CONSOLIDATING ORACLE® OLTP WORKLOADS WITH XTREMIO

Abstract
This Reference Architecture explains the benefits of employing the always-on Inline Data Reduction and copy services of EMC’s XtremIO All-Flash Array in consolidating Oracle production environments with instant, on-demand QA and Test/Development instances. This paper showcases XtremIO’s consistent performance and scalability in such consolidated environments.

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Executive Summary

The quantity of data that is processed and stored in modern enterprises has been growing exponentially, often through the sprawl of database instances for production and non-production purposes. On top of this unmanageable explosion in data usage, companies are expected to be agile and to adapt to these circumstances without impacting the bottom line. IT infrastructures require efficient management while simultaneously controlling their costs, and yet, must be able to continue delivering extraordinary levels of application performance.

Databases are widely adopted in the enterprise, as they have become the foundation of all business systems. The proliferation of databases has led to some inefficient practices which further contribute to the database sprawl. For example, it is quite common to create multiple copies of a database that is being used in production for other applications (such as analytics and reporting), or to test and develop new versions of applications to use the same data. This increases storage sprawl and the associated capital and management costs. Far worse, the agility of the operational workflow is unnecessarily limited. These separate silos and the overhead incurred by brute-force copies, usually means that dev/test and analytics teams never receive as many copies as they want nor as frequently as they want them. Finally, many secondary copies are stored on tier-2 or tier-3 storage environments, with sub-par performance that hinders their objectives.

The EMC XtremIO All-Flash Storage Array, with its powerful always-on Inline Data Reduction and space-efficient in-memory copy services, solves this problem by consolidating databases without any capacity or performance SLA penalties and by providing the service levels that can be expected from an all-flash platform.

XtremIO’s Storage Array has the benefit of increasing CPU utilization on the database server platforms, and thus reducing inefficiencies and allowing for fewer servers. Reducing capital expenditure and operating expenses are among the major factors driving enterprises to consolidate their database servers onto EMC XtremIO Storage Arrays. As the XtremIO infrastructure can now be centrally managed as a consolidated infrastructure for all instances, database storage sprawl can be eliminated. Most importantly, database and application administrators gain dramatic agility benefits, with instant on-demand, full-performance copies for real-time analytics, on-demand reporting, and accelerated dev/test capability. This Reference Architecture demonstrates the underlying performance consistency and the ability to meet all SLAs in such mixed production and non-production consolidated environments.
Audience
This Reference Architecture is intended for the following audiences:

- Enterprise and database architects
- Database and storage administrators
- Anyone interested in Oracle® performance and agile data management

Introduction

This Reference Architecture has two objectives. Firstly, it demonstrates the storage efficiency that can be gained when Oracle databases are consolidated on EMC XtremIO Storage Array scale-out clusters. These storage efficiencies are not forfeited for sub-optimal performance, for neither application response time nor IOPS and bandwidth. The second objective of this Reference Architecture is to demonstrate the performance of OLTP-like SLOB®† workloads executing on a single-instance Oracle database (as opposed to Oracle RAC) hosted on Intel servers, and a single XtremIO Storage Array. This database is the primary database, meant to simulate an actual production database. Exact duplicate copies of this database are then created from it. The duplicate copies represent the actual copies of production data existent in enterprise database environments.

This paper presents performance results of running SLOB against the duplicate copies of the primary database. The results presented herein conclusively demonstrate that customers can expect parity in performance between the primary database and any of the duplicate copies (clones). The primary and all copies of the database can also collectively enjoy the full performance of the entire array. This Reference Architecture also provides guidance to enterprise architects responsible for database sizing, in order to evaluate and compare the performance of OLTP (online transaction processing) workloads in their specific environment against a standardized SLOB workload running on an EMC XtremIO All Flash Array.

OLTP applications dominate the enterprise application landscape and are in the critical path of all revenue-generating activities. The I/O profiles of such workloads can introduce high levels of stress on the underlying infrastructure (both compute and storage) as it tries to keep up with the IOPS demand, or maintain low latencies.

