

Boost Database Performance with the Cisco UCS Storage Accelerator

Performance Brief
April 2013



Highlights

Industry-leading Performance and Scalability

Offloading full or partial database structures to a Cisco UCS 785GB MLC Fusion-io ioDrive2 in the Cisco UCS B200 M3 Blade Server allows customers to improve performance of all applications, reduce IT costs through consolidation, manage more data on less hardware, and make better business decisions in real time.

Improved Database Productivity with Less Maintenance and Tuning

Overall productivity can be increased through the elimination of inherent problems that arise with spinning-disk solutions.

Lower Costs

Reduced storage infrastructure requirements result in significant cost reduction.

The Cisco UCS® B200 M3 Blade Server with the Cisco UCS Storage Accelerator was tested to assess its performance with an Oracle database. Two types of database performance use cases were tested. In one, an entire database was placed in the flash memory. In a second, hybrid deployment, hot performance-demanding database structures such as logs, temporary tablespaces, and selected indexes of the database were placed on the Cisco UCS Storage Accelerator, and the rest of the database remained on a SAN. The hybrid deployment resulted in dramatic overall performance improvements while reducing I/O demands on SAN storage.

Cisco UCS B200 M3 Blade Server

The Cisco UCS B200 M3 Blade Server addresses a broad set of workloads, including IT and web infrastructure and distributed database tasks. Building on the success of the Cisco UCS B200 M2 Blade Server, the enterprise-class Cisco UCS B200 M3 Blade Server extends the capabilities of the Cisco Unified Computing System™ (Cisco UCS) portfolio in a half-width blade form factor. It harnesses the power of the latest Intel® Xeon® processor E5-2600 product family, with up to 768 GB of RAM (using 32-GB DIMMs), two disk drives, and up to four dual 10 Gigabit Ethernet throughput. In addition, Cisco UCS has the architectural advantage of not having to power and cool excess switches in each blade chassis. With a larger power budget per blade server, Cisco can design uncompromised expandability and capabilities in its blade servers, as evidenced by the new Cisco UCS B200 M3, with its leading memory slot and drive capacity.

The Cisco UCS B200 M3 provides:

- 2 multicore Intel Xeon processor E5-2600 CPUs with up to 16 processing cores
- 24 DIMM slots for industry-standard double-data-rate 3 (DDR3) memory running up to 1600 MHz and up to 768 GB of total memory (using 32-GB DIMMs)
- 2 optional, hot-pluggable SAS or SATA hard disk drives (HDDs) or solid-state drives (SSDs)
- Industry-leading 80-Gbps throughput bandwidth
- Remote management through a Cisco® Integrated Management Controller (IMC) that implements policy established in Cisco UCS Manager

- Out-of-band access by a remote keyboard, video, and mouse (KVM) device, Secure Shell (SSH) Protocol, and virtual media (vMedia) as well as the Intelligent Platform Management Interface (IPMI)

The Cisco UCS B200 M3 is a half-width blade. Up to eight of these high-density, 2-socket blade servers can reside in the six-rack-unit (6RU) Cisco UCS 5108 Blade Server Chassis, offering one of the highest densities of servers per rack unit in the industry.

Cisco UCS 785-GB Multilevel Cell Fusion-io ioDrive2 Adapter

Fusion-io builds server-resident Peripheral Component Interconnect Express (PCIe) flash storage for applications requiring a high number of I/O operations per second (IOPS) with low latency. Fusion's industry-leading, low-latency ioMemory eliminates I/O bottlenecks to improve virtual machine workload capabilities in all servers, allowing organizations to achieve the full potential of virtualization.

The Cisco UCS Storage Accelerator significantly reduces Oracle database latency with a high-capacity, high-performance memory tier. The adapter offers a persistent storage option, enabling the card in a server to load an entire database of less than 785 GB into the card's flash memory or just the performance-demanding structures of a larger database. Offloading storage requirements to the card from the SAN and closer to the server can significantly increase performance. This hypothesis was proven in the online transaction processing (OLTP) database tests discussed in this document.

