Panel & Agenda

Amit Golander – Software Defined Memory (SDM)
- CTO and VP R&D, Plexistor – A technology leadership expert with experience at Primary Data, Tonian, and IBM. Amit has a rich R&D background, leading global hardware and software technical teams since 2000 and composing over 15 papers and 35 patents so far. Amit has a PhD in computer architecture and diverse work experience in storage, servers, and networking.

Alex Fuxa – Persistent Memory
- Persistent Memory R&D Manager, HPE – He manages the HP Servers Persistent Memory R & D team. The Persistent Memory R & D team is interested in finding innovative ways to bring emerging non-volatile memory products to market. Alex holds a BS in Electrical and Computer Engineering from University of Texas at Austin. Before joining the HP Servers Persistent Memory team Alex developed Firmware for HP Servers Smart array controller and developed Flash Translation Layers for enterprise solid state disks. Alex has been granted 11 patents related to RAID and Flash technologies.

Marc Schneider – NVDIMM Systems Update
- Senior Product Manager, Supermicro - He leads the IA Dual Processor Motherboard Group. He has launched multiple generations of award winning datacenter and enterprise products based on Intel’s E5-2600 family of Xeon processors. With over 25 years of industry experience, he has held positions in product management, engineering management, and product design at various technology start-ups as well as Sun Microsystems and Philips Semiconductors. Marc holds a BSBA in High Tech Management from San Jose State University.
Background

NVDIMM-N marries the best of both worlds:

HDD

IOPS
(even if random…)

FLASH

Latency
(even under load…)

NVDIMM

New amazing hardware technology

Memory Speed + Storage Persistency
We all agree that Persistent memory is the ultimate high-performance storage tier.

But How does Joe, an IT Admin from Corporate X, leverage it?

Amazing technology will stay a niche if Joe can’t use it.
Existing Vs. Emerging Software

<table>
<thead>
<tr>
<th>Traditional applications</th>
<th>NVM-aware applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSIX</td>
<td>NPM</td>
</tr>
<tr>
<td>Legacy storage software</td>
<td>FS-DAX</td>
</tr>
<tr>
<td>PM+SSD</td>
<td>PM</td>
</tr>
</tbody>
</table>

Pros:  
Traditional applications:  
- Works out of the box  
- Multi tier solutions exist

NVM-aware applications:  
- Very fast  
- Byte addressable

Cons:  
Traditional applications:  
- Performance compromise  
- Expensive (low HW efficiency)

NVM-aware applications:  
- Rewrite application & data services  
- Expensive (single tier)

New amazing technology – Adds a new level of complexity
# Software Defined Memory

<table>
<thead>
<tr>
<th>Applications</th>
</tr>
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<tbody>
<tr>
<td>POSIX</td>
</tr>
<tr>
<td><strong>Software Defined Memory (SDM)</strong></td>
</tr>
<tr>
<td>PM+SSD</td>
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</tbody>
</table>

**SDM:**
*A converged memory and storage architecture that enables applications to access storage as if it was memory and memory as if it was storage*

**Pros:**
- Single storage for POSIX and NPM
- Fast, Byte addressable & Highly efficient
- Built-in data services

**Cons:**
- Requires new kernel versions

New amazing technology & Invisible to Joe √
Plexistor SDM – (POSIX) Performance

<table>
<thead>
<tr>
<th>Operation per second</th>
<th>Latency in μs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ZFS</td>
</tr>
<tr>
<td>Random 4KB write</td>
<td>1,150</td>
</tr>
<tr>
<td>Single threaded FIO benchmark</td>
<td></td>
</tr>
<tr>
<td>Random 4KB write</td>
<td>2,146</td>
</tr>
<tr>
<td>Multi threaded FIO benchmark</td>
<td></td>
</tr>
<tr>
<td>Random 128B write</td>
<td>2,177</td>
</tr>
<tr>
<td>Multi threaded FIO benchmark</td>
<td></td>
</tr>
<tr>
<td>SQL Database</td>
<td>-</td>
</tr>
<tr>
<td>SPEC SFS 2014 Database</td>
<td></td>
</tr>
<tr>
<td>MongoDB NoSQL</td>
<td>13,471</td>
</tr>
<tr>
<td>MongoDB v3.2 on WiredTiger. Mixed (50% update)</td>
<td></td>
</tr>
</tbody>
</table>

