ESG Lab Review

Vblock Specialized Systems For High Performance Databases

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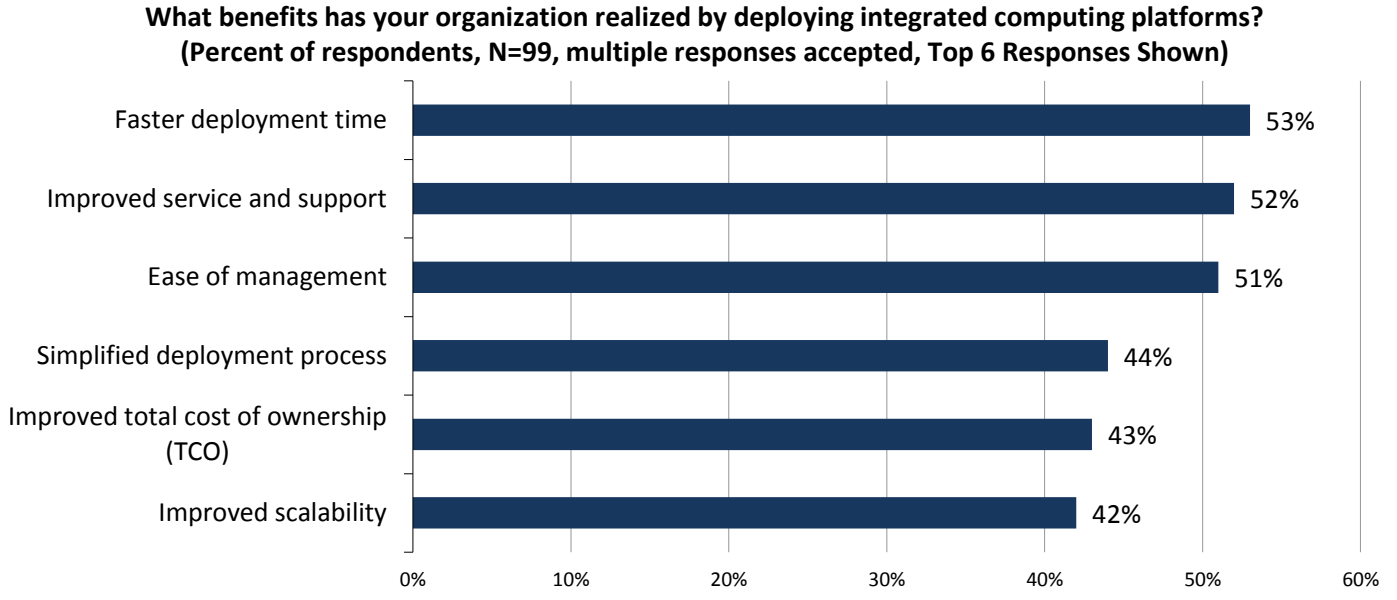
Abstract: *This ESG Lab review documents hands-on testing of the Vblock Specialized Systems for High Performance Databases with EMC VNX storage focusing on high performance in an Oracle 11g RAC Release 2 environment.*

The Challenges

Databases only perform as well as the systems they run on. Designing a system to power a true high performance database requires design choices that offer extreme performance, interoperability, and specific knowledge of tuning parameters that help streamline the operation of the database. The engineering resources and expertise required to design such a system are not generally available to all organizations. This drives many organizations to turn to specialized consulting services to help them piece together a high performing database system using high-end specialized components from various hardware vendors.

The Enterprise Strategy Group (ESG) uses the term "Integrated computing platform," or ICP, to refer to a converged platform that combines servers, storage, network connectivity, and (in some cases) software in a single integrated solution. ICPs have proven to save businesses countless hours designing, configuring, and testing servers, networks, and storage subsystems. ESG research respondents indicated that faster deployment times, improved service and support, and improved total cost of ownership (TCO) are some of the benefits that ICPs offer their organizations (see Figure 1).[1]

Figure 1. Top Six Benefits Of Integrated Computing Platforms (ICPs)



Source: Enterprise Strategy Group, 2014.

[1] Source: ESG Research Report, *Trends in Private Cloud Infrastructure*, March 2014.

