4 Top Use Cases for Big Memory
Today and Tomorrow

Charles Fan, CEO & Co-Founder, MemVerge
The Future of Infrastructure
Big Memory Computing for Big and Fast Data

Big Data Apps

Huge data sets

Real-time results

In-Memory Apps

HA with memory snapshot & recovery

Big Memory Lake

DRAM

Big Memory Software

CPU

App

Big Memory Computing for Big and Fast Data

Huge data sets

Real-time results

HA with memory snapshot & recovery

Big Memory Lake

DRAM

Big Memory Software

CPU

App

Big Memory Computing for Big and Fast Data

Huge data sets

Real-time results

HA with memory snapshot & recovery

Big Memory Lake

DRAM

Big Memory Software

CPU

App
Platforms & Apps Needing Lower Cost, Higher Capacity, and HA Memory

- Financial Services
  - Digital Banking

- Health Sciences
  - Genomics

- Media & Entertainment
  - Animation/Visual Effects

- Social Media
  - Customer Profiling

- Retail
  - Recommendation Engines

---

In-Memory Databases

- jupyter
- PyTorch
- R
- TensorFlow
- XGBoost

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

Containers

- RANCHER
- RED HAT OSENSHIFT
- VMware Tanzu
- Containers
- Amazon EKS
- Azure AKS
- Google Kubernetes Engine

Server Virtualization

- vmware
- KVM

Cloud & On-Premises

- Alibaba.com
- aws
- Azure
- Cloud & On-Premises
- Google Cloud
- Tencent
Memory Machine™
Big Memory without Compromises

New Memory Price/Performance
• 30-40% memory cost savings
• Same DRAM-like performance

Now Practical to Put all Data in Memory
• Solving performance problems due to data-greater-than-memory (DGM)
• By eliminating IO to storage

Unleashes New Class of Memory-based Data Services for Higher Availability and Productivity
• ZeroIO™ in-memory snapshots
• HA with auto save, time machine, replication, and instant recovery
• Higher productivity with cloning of IMDBs and ML stages

All With No Changes to Your Application!
Top 4 Use Cases Today

Cloud Infrastructure

Databases

Genomics

Animation & VFX
Top 4 Big Memory Use Cases Today

Cloud Infrastructure

VM density is money
Top 4 Big Memory Use Cases Today

Big Memory for Virtualized Servers

Memory Virtualization
KVM allocates memory from a tiered memory pool of software-defined memory (DRAM + PMEM)

glibc compatible
No application change, rewrite or recompile is needed

Provisioning on a per-app basis:
Maximum DRAM and PMEM
Different DRAM and PMEM ratios
Dynamic tuning of DRAM tier size for each VM

Resource isolation on a per-app basis
Allocate from different memory pools, avoiding noisy neighbours

Monitoring and visualization
of memory usage of multiple physical servers and each app

High performance
DRAM + PMEM pool at near-DRAM performance

Memory Machine

Libvirtd Management

Kernel-space

User-space

Hardware

Libvirtd Management

VM
App
Qemu

User-space

VM
App
Qemu

VM
App
Qemu

VM
App
Qemu

Libvirtd Management

KVM
DAX

Kernel-space

CPU
DRAM
PMEM
Disk/SSD
Network

Hardware

© 2021 SNIA Persistent Memory+Computational Storage Summit. All Rights Reserved.
Cloud Server Consolidation & Lower TCO
By Eliminating Noisy Neighbors & Increasing Memory Density

Intel Memory Mode

Memory Machine

With DRAM DIMMs-Only

245 Servers
x $2,500
$612,500

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

90 Servers
x $4,500
$405,000

768GB DRAM
$7.65/GB

x 245 Servers
$1,439,424

768GB DRAM
$7.65/GB

x 90 Servers
$528,768

1.5TB PMEM
$4.00/GB

x 90 Servers
$552,960

Total
$2,051,924

Total
$1,486,728

© 2021 SNIA Persistent Memory+Computational Storage Summit. All Rights Reserved.
Top 4 Big Memory Use Cases Today

**Databases**

Data frequently becomes greater than memory and IO to storage is **slow**

Scaling DRAM to improve performance is **expensive**

Big memory blast zone is big making recovery from storage slow and **disruptive**
25% Greater Capacity Utilization

Installed = 384GB DRAM + 1,536GB of PMEM = 1,920GB
More & Bigger Shards & Members/Node

Node 1

DRAM

Shard 1  Shard 2  Shard m

DRAM + PMEM + Memory Machine

Shard 1  Shard 2  Shard 3  Shard m, n, o...