ES-2650 v3 CPU, 32GB DRAM, 32GB NVDIMM, CloudSpeed SSD

SDM delivers
Plexistor SDM – Main Features

SDM CE v1.7.0:

- Unified for POSIX and NPM
  - Performance for POSIX
  - Capacity for NPM
- Auto-tiering
  - 1st tier: PM / DRAM
  - 2nd tier: SSD / NVMoF / AFA…
- Data migration across platforms
- NUMA optimized

Performance, flexibility and efficiency
On-Premise deployment

You can download free Community Edition (CE) of Plexistor SDM software to run on any server in two configurations: persistent and ephemeral computing.

In a persistent configuration you will need to purchase NVDIMM from the following list to be used as SDM first storage tier.

An ephemeral computing configuration is very similar to an Amazon instance. SDM will use DRAM as the first storage tier and will NOT maintain persistency in case of a power failure. This configuration is relevant in cases where the application maintain it’s own persistent (logging) schedule.

Currently SDM is supported by Linux kernel 4.x and above and tested on Ubuntu and CentOS distributions.

Public Cloud deployment

Install free Community Edition (CE) of Plexistor SDM software on Amazon EC2 in minutes. No configuration or set up is required. You can get an EC2 instance with SDM capacity ranging from 64GB to 2.6TB at near-memory speed.

Plexistor SDM can be deployed in any i2 machine,

Free download available on www.plexistor.com/download/
Plexistor HA Architecture

RDMA & 100Gbps enables few µsec latency @ high throughput

App server 1
Plexistor SDM
100Gbps

App server 2
Plexistor SDM
100Gbps

App server N
Plexistor SDM
100Gbps

100Gbps switch

PM & Flash Brick 1
100Gbps

PM & Flash Brick M
100Gbps
Thank You
JANUARY 20, 2016, SAN JOSE, CA

Alex Fuxa
Hewlett Packard Enterprise
Persistent Memory R&D Manager
HPE Persistent Memory
Persistent Memory Mediums

Room for multiple mediums

Access latency in ns

Cost in $/GiBytes

$ 100.00

$ 10.00

$ 1.00

$ 0.10

$ 0.01

10^0 10^1 10^2 10^3 10^4 10^5 10^6

Industry Target
“Universal Memory”

DRAM

Flash
Evolving the Software

Applications must change

- **Objects**
- **Interpreters**
- **Libraries**

- **File system**
- **I/O Buffers**
- **Drivers**

- **Controller**
- **Cache**
- **Media**

- **Application**
- **Bottleneck?**

- **Objects**
- **Interpreters**
- **Libraries**

- **Application**
- **Bottleneck?**

- **3 instructions**
- **0 data copies**

- **25k instructions**
- **5 data copies**
Opportunities for Acceleration

Not every device will impact every software stack
Key Takeaways

- No universal memory
- Many mediums and use cases
- Need an open standard for connecting devices
- Latencies force software to fundamentally change
- HPE is innovating through standards like JEDEC 2233.22
- Database-like applications will be early adopters
- HPE is ready to work with you
Agenda

- NVDIMM Advantages
- Development Update
- NVDIMM-enabled Systems
- Next Steps
NVDIMM Advantage

Technology Benefits

- **Higher Performance** – Accelerates business applications by increasing metadata performance
- **Cost-Effective** – Improves TCO compared to batteries or UPS solutions
- **Reliable** – Preserves critical data in the event of a power loss
- **Compatible** – Integrates into x86 server and Storage architectures
- **Eco-Friendly** – Lead Free Supercaps

Typical Applications

- Server RAID Storage, Storage cache tiering, Metadata persistent storage, Data logging, De-duplication, system/application checkpoints
Development Update