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*Oracle is the trademark or registered trademark of the Oracle Corporation.
Background on OLTP Workloads

Online transaction processing (OLTP) systems are among the most common data processing systems in today's enterprises. Classical examples of OLTP systems are order entry, retail sales, and financial transaction systems. OLTP workloads are primarily characterized by the following characteristics:

- Short response times
- Small transactions

While each transaction is small, it updates several database tables. OLTP workloads are intrinsically parallel, and database systems employ multiple servers to process client transactions. OLTP database systems typically service hundreds or thousands of concurrent users. The OLTP database transactions performed by the thousands of concurrent users become translated into tens of thousands of I/O requests to the backend storage subsystem (depending on the nature of the OLTP transactions). The database host CPUs may only be efficiently utilized if the storage subsystem is capable of servicing very low latency I/O requests. In a high-latency storage environment, hosts suffer large IOwait* times instead of enjoying good throughput.

* IOwait is the CPU 'waiting time' for an I/O operation to complete.
Reference Architecture Diagram

Figure 1: Fabric Diagram

Hardware
Testing for this Reference Architecture was performed on two industry-standard Intel servers (with two 10 core Intel E5-2690 3.0GHz CPUs, and 320 GB of RAM). Each Intel server was equipped with a single dual-ported Emulex LPe 16002 Gen5 HBAs which was attached via a Brocade Gen5 16GFC SAN to a single X-Brick Array.

Software
Specific configurations and customizations made to the Oracle database for the tests are documented in the companion white paper titled XtremIO Performance and Data Services for Oracle. The significant configuration settings are detailed as follows:

- Oracle 12c Release 1 (12.1.0.2.0) for Linux x86-64.
- Archive log mode; disabled.
- Three Redo log groups, each 30Gb in size. The Redo logs created by DBCA were dropped and new logs were created (in order to enable the new Redo logs to be configured with a 4KB block size).
- Oracle database initialization parameters:
  - *.sga_target=0 (turns off ASMM)
  - *.db_cache_size=2g (size determined to be just right to achieve a 50/50 SGA cache hit/cache miss ratio)
  - _db_block_prefetch_limit = 0
  - _db_block_prefetch_quota = 0
  - _db_file_noncontig_mblock_read_count = 0
Testing Methodology

The testing methodology for this Reference Architecture was comprised of a series of tests on either the primary Oracle database or a copy of the primary database. Testing was performed using the SLOB toolkit to generate I/O through the database. A performance baseline was established by running SLOB against the primary Oracle database. Since subsequent tests comprised of running SLOB on copies of this Oracle database, the Oracle database used was labeled as the primary database. Performance was also characterized on copies of the primary database.

Copies were created by the following two methods:

- Using Oracle's CloneDB functionality (based off of RMAN\(^\ast\)) to backup and restore a copy of the primary database.
- Using XtremIO snapshots to create an instant, full-performance writeable copy of the original LUN. This is fully space-efficient, as only new unique compressed blocks are written.

Once the baseline performance characteristics were established (by using the primary datasets), subsequent tests were run on copies of the primary databases. These tests help to simulate the consolidation of Oracle workloads on the EMC XtremIO Storage Array. In summary; there were four separate tests conducted to characterize the performance of Oracle OLTP workloads on XtremIO, as follows:

1. Running SLOB against just the primary copy of the Oracle database
2. Running SLOB against just a copy of the primary database created by CloneDB.
3. Running SLOB against just a copy of the primary database created from snapshot(s) of the LUN(s) on which the primary database resides.
4. Running SLOB against the primary database as well as its copies, created by both CloneDB and by XtremIO snapshots.

\(^\ast\) Oracle Recovery Manager
**SLOB**

SLOB is a testing tool that uses SQL in an Oracle database to generate maximum physical I/O while utilizing the least possible amount of host CPU. The tool tests either CPU and memory (logical I/Os) or storage (physical I/O), depending on the amount of memory allocated to the SGA buffer pool. SLOB uses index range scans and accesses table blocks via fetch by ROWID. The SLOB tool is ideally suited to assess Oracle random physical I/O capability on a given storage platform in preparation for OLTP/ERP style workloads.

SLOB supports testing:

- Oracle logical read (SGA buffer gets) scaling
- Physical random single-block reads (db file sequential read)
- Random single block writes (DBWR flushing capacity)
- Variable levels of REDO logging

**SLOB Testing**

For each of the four tests described above, the I/O workload was increased by increasing the number of users until the optimal performance level was reached.

