Endless Memory

In search of the perfect analytics solution

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Endless Memory Team

Moderator

Big Memory Computing

Big Memory Use Cases

Eric Doyle
Director, Channels & Alliances
MemVerge

Mike Hoey
Director of Sales
MemVerge

Eddie Blanton
Director, Solutions Enablement, SSG
Penguin Computing

Stay until the end!

Big Memory Technology

Mike Hoey
Director of Sales
MemVerge
mike.hoey@memverge.com

Digital Transformation Driving Big & Fast Data

A Select Few Apps Today

Financial Services
Digital Banking

Life Sciences
Genomics

Social Media
Customer Profiling

Retail
Recommendation Engines

Media & Entertainment
Animation/Visual Effects

Pervasive in the Future

jupyter | PyTorch | R | AI/ML | TensorFlow | XGBoost

databricks | Microsoft SQL Server | redis | In-Memory Databases | hazelcast | MySQL | mongoDB

RANCHER | RED HAT OPENSHIFT | VMware Tanzu | Containers | Amazon EKS | Azure AKS | Google Kubernetes Engine

vmware | Server Virtualization | KVM

Alibaba.com | aws | Azure | Cloud & On-Premises | Google Cloud | Tencent 腾讯

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The Memory-Storage Dichotomy: A Fundamental Bottleneck

Apps Run in DRAM

DRAM

Pros
- Fast

Cons
- Low Capacity
- High Cost
- Volatile

App

CPU

DRAM

I/O

Storage

Storage

Pros
- High-Capacity
- Low-Cost
- Non-Volatile

Cons
- Slow

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Brass Tacks...Root Cause

| Server Virtualization | In-Memory Databases | AI/ML | HPC | Big Data Analytics |

Bare metal, container, or VM

DRAM

<100ns

$13/GB

⬌

SSD Storage

100us

35¢/GB
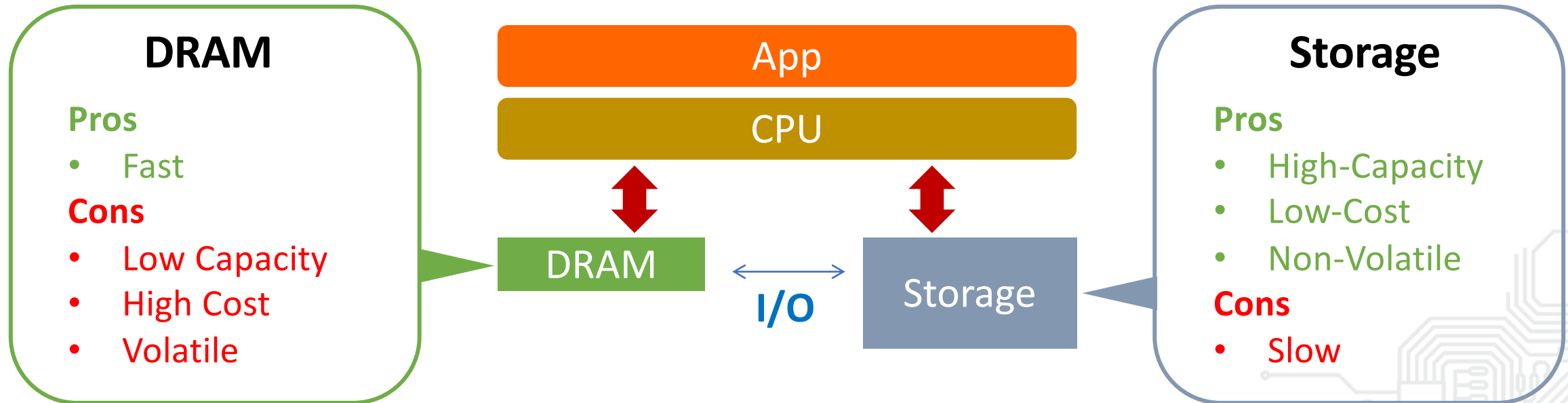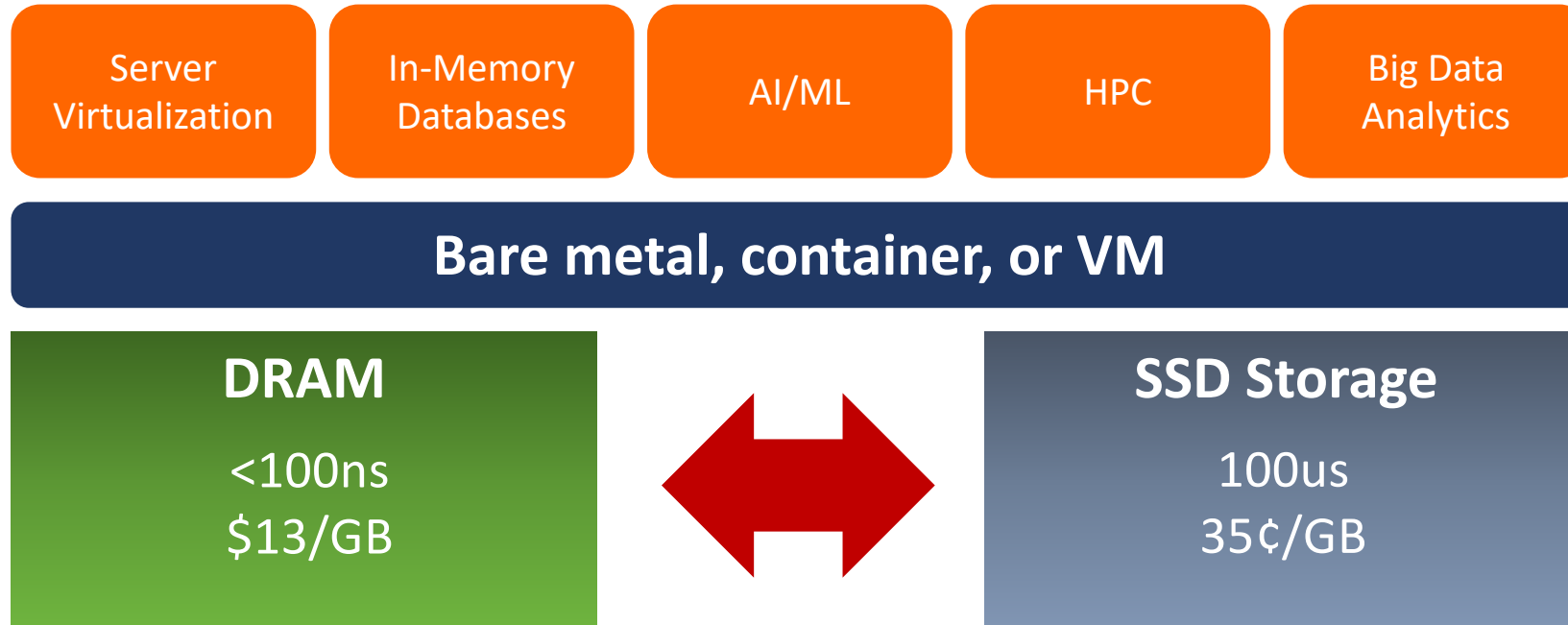
IO to Storage kills performance
SSD storage media 1,000x slower than memory
Data serialization / deserialization overhead
Data transport overhead

Real-Life Pain Points by the Numbers

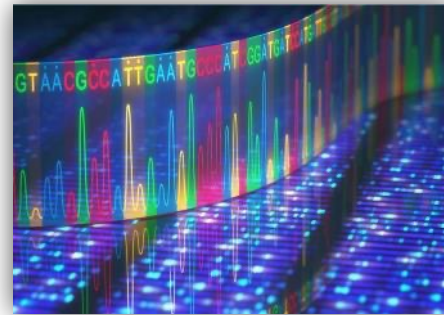### Financial Services
Databases

3hrs

How long it takes to recover a fraud, risk analysis, or payment cluster from storage.

Data Sciences
Multi-Stage Analytics

60%

Of multi-stage pipeline throughput is repetitive loading and execution from storage.

