Abstract: Author concludes that because of high random read speed of Flash, RAID-5 is no less performance-efficient than RAID-10, and is generally the preferred RAID solution for all Flash SSD arrays due to significant cost saving.

Raid Performance with Flash SSDs

Flash Solid State Disks are rapidly becoming a viable option as a replacement for traditional disk drives. This includes use in arrays setup running traditional RAID storage options. Because of the performance characteristics of Flash SSDs, optimal RAID design is different for Flash SSDs than for traditional disk drives.

Performance Asymmetry:

Traditional hard drives are roughly symmetric in terms of read/write performance. If a drive can read 150 4K blocks per second, it can probably also write 150 4K blocks per second. Flash drives are different. A typical Flash drive might read 3500 4K blocks per second but only write 24 4K blocks per second. It is this asymmetry that impacts how you design RAID arrays for optimal performance.

Because of this asymmetry, write performance for RAID arrays with Flash SSDs scale differently than for traditional hard drives. For example, with HDDs, RAID-5 and RAID-6 arrays tend to saturate with a single random write stream. This occurs because doing a random write to RAID-5 or RAID-6 requires exactly one IO operation on every drive in the array. Thus with a 5 drive RAID-5 array, a random write requires 1 regular write, 3 reads to read the stripe so that parity can be computed, and 1 additional write to store the parity block. Thus each drive requires one IO operation for each logical random write, 2 writes, and N-2 reads. With RAID-6, the situation is similar with 3 writes, and N-3 reads.

If you do the same RAID-5 random write with Flash SSDs, the same IO operations occur. But with Flash SSDs, the reads are nearly instantaneous and the only actual time consumed is the time for the writes. This means that only 2 of the drives are actually busy during the write operation. This lets a smart disk controller overlap operations and actually achieve write rates that are better than the write rate of a single drive.

Thus the write throughput of RAID-5 on HDDs is identical to the write throughput of a single drive. With Flash SSDs, the RAID-5 throughput is N/2 the write throughput of a single drive. RAID-6 arrays end up with N/3 the write throughput of a single drive. This means that a 6 drive RAID-5 array actually writes 3 times as fast as a single bare drive. This is exactly the same performance benefit you would get running HDDs RAID-10.

Conclusion:

The conclusion is that RAID-10 does not make sense for Flash SSDs. With hard disks, RAID-10 is a way of optimizing random writes. With Flash SSDs, you get nearly the same per/drive write performance with RAID-5 without incurring the capacity penalties. And with the cost/GB of Flash as high as it is, any help on the capacity side is appreciated.

On the other hand, traditional Flash SSDs are still terrible at random writing. At least with RAID arrays, they do get a little better as the array grows.

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