STORAGE DEVELOPER CONFERENCE

SDC 21

BY Developers FOR Developers

Virtual Conference
September 28-29, 2021

A SNIA Event

Power-Efficient Data Processing with Software-Defined Computational Storage

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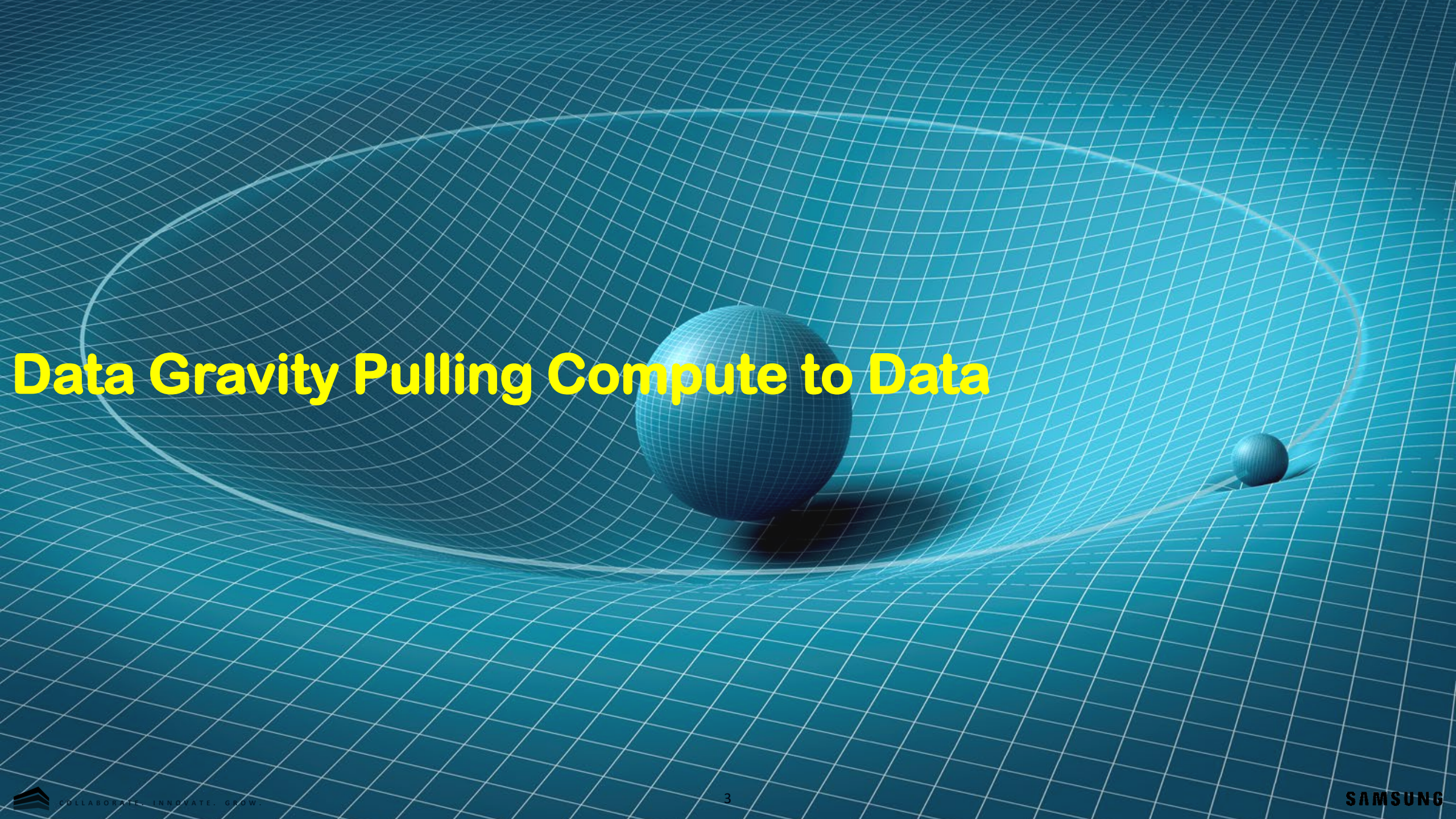
SAMSUNG

Outline

- Data Gravity Pulling Compute to Data
- Power-efficient Computing for Data at Rest
- Samsung's R&D History for Computational Storage
- Call for Participation in New Value Constellations