Cloud Infrastructure
Compute Instances
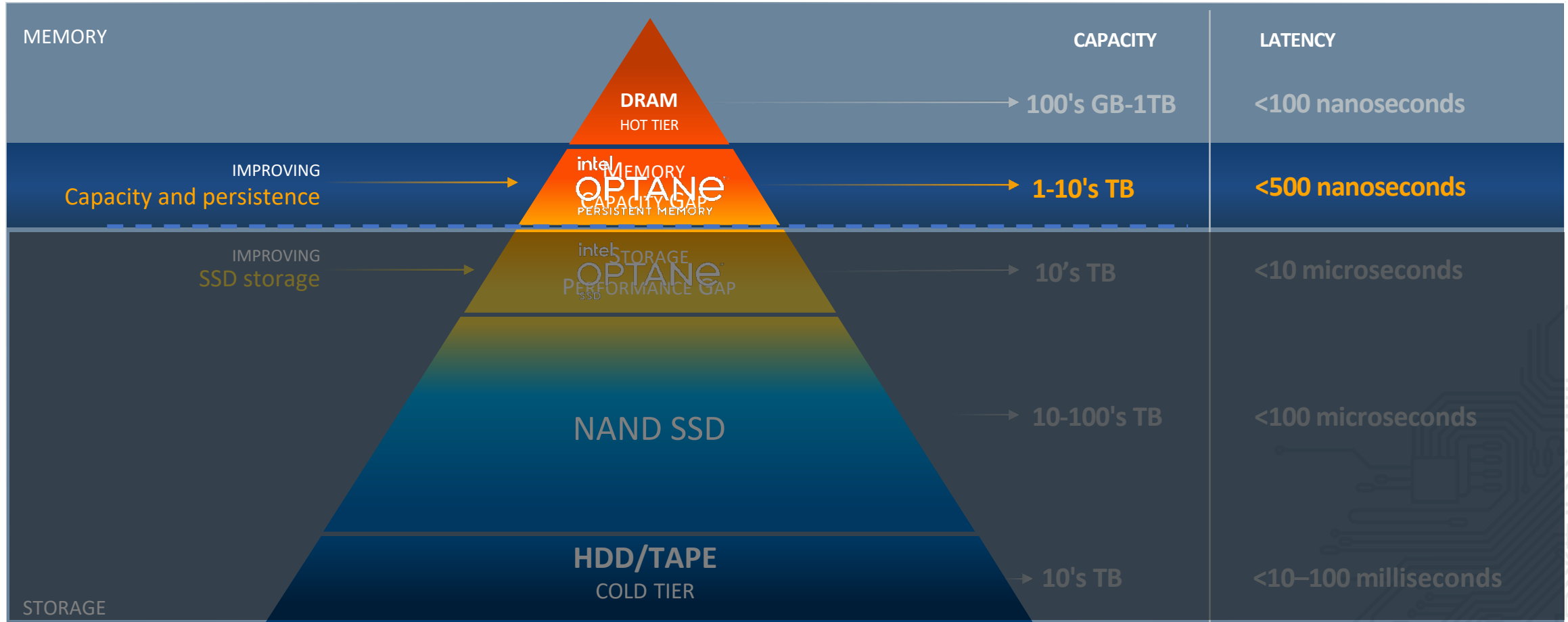

$500K

Server overhead due to memory capacity limitations.

Re-architecting the Memory/Storage Hierarchy
Intel® Optane™ Persistent Memory (PMem) fills the DRAM -> NAND gap

MEMORY

	CAPACITY	LATENCY
DRAM HOT TIER	100's GB-1TB	<100 nanoseconds
intel MEMORY OPTANE CAPACITY GAP PERSISTENT MEMORY	**1-10's TB**	**<500 nanoseconds**
intel STORAGE OPTANE PERFORMANCE GAP SSD	10's TB	<10 microseconds
NAND SSD	10-100's TB	<100 microseconds
HDD/TAPE COLD TIER	10's TB	<10–100 milliseconds

IMPROVING
Capacity and persistence
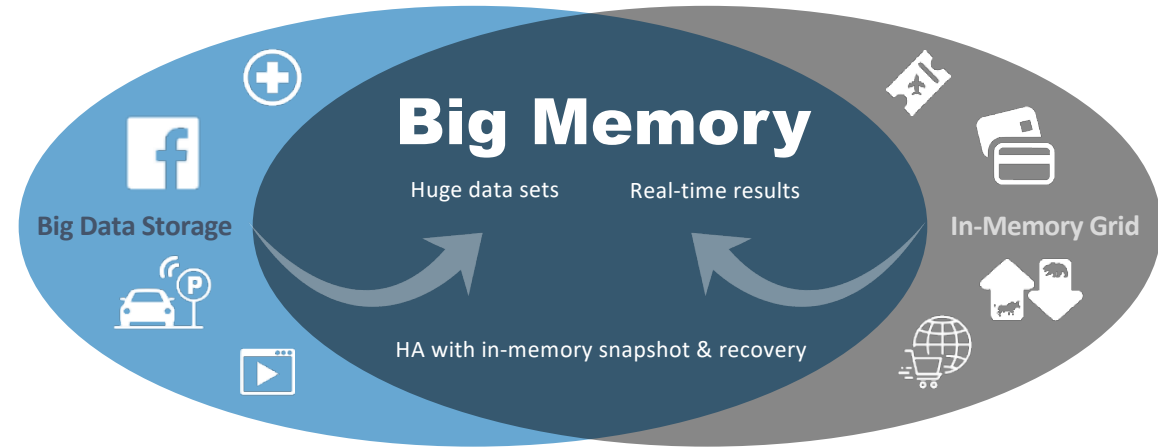
IMPROVING
SSD storage

STORAGE

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Introducing MemVerge®

Led by the creators of VSAN & XtremIO

Market share leaders and product lines with $ billions in annual revenue.