Optimal performance corresponds to the highest IOPS achieved before the latency exceeds 1 millisecond. The latency was measured both at the storage subsystem level and in the application stack. Storage latency is calculated from the time the I/O operation is received by the SCSI stack in the XtremIO Storage Controllers until the response is subsequently sent out. The application stack latency was measured as the response times for single block read processes, as well as the main Oracle background processes. The single block Read processes were spawned by the SLOB users.

The pertinent Oracle background processes are the Database Writer Process (DBWR) and the Log Writer Process (LGWR). DBWR is an Oracle background process that is responsible for buffer cache management. LGWR is the Log Writer Process that writes redo log buffers to redo log files on disk. The response times of each of these processes is a measure of the latencies experienced by the application.

Whereas the charts in the following sections depict the storage latency, the application latency was also monitored. The companion white paper titled *XtremIO Performance and Data Services for Oracle* documents the application latencies that were measured during each of the tests.
Storage Efficiency in Oracle Database Environments

An Oracle database stores tables and indexes in tablespaces. Tablespaces, in turn, consist of datafiles. When a datafile is added to a tablespace, the Oracle database initializes each data block with a unique header and tail structure that is universally unique to the database. Hence, there are no duplicate blocks in a single Oracle database. However, it would be naïve to presume that data reduction benefits only manifest themselves from the data that comprises a database. A common database environment practice is to create multiple copies of the same database. Oracle offers guidelines and procedures on how to create such copies (see items 3 and 4 in References and More Information, on page 24). These copies of the same database enjoy maximum deduplication, which potentially leads to great storage efficiencies without the need to sacrifice performance on XtremIO.

Database Sprawl

The main motivation behind cloning Oracle databases is the need to create a duplicate database which is a separate database that contains all (or a subset) of the data in the source database. These duplicate databases can then be used for a variety of purposes within the enterprise including reporting, ETL for analytics, and development and test processes.

Creating multiple copies of the Oracle database that is being used in production is a common practice in enterprise Oracle environments. According to a 2013 Enterprise Data Performance Survey by the Independent Oracle Users Group, an overwhelming majority (96%) of respondents had more than one copy of their production database, while more than half of the respondents (53%) had between three to ten copies of their production data held in non-production databases (see item 2 in References and More Information, on page 24).

There are several reasons for duplicating production databases. Some of the important use cases are:

- **Reporting Environments:**
  Many reporting tools require Read (and sometime Write) access to the primary database.

- **QA Environments:**
  Test the effect of applications on database performance. Effective integration and performance testing requires recent copies of the production data.

- **Development Environments:**
  Developers need access to the production copy of the data for effective unit testing, and to develop new features and functionality into applications.
• Test Backup and Recovery Procedures:
  For example, the production database is duplicated from one host to another. The
duplicate copy of the database is then used to practice restoring and recovering
this database while the production database operates as usual.

• Environment Management:
The duplicate database can be used to test an upgrade to a new release of the
Oracle database software. New versions of build scripts can be tested against the
production data.

• Data Recovery:
  Export data, such as a table that was inadvertently dropped from the production
database and imported back into the production database.

• Training Environments:
  Many applications require a training version. Occasionally, such training versions
become wiped or are used for integration testing.

As previously mentioned, two different mechanisms can duplicate or clone the
production database:

1. Using tools such as RMAN to backup image copies of the production database
   and then restoring the image copies.

2. Using the XtremIO’s volume snapshot feature to create a point-in-time copy of the
   volume (LUN) or group of volumes (LUNs) on which the production database is
   stored.

Note: RMAN backups can be created in one of two formats: either as image copies or
as backup sets. A backup set stores one or more files in an RMAN-specific format.
Consequently, the backup data pattern on disk differs from the original database
pattern, and does not deduplicate. An image copy (as the name suggests) is a bit-for-
bit duplicate of a database file, identical to a copy made with an operating system
copy command. This is why "image copies" deduplicate perfectly with the original
database files. Additionally, some customers choose the backup set format because
RMAN can skip some datafile blocks not currently containing data, thus reducing the
size of backup sets. However, as the image copies deduplicate so well on the XtremIO
Array, the smaller size of backup sets no longer provides an advantage.

