result.

2-node X7500

The 2-node X7500 configuration result shows the benefit of adding a second node using Intel's QPI scaling procedure. This involves connecting two x3850 X5 chassis together with four QPI cables to form a single 8-processor server. In this configuration the memory and processors are doubled compared to the Standard configuration. When connecting the two chassis together, the Windows operating system does not need to be reinstalled. It simply

requires a reboot and the new processors and memory are available to Windows. It takes about one hour less time to build the cube than in the Standard (1-node X7500) configuration, which is a 31% improvement, as shown in Figure 4.

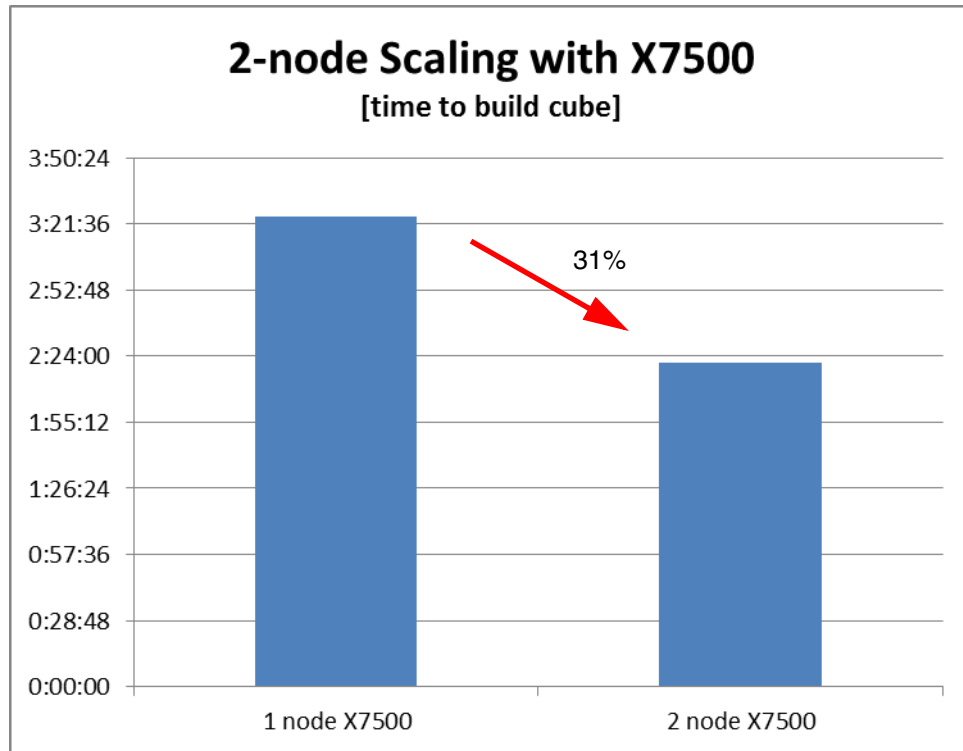


Figure 4 2-node scaling with X7500

1-node E7-8800

The 1-node E7-8800 configuration result shows the benefit of upgrading the four processors from 8-core X7500 2.26 GHz to 10-core E7-8800 2.40 GHz. This involves upgrading the eight memory cards along with the processors. The same DIMMs can be used on the upgraded memory cards. In this configuration the processors are running slightly faster than the Standard configuration and there are more cores: 40 compared to 32. Again, Windows recognizes the modified hardware after a reboot. It takes about half an hour less time to build the cube than in the Standard configuration, which is an 18% improvement, as shown in Figure 5 on page 13.

