Considering the 2.5-inch SSD-based RAID Solution:

Using Infortrend EonStor B12 Series with Intel SSD in a Microsoft SQL Server Environment

Application Note

Abstract

This application note discusses the benefits of Infortrend 2.5-inch SSD-based RAID solution and provides deployment suggestions on using the solution in a Microsoft SQL Server environment.

The SSD Benefits

Over the past 20 years, hard drives have become significant bottleneck of datacenter performance since they fail to keep pace with the CPU performance rapidly promoted by the advancement of microprocessor technology. (See **Figure 1**)[1]

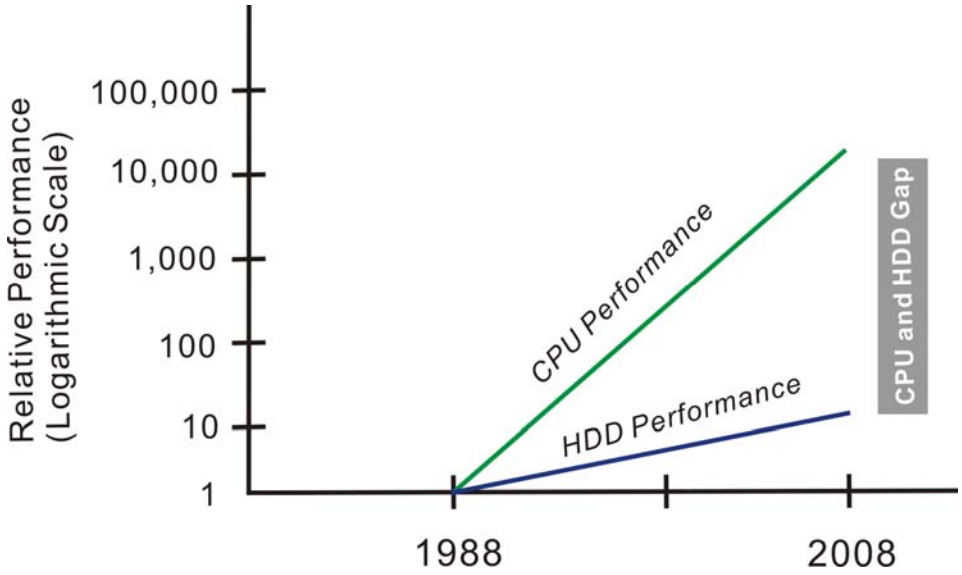

Figure 1. Performance Gap Between CPU and HDD

When the power of 15,000 RPM disk drives can no longer satisfy the rising performance demands, more and more enterprises turn to solid state disks (SSDs).

SSDs are disk drives made of silicon memory chips. Thanks to the absence of moving parts, they have nearly no seek time and rotational delay. (See **Figure 2** and **Figure 3** for the structure difference between hard drives and SSDs)

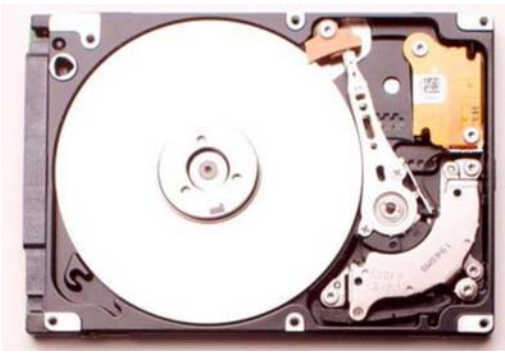

Figure 2. Hard Drive Inner Structure

[1] Reference source: http://download.micron.com/pdf/whitepapers/performance_productivity_for_ent_apps.pdf

Figure 3. Flash Solid State Disk Inner Structure

Translated into practical application benefits, the largely reduced response time and latency mean enhanced productivity. There are two forms of SSDs: RAM-based and flash-based. On per-gigabyte base, the former costs around 10-20 times as much as Fibre Channel disks, while the latter costs 4-5 times. For niche customers who desire the shortest possible latency and highest possible IOPS performance, RAM-based systems are their uncompromised choice regardless of the high price. However, for most companies, flash-based systems coming with lower price are a more viable option. The performance of flash-based SSDs is not so astonishing as that of RAM-based SSDs but is several times better than that of traditional disk drives.

