A Platform for CXL Memory Services

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EMPOWERING OPEN.

OCP GLOBAL SUMMIT
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SAN JOSE, CA

MemVerge: Pioneering Big Memory Software since 2017

Built World's 1st Software-Defined Memory Product:

Memory Machine

Founders were creators of $B product lines

Powered By vmware vSAN

XtremIO

Raised $93M of Investment

SK hynix

intel capital

NetApp

cisco investments

Memory Machine Customers

VISA

American Express

Tencent Cloud

Alibaba Cloud

MEMX

ByteDance

A&M

PennState

Analytical Biosciences

tgen An affiliate of City of Hope

INTESA SANPAOLO

GT

CXL Road Map: CXL 3.0

CXL 3.0 Spec Feature Summary

Compute Express Link

Paper Release ! →

Features	CXL 1.0 / 1.1	CXL 2.0	CXL 3.0
Release date	2019	2020	1H 2022
Max link rate	32GTs	32GTs	64GTs
Flit 68 byte (up to 32 GTs)	✓	✓	✓
Flit 256 byte (up to 64 GTs)			✓
Type 1, Type 2 and Type 3 Devices	✓	✓	✓
Memory Pooling w/ MLDs		✓	✓
Global Persistent Flush		✓	✓
CXL IDE		✓	✓
Switching (Single-level)		✓	✓
Switching (Multi-level)			✓
Direct memory access for peer-to-peer			✓
Enhanced coherency (256 byte flit)			✓
Memory sharing (256 byte flit)			
Multiple Type 1/Type 2 devices per root port			
Fabric capabilities (256 byte flit)			✓

