New Levels of Scalability for Real-Time Analytics and Transactions

Relational Databases and the Need for Storage Performance

The popularity of data-intensive applications has created a demand for relational databases that run time-sensitive queries to enable effective decision making. Hardware and software innovations are needed to enable these databases to run faster so they can keep up with data and user growth. In the past, relational databases consisted of software running on a large server attached to a dedicated storage environment. Today, relational databases span from large systems to networked clusters to in-memory operational environments. Organizations need a way to effectively integrate in-memory database solutions, ensuring that the right hardware is in place to optimize performance and meet key requirements. To help solve this challenge, Intel® Solid-State Drives (Intel® SSD) are emerging as a key infrastructure component to deliver the scale and performance needed for in-memory databases.

Oracle® TimesTen® In-Memory Database

The Oracle® TimesTen In-Memory Database is a relational database that runs purely in system memory (RAM) to boost performance. Because the Oracle® TimesTen database is fully relational, all transactions are logged to some form of persistent storage. To keep up with the in-memory speed of transaction processing, a storage system that can persist transactions quickly to process large volumes of transaction logs is necessary.

Local disks, storage area networks (SAN), serial attached SCSI (SAS) drives, SSDs, and flash memory can be used for storage. The input/output bandwidth and latency for data persisting in storage are key criteria for running write-intensive, high-volume transactional applications.

In a recent benchmark and demonstration at Oracle® OpenWorld 2012, Oracle® and Intel showed a configuration using a four-socket Intel® Xeon® processor E7 4870 system with 256GB memory, and Intel® Solid-State Drive DC S3700 Series to reach levels of scalability that would be nearly impossible using standard rotating media.

Intel® SSD DC S3700 Series

The Intel® SSD DC S3700 Series was architected to meet the needs of data center applications that require fast and consistent performance, stress-free protection, and high-endurance technology. The Intel® SSD DC S3700 Series accelerates data with consistently low latencies and tight input/output per second (IOPS) distribution. It protects data with hardware- and firmware-assisted full data path protection features that guard against data loss and

corruption. The Intel® SSD DC S3700 Series can also handle demanding workloads with a write endurance specification of 10 drive writes per day over five years, providing added peace of mind for write-intensive applications. For persisting data in an in-memory database, the predictability of response time and the ability to service high writes are key.

Oracle® TimesTen In-Memory Database and Intel® SSD DC S3700 Series Performance Demonstration

The demo presented at Oracle® OpenWorld simulated a telecommunications industry application accessing a database containing basic subscriber and account balance information, simulating mobile prepaid subscriber activities. The transaction workload included processing new calls, account authentication, and check, debit, or refill of the account balance. Oracle® TimesTen In-Memory Database was used to process transactions in real time. The operations and benchmarking were completed on two identical systems with the exception of storage devices—one used a 400GB SAS 10kRPM hard disk drive while the other used the Intel® SSD DC S3700 Series.

The objective was to show the maximum number of subscribers that the system could handle using two different storage configurations. In the demo, multiple database partitions were added to each server to simulate subscriber workload growth. Each time a new database partition was added, the number of subscriber activities doubled. As the volume of the workload increased, the volume of transaction logs persisting in storage grew. Storage was used to update transaction logs and checkpoints periodically. The demonstration showed that the rotational media hard disk drives quickly became a bottleneck. Using the Intel® SSD DC S3700 Series for storage allowed the application to achieve a noticeable throughput increase.

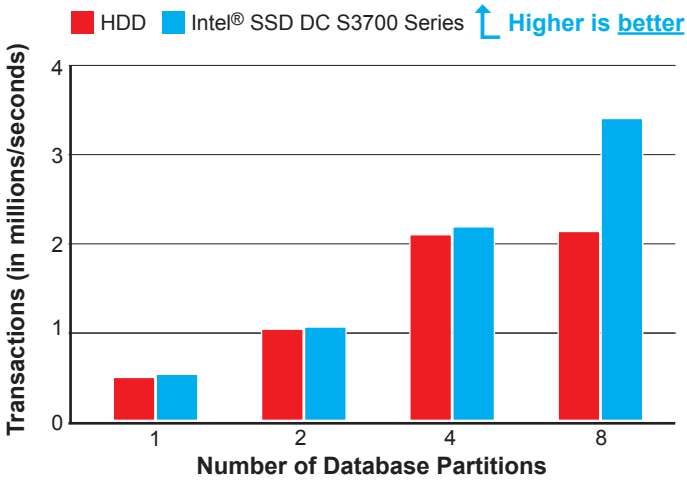

Figure 1: Transaction rate comparison for the Intel® SSD DC S3700 Series and hard disk drive (HDD)