Specifications for Performance Testing

- Cisco UCS B200 M3 Blade Server
 - 2 Intel Xeon processor E5-2690 product family CPUs
 - 256 GB of RAM
 - 2 mezzanine adapter slots (one dedicated to the Cisco UCS Virtual Interface Card [VIC] 1240 for total throughput bandwidth of 80 Gbps)
 - Up to 2 optional front-access SAS or SATA HDDs or SSDs
 - Up to 2 terabytes (TB) maximum internal storage
 - LSI SAS 2004 integrated RAID controller
 - RAID 0 and 1 support
 - 2 slots for 16-GB Secure Digital (SD) flash memory cards (future enablement through a software update)

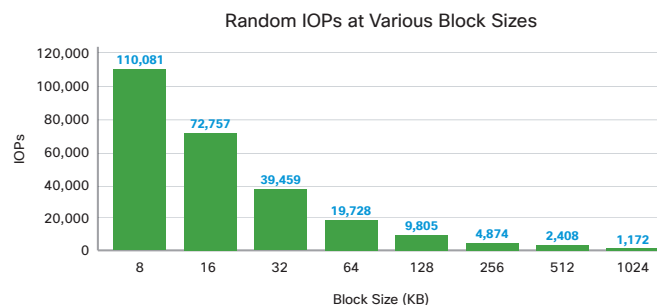
- Cisco UCS 785 GB Fusion-io ioDrive2 Adapter
 - 785-GB multilevel cell (MLC) flash memory capacity
 - 1.5-GBps bandwidth (1 MB read)
 - 1.1-GBps bandwidth (1 MB write)
 - 141,000 IOPS (512 bytes random read)
 - 535,000 IOPS (512 bytes random write)
 - 15 microseconds of write latency and 68 microseconds of read latency
 - Hardware supported: All Cisco UCS M3 blade servers
 - Software supported: Cisco UCS Manager 2.1

Cisco UCS Storage Accelerator Tests: Speed and Feed Rate

The test used Oracle I/O Numbers (Orion), software that mimics the type of I/O operations performed by Oracle databases. Orion allows testers to measure I/O performance for storage systems without actually installing Oracle.

Figure 1 shows I/O tests at different block sizes and corresponding IOPS that can be supported using the Cisco UCS Storage Accelerator.

Figure 1. Random IOPs at Various Block Sizes



Note: These numbers are generated using the default I/O scheduler (CFQ) for Oracle Linux 5.7. Changing the I/O scheduler to NOOP boosted I/O performance boost by from 5 to 10 percent.

Figure 2 shows the bandwidth tests at various I/O bandwidth sizes.

Figure 2. Bandwidth Tests

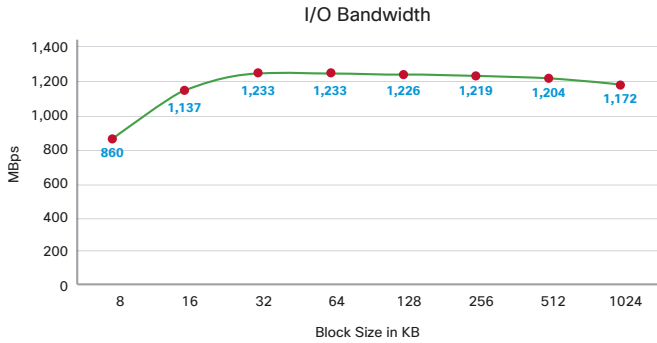
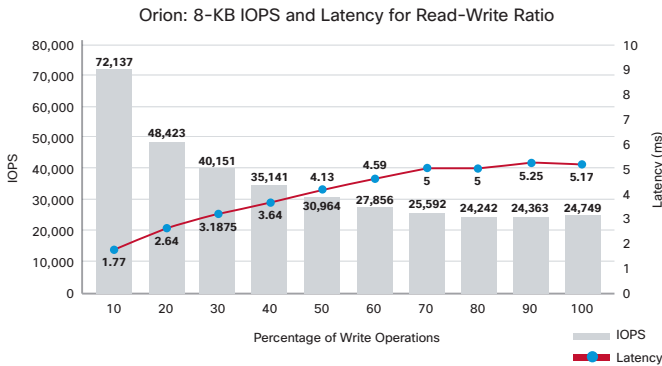


Figure 3 shows I/O and latency tests at various read-write ratios.

