White Paper

EMC XTREMCACHE ACCELERATES ORACLE

EMC XtremSF, EMC XtremCache, EMC Symmetrix VMAX and VMAX 10K, Oracle Database 11*g*

- XtremSF and XtremCache dramatically improve Oracle performance

- Symmetrix VMAX and VMAX 10K protects data

EMC Solutions Group

Abstract

This white paper describes the testing of EMC XtremSF and XtremCache with EMC Symmetrix VMAX to accelerate online transaction processing (OLTP) performance in an Oracle Database 11*g* R2 environment. Though the testing was performed on Symmetrix VMAX 40K, the capabilities and benefits of XtremCache are applicable to Symmetrix VMAX 10K.

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Table of contents

Executive Summary

Business case

In an increasingly competitive environment, businesses are being driven to optimize business processes and to improve service, while lowering IT costs. Meeting these new requirements has become critical to the financial success of many companies. Consequently, operational and revenue-generating applications are experiencing dramatic demands on performance, driven by:

- Growth in the numbers of active users

- Time-critical applications and escalating service-level agreements

- Increased complexity of business processes and new analytic workloads

- Multiple databases with high concurrent access

Businesses need to consider new approaches to performance challenges in order to meet these demands cost-effectively and without sacrificing data protection.

The storage performance challenge

The latest servers with multi-core processors represent a potential performance bottleneck for the storage subsystem. As processing capacity and heavier workloads are added, the storage system is challenged to keep pace with the growing I/O demands. While CPU performance improves 100-fold every decade, magnetic disk remains relatively flat, as shown in Figure 1.
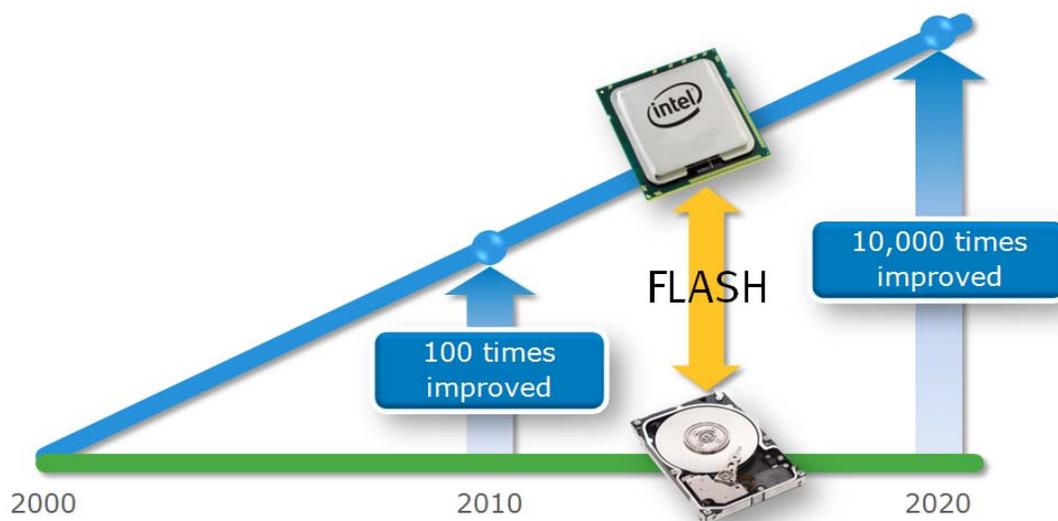

Figure 1.   CPU performance versus disk drives

In a traditional architecture, as shown in Figure 2:

- Reads and writes are serviced by the storage array

- Performance varies depending on the back-end array's media, workload, and network
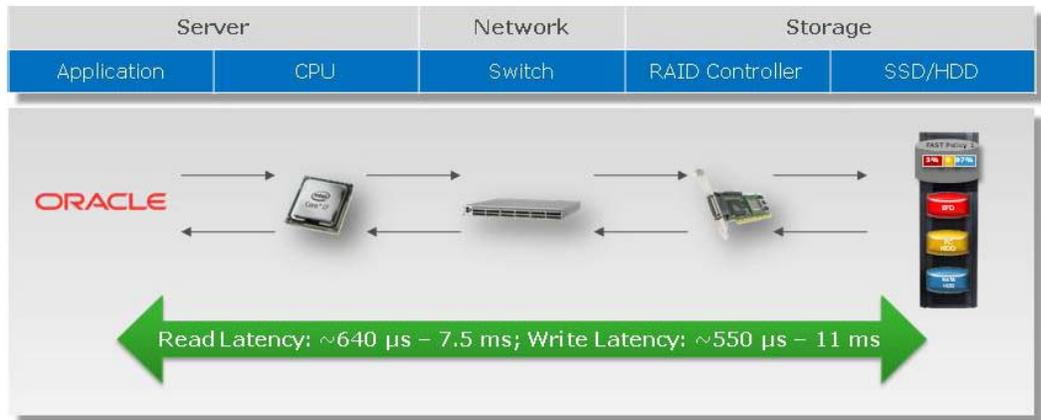
Figure 2. **Traditional architecture**

What if you could double your application performance by decreasing latency and increasing IOPS and transactions per minute?