2H23 To 1H24

1H24 To 2H24

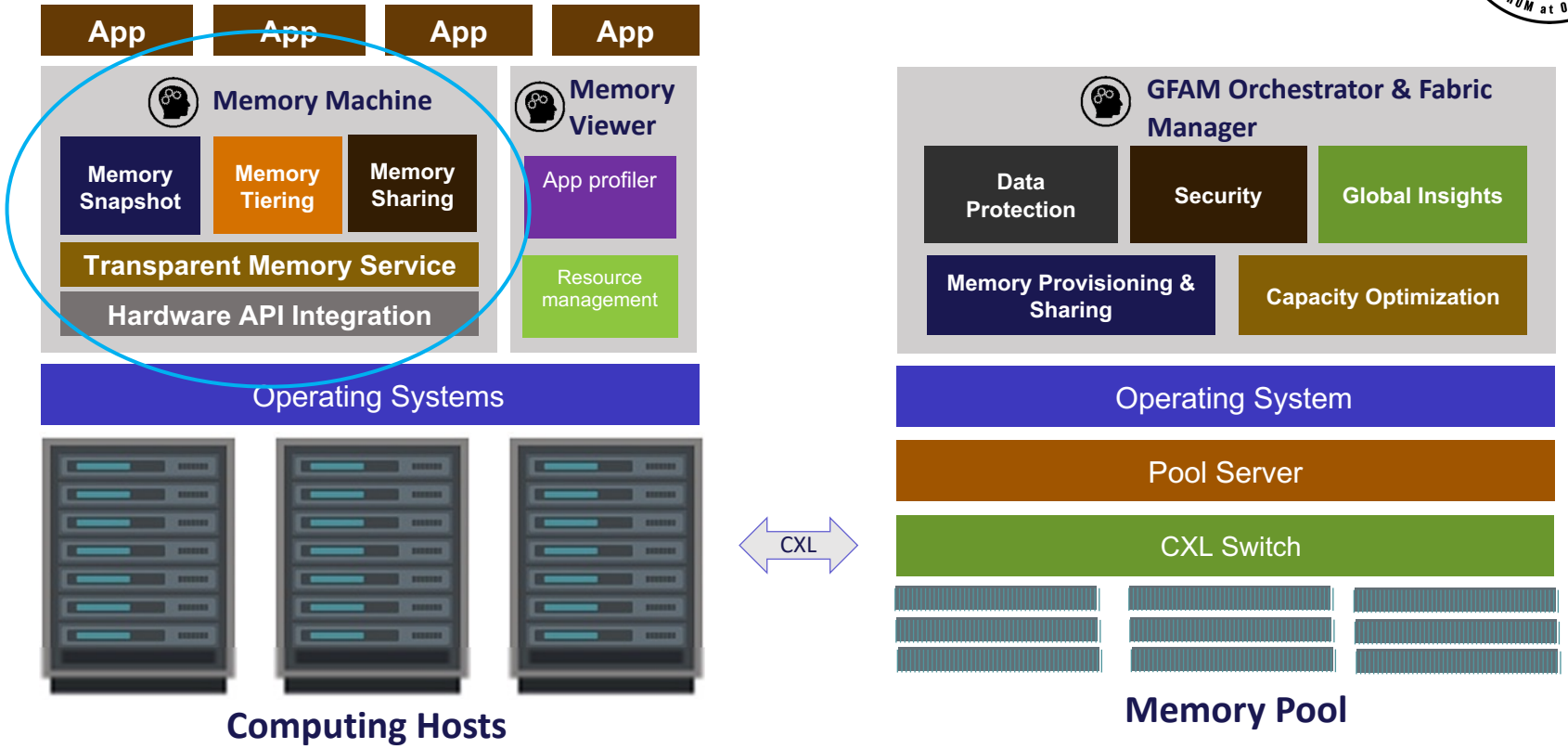
2025+

Not supported

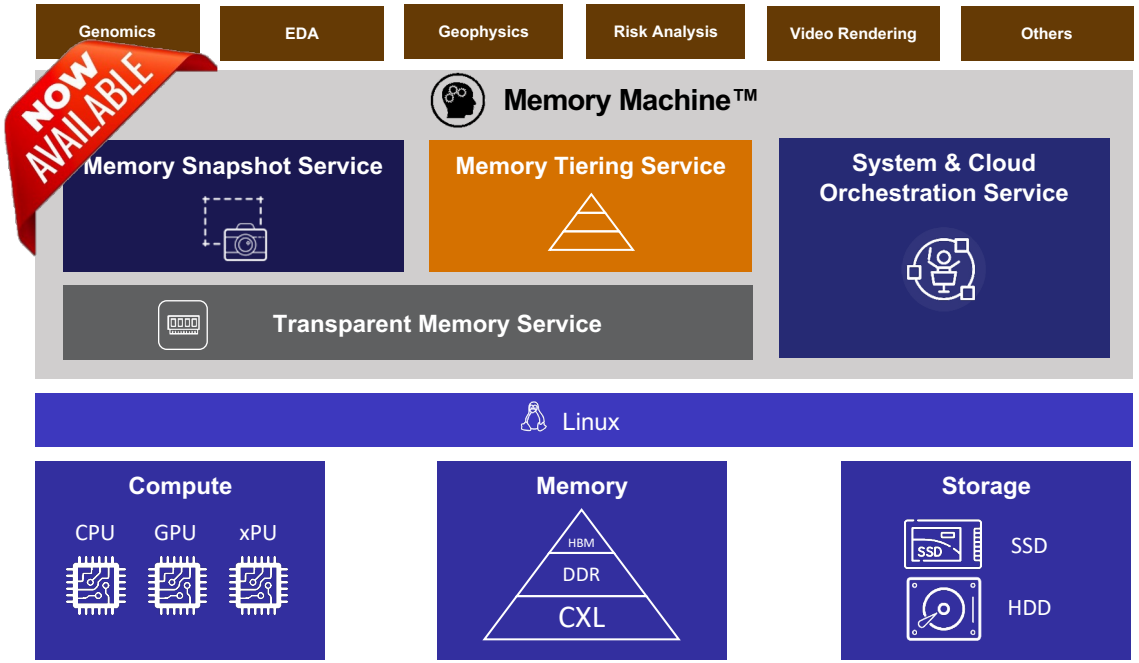
✓ Supported

Market Availability

The ❤ of Big Memory in the CXL era is Software



Memory Machine Available Now



Memory Capacity Expansion

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

