

# SmartSSD<sup>®</sup> Computational Storage Drive

## OVERVIEW

The Samsung SmartSSD computational storage drive (CSD) is the industry's first adaptable computational storage platform. It empowers a new breed of software developers to easily build innovative hardware-accelerated solutions in familiar high-level languages. The SmartSSD dramatically accelerates data intensive applications by 10X or more by pushing compute to where the data lives.

At the heart of the SmartSSD is the Xilinx Adaptive Platform, a powerful toolkit which enables customers to create customized, scalable applications to solve a broad range of data center problems.



## TARGET APPLICATIONS

- > AI/ML Inference
- > Big Data Analytics
- > Business Intelligence
- > Data Lake/DB Acceleration
- > Data Warehousing
- > Encryption/Decryption
- > Financial Services
- > Genomics
- > Search Queries
- > Storage & Virtualization
- > Transparent Compression
- > Video Analytics
- > Video File Transcoding



## CHALLENGE

**Turning Big Data Into Fast Data**

The global datasphere will grow from 45 zettabytes in 2019 to 175 by 2025, and nearly 30% of the world's data will need real-time processing. This data explosion provides tremendous opportunity for business insights, but the sheer volume creates challenges for secure storage, retrieval, processing and analysis.

Traditional processor-centric architectures rely on the CPU for all data processing, but moving the data between storage and CPU creates performance bottlenecks for data-intensive applications. The results are unacceptable delays in data processing, high costs, and density and scalability issues



## SOLUTION

**Bring Compute To Where The Data Lives**

The SmartSSD CSD performs high speed computations on data where it is stored. Combining a high performance Samsung Enterprise SSD and an acceleration-dedicated Xilinx Kintex<sup>®</sup> Ultrascale+ FPGA with a fast private data path between them, the SmartSSD CSD enables efficient parallel computation on data itself. This unlocks massive performance gains and dense, linear scalability, while freeing the CPU to handle other higher-level tasks more efficiently.

## XILINX ADAPTIVE PLATFORM

At the heart of the SmartSSD CSD is the Xilinx Adaptive Platform, which harnesses the programmability of Xilinx FPGAs to create the first fully customizable computational storage device. The SmartSSD CSD combines the uncompromising performance of hardware acceleration with total programmability, using common high level languages like C, C++ and OpenCL.

The SmartSSD CSD supports the [Vitis development environment](#) and accelerator framework, plus a library of acceleration kernels that makes creating new accelerators and integrating them into applications easier than ever before.

With Xilinx Storage Services, the SmartSSD CSD includes powerful offload capability that is integrated with popular storage software such as dm-crypt and Virtual Data Optimizer.

## SIMPLIFIED DEVELOPMENT

The Xilinx Vitis environment is a unified software toolkit that enables a broad new range of developers – including software engineers and AI scientists – to take advantage of the power of hardware adaptability. The Vitis environment allows development in C, C++, or OpenCL, automatically tailoring the Xilinx hardware architecture to the software or algorithmic code without the need for hardware expertise. Rather than imposing a proprietary development environment, the Vitis platform plugs into common software developer tools and utilizes a rich set of optimized open source libraries, enabling developers to focus on their algorithms

Additionally, 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.



## PERFORMANCE EXAMPLES

### Real-time Analytics

**2.8x**

faster SQL query execution on Parquet data from 1 SmartSSD CSD, and performance scales with additional drives

### Rich Media

**87%**

reduction in CPU utilization from 3 SmartSSD CSDs, while maintaining the same video transcoding frame rate

### Data Services

**72GBps**

read rate of LZ4 compressed data and line rate decompression from 24 SmartSSD CSDs in a single 2U server



## INTERNAL DATA PATH

The FPGA provides logic elements and CPU cores for acceleration. The SSD controller provides the NAND media interface and management while a private, high-speed peer-to-peer link connects the SSD controller to the FPGA and transfers data between them.

## XILINX STORAGE SERVICES

With Xilinx Storage Services, the SmartSSD CSD includes powerful offload capability that is integrated with popular storage software such as dm-crypt and Virtual Data Optimizer.

## SCALABLE PERFORMANCE

Accelerator processing power and accelerator-to-data bandwidth scale with the amount of data and the number of SmartSSD CSDs. SmartSSD CSD-based servers remove PCI-Express bottlenecks, producing near-linear performance scaling even on an over-subscribed host CPU.

## PARTNER SOLUTIONS

Using the power of the Xilinx Adaptive Platform, [custom accelerators](#) have been developed by Xilinx partners, including data analytics, search-in-storage, video file transfer, and no-load compression.

## SPECIFICATIONS

<b>Form Factor</b>	2.5" (U.2)	
<b>Storage Capacity</b>	3.84TB	
<b>Host Interface</b>	Single Port PCIe Gen3x4	
<b>Spec Compliance</b>	NVMe spec rev. 1.3, PCIe based specification rev 3.0, NVMe Management Interface (NVMe MI) 1.0	
<b>NAND Flash Memory</b>	<b>Enterprise Class SSD Controller</b>	
	Samsung V-NAND®	
	Write Endurance	1DWPD for 5 Years
	Sequential Read (128KB)	Up to 3,300 MB/sec
	Sequential Write (128KB)	Up to 2,000 MB/sec
	Random Write (4KB)	Up to 800,000 IOPS
	Random Read (4KB)	Up to 110,000 IOPS
	Uncorrectable Bit Error Rate (UBER)	1 sector per 10 <sup>17</sup> bits read
Mean Time Between Failure (MTBF)	2,000,000 hours	
<b>Hot Plug Support</b>	Power Loss Protection Included Inrush Current Protection Included	
<b>Dimensions</b>	60 x 100 x 15 mm	
<b>Weight</b>	400 grams	

	Xilinx Kintex™ Ultrascale+ KU15P FPGA	
	<b>Programmable Hardware Accelerator (FPGA)</b>	System Logic Cells
Available LUTs for acceleration tasks		Approx. 300K
DSP Slices		1,968
Internal Distributed RAM		34.6 Mbit
Internal UltraRAM		36.0 Mbit
Accelerator-dedicated RAM		4 Gbyte DDR4 SDRAM @2400 Mbps
Speed Grade		-2LE
<b>Temperature</b>	Operating	0 to 70° C
	Non-Operating	-40 to 85° C
<b>Humidity</b>	Non-Operating	5% to 95%, Non-condensing
<b>Power Consumption</b>	Power Management	Dynamic power management and throttling
	Active	<=25W
	Idle	18W
<b>Vibration</b>	Non-Operating	20G (10~2000HZ, sweep sine)
<b>Shock</b>	Non-Operating	1500G, Duration 0.5 msec, Half-Sine Wave