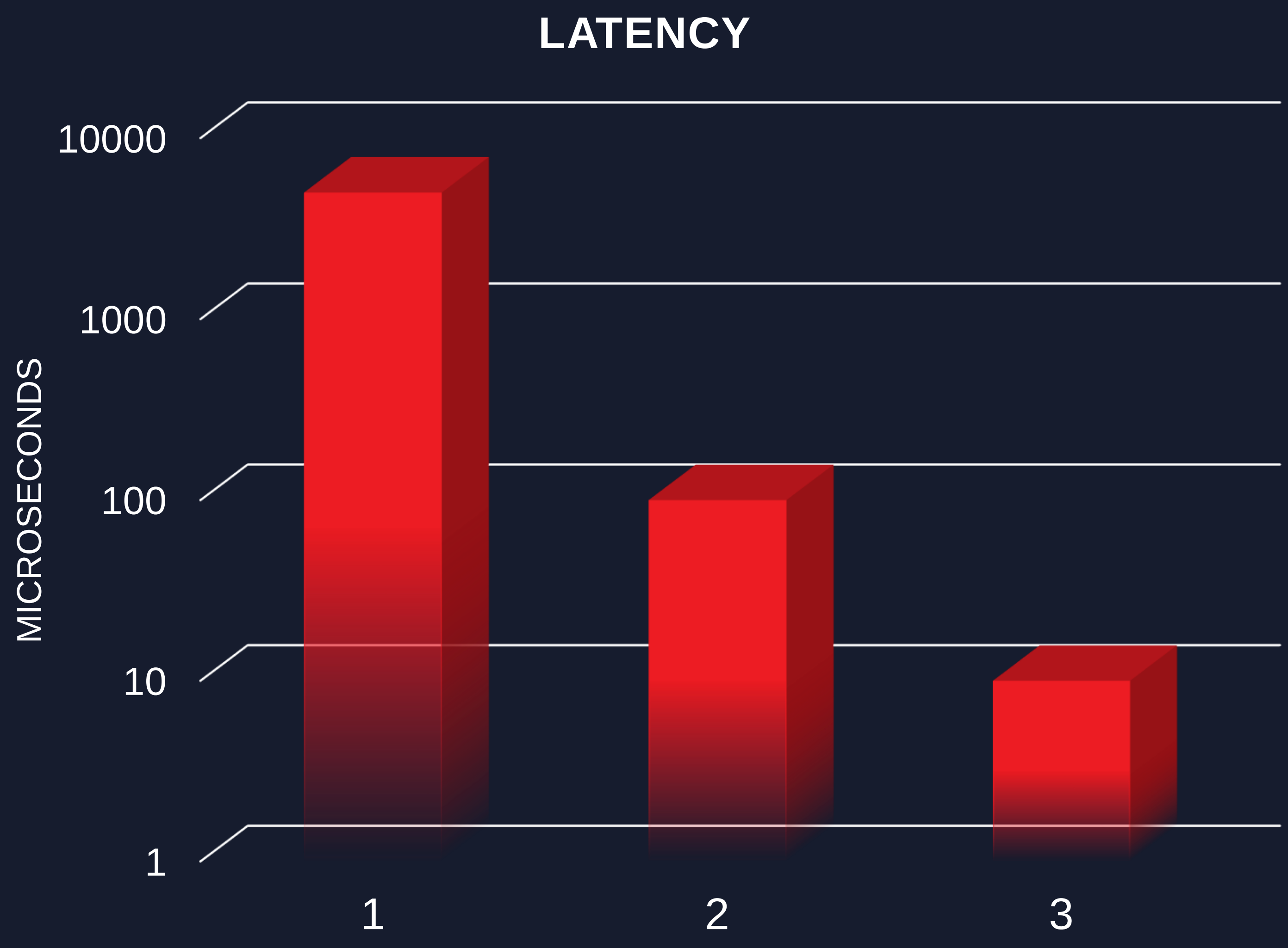
FPGAs: The Key to Accelerating High-Speed Storage Systems

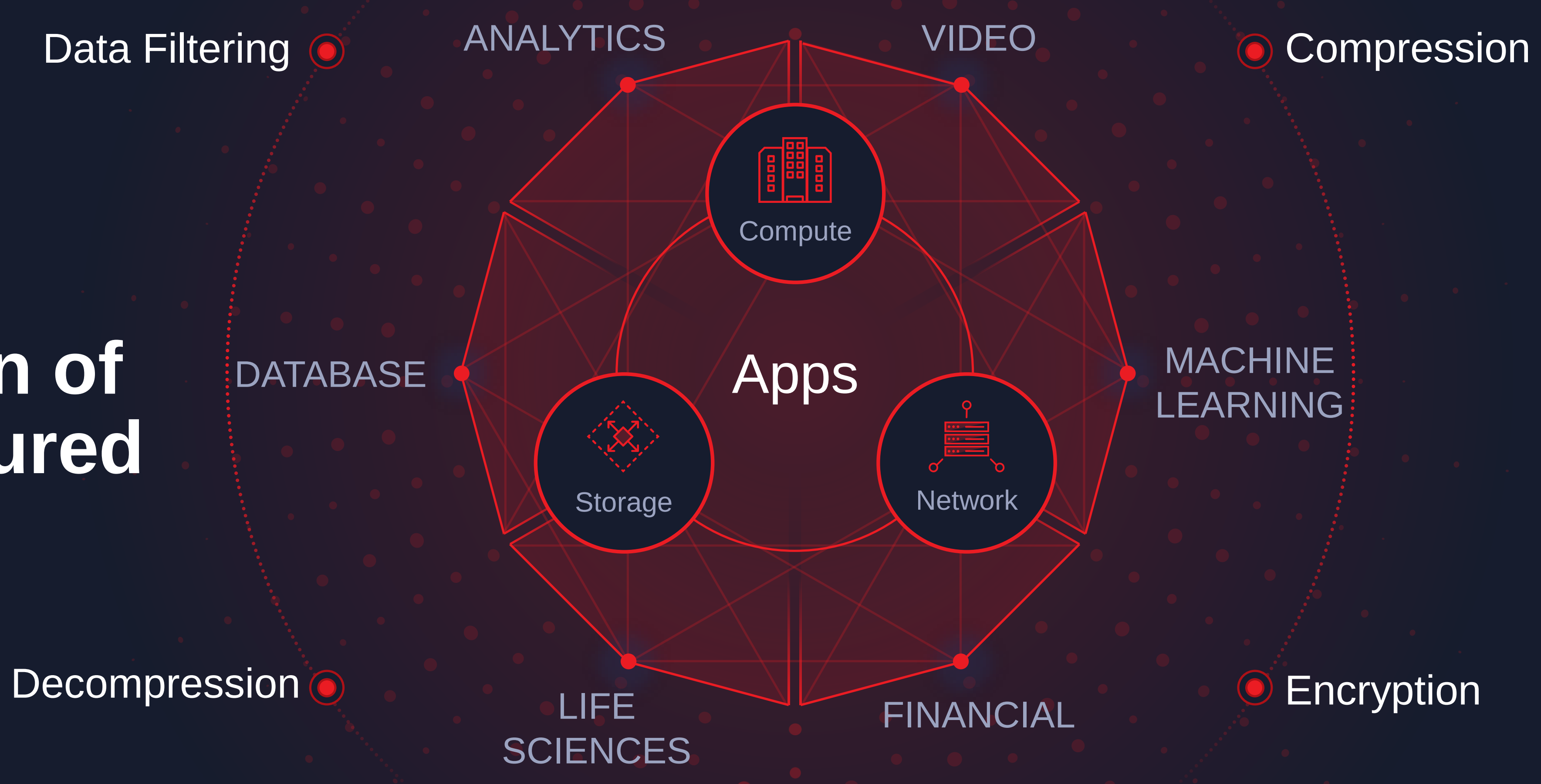
Salil Raje
Executive Vice President & GM
Xilinx Data Center Business

XILINX

SSDs Have Been a Game Changer for Storage



Explosion of Unstructured Data



Continuously Evolving Standards

Data Filtering
- Hadoop
- Spark
- Aerospike
- RocksDB
- Cassandra
- Foundation DB