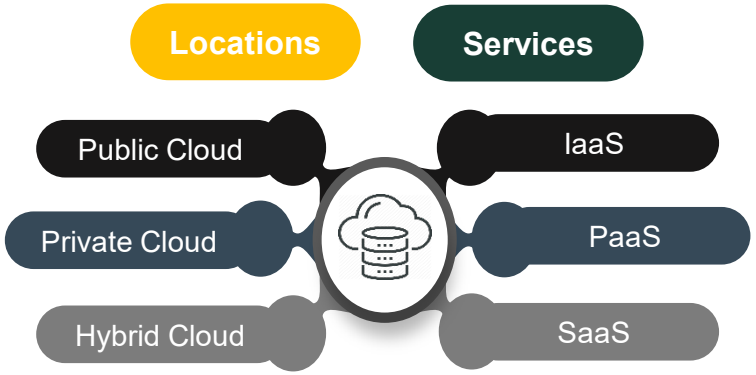

Data Gravity Pulling Compute to Data

Technologies for Modern Data Analytics

- **Democratization of big data storage and processing technologies**

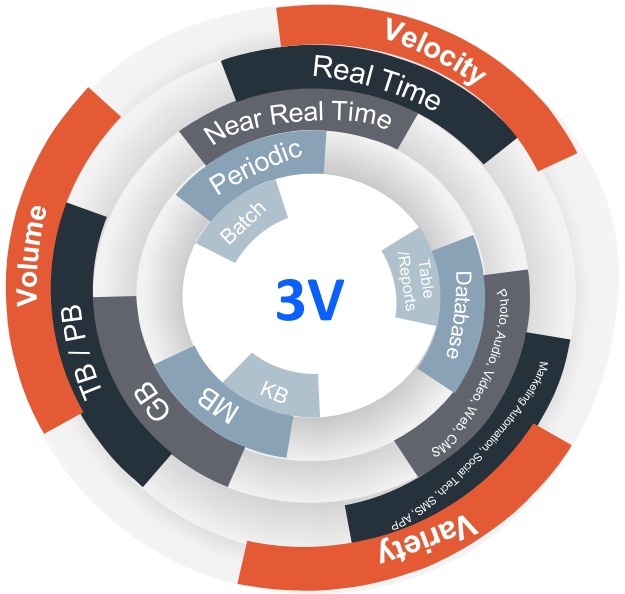
Cloud

- Scalable IT resources on demand



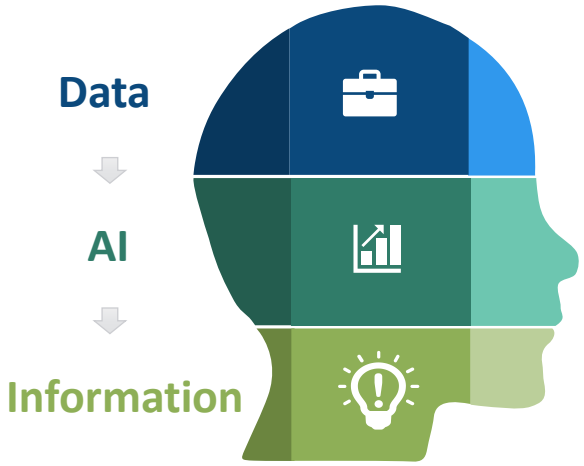
Big Data

- Rapid growth of various types of data



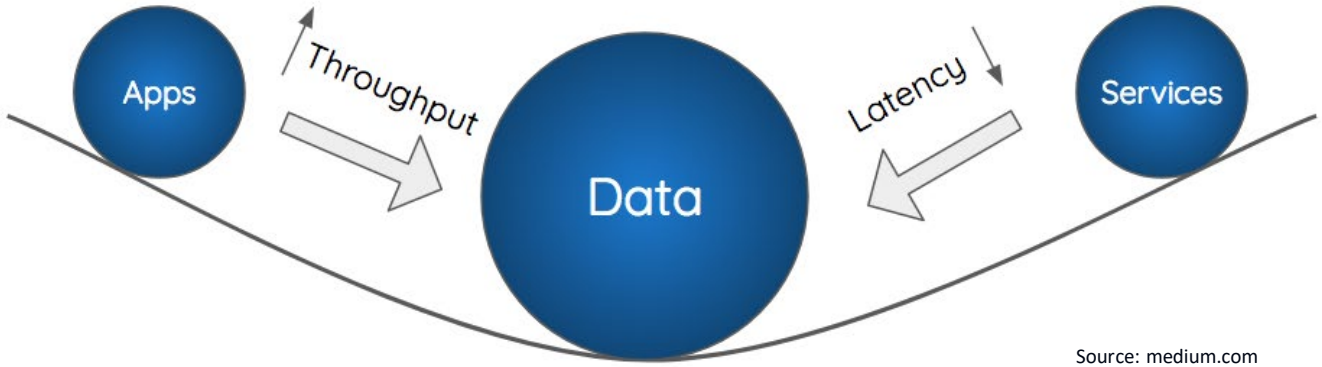
Artificial Intelligence

- Value creation out of raw data



Data Gravity

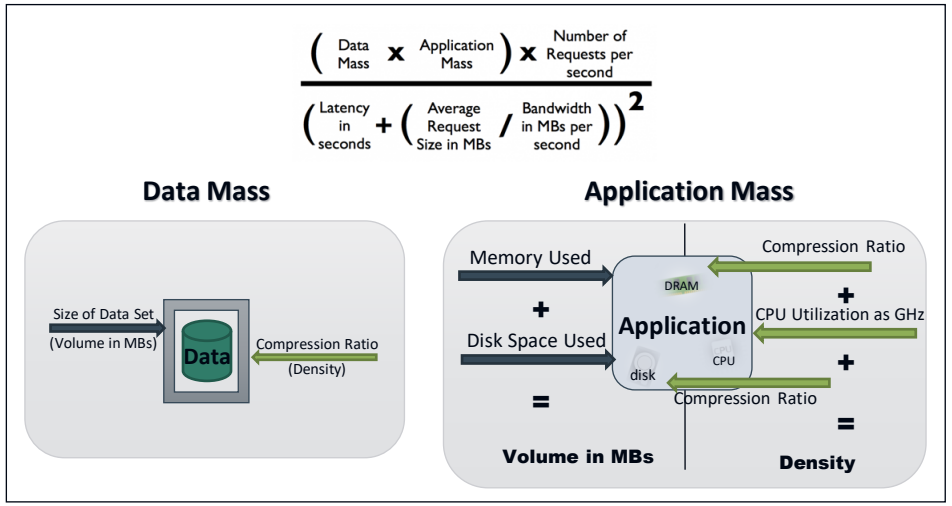
- **Applications and services move to massive data closer**



Source: medium.com

Dave McCrory's Data Gravity Force

$$\frac{\left(\text{Data Mass} \times \text{Application Mass}\right) \times \text{Number of Requests per second}}{\left(\text{Latency in seconds} + \left(\text{Average Request Size in MBs} \,/\, \text{Bandwidth in MBs per second}\right)\right)^2}$$



Source: infoq.com

Gravity Acceleration

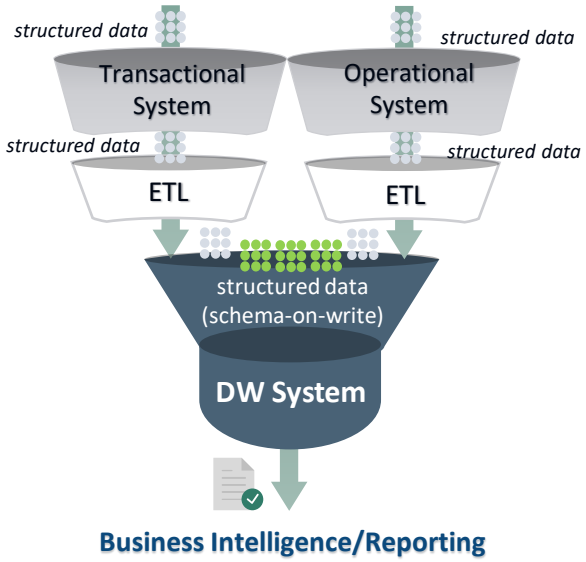
Source: digitalrealty.com

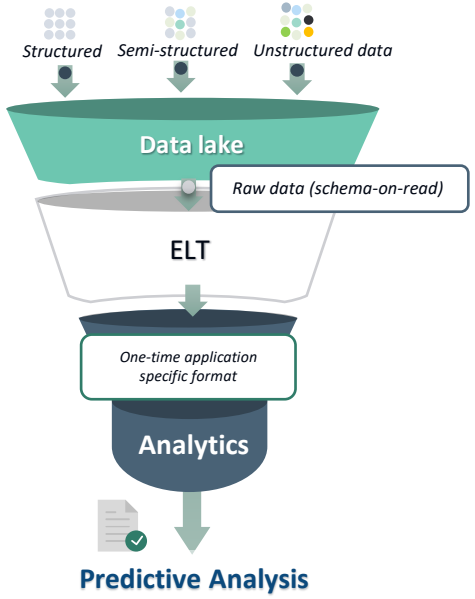
Asymmetric Price Policy

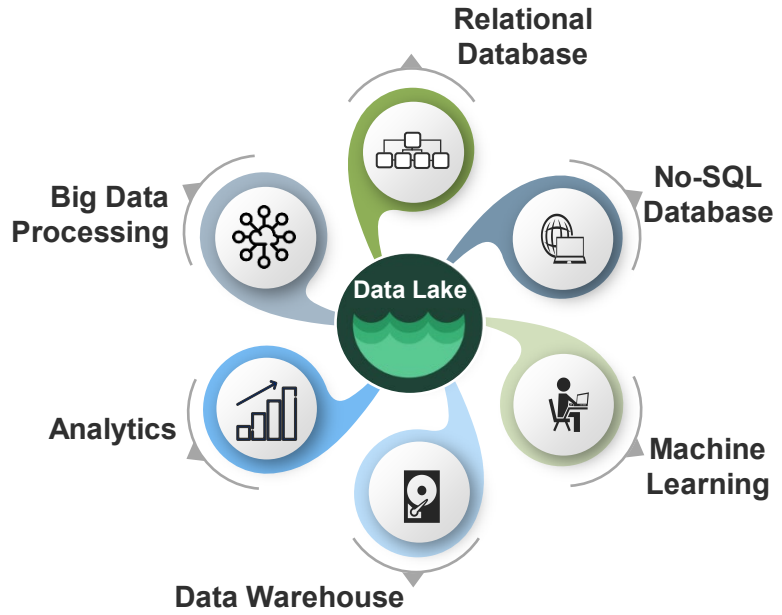
Paradigm Shift of Massive Data Processing

- **Data processing centered around massive (un)structured data**

Data Warehouse (DW) | **Data Lake** | **Data Lakehouse**



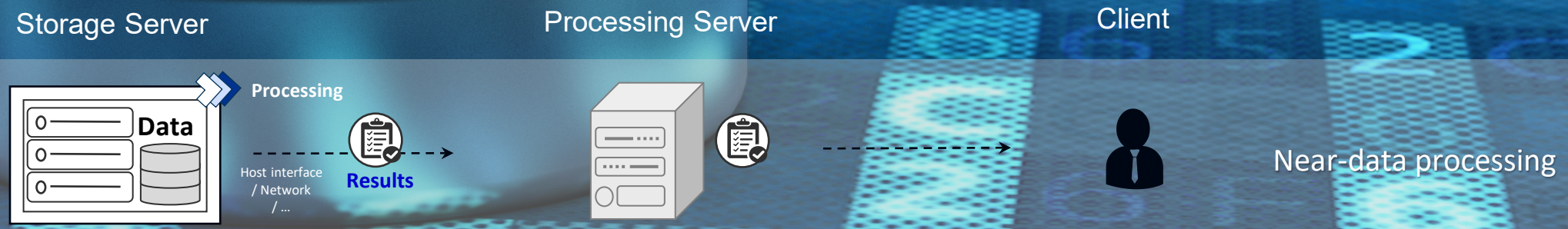




Independent data storage and processing:
Move Data to Processing

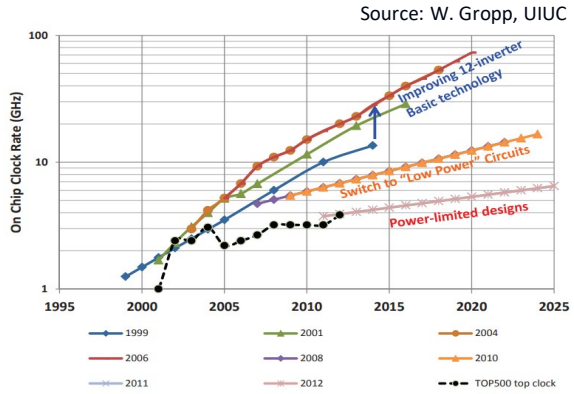
Platform of data storage and processing:
Move Processing to Data

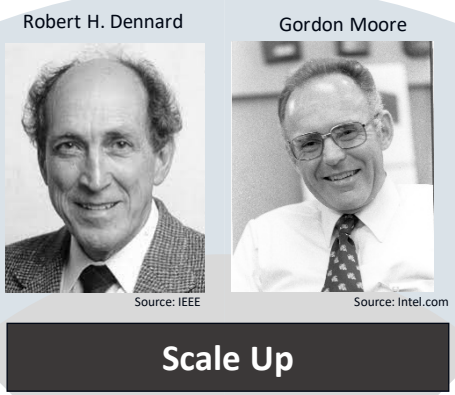
Power-efficient Computing for Data at Rest

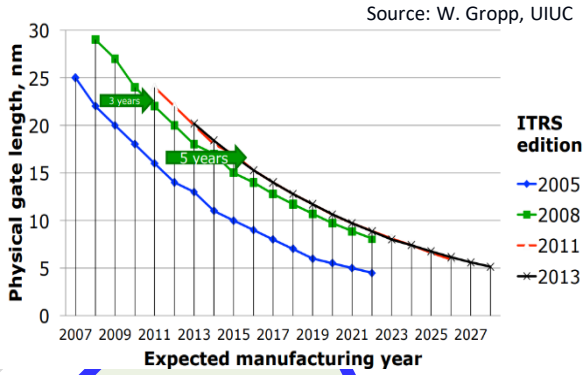


Computer Architecture Trend

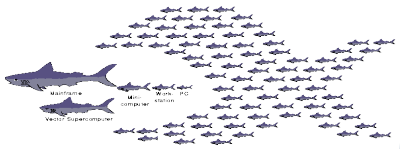
- **Era of domain specific architecture**