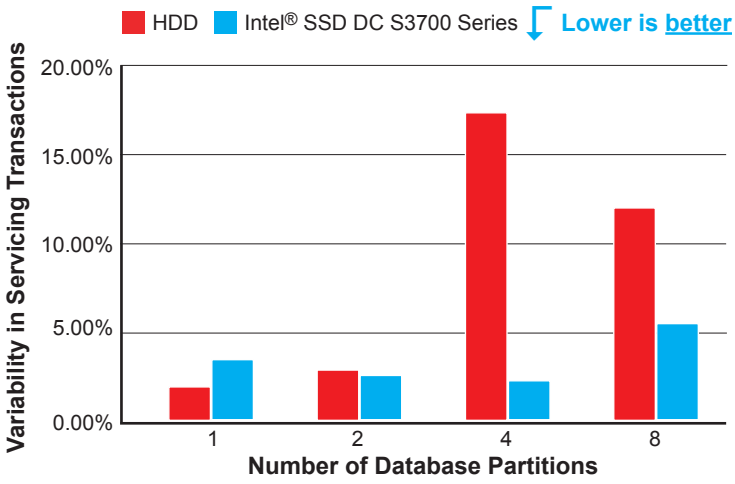

Figure 2: Response time variability comparison for the Intel® SSD DC S3700 Series and HDD

Figure 1 illustrates the limitations of the traditional hard disk drive and the benefits of the Intel® SSD DC S3700 Series. At relatively low transactions (partition count 1 and 2), the hard disk drive-based system avoided input/output (I/O) contention, but as number of transactions increased (partition count 4 and 8), the hard disk drive-based system became saturated due to I/O bandwidth limitations. At its maximum transaction load, the peak throughput declined for the hard disk drive-based system, while the system with the Intel® SSD DC S3700 Series continued scaling.

Figure 2 shows how as I/O contention increased, transaction response time fluctuated widely for the hard disk drive-based system and produced inconsistent application response times. The addition of workloads to the hard disk drive-based system reduced performance and throughput was capped at approximately 2.3 million transactions. In a standard IT environment, this situation would typically force IT to deploy additional server and database resources, involving significant hardware and license costs to appropriately scale the system performance.

The system with the Intel® SSD DC S3700 Series offered consistent performance, even as the number of workloads and partitions increased. In order to maintain service level agreements, database managers need to pay close attention to response time variability and Intel SSD DC S3700 Series services that are needed. By taking advantage of the low latency and tight IOPS distribution of the Intel® SSD DC S3700 Series, the application successfully scaled to eight database

partitions, and throughput increased to more than 3.7 million transactions per second—a 61 percent improvement compared to the hard disk drive-based system. This was achieved with consistent response time (less than 6 percent variation) demonstrating the quality of service enhancement delivered by the Intel® SSD DC S3700 Series.

Scalability and Performance for Real-Time Analytics and Transactions

The demonstration successfully showcased how the Intel® SSD DC S3700 Series paired with Oracle TimesTen can offer greater scalability by removing storage bottlenecks. By replacing existing rotational media, the Intel® SSD DC S3700 Series system provided reliable scalability of Oracle TimesTen In-Memory Database applications and datasets. This will help organizations use Oracle TimesTen In-Memory Database at its full potential to manage data in real time, even as data and users grow.

Additional Resources

- Oracle® TimesTen In-Memory Database
  www.oracle.com/us/products/database/timesten/overview/index.html
- Oracle® In-Memory Database Cache
  www.oracle.com/us/products/database/options/in-memory-database-cache/overview/index.html
- Intel® SSD DC S3700 Series
  www.intel.com/content/www/us/en/solid-state-drives/ssd-dc-s3700-spec.html
- Intel® SSD Boosts Oracle® TimesTen In-Memory Database Performance Demo DC S3700 Series
  www.youtube.com/watch?v=3LUchp3EAFs

Hard Disk Drive System Configuration

Intel® Xeon® Processor E7-4870 @ 2.40 GHz, Four sockets, 40 cores with hyper-threading enabled
256GB DDR3 RAM
Seagate* Cheetah NS, 400 GB SAS HDD 10kRPM, Model: ST3400755SS
Oracle® TimesTen In-Memory Database 11.2.2.3
Red Hat Enterprise Linux* 6.1

Intel® SSD System Configuration

Intel Xeon Processor E7-4870 @ 2.40 GHz, Four sockets, 40 cores with hyper-threading enabled
256GB DDR3 RAM
Intel® SSD DC S3700 Series, 800GB
Oracle® TimesTen In-Memory Database 11.2.2.3
Red Hat Enterprise Linux 6.1