Figure 3. IOPS and Latency for Read-Write Ratio



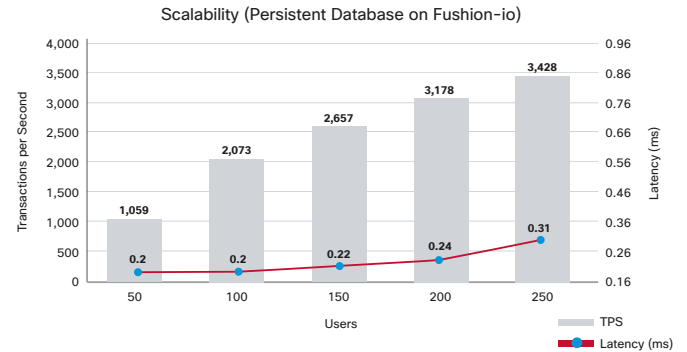
Test Case 1: Placing an Entire Database in Flash Memory

Test case 1 uses an entire single instance of an Oracle 11gR2 database of 720 GB with all database structures on a persistent Cisco UCS Storage Accelerator (Figure 4). The tests used swingbench order entry, which is an OLTP workload, and a 64-GB system global area (SGA) for the Oracle database.

For small and medium-sized businesses, departmental databases, and quality assurance groups running smaller databases (less than 785 GB), an entire Oracle database is shown to perform excellently on a Cisco UCS Storage Accelerator in a Cisco UCS B200 M3 Blade Server. Scalability tests were run against a 720-GB database, with users scaling from 50 to 250 in increments of 50 users. The tests showed

near-linear performance in the number of transactions for per second (TPS) as the number of users scaled. While running 250 users tests, data set concurrency problems occurred that resulted in slightly reduced TPS and higher latency. This result typically indicates that too many users are running against a small data set, and not a hardware limitation.

Figure 4. Scalability of a Persistent Oracle Database on Cisco UCS Storage Accelerator



Test Case 2: Placing a Partial Database in Flash Memory

To demonstrate the typical bottlenecks that hinder I/O scalability, a 1.2-terabyte (TB) swingbench order entry OLTP database was created on traditional SAN storage with 56 Fibre Channel disks. The same user scalability tests as discussed in the previous test were run against the traditional SAN-based database deployment.

Figure 5 shows increased latency (in milliseconds) as the number of users and the TPS rate increase. The chart shows an increase in latency as I/O pressure on the storage increased.

Figure 5. Traditional SAN Database Deployment

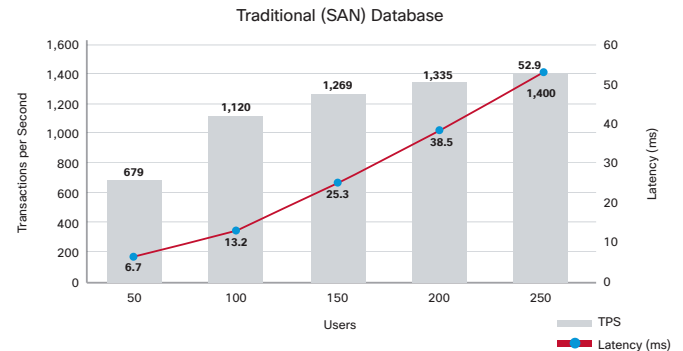


Figure 6 show that this storage configuration reaches an I/O bottleneck at 6100 IOPS. This behavior is confirmed in an Oracle Automatic Workload Repository (AWR) report shown in Figure 7.

