STORAGE DEVELOPER CONFERENCE
SDC 22
Fremont, CA
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BY Developers FOR Developers
A SNIA Event

Memory Disaggregation and Pooling with CXL

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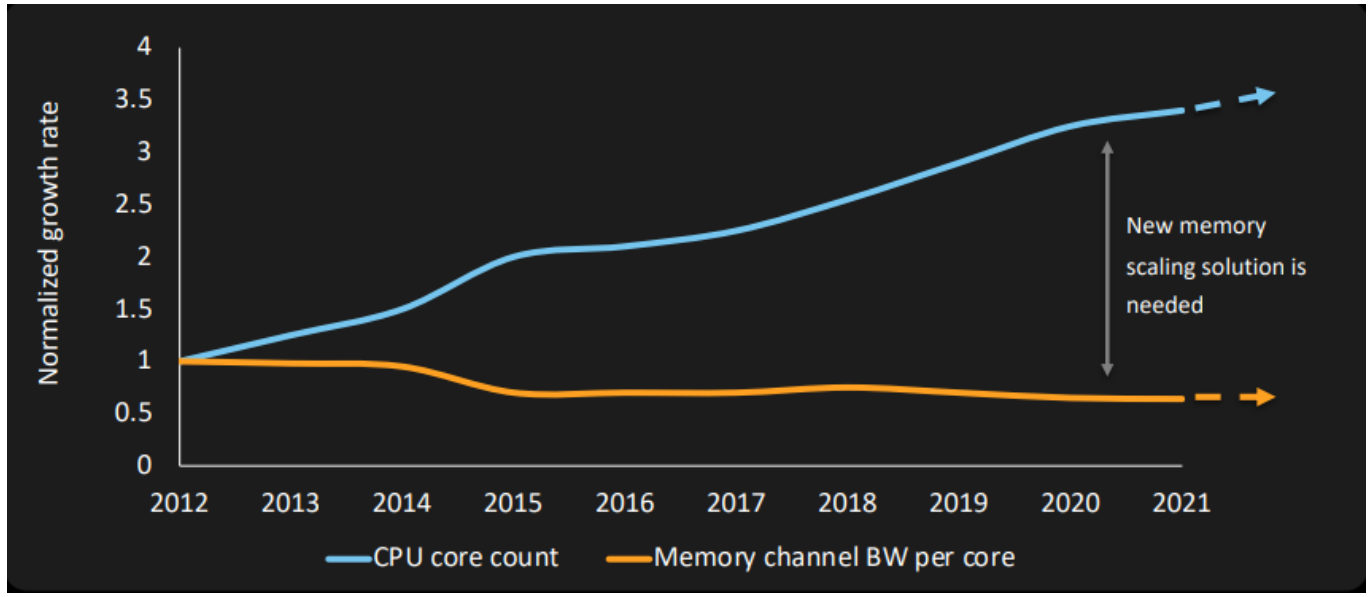
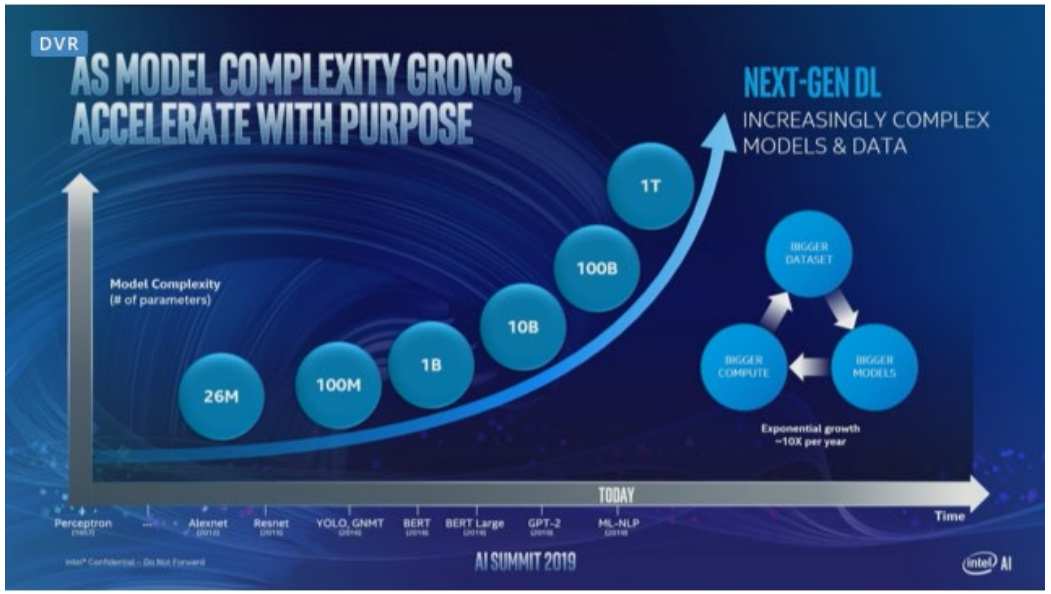
Co-founder &CEO
MemVerge

Challenges: Memory Wall and IO Wall



Meta presented at OCP Global Summit 2021: Memory channel bandwidth per core decreasing while the CPU core count increases

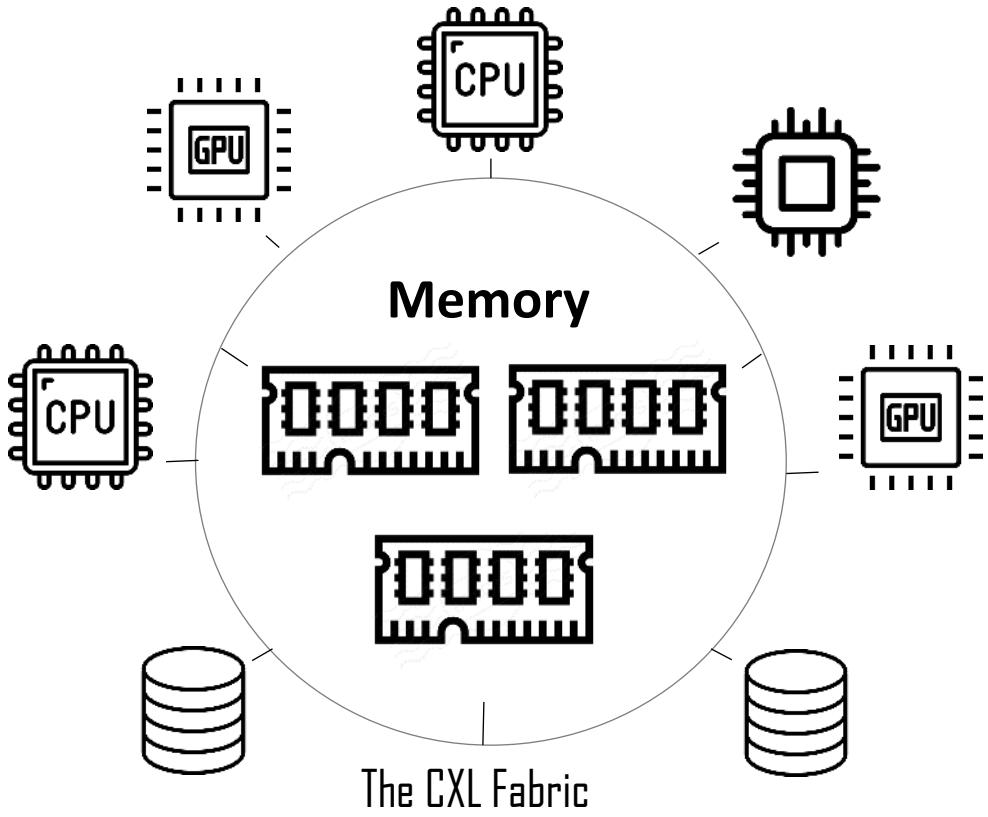
Memory-Wall: Memory bandwidth as a bottleneck



Intel Summit 2019: Data size growing exponentially. Memory capacity can not keep up. Some data are stored by storage and incurs storage/network IO

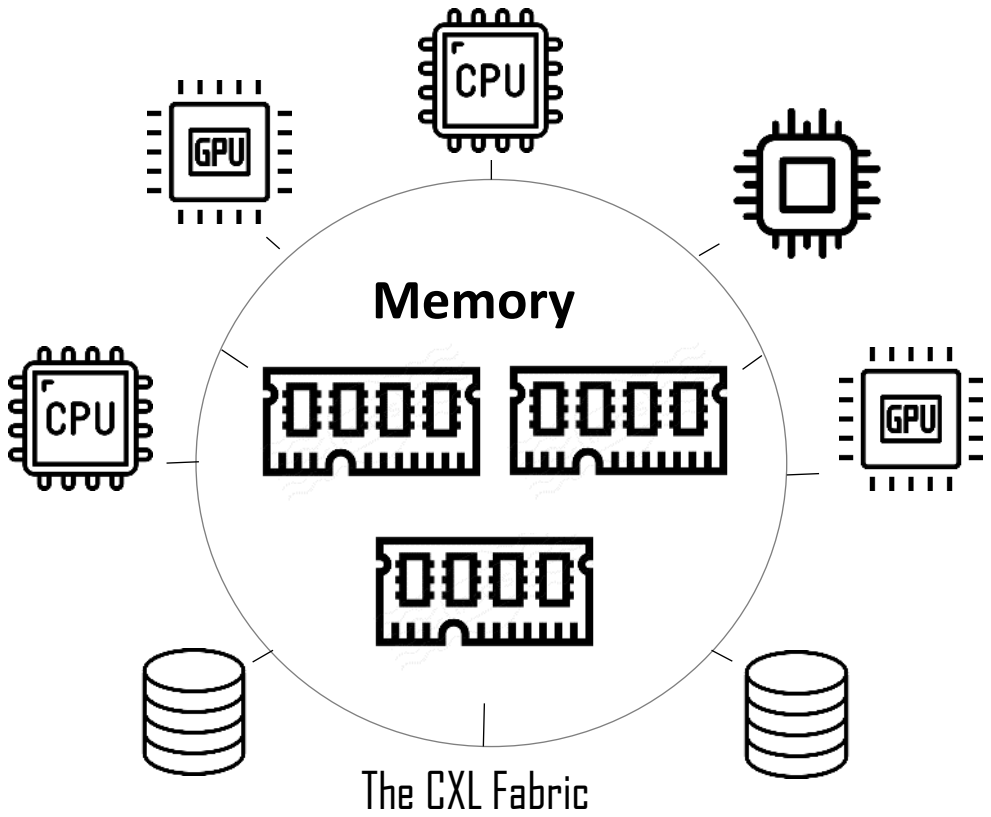
IO-Wall: Storage/network IO as a bottleneck