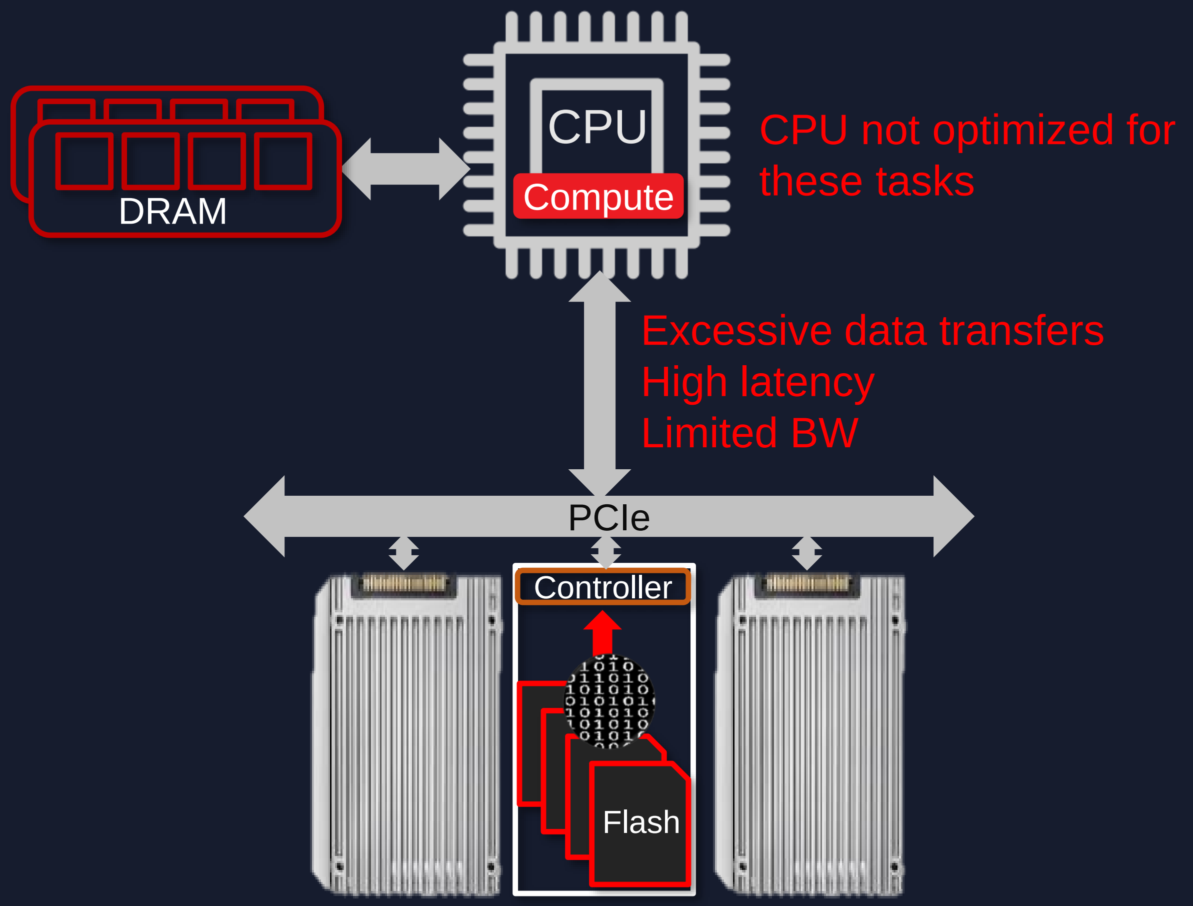
Compression
- GZip
- zSTD
- Huffman
- LZ
- Zipline
- Brotli

Decompression
- LZ
- Brotli
- Zipline

Encryption
- DES
- AES-XST
- SHA1-256
- Block chain

Bottlenecks Remain for Data Intensive Applications

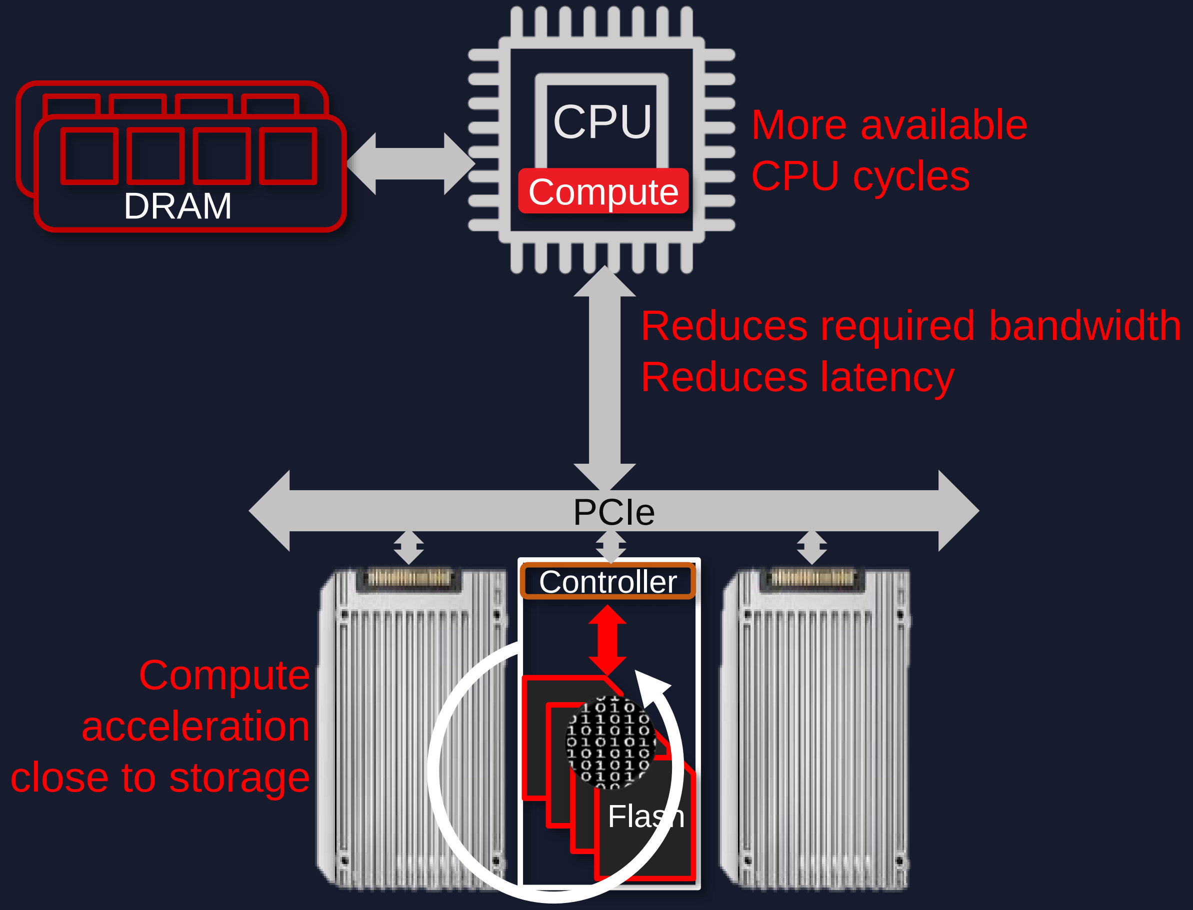
Processor-centric architecture



XILINX.