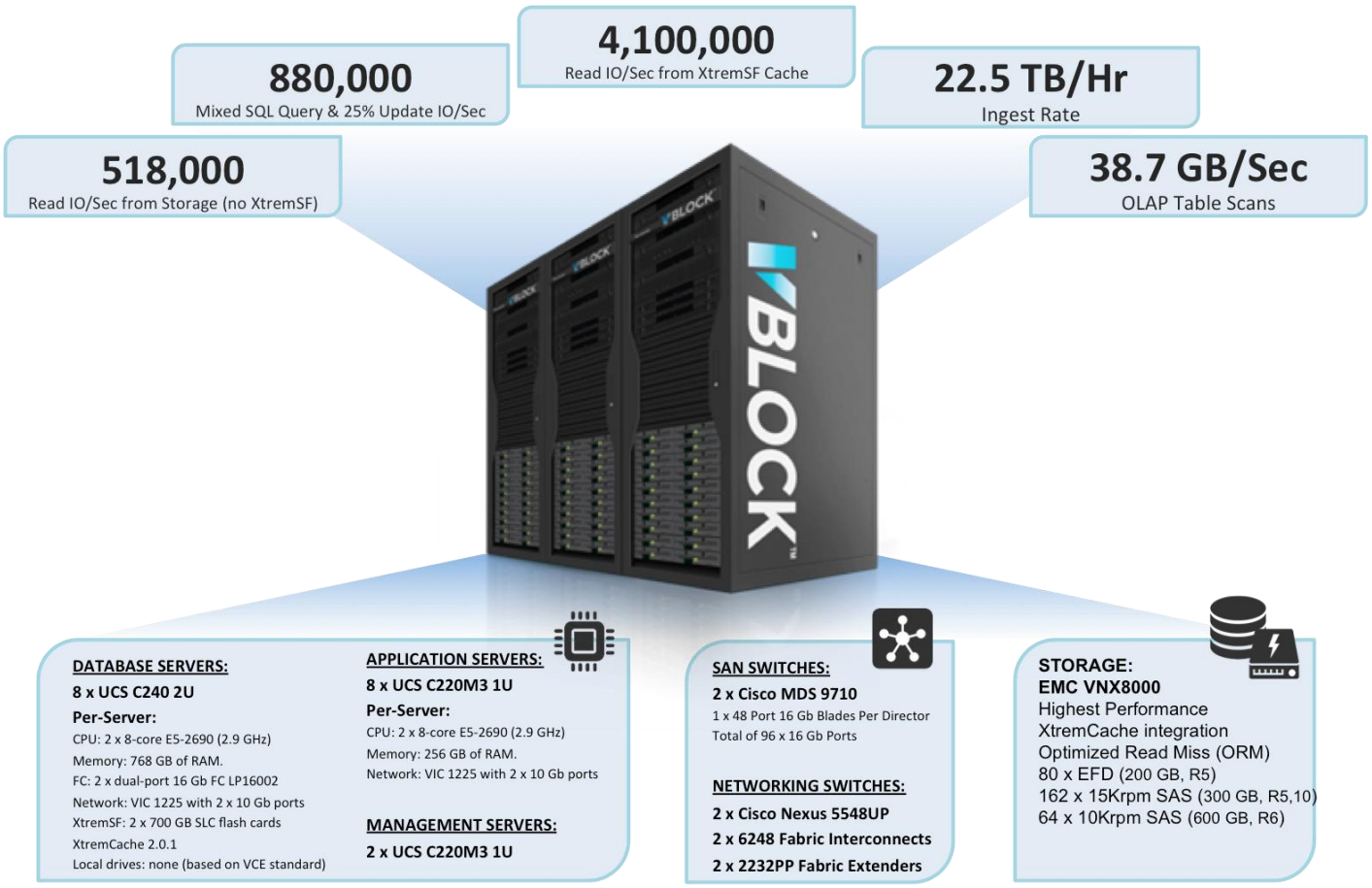
The Solution: Vblock Specialized Systems For High Performance Databases

The VCE Vblock System is a well-known and extensively deployed converged infrastructure platform that combines best-of-breed technologies from VMware, Cisco, and EMC into a powerful integrated computing platform. The new Vblock Specialized Systems for High Performance Databases (VSS HPDB) are designed as a simple solution to the most demanding transactional and response-time-sensitive databases required by today's businesses.

Like all Vblock Systems, the VSS HPDB are comprised of compute (database, application, and management servers from Cisco), network (cutting-edge, three-layer network and SAN technologies from Cisco), and storage (EMC storage arrays and EMC XtremSF flash adapters in servers). This report presents the results of Oracle 11g RAC performance testing with a goal of highlighting how the EMC VNX models can cost-effectively maximize infrastructure efficiency and performance and reduce Oracle licensing costs. The high performance results that are summarized in Figure 2 are enabled by a combination of technologies, including:

- EMC VNX storage with a mix of flash, performance, and capacity drives optimized with FAST-VP autotiering.
- Enterprise-class 10 Gb Ethernet and 16 Gb FC networking with Cisco Director Class Switches.
- Server-based dual PCIe EMC XtremSF cards along with EMC XtremCache software.
- Cisco UCS database servers with maximized memory and processing power.
- Optional consolidation of VMware virtualized workloads with Oracle and other database workloads.

