SNIA PERSISTENT MEMORY PM SUMMIT

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Storage at Memory Speed and Amazing Future of Virtual Non-Volatile Memory

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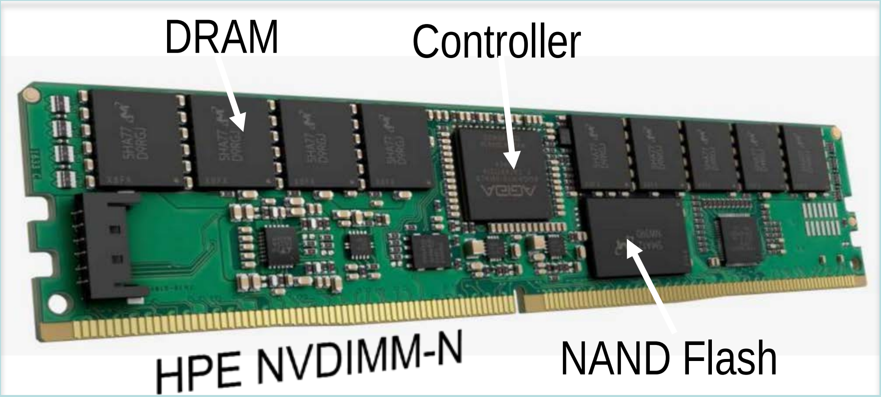
The information in this presentation is intended to outline our general product direction and it should not be relied on in making a purchasing decision. It is for informational purposes only and may not be incorporated into any contract.

Storage at Memory Speed

- Persistent Memory (PMEM or NVM)
  - Fundamental change in storage architecture happening now
  - e.g., 3D XPoint^{TM}, HPE NVDIMM-N
- Persistent Memory is Storage at…
  - DRAM latency: a few hundred nanoseconds latency
  - DRAM bandwidth: a few GBs of bandwidth
  - DRAM granularity: byte-level access
  - DRAM model for software: load/store instructions

CPU/Memory vs. Storage Speed

- Software Solutions
  - Use volatile DRAM as a large cache
  - Employ complex schemes to deal with power failure
  - Complicate code by using Asynchornous IO to hide latency
- Hardware Solutions (HPE NVDIMM, 3D XPoint^{TM})