Emergence of Computational Storage as the Solution

Computational storage architecture



XILINX

Growing Industry Momentum for Computational Storage

How FPGAs Address the Computational Storage Problem

XILINX®

FPGAs in Storage Today

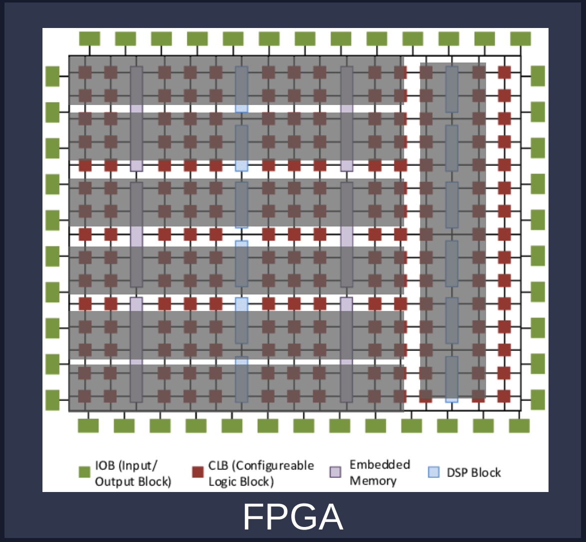
> Flash controllers

> Storage Systems

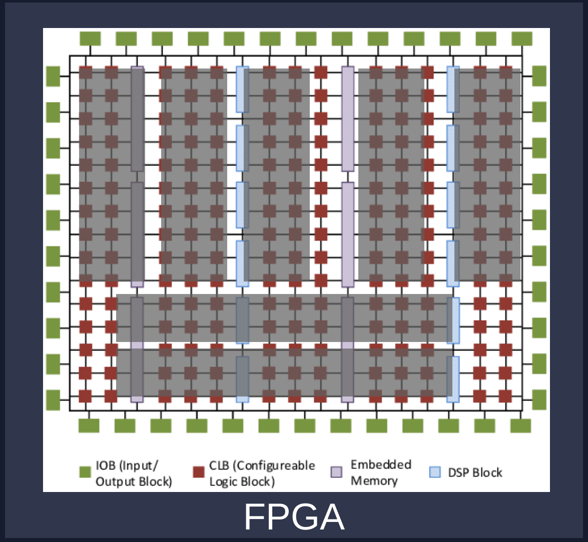
>> Cache-offload
>> Storage System & Switching connectivity
>> Data Reduction

FPGA Advantages for Computational Storage

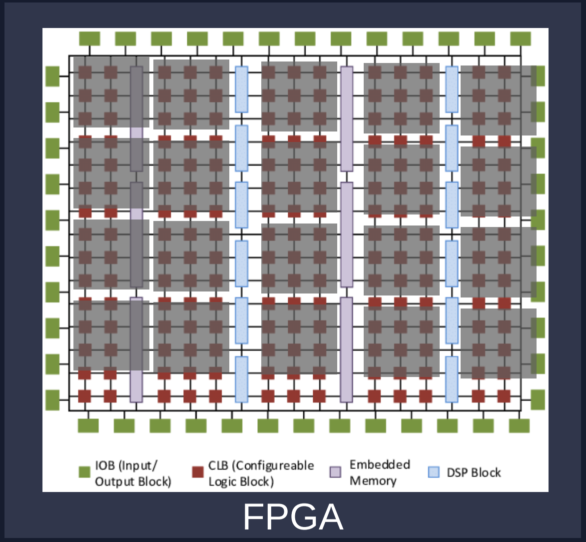
- Flexible, fully customizable architecture adapts to specific applications
  - Massive parallelism, I/O and customizable data path
- Performance, power and latency of dedicated HW + reconfigurability of SW
- More economical than ASIC/ASSP for many applications



