Solid State Storage: Making the skies more friendly

Solid state storage (SSS) is a data storage technology made from Flash memory chips instead of spinning metal platters or streaming tape. There's much debate about how fast and to what extent SSS will be adopted into the broad range of commercial applications.

By Khaled Amer, Chair of SSS TWG Performance and Benchmarking Committee, and Neal Ekker, Vice Chair SSSI Education Committee and VP Texas Memory Systems.

Thoughtful industry observers point out that a key ingredient to the adoption of any new technology lies in finding and articulating examples where the technology solves "real world" problems at a down-to-earth cost. In the case of SSS, maybe it's time to look to the skies.

In-flight entertainment (IFE) systems may furnish good examples to illustrate where SSS offers real advantages in real world enterprise environments. Commercial airline digital audio/visual entertainment solutions must perform well on aircraft while operating under severe restrictions in weight, size, and power consumption. Hard disk drives (HDDs) contribute significantly toward these problems. HDDs are also not very suitable for handling the vibrations of an aircraft environment. It may be that the advantages offered by SSS are exactly those needed to make the skies a friendlier place, at least more media rich and responsive.

Up In the Air: Problems with streaming media 7 miles high

IFE systems have come a long way in the last 10 years. Some industry experts expect that around 70% to 80% of 100+ seat aircraft will have some type of IFE by the year 2011, a nearly 50% increase from 2008. IFE systems typically offer very little interactivity, and passengers must be grouped together to watch a movie. You'll wait up to 15 minutes after making your selection. The data storage system is the culprit; waiting this long reduces the amount of concurrent video streams coming out of the storage.

A new generation of IFE provides audio/video on demand (AVOD) and personal televisions (PTVs) that provide airliner passengers with channels ranging from movies and pre-recorded news to music and video games. These new IFEs enable passengers to make their choices and watch movies separately, without delays. They can pause, rewind, fast-forward, or stop a program that they have been watching.

Upgrading IFE systems from non-interactive to AVOD with PTVs for every passenger certainly makes the skies much more friendly and entertaining. However, data storage system weight, size, power consumption, and sensitivity to vibrations pose serious technical challenges. IFEs often provide services to hundreds of passengers on a single aircraft. When the streams of all these services are multiplexed together, the access pattern at the storage device looks like a combination of random access (various streams sharing time slices) and sequential access (each stream taking turns reading a block of its video stream). Tape-based storage would be unable to respond in any acceptable timeframe to such large queues of data requests, so IFEs have moved toward HDDs to address storage needs. But HDDs don't fly particularly well in this environment, on the ground or in the air. Using mechanical moving parts makes them unsuitable due to the issues mentioned above (weight, size, power consumption, and sensitivity to vibrations). To make things worse, to meet the performance requirements of all the passengers using AVOD and video games concurrently, it is necessary to use multiple HDD arrays which become a main contributor to the weight of these systems (some weigh as much as 2,268 kilograms).

Flash Fits Well in the Fuselage

Unlike mechanical hard disks, the capabilities of Flash solid state storage match quite well with the requirements of in-flight entertainment systems. First, Flash SSS has no mechanical moving parts, making the system more reliable and less sensitive to vibrations and rough landings. This would allow the IFE to continue playing your movie or game while the aircraft lands and taxies towards the gate, instead of having to interrupt it 30 minutes or so before you need to leave the plane. Also, Flash SSS weighs substantially less than HDD storage, and it uses much less power. SSS processes around 1,000 transactions per Watt, while HDD processes 5-15 per Watt. In crowed electronics areas this translates into much less heat and lower cooling requirements. SSS is far denser than HDD systems as well, which means it takes up less space for the same amount of storage.

Beyond all of these factors, Flash SSS offers much higher performance than HDDs, for both the random or sequential reads that characterize streaming media entertainment systems. Flash SSS can handle much higher throughput than HDD, allowing more entertainment to be served. Also, Flash response time, or latency, is much lower than HDD. A spinning mechanical disk finds and reads a block of data in no less than 5 milliseconds under optimum conditions. Flash SSS responds about 50 times faster, in tens of microseconds. This makes a significant difference, especially in random access.

Another way to think about throughput or bandwidth and latency is to multiply these metrics together to get total random input/outputs per second (IOPS). One hard drive, even a very fast, relatively expensive one, provides only 100 – 300 IOPS. The HDD head actuators perform acrobatics in their struggle to keep up with random access patterns such as those from hundreds of airline passengers. It's really a matter of mechanics. In contrast, some Flash SSS devices are currently approaching or even exceeding 100,000 IOPS. When several hundred passengers on a large airliner all watch movies, play video games, or listen to music simultaneously, it takes many HDDs to adequately respond, but only one small lightweight Flash SSS device can provide all the storage performance needed.

For passengers, with the huge increase in available bandwidth (random and sequential) provided by SSS, each can request to watch their movie of choice and not need to wait until the system collects a number of requests and streams them out together, which is needed in HDD systems to reduce the effects of random access storage requirements.

Conclusions

The capabilities offered by solid state storage and the requirements of in-flight entertainment systems are almost a perfect match. SSS is faster, lighter, denser, more rugged, and less power hungry than traditional HDD systems. But before you rush out to alert the commercial airline industry, don't forget about similar entertainment media requirements aboard ocean cruise liners and passenger trains around the world, as well as countless other applications. Additionally, because of the performance benefits of SSS, a whole new set of applications will undoubtedly find their way to in-flight and on-board entertainment systems. When it comes to solid state storage, it looks like the sky and our imagination are the only limits.

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