The XtremCache solution

EMC XtremCache™ is server flash caching software that uses EMC XtremSF™ server-based PCIe flash technology to reduce latency and increase throughput, which dramatically improves application performance.

XtremCache brings Flash memory performance into the server. The "hottest" data automatically resides on XtremSF in the server, providing significantly faster access. The caching optimization within XtremCache automatically adapts to changing workloads by determining which data is most frequently referenced and promoting it to the server flash cache.

XtremCache enhances both virtualized and physical applications so you can smoothly migrate your data center to a private cloud at a pace that makes sense for your business.

XtremCache protects data by using a write-through algorithm, which means that writes persist to the back-end storage array. EMC® trusted networked storage, such as EMC Symmetrix VMAX™ and EMC VNX™ family of storage arrays, protect data with advanced data services, which include high availability, data integrity, reliability, and disaster recovery, as shown in Figure 3.
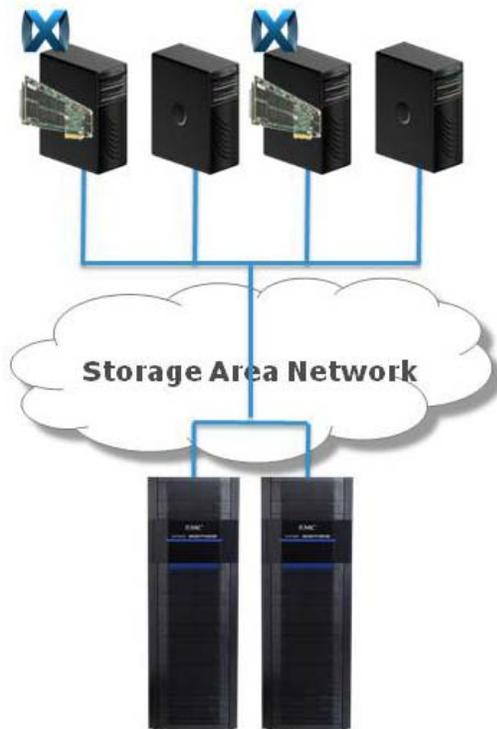
Figure 3. **XtremCache accelerates I/O performance within the server**

XtremCache is transparent to applications. When XtremCache is present, applications do not have to be rewritten, recertified, or retested.

As shown in Figure 4, XtremCache dramatically accelerates the performance of read-intensive applications:

- Reads are serviced by XtremCache for performance
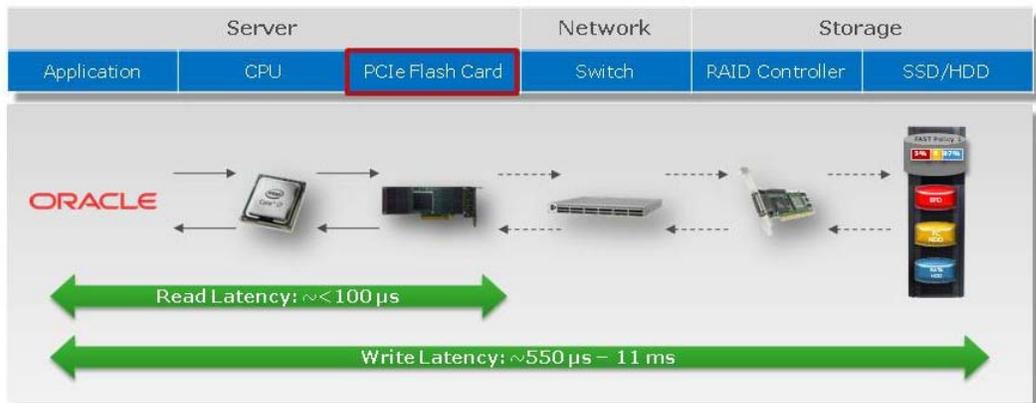- Writes are passed through to the storage array for protection

Figure 4. **Advanced architecture with EMC XtremCache**

While this white paper focuses on Oracle Database 11g, the XtremCache architecture can directly enhance the performance of many other applications and indirectly enhance write-intensive applications that now have greater access to SAN resources.