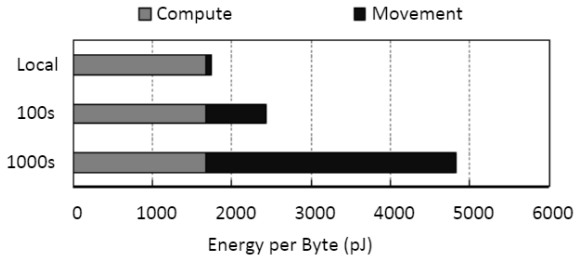
Scale Up



Google

Big Data

Scale Out



Source: S. Choi, Memsys'15

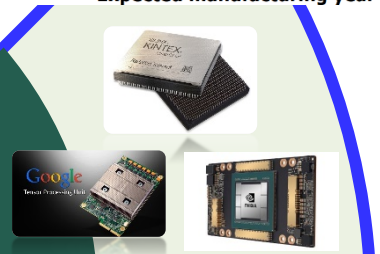
POWER

High **power** consumption due to many servers and data transfer

TCO

Moore's Law

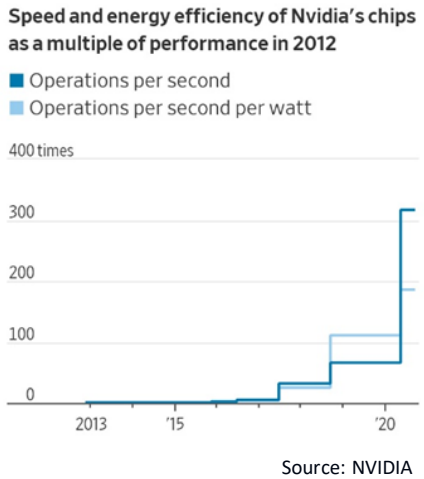
Scale In



Jensen Hwang

Source: ceoworld.biz

Moore's law enabled in domain specific computing architecture

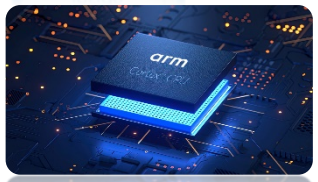


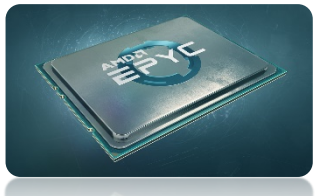
Source: NVIDIA

Data State and Domain Specific Computing Architecture

- **Special-purpose, power-efficient, high-performance data processing**

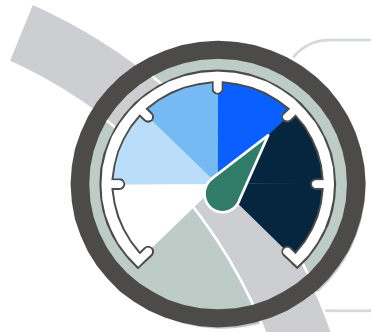
CPU





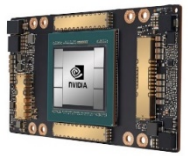
Data in Any States

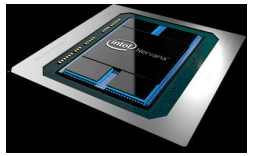
vs.