Figure 2. Vblock Specialized Systems For High Performance Databases



Getting Started

The ESG Lab review began with a tour of the cutting-edge VCE facility in which new Vblock Specialized Systems for High Performance Databases (VSS HPDB) are built, configured, and tested prior to being shipped to the customer. The facility was laid out in a highly efficient manner that made use of patented processes to speed production, ensure quality, eliminate configuration errors, and label/document all system connections. The entire process was designed to save customers months of work and bring their databases to production as quickly as possible. In some cases, specialized software installations can occur on site.

Flexibility With EMC VNX Storage

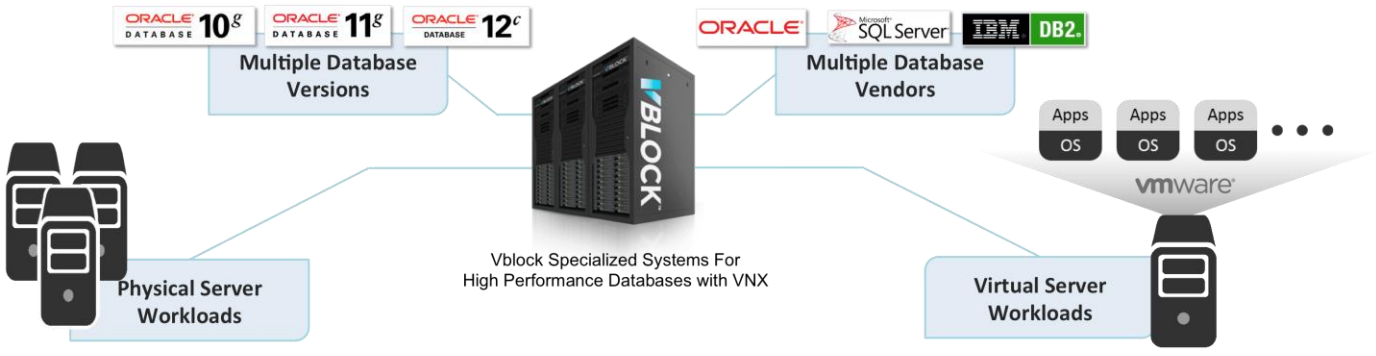
ESG Lab next took a closer look at the Vblock Specialized Systems for High Performance Databases configured with EMC VNX storage. The VSS HPDB is an ideal solution for organizations looking to balance the simplicity and deployment benefits of the VCE architecture with the modular scalability and flexibility of EMC VNX storage. The VSS HPDB with VNX can be configured with a right-sized mix of servers, networking, and VNX storage processor nodes to match the needs of nearly any database application. The VSS HPDB tested by ESG was configured with eight Cisco UCS server nodes and an EMC VNX8000 storage array.

Each of the Cisco UCS servers was equipped with a pair of EMC PCIe attached flash adapters with EMC XtremCache software that includes a unique Oracle RAC integration feature that discovers the Oracle grid infrastructure and takes advantage of Distributed Cache (DCACHE) mode. In DCACHE mode, the XtremCache can synchronize written blocks of data in server cache to all other Oracle RAC nodes.

The EMC VNX8000 storage system leverages MCx (Multi-Core) technology to optimize storage processing power and caching performance, and FAST Cache and FAST-VP to get the most from flash technologies. The powerful EMC VNX storage processors eliminate the need to purchase and power dozens of storage servers while providing industry-leading storage features and functionality. The mirrored write cache and advanced flash technologies offer higher performance and reduce the amount of flash that must be maintained to ensure high availability for writes versus a distributed storage server approach.

The performance potential of the VSS HPDB with EMC VNX also makes it perfect for use as a consolidation platform. It can be used to consolidate multiple Oracle databases, even if they are deployed on different Oracle RDBMS versions. This not only minimizes Oracle software licensing costs but also redeployment costs because scripts and applications do not need to be modified prior to deployment. The VSS HPDB can consolidate multiple database platforms, can be used to consolidate database and virtualized application workloads, and can run production, test, and development copies of databases simultaneously. Figure 3 summarizes the workloads that can be deployed and consolidated on the VSS HPDB.