Encryption Accelerator



Decryption Accelerator

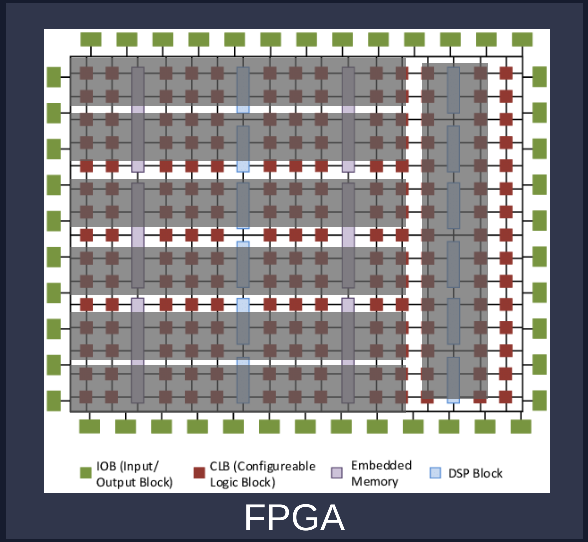


Analytics Accelerator

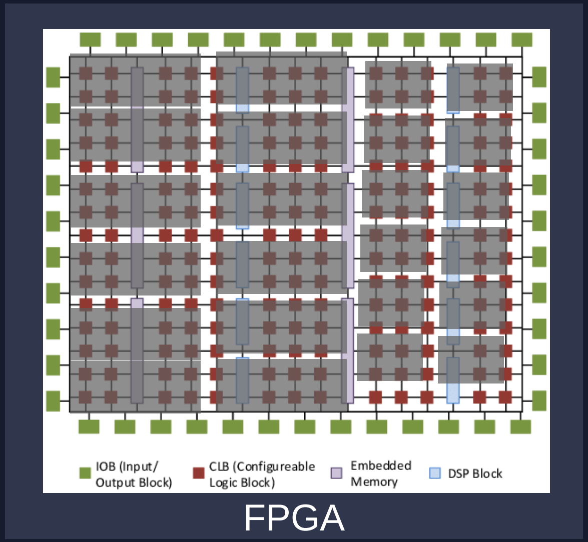
FPGA Advantages for Changing Standards

Architecture easily adapts to latest compression algorithms

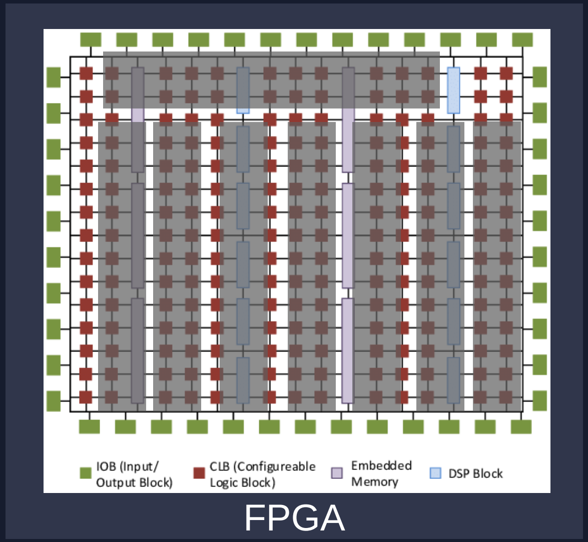
Gzip Accelerator



Brotli Accelerator



Zipline Accelerator



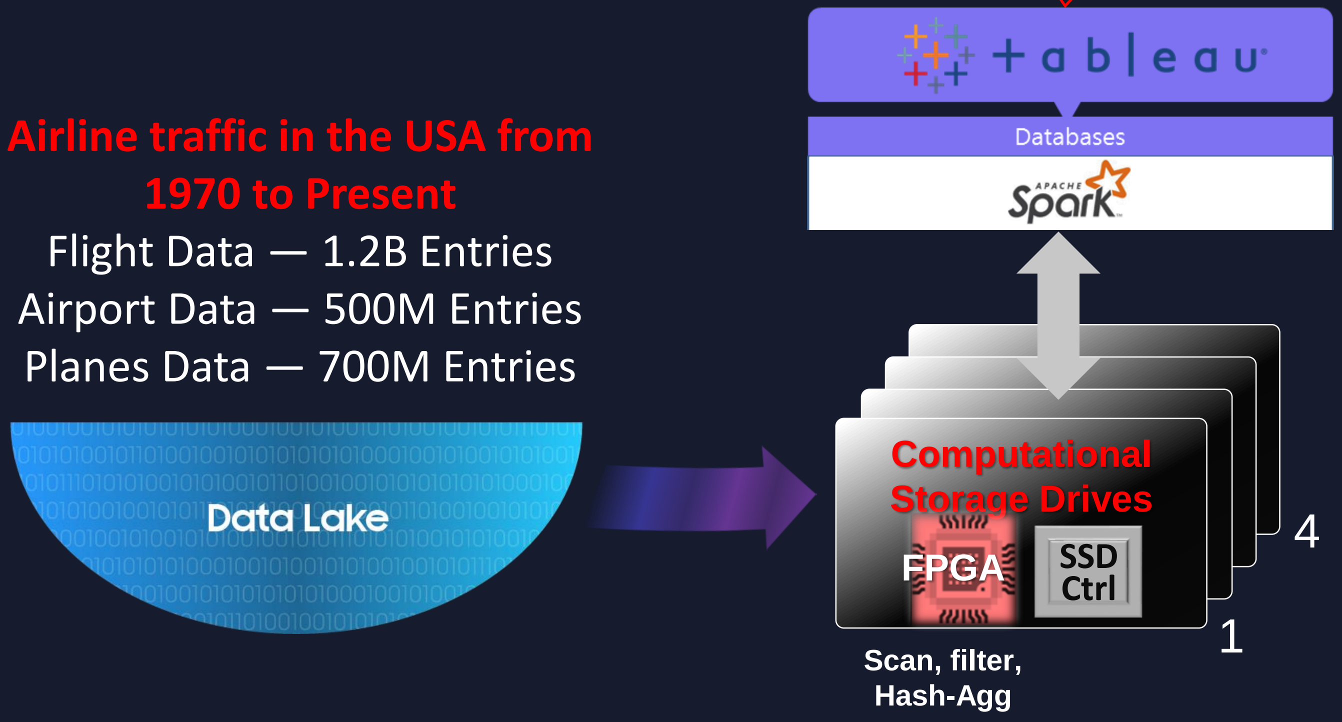
XILINX

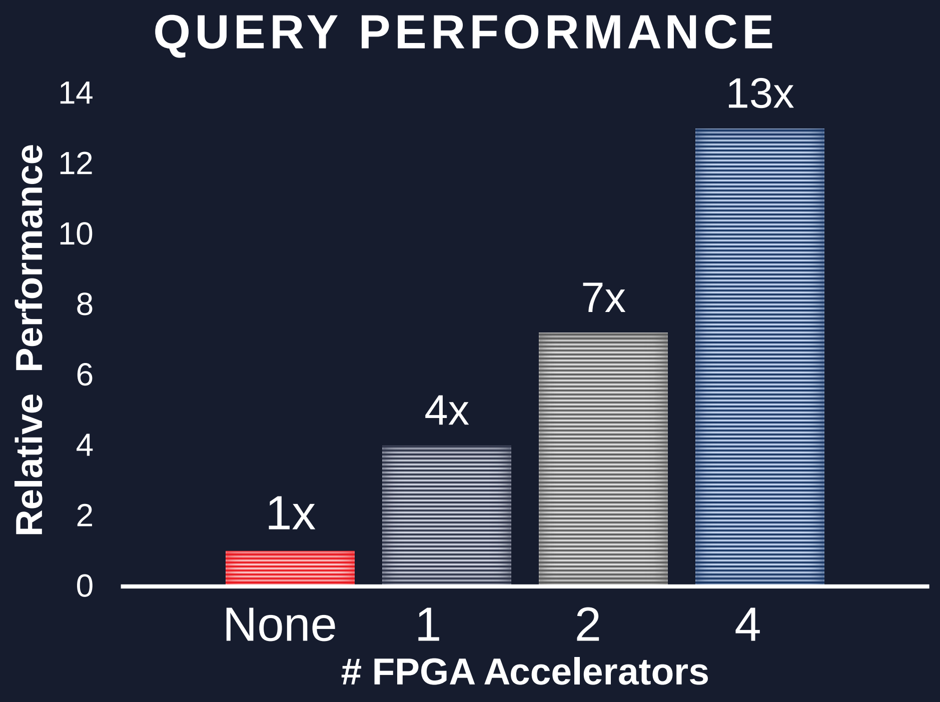
Example of Analytics Acceleration

Q1: "Which cities originate the most flights with >10min delays?
Q2: "Which airport in the Bay Area has the worst record?

Airline traffic in the USA from 1970 to Present

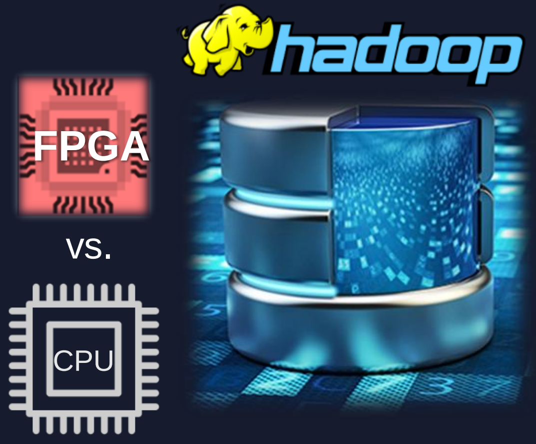
Flight Data — 1.2B Entries
Airport Data — 500M Entries
Planes Data — 700M Entries





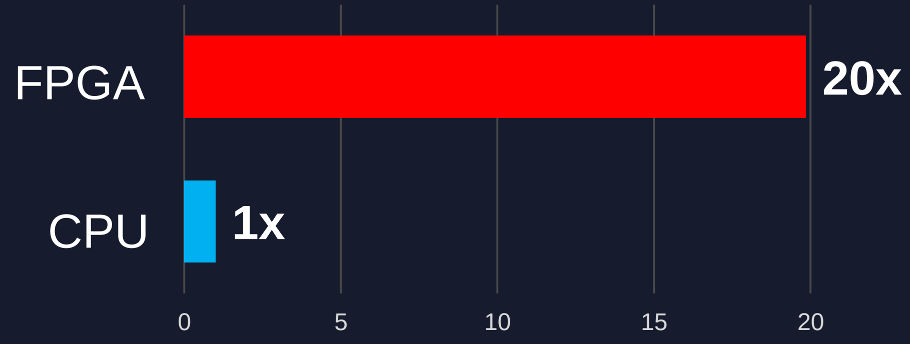
Example of Line Rate Hadoop Compression Acceleration

The challenge: Ingest real-time
retail sales data during peak shopping season



Compression / Decompression Acceleration

CPU can't keep up with line-rate data ingestion making compression impractical



Intel Skylake-SP 6152 @2.10GHz CPU (Ubuntu 16.04), GB/s compression per CPU core = .0229. Alveo U50 = 10GB/s

XILINX.

XILINX

FPGA-based Data Compression Enables Server Consolidation

Without Compression Acceleration	With FPGA Compression Acceleration
	
2x Dual CPU Servers With 192TB (uncompressed)	**Single Socket Server** 2x Accelerators, 96 TB (compressed)
	50% Reduction in Nodes 40% Lower Cost

Intel Skylake-SP 6152 @2.10GHz CPU (Ubuntu 16.04), GB/s compression per CPU core = .0229. Alveo U50 = 10GB/s, Assume 2:1 compression

XILINX

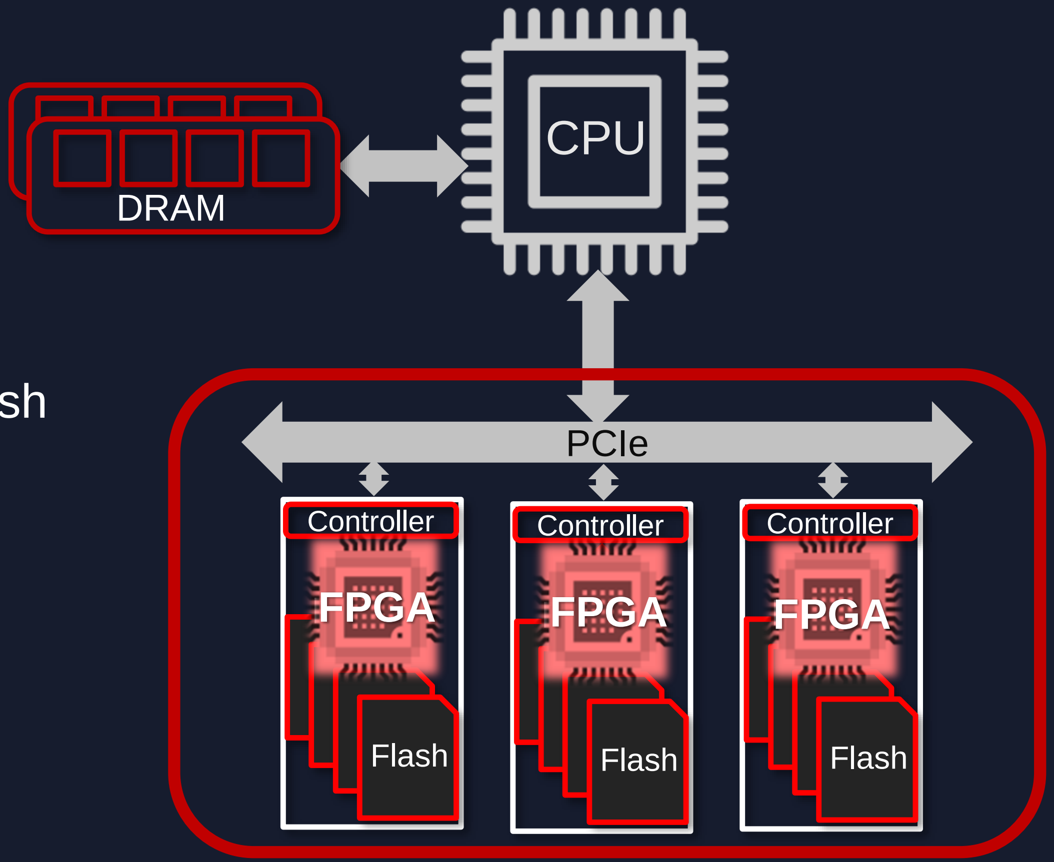
Computational Storage Deployment Options