Data in Use

GPU/TPU/NPU





Data in Transit

Data Processing Unit

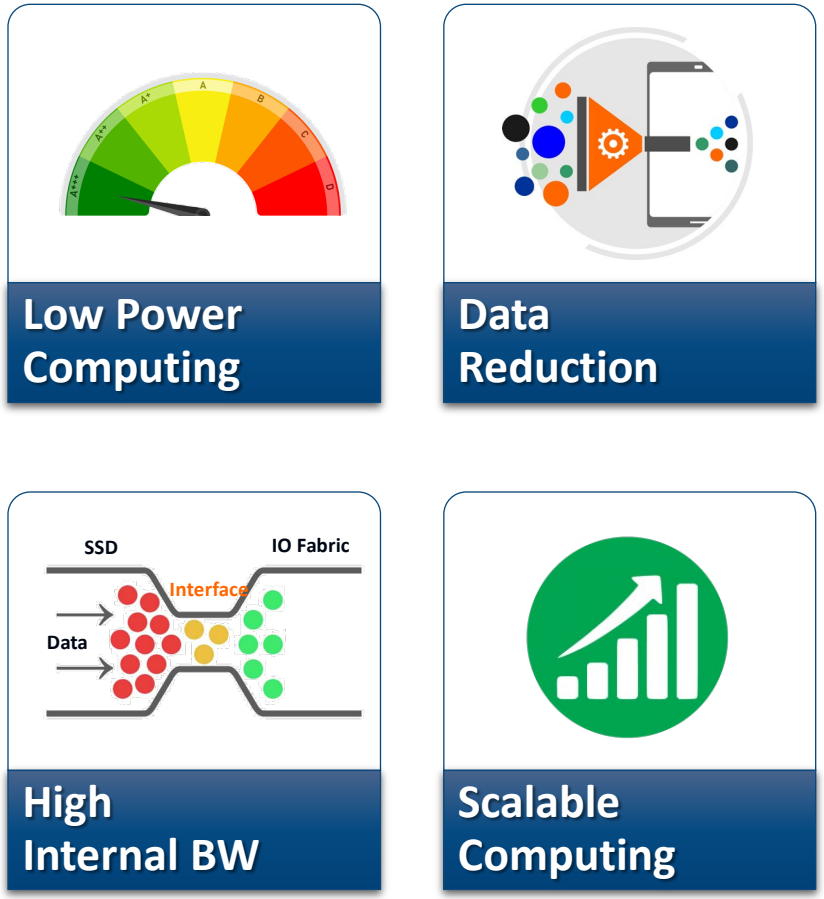
Data at Rest

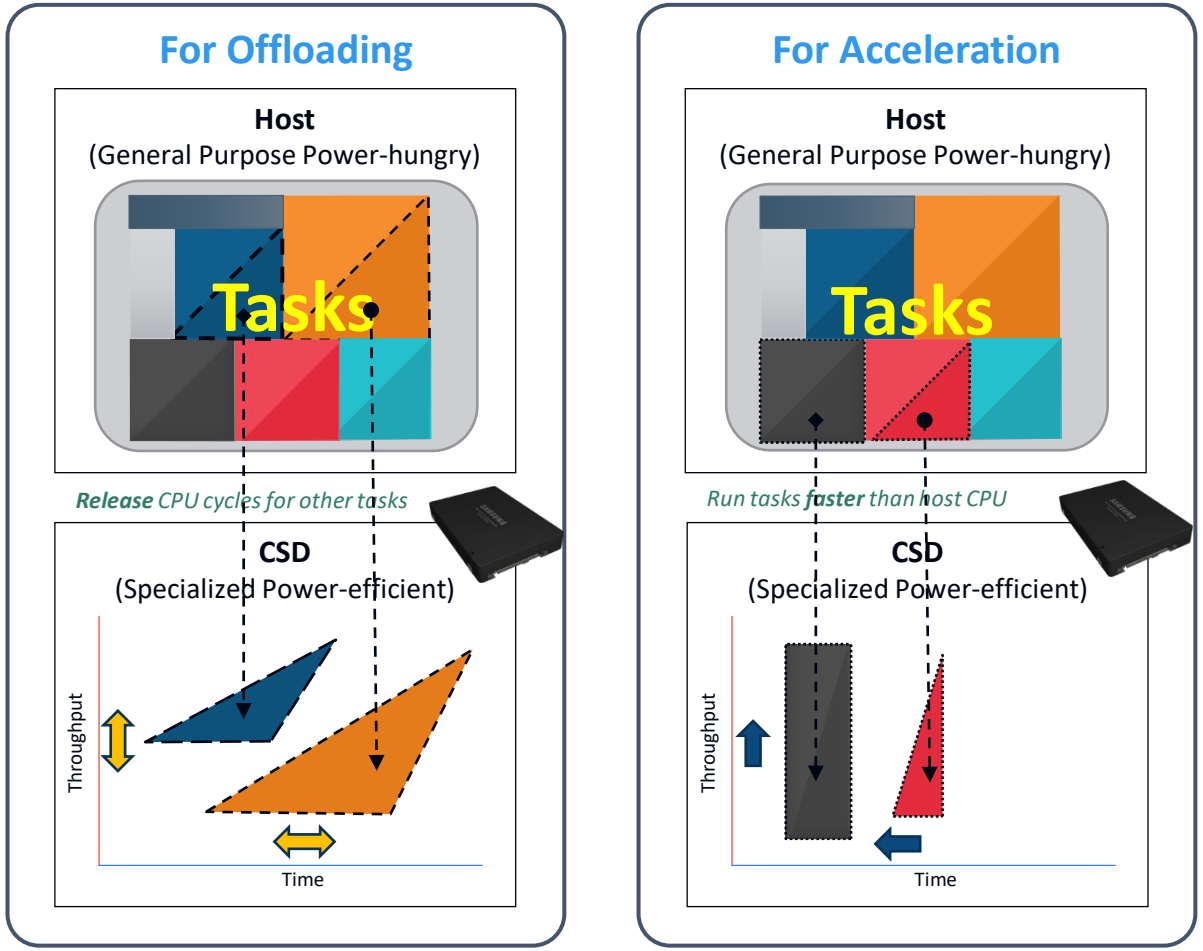
Computational Storage

Computational Storage Device (CSD) for Big Data at Rest

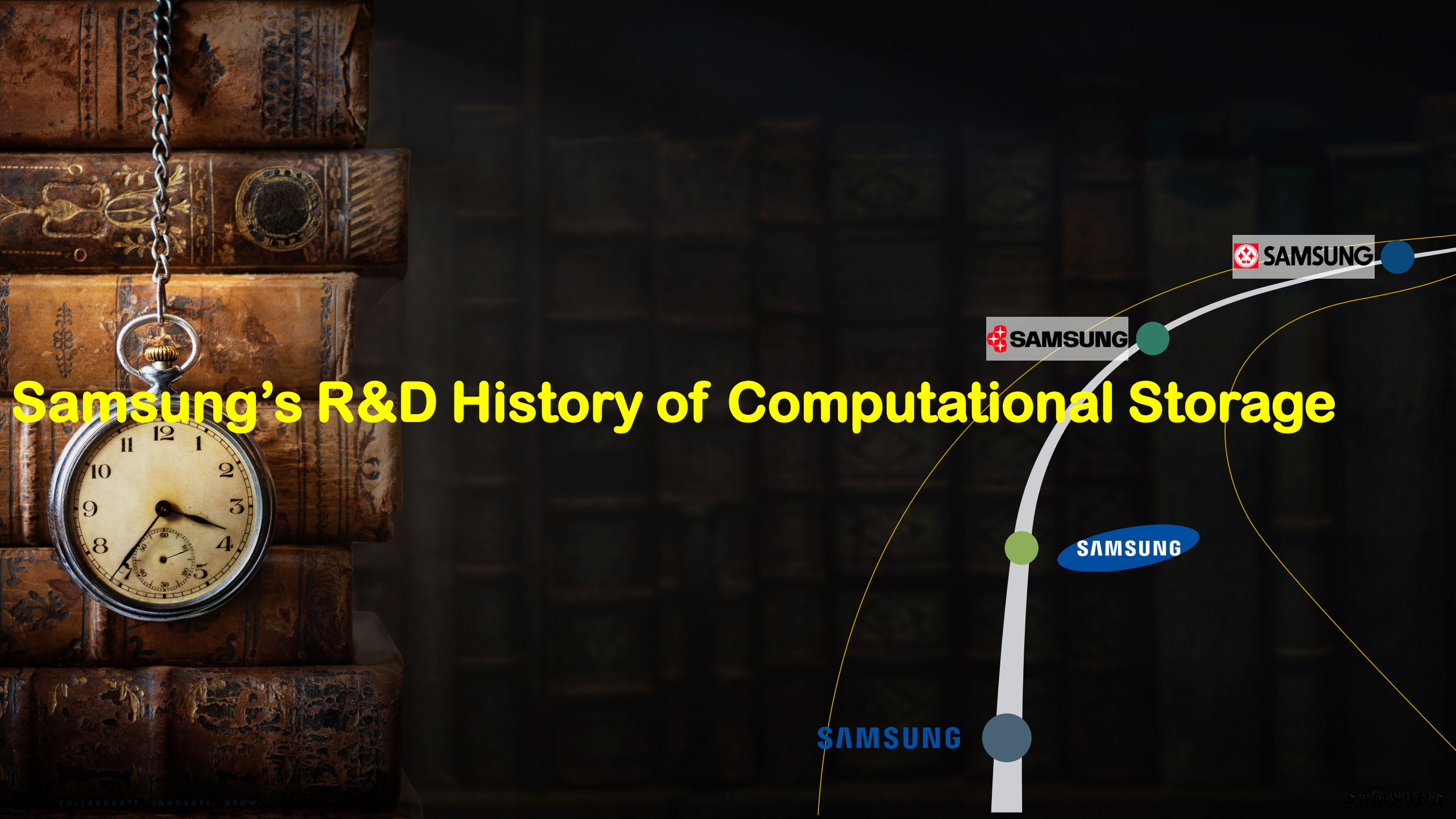
- **Low-power in-situ processing for data refinement and maintenance**

Potential CSD Benefits





performance/watt(⬇)/$** **performance(⬆)/watt/$

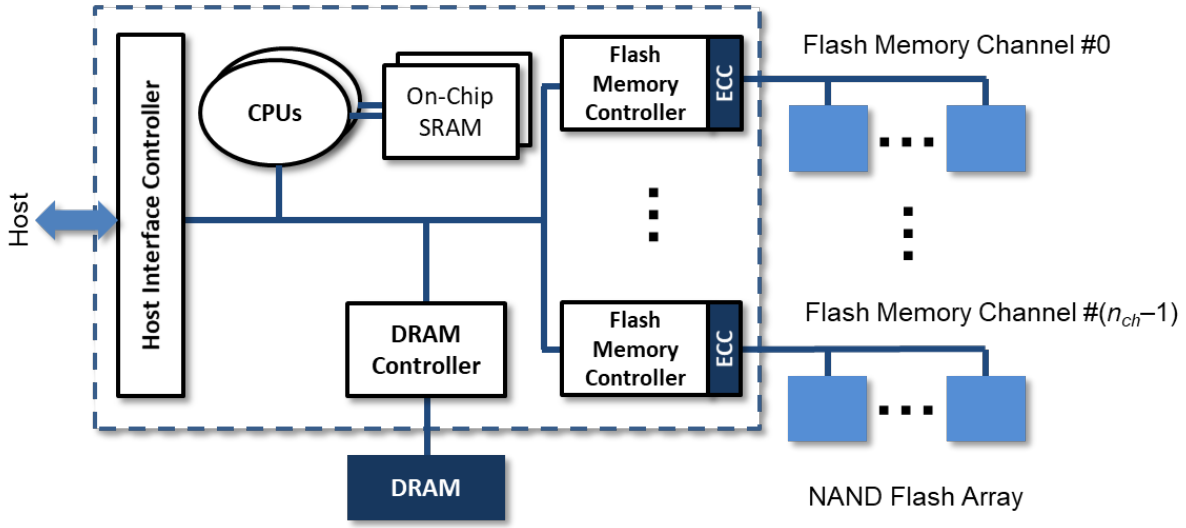


Samsung's R&D History of Computational Storage

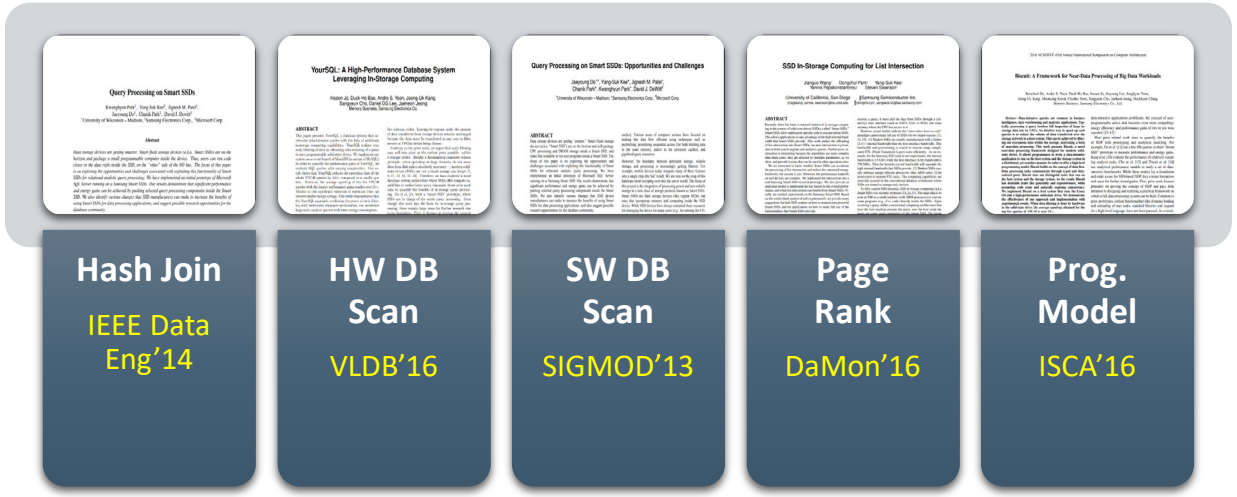
1st Gen: In-Storage Computing (ISC) Research (2011-2016)

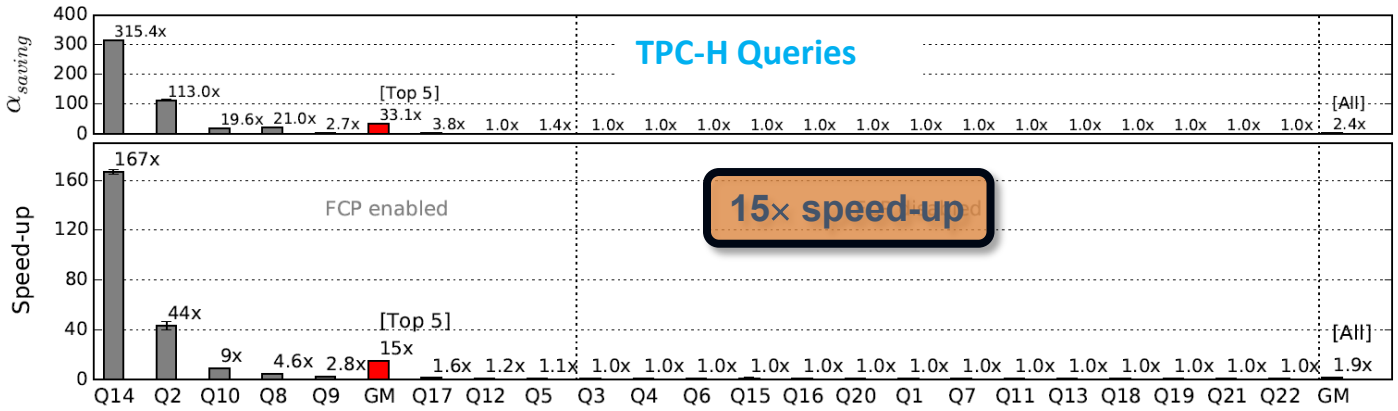
- **Power-efficient data filtering acceleration**