Solution: CXL-Enabled Memory-Centric Data Center



- Heterogeneous Computing
  - CPUs (X86 & ARM), GPUs, AI Chips…
- CXL disaggregated between Memory and CPU
- Fully composable infrastructure
  - dynamic provisioning of compute, memory and storage resources
- Data is at the center, not CPUs
- Data Centers become Memory Centers

Benefits of the New CXL Architecture



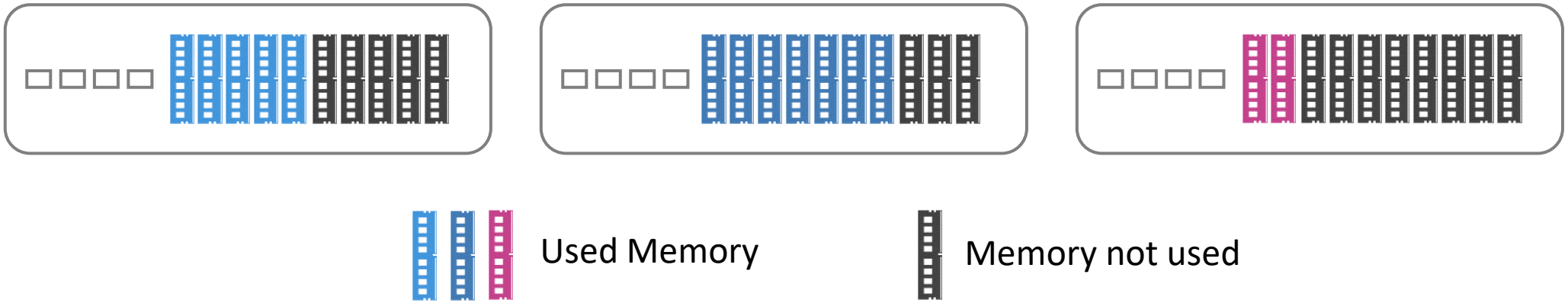
- Breaks through the Memory Wall
  - 3X memory bandwidth per CPU pin
- Avoids the IO Wall
  - More scalable memory capacity
  - Less active data on storage to avoid storage/network IOs
- Improves TCO
  - Memory pooling reduces stranded memory
  - Full composability and enabler for true heterogeneous computing

Use Case #1

Dynamic Memory Expansion

Reduces Stranded Memory

Before CXL



Azure Paper*:

- **Up to 50% of server costs is from DRAM alone**
- **Up to 25% of memory is stranded**
- **50% of all VMs never touch 50% of their rented memory**

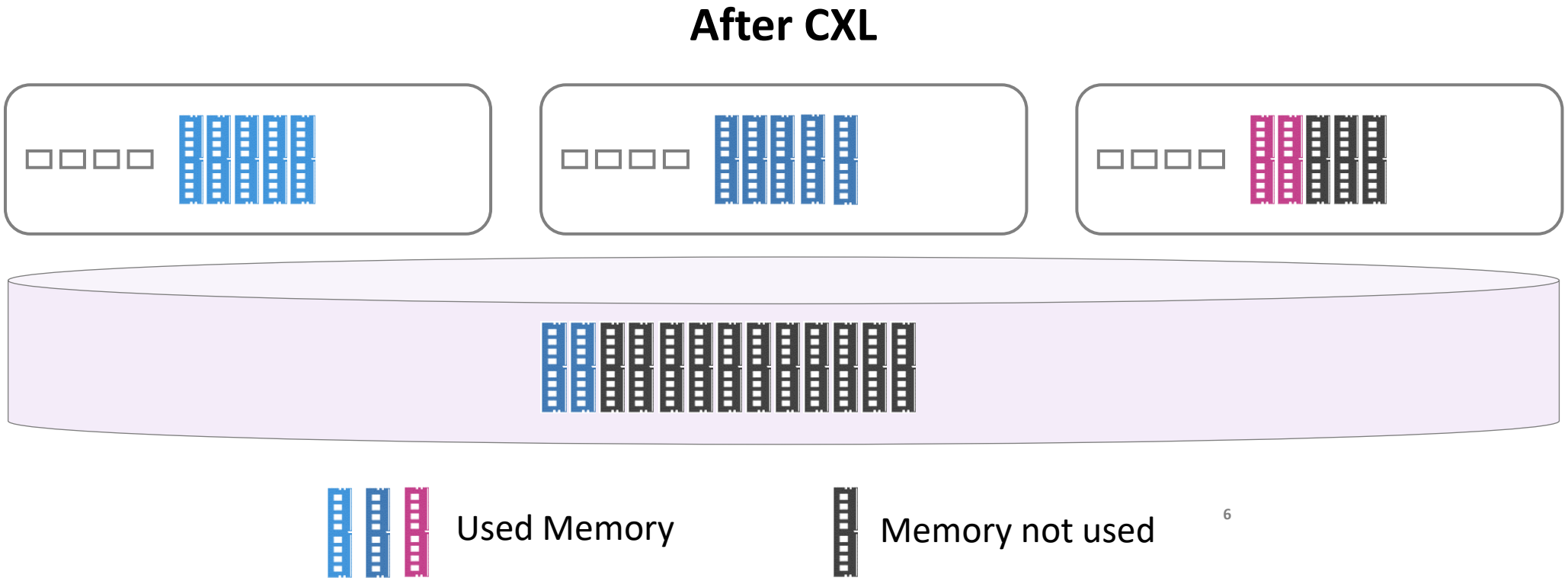
5

* H. Li et. Al. First-generation Memory Disaggregation for Cloud Platforms. arXiv:2203.00241v2 [cs.OS], March 5, 2022

Use Case #1

Dynamic Memory Expansion

Reduces Stranded Memory



Memory disaggregation can save billions of dollars per year.