XtremCache software caches the most frequently used data on the server-based PCIe card, thereby putting the data closer to the application. By operating in the server on the PCIe bus, XtremCache reduces the need to access data across the network from the storage array. This decreases response time and increases performance.

XtremCache provides better performance for the applications that involve heavy read I/O. In one of the tests, XtremCache demonstrated read throughput improvements of 210 percent and reductions in read latency by as much as 60 percent. XtremCache works with applications as diverse as databases, analytics, enterprise application servers, email, and web servers to give them the performance boost they need.

XtremCache offloads much of the read I/O traffic from the storage array, which allows it to allocate greater processing power to other applications. While one application is accelerated with XtremCache, the array's performance for other applications is maintained or even slightly enhanced. As XtremCache is installed on more servers in the environment, the result is a highly scalable I/O processing model. The environment as a whole, including the servers and the storage system, is capable of processing increasingly more IOPS.

For more information about EMC XtremCache, see the *Introduction to EMC XtremCache* White Paper.

Stale data

Even with Oracle non-RAC databases, you have to be cautious about two possible scenarios that can leave stale data in the XtremCache:

- **Using storage array snapshots:** A LUN that is restored from an earlier snapshot without the knowledge of XtremCache software on the server can potentially leave stale blocks in XtremCache.

- **Migrating between servers:** If the database instance was migrated to a different server for operational reasons and relocated back to the original server without the knowledge of XtremCache, this can also result in stale blocks in the cache.

To avoid either of these situations, you should purge the cache prior to restoring the LUNs from snapshot or moving the database between servers. There is no need to purge the entire cache; you can choose to purge only the LUNs that are affected by the operation.
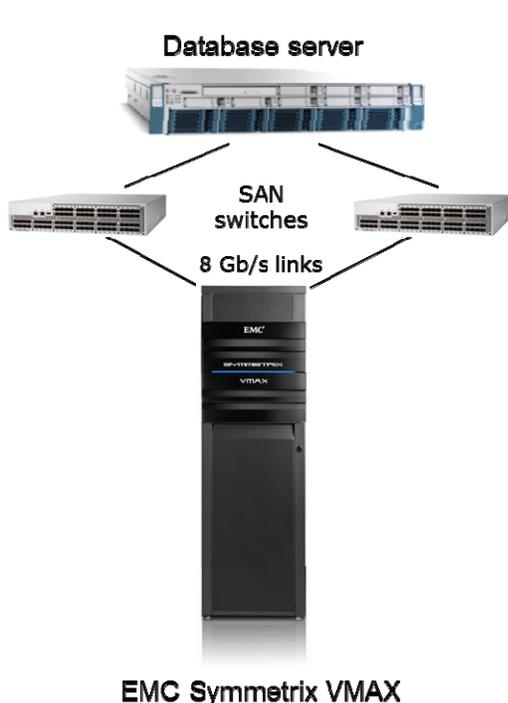
Solution architecture

Introduction   This section provides an overview of the physical architecture of this solution.

Physical architecture   Figure 5 shows the physical architecture for this solution.

Database server platform
- Cisco UCS C-250 server with 12 cores
- XtremSF & XtremCache
- Red Hat Enterprise Linux 5
- VMware vSphere 5

Oracle Database platform
- Oracle Database 11*g* R2
- ASM volume management

EMC Symmetrix VMAX SE
- Single-engine Symmetrix VMAX
- Storage pool for data
- Storage pool for logs

Figure 5.   EMC XtremCache with Oracle Database and EMC Symmetrix VMAX

The solution architecture consists of an Oracle Database, Cisco server, and a Symmetrix VMAX storage array. The solution can be configured with a number of storage arrays, such as Symmetrix VMAX 10K or VNX. In this solution, we used Symmetrix VMAX 40K. The server used for this test configuration was a Cisco UCS C-460 rack-mount server with four Xeon processors. The server configuration included the XtremSF PCIe flash hardware, XtremCache software, and two 8 Gb/s connections to the SAN switches.

EMC Symmetrix VMAX   EMC Symmetrix VMAX storage arrays provide high performance and scalability for demanding enterprise storage environments. Built on the strategy of simple, intelligent, modular storage, the VMAX incorporates a highly scalable Virtual Matrix Architecture™ that enables it to grow seamlessly and cost-effectively from an entry-level configuration into the world's largest storage system. The VMAX supports Flash drives, SAS drives, Fibre Channel (FC) drives, and SATA drives within a single array, as well as an extensive range of RAID types.

