CPO Case Study: The x3850 X6 with eXFlash Memory-Channel Storage Outperforms HP

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Executive Summary

The Introduction of the IBM System x3850 X6, among other features IBM introduces new eXFlash memory-channel storage. IT managers seeking extremely low-latency flash storage will find this storage solution well suited for workloads like transactional databases, among others.

The IBM Competitive Project Office performed a case study to see how the x3850 X6 with eXFlash DIMMs compared to a similarly configured HP server using internal SSDs with an I/O intensive, Online Transaction Processing workload. Since the IBM X6 is the only server that currently can use the eXFlash DIMMs, this compares the lowest latency storage of the IBM X6 with the lowest latency storage offering from HP.

The results show that the eXFlash DIMMs can dramatically improve performance for an I/O intensive workload.
**Introduction**

Many enterprise clients are looking for ways to improve the performance of their servers. With processors getting faster, along with more and more cores, storage can quickly become a bottleneck for workloads with high I/O. Applications like analytics, Big Data, and high-frequency financial transactional workloads need faster storage.

There is a saying that you can ask for two of the three of: better, faster, or cheaper. But you cannot have all three. For many enterprise clients, faster is better, so you already have two. But, today’s budgets still being tight, it better not cost a lot more. IBM’s new eXFlash memory-channel storage delivers high IOPS with extremely low latency and does so for very little extra cost.

The IBM Competitive Project Office (CPO) compared an x3850 X6, with 4 Compute Books, using the new eXFlash memory-channel storage to an HP DL-580 Gen8 using SSD’s. This compares the lowest latency storage available for each server. We used an I/O intensive Brokerage OLTP workload to drive both scenarios to see if the eXFlash DIMMs would provide better IOPS and latency for a real-world application.

**Balanced Systems Design 101**

For transactional database systems, there is a delicate balance between the CPU processing power and the I/O throughput needed out of the storage. There are other factors, like memory, involved but the basic concept is that when you add more CPU processing power, you can become I/O limited. The CPU

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spends more time waiting for the data to come off of the I/O system. As you add more to your I/O system, the system can then become CPU starved as the I/O waits for the CPU.

Even a well-tuned database can still have a substantial I/O wait. Figure 2² demonstrates this occurrence during a time slice when at least half the time is used waiting for I/O operations to process. If the time the system waits for I/O is minimized, the application can process many more operations. And if these operations are revenue-generating transactions, minimizing wait time helps generate more revenue. The message in Figure 2 is that in such cases, expensive servers are sitting with their CPU idle most of the time.

![CPU Time](image)

The x3850 X6 with 15 cores and 30 threads per socket, 25% more cache, triple the memory capacity along with faster memory speed, demands high IOPS capability and low latency like never before.

**What is eXFlash memory-channel storage**

The IBM® eXFlash memory-channel storage is a solid-state storage device connects the flash memory module directly to a DDR3 memory bus using a standard DIMM form factor. It offers an ultra-low latency, highly scalable storage that can significantly decrease the I/O response time and balance that processing power of a server like the IBM x3850 X6.

One of the reasons for this is that the eXFlash DIMM modules are installed into the DDR3 slots used for RAM DIMMs and use the memory channels of the processors. Data transfers between processors and eXFlash DIMMs run directly without any extra controllers such as PCIe controller and SAS/SATA.

² Here the I/O Wait % is the time spent waiting for data from the storage system. App % is the time spent executing user instructions in a program. System % is time spent managing database locks, shared memory, context switches in memory, etc.; in support of user programs.
controllers. The closer the data is to the CPU itself, the faster that I/O performance is. This can significantly reduce latency and improve performance.

Figure 3 shows the differences in data access of the eXFlash memory-channel storage, PCIe SSD’s and SAS SSD’s and HDD’s.

![Figure 3: Comparison of data access speeds for different storage types](image)

**Case Study Methodology**

Figure 4 shows the hardware (HW) and software (SW) used for the Competitive Project Office (CPO) case study. A separate client server ran the OLTP workload against two different servers.

**IBM X3850 X6**

The first server was an IBM x3850 X6 server with four Compute Books and the new Intel Xeon E7-4890 v2 processors in each book. Each processor had 15 cores for a total of 60, and with hyperthreading turned on, that gave 120 threads. Each book also had 8 x 16GB DIMMS, giving the server a total of 512GB of RAM. Eight eXFlash DIMMs were used. Two of the Compute Books getting four eXFlash DIMMs each. The 8 eXFlash DIMMs had to be mirrored in two RAID 10 groups since four were connected locally to one processor, and four connected to a second processor.
**HP DL580 GEN8**

The second server was an HP DL580 Gen8 four-socket server, also with new Intel Xeon E7-4890 v2 processors. The DL580 also had a total of 512GB of RAM. The RAM DIMMs were the same in both servers. The fastest internal storage available for the HP is SSD’s, so 8 200GB SSD’s were installed into the HP using RAID10. This made the storage for the two servers similar in terms of RAID level and amount of storage.

DB2 10.5 was used for the SW in both cases. In both cases the amount of memory for DB2 was limited to 256 GB. This was done to keep DB2 from simply using all the RAM and then not having to do much in the way of I/O.

For the workload, we utilized a TPC-E “kit” created by the Toronto DB2 performance group to run an OLTP Brokerage workload against a database (DB) that is similar to a TPC-E DB. The parameters were adjusted slightly to create a higher level of I/O to emphasize the storage performance differences. After some analysis of the resulting data, we calculate a value for the average transactions per second (TPS) from the database server.

The database was approximately 620GB.

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**Figure 4 - HW Architecture for test**
Case Study Findings

Figure 5 shows the TPS generated by the x3850 when using the eXFlash DIMMs was consistently about 2.8 times as much as the DL580 using SSDs. One could argue that it is unfair to compare Flash DIMMs with more IOPS and lower latency against SSDs. But, that is actually the point - IBM has an advantage. IBM’s competitors do not have the memory-channel storage to compete. So, we compared Flash DIMM against the fastest they have, which is SSDs.

![Figure 5](image)

Performance is important and it comes with a price. There is value in a server that costs twice as much but yields twice the performance. In this case the cost of the X3850 is about 7% more due mainly to the higher cost of the eXFlash DIMMs compared to SSDs. However, the x3850 x6 with eXFlash DIMM yields 280% higher performance. It is clear in figure 6 below, when you compare the cost per TPS of the two servers, the x3850 X6 is 62% less costly than the DL580.
Summary

SSD’s provide high IOPS and low latency for workloads that need it, as in the case of high intensity transactional systems. Servers like the x3850 X6 with faster processors, along with more cores, need even faster storage to avoid an I/O bound situation. IBM’s eXFlash memory-channel storage provides exactly that: higher IOPS and lower latency than even SSDs. This case study showed that in a nominal case, 2.8 times as much TPS could be achieved using an x3850 X6 with eXFlash DIMMs versus an HP DL580 Gen8 with SSDs. When considering that you can get 280% higher performance for an increase in hardware cost of about 7% when using the eXFlash DIMMs, this level of price performance makes the IBM x3850 X6 with eXFlash DIMMs the optimal choice.