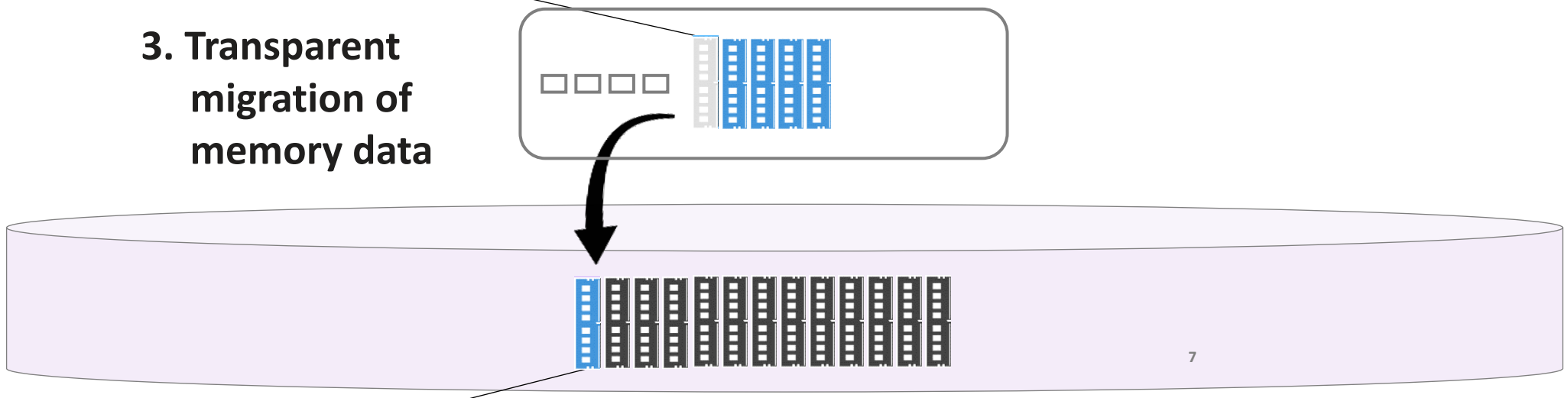
Use Case #2

Memory Auto-healing
With Transparent Migration

1. A memory module is becoming bad: error rate going up.

4. Memory Auto-healing complete

3. Transparent migration of memory data

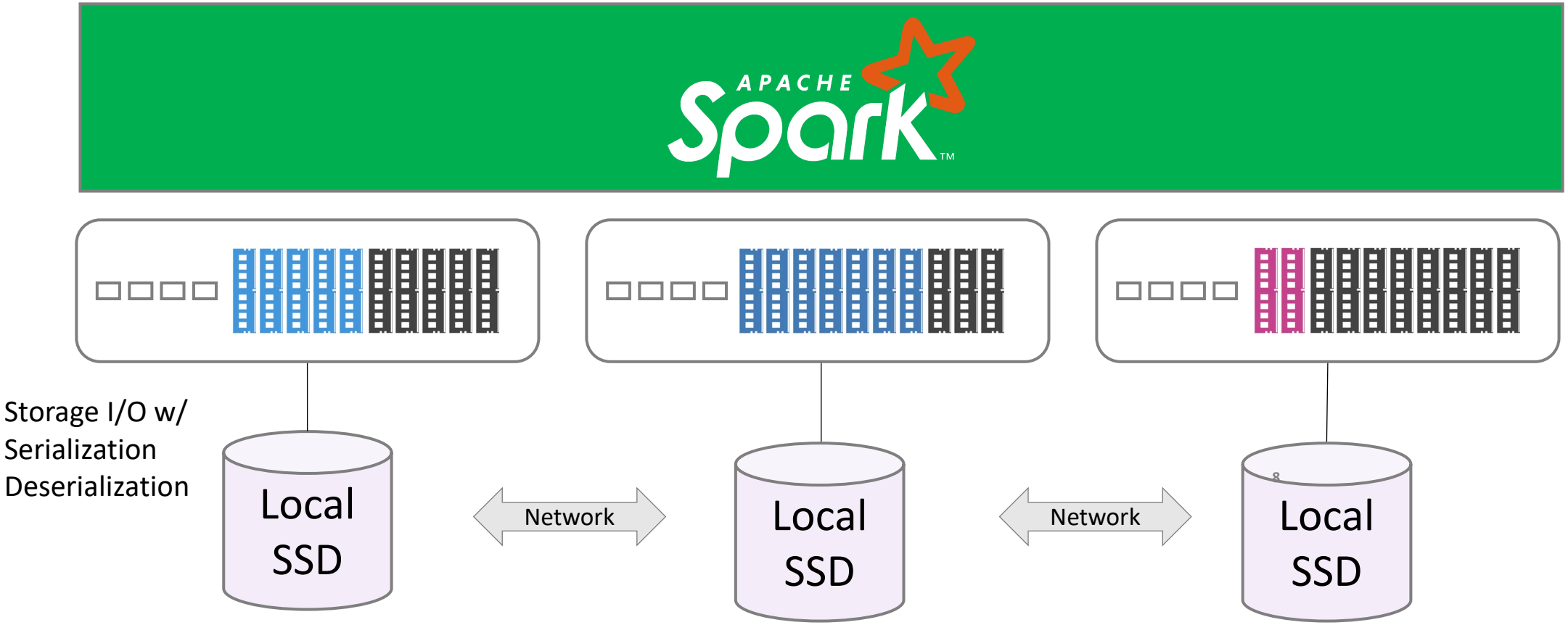


2. Provision a new memory region from the pool

Use Case #3

Distributed Application Data Shuffling

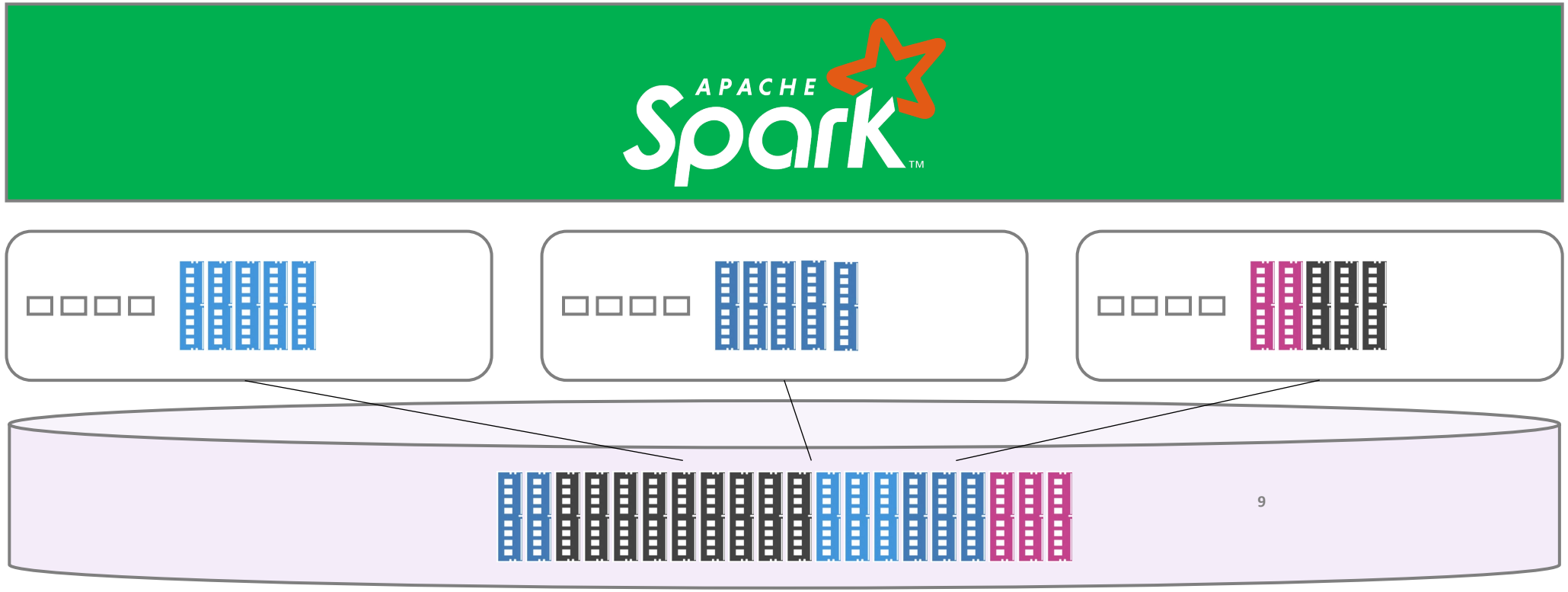
Before CXL



Use Case #3

Using Shared Memory Read

After CXL



Project Splash is open source: https://github.com/MemVerge/splash

S. Chen, et. Al. Optimizing Performance and Computing Resource Management of in-memory Big Data Analytics with Disaggregated Persistent Memory. CCGRID'19