Computational Storage Drive (CSD)

> Integrated Accelerator and Flash

> Benefits:

- Easy to implement- plug & play
- Adding capacity adds accelerators + performance
- Ability to optimize BW between accelerator and flash
- Ability to customize FTL for specific workloads

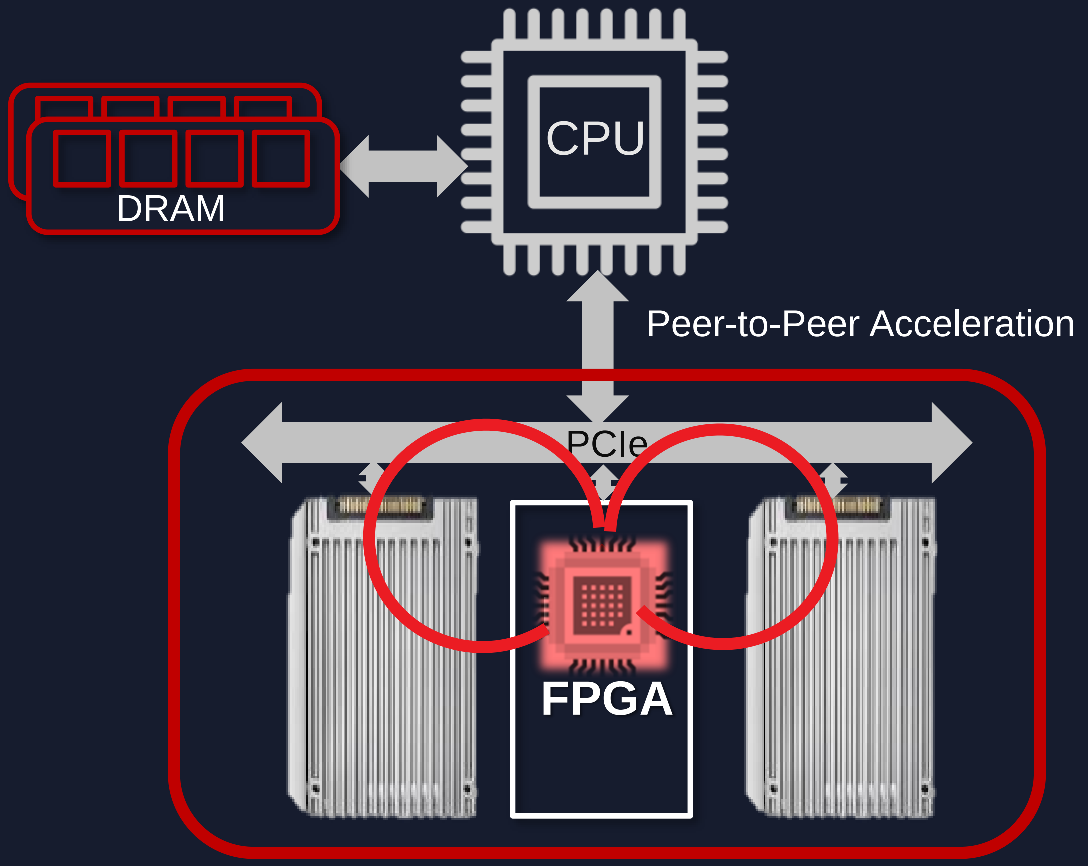


> Vendors at FMS:

- Samsung
- Scaleflux

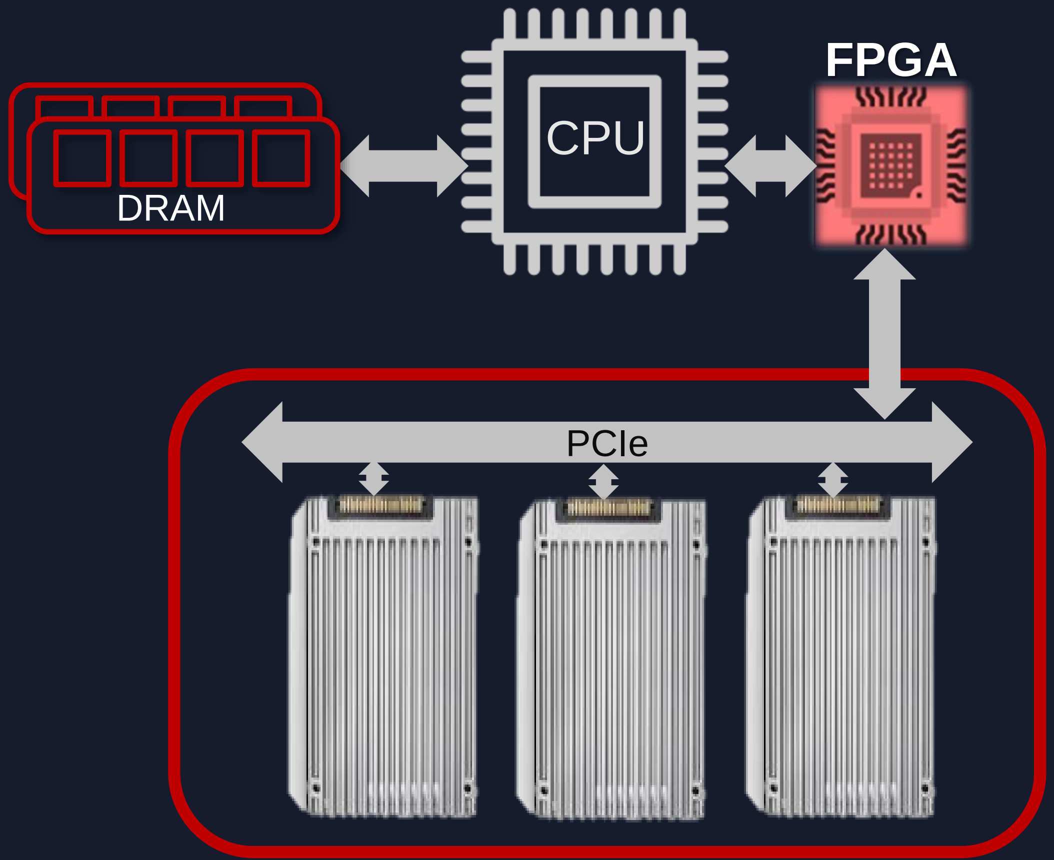
Computational Storage Processor (CSP)

- **Accelerator and Storage on same PCIe subsystem**
- **Benefits:**
  - SSD vendor independence
  - Plugs into standard slot
  - PCIe Peer-to-peer transfers for high bandwidth and low latency
- **Vendors at FMS:**
  - Bittware
  - Eideticom
  - Xilinx