Flash-based SSDs depend on two different NAND technologies: Multi-Level Cell (MLC) and Single-Level Cell (SLC). A MLC memory chip stores two or more bits of information in each cell, while a SLC memory chip stores one. MLC NAND offers larger capacity but delivers slower transfer speeds, higher energy consumption and lower write endurance. With the advantage of lower manufacturing costs, the technology is often used in consumer products, such as USB drives, digital cameras and cell phones. As to SLC NAND, though at a higher price point, it provides enhanced performance, lower energy consumption and higher write endurance[2]. These benefits make SLC SSDs a more ideal choice for enterprise applications.

Out of the same reason of moving part absence, flash SSDs present some more advantages over traditional drives other than performance, such as better ruggedness and lower power consumption,. The risk of mechanical failure of SSDs is quite low. Data can be well preserved even in very rugged conditions such as earthquakes, in volcano survey institution, the oil drill industry and in space programs. Moreover, SSDs theoretically consume about 40% to 80% less power and generate less heat than hard drives. The reduction of cost spent on energy and airflow ventilation is beneficial to both

[2] Implemented with the wear-leveling technology, it can endure as many as 1 million to 5 million cycles.

businesses and environment. With all the benefits mentioned above and the continuously declining quote of flash memory (about 40% of reduction each year), SSD adoption is going beyond niche market and spreading as a common need in businesses.

Using Intel SSDs in Infortrend EonStor B12 Series

Infortrend B12 Series is world's first RAID storage systems designed to house SFF (Small Form Factor) hard drives.

Figure 4. Infortrend B12 Series

The B12 Series includes 4 models: the EonStor B12S-R1030/B12S-G1030 featuring SAS host connectivity and the B12F-R1430/B12F-G1430 featuring Fibre Channel (FC) host connectivity. Ever since its announcement, the storage system accommodating 12 drives in a compact 1U chassis has been honored with many awards and positive reviews as an ideal candidate for future storage. Leveraging the benefits of SFF drives, the B12 Series stands out by its power to achieve greater performance in the same footprint with lower power consumption than the traditional arrays housing 3.5-inch drives. In the challenging economic times, the solution enabling cost reduction with energy and space efficiency becomes even more outstanding.

Seeing the trend that SSD-based storage solutions are more and more required to meet rising datacenter performance demands, Infortrend recently extends the drive options of the B12 subsystems to include Intel X25-E Extreme SSDs. Without requiring users to make new hardware investment on the storage system, Infortrend allows them to readily adopt the advanced drive option through firmware upgrade. The new drive option further enhances B12's edge in performance and energy efficiency. Intelligently tuning the way of I/O processing, Infortrend firmware automatically optimizes the IOPS performance for LDs consisting of SSDs. According to our internal tests, in RAID5 end-to-end, random I/O configuration, the SSD arrays deliver 10 times greater random read and 2 times greater random write IOPS performance as much as that of the SAS HDD array. And the power consumption is 20% less. The productivity improvement and energy savings users can enjoy by adopting SSD-based solutions are quite evident.

By attaching to 2.5-inch drive JBODs or 3.5-inch drive JBODs, the B12S and B12F arrays can be scaled for abundant capacity.