A Typical CXL Pooled Memory Solution

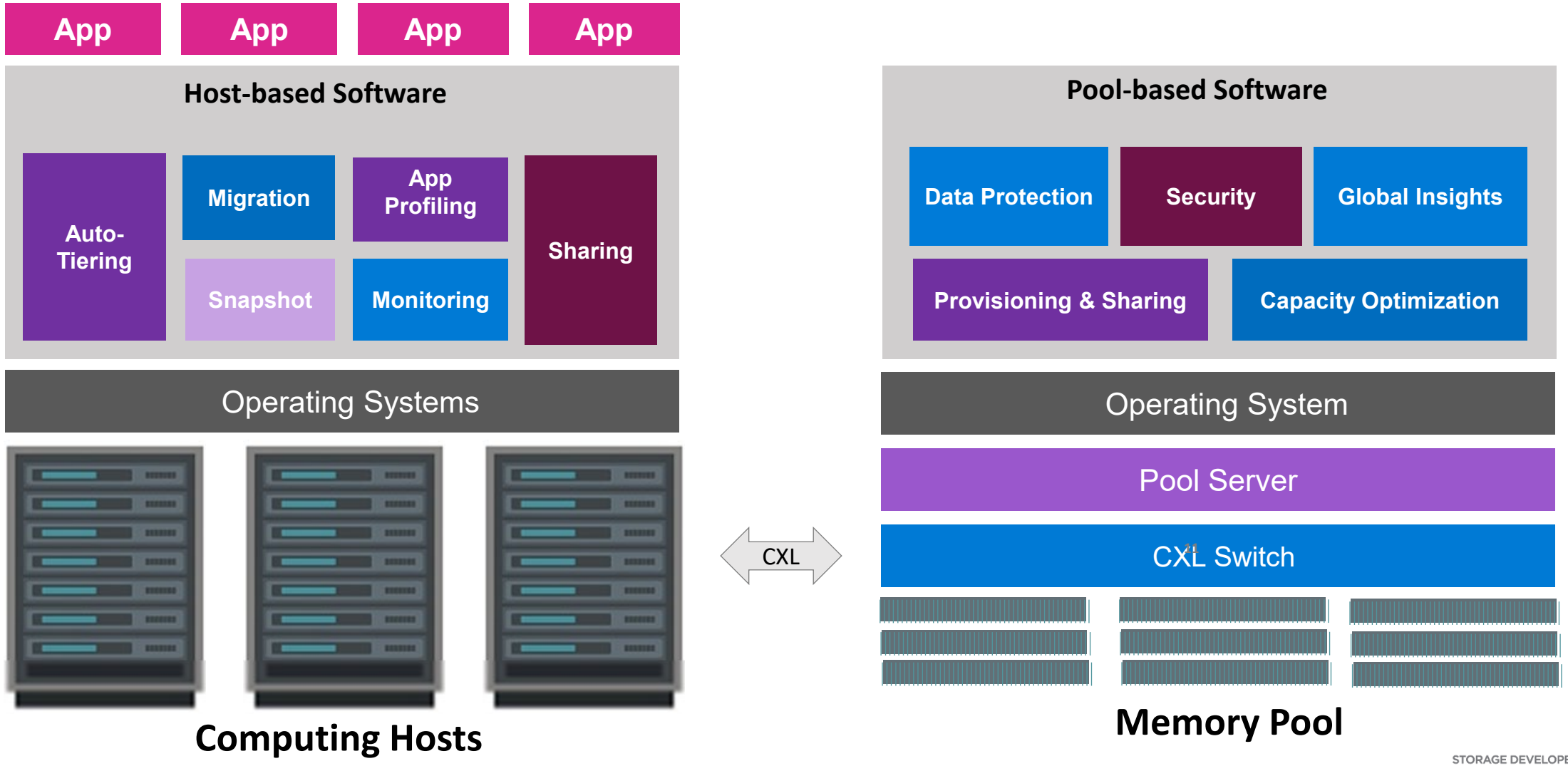
CXL Switch

Memory Pool

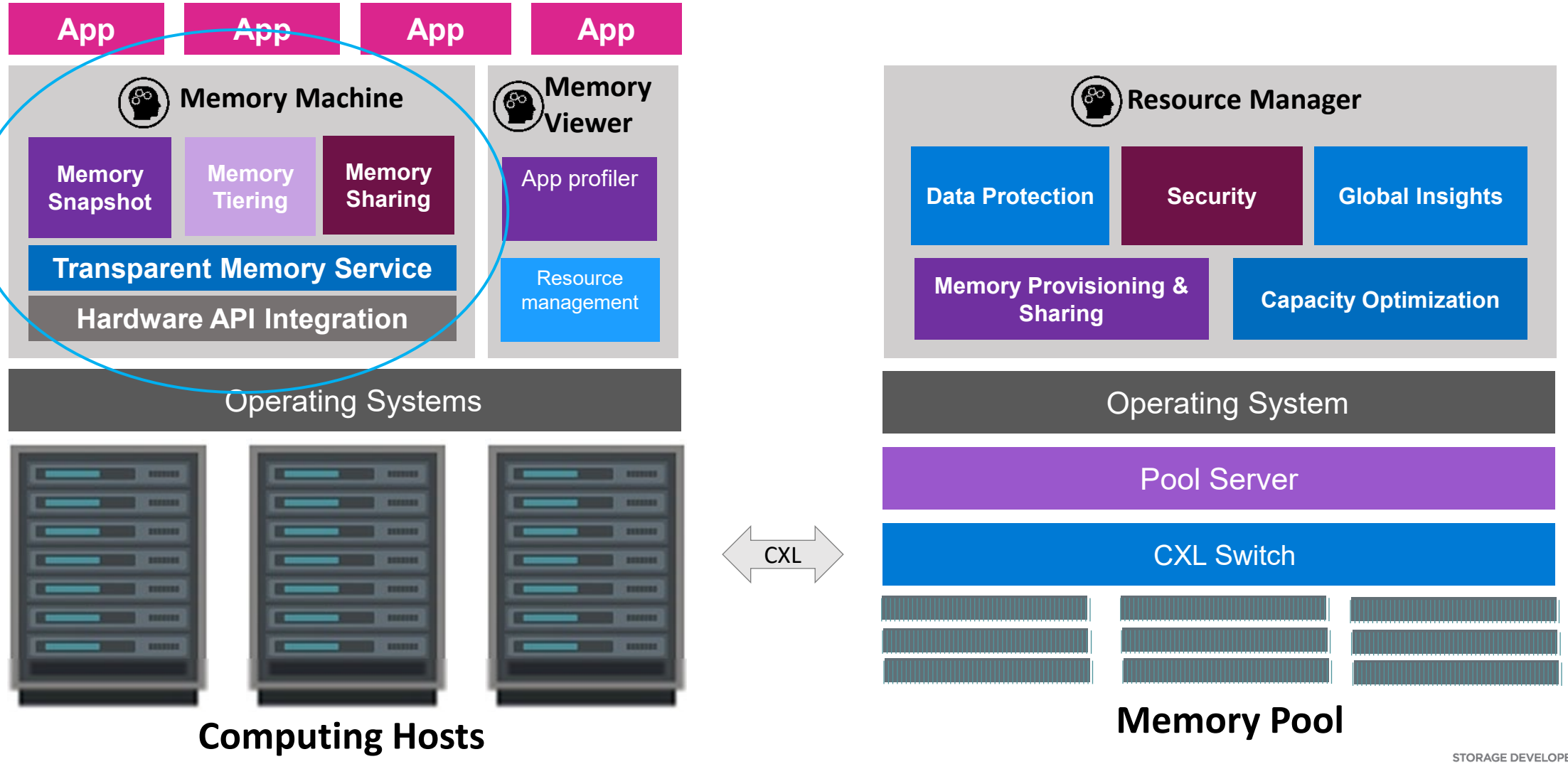
Resource Manager

Computing Hosts

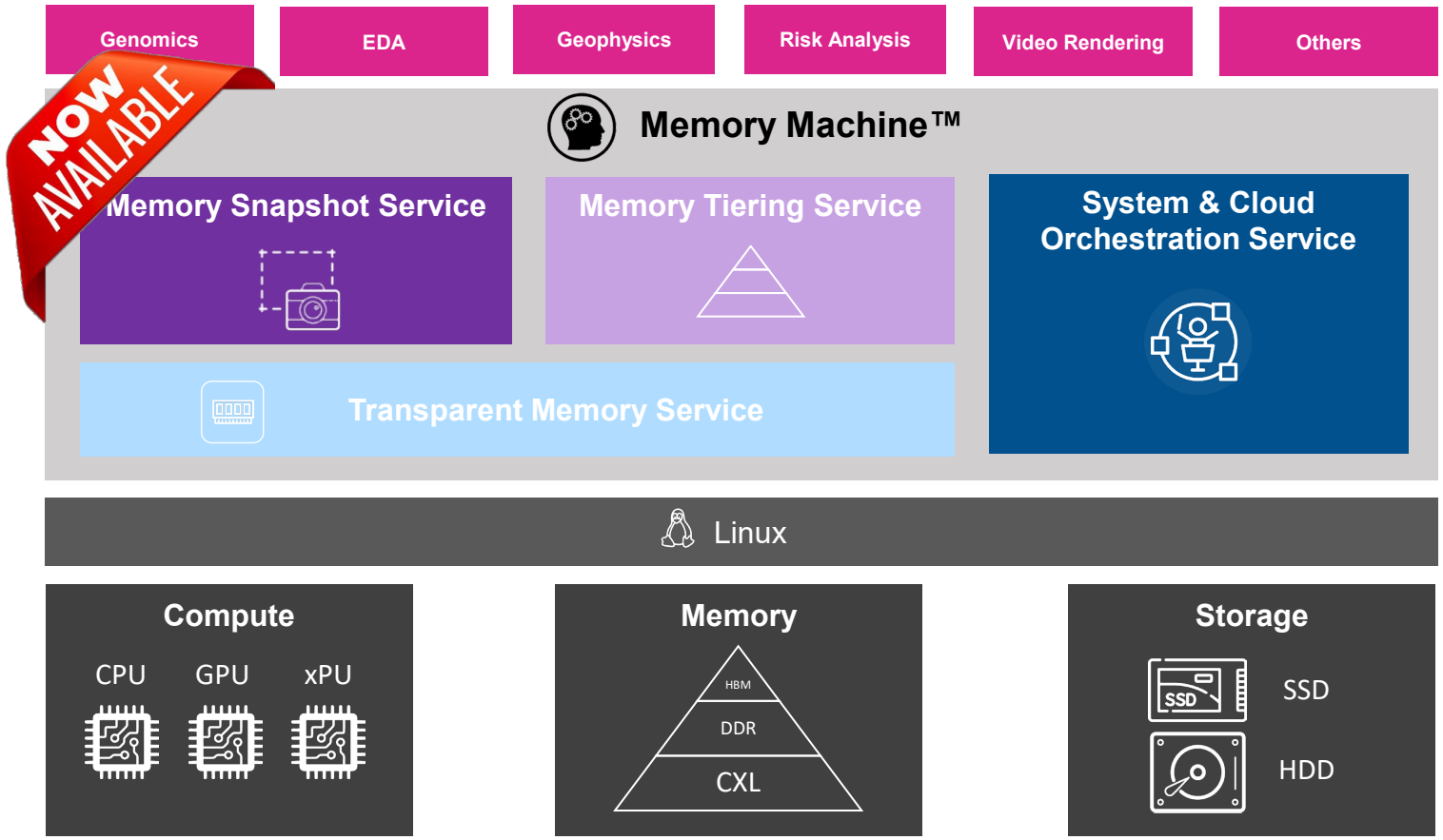
Pooled Memory Solution Needs Software



MemVerge Software-Defined Memory Suite



Announcing Memory Machine Cloud Edition



Memory Capacity Expansion

- Software-defined Memory Pool with intelligent Auto-tiering
- No application change required