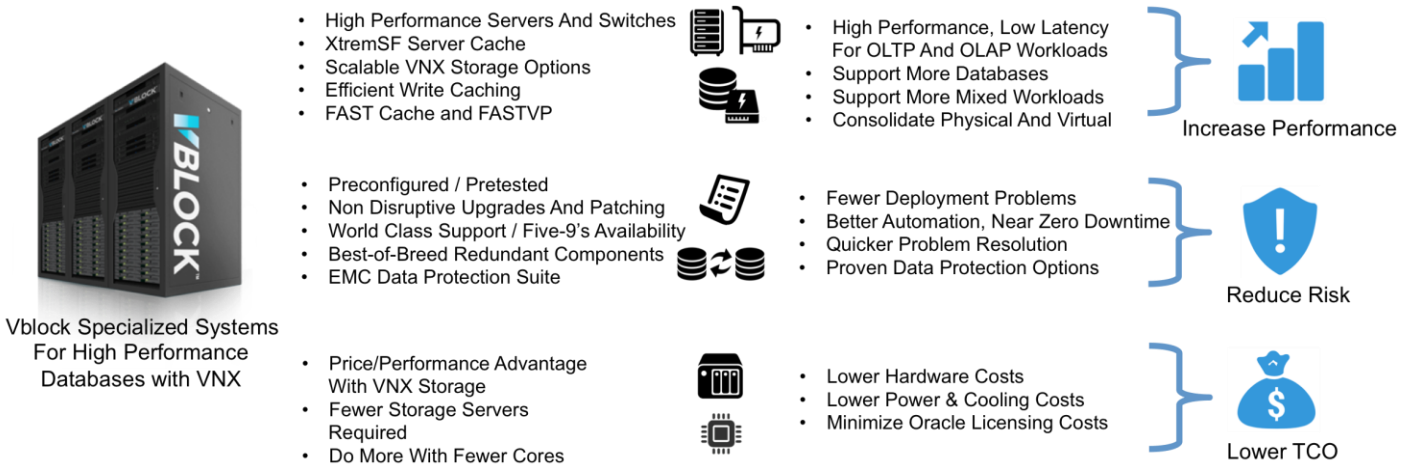
Figure 3. Consolidation With The Vblock Specialized Systems For High Performance Databases



The VSS HPDB with EMC VNX helps reduce both capital and operational expenditures when compared with other integrated high-performance database solutions. All Vblock Systems are designed using proven, best-of-breed, open technology, so there is no technology lock-in. The system can reduce Oracle licensing costs by right-sizing the servers to minimize the total number of database server cores needed to run mission-critical application workloads. Organizations that choose to deploy a pretested, predesigned VSS HPDB can help lower costs and reduce risk while still having the flexibility to match the right servers and storage to achieve the optimal balance of performance, scalability, and licensing costs. These combined benefits help to significantly lower the total cost of ownership (TCO).

While the VSS HPDBB are designed to deliver extremely high levels of performance, every component in the system is also designed to provide extremely high levels of availability. The VSS HPDB combines the high availability of Oracle RAC with the highest availability redundant hardware components from Cisco and EMC. EMC VNX data protection capabilities such as backup, recovery, and continuous availability give IT administrators the ability to meet the most demanding SLAs. VNX Storage proven five-9's reliability and ability to perform non-disruptive upgrades and patches give the VSS HPDB a distinct reliability advantage over other integrated database solutions. Figure 4 summarizes the features and benefits of the VSS HPDB with EMC VNX.

Figure 4. Advantages Of Using Vblock Specialized Systems For High Performance Databases



Why This Matters

IT organizations often struggle to find a balance between simplicity and flexibility when choosing to deploy a database on an integrated compute platform. While the benefits of using a pretested, preconfigured solution are well known, many organizations may fear the technology lock-in that comes with deploying a rigid solution from a single vendor.

ESG Lab found that deploying VSS HPDB with EMC VNX storage and Cisco servers helps to lower TCO, reduce risk, and increase performance while still allowing organizations flexibility in their choice of hardware. Organizations can chose the servers, switches, and storage that are right for their high-performance database needs while avoiding technology lock-in, keeping costs to a minimum, and benefiting from world-class support.