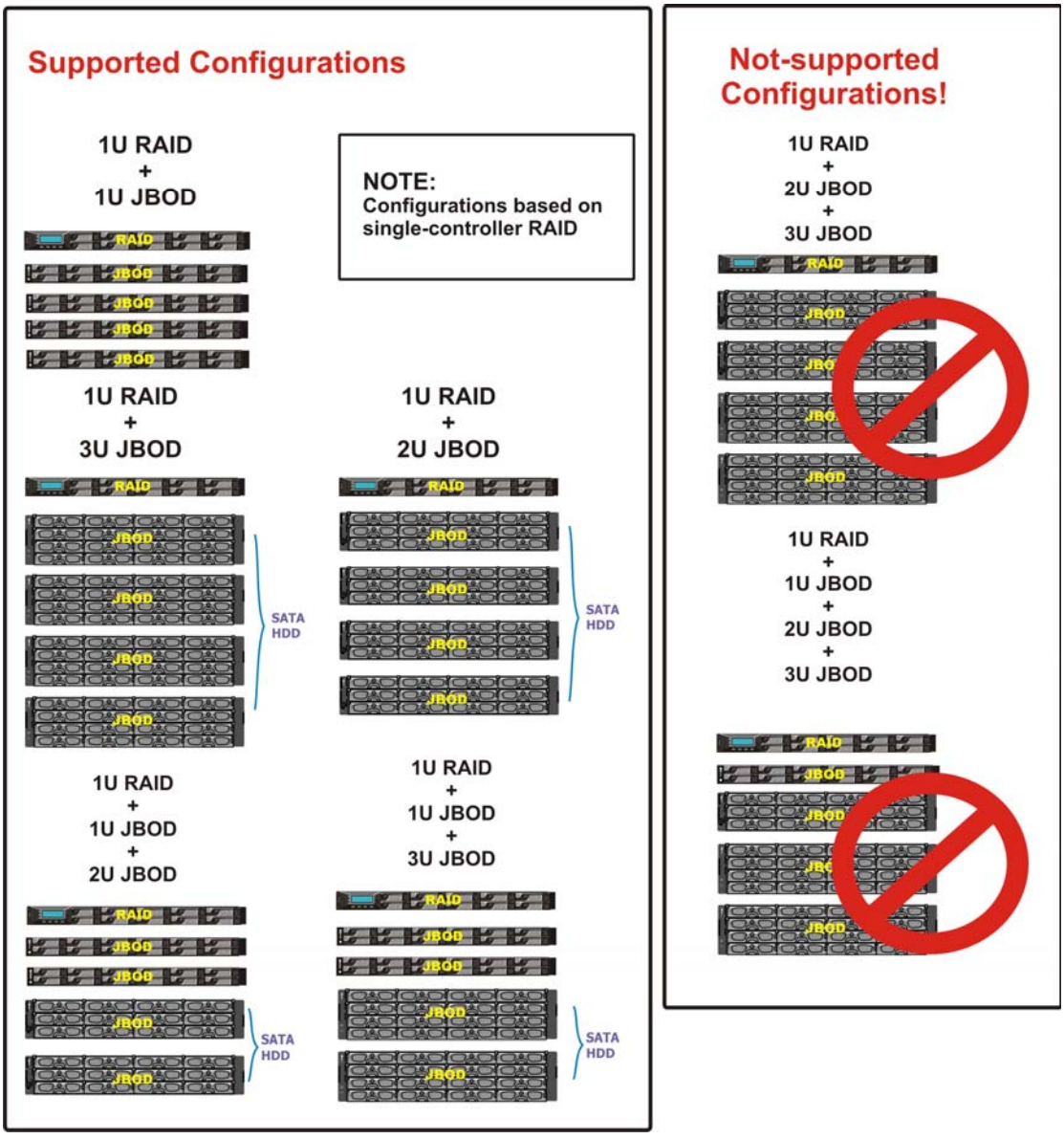

Figure 5. Supported JBOD Configurations of the B12 Series

In the same configuration, SSDs, SAS and SATA drives can be flexibly intermixed to build a tiered storage environment satisfying various application needs with optimal cost-efficiency.

Figure 6. Tiered Storage Deployment Example with the B12 Series

Use Case: Deploying SSD in a Microsoft SQL Server

Environment

Microsoft SQL Server is considered a high I/O requirement application because it commonly produces a lot of storage traffic. The more database-related applications and concurrent user access there are, the longer the response time will be. Users often alleviate the latency problem with the following approaches:

- Moving the most frequently accessed data to faster devices or disks

In terms of traditional spindle drives, the fastest 15000 RPM SAS drive is the most ideal choice.