Powered By
vmware
vSAN™
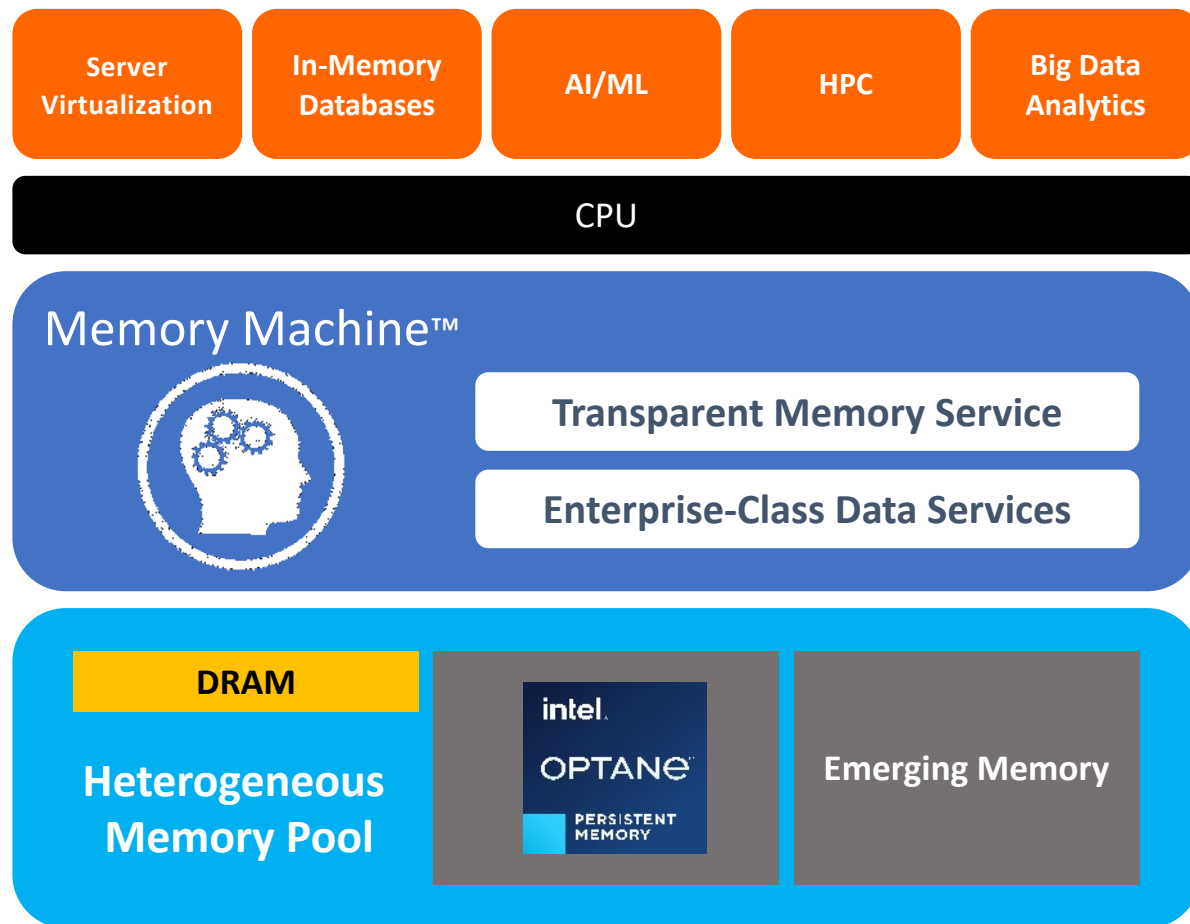
Xtrem IO

Pioneering Big Memory Computing

Big Data Storage

Big Memory

Huge data sets   Real-time results

HA with in-memory snapshot & recovery

In-Memory Grid

Investors

CISCO investments

intel capital

NetApp™

SK hynix

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Memory Machine™
Big Memory without Compromises

Server Virtualization	In-Memory Databases	AI/ML	HPC	Big Data Analytics

CPU

Memory Machine™

> **Transparent Memory Service**
>
> **Enterprise-Class Data Services**

Heterogeneous Memory Pool

DRAM	intel. OPTANE PERSISTENT MEMORY	Emerging Memory

Higher Performance
- Elimination of Storage I/O
- Solves Data-Greater-than-Memory (DGM) Problem

Lower Cost
- Higher Consolidation Ratio
- DRAM-like Performance @ 40% less cost

Enterprise-class features for HA & Productivity
- ZeroIO™ In-Memory Snapshot
- HA with AutoSave, Time Machine, Replication, and Instant Recovery
- Higher Productivity with IMDB and ML Cloning

No Application Changes needed !

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Comparison of PMEM Deployment Modes

Memory Mode – single pool of volatile memory

Pros
- ❏ Higher VM density
- ❏ No application changes needed

Cons
- ❏ DRAM capacity will be hidden
- ❏ Total memory capacity = PMEM capacity only
- ❏ PMEM becomes volatile
- ❏ Multi-VM performance issues
- ❏ Fixed DRAM-to-PMEM ratio for all VM's

App Direct Mode – (2) distinct pools of memory

Pros
- ❏ PMEM is persistent

Cons
- ❏ Cannot be used to extend VM's memory
- ❏ Application changes needed

Why MemVerge's Memory Machine ?
Big Memory without Compromises

Capability	Intel Memory Mode	Intel App Direct Mode	Memory Machine ™
Requires **changes to app**	No	Yes	No
100% Capacity Utilization (DRAM + PMEM)	No	Yes	Yes
Full **Persistence** in memory	No	Yes	Yes
Auto Tiering/Tuning	No	No	Yes
Modern memory allocator delivering **DRAM-like performance** for pool of DRAM + PMEM	No	No	Yes
High availability with local and cluster memory-to-memory snapshots and instant recovery	No	No	Yes
Higher IT and business productivity with cloning of IMDBs and ML stages, and on-prem/cloud snapshot mobility	No	No	Yes
Lower TCO no application rewrite, higher capacity utilization, and higher VM density / less servers with great performance	No	No	Yes

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Case Study **Trading Firm**

Java C++ App
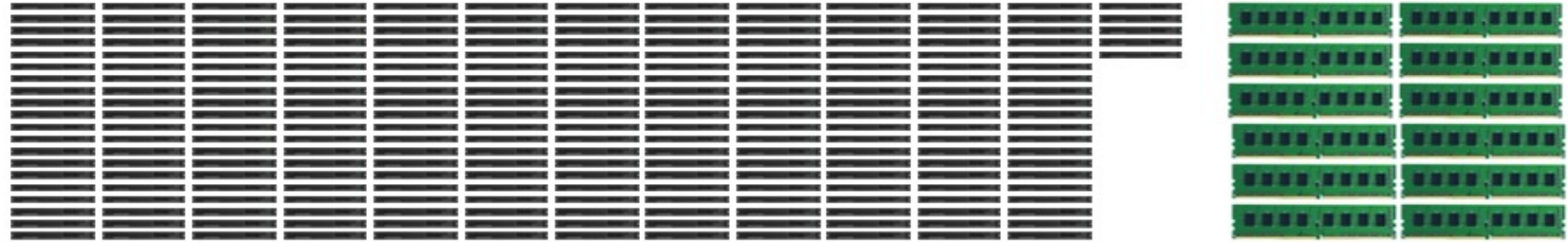
Lower TCO by consolidating servers and memory

With DRAM DIMMs-Only

245 Servers
x $2,500
$612,500

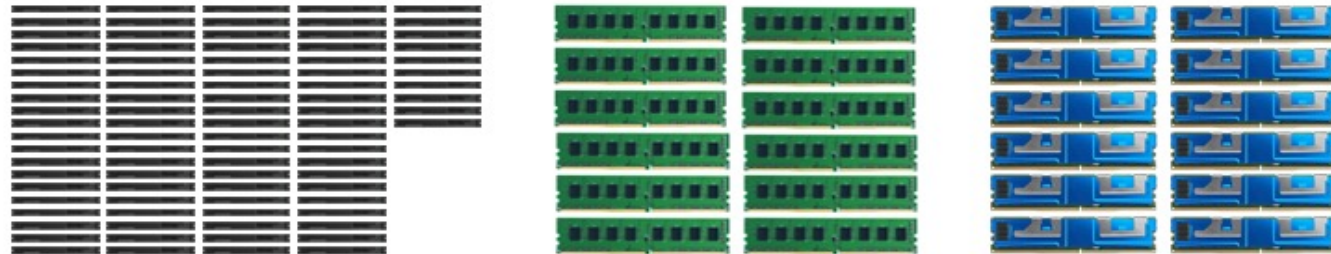768GB DRAM
$7.65/GB
x 245 Servers
$1,439,424

Total
$2,051,924

With Intel® Optane™ Persistent Memory and DRAM capacity @ 2:1

90 Servers
x $4,500
$405,000

768GB DRAM
$7.65/GB
x 90 Servers
$528,768

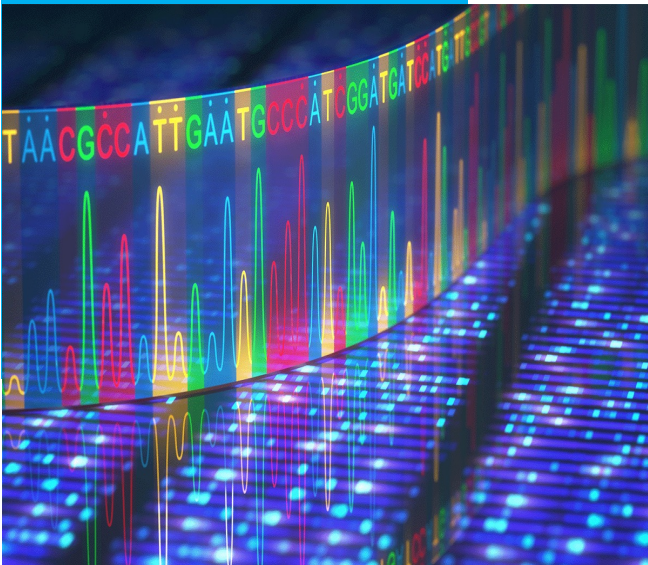1.5TB PMEM
$4.00/GB
x 90 Servers
$552,960