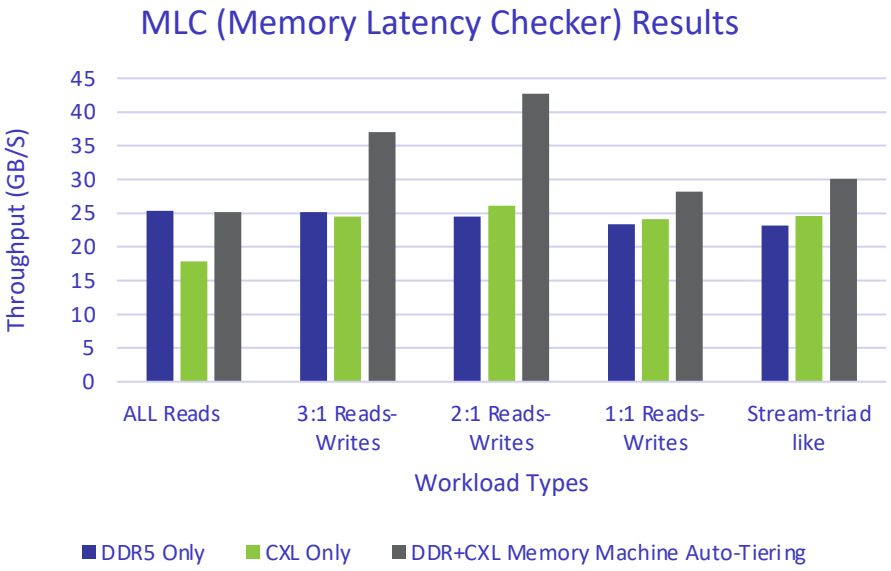
Accelerate Time-to-discovery

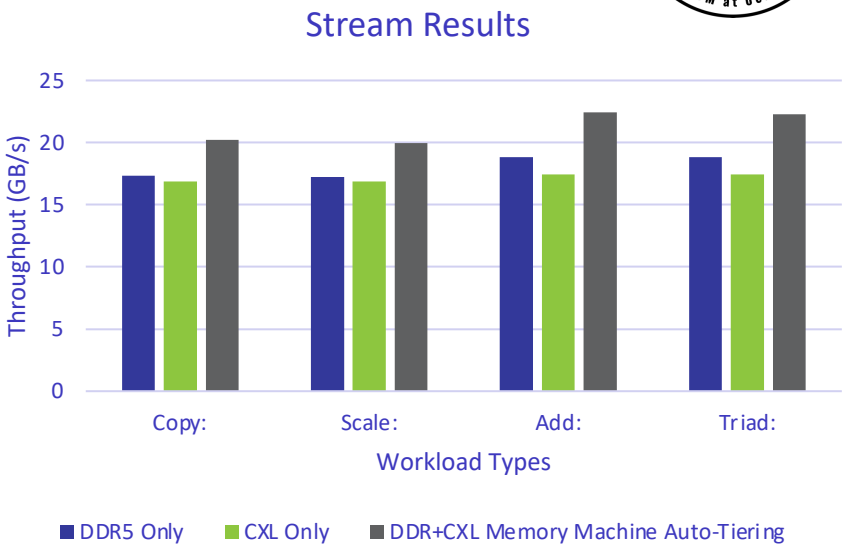
- Transparent checkpointing
- Roll-back, restore and clone anywhere any time

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

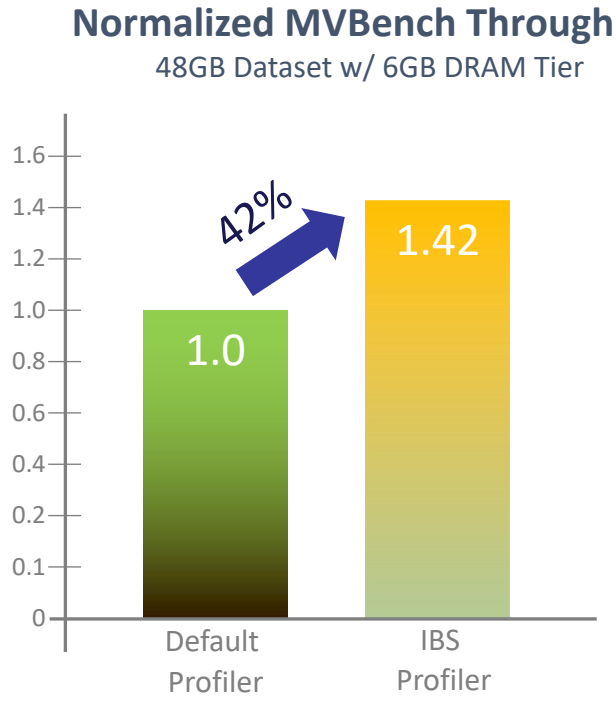
Early Results Running Memory Machine on CXL

