

Samsung SmartSSD[®]

Computational Storage Drive

Challenge: Turning Big Data Into Fast Data

The growth of machine- and user-generated content provides tremendous opportunity for business insights, but the sheer volume of data creates challenges for secure storage, retrieval, processing and analysis. Traditional storage and server architectures rely on moving all data through a host CPU for processing. Moving the data creates bottlenecks between storage and CPU and reduces the usable processing resources at the CPU. The result is substantial and unpredictable delays.



Solution: Bring Computation To The Data

The Samsung SmartSSD drive performs high speed computations on the data where it is stored. Combining a Samsung solid state drive (SSD) and a Xilinx Field-Programmable Gate Array (FPGA), with a fast private data path between them, the SmartSSD drive enables efficient parallel computation at the data itself. This frees up a host CPU to handle other higher level tasks more efficiently.

Example Applications

The Samsung SmartSSD computational storage drive is a flexible, programmable platform that developers can use to create a variety of unique and scalable accelerators for competitive advantage. The range of functions performed on the SmartSSD drive is limited only by developers' imaginations.

Primary Usage Of The SmartSSD Drive	Example Acceleration Functions Performed By The SmartSSD Drive
Data Acceleration Services	Compression/Decompression Encryption/Decryption Erasure Coding Metadata management Data format conversions On-the-fly video transcoding
Analytics Acceleration Services	Database and data lake acceleration Predicate pushdown for ad-hoc queries on databases: e.g. scan, filter, aggregate Searching of data logs Image recognition/object detection Media content distribution AI/ML inference

Performance Examples*

Real Time Analytics & Business Intelligence:

2.8x faster SQL query execution on Parquet data, and performance scales with additional SmartSSD drives

Rich Media:

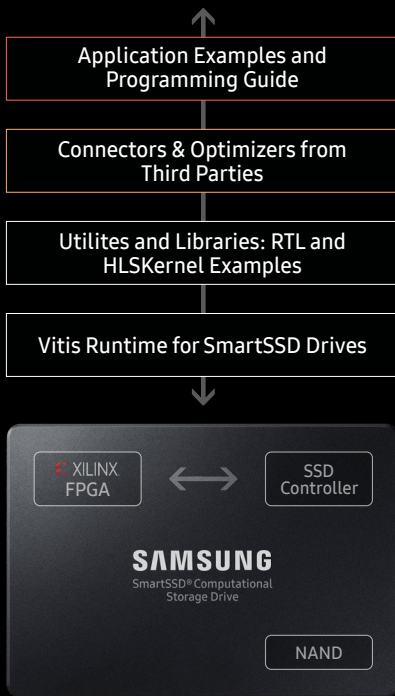
3 SmartSSD drives reduce CPU utilization by 87% while maintaining the same video transcoding frame rate

Data Services:

24 SmartSSD drives operating in parallel read LZ4 compressed data at 72 GBps and decompress at line rate

SmartSSD Drive Benefits

- **Technology Leadership:** The SmartSSD drive integrates SSD and FPGA from the technology leaders, Samsung and Xilinx.
- **Leading NAND and proven SSD Controller:** A high performance Samsung Enterprise SSD controller SoC provides Flash Translation Layer and Flash Management functions.
- **Fast and Flexible Acceleration Engine:** The SmartSSD drive contains the Xilinx Kintex Ultrascale+ FPGA, fully dedicated for acceleration. This delivers extreme parallelism, deep pipelining, and high power-efficiency for data path intensive tasks.
- **Scalable Performance:** Accelerator processing power and accelerator-to-data bandwidth scale with the amount of data and the number of SmartSSD drives. SmartSSD-based servers remove PCI-Express bottlenecks, producing near-linear performance scaling even on an over-subscribed host CPU.
- **PCIe Lane and Space Savings:** Other computing accelerators (e.g. GPUs, external FPGAs) use up precious PCIe lanes in the host CPU. In contrast, the SmartSSD drive connects via PCIe lanes already used for storage, freeing up lanes for additional storage and/ or networking.



Flexible Accelerator IP Development Options

- **Third party IP development:** Samsung and Xilinx partners provide IP and acceleration solutions for deployment on the SmartSSD drive. Custom IP development is also available via partners.
- **Redeployment of IP:** From Cloud to Enterprise workloads, Xilinx tools provide seamless FPGA IP mobility.
- **Simplified development:** The Xilinx Vitis environment allows development in C, C++, or OpenCL. By using a fixed “Design Support Archive” (DSA) I/O shell, developers can achieve high productivity by focusing only on the accelerator kernel under development.
- **HDL development:** The Xilinx Run Time environment allows access to the full spectrum of hardware description languages (HDLs), including Verilog and VHDL, for maximum design flexibility and optimization. This design flow also simplifies the re-use of existing accelerator IP designed in HDL for ASICs or FPGAs.

Internal Data Path

The SSD controller provides the NAND media interface and management while the FPGA provides logic elements and CPU cores for acceleration. A private, high-speed peer-to-peer link connects the SSD controller to the FPGA and transfers data between them. This internal bandwidth scales as SmartSSDs are added to a system.

SmartSSD Computational Storage Drive Specification*

Form Factor	2.5" (U.2)	
Storage Capacity	3.84TB (other capacities coming soon)	
Host Interface	Single-port PCIe Gen 3x4	
Spec Compliance	NVMe spec rev. 1.3, PCIe base specification rev. 3.0, NVMe Management Interface (NVMe MI) 1.0	
Programmable Hardware Accelerator (FPGA)	Xilinx Kintex Ultrascale+ KU15P FPGA	
	System Logic Cells	1,143 Million
	Available LUTs for acceleration tasks	Approx. 300k
	DSP Slices	1,968
	Internal Distributed RAM	34.6 Mbit
	Internal UltraRAM	36.0 Mbit
	Accelerator-dedicated DRAM	4 GByte DDR4 SDRAM @ 2400 Mbps
Speed Grade	-2LE	
SSD Controller	Enterprise class SSD controller	
NAND Flash Memory	Samsung V-NAND®	
	Write Endurance	1 DWPD for 5 Years
	Sequential 128k Read, QD 256	3300 MB/sec
	Sequential 128k Write, QD 256	2000 MB/sec
	Random 4k Read, QD 64	800,000 IOPS
	Random 4k Write, QD 64	110,000 IOPS
	Uncorrectable Bit Error Rate (UBER)	1 sector per 10 ¹⁷ bits read
Mean Time Between Failure (MTBF)	2,000,000 hours	
Power Consumption	Dynamic power management and throttling	
Operating Temperature	Commercial range	
Physical Dimensions	69 x 100 x 15 mm	
Weight	400 grams	



Visit <https://samsungsemiconductor-us.com/smartssd/> to learn how.

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