Total
$1,486,728

Run time reduced
from: 12 -13 hours
to: 3 – 4 hours

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Case Study — Bank
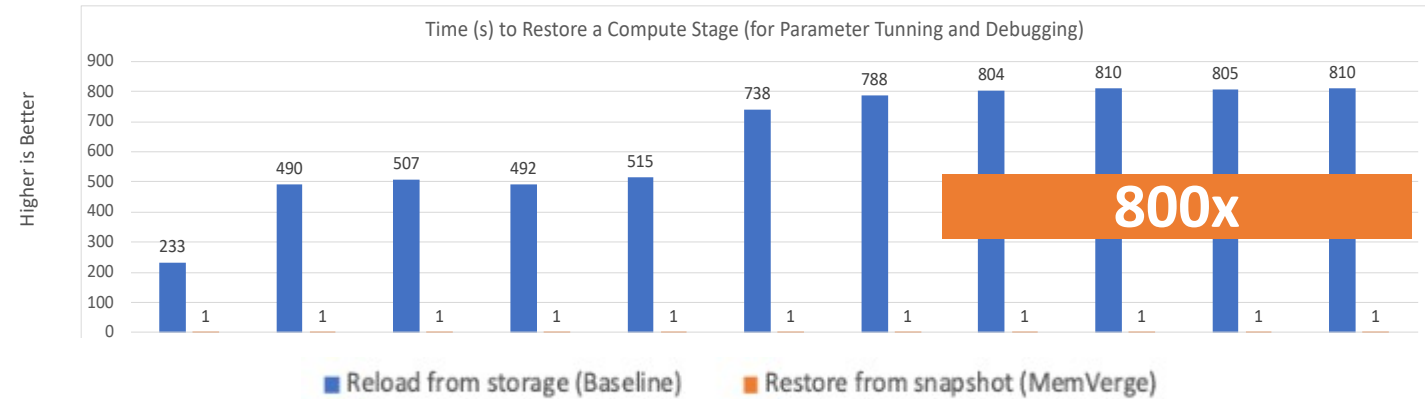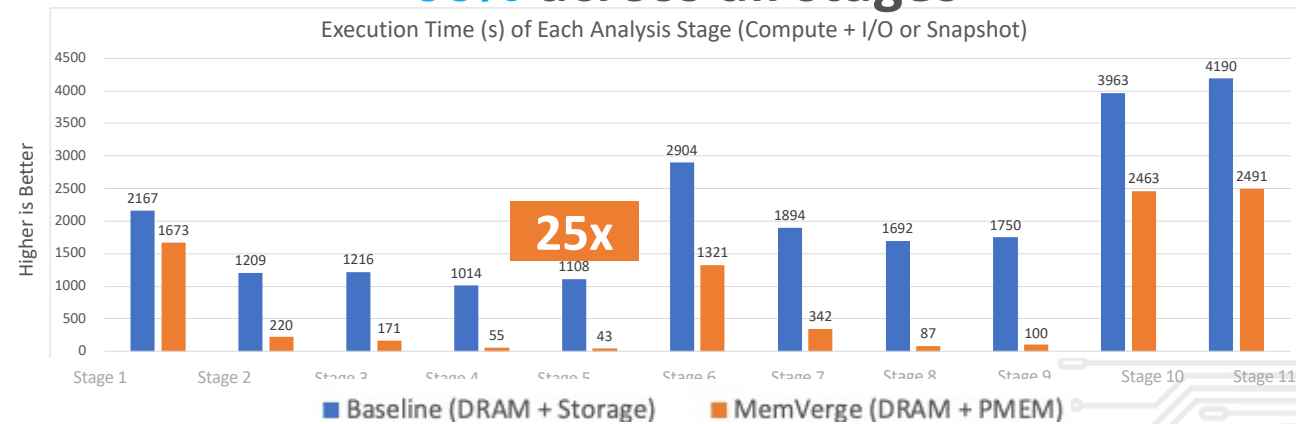
Increase Availability with ZeroIO™ In-Memory Snapshots and Instant Recovery

ZeroIO™ Snapshot Coordinator

Hazelcast Cluster

Recover from storage — 2 HRS → Recover from PMEM — 2 SECS

More memory → more instances per server and High Availability / fast recovery !

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Case Study — **Animation Studio**

Increase Availability with ZeroIO™ In-Memory Snapshots / Auto Save and Restore

Without Memory Machine: Manual, disruptive snapshots to storage

Manual snapshot	Snapshot takes seconds	Restore takes minutes
	10 sec	10 minutes

With Memory Machine: Memory snapshots and instant recovery

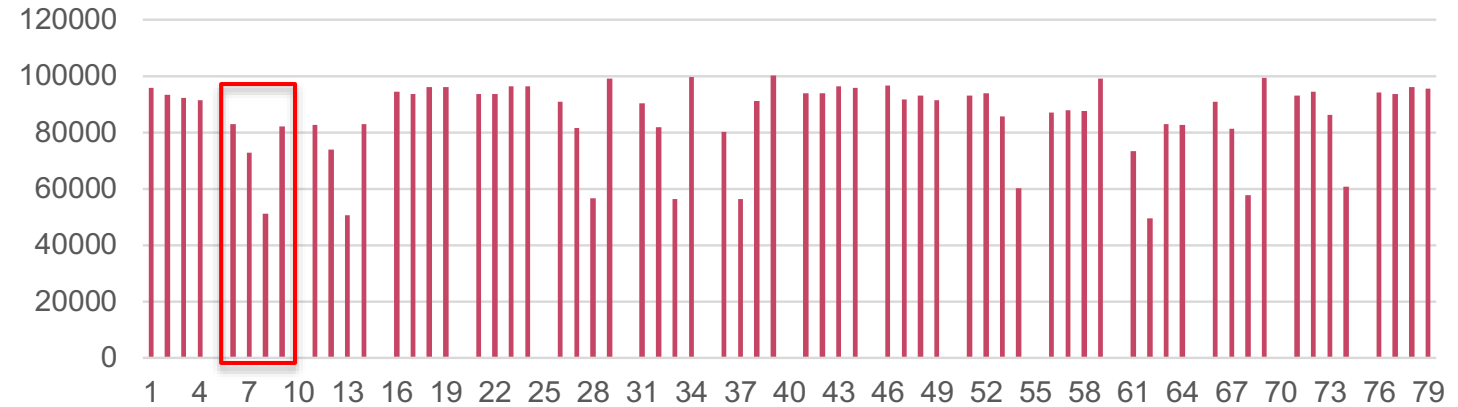| Auto Save	Snapshot takes 1-2 sec	Restore takes 1-2 sec
On	1 SEC	1 SEC

Reduced downtime & recovery, reduced overtime, and higher quality of work !

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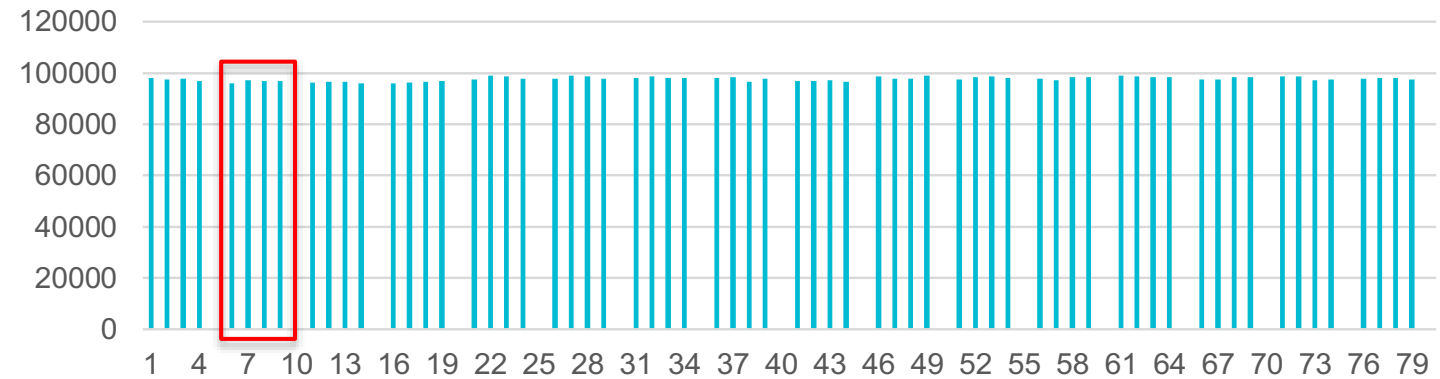
Case Study   **CSP**