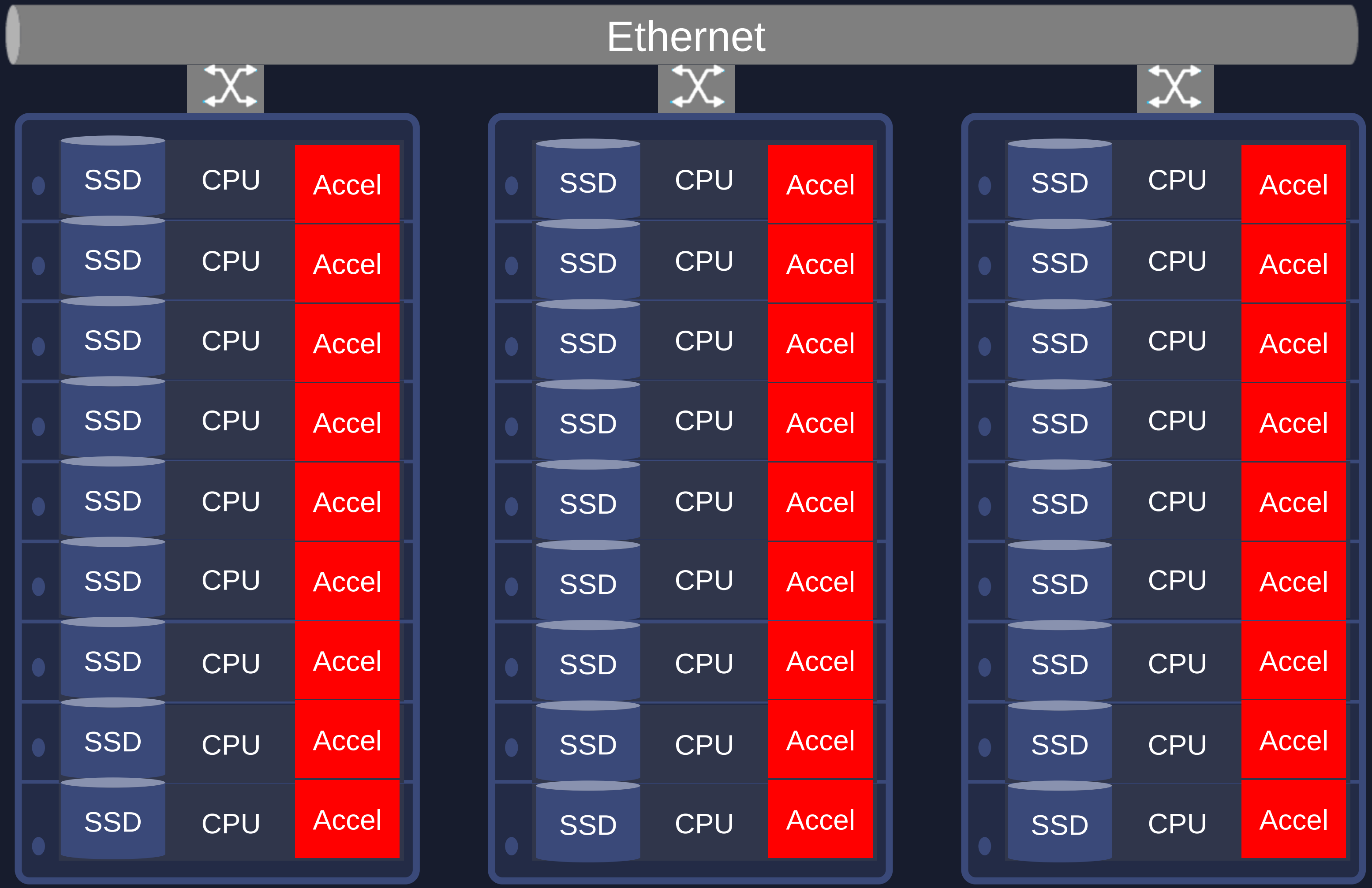
Computational Storage Array (CSA)

- **Accelerator in-line with storage**
- **Benefits:**
  - SSD vendor independence
  - Independently scale accelerators and SSDs
  - Ability to optimize BW between accelerator and SSDs
- **Vendors at FMS:**
  - Bittware



Future Directions

Current Data Center Architecture:
Fixed Resources, Sub-optimal Utilization



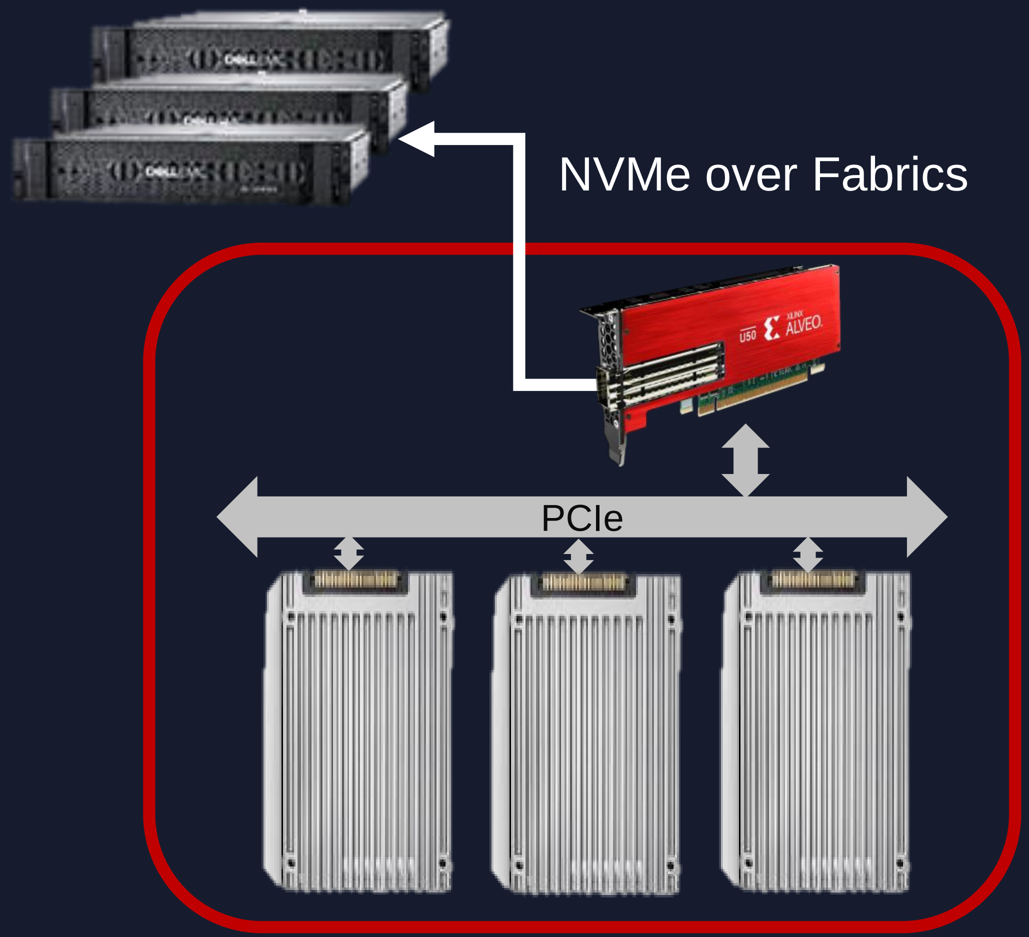
Future Data Center : Disaggregated and Composable

