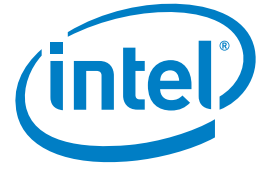


## CASE STUDY

Intel® Xeon® Processor 5500 Series  
Intel® X25-E Extreme SATA Solid-State Drive  
Enterprise Server  
Performance: Data Intensive Computing



# Same Budget, Better Performance

Intel® Xeon® processor X5560 and Intel® X25-E Extreme Solid-State Drive improve database server performance by up to 25 times at Kstudy



## CHALLENGES

- **Maximize performance on a fixed budget.** With a KRW 50 million budget for hardware upgrades, Kstudy needed to find the optimal hardware configuration to achieve its target performance.
- **Improve database response time.** To handle real-time inquiries for study records, Kstudy needed to reduce the execution time from 10 seconds to less than one second. The existing database was stored on a hard disk-based server. To be successful, Kstudy needed to significantly enhance the database server performance to support the large increase in student information queries.
- **Perform benchmark testing.** Benchmark testing was performed using two different server configurations—one hard drive-based and the other SSD-based.

## SOLUTIONS

- **Solid-state drive solution.** Kstudy considered storage area network (SAN)-based, high-speed, external hard disk storage but it discarded the idea because the cost was almost double the project's budget. Although solid-state drive (SSD) storage cost more than a hard disk-based server, Kstudy chose the approach because even with its unparalleled read/write performance, it still fit within the budget.
- **Deploy Intel® Xeon® processor with Intel® SSD.** Kstudy chose a 1U-size server equipped with two Intel® Xeon® processors X5560<sup>1</sup> and eight Intel® X25-E SATA Solid-State Drives, which were partitioned using RAID5 with hot spare method.

## IMPACT

- **Successful database server upgrade—under budget.** For only KRW 45 million, 10 percent less than its budget of KRW 50 million, Kstudy was able to afford the database server upgrade plus a voice on demand (VOD) service server.
- **Up to 25 times better performance.** Before the upgrade, processing the study record inquiries real-time took more than 10 seconds during peak traffic periods. After upgrading to the solid-state drive-based server with Intel Xeon processor X5560 series, the same process took less than 0.4 second—a performance improvement of more than 25 times.
- **Improved user experience and lower management costs.** The improved database performance allowed Kstudy to implement its high-performance student management program that reduced study management costs while providing better service to students.

# Kstudy significantly improved database server performance 25 times by utilizing Intel Xeon processor with Intel Solid-State Drives



“Choosing servers with Intel X25-E SATA Solid-State Drive and Intel Xeon processor x5560 not only improved our processing performance, it also enhanced our overall organizational efficiency and cut costs.”

*Choi Won Seok  
CEO  
Kstudy*

Kstudy—a distance-learning academic education center fully accredited by Korea’s Ministry of Education, Science and Technology—provides credit courses for social workers and childcare teachers through its credit bank system. Due to its heavy reliance on e-Learning, Kstudy needs to store and analyze, in real time, vast amounts of data ranging from students’ credit applications to their grades. More than eight million study logs and study materials are stored in Kstudy’s servers during a single 15-week semester. These stored logs are aggregated and analyzed in real time to provide complete study records to students and managers.

To get the high-speed, random read/write and CPU processing performance it needs for real-time storage and aggregation of the educational data, Kstudy chose servers with Intel® Xeon® processor X5560 and Intel® X25-E SATA Solid-State Drive.

## Improving Response Time

By 2009, Kstudy had approximately 7,000 students with most taking six to seven courses per 15-week semester. Every week, students review 12 study modules, with the related logs recorded as study records. Every year students generate about 48 million logs that are aggregated, reprocessed, and provided to students in real time.

In 2007 and 2008, when Kstudy had fewer students, problems with the study records were rare. However, by the end of 2008, Kstudy had more student records than its hard disk-based server could handle—leading to a significant delay in response time.

To solve the problem, Kstudy needed a database server upgrade. It considered several upgrade methods:

- **Implement SAN storage for performance improvement.** Because of the high cost of the storage server and network build-up—double the project budget—Kstudy quickly discarded this idea.
- **Use an SSD-based server.** This approach showed unparalleled random read/write

performance compared to a hard disk-based server, so Kstudy chose a server based on the Intel® X25-E SATA Solid-State Drive with its proven performance.