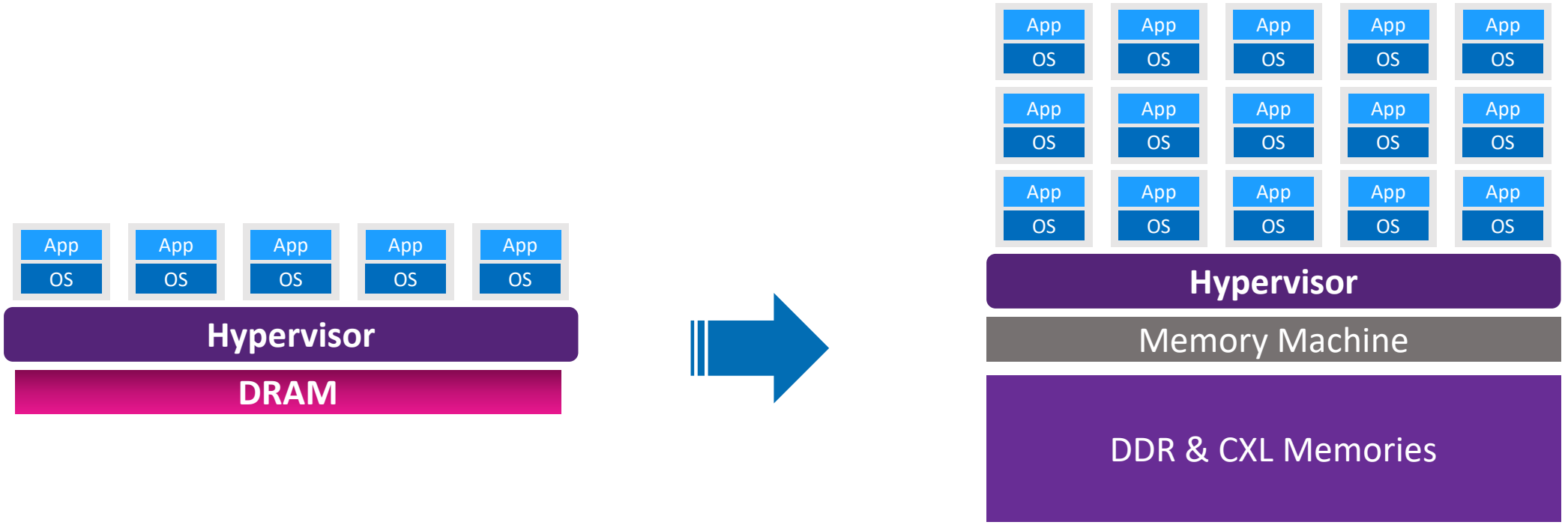
Accelerate Time-to-discovery

- Transparent checkpointing
- Roll-back, restore and clone anywhere any time

Reduce Cloud Cost by up to 70%

- Enable long-running applications to use low-cost Spot instances
- Integration with cloud automation and scheduler to auto-recover from CSP preemptions

Expands Memory Capacity & Lowers TCO

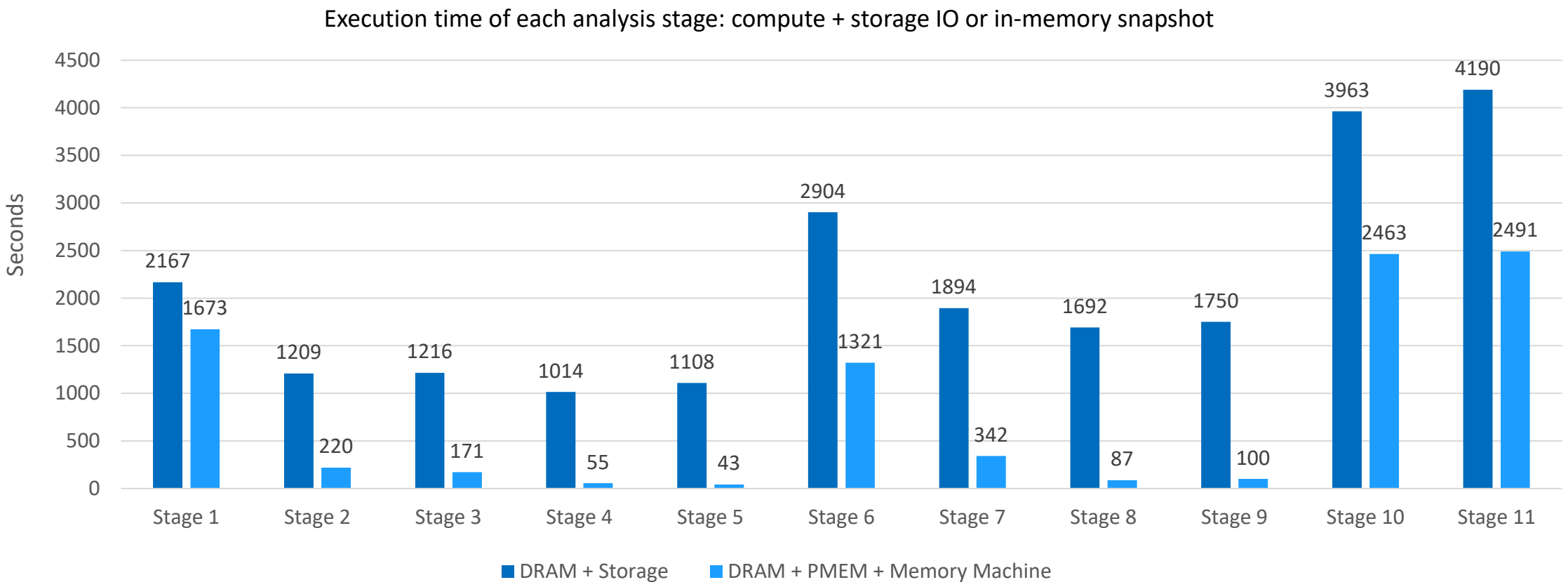


Memory Machine enables:

- Higher VM density
- Lower space, power, & cooling
- Lower TCO

Shortens Execution Time by 60%+

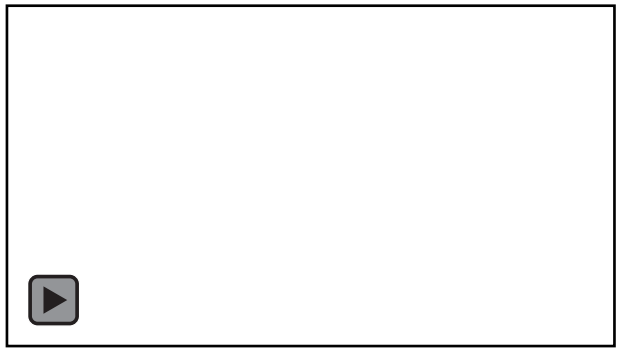
Mouse Cell Atlas (GSE108097), 176 Samples, Matrix Size 31787 x 813348



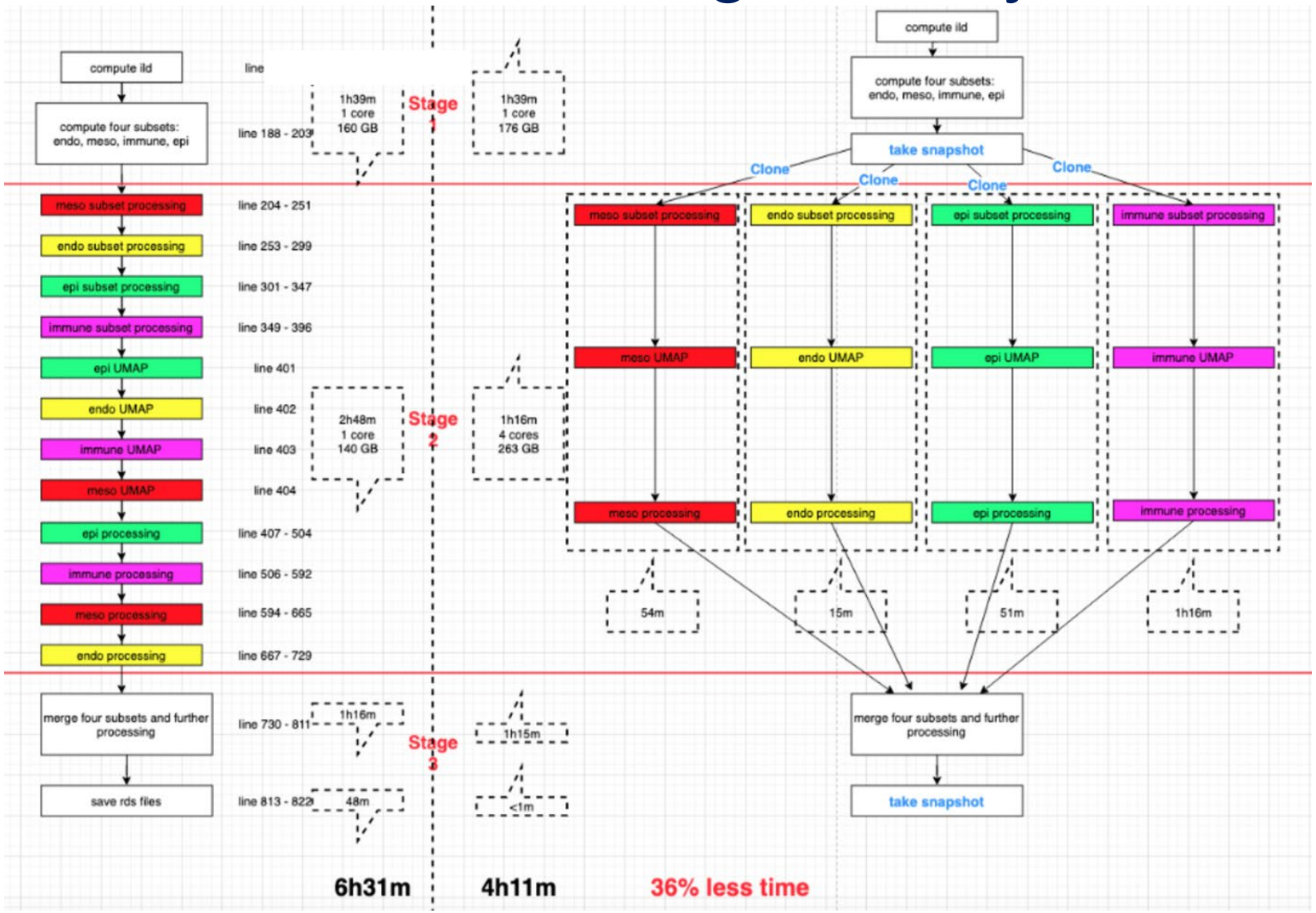
Austin Guetierez, TGEN Bioinformatician:

Fitting a matrix of 30k genes & 114K cells into fat memory nodes

Parallelizing a stubbornly single-threaded pipeline, saving 36% off pipeline time



Accelerates Running Time by 36%



Problem Single thread processing of large dataset causing long execution time.