Both of the above options have unique advantages. Customers have the choice of
using the mechanism that is most appropriate in their specific infrastructure. The
following section illustrates the expected savings when using the "RMAN backup to
image copy" approach for deploying Oracle database clones. The advantages of using
XtremIO’s snapshot-based approach are also presented.
**An Illustrative Example of Data Reduction Benefits**

The following figures demonstrate the capacity savings to be gained by having multiple copies of the same database on an XtremIO Storage Array. Figure 2 shows two databases that are initially created on the XtremIO Array. These are the primary databases. The workflow illustrates the distinct deduplication and compression ratios that are achieved after backing up, as well as restoring the primary databases, using RMAN. The specific details of the configuration are documented in the white paper titled *XtremIO Performance and Data Services for Oracle databases*.

Figure 2 shows the logical and physical capacity consumed when two 1TB SLOB databases are provisioned on a single X-Brick cluster. These constitute the primary copies of "production" databases. Note the Deduplication ratio of 1:1.

<table>
<thead>
<tr>
<th>Storage</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Efficiency</td>
<td>10:1</td>
</tr>
<tr>
<td>Data Reduction Ratio</td>
<td>3.9:1</td>
</tr>
<tr>
<td>Deduplication</td>
<td>1:1</td>
</tr>
<tr>
<td>Compression</td>
<td>3.8:1</td>
</tr>
<tr>
<td>Thin Provisioning Saving</td>
<td>60%</td>
</tr>
</tbody>
</table>

**Figure 2: Two 1TB SLOB DBs Provisioned on Single X-Brick Cluster**
Figure 3 shows Oracle Recovery Manager (RMAN) using image copies to back up the two primary databases. The deduplication ratio increases to 2.0:1, as the original database and the copies both reside on the XtremIO Storage Array.

<table>
<thead>
<tr>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Efficiency</td>
</tr>
<tr>
<td>Data Reduction Ratio</td>
</tr>
<tr>
<td>Deduplication</td>
</tr>
<tr>
<td>Compression</td>
</tr>
<tr>
<td>Thin Provisioning Saving</td>
</tr>
<tr>
<td>Volume Capacity</td>
</tr>
<tr>
<td>Physical Capacity</td>
</tr>
</tbody>
</table>

Figure 4 shows the RMAN image copies used to create replicas, or clones, of the source databases. As there are now three copies of the primary database (the original, the backup copy, and finally, the clone), created by restoring the RMAN image copy, the deduplication ratio is 2.9:1.

<table>
<thead>
<tr>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Efficiency</td>
</tr>
<tr>
<td>Data Reduction Ratio</td>
</tr>
<tr>
<td>Deduplication</td>
</tr>
<tr>
<td>Compression</td>
</tr>
<tr>
<td>Thin Provisioning Saving</td>
</tr>
<tr>
<td>Volume Capacity</td>
</tr>
<tr>
<td>Physical Capacity</td>
</tr>
</tbody>
</table>

Figure 4: RMAN Image Copies Used for Replicas/Clones of Source DBs
Duplicating Oracle Databases from XtremIO Snapshots

Deploying Oracle databases using XtremIO’s point-in-time snapshots is extremely fast and efficient. All meta-data operations occur in memory and consume no capacity. Figure 5 depicts XtremIO’s Dashboard after two additional clones of the primary databases are created from snapshots. There is no material change in the deduplication ratio, as the snapshot volumes are based on pointers to the original blocks of data, and not actual blocks that were duplicated by a copy tool (such as RMAN). Even so, the space savings are real because the snapshots represent the capacity that does not need to be provisioned. This is illustrated on the Dashboard, noting that the Thin Provisioning Savings have now increased from 20% to 36%.

Figure 5: Clones Created from Snapshots
Advantages of XtremIO Snapshots

There are several reasons for using XtremIO Storage Array snapshot features for creating copies of production databases:

- Cloning databases using tools such as Oracle RMAN image copy can typically be time consuming. Alternatively, a point-in-time copy of the database can be created much faster by using snapshots instead of a complete physical copy, as a snapshot is typically created within a few seconds.

- The capacity required to store the copy (or copies) of the production database can be expensive. Maximizing the return on hardware is an important business concern. XtremIO’s unique architecture ensures that creating a point-in-time copy takes up no space on the array.