**Lower TCO
by Eliminating
Noisy Neighbors
to Increase VM
Density**

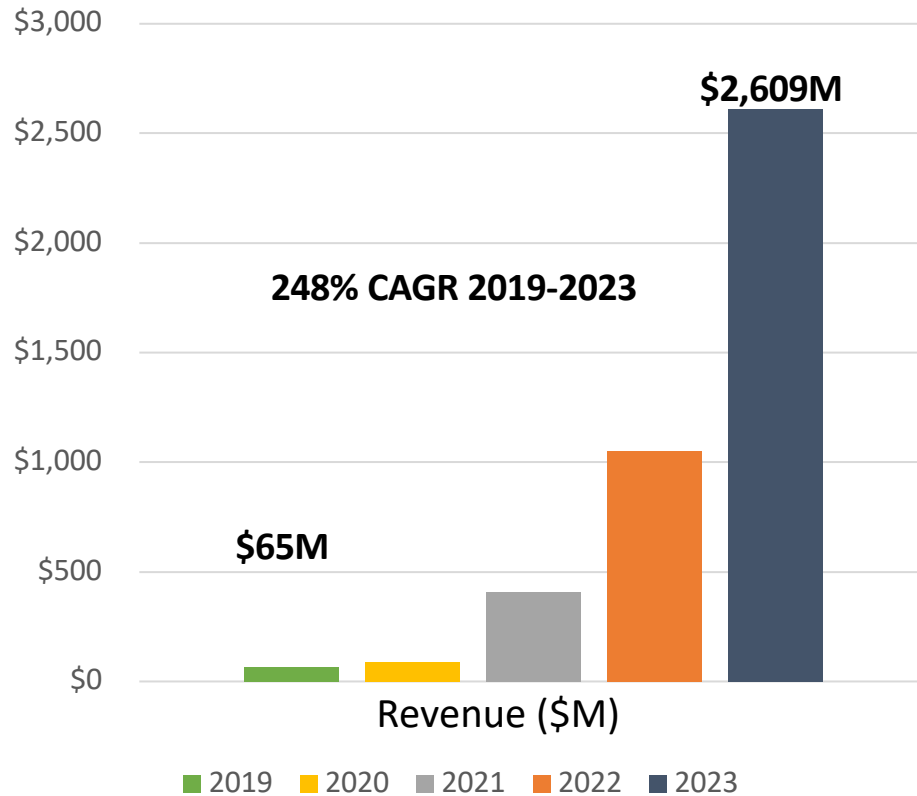**Intel Memory Mode**

Memory Machine ™

⭐ *Regained lost DRAM capacity, gained performance,
and smoothed out Service Levels across VM's !*

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Big Memory is a Massive New Market

$2.6B by 2023

Byte-Addressable Persistent Memory
Revenue ($M)

248% CAGR 2019-2023

$2,609M

$65M

Revenue ($M)

Legend: ■ 2019 ■ 2020 ■ 2021 ■ 2022 ■ 2023

$25B by 2030

Emerging Memories
Shipments (PB)

DRAM

PMEM

Petabyte Shipments

Legend: MRAM, DRAM, 3D XPoint, NAND

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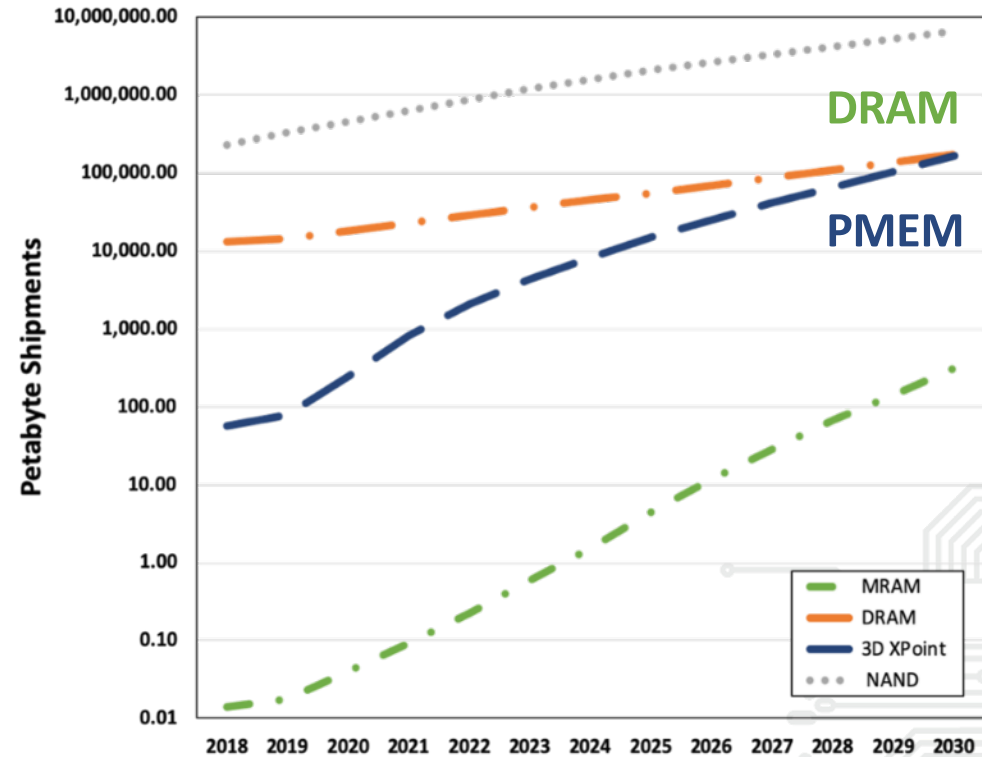
The Future is Memory Centric !

Digital Transformation Driving New "Big Memory" Requirements
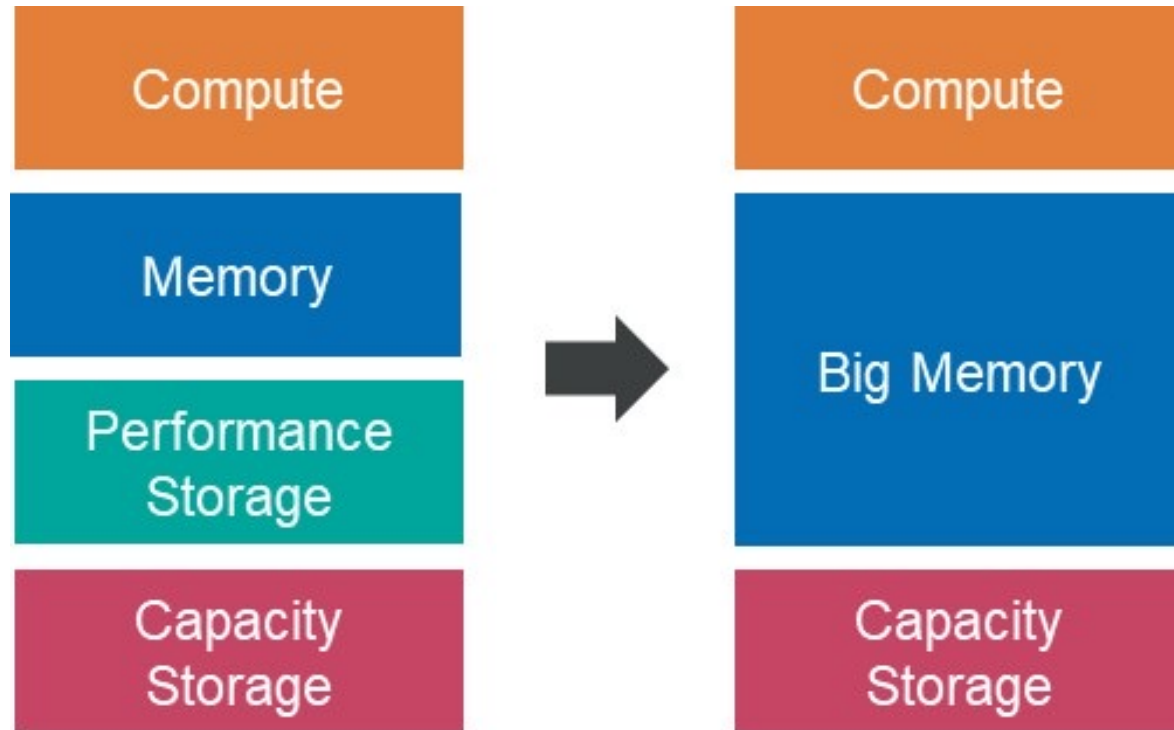
Source: IDC

"Big Memory Computing"

- **Enables the ability to run applications in memory for improved performance and efficiency**
  - Leverages byte addressable memory media

- **Includes enterprise-class data services to handle Tier-1 availability and management requirements**

- **Runs on a software-based memory virtualization layer on industry standard hardware without application modification**

- **The technology enabler for mission-critical real-time computing**

Live Data

Eddie Blanton

Director, Solutions Enablement, SSG

Penguin Computing

LiveData - MemVerge Memory Machine

Data Practice

LiveData
Big Memory

LiveData with Memory Machine addresses provides a memory virtualization software layer that delivers software-defined memory services to the applications without application changes.