- Striping database I/Os across more hard drives

If users would like to adopt this practice but have budget concerns, they can choose to use a vast number of lower-priced SATA drives. Although SATA drives come with faster access time, they provide more spindles than SAS drives at the same costs.

These HDD-based solutions do improve application performance but fail to achieve it with space, cost and management efficiency. Below we will illustrate how SSDs and RAID arrays complement each other to deliver the benefits that make them a better solution to SQL Server performance enhancement.

How RAID Storage Systems Complement SSDs

More Protection

As mentioned earlier, since SSDs contain no moving parts, its risk of mechanical failure is much reduced. Although SSDs feature high reliability, some users are still concerned

that SSD solutions can not host such a transaction-intensive application as SQL Server for long because SSDs can handle only a limited number of write cycles. Integrating SSDs into RAID storage systems can minimize the concern because the high fault-tolerance features including RAID protection and redundant hardware components can guarantee the high data availability and integrity required by business-critical applications.

More Capacity

The capacity of current SSDs is limited, which makes some users choose to place only the most frequently accessed data on SSDs, instead of the entire database. Using SSDs in a RAID storage system makes it possible to consolidate multiple SSDs into one large logical drive. This reduces users' capacity concerns in deploying SQL Server files on SSDs.

More Speed

The random Read performance of SSDs is much better than any other storage devices, but their write performance does not lead with such a broad margin. When serving write-intensive applications, SSDs may easily reach the performance limit. RAID storage systems compensate this weakness through the data striping technology. By evenly spreading data blocks among the member drives of a large logical drive, RAID systems help SSDs achieve even better read performance and satisfactory write performance.

How SSDs Complement RAID Storage Systems

Less Response Time

The average SSD access time is around 100 microseconds, which is 20 to 30 times faster than that of traditional hard drives. The performance improvement SSDs enable by reducing latency and seek time is especially beneficial for applications composed mostly of random I/Os. As one of such applications, SQL Server can benefit much from the reduced I/O delays in its transaction throughput.

Lower Power Consumption

Database applications are expected to provide 7x24 services, so they are continuously consuming energy. After a long time of operation, the power efficiency advantage of SSD-based solutions will accumulate into a significant amount of cost savings.

Reduced Environmental Impacts

Compared with traditional HDDs, SSDs generate less heat and noise when working. Moreover, the introduction of SSDs can largely reduce the number of HDDs since users

no longer need to add drives for performance enhancement. These characteristics make SSD-based arrays a “greener” solution for the SQL Server environment. While benefiting businesses with supreme power, it minimizes the harm to the environment.

Moving SQL Server Files to SSDs

Users can consider moving the following SQL files to SSDs:

- If users find their databases often have high concurrent access and users frequently access randomly all the tables in the databases, they should move the **entire databases** to SSDs.

- Whenever a database write happen, a **transaction log** entry will be created by SQL Server. Since transaction logs constantly causes I/Os during database operation, users can improve overall performance by moving them to SSDs.

- **Temporary database** (tempdb) is used to support temporary data, such as complex queries, joins and index creations. Because the data are related to many kinds of operations, users can ensure good performance by placing tempdb database on SSDs.

- When a read request occurs, SQL Server allows users to access the correct record quickly based on the **indexes**. Along with the adding or modification of a record, the table indexes would be updated. An index may be accessed by many users at the same time. Placing indexes on SSDs can accelerate the concurrent access and in turn enhance application performance.

- **Frequently accessed tables** are one of the main causes of random data requests. If they are not stored on storage device delivering access time fast enough, they tend to inflict I/O wait times. Concerning this, users should move these tables to SSDs.

Conclusion

SSD is a rare bright spot in the challenging economy. Its characteristic of moving part absence leads to significantly higher performance and lower energy consumption than HDDs. Integrating SSDs into Infortrend’s industry-leading B12 Series arrays makes an ideal solution to performance-hungry and power-hungry applications. By properly

deploying the SSD-based solution in a Microsoft SQL Server Environment, users can enjoy much enhanced productivity on reduced operational costs.

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