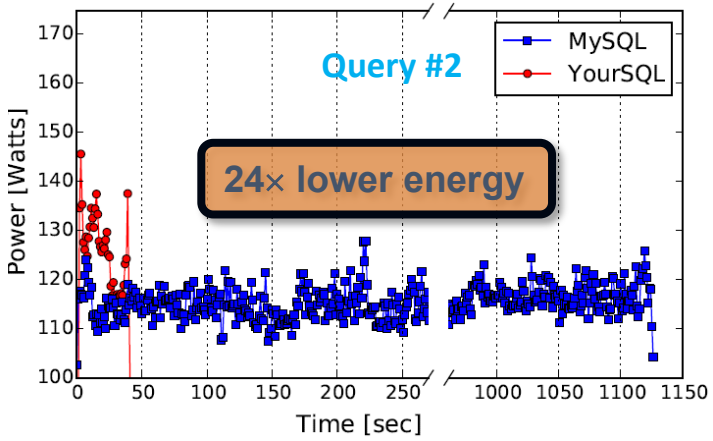
SSD Architecture



High Performance/Watt Using ISC SSD



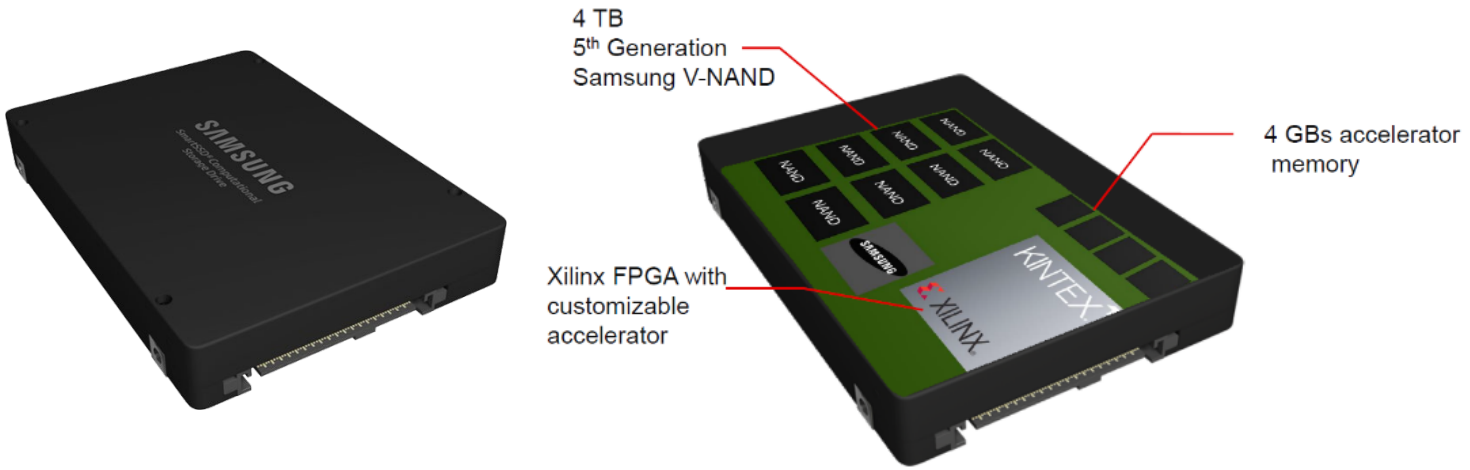


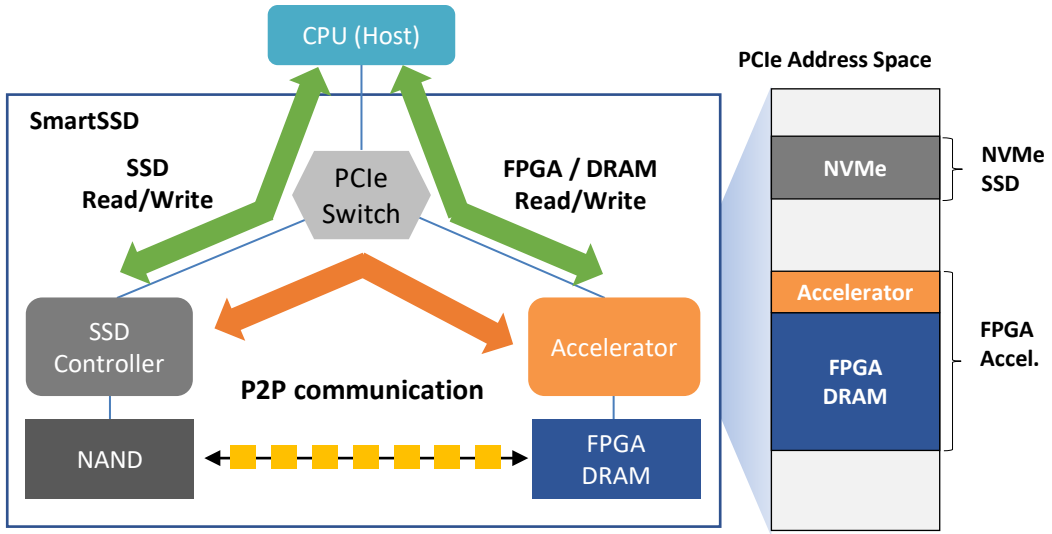


System Configuration
- On dual Intel Xeon E5-2640 w/ 64 GB DRAM
- Samsung PM1725 1TB SSD
- MariaDB 5.5.42 w/ modifications using Biscuit
- Workload is TPC-H w/ a scale factor of 100

2nd Gen: SmartSSD® CSD Product (Available via Xilinx)

- **Cost-effective scalable data processing**





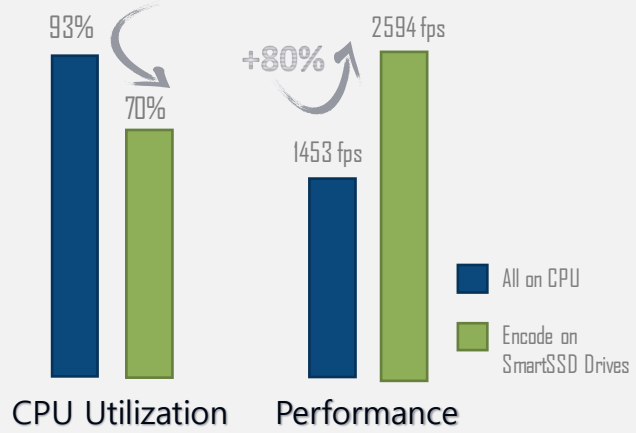
SSD	Spec
Form Factor	2.5”
Capacity	3.84TB
Interface	PCIe Gen3 x 4
Seq. Read	3,300 MB/sec
Seq. Write	2,000 MB/sec
Ran. Read	100K IOPS
Ran. Write	800K IOPS
UBER	1 sector per 10^{17} bits
MTBF	2M hours

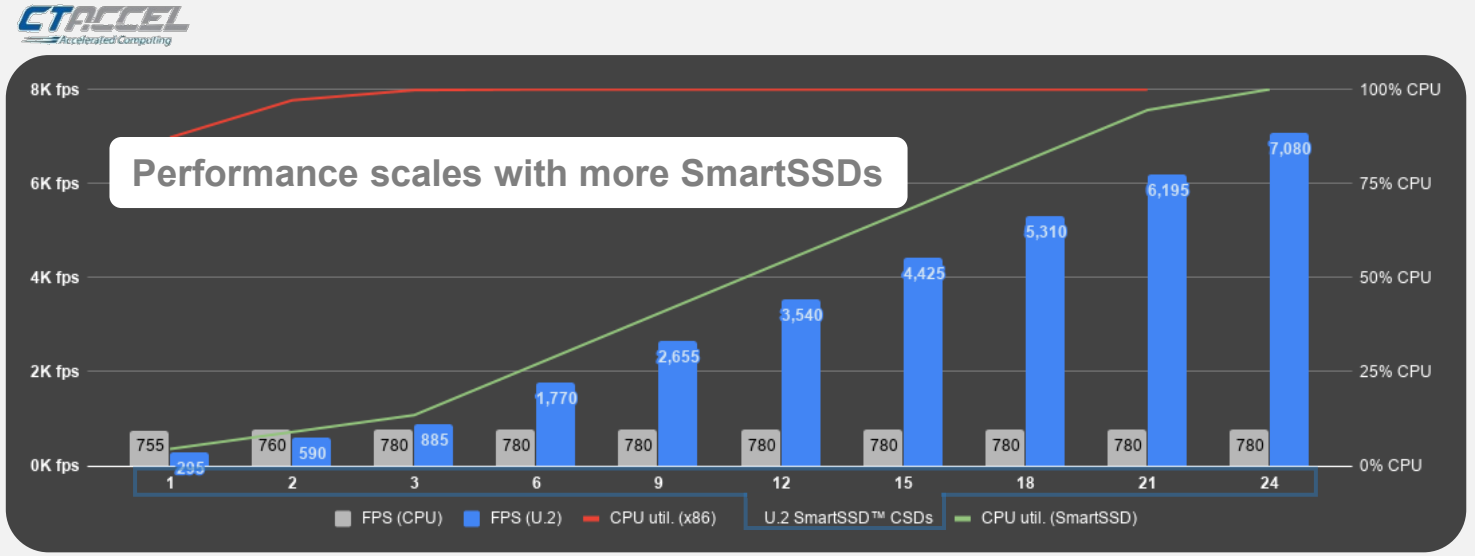
FPGA	Spec
Logic Cells	1,143 Million
LUTs	Approx. 300K
DSP Slices	1,968
Distributed RAM	34.6 Mbit
UltraRAM	36.0 Mbit
DRAM	4GB DDR4 SDRAM @2400 Mbps
Active Power	<= 25W
Idle Power	18W