Features

- Tier PMEM and DRAM
- Low-latency memory replication
- Virtualized platform for enterprise-class data services.
- Plug-compatible access with existing applications.
- Recover 100s of GBs in seconds with ZeroIO™ memory snapshots
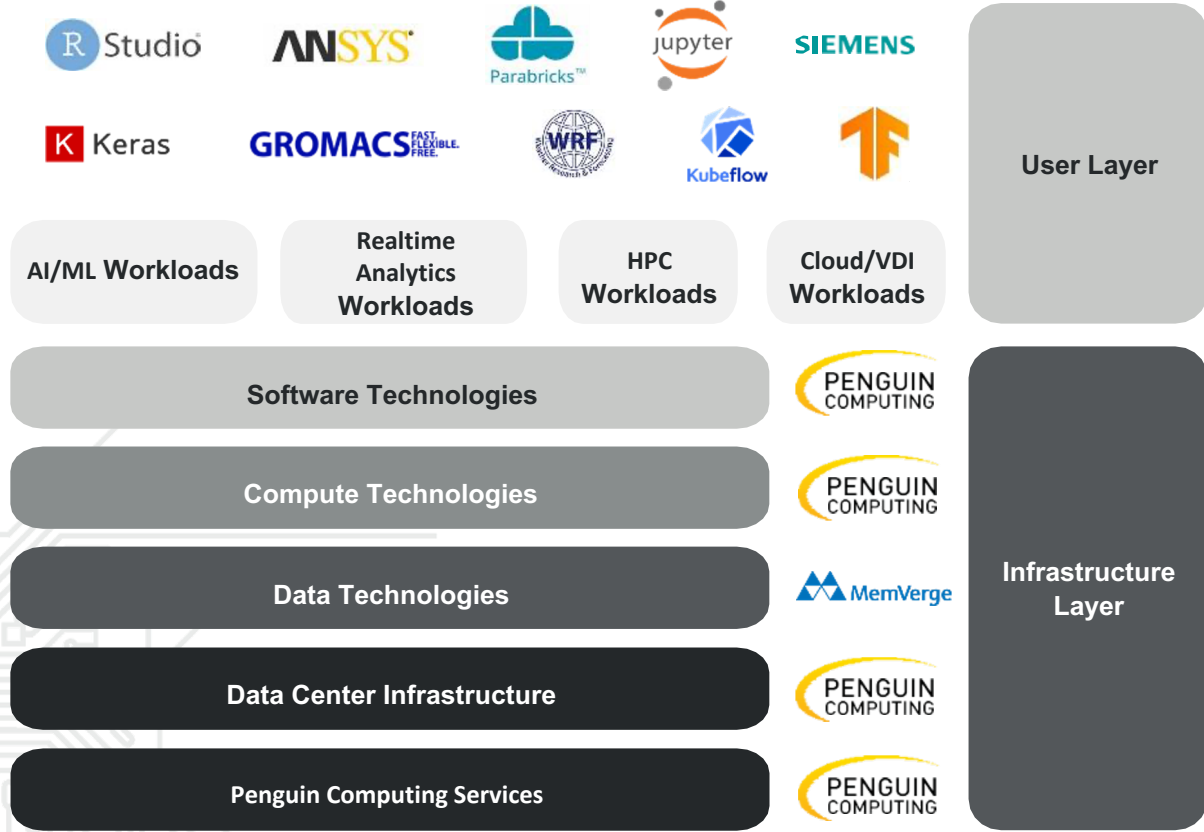- Clone databases in seconds

Benefits

- Scale memory capacity and improve system performance.
- Maintain availability - recover in seconds, not hours.
- Enable agility with efficient clone deployment, and fast application rollbacks.
- Avoid application disruption or rewrite.
- Reduce latency.

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LiveData - MemVerge

Penguin Computing LiveData Components

Data Practice

R Studio · ANSYS · Parabricks™ · jupyter · SIEMENS K Keras · GROMACS FAST. FLEXIBLE. FREE. · WRF · Kubeflow · TF	**User Layer**
AI/ML Workloads · Realtime Analytics Workloads · HPC Workloads · Cloud/VDI Workloads	
Software Technologies — PENGUIN COMPUTING	
Compute Technologies — PENGUIN COMPUTING	
Data Technologies — MemVerge	**Infrastructure Layer**
Data Center Infrastructure — PENGUIN COMPUTING	
Penguin Computing Services — PENGUIN COMPUTING	

LiveData Platform - Relion XE1112e

Key Features

- 1U Form Factor
- Dual Intel Xeon Scalable Processor
- Up to 165W TDP with air cool
- Up to 1.5TB DDR4-2933MHz (12 x DIMM)
- Up to 6TB DDR4-2666MHz (12 x PMEM)
- 4 x 2.5" Hot Swappable SATA/SAS SSD
- 4 x 2.5" Hot Swappable SATA/SAS or NVMe SSD
- 1 x Dedicated BMC + 2x 10GBase-T
- 2 x PCIe Gen3 (x16) LP
- 1 x PCIe Gen3 (x16) OCP Mezzanine 2.0

(intel)

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LiveData - MemVerge

LiveData - MemVerge

32-Node Rack

Memory

- Up to 48 TB DDR4 DRAM
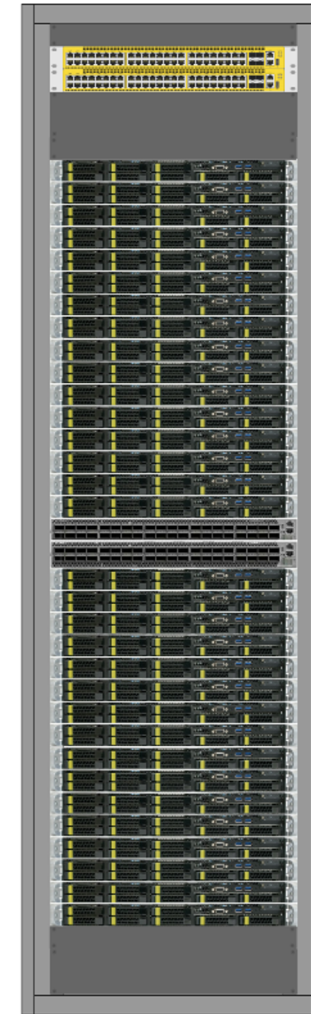- Up to 192 TB Intel Optane PMEM
- Up to 240 TB Total Memory