Challenge: Reduced Bandwidth and Increased Latency

XILINX

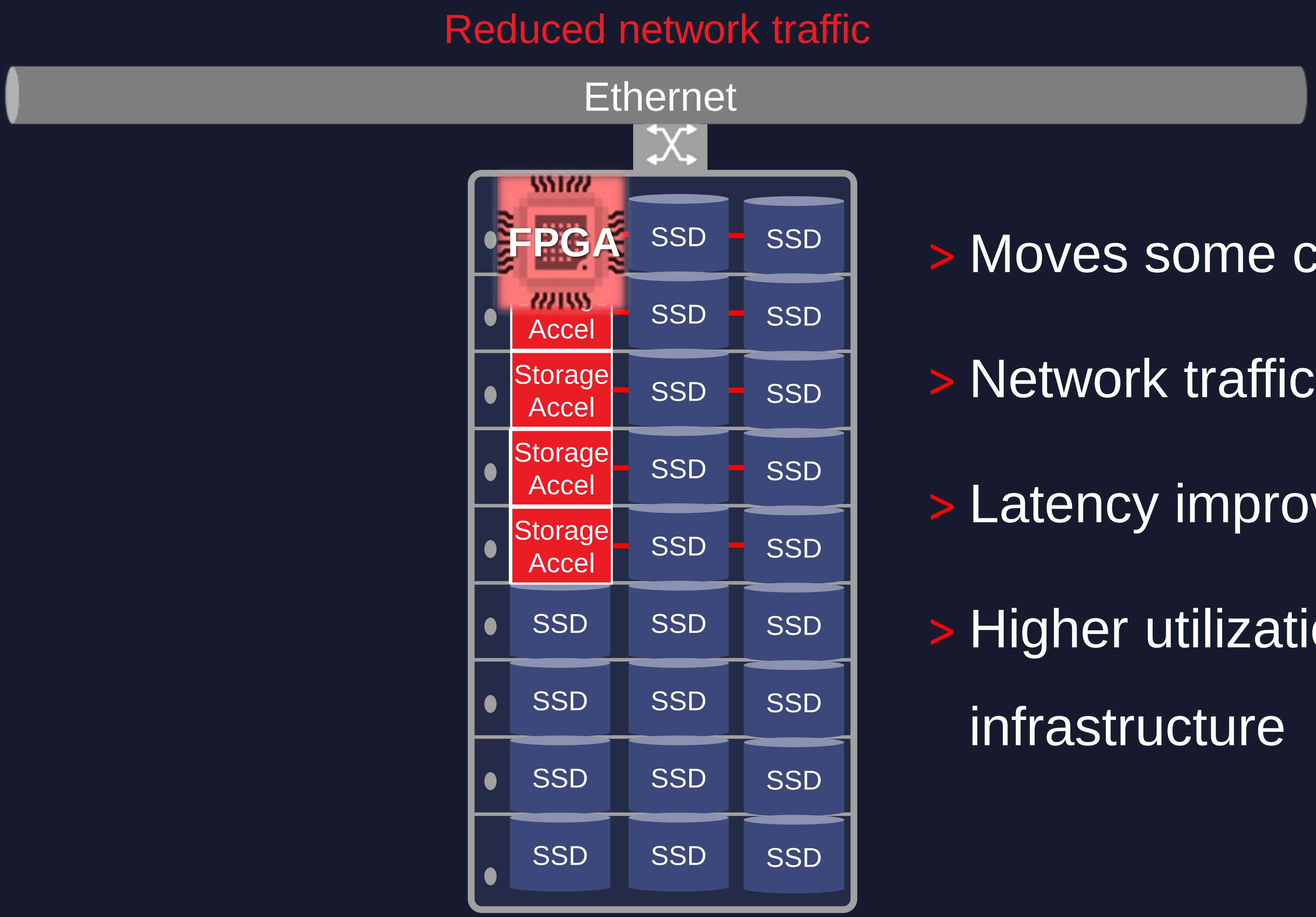
Introducing Composable Storage Acceleration

- **Enables composability without significant performance penalty**
- **Benefits**
  - Performance and latency benefits of computational storage
  - Scale compute / storage independently
  - Higher density per rack
  - Lowest TCO
- **Vendors at FMS:**
  - Xilinx



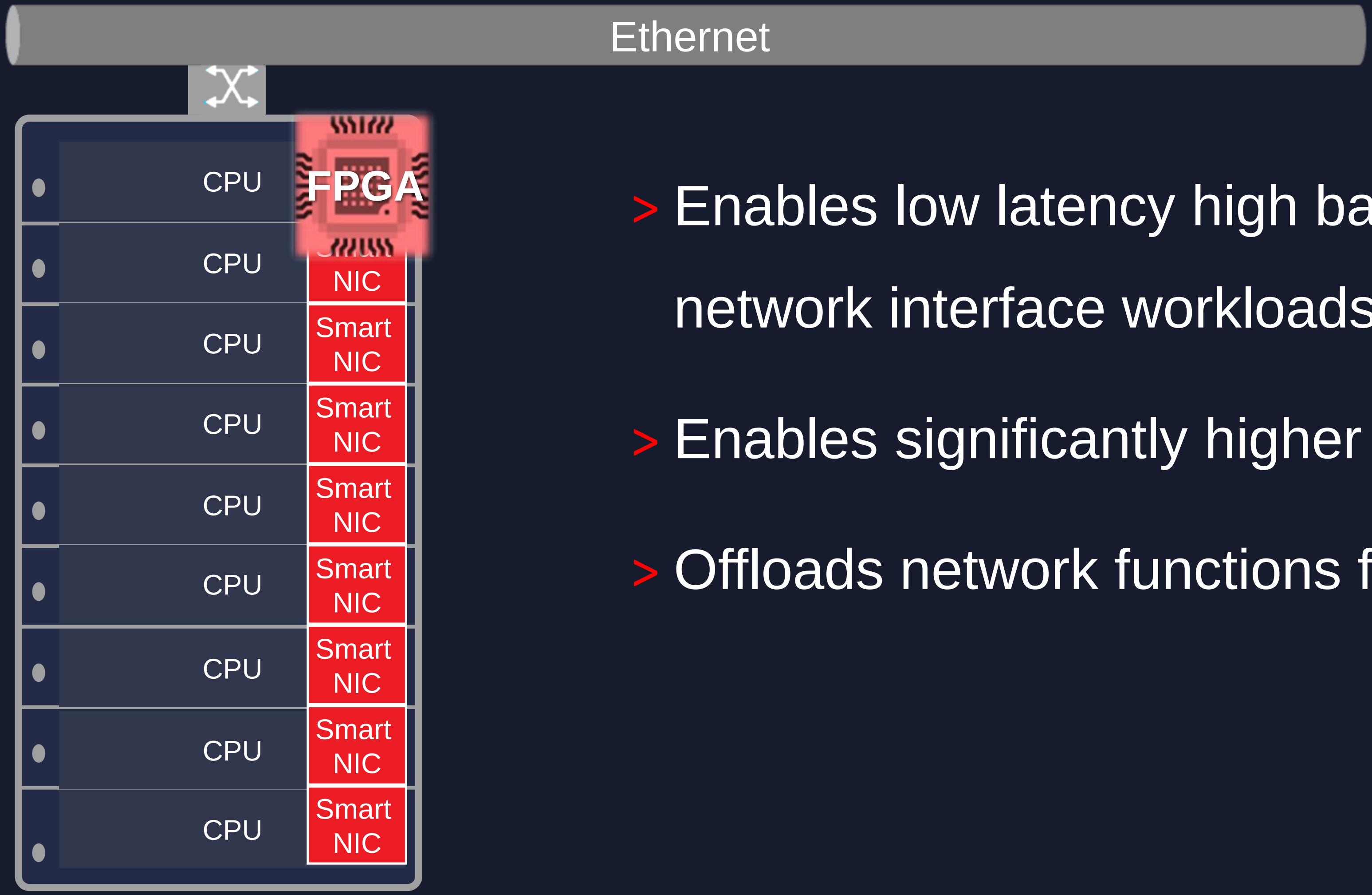
XILINX.