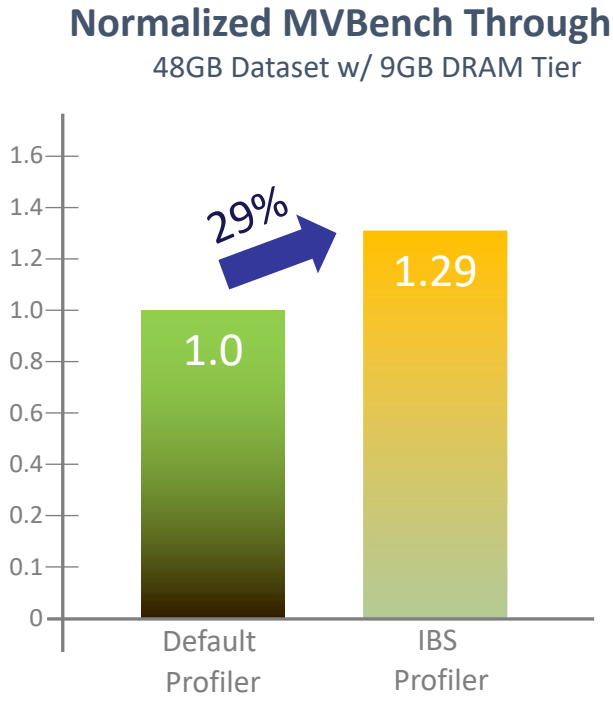




DDR5 Latency: 108ns
CXL Latency: 272ns

HW-assisted Memory Profiling Boosts Tiering Performance





Note: This demonstration used pre-production hardware, firmware, and devices. Performance varies by use, configuration and other factors