XtremCache technology with Oracle Database: testing and validation

Introduction
EMC tested the capabilities of XtremCache to accelerate online transaction processing (OLTP) performance in an Oracle Database 11g R2 non-RAC environment. This section presents the results of the testing.

Note
Benchmark results are highly dependent upon workload, specific application requirements, and system design and implementation. Relative system performance will vary because of these and other factors. Therefore, this workload should not be used as a substitute for a specific customer application benchmark when critical capacity planning and/or product evaluation decisions are contemplated.

Workload profile
Our testing employed an OLTP workload with a 1.2 TB database and a 70-30 percent read/write mix. We took a performance baseline to validate the performance characteristics of the environment. We enabled XtremCache and then took measurements of transactions per minute, application-level transaction latency, and Oracle I/O wait times to demonstrate the performance contribution of XtremCache to the application.

This 1.2 TB database had approximately 250 GB of hot data.

Recommended configuration
XtremCache is enabled on all of the data LUNs. However, XtremCache was not enabled on the log LUNs because they are dominated by writes.

No specific tuning was required for Oracle Database.

With this configuration, XtremCache uses its caching algorithms to automatically maintain a copy of the hottest data for immediate access.

Performance characteristics
Figure 6 compares the overall system throughput (transactions per minute) of the baseline and XtremCache-enabled environments. Tests were run in various configurations that had different complements of storage and application configurations. The availability of the hot data in the servers can provide XtremCache results in the 40 to 210 percent improvement range, as shown in Figure 6.
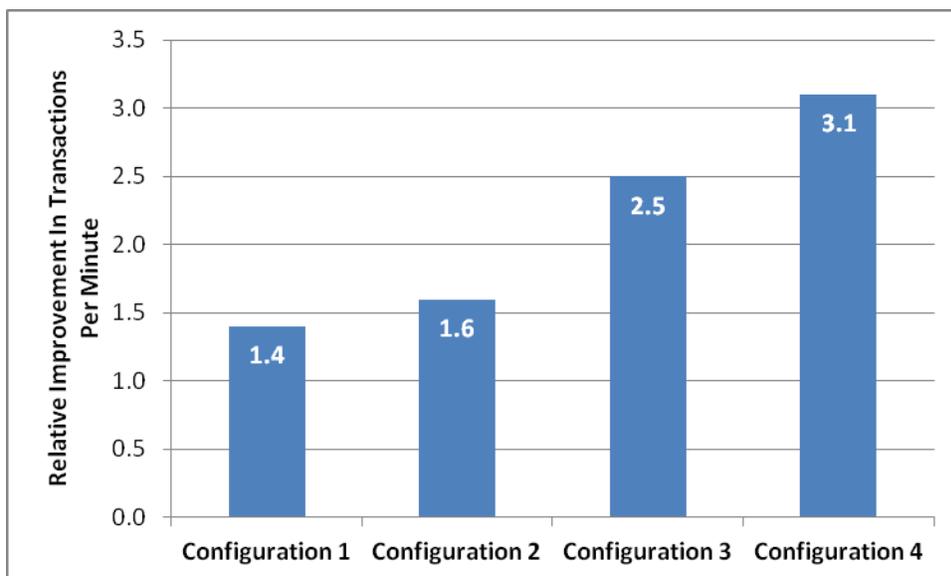
Figure 6. Relative OLTP transactions per minute (TPM) improvement

The throughput performance improvement is a result of a dramatic reduction in read latency, as shown in Figure 7.
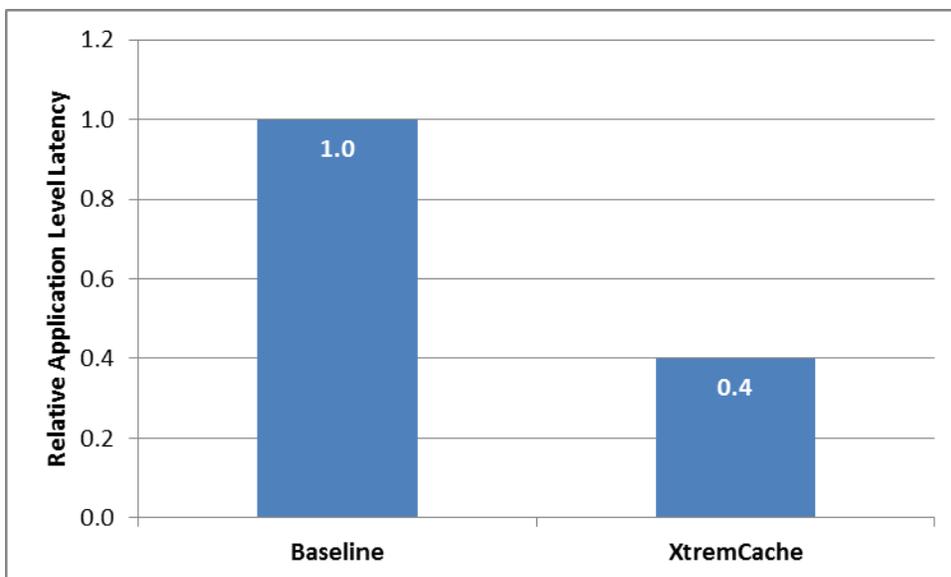