Solution Memory Machine snapshots process at start of pipeline and clones 4 copies to execute in parallel, all accessing the same large dataset in shared memory.

Result Execution time reduced from **6.5 to 4.2 Hours,** with minimal memory usage overhead

Memory Machine Cloud Edition

Reduces Cloud Cost by 70%

Cloud Cost

Enables stateful non-fault-tolerant applications to use low-cost Spot Instances

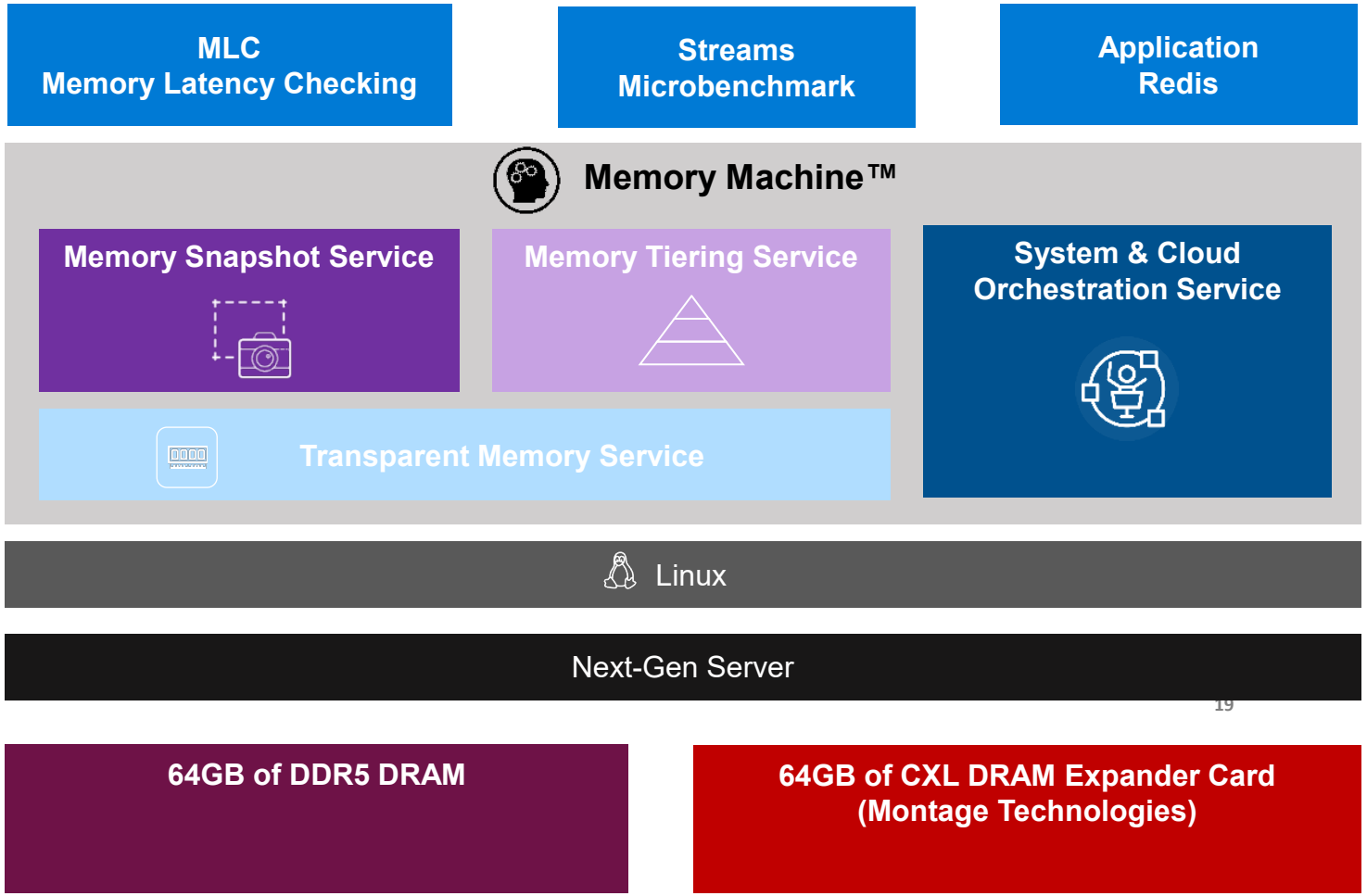
Cloud Burst

Move workload to Cloud from on-prem during peak time

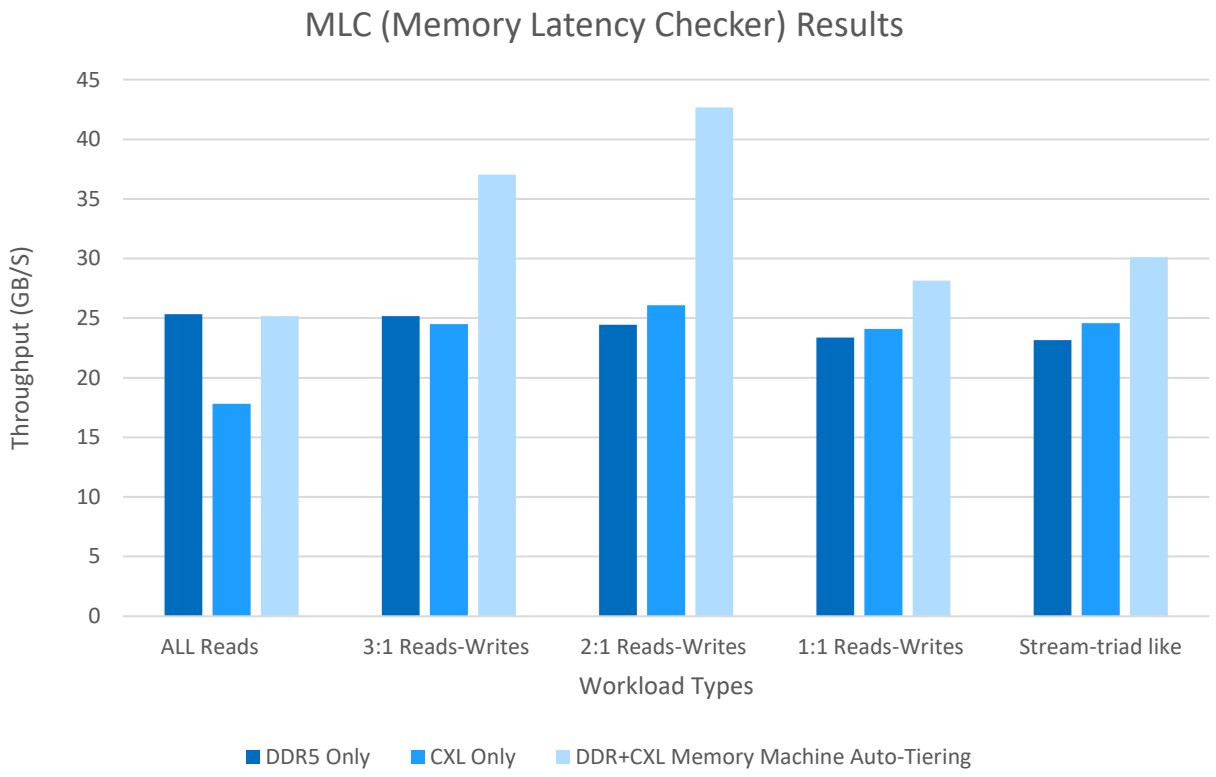
Cloud Mobility

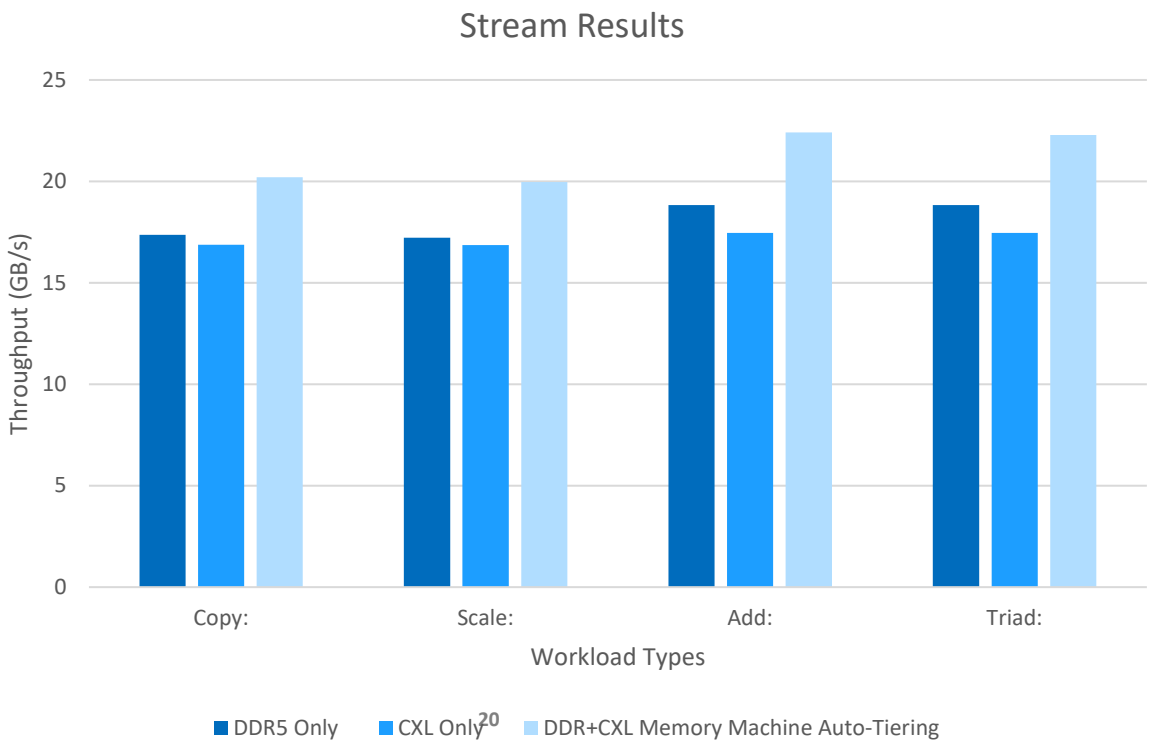
Move long-running workload between cloud instances