Future DC: Composable + Adaptable Computational Storage



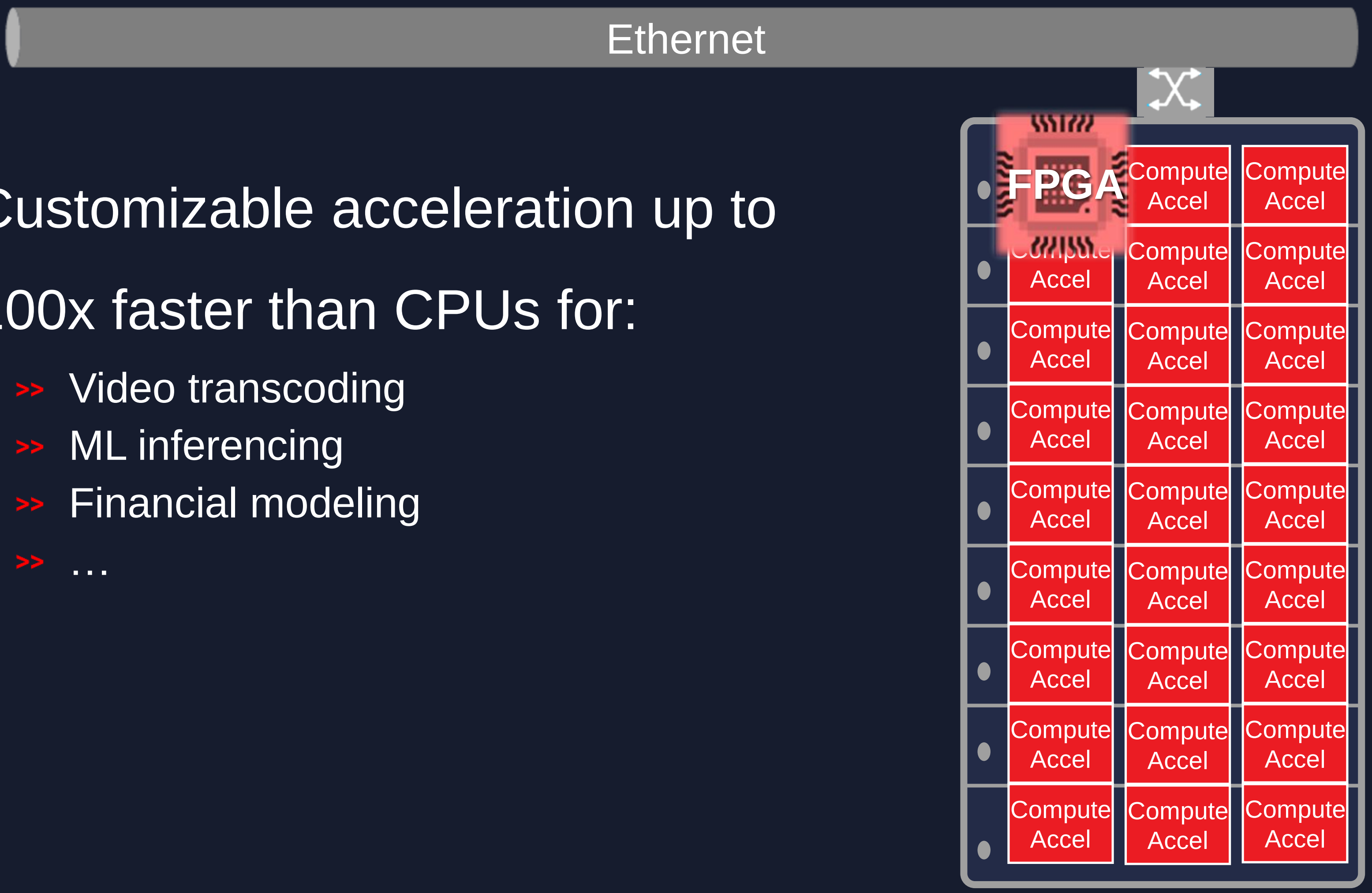
- Moves some compute next to the data
- Network traffic reduced
- Latency improved
- Higher utilization with composable infrastructure

Future DC: Composable + Adaptable Network Acceleration



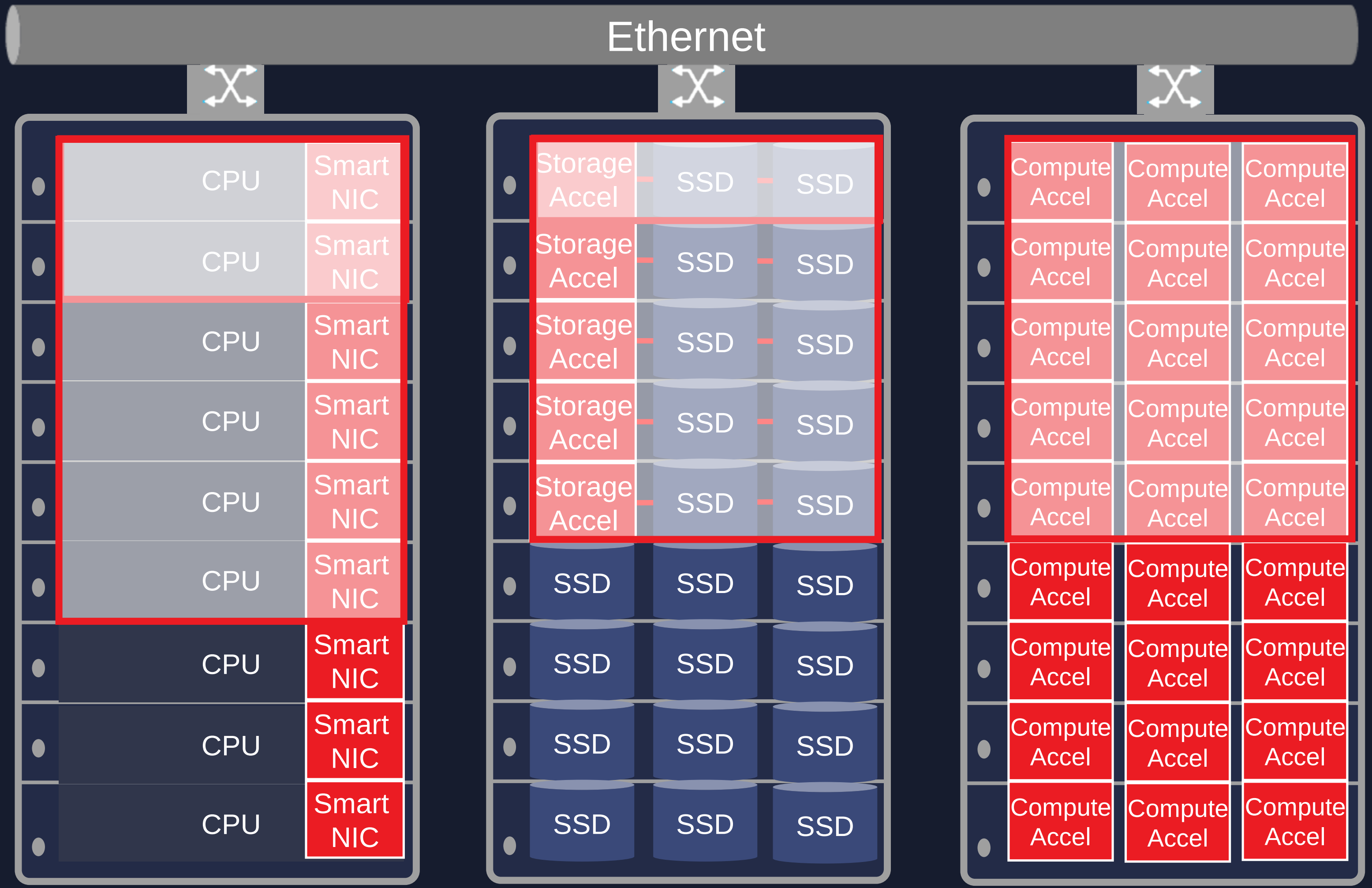
- Enables low latency high bandwidths acceleration of network interface workloads.
- Enables significantly higher packets per second
- Offloads network functions from the CPU

Future DC: Composable + Adaptive Compute Acceleration



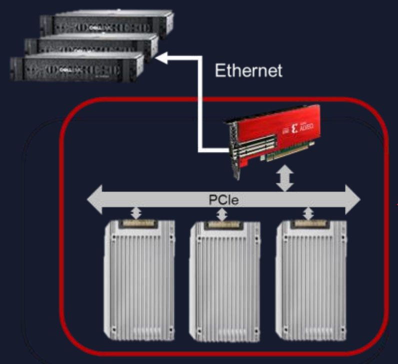
- Customizable acceleration up to 100x faster than CPUs for:
  - Video transcoding
  - ML inferencing
  - Financial modeling
  - …

Future DC: Composable + Distributed Adaptive Acceleration



- Composable accelerated storage, networking and compute
- Optimized for each workload
- Optimal infrastructure utilization

FPGAs are Key to Accelerating High-Speed Storage Systems



Computational storage addresses a broad range of application bottlenecks

Offers data center operators >5x performance boost and up to 2x reduction of TCO

Xilinx is leading the way in distributed adaptive acceleration

Computational Storage in Action

- Visit Xilinx in booth 313
- Visit our partners
  - Alpha Data, Bittware, Burlywood, Codelucida, GigaIO, Echo Streams, Eideticom, Everspin Technologies, IP-Maker, Mobiveil, Pliops, PLDA, Scaleflux, Smart IOPS, Samsung, SMART Modular, Toshiba Memory America, Western Digital
- Visit our Computational Storage microsite

  www.xilinx.com/computational-storage

- Join SNIA working group for Computational Storage

Adaptable.
Intelligent.

XILINX®