Figure 7. Relative application-level latency improvement

XtremCache copies and stores the hottest read data on XtremSF within the server. This data can be repeatedly read by the application without sending the I/O request to the back-end storage. In a workload with a 70-30 percent read/write mix, this resulted in an overall average transaction latency decrease of 60 percent.

The effect of servicing read requests from XtremCache can be seen in the distribution of wait times, as shown in Figure 8. In the baseline results, approximately 60 percent of requests are serviced within one millisecond (ms).

By servicing hot data read requests from XtremCache, we observed a 50 percent increase in the number of requests that are serviced within 1 ms or less.
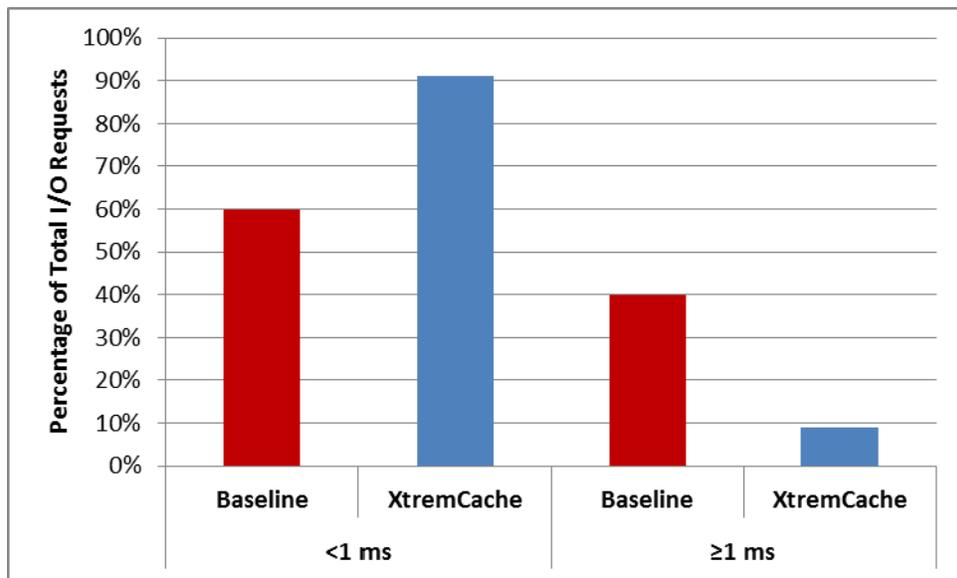
Figure 8.   **XtremCache impact on Oracle I/O wait events**

Conclusion

Our testing in an Oracle OLTP workload compared a system equipped with XtremCache against a baseline configuration without XtremCache. The XtremCache-equipped server demonstrated the following performance advantages:

- System throughput, measured in transactions per minute, was up to 3.1 times the throughput of the baseline with the configuration and test cases that were used.

- Overall transaction latency was up to 60 percent less than the baseline.

- Fifty percent more I/O requests were serviced within 1 ms or less.

References

White papers   For additional information, see the white papers listed below:

- *Introduction to EMC XtremCache*

- *EMC XtremCache Accelerates Virtualized Oracle—EMC XtremSF, EMC XtremCache, EMC Symmetrix VMAX and VMAX 10K, VMware vSphere, Oracle Database 11g*

- *EMC XtremCache Accelerates Microsoft SQL Server—EMC XtremSF, EMC XtremCache, EMC VNX, Microsoft SQL Server 2008*

- *EMC XtremCache Accelerates Oracle—EMC XtremSF, EMC XtremCache, EMC VNX, Oracle Database 11g*

Product documentation   For additional information, see the product documents listed below:

- *EMC XtremCache* Data Sheet

- *EMC Symmetrix VMAX Data Storage System* Specification Sheet