Memory Machine Runs on CXL



Early Results Running Memory Machine on CXL

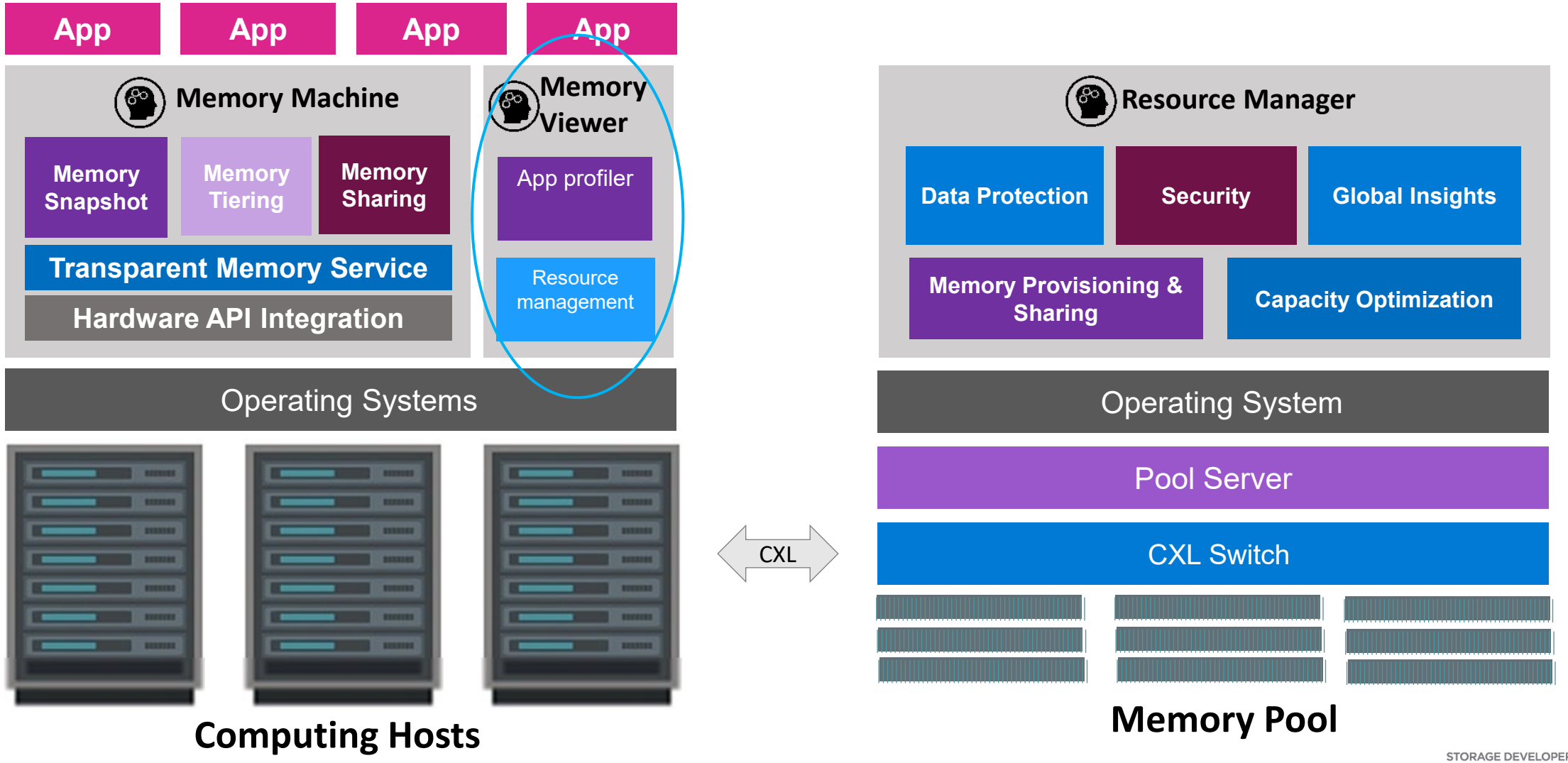




DDR5 Latency: 108ns

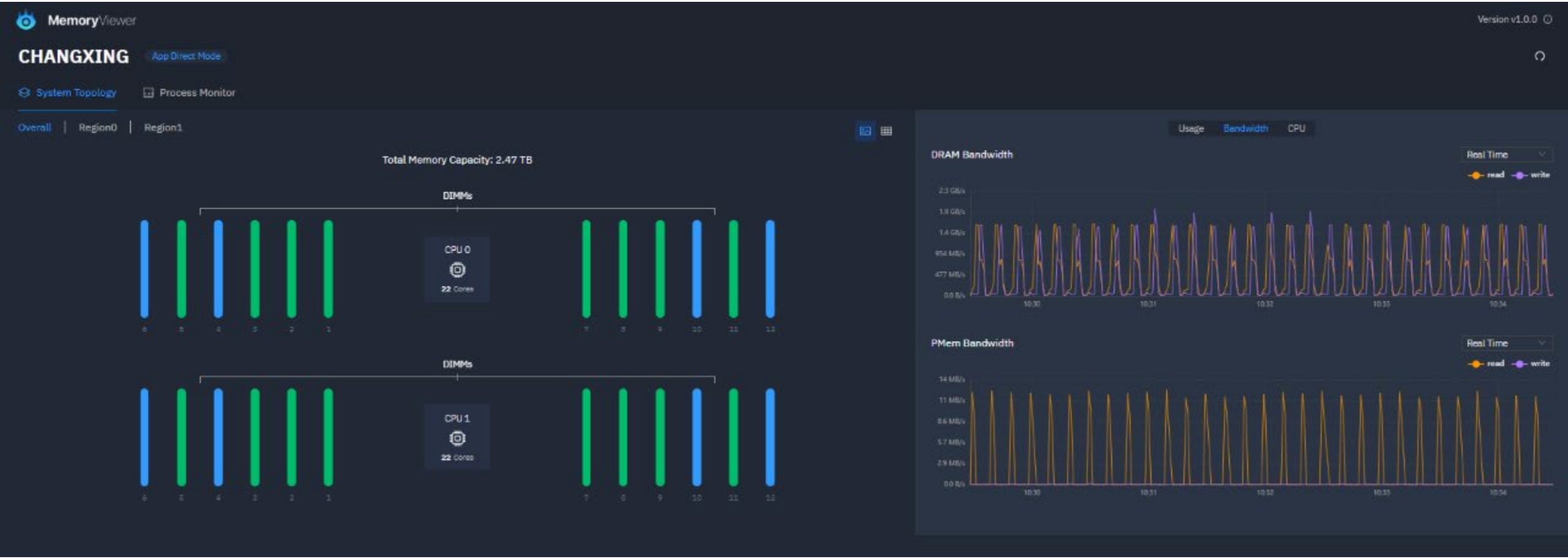
CXL Latency: 272ns

MemVerge Software-Defined Memory Suite

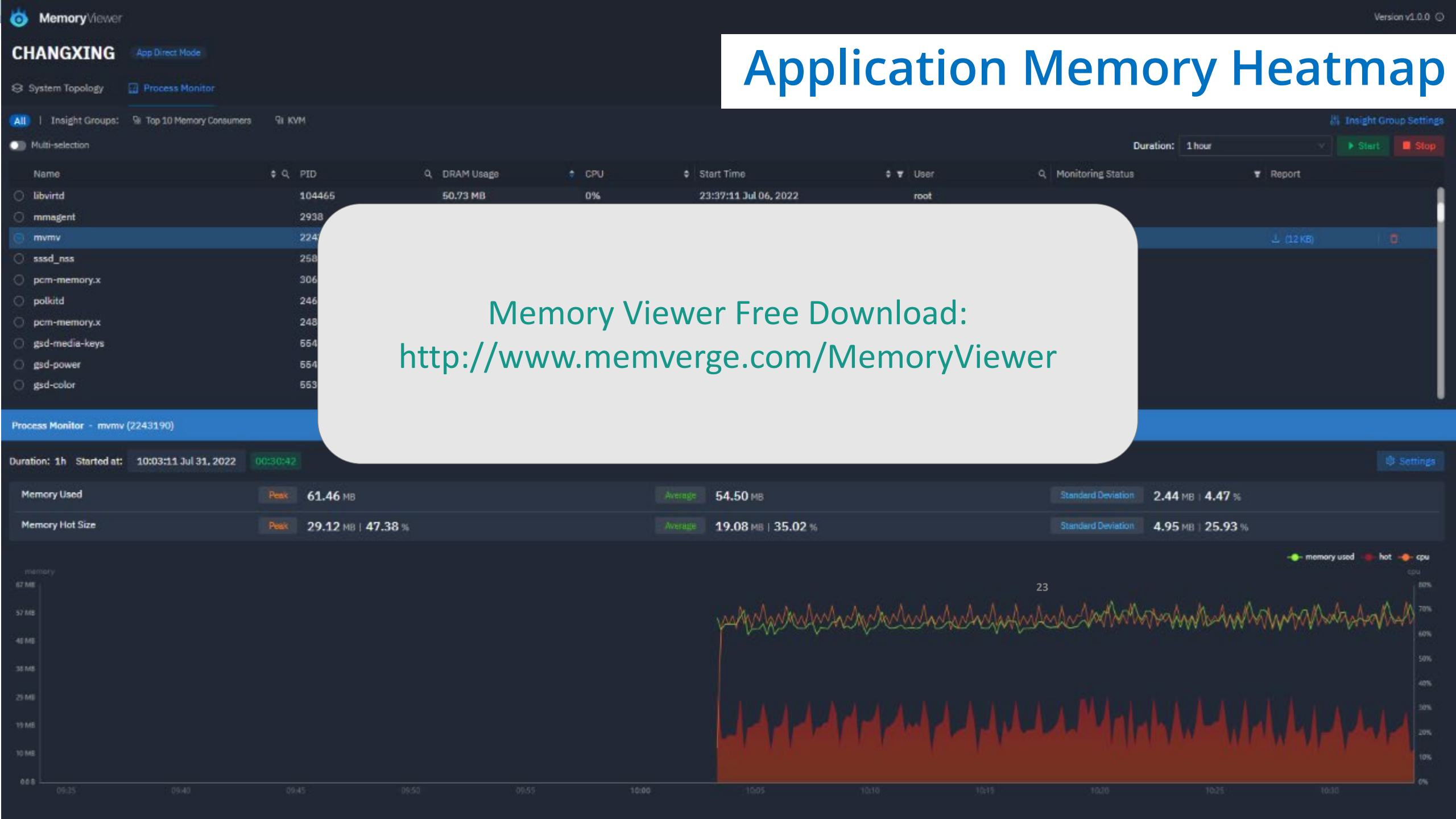


AVAILABLE NOW

MemoryViewer

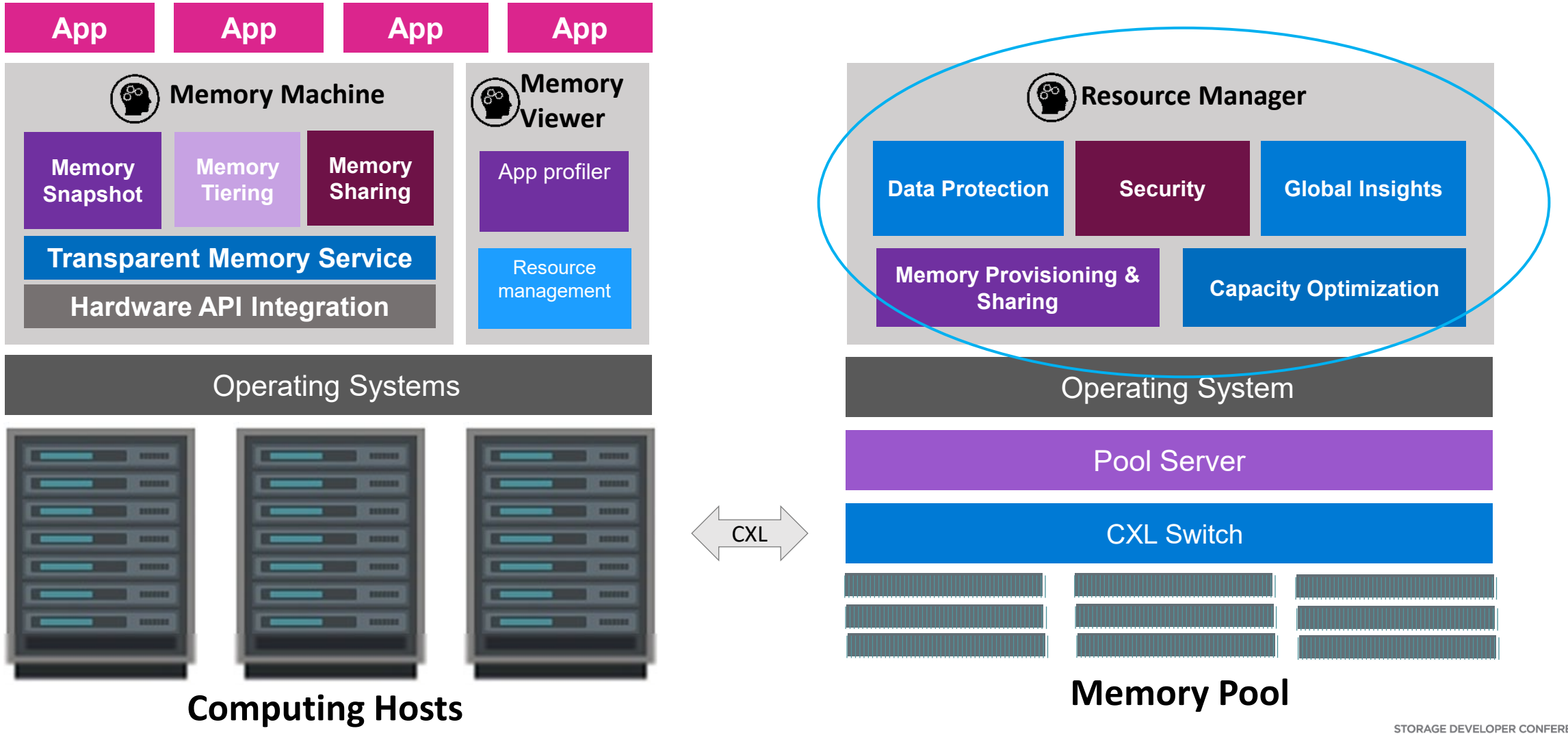


Application Memory Heatmap



Memory Viewer Free Download:
http://www.memverge.com/MemoryViewer

MemVerge Software-Defined Memory Suite



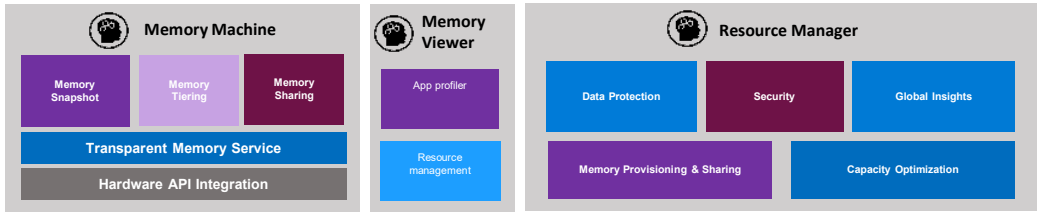
Software Partner for the CXL Ecosystem

MemVerge

Switches: MARVELL, XCONN TECH, Elastics.CLOUD, LIQID, GIGAIO

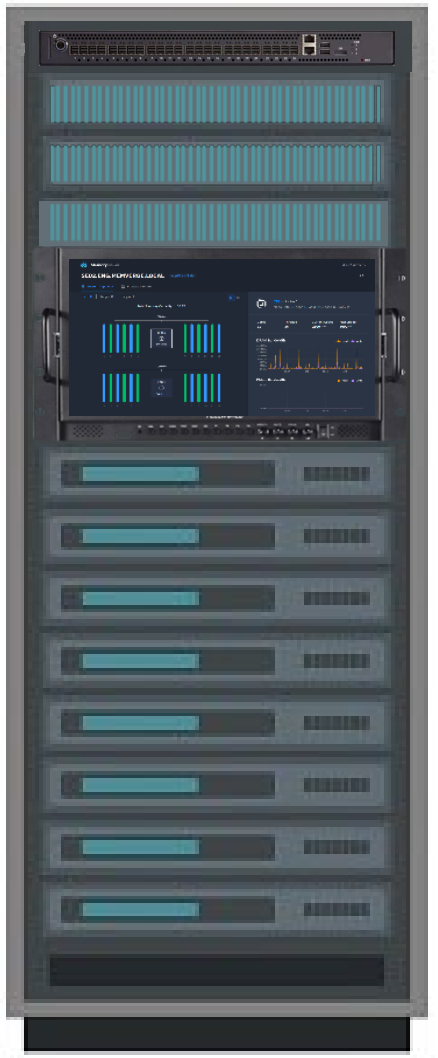
Memory Systems: SAMSUNG, SK hynix, Micron, KIOXIA, Rambus, MONTAGE Technology, AsteraLabs, SMART Modular Technologies, Western Digital, SEAGATE

Big Memory Software



Processors: intel, AMD, NVIDIA, arm

Servers: DELL, Hewlett Packard Enterprise, CISCO, Lenovo, SUPERMICRO, PENGUIN COMPUTING



Standards Bodies

CXL Compute Express Link, OPEN Compute Project, SNIA

Big Memory Apps

SYNOPSYS, cadence, HAZELCAST

Clouds

aws, Alibaba Cloud, Azure, Tencent Cloud, Google, ByteDance, Meta, phoenixNAP GLOBAL IT SERVICES

STORAGE DEVELOPER CONFERENCE SDC 22

What Happened to Storage 30 Years Ago

Just Bunch of Disks

Fiber Channel

Storage Area Network (SAN)

Storage Data Services

Advanced Storage Services

What will Happen to Memory…

Just Bunch of Disks

Fiber Channel

Storage Area Network (SAN)

Storage Data Services

Advanced Storage Services

CXL

Memory Data Services

New Memory

Pooled Memory

Memory-as-a-Service

Summary

- CXL is a key enabler of a new memory-centric data center architecture that breaks Memory Wall and IO Wall
- For the first time in history, software will become a critical component of new memory systems
- The combination of hardware and software innovations will give rise to a new memory system market of $10B+

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