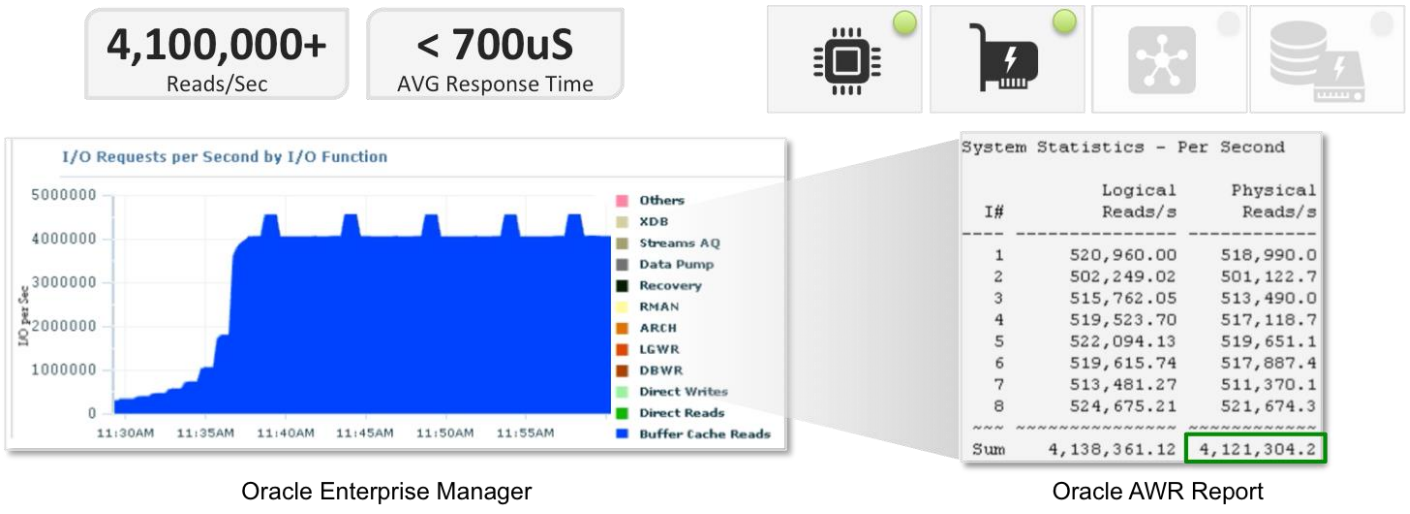
Performance Testing

ESG Lab validated the performance of the VSS HPDB running an eight-node Oracle Real Application Clusters (RAC) configuration of an Oracle Database 11g Release 2 on RHEL 6.3. All performance testing was completed on a simulated real-world populated database. Testing focused on measuring the aggregate throughput and overall latency of Oracle SQL-driven I/O and the bandwidth driven during large partitioned table scans. ESG Lab utilized the widely adopted and publicly available Silly Little Oracle Benchmark (SLOB) kit to efficiently generate realistic system-wide, random, single-block, and application-independent SQL queries. The SLOB benchmark tool exercised all components of the VSS HPDB by stressing the physical I/O layer of Oracle through SGA-buffered random I/O without being limited to a specific load-generating application.

First, ESG Lab measured the maximum system performance achieved when utilizing a data set that fit entirely into the host-based EMC XtremCache. Each database server contained two 700 GB SLC EMC XtremSF flash cards and XtremCache 2.0.1. The cards are used as a write-through cache to retain a server-side copy of the data and cache read I/O.

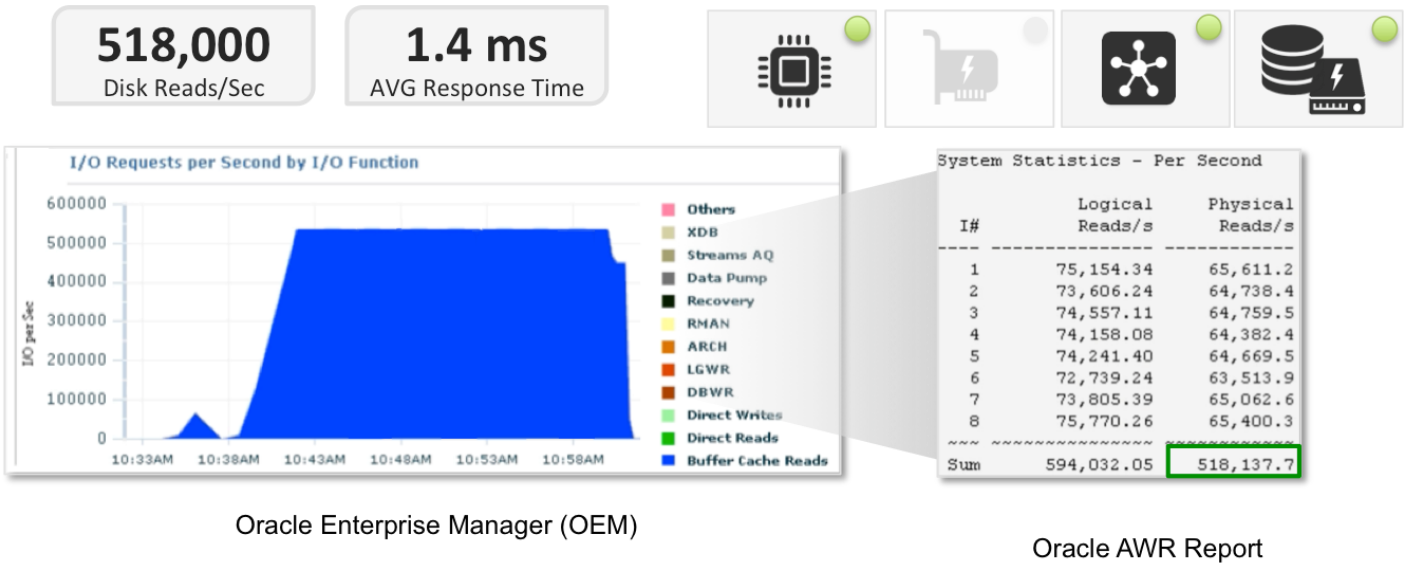
The SLOB workload was configured to simulate 200 users accessing a 1 TB active data set. The high transactional workload generated a heavy CPU burden on the database servers. VCE designed the system under test with minimal tuning parameters to best simulate a default Oracle database configuration. ESG Lab witnessed high, sustainable performance of over four million random Oracle database I/Os per second while delivering a very low 700 microseconds response time. Highlights of the results are shown in Figure 5.