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

TCO (Total Cost of Ownership) and Scalability

Video Transcoding



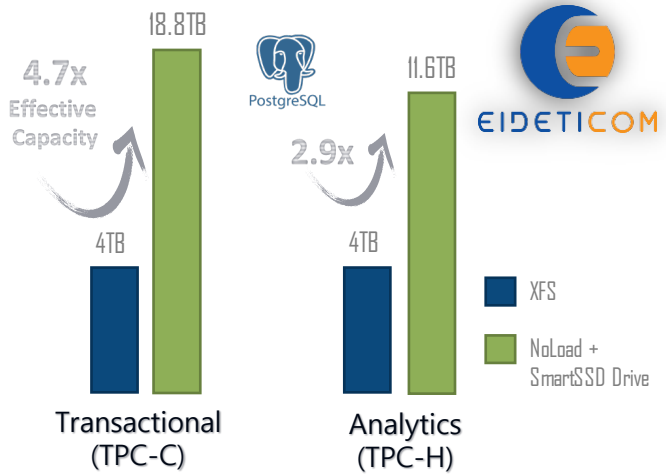


Source: https://www.xilinx.com/publications/solution-briefs/xilinx-smartssd-ctaccel-solution-brief.pdf

Cyber-forensics

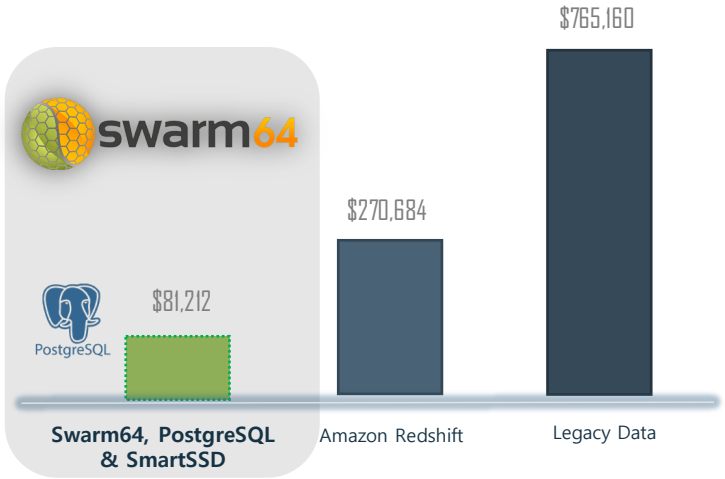
Source: https://www.xilinx.com/publications/solution-briefs/xilinx-smartssd-lrl-solution-brief.pdf

File Compression



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

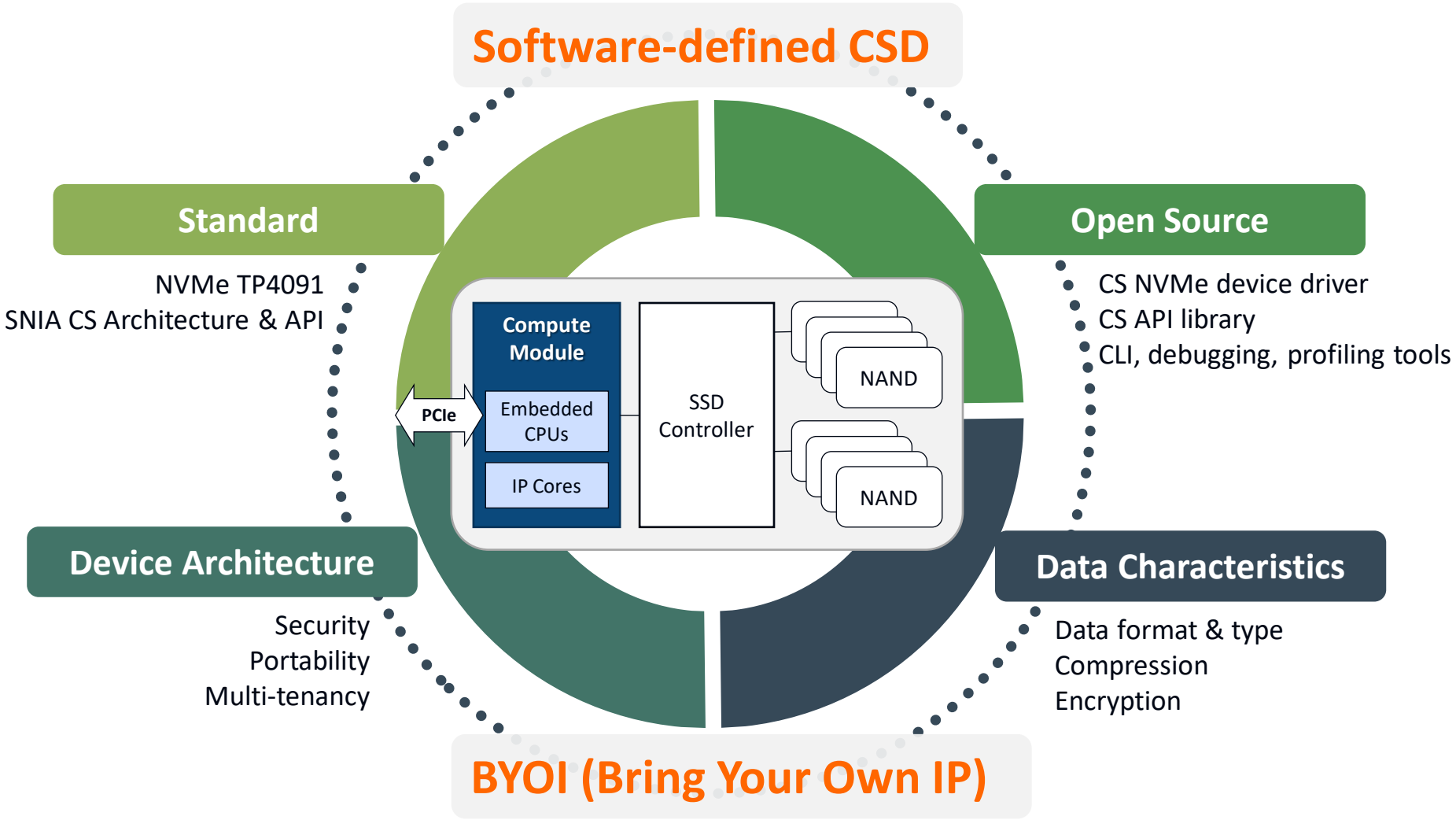
Data Warehouse



https://swarm64.com/wp-content/uploads/2020/06/Swarm64-SmartSSD-Overview.pdf

3rd Gen: Future Products (2022-)

