OCZ enterprise

Case Study

Cartal-Rijsbergen Automotive Improves SQL Server Performance and I/O Database Access with OCZ's PCIe-based ZD-XL SQL Accelerator

ZD-XL SQL Accelerator Significantly Boosts Data Warehousing, Data Mining and OLTP Applications Delivering 4.5 Times Improved Performance over HDD SAN Storage

Scott Harlin

CARTAL AUTOMOTIVE   RIJSBERGEN AUTOMOTIVE

OCZ Technology Group

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1 Objectives and Results

User Objectives

- Reduce/eliminate disk I/O storage bottlenecks
- Improve SQL Server database performance
- Accelerate access to stored SQL Server data

Return on Investment (ROI)

- Improved SQL Server database performance by over 450%
- Improved SQL Server data throughput by 150%

2 Introduction

Cartal-Rijsbergen Automotive (CRA) has been active in the Netherlands for many years as a leading provider of automotive parts, equipment, tires, tools and accessories supporting such customers as garages, mechanics, dealers, specialists, custom fitters, rebuilders, fleet owners, insurance agencies, etc. With headquarters in Amsterdam, 18 sales locations throughout Holland (and growing), and two large central warehouses, CRA has earned a competitive advantage of wide product availability and fast delivery that has resulted in high customer satisfaction, brand loyalty and significant return business.

Supporting this after-market business is an IT infrastructure that features a Microsoft SQL Server platform for such critical database applications as data warehousing, data mining and OnLine Transaction Processing (OLTP). In its introductory stage of implementation a few years ago, this environment sufficed the needs of CRA and its customers, but as more products were added to the

data warehouse, and more data analysis was required to improve business decisions, and more orders were secured, data traffic increased considerably and disk I/O performance became taxed and challenged.

In mid-2013, the IT department initiated an infrastructure assessment to evaluate its hard drive-based storage area network (SAN) and find the best way to overcome their SQL Server performance bottlenecks. This included an evaluation of solid-state drives (SSDs) that use NAND flash memory to store data, and with no moving mechanical heads like hard disk drives (HDDs), handle random data access with ease to deliver I/O performance comparable to a large SAN array with hundreds of HDDs implemented.

As part of the assessment process, CRA conducted its own internet research and found PCI Express (PCIe) SSDs as a viable storage option to improve database performance, and with a compact card format (half-height or full-height) that fits directly into a server's PCIe bus, not only improves power efficiency but delivers more than 40 times faster speed than SAS or SATA cabling interfaces. Through this research, CRA became familiar with a solution from storage leader OCZ Technology designed specifically for SQL Server platforms. After extensive testing, CRA's IT team would select this solution and deploy it into their production SQL Server environment.

This case study outlines how Cartal-Rijsbergen Automotive's IT team addressed the storage challenges it faced by upgrading its storage infrastructure with improved capabilities that deliver optimized flash caching so that data is right, relevant and readily available to SQL Server when the application needs it. OCZ's tightly integrated plug-and-play ZD-XL SQL Accelerator solution provides accelerated access to SQL Server data and once deployed into the CRA enterprise, significantly improved database performance while reducing data center costs.

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3 Key SQL Server Databases

To be successful in a very competitive automotive after-market business requires a high-performance IT infrastructure that can heighten the customer's online shopping experience, deliver the most accurate real-time product information, and discover data usage patterns and relationships that help enable good business decisions. With these requirements, Cartal-Rijsbergen Automotive implemented a Microsoft SQL Server RDMS as part of its initial enterprise infrastructure that provides multi-user access to a number of the databases developed by CRA in support of data warehousing, data mining and OLTP applications.