Figure 6. Traditional SAN Database Deployment: Scalability Limited by I/O Bottleneck

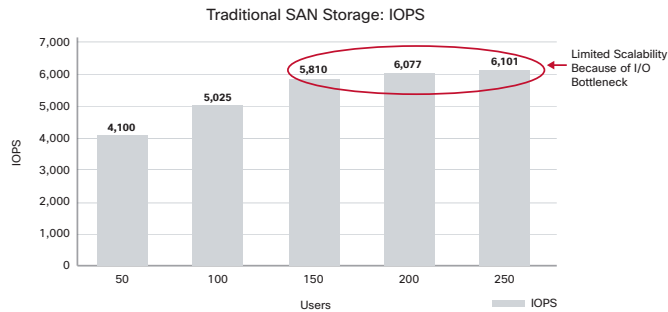


Figure 7 shows the Oracle AWR report Top 5 wait events for a 200-user test. In the traditional deployment based on 200 users, 91 percent of the total time is spent on the **db_file_sequential_read** wait event. This wait event is typically the result of indexed reads that are single-block (8 KB) reads. This report identifies index tablespace, or some of the indexes, as the best candidates to move to flash memory.

Figure 7. Traditional SAN Database Deployment: Oracle AWR Report Top 5 Wait Events

Top 5 Timed Foreground Events					
Event	Waits	Time	Avg wait (ms)	% DB time	Wait Class
db file sequential read	11,857,859	456,882	39	91.1	User I/O
log file sync	2,842,014	23,302	8	4.6	Commit

The Tablespace IO Stats section in the same Oracle AWR report shows an average latency of 38.5 milliseconds (ms), which is very high. The indexed read operations can also be confirmed through average number of blocks read, shown in Figure 8.

Figure 8. Traditional SAN Database Deployment: Corresponding Latency

Tablespace									
Reads	Reads/s	Rd (ms)	Blks/Rd	Writes	Writes/s	Buffer Waits	Av Buffer Wt (ms)		
SOE	11,824,296	3.329	38.5	7,614,064	2,144	6,656	20.7		
UNDOTBS1	5	0	4.0	47,471	13	800	9.2		

As a next logical step, a separate scale order entry (SOE) index tablespace named **SOE_INDEX** was created on the Cisco UCS Storage Accelerator, and all indexes were moved there. Figure 9 shows that this operation increased performance by more than 300 percent compared to a traditional SAN deployment. This increased work is also achieved with significantly less latency.

Figures 9 through 11 show a comparison of a traditional database storage deployment with a hybrid deployment using I/O performance-demanding database structures on the Cisco UCS Storage Accelerator on a Cisco UCS B200 M3 Blade Server.

Figure 9. Traditional Compared to Hybrid Database Deployments: Transactions per Second

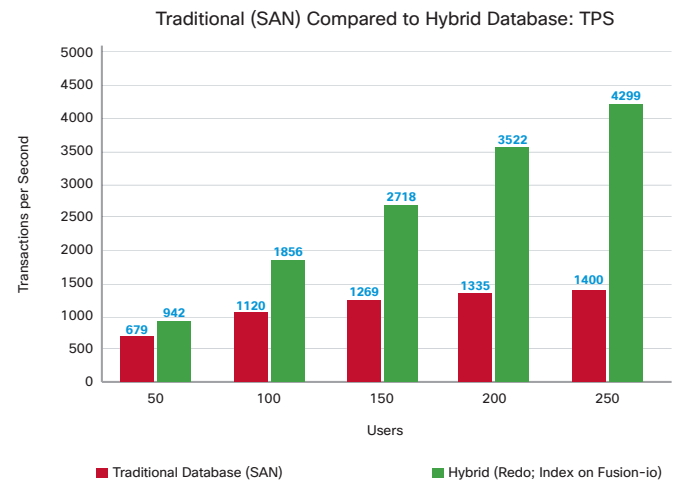


Figure 10 shows the IOPS improvement due to the Cisco UCS Storage Accelerator in the same test.