Figure 5. SQL Query Performance With XtremSF Host-based Cache Cards



Next, ESG Lab validated the performance of the system while performing random Oracle database physical I/O to the VNX8000 Storage system. The EMC XtremCache was disabled prior to testing to simulate a scenario in which transactions overflowed from an active EMC XtremSF and XtremCache environment. ESG Lab verified that the storage system was able to deliver 518K disk reads/sec while maintaining a low average response time of 1.4 milliseconds using both Oracle Enterprise Manager and EMC Unisphere Performance Monitor. The test results are shown in Figure 6.

Figure 6. SQL Query Performance

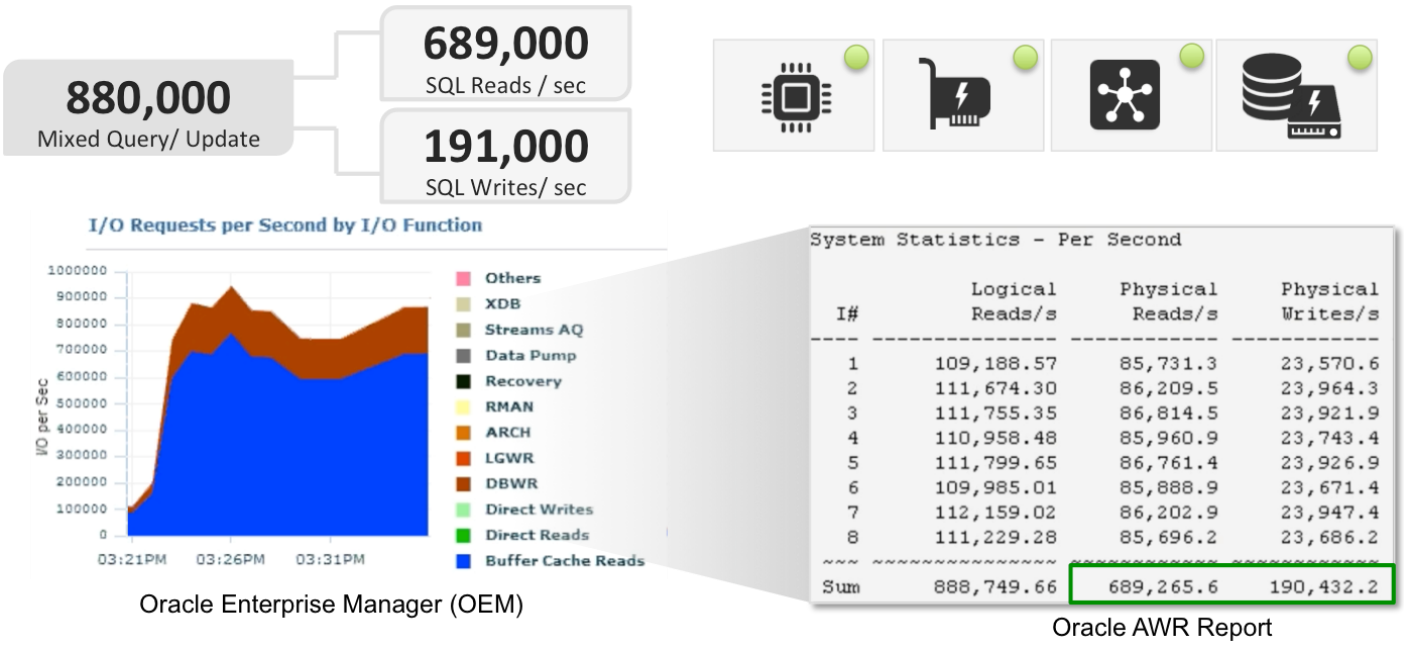


Oracle Enterprise Manager (OEM)

Oracle AWR Report

The performance of a mixed query and update workload was then tested. SLOB was used to generate a workload that consisted of 75% database queries (reads) and 25% updates (writes). The reads were mainly serviced from the EMC XtremSF cache card and the writes were handled by the VNX storage system. ESG Lab measured over 689K IO/sec for the read portion of the workload and over 190K IO/sec for the write portion producing a combined aggregate total of over 880K IO/sec. In Figure 7, the blue portion of the AWR Report displays the database reads per second and the red portion displays the database writes per second (updates).