Data Warehousing	OLTP	Data Mining
Provides CRA sales locations and customers with the most accurate, online information of its product portfolio	Facilitates and manages all online transactions whether they originate from a CRA sales location or directly from the customer	Sorts through CRA's data to find undiscovered usage patterns and relationships, and through analysis, can help CRA make good business decisions

CRA utilizes a SQL Server-based data warehouse of its product portfolio covering automotive parts, equipment, tires, tools and accessories that includes a few hundred thousand products and a few million records. The data warehouse provides CRA sales locations and customers with up-to-date online information on product pricing, assortment, stock availability, specifications, features, benefits, warranties, rebates, discounts, etc. The accuracy of this information and the ability to deliver it in real-time can be the difference in securing customer orders and providing a heightened user experience.

In conjunction with the data warehouse, CRA implemented OLTP databases to facilitate and manage all online transactions whether they originate from a CRA sales location or directly from the customer. These databases capture information surrounding a sale and enable the data to be segmented, grouped, stored and retrieved for a specific use-case or analysed as business intelligence (BI). Data captured includes customer contact information, products ordered and sales prices, shipping and routing information, method of payment, applied warranties/rebates /discounts, sales history, sales location and any number of other variables available through the sales order process.

Though data warehousing and OLTP are critical transactional applications, CRA implements data mining to sort through SQL Server data and find undiscovered usage patterns and relationships that help them make more informed business decisions. The business intelligence obtained from data mining has enabled CRA in the analysis of sales, products, shipping and routing, sales territories, Enterprise Resource Planning (ERP), forecasting and financial projections, to name a few.

So, all encompassing, the CRA enterprise includes six key SQL Server databases that support data warehousing, data mining and OLTP applications, with the largest data warehousing database approximately 200GB in size. With millions of database records captured, excessive combinations of product inquiries, online purchases, data analysis and/or real-time data warehouse modifications adversely affected CRA's HDD-based SAN resulting in system strain and non-optimal SQL Server performance requiring an improvement in read/write performance.

4 Infrastructure Issues

The solution, OCZ's ZD-XL SQL Accelerator, was introduced at the Interop Show in May 2013 and won the coveted Best of Interop award in the Data Center & Storage category.

The Cartal-Rijsbergen Automotive SQL Server system configuration included a Dell PowerEdge R-820 server with RAID 5 capabilities, a Dell NX-3100 networked attached storage (NAS) device and a Dell EqualLogic SAN Array with 8 HDDs included.

While the PowerEdge server is capable of handling hundreds of thousands of input/output operations per second (IOPS), each HDD in the SAN Array can only deliver a few hundred IOPS of performance. As a result, the HDDs cannot keep up with SQL Server demands even if more HDDs were added to CRA's system configuration. As multiple SQL Server workloads run concurrently in the Cartal-Rijsbergen Automotive enterprise, strong random access is necessary to accelerate I/O and is the shortcoming of HDDs as they require their mechanical heads to move from location to location, limiting each drive's physical ability to quickly read or write random data. IOPS performance and latency are slowed until data is found and accessed.

Given these performance challenges, Cartal-Rijsbergen Automotive's IT department monitored and assessed SQL Server performance daily in its enterprise and ran industry standard read and write IOPS tests that they have used over time as their proven testing process. Through these benchmark tests, it was determined that an upgrade of the storage media would be necessary to improve access and retrieval of data stored within SQL Server applications.

5 The ZD-XL SQL Accelerator Solution

With the mantra of solving its database performance challenges, CRA evaluated potential PCIe-based SSD solutions and identified a new offering designed specifically to accelerate SQL Server applications. The solution, OCZ's ZD-XL SQL Accelerator, was introduced at the Interop Show in May 2013 and won the coveted Best of Interop award in the Data Center & Storage category. Cartal-Rijsbergen Automotive's IT department contacted OCZ and proceeded to test the solution in their environment.

ZD-XL SQL Accelerator provides optimized and efficient flash acceleration for SQL Server applications through tightly integrated hardware and software elements. It delivers lightning fast flash speed, a unique cache mechanism that makes advanced and statistically-optimized decisions on what data to cache,

and implementation wizards that enable database administrators to set-up caching policies and flash resources that guide them through a plug-and-play installation.