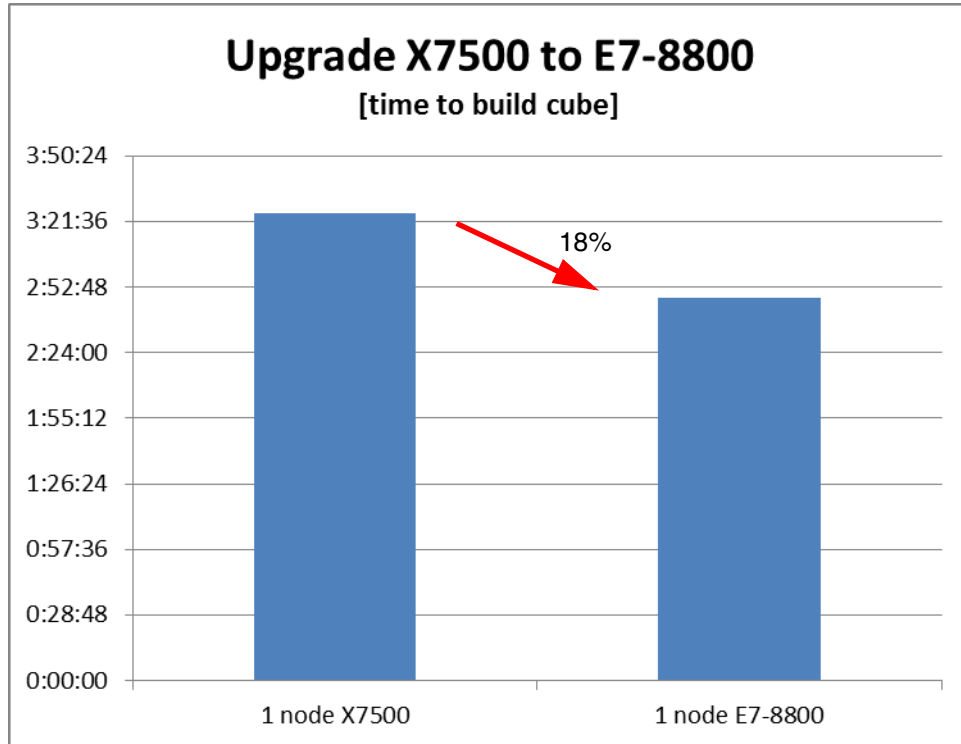


Figure 5 1-node E7-8800

Note: We will discuss two-node E7-8800-based solutions in a future paper.

Conclusion

In this paper, we described three reference configurations for the IBM Business Intelligence solutions with Microsoft SQL server. Based on our analysis, results show the configurations to be well-suited for Microsoft SQL DW and BI applications:

- ▶ These configurations show the IBM XIV Storage System provides excellent performance and ease of use for this business intelligence workload.
- ▶ Additional speed-up can be realized by implementing the 2-node X7500 configuration (31%), or by upgrading to E7-8800 processors (18%).
- ▶ Complex cube processing and querying is performed in a timely manner using the x3850 X5 server, which supports the extraction of actionable insights from a company's transactional data, the goal of business intelligence solutions.

Appendix

Hardware and specifications

The specifications were the same for all configurations, as shown in Table 4.

Table 4 Hardware specifications

Hardware	Description
Server	<ul style="list-style-type: none"> ▶ IBM System x3850 X5 with four or eight Intel Xeon X7560 8C / 2.26GHz processors ▶ IBM System x3850 X5 with four Intel Xeon E7-8800 10C / 2.40GHz processors
Server local drives: OS & SQL Server	1 RAID-1 array, 2 drives, 146 GB, 10K rpm, SFF
Memory	DDR3 10667 MHz
SAN disks	XIV 180 x 1 TB, 7200 rpm, SATA
SQL Server	Microsoft SQL Server 2008 R2 – 10.50.1600.1 (x64) Enterprise Edition (64-bit)
Windows	Windows Server 2008 R2 Enterprise Edition x64 Build 7600

Tuning parameters

Table 5 shows the tuning parameters used for the reference configurations.