Figure 10. Traditional Compared to Hybrid Database Deployments: IOPS

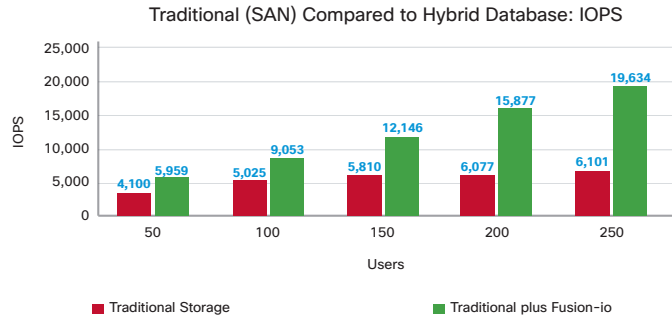
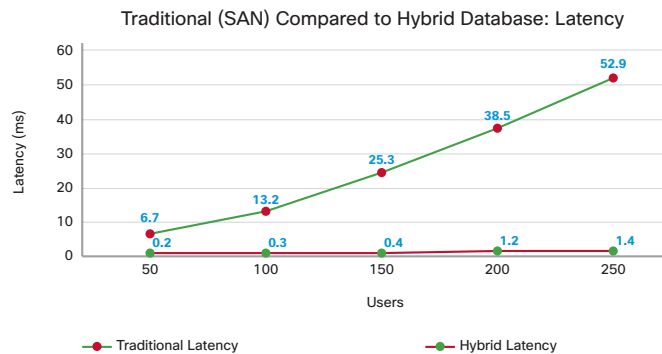


Figure 11 compares the latency results of traditional and hybrid deployments, with the hybrid deployment resulting in far lower latency as the numbers of users and transactions per second increase.

Figure 11. Traditional Compared to Hybrid Database Deployment: Latency



The database Oracle AWR report for 200 users show a significant performance boost with faster indexed read operations (Figure 12).

Figure 12. Performance Boost with Faster Indexed Read Operations in Hybrid Deployment

Top 5 Timed Foreground Events

Event	Waits	Time(s)	Avg wait (ms)	% DB time	Wait Class
db file sequential read	30,118,517	84,198	3	56.8	User I/O
DB CPU		36,066		24.3	

Figure 13 shows 1.2-ms average latency for indexed read operations on the Cisco UCS Storage Accelerator. The Oracle AWR report also indicates improved read latency on traditional SAN storage (SOE tablespace). This improvement is due to reduced read pressure as indexed read operations moved to the extremely fast and efficient Cisco UCS Storage Accelerator.

Figure 13. Performance Boost with Faster Indexed Read Operations in Hybrid Deployment

Tablespace IO Stats
-> ordered by IOs (Reads + Writes) desc

DB/Inst: ORCL/orcl Snaps: 18-19

Tablespace	Av Reads	Av Reads/s	Av Rd (ms)	Av Blks/Rd	Writes	Av Writes/s	Buffer Waits	Av Buffer Wt (ms)
SOE_INDEX	19,580,170	5,436	1.2	1.0	21,588,193	5,993	4,101	0.2
SOE	10,535,828	2,925	5.8	1.0	905,746	251	5,138	0.9

Conclusion

The tests discussed here show that offloading a complete Oracle database or specific hot database structures to the Cisco UCS Storage Accelerator deployed in a Cisco UCS B200 M3 Blade Server results in dramatic performance improvements.

For smaller databases, moving the full database to the Cisco UCS Storage Accelerator enables performance to scale linearly in terms of users and transactions. For larger databases, moving selected database structures to the Cisco UCS Storage Accelerator reduces storage requirements in the SAN. This approach resulted in significant overall performance improvements, reduced mechanical failures, and reduced power and cooling requirements for the SAN infrastructure.

For More Information

Cisco Oracle

<http://www.cisco.com/go/oracle>

Cisco Servers for the Cisco Unified Computing System

http://www.cisco.com/en/US/prod/ps10265/cisco_servers_for_ucs.html



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