What’s New

❖ JEDEC DDR4 Standardization
  ❖ Supercap recharge times have been greatly reduced
  ❖ SAVE_n pin sets a efficient interface to signal a backup
  ❖ EVENT_n asynchronous event notification pin
  ❖ I²C Device Addressing
  ❖ JEDEC defined SPD/Registers to comply with DDR4 RDIMM
  ❖ NVDIMM firmware interface table (NFIT) added in ACPI 6.0

❖ Supermicro
  ❖ Supermicro continues to lead the industry in NVDIMM adoption on the Intel Xeon™ E5-2600 v3 platform
  ❖ Five vendors supported via Intel MRC with more to come!
  ❖ 20+ X10 DP Motherboards currently enabled
  ❖ 60+ X10 DP Servers now support NVDIMM, including over 20 SuperStorage solutions
## NVDIMM-N Enabled Models
### X10 Motherboard

<table>
<thead>
<tr>
<th>Market Segment</th>
<th>X10 Model</th>
<th>Available Configurations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Channel</strong></td>
<td>X10DRC/i-LN4+/T4+, X10DRi(T), X10DRX, X10DRH-C/i(T), X10DRH-C/iLN4</td>
<td>Motherboard, barebones or complete server</td>
</tr>
<tr>
<td><strong>Enterprise</strong></td>
<td>X10DRU-i+ (Ultra Series)</td>
<td>Complete server-only</td>
</tr>
<tr>
<td><strong>HPC</strong></td>
<td>X10DRT-H/HIBF, X10DRT-P/PT/PIBF, X10DRT-L/LIBQ/LIBF, X10DRT-PS, X10DRFR(N)(T), X10DRFF(-C), X10DRFF(C/TG)</td>
<td>Motherboard or complete server</td>
</tr>
<tr>
<td><strong>Data Center</strong></td>
<td>X10DRD-L/I(N)T, X10DRD-LTP/I(N)TP, X10DDW-I(N), X10DRW-I(T), X10DRW-E/N(T)</td>
<td>Motherboard, barebones or complete server</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>X10DRS-2U/3U/4U, X10DSC+, X10DSC-TP4S, X10DRH-C/i(T), X10DRH-C/iLN4</td>
<td>Motherboard, barebones or complete server</td>
</tr>
<tr>
<td><strong>GPU</strong></td>
<td>X10DRG-Q</td>
<td>Motherboard, barebones or complete server</td>
</tr>
</tbody>
</table>
## NVDIMM-N Enabled Models

### X10 SuperStorage

<table>
<thead>
<tr>
<th>U Height</th>
<th>2U</th>
<th>3U</th>
<th>4U</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disk qty</td>
<td>2.5” x 24</td>
<td>3.5” x 12</td>
<td>3.5” x 16</td>
</tr>
</tbody>
</table>

#### Hardware RAID (LSI3108)
- 2028R-ACR24H
- 6028R-E1CR12T
- 2028R-E1CR24N
- 6028R-E1CR12N
- 6038R-E1CR16N
- 6048R-E1CR24N
- 6048R-E1CR36N
- 2028R-E1CR24H
- 6028R-E1CR12H
- 6038R-E1CR16H
- 6048R-E1CR24H
- 6048R-E1CR36H

#### IT Mode (LSI3008)
- 2028R-ACR24L
- 6028R-E1CR12L
- 6038R-E1CR16L
- 6048R-E1CR24L
- 6048R-E1CR36L
- 6048R-E1CR72L

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**UP**
- 5028R-E1CR12L
- 5048R-E1CR36L
Next Steps

Calls to Action

Hardware

- Data encryption/decryption with password locking JEDEC standard
- “Write-back” feature to meet RDIMM performance
- Standardized set of OEM automation diagnostic tools
- JEDEC support of NMI trigger method alternative to ADR trigger
- Improve Supercap performance, size, and cost

Software

- O/S recognition of APCI 6.0 (NFIT) to ease end user application development
- JEDEC standardize NVDIMM C library to speed up the OEM and end user development cycle
Thank You
Questions?