Table 5 Tuning parameters

	Standard	2-node X7500	1-node X7500
Server			
Hyper Threading	ON	OFF	OFF
SQL Server			
Tempdb files	64	64	64
sp_configure: max server memory	30%	30%	30%
sp_configure: alter server configuration set process affinity numanode	0,1	0,1	2,3
sp_configure: max degree of parallelism	1	1	1
Analysis Services			
Msmdsrv.ini: ConfigurationSettings\LogDir	Y:\OLAP\Log	Y:\OLAP\Log	Y:\OLAP\Log
Msmdsrv.ini: ConfigurationSettings\TempDir	Y:\OLAP\Temp	Y:\OLAP\Temp	Y:\OLAP\Temp
Msmdsrv.ini: OLAP\Process\AggregationMemoryLimitMin	1%	1%	1%
Msmdsrv.ini: OLAP\Process\AggregationMemoryLimitMax	5%	5%	5%
Msmdsrv.ini: Memory\TotalMemoryLimit	50%	50%	50%
Msmdsrv.ini: Memory\LowMemoryLimit	30%	30%	30%
Msmdsrv.ini: Memory\PreAllocate	35%	35%	35%
Msmdsrv.ini: ThreadPool\Process\MaxThreads	640	640	640

	Standard	2-node X7500	1-node X7500
Msmdsrv.ini: ThreadPool\Query\MaxThreads	128	128	128
Create cube xmla: MaxActiveConnections	64	64	64
Process cube xmla: Parallel MaxParallel	64	64	64

Other resources for more information

Use the following resources for additional information.

- ▶ Microsoft AS performance tuning guide:
<http://sqlcat.com/whitepapers/archive/2009/02/15/the-analysis-services-2008-performance-guide.aspx>
- ▶ SQL Server books online:
<http://msdn.microsoft.com/en-us/library/ms130214.aspx>
- ▶ SQL CAT (Customer Advisory Team) Analysis Services resources:
<http://sqlcat.com/tags/Analysis+Services/default.aspx?PageIndex=1>

Acknowledgements

We would like to acknowledge the Microsoft SQL team for providing the Web Tracking DW and the associated workloads.

The author who wrote this guide

Michael Lawson is a Database and Virtualization Specialist at the IBM Center for Microsoft Technologies in Kirkland, WA. He has a Bachelor of Arts degree in Information Sciences and Mathematics from the University of California at Santa Cruz. Michael has 31 years of experience as a database administrator, the last 15 years with the Microsoft SQL Server. Since joining IBM in 1999, he has supported IBM customers running SQL Server on System x® servers, especially very large NUMA configurations. He was the principal IBM SQL Server DBA for the Sydney 2000 Olympics. He is a regular speaker at the IBM Executive Briefing Center in Kirkland, WA. He hosted a Windows Solution Lab technical engagement resulting in the largest Microsoft ERP solution in the United States. He holds the Microsoft Certified Database Administrator certification. Michael is also an author of other IBM Redbooks® publications, including *Running Microsoft SQL Server 2008 on the IBM System x3950 M2*, REDP-4476, and the four other IBM Redguides™ in this series.

Thanks to the following people for their contributions to this project:

- ▶ Vinay Kulkarni, IBM System x Performance team
- ▶ Stephen Smith, IBM Redbooks
- ▶ David Watts, IBM Redbooks

Thanks to the authors of the previous papers in this series:

- ▶ Vinay Kulkarni
- ▶ Michael Lawson

Now you can become a published author, too!

Here's an opportunity to spotlight your skills, grow your career, and become a published author—all at the same time! Join an ITSO residency project and help write a book in your area of expertise, while honing your experience using leading-edge technologies. Your efforts will help to increase product acceptance and customer satisfaction, as you expand your network of technical contacts and relationships. Residencies run from two to six weeks in length, and you can participate either in person or as a remote resident working from your home base.