During their evaluation, CRA's IT department created a test platform to replicate its production SQL Server environment and utilized a comparable test server with RAID 5 functionality to drive it. What they would discover during this initial deployment stage was an intuitive graphical user interface (GUI) within ZD-XL SQL Accelerator that guided them through best practice models of the available flash-based resources enabling them to easily deploy it into their SQL Server test environment.

Once deployed into the test environment, CRA ran ZD-XL SQL Accelerator through a number of tests and queries as if it was deployed in a production SQL Server environment and discovered a unique capability. It can partition its flash volumes so that tempDB data files can benefit from high flash performance while hot database data can be cached on flash locally for immediate use by SQL Server. The result enabled all CRA SQL Server data types to be optimized and accelerated.

6 Innovative Flash Caching

ZD-XL SQL Accelerator partitions the flash resource pool into two parts – one that is used for flash caching while the other is used as a flash volume for tempDB files. This unique flash caching developed by OCZ employs advanced SQL Server policy-based algorithms and optimized 'application-specific' caching policies, and through OCZ's innovative Direct Pass Caching Technology (see Figure 1), provided CRA's IT team with advanced, statistically-optimized decisions on what data to store in cache while achieving high hit ratios.

Figure 1: OCZ's innovative ZD-XL SQL Accelerator Direct Pass Caching Technology
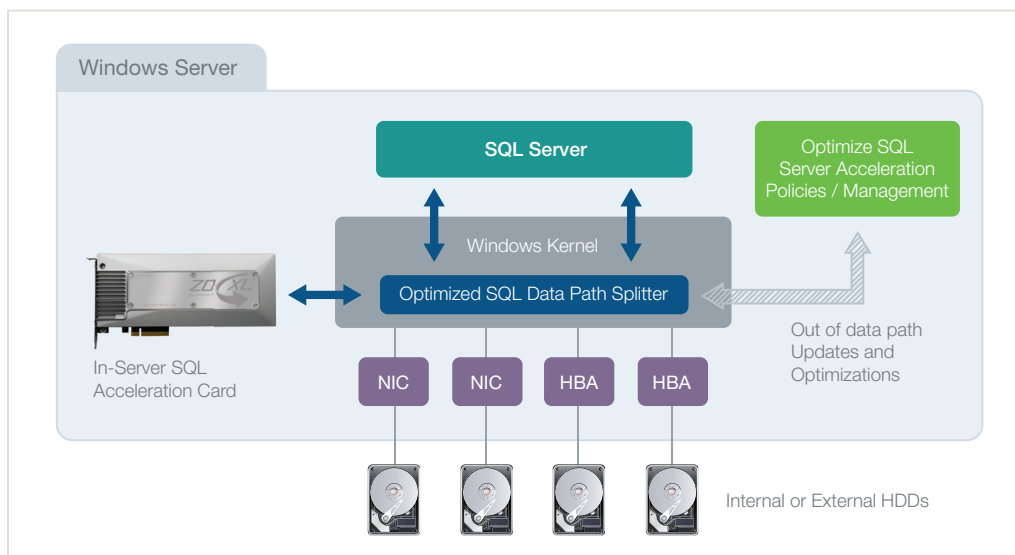
This is achieved through a cache director that differentiates between relevant and irrelevant data access patterns and filters out background processing tasks to prevent irrelevant data from entering the cache. It dynamically sends data access metadata to the cache analysis engine which then performs deep statistical

ZD-XL SQL Accelerator partitions the flash resource pool into two parts – one that is used for flash caching while the other is used as a flash volume for tempDB files.

'out-of-band' analysis without interfering with the data path itself. The cache analysis engine then dynamically directs the optimized selection rules back to the data path cache director so it knows what hot zones need to be inserted into flash cache. This highly advanced 'decision engine' is able to efficiently select what CRA data to place in ZD-XL SQL Accelerator's flash cache without needing to perform cycle-consuming analysis in the data path itself.