- Different groups have different requirements. In most enterprise environments, the Development, QA and Reporting divisions have different needs requiring different environments. If multiple projects run concurrently, there is a need for even more environments.

Performance Profile of a Single X-Brick Array

The results from running the suite of tests are presented below. The I/O profile of typical OLTP systems are dynamic in nature, but can be considered as heavily dominated by Reads. Conventionally, a 70:30 Read/Write ratio is assumed for OLTP workloads. However, practically speaking, these Reads may be anywhere from 90% to 70% of the I/O mix. This is so because Oracle database cannot modify data that is not stored in the main memory (for example, the SGA). Therefore, a modify transaction (such as INSERT, UPDATE or DELETE) consists of reading the block into the SGA, then modifying it, and then writing the changes to the online redo log. EMC engineers refer to this as the "Read-Modify-Log Write" I/O pattern.
Running SLOB on the Primary Database

A baseline test is run against the primary copy of the database. This establishes the performance of a single instance primary Oracle database.

Table 1: Running SLOB on the Primary Database

<table>
<thead>
<tr>
<th>SLOB Users</th>
<th>% Update</th>
<th>IOPS</th>
<th>Latency (µs)</th>
<th>AVG CPU UTIL</th>
<th>Read Ratio</th>
<th>Ave IO Block Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0</td>
<td>184089</td>
<td>897</td>
<td>85</td>
<td>100.00</td>
<td>8.0</td>
</tr>
<tr>
<td>160</td>
<td>5</td>
<td>163879</td>
<td>934</td>
<td>80</td>
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<td>130</td>
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<td>61</td>
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<tr>
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<td>71068</td>
<td>991</td>
<td>50</td>
<td>46.77</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Figure 6: Storage Performance
The results confirm that a single X-Brick accommodates between 110K IOPS and 150K IOPS operating in the typical OLTP range of from 70% to 90% Reads at sub-millisecond latencies. This is the unique consistency of response times that enables database administrators utilizing the XtremIO Storage Array to confidently size their infrastructures, regardless of physical space consumption.

**Note:** It is important to note that it is possible to achieve higher IOPS. However, this leads to higher latency times, which may be undesirable in Oracle OLTP environments. Additionally, the XtremIO Storage Array is specifically designed to scale out to meet future performance and capacity needs. The architecture of XtremIO allows its performance and capacity to be increased linearly by simply adding building blocks (X-Bricks).
Running SLOB on a Copy of the Primary DB Made via CloneDB

Table 2: Running SLOB on a Copy of the Primary Database Made via CloneDB

<table>
<thead>
<tr>
<th>SLOB Users</th>
<th>% Update</th>
<th>IOPS</th>
<th>Latency (µs)</th>
<th>AVG CPU UTIL</th>
<th>Read Ratio</th>
<th>Ave IO Block Size</th>
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<tbody>
<tr>
<td>200</td>
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</table>

Figure 7: Storage Performance (Oracle Clones)

The realized performance for the database copy (after using CloneDB) is consistent with the performance shown during testing of the lone primary database. This is an expected result. However, it is shown here to prove the concept that, the copied database is, in essence, an instantaneous mirror of the primary database with all data contained, and with immediate availability at the necessary service levels.
Running SLOB on a Copy Created via XtremIO’s Snapshot

Table 3: Running SLOB on a Copy Created via an XtremIO Snapshot

<table>
<thead>
<tr>
<th>SLOB Users</th>
<th>% Update</th>
<th>IOPS</th>
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<td>77022</td>
<td>925</td>
<td>56</td>
<td>46.75</td>
<td>8.6</td>
</tr>
</tbody>
</table>

Figure 8: Storage Performance (XtremIO Snapshots)
Again, the performance of the database created from a snapshot is consistent with that observed when testing on just the primary database. Also, in following with the natural progression of this test sequence, this is a third copy of the primary database but no additional physical capacity is consumed on the storage array.

