Tutorial 5

Flash memory (SSD-solid state disks) are starting to become very competitive in many applications as they have excellent sustained random IOPS performance for reads (good for writes) and very good sustained sequential bandwidth for reads (good for writes). The write side is slightly more problematic for server workloads, as SSDs can tolerate only a limited number of flash erase cycles (under warranty), and this limits their usability for write-intensive server workloads. In the following we consider both the potential gain from SSDs as well as potential problems on the write endurance side based on datasheet numbers from various contemporary SSDs.

1. The Intel consumer SSD 320 specification sheet lists 4KB random reads at up to 39500 IOPS, and sequential read bandwidth at up to 270 MB/s. Let us use these values as estimates of a consumer SSD performance. Also assume typical consumer hard disk 4KB random read IOPS at 100 IOPS, and read bandwidth at 100MB/s.

   a) How many consumer hard disks are needed to match the random read IOPS performance of a consumer SSD using the estimates listed above? (Note: It might be hard to achieve the SSD read IOPS performance without highly optimized code, as e.g., many currently widely used database systems become CPU limited with SSDs.)

   b) How many consumer hard disks are needed to match the sequential read bandwidth of a consumer SSD? (Note: Many sequential read/write workloads are served nicely by a RAID-array of hard disks.)

2. The Intel SSD 320 is a fairly typical consumer hard disk that is specified with life expectancy of 5 years with a typical client write workload of 20GB writes per day, giving its write endurance as the multiplication of these two. The same specification also lists the sustained sequential write speed as 220 MB/s.

   a) What is the amount of write endurance in terabytes for this SSD?

   b) If we use this SSD in a 100% write workload running at the sustained sequential write speed, how many days does it take to exceed the specified write endurance? (Note: For example heavily used database log disk might face such a workload.)

3. The Intel SSD 710 is an enterprise SSD that has a higher write endurance. The specification lists the write endurance of the largest 300 GB model at 1.1 petabytes (with 4KB data blocks). The same specification also lists the sustained sequential write speed as 210 MB/s.

   a) How many times more data is the write endurance of the enterprise 710 model compared to the write endurance of the 320 consumer model?

   b) If we use this SSD in a 100% write workload running at the sustained sequential write speed, how many days does it take to exceed the specified write endurance? (Note: For example heavily used database log disk might face such a workload.)

Note: Observed real-time SSD endurances seem much higher than the official datasheet figures promise, see:
http://techreport.com/review/24841/introducing-the-ssd-endurance-experiment