MemVerge Memory Machine | Memory Viewer

localhost:18080/#/

MemoryViewer

Version v1.0.0

FEDORA CXL

System Topology | Process Monitor

Overall

Total Memory Capacity: 125.63 GB

Host DIMM Memory

CPU 0

52 Cores

8 7 6 5 4 3 2 1 9 10 11 12 13 14 15 16

Host DIMM Memory

CPU 1

52 Cores

8 7 6 5 4 3 2 1 9 10 11 12 13 14 15 16

Local CXL Memory

CXL bus

CXL Memory 01
Capacity: 512.00 GB

CXL Memory 02
Capacity: 512.00 GB

CXL Memory 03
Capacity: 64.00 GB

CXL Memory 04
Capacity: 96.00 GB

Usage | Bandwidth | CPU

DRAM Bandwidth

Real Time

read write

65 GB/s
56 GB/s
47 GB/s
37 GB/s
28 GB/s
19 GB/s
9.3 GB/s
0.0 B/s

00:22 00:23 00:24 00:25 00:26

09-26 00:24:04
read: 184 MB/s
write: 144 MB/s

CXL Memory Bandwidth

Real Time

read write

17 GB/s
14 GB/s
11 GB/s
8.4 GB/s
5.6 GB/s
2.8 GB/s
0.0 B/s

00:22 00:23 00:24 00:25 00:26

CDM212364_Set....zip

Show All

Application Memory Heatmap

MemoryViewer

Version v0.7.1

SE02.ENG.MEMVERGE.LOCAL App Direct Mode

System Topology | Process Monitor

All | Insight Groups: Top 10 Memory Consumers KVM

Insight Group Settings

Multi-selection

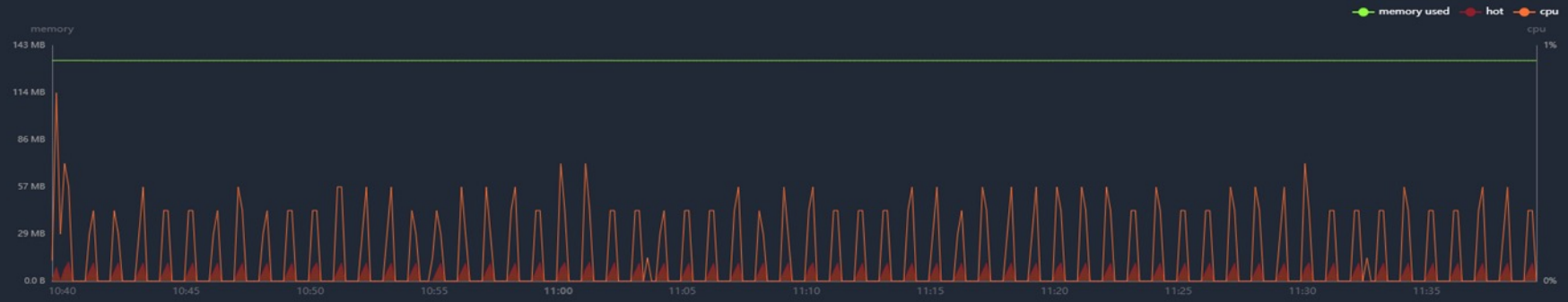
Duration: 1 hour Start Stop

Name	PID	DRAM Usage	CPU	Start Time	User	Monitoring Status	Report
gnome-shell	3512	133.88 MB	0.09%	09:01:05 May 18, 2022	gdm	1.00 hours	(45 KB)
mmctl	2052	91.86 MB	0.02%	09:01:02 May 18, 2022	mvmm	1.00 hours	(42 KB)
grafana-server	5469	81.23 MB	0.24%	09:06:09 May 18, 2022		1.00 hours	(45 KB)
prometheus	117975	66.18 MB	0.12%	20:47:07 May 18, 2022	nfsnobody	1.00 hours	(43 KB)
mmagent	2055	61.09 MB	0.12%	09:01:02 May 18, 2022	mvmm		
dockerd-current	5032	52.54 MB	0.25%	09:05:25 May 18, 2022	root		
mvmv	78301	49.88 MB	2.27%	14:00:38 Jul 25, 2022	root		
Xorg	3375	33.34 MB	0%	09:01:04 May 18, 2022	root		
gsd-color	3698	31.45 MB	0.22%	09:01:06 May 18, 2022	gdm	1.00 hours	(44 KB)
docker-containerd-current	5053	31.02 MB	0.12%	09:05:25 May 18, 2022	root		

Process Monitor - gnome-shell (3512)

Started at: 10:39:36 Jul 06, 2022 Ended at: 11:39:26 Jul 06, 2022

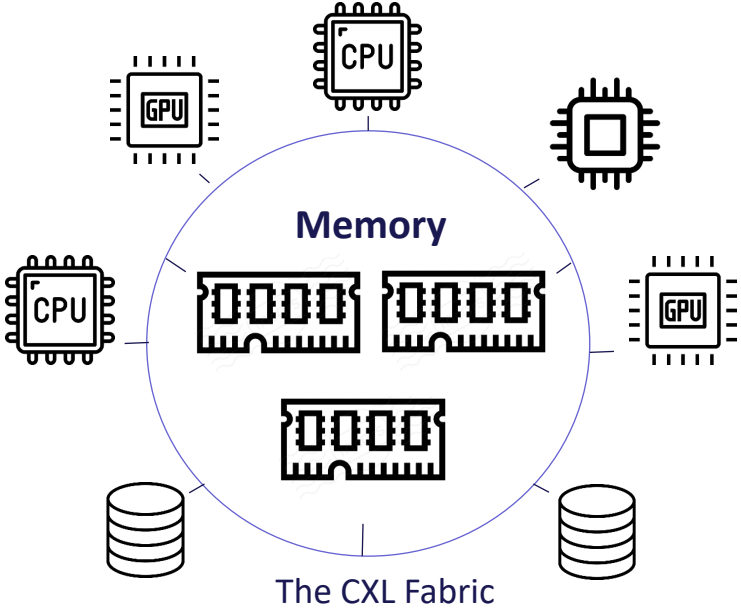
Memory Used	Peak	134.01 MB	Average	133.94 MB	Standard Deviation	11.78 KB | 0.01 %
Memory Hot Size	Peak	11.64 MB | 8.69 %	Average	2.87 MB | 2.15 %	Standard Deviation	4.20 MB | 146.28 %



Examples of CXL Memory Services that can be enabled with Software

- Stranded Memory problem- automatic tiering/dynamic profiling
- Underutilized/Overallocated Memory within VMs
- Enable Memory Composable infrastructure
- Increase Resilience
  - Self-healing for DIMM failures
  - Transparent checkpoint/recovery and data protection with high-speed memory snapshots
- Enable Shared Memory Collaboration through shared memory objects or snapshots
- Consolidate distributed compute memory caches

CXL + Software Enables Memory-Centric Data Center



- Memory Expansion with Tiering
  - Capacity Expansion
  - Bandwidth Expansion
- Memory Pooling
  - Dynamic Elastic Memory
  - Composable Infrastructure
- Memory Sharing
  - Low Latency Pub/Sub
  - Shared Storage Cache
- For the first time in history, software becomes critical for memory!

Summary

- CXL is the game changer that will enable Big Memory
- Software will be at the heart of a CXL-based Big Memory solution
- MemVerge looking to partner with rest of industry to deliver solutions to Memory tiering, pooling, and sharing as well as advanced memory services.
- MemVerge software already supports CXL. MemVerge intends to deliver the best CXL middleware software solution to customers.

MemVerge

Memorize the Future

ENDLESS MEMORY

CXL FORUM at OCP Summit

Thank you

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