Of all the features and capabilities available in ZD-XL SQL Accelerator, CRA deemed the Direct Pass Caching Technology as the most important to accelerate SQL Server performance.

7 TempDB Flash Volumes

Efficiently placing transient calculation tables, such as tempDB files, on server-side flash volumes was another important capability that ZD-XL SQL Accelerator provided CRA to improve SQL Server performance. It achieves this by exposing part of its flash storage capacity as a volume for tempDB usage while simultaneously exposing other portions of its flash volume for use as a hot data cache as discussed in the previous section and depicted in Figure 2.
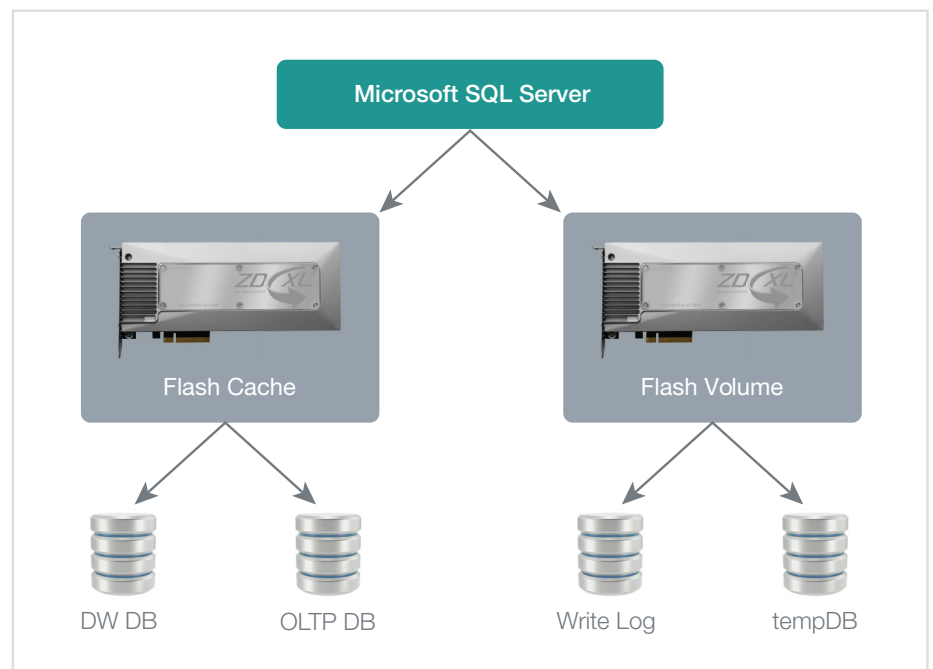

Figure 2: ZD-XL SQL Accelerator exposes its flash volume for tempDB usage and for use as a hot data cache

By exposing its SSD flash volumes on-host locally in the CRA environment, ZD-XL SQL Accelerator efficiently distributes the random database workloads in parallel between all available flash. With write-intensive write log and tempDB files typically 2GB in size or less, storing these data types directly on ZD-XL SQL Accelerator flash volumes enabled CRA to take advantage of high flash performance.

The test results yielded over a 450% improvement in read/write performance when compared to the non-accelerated HDDs.

CRA's data warehouse databases are a good example representing the need for server-side flash volumes as these workloads consume large amounts of the 98GB of available RAM that CRA has secured to address results from intermediate user queries. In many cases, when SQL Server does not have enough RAM available, the queries automatically spill into a tempDB. When tempDB resides on a remote SAN array, these redirections caused a drop in database performance.

The ability for ZD-XL SQL Accelerator to partition flash volumes provided CRA the best of both worlds -- an optimized solution where the write log and tempDB data files benefit from high flash performance while hot areas of the database are flash cached for immediate use by SQL Server.