Figure 7. Mixed Database Query And Update Workload Performance

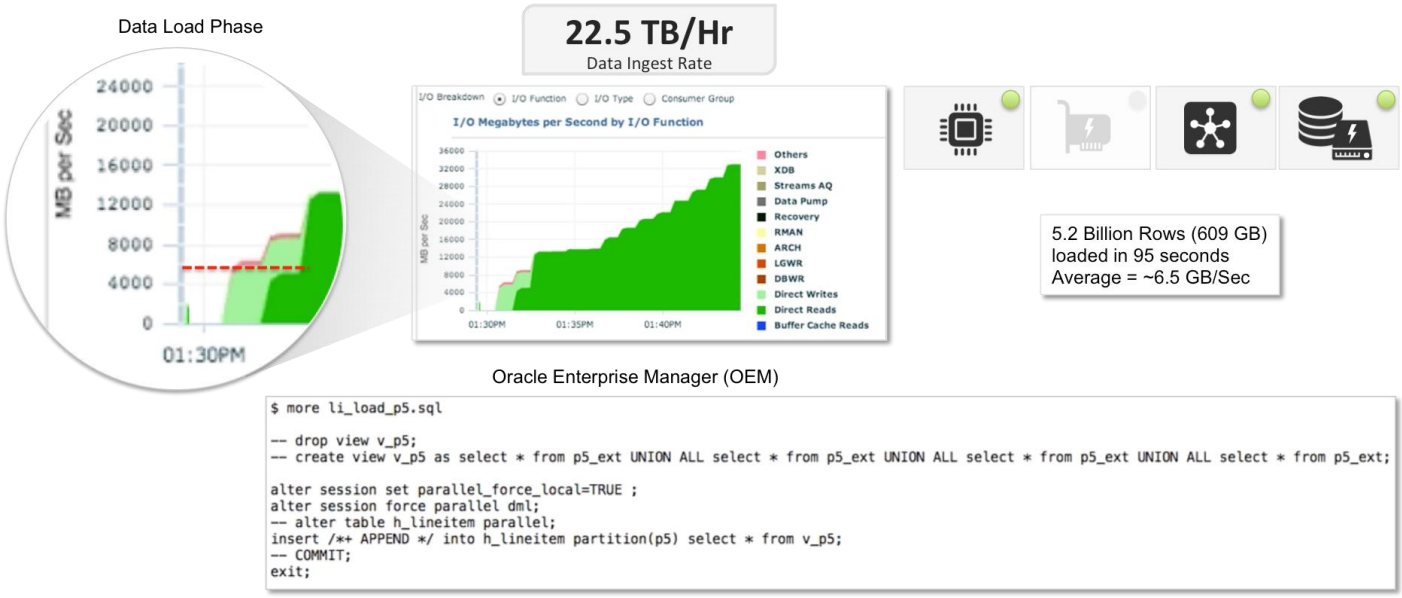


Oracle Enterprise Manager (OEM)

Oracle AWR Report

ESG Lab then measured how fast the VSS HPDB could write data into tables. The data ingest rate was measured using a script to populate line items into a database table. The script used eight concurrent partitions to populate a total of 5.2 billion rows into an empty table. In just 95 seconds, the table had been fully populated with 609 GB of data. By dividing the amount of data written (609 GB) by the time to write the data (95 seconds), we were able to calculate an ingest rate of 6.5 GB/sec. This translates into an impressive hourly ingest rate of 22.5 TB/hr. The light green portion of the OEM chart in Figure 8 shows the partitioned table population via direct writes.

Figure 8. SQL Data Table Ingest Throughput Performance



Immediately following the partitioned table data load operation, ESG Lab validated that the VSS HPDB was able to provide high throughput performance when running parallel partitioned table scans. ESG Lab generated eight concurrent SQL queries that scanned a 609 GB partitioned table and monitored the performance using Oracle Enterprise Manager and EMC Unisphere. Once the test run completed, the results were validated through auditing of the Oracle AWR report, where ESG Lab verified very high throughput performance of nearly 39 GB/sec. The results of the OLAP table scan performance testing are shown in Figure 9.