Compute

- Up to 1792 Intel Scalable Cores
- Up to 3.9GHz Base Clock Speed

Network

- Up to 800 GB/s 1:1 FBB
- Ethernet, InfiniBand, Omni-path

Power

- 27.6 kW Maximum
- 22.1 kW Nominal

LiveData - MemVerge

LiveData - MemVerge

40-Node Rack

Memory

- Up to 60 TB DDR4 DRAM
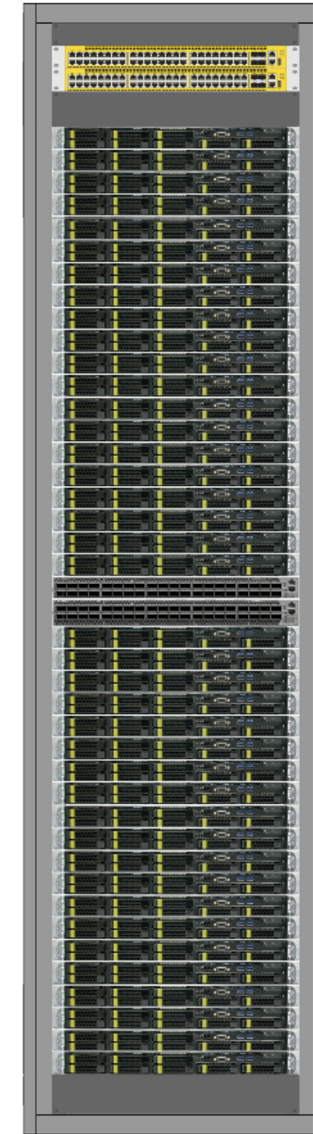- Up to 240 TB Intel Optane PMEM
- Up to 300 TB Total Memory

Compute

- Up to 2240 Intel Scalable Cores
- Up to 3.9GHz Base Clock Speed

Network

- Up to 1000 GB/s 1:1 FBB
- InfiniBand

Power

- 34.0 kW Maximum
- 27.2 kW Nominal

Use Cases

LiveData - Real-Time Workloads

According to IDC, by 2021, 60-70% of the Global 2000 organizations will have at least one mission-critical real-time workload. Below are just a few examples of use cases that are implementing Big Memory now.

Latency-Sensitive Transactional Workloads

Real-Time Big Data Analytics
in financial services, healthcare, retail, Federal Govt, and security.

AI/ML Analytics and Inferencing
like fraud detection, image and video recognition, autonomous vehicles and healthcare.

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Big Memory for Financial Services

Financial Services

LiveData
Big Memory

hazelcast

Problem - IMDB Cluster takes 2 Hours to Restore

- Hazelcast in-memory database distributed across 40 servers.

- A cluster crash takes over 2 hours to completely restore

- Each server limited to 100GB of DRAM because scaling DRAM is extremely expensive

- Deploying lower cost PMEM sacrifices performance

Big Memory for Financial Services

Financial Services

LiveData
Big Memory

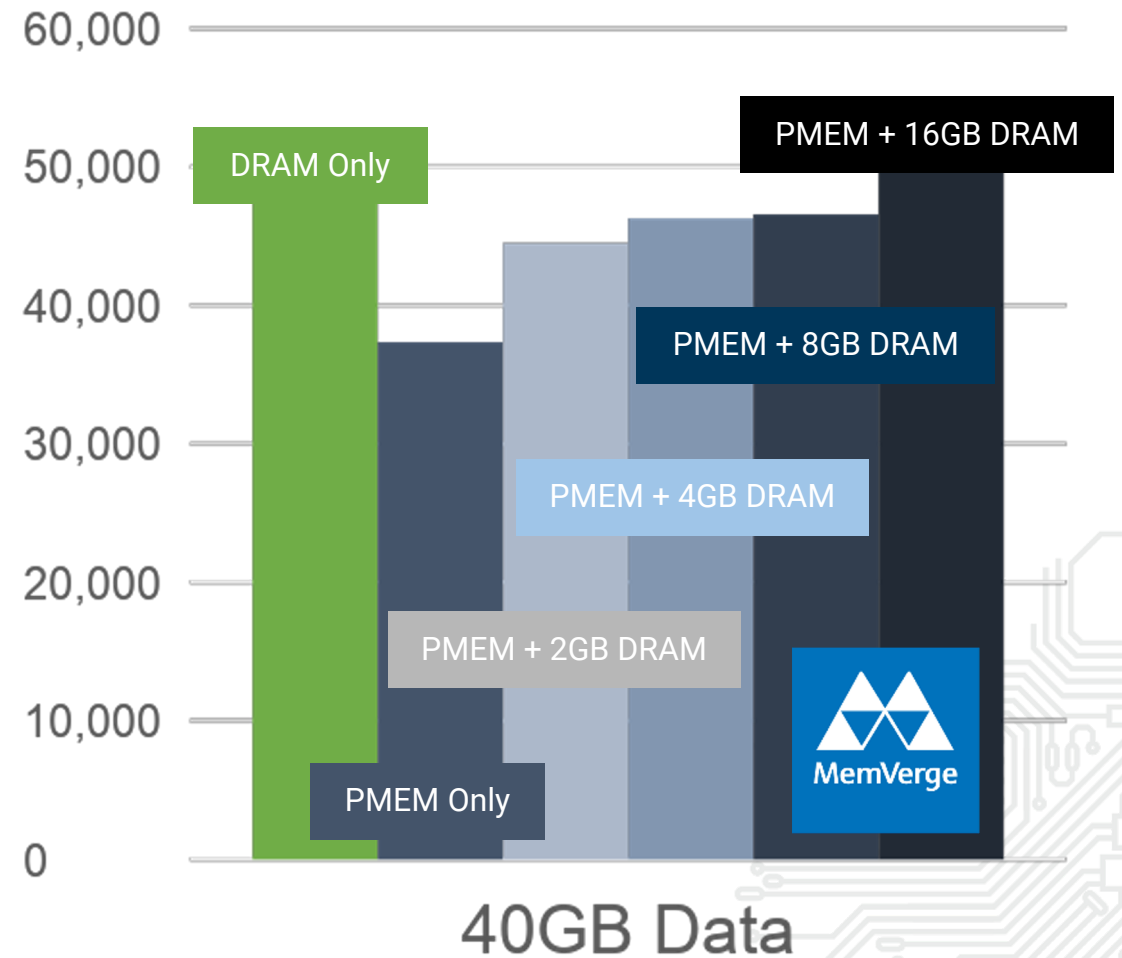Solution - IMDB Cluster Restored in Seconds

- MemVerge allows for Hazelcast cluster to be restored in seconds
- TCO - PMEM provides nearly twice the memory for the same cost
- 10x Server Consolidation
- MemVerge memory allocator technology allows PMEM to go as fast or faster than DRAM

Big Memory for Financial Services

Financial Services

LiveData
Big Memory

- DRAM = 48.3K Transactions Per Second

- PMEM + 16GB DRAM = 50K Tps (+3.5%)

60,000

50,000

40,000

30,000

20,000

10,000

0

DRAM Only

PMEM + 16GB DRAM

PMEM + 8GB DRAM

PMEM + 4GB DRAM

PMEM + 2GB DRAM

PMEM Only

MemVerge

40GB Data

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Big Memory for M&E

Media & Entertainment

LiveData
Big Memory

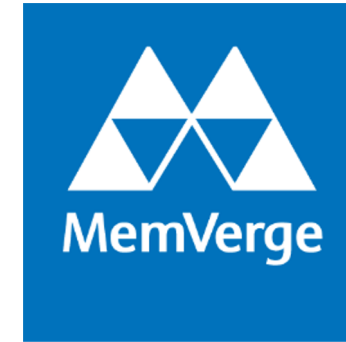## Problem - 83,000 Hours of Creative Artist Time Lost Per Year

- "We need more RAM" is the top request from artists

- Creative artist time is the biggest cost item for any movie production!