Benchmark testing was performed using two servers: one hard disk-based and the other SSD-based. Both configurations used Microsoft Windows Server 2003\* (64-bit) and Microsoft SQL Server 2005\*, 64-bit Standard Edition.

To test performance, Kstudy backed up its database and restored it in each server, and then measured the query response performance. Database query performance testing was conducted by generating the text file after capturing a real student query sent from the Web server to the database server using Microsoft SQL Server Profiler\*. Next, 500 text files were generated using 500 student IDs. Every generated text file contained about 1,200 queries—select, insert, update, and others. Using Microsoft Cscript\* on a Microsoft Windows\* server, these text files were sequentially executed up to 500 times using osql.exe in Microsoft SQL\*. The success/failure results and duration of the query files were recorded.

The test results showed that in the hard disk-based server, the overall execution time significantly slowed down from the 40<sup>th</sup> query file onwards. The execution failed from the 68<sup>th</sup> file onwards. However, using the SSD-based server, successful executions took place at up to the 240<sup>th</sup> query file. Let us assume that the performance limit value for the hard-disk based server is at the 68<sup>th</sup> query file since this is when the execution failed. In terms of performance limit value, in the hard disk-based server, it took 607.53 seconds per file up to the 68<sup>th</sup> query file. In the SSD-based server, assuming that its performance limit is at the 240<sup>th</sup> query file, it took only 13.35 seconds per file. This was an impressive 45 times faster, even in performance limit value. The test results confirmed that the random read/write performance of the Intel X25-E SATA Solid-State Drive can be superb even when it is used in the database

server. The Intel Xeon processor X5560 also contributed significantly to overall performance by driving higher I/O traffic to the SSD.

### Implementing the solution

Several weeks after the successful benchmark testing, Kstudy set up a service server. It took a week to replace the old database server and, after various stabilization tasks, the service server was put into real service.

Once in service, compared with using the existing SCSI hard disk-based HP ProLiant DL-580 G2\* server (15k rpm, RAID 1+0) as the database server, the overall Web site response time was much faster, even with an increased number of students. In numbers, the response time for accessing a study record page, which usually took more than 10 seconds, went down to just 0.4 second, a significant improvement.

Kstudy also has sales teams that recruit students. The upgrade enabled the sales teams to have an effective customer relationship management (CRM) system that could let them access files in real time. For example, all the calls to Kstudy pass through an IP-PBX. Call logs from the IP-PBX were integrated with customer information to provide real-time information about the caller such as general information, past calling history, study information, and more. Giving the customer service staff quick access to this information helped improve efficiency—meaning Kstudy could have a smaller customer service staff. In 2008, four employees supported all students and sales people. Currently, with only five people, the team is able to support more than 30,000 students and 30 sales people—double the number it supported in 2008. This is all based on using three Web servers and one SSD-based database server.

### Added benefits

Since May 2009, when the new database was implemented, results show that average processor usage of the database server has dropped from approximately 60 to 70 percent for the old system to

between five and 12 percent with the new system.

The new system has also proven to be very efficient at disaster recovery. When the new system was tested with one disk separated from eight partitioned disks using the RAID5 plus hot spare method, the hard disk-based server took more than 12 hours of RAID rebuild time. With the new server based on Intel® X25-E SATA Solid-State Drive, the RAID rebuild time was just 30 to 40 minutes. Also, since the SSD has no mechanical operating parts to fail, it should be safe from shock or vibration and have a long mean time before failure (MTBF), which a hard disk-based server cannot provide.

“Choosing servers with Intel X25-E SATA Solid-State Drive and Intel Xeon processor X5560 not only improved our processing performance,” explained Choi Won Seok, CEO of Kstudy, “it also enhanced our overall organizational efficiency and cut costs.”

### Stretching a limited budget

Without the new servers, improving the database query performance would have negatively impacted Kstudy’s enterprise productivity.

“Unlike enterprises or large portal service providers that can heavily invest in IT infrastructure for performance improvement and a reliable user experience, we had a limited budget to invest in IT infrastructure,” said Choi Won Seok. “We agonized over how to use our limited budget and resources efficiently. The server equipped with both the Intel X25-E SATA Solid-State Drive and Intel Xeon processor X5560 provides vast benefits with a small cost.”

By implementing the Intel® X25-E SATA Solid-State Drive-based server, Kstudy more than achieved its performance while maximizing its limited budget.