- **Collaboration platform to make technology scalable**

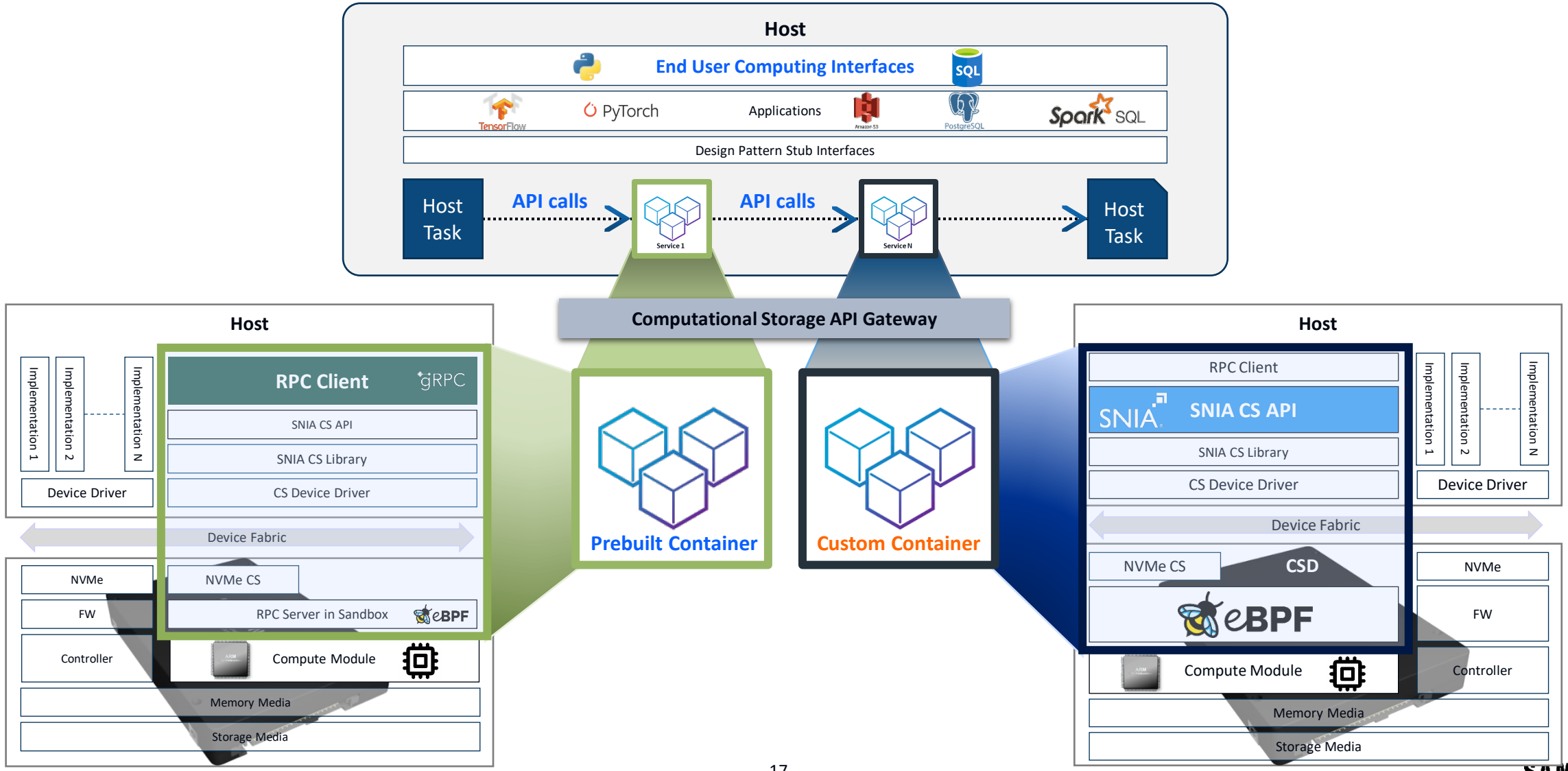


HW SW Co-design Platform for In-Storage Computing

- Connect your IPs to computational storage device

Software-Defined Computational Storage

- **Repurpose storage device using SNIA CS APIs**



Call for Participation in New Value Constellations

Computational Storage in Its Infancy

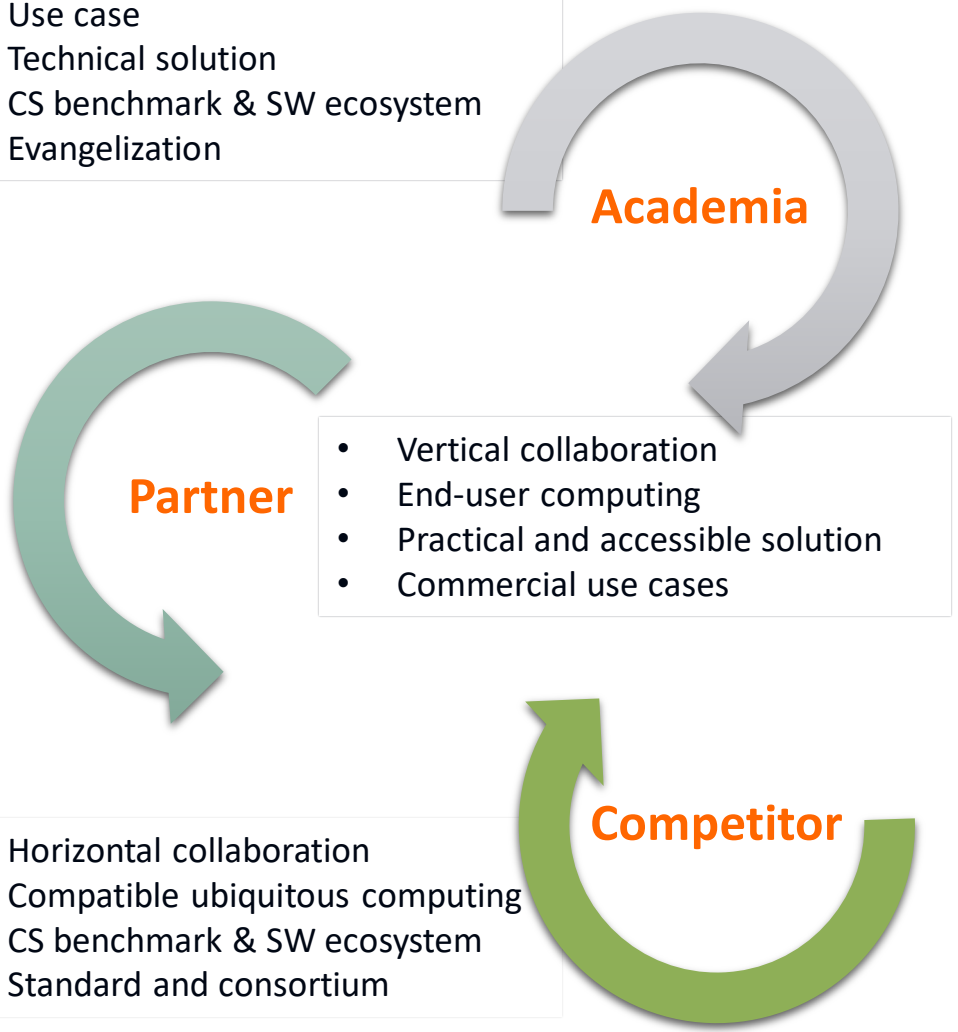
- **Community efforts are needed!**

Business Challenges

Broad Use Cases

TCO (Total Cost of Ownership) Benefits

Low Barriers to Adoption



Technical Challenges

SW Ecosystem
- Cache
- Consistency
- Virtualization
- Multiple device support
- Data fragmentation

Device Architecture
- Security
- Portability
- Multi-tenancy
- Device Interface
- Performance

Data Characteristics
- Compression
- Encryption
- Types
- Formats
- Encoding

Vertical Collaboration

- **Make the technology consumable by end users**

EUC

Applications

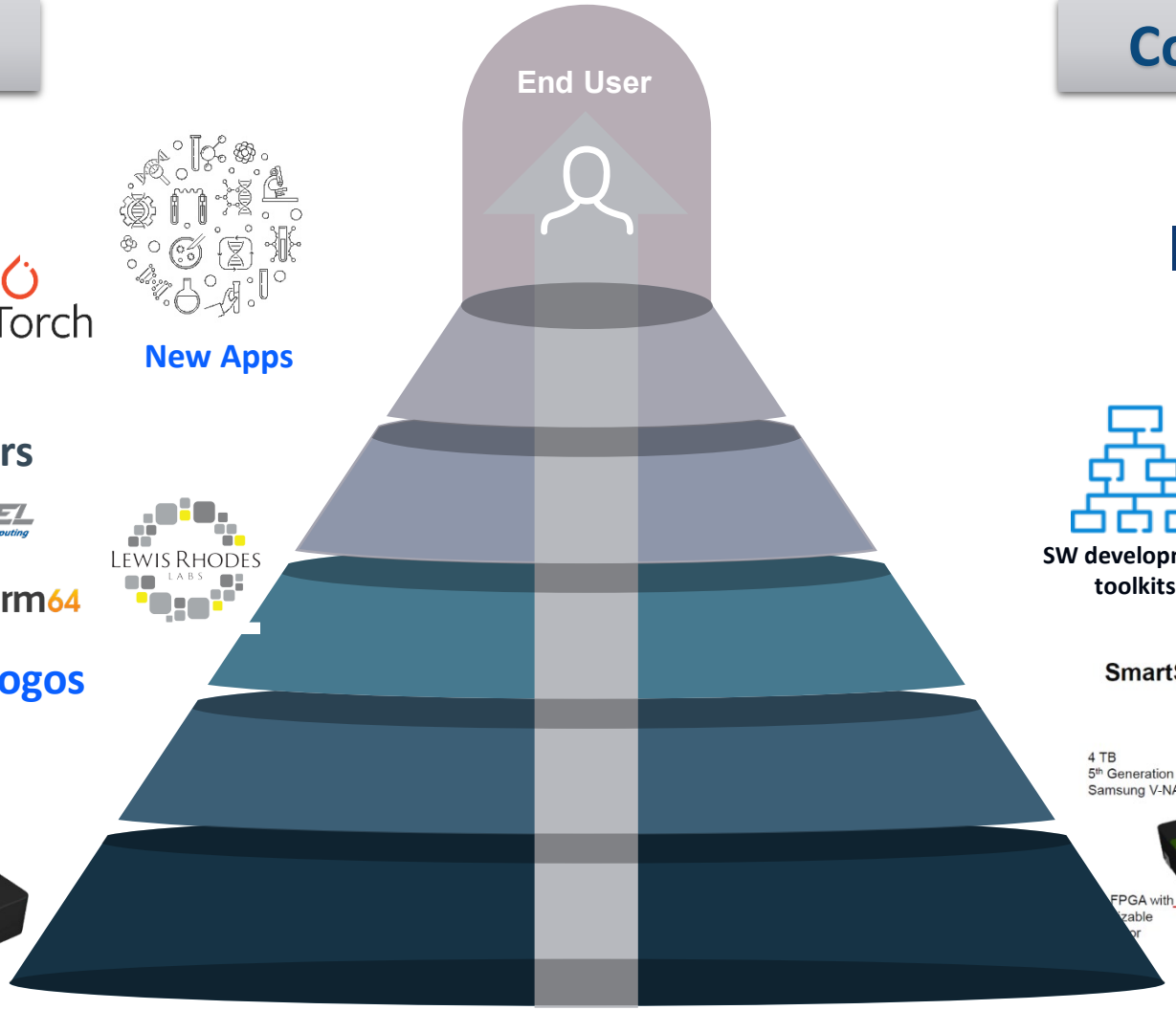
Spark · PostgreSQL · Amazon S3 · PyTorch