Figure 9. Measured SQL Throughput Performance

What The Numbers Mean

- The VSS HPDB with EMC XtremSF Server Flash cards combined with EMC XtremCache leverage database server-side caching, which resulted in extremely high throughput (over 4.1M IOPS) and extremely low latency (under 700 microseconds) against 11.2 TB of data. OLTP databases can cost-effectively support more users.
- For data that does not fit into server cache and EMC XtremSF flash cards, the EMC VNX storage system performs extremely well, achieving over 518K IOPS for OLTP queries and combining with EMC XtremSF cards to perform over 880K IOPS for a mixed query and 25% update workload.
- The VSS HPDB ingested data at a rate of over 22.5 TB per hour, helping to minimize the total time to migrate existing databases to the VSS HPDB or ingest large data sets into the database.
- The VSS HPDB with EMC VNX achieved 38.7 GB/sec when performing large OLAP partitioned database table scans. This means tables can be scanned quicker, and more concurrent scans can be handled simultaneously, resulting in faster insight into your data.

Why This Matters

Modern performance-oriented database workloads require high throughput, low latencies, and flexible scalability to keep up with today's demands for data. Spending less time accessing data can mean hundreds of thousands of dollars of revenue to a data-driven organization. Designing a database with the ability to scale and deliver high performance for mixed workloads like OLTP and OLAP table scans within the same system can be very expensive and is a challenge for even the most skilled database architects.

ESG Lab validated that a single configuration on the Vblock Specialized Systems for High Performance Databases performed over four million I/Os per second with a 700 microseconds average response time for OLTP workloads. The system also delivered close to 39 GB/sec while performing OLAP table scans. Designing a database system to achieve these high levels of performance would be difficult for any sized organization, but VCE made the configuration and delivery process quick and easy. Even better, the VSS HPDB with modular EMC VNX Storage Systems can be right-sized to cost effectively meet the needs of any high performance database.

The Bigger Truth

Performance and reliability are absolutely critical in today's mission critical high performance databases. Databases are constantly demanding higher levels of throughput, lower response times, and higher levels of data protection, all while continuing to give the core business a competitive edge. ESG research shows that organizations with database applications for OLTP and OLAP are by far the leading adopters of high performance, low-latency, solid-state storage.[2] But simply adding solid-state storage to your existing infrastructure will not solve the problem. Designing a high performance database that meets the demands of today's business can be a daunting task and few organizations have the expertise or the time to accomplish this in-house.

The Vblock Specialized Systems for High Performance Databases are designed to make it simpler and quicker for an organization to deploy a high performance database. The system is designed for fast and easy ordering using the highest performing and most reliable components from Cisco and EMC. In addition to fast servers, switches, and storage, highly available EMC XtremSF server-side flash cards coupled with EMC XtremCache software, are utilized to ensure the highest throughput and lowest query response times. The system is designed, configured, installed, tuned, and stress tested by expert database performance engineers at VCE before delivery to the customer. Once it hits the customer floor, this product is ready for deployment—lowering the TCO by saving the customer months of internal work and increasing the ROI by speeding the time to deployment.

The VSS HPDB configured with EMC VNX storage delivers outstanding value by giving customers the opportunity to leverage the optimal Cisco servers and switches, with the EMC VNX storage system that best meets their database requirements. The features and flexibility of the VNX storage allow organizations to configure a premium integrated compute platform that is not only optimized for Oracle deployments, but also can be used to consolidate database and other applications workloads, helping to minimize the TCO.

ESG Lab validated the high performance capabilities of eight-node VSS HPDB with an EMC VNX8000 Storage System using an Oracle Database 11g Release 2 in a RAC configuration. The system performed over four million random physical I/Os per second driven by Oracle OLTP-like SQL queries at an impressively low 700 microseconds average response time, and delivered close to 39 GB/sec while performing eight concurrent OLAP table scans.

ESG Lab also measured an impressive 22.5 TB/hr ingest rate and 818K IO/sec for a mixed 75% SQL query and 25% update workload. This extreme high performance coupled with the flexibility, availability, and scalability of the VSS HPDB delivers tremendous value for today's most demanding high performance databases.

By offering the Vblock Specialized Systems for High Performance Databases, VCE has expanded its portfolio into massive database environments while continuing to offer customers choice. VCE is not only offering the customer a best-of-breed, generalized platform in the Vblock System 700, Vblock System 500, Vblock System 300, Vblock System 200, and Vblock System 100 with which to build an infrastructure for running mission critical databases, as well as other enterprise workloads, but it is also helping to solve a complex and costly business problem for organizations. If your organization is preparing to spend months designing, testing, tuning, and troubleshooting a high performance database, ESG Lab strongly suggests letting VCE do the heavy lifting for you.

[2] Source: ESG Research Report, *Solid-state Storage Market Trends*, November 2011.