

VIRTUAL EVENT • MAY 24-25, 2022

Innovation with SmartSSD® for Green Computing

Yang Seok Ki, Ph.D.

Vice President, Memory Solutions Lab, Samsung Electronics



 Data-centric computing using computational storage devices can be a promising green computing alternative for emission reduction.





Climate Change and Data Center

The Climate Has Worsened



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CO2 Concentration







Credit: https://climate.nasa.gov/interactives/climate-time-machine



2077

Data Centers Have Been Doing Relatively Well So Far

Data Center Energy Index



Source: https://www.iea.org/reports/data-centres-and-data-transmission-networks

- Data centers used 1% of the world's electricity in 2020
 - 200-250 Tera Watt hours / year
- Almost flat since 2010 due to technology innovations



Source: Recalibrating global data center energy-use estimates, Eric Masanet et. al, Science Feb. 2020



We Need to Do Better for Next Generation

A challenging milestone has been set for 53% emission reduction.



Source: https://sciencebasedtargets.org/resources/legacy/2020/04/GSMA_IP_SBTreport_WEB-SINGLE.pdf?msclkid=cb58e569b80b11ec9a0efd3cf4645555

2030

2025





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2020

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Server Energy Efficiency

What Consumes the Most Energy in Data Centers?

Servers use more than 50% electricity of data centers.



Source: Recalibrating global data center energy-use estimates, Eric Masanet et. al, Science Feb. 2020



Has Server's Compute Density Increased?

Moore's law made possible high-density servers with more computing power.



Source: Summarizing CPU and GPU Design Trends with Product Data, https://arxiv.org/abs/1911.11313



How About Server's Utilization?

Cloud and virtualization have reduced server idle time.



_Source: https://www.iea.org/data-and-statistics/charts/global-data-centre-energy-demand-by-data-centre-type____2010-2022?msclkid=6e348efcb85611eca7c09fa038acf209



Source: https://www.spiceworks.com/marketing/reports/state-of-virtualization/?msclkid=7650175eb8e211eca094a43ee0056d86



How Can We do Much Better?

Existing solutions have little room for further improvement.

Server Density

- Dennard scaling does not work any more.
- Moore's law is slowing down.

Server Utilization

- Majority of data centers are already cloud-based (>80%).
- Most servers are already virtualized (>92%).





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Green Computing Using Computational Storage Devices

What Is a CSD (Computational Storage Device)?

A storage device with processing capabilities to improve system efficiency





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What Are the Potential Benefits of CSDs?

 Scalable, low-power processing with a low bandwidth footprint at the rack level



Can CSDs Provide Higher Server Density?

Given a rack power budget, determine the power trade-off between CSDs and server CPUs for maximum server throughput.





Can CSDs Provide Higher Server Density? (Cont'd)

A roofline model study shows that CSD is competitive for IO-intensive tasks.







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Samsung SmartSSD CSD

The 1st SmartSSD CSD Product Was Released 2020

Computational storage device with flexible HW acceleration

4 TB 5th Generation Samsung V-NAND 4 GBs accelerator memory Xilinx FPGA with customizable accelerator CPU (Host) PCIe Address Space SmartSSD CSD NVMe FPGA / DRAM SSD **NVMe** PCle SSD Read/Write Read/Write Switch FPGA Accel. Controller FPGA P2P communication DRAM FPGA DRAM

https://www.xilinx.com/applications/datacenter/computational-storage/smartssd.html

SSD	Spec
Form Factor	2.5″
Capacity	3.84TB
Interface	PCle Gen3 x 4
Seq. Read	3,300 MB/sec
Seq. Write	2,000 MB/sec
Ran. Read	100K IOPS
Ran. Write	800K IOPS
UBER	1 sector per 10^{17} bits
MTBF	2M hours
FPGA	Spec
Logic Cells	1,143 Million
LUTs	Approx. 300K
DSP Slices	1,968
Distributed RAM	1 34.6 Mbit
UltraRAM	36.0 Mbit
DRAM	4GB DDR4 SDRAM @2400 Mbps
Active Power	<= 25W
Idle Power	18W
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TCO and Scalability Benefits Were Confirmed





Source: https://www.xilinx.com/publications/solution-briefs/xilinx-smartssd-ctaccel-solution-brief.pdf

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Next Generation Will Be Available Soon

The 2nd SmartSSD CSD with user-friendly programming will be available for evaluation 2022.



SmartSSD CSD Will Be a HW SW Co-design Platform

Integrate your IPs to SmartSSD CSD



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Federated Data-centric Computing Using Domain Specific Architectures

Domain Specific Architectures Are Already Available

 Effectively process data by state using the existing power-efficient, performant processing units.



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Federated Data-centric Computing Are Promising

Perform computation near the data that can be processed most energy-efficiently.



This New Paradigm Requires Open Innovation

Create new value constellations together for a new computing paradigm



RE-Cap



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