New Apps

Solution Partners

bigstream · CTACCEL Accelerated Computing · EIDETICOM · swarm64 · Lewis Rhodes Labs

Your company logos



Collocated Service

NIMBIX an atos company

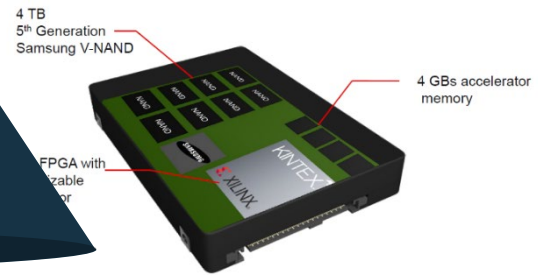
CS Compute Instance

SW development toolkits

HW IP development toolkits

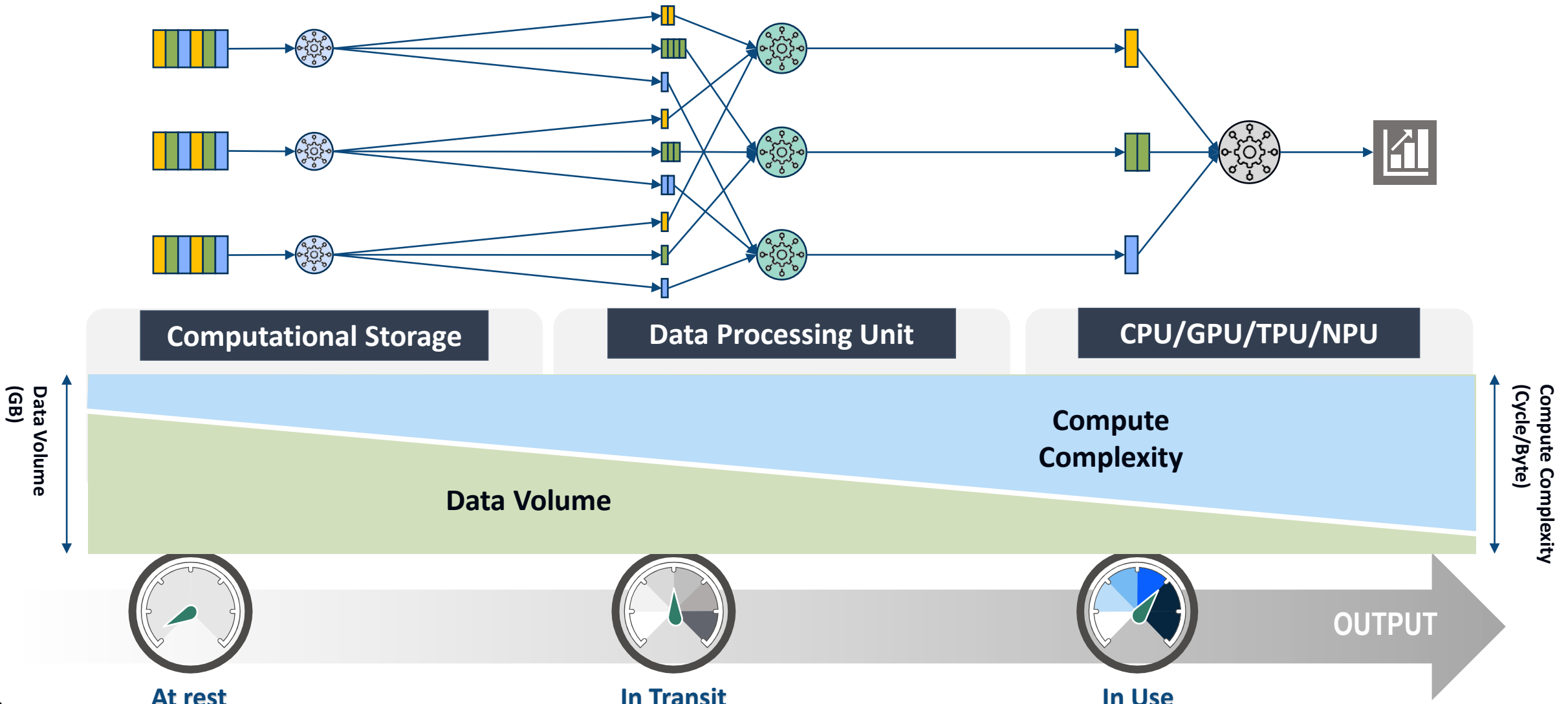
XILINX

SmartSSD® CSD



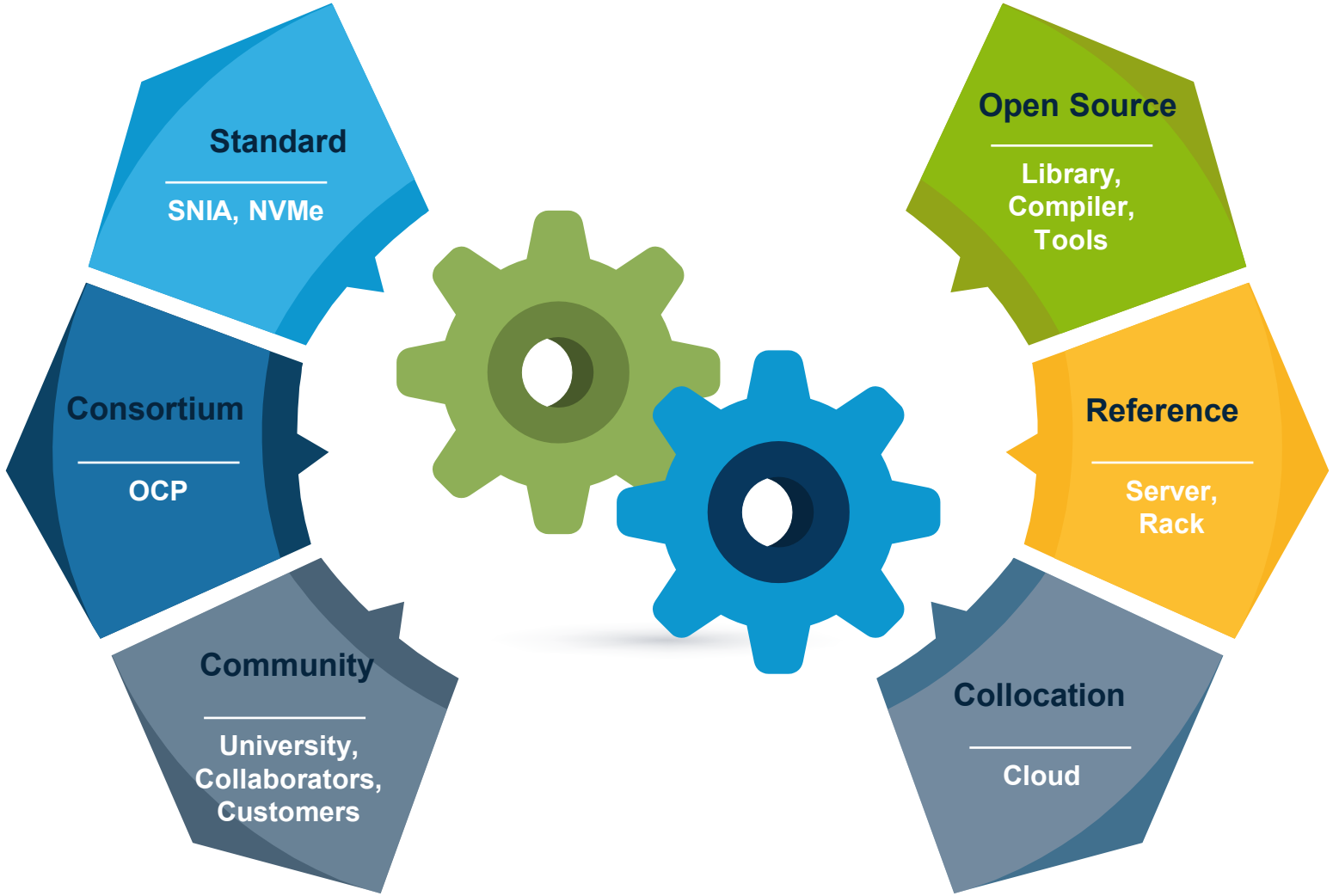
Horizontal Collaboration

- Holistic task partitioning across architectures best for data states



Open Innovation

- Create new value constellations including computational storage



Breakout Session 1

- **Title**: Computational Storage APIs
- **Speaker** : Oscar Pinto

Breakout Session 2

- **Title**: Computational Storage Moving Forward with an Architecture and API
- **Speaker**: Bill Martin

Thank You!