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IBM POWER8 and IBM FlashSystem accelerate Oracle Database

Executive summary

CTOs, CIOs, and system managers have a wide choice of server and storage technologies. This breadth of servers and types of storage can lead to decision paralysis, where staying with existing technologies can seem to be the safest course of action. This whitepaper will review the new IBM® Power Systems™ server with IBM POWER8™ technology in combination with IBM FlashSystem™, an all-flash storage array that delivers outstanding performance, reliability, and flexibility. In addition, performance testing is reviewed using a brokerage workload to demonstrate the capabilities of the IBM POWER8 and FlashSystem combination.

Brokerage workload for OLTP

The brokerage workload models an online transaction processing (OLTP)-style application environment, as would be seen in a stock brokerage organization. Like most OLTP environments, sub-second response times are the standard with the brokerage workload. Moreover, the brokerage workload models a realistic data application architecture that includes referential integrity, complex transactions, and multiple interacting subsystems and input feeds. The predominant input/output (I/O) pattern with the brokerage workload is random, which is often bottlenecked on traditional hard disk drive-based storage. This is due to the seek and rotational latencies that are inherent in that technology.



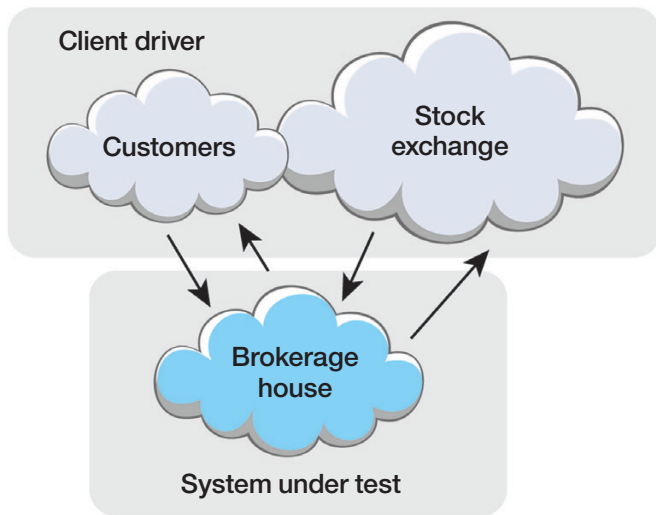


Figure 1. Brokerage transaction model

IBM FlashSystem features and benefits

Flash memory technology has been available for many years. With the explosion of consumer electronics that utilize flash, the price per chip for flash-based memory plummeted to the point that using flash for high volume storage of computer data became viable.

IBM FlashSystem reliability, availability and serviceability

With a true RAS (reliability, availability, serviceability) designed architecture where all components are hot-swappable, IBM FlashSystem is a robust, reliable, and high performance storage system with no single point of failure. Figure 2 illustrates the FlashSystem 840 RAS features that are very beneficial for Oracle Database environments.

For industry-leading data protection, IBM FlashSystem employs two-dimensional RAID: system level RAID 5 along with patented IBM Variable Stripe RAID™ (VSR). In most flash storage devices, such as hard disk form-factor solid state drives (SSD), if one of the channels on a flash chip fails, the entire chip is failed and then the entire SSD is failed. With VSR, IBM immediately recreates that channel of data into an empty channel stripe, erases the stripe, and re-stripes at its previous level minus one, resulting in the basic 9+1 RAID configuration dropping to an 8+1 with the first channel failure; however, the storage is still available and usable. This enables each flash module to undergo multiple channel-level failures before the module has to be failed and replaced, which means that module-level striping covers chip level failures and system-level RAID 5 covers module level failures.

IBM FlashSystem 840: hardware view

Improved RAS features

- Front/back accessible hot-swap flash modules, power supplies, batteries, fans, controllers w/ interface cards and canisters
- Non-disruptive maintenance and firmware updates (concurrent code load)

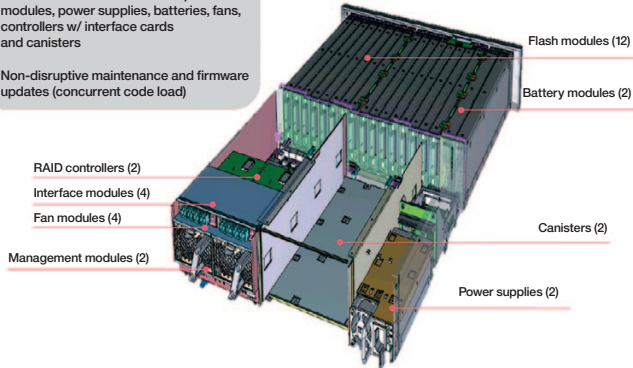


Figure 2. RAS Features of IBM FlashSystem 840

IBM POWER8 Server features and benefits

The IBM Power System S824 server was used for the testing described in this paper. This server provides the following features:

- Up to 12 processor cores per socket
- Up to SMT8, 8 parallel threads per core with 1,2,4, or 8 selectable threads/core
- Up to 96 MB of on-chip cache and 256 MB of off-chip cache
- 2.3x bandwidth to memory versus the IBM POWER7®
- 2.4x bandwidth to I/O versus the IBM POWER7
- CAPI—PCIe3 direct connect interface for storage
- Improved OLTP database performance with transactional memory; an engineering feature from IBM mainframe architecture
- Increased speed and performance with Native PCIe running PCIe GEN3 into the processor
- PowerKVM, providing a standard, Linux-based virtualization solution

These features provide better scale-up performance with more throughput than previous generations of IBM POWER® systems. In addition, the SMT8 capabilities offer more flexibility for virtual machine (VM) usage where customization of parallel threads provides the best solution to application performance requirements.



Figure 3. The POWER8-S824 Server

The S824 server's increased CPU caches provide better performance due to reduced latency for memory-hungry applications such as databases. Its higher internal throughput addresses bandwidth-hungry applications such as big data and analytics, enabling servers to respond quicker and scale effortlessly.

Description of test environment

For this series of tests, a POWER8-based Power System S824 server with two sockets, 24 cores, and 200 gigabytes (GB) of core memory running the IBM AIX® 7.1 operating system was utilized. It was connected via a switch to an IBM FlashSystem 840 array using the native 2D RAID 5 with 40 terabytes (TB) of usable flash storage. Eight gigabit per second (Gb/s) Fibre Channel (FC) ports were used to connect to the IBM FlashSystem array.

The tests compared the POWER8 configuration described above to a POWER7-based IBM Power® 770 with 32 cores and 200 GB of memory, also running AIX 7.1. It was connected via a switch to an IBM FlashSystem 820 array with 20 TB of usable flash storage and four 8 Gb/s FC ports.

The test system was configured with Oracle Database 11g Release 2 with the PSU6 patch set. Initial testing showed that a 160 GB Oracle Database shared global area (SGA) size was nominal for the purposes of testing physical I/O.

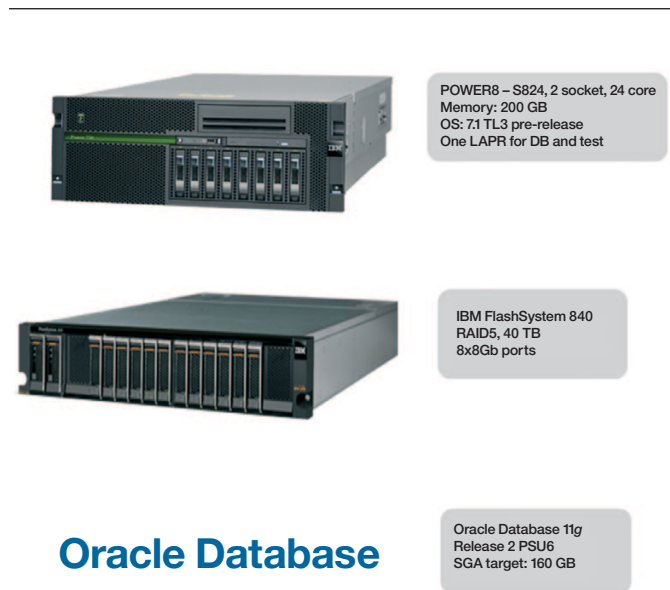


Figure 4. The test environment

Description of brokerage workload

The brokerage workload was designed to simulate a realistic OLTP environment modeling a financial/brokerage system. In order to be successful, the test system must provide:

- Sub-second response times
- Multiple access streams

The brokerage workload utilized a complex data application architecture that included:

- Multiple tables, indexes, and data types
- Required referential integrity
- Complex transactions
- Multiple interacting subsystems

Two database sizes were used in the testing—6,000 customers and 50,000 customers—to provide a workload that could be compared to existing hard disk drive-based architectures and that would stress the IBM FlashSystem capabilities.

Test results

What should you expect based on the change in the computing platform from the POWER7 to the POWER8? Based on the improved cycles per second and improved memory and I/O throughput, you should experience improved transactions per second and improved response time. The combination of the Power System S824 and FlashSystem 840 delivered 1.6 times more transactions per second per core than the Power 770 and FlashSystem 820, along with a 40 percent better response time per transaction.