- Creative artist's lose on average 1-2 hours of productivity per week

- 800 Artists x 1,600 hours per week = 83,200 hours per year

Big Memory for M&E

Media & Entertainment

LiveData
Big Memory

Solution - Time Equivalent to 40 Creative Artists Restored

- Lower TCO: Workstations with double the Memory + MemVerge for the same cost or less

- "Autosave" improves productivity by potentially 40 Creative Engineers annually

- $8M potential savings annually

- Higher quality movies & faster time to market

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Big Memory for M&E

Media & Entertainment

LiveData
Big Memory

Productivity

Snapshot Time
- 99.66% Reduction

Restore Time
- 99.98% Reduction

Artist Experience

Auto Save

Snapshot
takes 1-2 Sec

Restore
takes 1-2 Sec

1 SEC

1 SEC

Time Machine –Instant roll back / forward

texture

red

Big Memory for AI/ML Inferencing

AI/ML Inferencing

LiveData
Big Memory

FRAUD DETECTION

Problem - Data Greater than Memory

- When data is greater than the size of DRAM, AI/ML performance slows down dramatically

- Memory-intensive inference jobs take a long time to load and restart

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Big Memory for AI/ML Inferencing

AI/ML Inferencing

LiveData
Big Memory

Solution - Big Memory Lake

- Create big memory lakes consisting of DRAM and PMEM to provide capacity needed for all data including models and embeddings

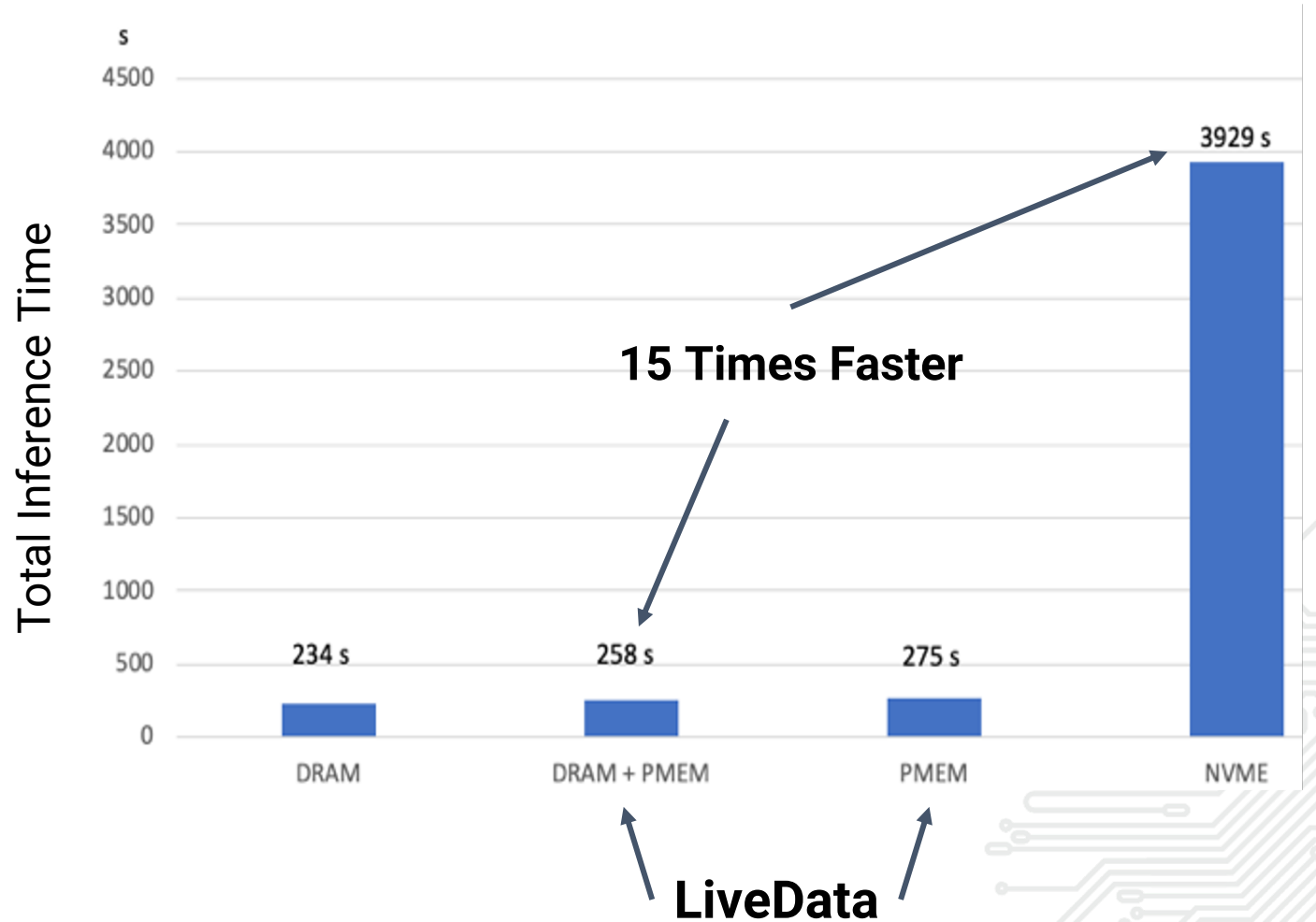- Fast data recovery and restart by using in-memory data snapshot
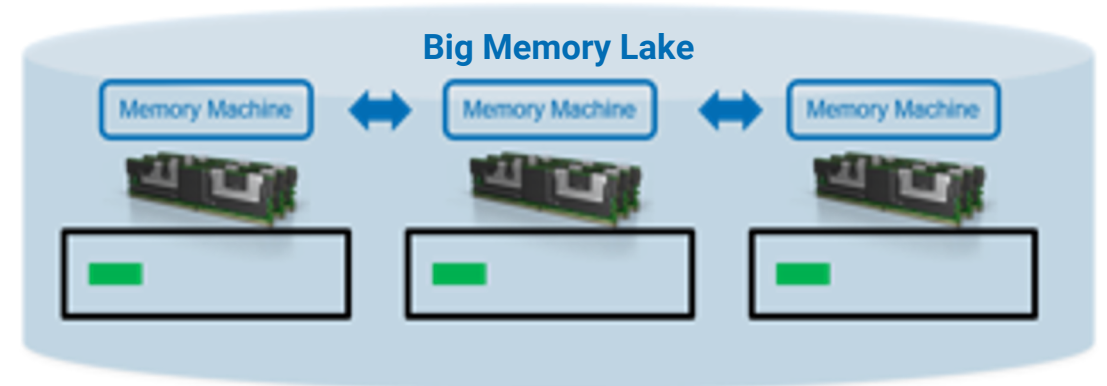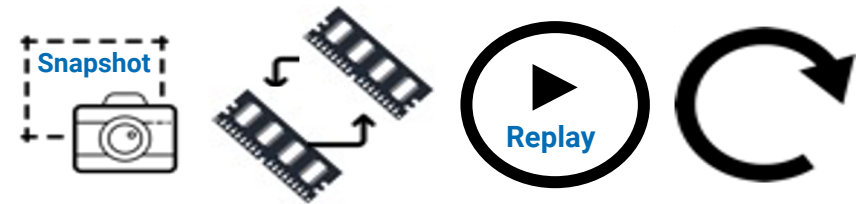
Big Memory for AI/ML Inferencing

AI/ML Inferencing
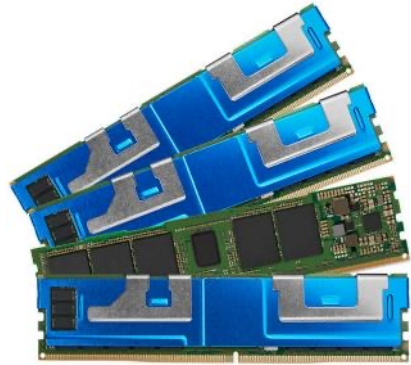
LiveData
Big Memory

Inference Time

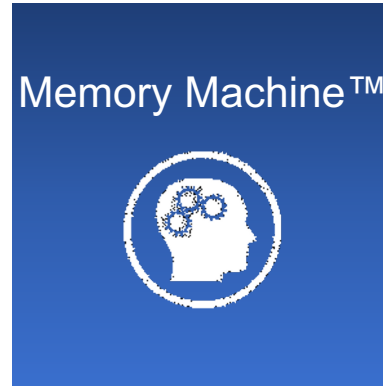- DRAM+PMEM is within 10% of DRAM
- DRAM+PMEM is 15X Faster than NVMe

15 Times Faster

LiveData

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Try it in your lab or ours

Server w/PMem

Memory Machine Software

Big Memory Labs

Memory Machine™

FREE TEST DRIVE START

Systems Engineering Support

PENGUIN COMPUTING

Memory Machine™
For Big and Fast Data

Q & A

Contact Us

- **Penguin Computing**

  - Phone: 415-954-2800

  - penguincomputing.com

- **MemVerge**

  - Phone: 408-823-3902

  - memverge.com

Endless Memory

In search of the perfect analytics solution

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