“The improved performance allowed us to provide new and effective customer services as well as more efficient work management,” explained Choi Won Seok, “and it gave us a strong foothold to become Korea’s best academic credit education center.”

### Future improvements

After using the new database server for 10 months, Kstudy believes its possibilities for future performance upgrades are limitless. However, there’s one shortcoming: The maximum capacity of the current Intel X25-E SATA Solid-State Drive is 64 GB. Due to the limited number of bays in the server, it will be somewhat difficult to expand capacity if the need arises in the future. To solve this, if the budget allows, Kstudy plans to implement SSD-based SAN storage for better performance and easier expansion.

#### SPOTLIGHT ON KSTUDY DISTANCE LIFELONG EDUCATION CENTER

- Kstudy Distance Lifelong Education Center (<http://www.kstudy.co.kr>) is a remote academic credit education center managed by Cybervil. Cybervil, the parent company of Kstudy, was founded in 2000 along with Kstudy Cyber Education Center.
- Over the last 10 years, it has grown into a distance-learning solution company that has provided Lecture Management Software\* (LMS\*) to several universities and also specializes in developing online learning content. Currently, about 50 people are working on managing Kstudy, supporting its students and developing new, innovative learning content and systems.
- Going forward, Kstudy’s K-LMS Version 4.0 Learning Management Platform\* and K-CRM\* Version 2.0 will be implemented in distance-learning academic credit education institutions newly accredited by the Ministry of Education, Science and Technology.

## Hardware / Software Configuration (Database Server)

PREVIOUS	MotherBoard	BIOS	BMC	FRUSDR
	ServerWorks CMIC-HE	Compaq P27	N/A	N/A
Chassis				
	DL580 G2 - Compaq Rack Mount Chasis			
SCSI HDD	Model	FW	Capacity	
	HP SCSI 15krpm 146G x 4(RAID1+0)	N/A	N/A	146GB
DDR2 Memory	Model	Type	Capacity	
	DDR2 ECC SDRAM 1GB x 8 = 8GB	Samsung M3 12L2828E0	PC2100	1GB
LAN	Model			
	Intel® PRO/1000 MT Dual Port Server Adapter			
Operating System	Model			
	Microsoft Windows 2003 Enterprise x86 Edt.			
NEW	MotherBoard	BIOS	BMC	FRUSDR
	Intel 5520 Chipset	48	49	22
Chassis				
	SR1625UR			
SSD	Model	FW	Capacity	
	Intel X25-E	SSDSA2SH064G1GC	8850	64GB
DDR3 Memory	Model	Type	Capacity	
	DDR3 1333 2GB x 4 = 8GB	DDR3 1333 Sockets		2GB
LAN	Model			
	Intel® PRO/1000 EB Network Connection			
Operating System	Model			
	Microsoft Windows 2003 Enterprise x64 Edt.			

Find a solution that is right for your organization. Contact your Intel representative or visit the Reference Room at [www.intel.com/references](http://www.intel.com/references)

<sup>1</sup>64-bit Intel® Xeon® processors with Intel® EM64T requires a computer system with a processor, chipset, BIOS, OS, device drivers and applications enabled for Intel EM64T. Processor will not operate (including 32-bit operation) without an Intel EM64T-enabled BIOS. Performance will vary depending on your hardware and software configurations. Intel EM64T-enabled OS, BIOS, device drivers and applications may not be available. Check with your vendor for more information. Performance will vary depending on the specific hardware and software you use. See most up to date benchmarks at <http://www.intel.com/products/benchmarks/server/index.htm> for detailed information.

Performance will vary depending on your configuration. Contact your vendor for more information.

This document and the information given are for the convenience of Intel's customer base and are provided "AS IS" WITH NO WARRANTIES WHATSOEVER, EXPRESS OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. Receipt or possession of this document does not grant any license to any of the intellectual property described, displayed, or contained herein. Intel products are not intended for use in medical, life-saving, life-sustaining, critical control, or safety systems, or in nuclear facility applications.

Performance tests and ratings are measured using specific computer systems and/or components and reflect the approximate performance of Intel products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance. Intel may make changes to specifications, product descriptions and plans at any time, without notice.

Copyright © 2010 Intel Corporation. All rights reserved. Intel, the Intel logo, Xeon and the Xeon logo are trademarks or registered trademarks of Intel Corporation in the United States and other countries.

\*Other names and brands may be claimed as the property of others.

0510/JAY/XIC/XX/PDF

323907-001US