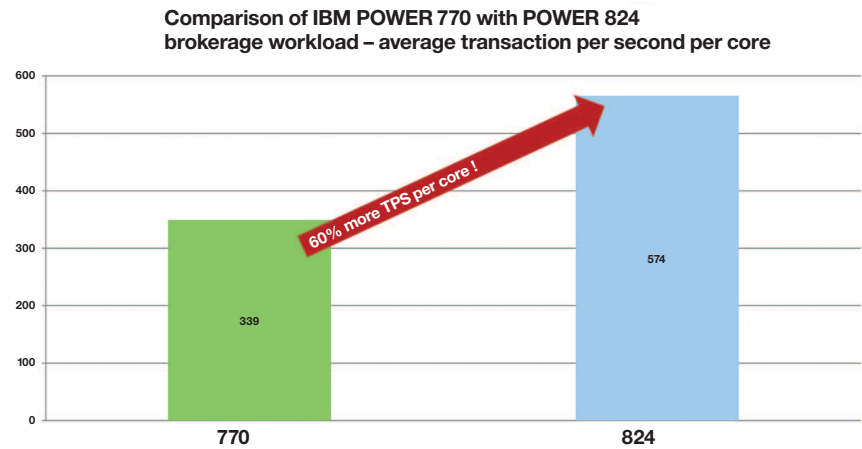


Figure 5. Power System S824 / FlashSystem 840 versus Power 770 / FlashSystem 820: Transactions per Second per Core

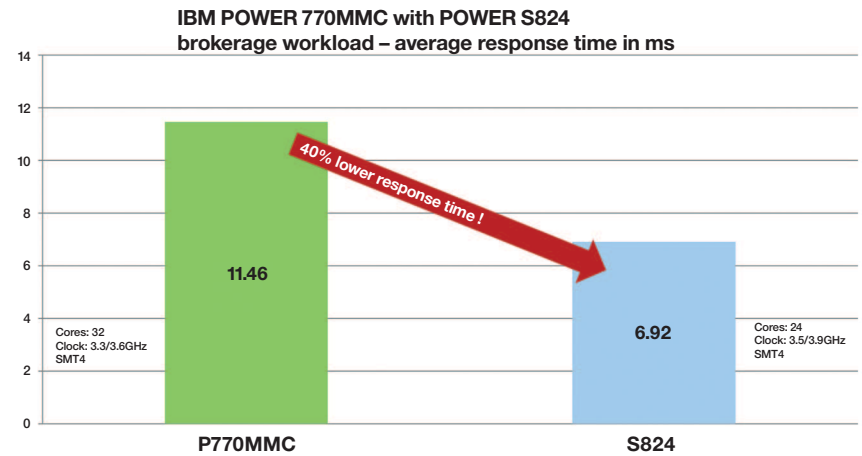


Figure 6. Power System S824/FlashSystem 840 versus Power 770/FlashSystem 820: response time

When the improved performance and throughput of the POWER8 is combined with the reduced latency of FlashSystem 840, a powerful and responsive synergy is created.

Using the brokerage workload, the benefits of FlashSystem over a traditional storage area network (SAN) array is apparent. The SAN array was tested using the 6,000 customer database configuration.

The traditional SAN array was configured with the following:

- 16 GB read/write cache
- 62 physical disks
- 31 RAID 1+1 arrays

The Power 770 and SAN storage performance showed linear gains in transactions per second (TPS) and increases in latency per transaction, as would be expected when users are contending for disk resources.

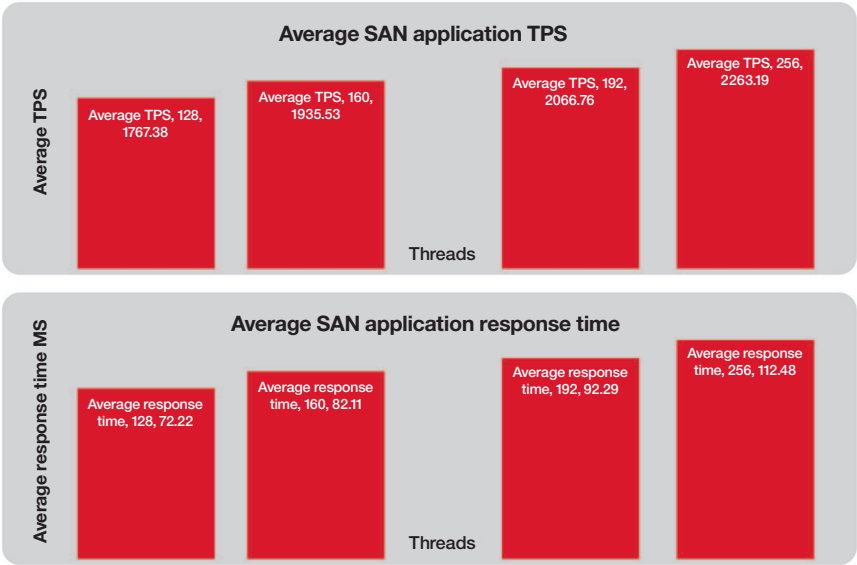


Figure 7. Power 770 showing traditional SAN performance with increasing load

SAN array tests at the 50,000 customer level showed poor performance overall due to the high level of input/outputs per second (IOPS) required.

