



Foreword to
Understanding SSD Performance Using the
SNIA SSS Performance Test Specification

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SSSI Chair, 2008-2010
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(White paper is available at <http://www.snia.org/forums/ssi/pts>)

I am honored to have been asked to write a foreword to this white paper. I believe it is by far the BEST white paper from SNIA's Solid State Storage Initiative (SSSI) to date. The SSSI is a group I chaired from its inception in 2008 through 2010 and is focused on solid state storage technology and the growth of the industry it has sprouted. This white paper provides an excellent explanation of the recently completed and approved Solid State Storage Performance Test Specification (PTS) – an effort that started almost three years ago by SSSI's sister group, the SSS – Technical Work Group (SSS-TWG). I believe that the PTS is a very important specification for the storage industry because it provides the guidelines and rules for measuring the performance of SSDs, thereby allowing users to competently evaluate and choose SSDs that best fit their unique situations.

To set the stage for this white paper, here are some pertinent facts on solid state storage that should benefit the reader:

- The solid state storage industry has been growing by leaps and bounds since it first emerged a few years ago; every major storage supplier now offers solid state storage products.
- There are approximately 160 solid state drive (SSD) manufacturers in the world today; mergers and acquisitions are occurring rampantly within this group.
- SSD revenues have jumped from around \$500M in 2008 to a projected \$15+B in 2012 – a 30x increase.
- The flash technology underlying SSDs seems to change and improve on a daily basis; Single-Level Cell (SLC) has been replaced by Multi-Level Cell (MLC) as the predominant type of flash used today, and semiconductor processing for flash has moved from 4x nm node products a couple of years ago to 2x nm products today; both of these improvements have resulted in significant capacity increases.
- SSD controllers are becoming much more complex and feature-rich, adding compression, de-duplication, ECC, and encryption to provide much higher reliability and endurance.
- Prices continue to fall, going from an average of \$17/GB today to a projected \$5/GB in 2015.

And finally – most relevant to this white paper...

- SSD performance has drastically improved, providing clear differentiation among product suppliers.

It is important to note that SSDs operate in a completely different manner than traditional hard disk drives (HDDs). The methods and procedures used to measure the performance of HDDs can't be used for SSDs. For instance, SSDs must be "preconditioned" prior to testing, taking them from a "Fresh-Out-of-Box" state to a "Steady State" where their performance can be accurately measured – this step doesn't exist for HDDs. In addition, the specific workload and hardware/software environment will dramatically affect the measured performance. These points are well documented in the white paper.



As you might expect, SSDs are not all made the same, and they don't perform the same. That's where the Solid State Storage Performance Test Specification (PTS) comes in. It describes how to test SSDs to measure their performance, allowing for accurate and fair SSD comparisons. It is a comprehensive specification that applies to both enterprise and client SSDs.

This white paper is "the user guide" for the PTS. It guides the reader through the steps necessary for testing multiple SSDs of different types and capacities, and describes the PTS reports in detail, explaining how to read and interpret each one. Included in this white paper are a total of 30+ figures with accompanying explanatory text that first introduces the reader to the topic of SSD performance in general, then very effectively takes that reader step-by-step through the varying factors, parameters and testing options involved with testing SSD performance. All things considered, this white paper is well written and extremely informative.

Before concluding, I must say a few words about the authors of this paper. I know them well as they were active members of the SSSI when I was its chairman. They are well respected in the industry and I am proud to have worked with them. First, Eden Kim and Easen Ho, the CEO and CTO of Calypso Systems Inc., respectively, were the driving forces behind this white paper, bringing their extensive experience in using the PTS for SSD testing to the project. Also, all of the test hardware and software was provided by Calypso Systems. Next, Tom West, the president of hyperI/O, Chuck Paridon of Hewlett Packard, and Doug Rollins of Micron are experts in storage performance testing and were key contributors, rounding out the authors of this paper. Finally, Jennifer Kim, also of Calypso Systems, spent untold hours performing the layout, editing and proofing of this paper.

There is much more to testing SSDs than one might imagine, and this white paper explains the many nuances in an easy-to-understand way. I applaud SNIA, the SSSI, the SSS-TWG, and especially the authors for a job well done!

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Author's Bio:

Phil Mills joined IBM in San Jose in January 1974. His 30+ year career was primarily in hardware design and architecture for storage subsystems, focusing on host to storage controller interfaces. FC, ESCON, FICON, SCSI, SSA and Parallel OEMI are some of the interfaces that Phil has worked on. He led numerous storage subsystem development teams, including the IBM 3880 and 3990 control units (IBM Shark predecessors). He holds several patents as a result of these efforts.

Phil has been involved with Fibre Channel since its inception. He has taught classes on FC architecture and written white papers for use in education for the IBM field force. This effort led to storage networking where he has spent 10 years.

Phil began working in the SNIA in June 2001 in the Supported Solutions Forum. He was elected to the SSF Chair which he held for two years. Phil was first elected to the SNIA Board of Directors in September 2002, and then re-elected in 2004, 2006 and 2008. He held the position of Secretary for all eight years of his service on the Board. During this time, Phil was instrumental in the development of the SNIA IP Policy, as well as maintenance of the Articles of Incorporation, the Bylaws and the Policies and Procedures. He was also heavily involved in the formation of the Data Management Forum (DMF) and held multiple seats on the DMF Board.

In 2008 Phil founded and chaired the Solid State Storage Initiative (SSSI). Phil was also instrumental in forming the Solid State Storage Technical Work Group (SSS-TWG), a "sister" group to the SSSI. The initial work to develop a performance test specification was started during this period.

During the time that Phil was leading the SSSI He held the chair position for two years at which time he began a new career in patent engineering where he has been working for the last year and a half. Phil holds a BSEE degree from New Mexico State University.



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