8 Testing and Implementation

CRA's IT department created a test platform to replicate its production SQL Server environment and utilized a comparable test server with RAID 5 functionality to drive it. Once deployed in the test environment, CRA ran ZD-XL SQL Accelerator through a number of tests they have run in the past to assess SQL Server performance. The test environment was a scaled down version of the actual CRA infrastructure and included the following:

- Test Server replicates Dell PowerEdge (includes two E5620 @ 4 GHz CPUs)
- Dell NX-3100 NAS
- Dell EqualLogic SAN Array
- Eight 10k rpm HDDs
- ZD-XL SQL Accelerator 800GB, Full-Height
- Windows Server Enterprise 2008 (64-bit)
- SQL Server 2012

Cartal-Rijsbergen Automotive ran their SQL Server database performance tests and compared these results to the HDD SAN environment with 8 HDDs connected. This included 200GB database sizes representing a typical data warehouse usage scenario. The test results yielded over a 450% improvement in read/write performance when compared to the non-accelerated HDDs. SQL Server data throughput also improved from 80 MB/s to 200 MB/s representing a 150% improvement.

One set of tests conducted by Cartal-Rijsbergen Automotive compared the read and write IOPS performance of OCZ's ZD-XL SQL Accelerator versus their hard drive array as follows:

Drive Type	Read IOPS	Improvement	Write IOPS	Improvement
Dell EqualLogic SAN (8-10k rpm)	5,500 IOPS		5,500 IOPS	
ZD-XL SQL Accelerator (800 GB)	30,000 IOPS	455%	30,000 IOPS	455%

Another set of tests conducted by Cartal-Rijsbergen Automotive compared SQL Server data throughput of OCZ's ZD-XL SQL Accelerator versus their hard drive array as follows:

Drive Type	Read Throughput	Improvement	Write Throughput	Improvement
Dell EqualLogic SAN (8-10k rpm)	80 MB/s		80 MB/s	
ZD-XL SQL Accelerator (800 GB)	200 MB/s	150%	200 MB/s	150%

In the CRA production environment, the improved ZD-XL SQL Accelerator performance led to a dramatic reduction in the time it took to perform key queries, in some cases, from 2.5 hours down to 45 minutes.

9 Conclusion

The combination of more and more products being added to its data warehouse, more data analysis to improve business intelligence, and more transactions being processed, data traffic within Cartal-Rijsbergen Automotive's SQL Server environment increased significantly causing disk I/O bottlenecks and system performance limitations. The SQL Server database indexes did not scale very well using conventional HDDs and adding hard drives to the SAN configuration would have potentially driven up TCO in the CRA enterprise increasing SAN purchases, power and cooling consumption, as well as maintenance, service and deployment costs.

The storage challenges that Cartal-Rijsbergen Automotive faced required solid-state capabilities to enable flash caching and improve data access to SQL Server applications. A further benefit of ZD-XL SQL Accelerator to CRA is its unique ability to partition its flash volumes so that tempDB data files can benefit from high flash performance while hot database data can be cached

locally for immediate use by SQL Server. This technological innovation enabled all SQL Server data types to be optimized and accelerated improving database performance four to five times over the previous HDD configuration.

ZD-XL SQL Accelerator vs. 8 HDD SAN Array
- Write IOPS performance improved 450%
- Data throughput improved 150%

"As we upgraded our IT infrastructure to support 18 stores with real-time, online connectivity throughout the Netherlands, we needed to make sure that our SQL Server database did not become a bottleneck. By deploying the ZD-XL SQL Accelerator in our database servers, we reduced the runtime of key jobs from 2.5 hours to 45 minutes, without replacing our SAN. Along with the performance benefits, the simple implementation wizards allowed us to easily migrate from our test environment to deployment in our production systems."

*- **Lars Ketting***
ICT for Cartal Rijsbergen Automotive

Scott Harlin is the Director of Marketing Communications of Enterprise Solutions for OCZ Technology, a leading provider of high-performance solid-state storage solutions for enterprise and personal computing applications.

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