Results from the S824 and FlashSystem 840 tests at 6,000 users demonstrated the performance gains possible with this combination of powerful technologies.

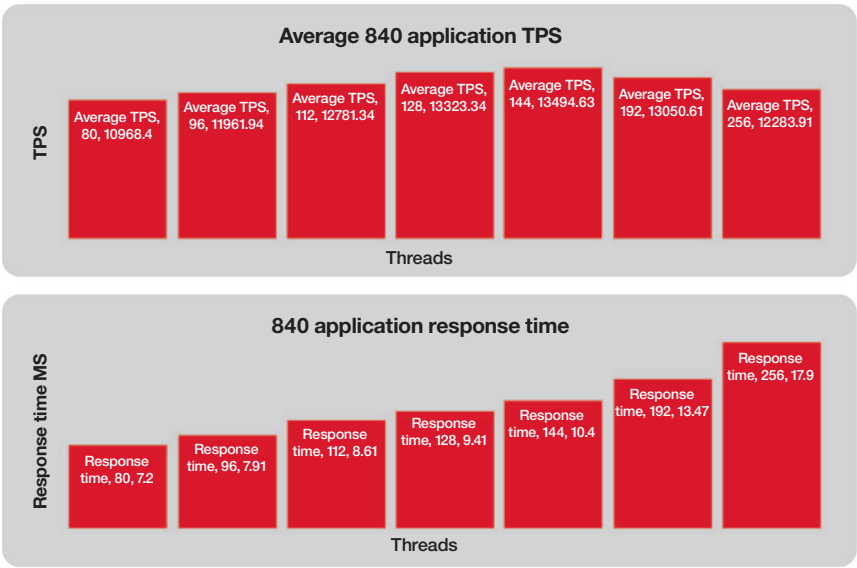


Figure 8. Power System S824 with IBM FlashSystem 840 performance with increasing load

The results show the superiority of the S824 and FlashSystem 840 solution. The flash-based system was able to reach peak performance at a lower thread count; 144 versus the 256 threads in the SAN-based solution, and that the peak TPS was six times higher: 13,494.63 versus 2,263 TPS.

At the peak TPS, the application response time was one-tenth—10.4 milliseconds (ms)—that of the traditional SAN (112.48 ms) per transaction.

The S824 and FlashSystem 840 were also tested with the 50,000 customer database workload.

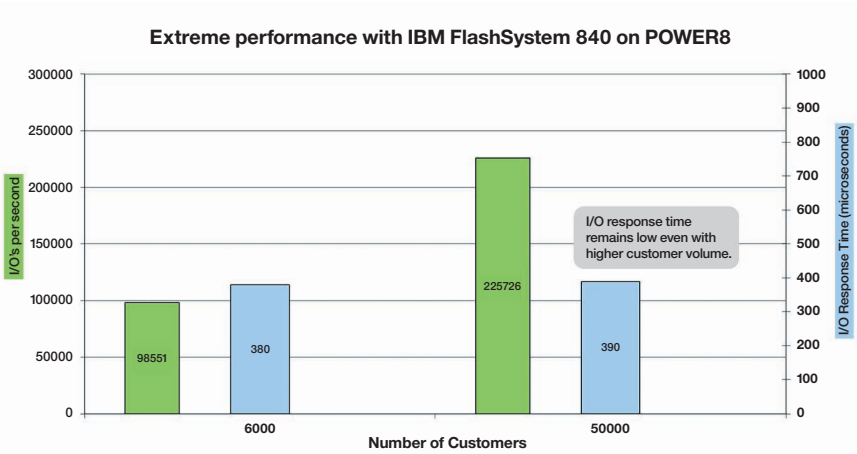


Figure 9. Comparison of the 6,000 to the 50,000 customer workloads

While the increased IOPS is impressive, rising from 98,551 to 225,726; the latency per I/O essentially didn't change; it went from 380 to 390 microseconds. Because that is well within the statistical margin of error of our measurement, the numbers are essentially the same. There is no traditional SAN array that will provide such a strongly linear response trace during a nearly factor of 10 increase in load.

Conclusion

The Power System S824 server combined with IBM FlashSystem 840 can offer a quantum leap forward in performance, scalability, and reliability. This combination of processing capability and reduced latency with increased storage capacity provides a new level of performance and capability unequalled by any other commercially available system.

For more information

To learn more about the, please contact your IBM representative or IBM Business Partner, or visit the following website: <http://www-03.ibm.com/systems/storage/flash/>.

To learn more about the Power System S824, visit: <http://www-03.ibm.com/systems/power/hardware/s824/>.

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