Node 1

DRAM

Member 1  Member 2  Member m

DRAM + PMEM + Memory Machine

Member 1  Member 2  Member 3  Member m,n, o....
No Memory Virtualization Overhead

<table>
<thead>
<tr>
<th></th>
<th>Get (ops/s)</th>
<th>Set (ops/s)</th>
<th>Total (ops/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAM &amp; Memory Machine</td>
<td>69,129</td>
<td>69,131</td>
<td>138,261</td>
</tr>
<tr>
<td>DRAM &amp; OS</td>
<td>68,294</td>
<td>68,296</td>
<td>136,591</td>
</tr>
</tbody>
</table>

Get (ops/s) Put (ops/s) Total (ops/s)

<table>
<thead>
<tr>
<th></th>
<th>Get (ops/s)</th>
<th>Put (ops/s)</th>
<th>Total (ops/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAM &amp; Memory Machine</td>
<td>11500</td>
<td>5750</td>
<td>17250</td>
</tr>
<tr>
<td>DRAM only</td>
<td>11530</td>
<td>5770</td>
<td>17300</td>
</tr>
</tbody>
</table>
Restore Entire Cluster in Seconds

- **ZeroIO™ Snapshot Coordinator**
  - redis
  - redis
  - redis
  - Memory Machine
  - Memory Machine
  - Memory Machine

Recover from storage

- **15 Minutes**

Recover from PMEM

- **13 Seconds**
Top 4 Big Memory Use Cases Today

Genomics

Workload Attributes

- Large datasets
- Multi-stage pipeline
- Requires frequent checkpoints of intermediary stage results
- Frequent Rollbacks to tune parameters
- Branching to support what-if analyses

Pain Points

- Checkpoint to disk and rollback extremely time-consuming
- Data loss risk
- Computation memory intensive
Big Memory Solution

Memory Snapshots
- ZeroIO™ snapshot: zero disk I/O
- Instant rollbacks
- Protects against data loss

Cloning
- Automatic Dedupe via copy-on-write
- Supports multi-branch what-if analyses

Memory Capacity
- Virtualize physical memory types
- Optimized performance
Time to Restore a Compute Stage

Time to restore a compute stage for parameter tuning & debugging

- **Stage 1**: 233 seconds
- **Stage 2**: 490 seconds
- **Stage 3**: 507 seconds
- **Stage 4**: 492 seconds
- **Stage 5**: 515 seconds
- **Stage 6**: 738 seconds
- **Stage 7**: 788 seconds
- **Stage 8**: 804 seconds
- **Stage 9**: 810 seconds
- **Stage 10**: 805 seconds
- **Stage 11**: 810 seconds

Reload from Storage vs. Reload from In-Memory Snapshot

- **Reload from Storage**: 800x Faster
Execution Time

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

Execution time of each analysis stage: compute + storage IO or in-memory snapshot

25x Faster

© 2021 SNIA Persistent Memory + Computational Storage Summit. All Rights Reserved.
Time Savings

Task Completion Time (Seconds)

DRAM+SSD

60% Less Time

DRAM + PMEM + Memory Machine

95% Less IO

Big Memory Workbench

© 2021 SNIA Persistent Memory+Computational Storage Summit. All Rights Reserved.
Top 4 Big Memory Use Cases Today

**Animation & VFX**

- Bleeding edge visual effects provided by fragile plug-ins
- Frequent crashes
- Artists out of the zone after 30 seconds
"Initially, we opened a poly-dense scene in Maya and it took two-and-a-half minutes. Then, we opened a scene from a snapshot we’d taken with Memory Machine and it took eight seconds. In addition to opening exponentially faster, another benefit of the Memory Machine snapshot is that it gets an artist right to the spot in the application where they were when they created a snapshot, there’s no need to repopulate the entire application." - Mark Wright, Technology Manager for Chapeau Studios
“...the ultimate vision of composable infrastructure includes a comprehensive range of disaggregated resources, including multiple processor, memory, cache and storage types. Today, composable infrastructure is held back by a lack of technology to disaggregate DRAM from processors, industry-standard configurable fabrics and cross-vendor APIs.” – Gartner: Understand the Hype, Hope and Reality of Composable Infrastructure
Memory Tier Leverages New Technology Without Changes to Apps

- Applications
- Memory Machine Virtualization Layer
- Software Updates

- Processors
  - Cascade Lake
  - Ice Lake
  - Sapphire Rapids
- Persistent Memory
  - Apache Pass
  - Barlow Pass
  - 3rd Gen
- Emerging Memories
- Memory Interconnects
  - CPU - DDR
  - xPU - CXL

Emerging Memory
Contact Us

Info@memverge.com
Thank you

Please visit www.snia.org/pm-summit for presentations