Refer to the graphical examples shown in *An Illustrative Example of Data Reduction Benefits*, on page 12.
Running SLOB on the Primary DB as well as Copies Made via CloneDB and XtremIO Snapshots

Table 4: Running SLOB on the Primary DB as well as Copies Made via CloneDB and XtremIO Snapshots

<table>
<thead>
<tr>
<th>SLOB Users</th>
<th>% Update</th>
<th>IOPS</th>
<th>Latency (µs)</th>
<th>AVG CPU UTIL</th>
<th>Read Ratio</th>
<th>Ave IO Block Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>0</td>
<td>180965</td>
<td>911</td>
<td>85</td>
<td>99.99</td>
<td>8.0</td>
</tr>
<tr>
<td>160</td>
<td>5</td>
<td>158492</td>
<td>897</td>
<td>80</td>
<td>94.15</td>
<td>8.1</td>
</tr>
<tr>
<td>130</td>
<td>10</td>
<td>140657</td>
<td>898</td>
<td>74</td>
<td>89.42</td>
<td>8.1</td>
</tr>
<tr>
<td>90</td>
<td>25</td>
<td>115619</td>
<td>967</td>
<td>68</td>
<td>76.71</td>
<td>8.2</td>
</tr>
<tr>
<td>80</td>
<td>30</td>
<td>109457</td>
<td>953</td>
<td>66</td>
<td>75.37</td>
<td>8.3</td>
</tr>
<tr>
<td>64</td>
<td>50</td>
<td>98125</td>
<td>1036</td>
<td>64</td>
<td>64.36</td>
<td>8.4</td>
</tr>
<tr>
<td>44</td>
<td>100</td>
<td>81037</td>
<td>1117</td>
<td>59</td>
<td>47.36</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Figure 9: Storage Performance (Combined)
Table 4 and Figure 9 show the performance results when SLOB is used to generate load on the primary database, as well as its copies created via CloneDB and via XtremIO snapshots. As expected, the performance is consistent with that observed with just the primary database.

To reiterate, the preceding sections' charts show that for a typical OLTP range (with 10% to 30% Writes), a single X-Brick is capable of supporting between 110K IOPS and 150K IOPS, while maintaining consistent sub-millisecond latency. Although the storage CPU usage is well under 70% at the IOPS levels shown, the test did not attempt to continue increasing the load due to the testing criteria of keeping latency at sub-millisecond level. If sub-millisecond latency is not a requirement, additional test should be performed to measure the maximum IOPS performance of the storage.
Conclusion

The XtremIO All-Flash Storage Array uniquely demonstrates the consistent IOPS and low latency performance for production, non-production, and consolidated combinations of the database copies.

The performance remains consistent regardless of whether the copies are made via Oracle’s CloneDB or via XtremIO’s space-efficient snapshots. Therefore, it is easy to have multiple copies of a database being serviced by several database servers and application servers – and maintain all service levels demanded from the storage system – when operating within the scale-out performance window of the XtremIO Storage Array. There is no capacity penalty for such copies, and therefore database administrators can create as many copies as needed, as frequently as needed.

This unique combination of scale-out consistent performance, aligned with XtremIO’s data reduction and copy services, finally enables database consolidation across production and non-production instances on centralized shared storage. This is achieved without risking performance service levels, while dramatically improving workflow agility and lowering infrastructure and licensing costs.

As illustrated in Figure 10, the performance profile of a single X-Brick cluster shows that it can deliver anything from 110K IOPS up to 150K IOPS within the OLTP I/O profile range. The performance scales such that two X-Bricks supply between 220K IOPS and 300K IOPS, and four X-Bricks supply between 440K IOPS and 600K IOPS within the OLTP range. The end-to-end latency can be expected to remain constant in the one millisecond range.

Figure 10: Expected IOPS (within the OLTP Range)
The XtremIO All-Flash Storage Array Storage System is well-suited for running OLTP workloads. Furthermore, consolidating copies of production OLTP databases offers the benefits of an all-flash array to different use cases, while lowering the total cost of ownership. XtremIO’s All-Flash Storage Array has the capacity to meet the demanding and disparate needs of these varied database workloads encountered in the typical enterprise environment.

References and More Information

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4. Cloning Oracle Databases section: Oracle Enterprise Manager Lifecycle Management Administrators guide 12c Release 4 (12.1.0.4)
5. XtremIO Performance and Data Services for Oracle Databases
6. Introduction to the EMC XtremIO All-Flash Array
7. Introduction to XtremIO Snapshots

For Case Studies, Solution Guides, Demos, and other Reference Architectures, go to www.XtremIO.com.