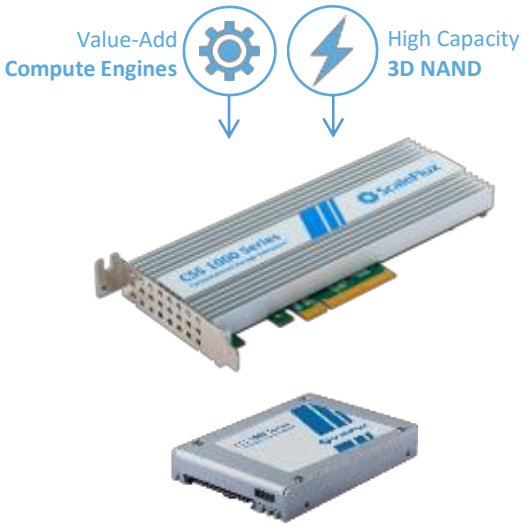
PRODUCT BRIEF

Computational Storage Subsystem (CSS) 1000 Series

Compute and Flash Storage for Data-Driven Applications



PCIe AIC & U.2

Target Applications

- Database / KV-Store
- Big Data
- Content Delivery
- Search
- Hyper-converged
- Mobile Edge Computing
- Data Mining/Warehouse
- HPC
- Cloud

Optimize the Scaling Trajectory

Modern enterprise and cloud infrastructure is faced with the daunting task of scaling compute and storage infrastructure to respond to the variety, velocity, and volume growth of data. With the demise of Moore's Law, adding millions of storage IOPS to servers via SSDs has exposed processing bottlenecks that limit overall server and storage scaling. CSS integrates value-add compute engines with high capacity Flash storage, dramatically increasing the processing efficiency of compute-intensive functions.

#compute2data

CSS brings heavy-duty compute engines right to the data and uniquely parallelizes compute resources across multiple Flash-based storage devices connected through PCIe. Compute resources scale as additional Flash storage is added. This alleviates CPU processing limitations and can reduce the highly expensive task of moving Petabytes of data from storage to the processor for computation. CSS is the foundation for modern, data- driven Enterprise and Cloud infrastructure.

Savings and Agility for an Evolving Data Center

CSS integrates state-of-the-art Flash controllers with LDPC error correction enabling the latest and most cost-effective 3D NAND Flash to be deployed in Enterprise environments. CSS enables field programmable and updateable compute engines through a soft-hardware platform approach. This allows the infrastructure to evolve in lock step with new applications and enables businesses to quickly deploy new revenue generating features to stay a step ahead of their customer demands.

RESPONSIVE PERFORMANCE	AFFORDABLE SCALING	AGILE PLATFORM
Minimize application latency and job run time by simultaneously solving both processing and storage I/O bottlenecks	Deploy high-capacity 3D Flash storage in standard server platforms; optimize utilization of CPU, memory, network & storage resources	Dramatically reduce time-to-deploy new computational capabilities with in-system, reprogrammable HW vs. multi-year cycles

ScaleFlux™

Revolutionary Performance, Evolutionary Integration

CSS integrates into x86/Linux server and storage environments through an easy-to-install ScaleFlux software module. Host-based Flash Translation Layer and Flash Management provides consistent latency and performance. CSS Compute Engines are accessible to applications through familiar APIs/libraries exposed from the software module. By simultaneously solving compute and storage I/O bottlenecks, CSS provides significant and proven run-time improvements to compute and data intensive applications.

Applications	Benchmark	ScaleFlux Value
Hadoop HDFS	TestDFSIO	**7-14X Throughput**
OpenZFS	FIO	**7-13X Throughput, Application Transparency**
Hadoop MapReduce	Teragen & Terasort	**66% *More Jobs Run***
Spark	Teragen & Terasort	**66% *More Jobs Run***
AEROSPIKE	ACT	**50-300% Transactions per Second**
APACHE HBASE	YCSB	**2.5X Throughput**
MySQL	SysBench	**3.6X Throughput**
RocksDB	RocksDB Random Write	**2X Throughput**
Content Delivery Server	Throughput	**6X Throughput**
Fuzzy Text Search	Unindexed, Edit Distance 8	**99X Infrastructure Scaling**

FEATURE	DESCRIPTION
Interface	▪ Low-Latency Flash storage I/O device compatible with available Local Filesystems ▪ (Ext3/4, ZFS, XFS, etc.) and all block storage applications ▪ Easy-to-use APIs/Libraries for Compute Acceleration integration
Field Updatable Compute Engines	▪ GZIP Compression, Erasure Coding (RS), KV-Store ▪ AES-128/256, SHA-3, … and others are also available
Host Linux Software Support	▪ Easy-to-install Linux package for kernel 2.6 & later ▪ Flash Translation Layer, Flash Management, Compute Engine APIs/Libraries, Driver
Application Tuning	▪ FTL/FM & Compute Engine parameters can be adjusted to fine tune performance ▪ Performance throttling based on temperature or power consumption
Data Protection	▪ End-to-end data protection and ECC (Error Correction Code) on all internal memories in the data path for data integrity assurance ▪ Integrated LDPC error protection and Flash die RAID assures 10^{-20} UBER
Power Loss Protection	▪ Complete data protection from unplanned power loss
Agile Compute & Storage Infrastructure	▪ Evolve your infrastructure with new applications by integrating updated computing capabilities through in-system programmability of hardware just like software

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ScaleFlux™