Find out more about the residency program, browse the residency index, and apply online at:

ibm.com/redbooks/residencies.html

Stay connected to IBM Redbooks

- ▶ Find us on Facebook:
<http://www.facebook.com/IBMRedbooks>
- ▶ Follow us on Twitter:
<http://twitter.com/ibmredbooks>
- ▶ Look for us on LinkedIn:
<http://www.linkedin.com/groups?home=&gid=2130806>
- ▶ Explore new Redbooks publications, residencies, and workshops with the IBM Redbooks weekly newsletter:
<https://www.redbooks.ibm.com/Redbooks.nsf/subscribe?OpenForm>
- ▶ Stay current on recent Redbooks publications with RSS Feeds:
<http://www.redbooks.ibm.com/rss.html>

Notices

This information was developed for products and services offered in the U.S.A.

IBM may not offer the products, services, or features discussed in this document in other countries. Consult your local IBM representative for information on the products and services currently available in your area. Any reference to an IBM product, program, or service is not intended to state or imply that only that IBM product, program, or service may be used. Any functionally equivalent product, program, or service that does not infringe any IBM intellectual property right may be used instead. However, it is the user's responsibility to evaluate and verify the operation of any non-IBM product, program, or service.

IBM may have patents or pending patent applications covering subject matter described in this document. The furnishing of this document does not give you any license to these patents. You can send license inquiries, in writing, to:

IBM Director of Licensing, IBM Corporation, North Castle Drive, Armonk, NY 10504-1785 U.S.A.

The following paragraph does not apply to the United Kingdom or any other country where such provisions are inconsistent with local law: INTERNATIONAL BUSINESS MACHINES CORPORATION PROVIDES THIS PUBLICATION "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. Some states do not allow disclaimer of express or implied warranties in certain transactions, therefore, this statement may not apply to you.

This information could include technical inaccuracies or typographical errors. Changes are periodically made to the information herein; these changes will be incorporated in new editions of the publication. IBM may make improvements and/or changes in the product(s) and/or the program(s) described in this publication at any time without notice.

Any references in this information to non-IBM Web sites are provided for convenience only and do not in any manner serve as an endorsement of those Web sites. The materials at those Web sites are not part of the materials for this IBM product and use of those Web sites is at your own risk.

IBM may use or distribute any of the information you supply in any way it believes appropriate without incurring any obligation to you.

Information concerning non-IBM products was obtained from the suppliers of those products, their published announcements or other publicly available sources. IBM has not tested those products and cannot confirm the accuracy of performance, compatibility or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

This information contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

COPYRIGHT LICENSE:

This information contains sample application programs in source language, which illustrate programming techniques on various operating platforms. You may copy, modify, and distribute these sample programs in any form without payment to IBM, for the purposes of developing, using, marketing or distributing application programs conforming to the application programming interface for the operating platform for which the sample programs are written. These examples have not been thoroughly tested under all conditions. IBM, therefore, cannot guarantee or imply reliability, serviceability, or function of these programs.

This document, REDP-4745-00, was created or updated on April 21, 2011.




Trademarks

IBM, the IBM logo, and [ibm.com](http://www.ibm.com) are trademarks or registered trademarks of International Business Machines Corporation in the United States, other countries, or both. These and other IBM trademarked terms are marked on their first occurrence in this information with the appropriate symbol (® or ™), indicating US registered or common law trademarks owned by IBM at the time this information was published. Such trademarks may also be registered or common law trademarks in other countries. A current list of IBM trademarks is available on the Web at <http://www.ibm.com/legal/copytrade.shtml>



The following terms are trademarks of the International Business Machines Corporation in the United States, other countries, or both:

IBM®	Redguides™	System x®
Redbooks®	Redbooks (logo)  ®	XIV®
Redguide™	System Storage®	

The following terms are trademarks of other companies:

Microsoft, Windows, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.

Intel Xeon, Intel, Intel logo, Intel Inside logo, and Intel Centrino logo are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.

Other company, product, or service names may be trademarks or service marks of others.