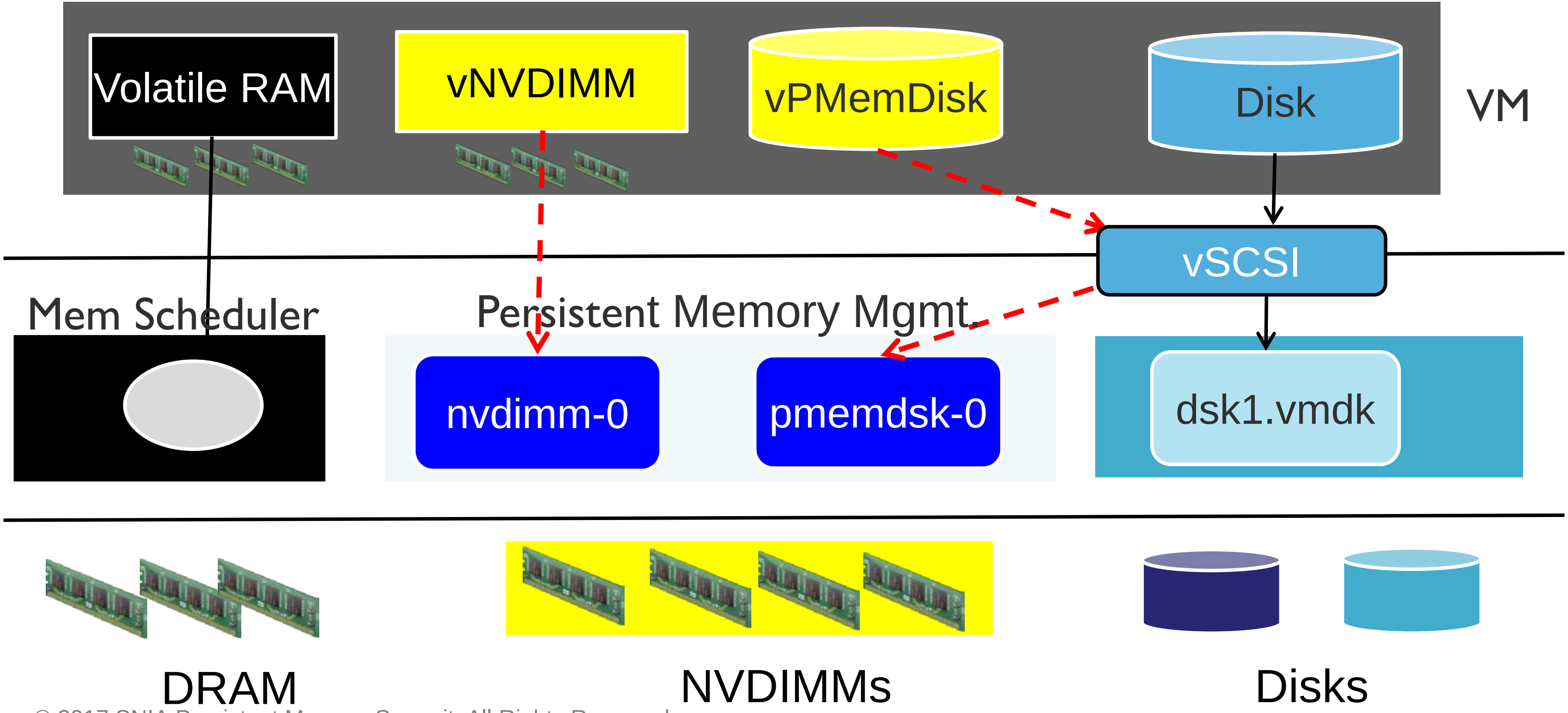
Operating Systems and Applications

- Operating Systems
  - Windows Server 2016, Fedora 24, RHEL 7.3, etc.
  - Provide Direct Access (DAX) mode access for applications
- Applications
  - Legacy: mount volume in non-DAX mode, use file access
  - PMem-optimized: use DAX mode, mmap file, byte-level updates
    - e.g., SQL Server 2016, PMem-aware Redis

Concept: vSphere Support for NVM

- Enable use of persistent memory hardware
- Support for legacy VMs
  - No change to guest OS/app – just a simple VM config change
- Expose virtual NVDIMMs
  - Byte-addressable with similar performance as physical NVDIMM
- Ease management by enabling vMotion and FT
- Help consolidation by intelligent cluster management

Where we are headed…



Physical NVDIMMs

- BIOS Requirements
  - NFIT, Namespace DSMs
  - Health information, ARS error reporting/clearing, MCEs
  - Block mode or BTT is not used
- Host-local Persistent Memory Datastore
  - Concatenates multiple namespaces (extents) to form a volume
  - Exposes a single persistent memory datastore per host
  - Plans to expose a single datastore even with different NVDIMMs

vPMemDisk and vNVDIMM

- Virtual Persistent Memory Disk
  - Guest accesses a regular vSCSI or vNVMe disk
  - Virtual disk is stored in persistent memory datastore
  - Provides atomic 512 byte block writes
- Virtual NVDIMM
  - Virtual BIOS exposes NVDIMM via NFIT, namespace DSMs, etc
  - PMem-aware OS and applications can run unmodified
  - Multiple virtual NVDIMMs can be attached to a VM
  - Almost zero overhead because ESXi avoids intercepts

Error Handling

- Physical Errors
  - Learns about errors via ARS records, MCEs, ACPI events
  - Avoids mounting if volume meta-data is corrupted
  - Marks data page errors permanently till poison clear or full write
- Exposing Errors
  - Exploring ways to expose virtual NVDIMM errors to guest
  - Clearing errors if vPMemDisk block IO covers error blast radius

Workload Mobility and Availability

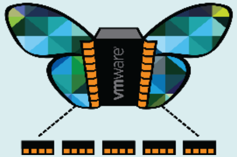
- Migration
  - Support migration of VMs with vPMemDisk and vNVDIMM
  - Changing host of a VM results in copying PMem contents
  - Virtual NVDIMM is always stored on a PMem datastore
  - vPMemDisk can be upgraded/downgraded from/to disk or SSD
- Availability
  - Synchronous replication of updates is costly, so no HA support
  - FT provides asynchronous replication and high availability

Cluster Management

- Distributed Resource Scheduler (DRS)
  - Helps to choose a host with sufficient PMem while creating VM
  - Migrates VMs for load-balancing and maintenance mode
  - Chooses a new host for migration based on PMem availability
- Replacing Physical NVDIMMs
  - Enter maintenance mode; move all (including powered-off) VMs
  - Power-off host and replace/reconfigure physical NVDIMMs
  - Power-on host, DRS will move VMs back to the host

VMware NVDIMM Program for ISVs

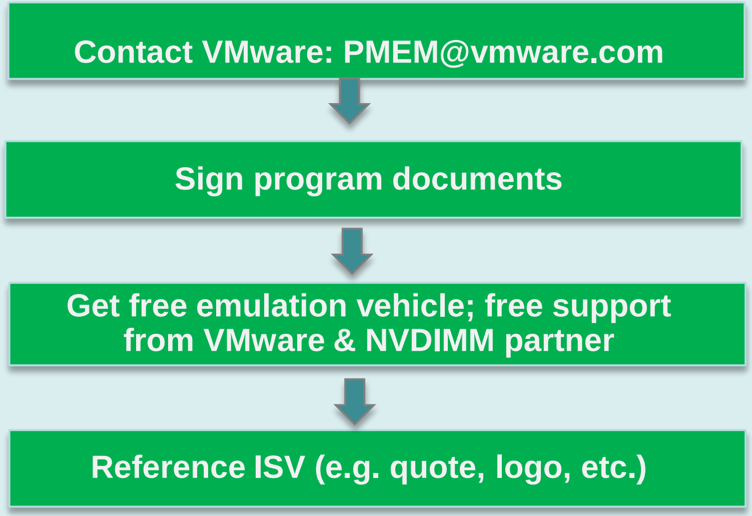
vSphere-based NVDIMM Emulation Vehicle



- Available Now
- Emulates all of the capabilities of NVDIMMs from different vendors
- Works with off-the-shelf commercial servers

To Get Emulation Vehicle

Join VMware NVDIMM Program



Contact VMware: PMEM@vmware.com

Sign program documents

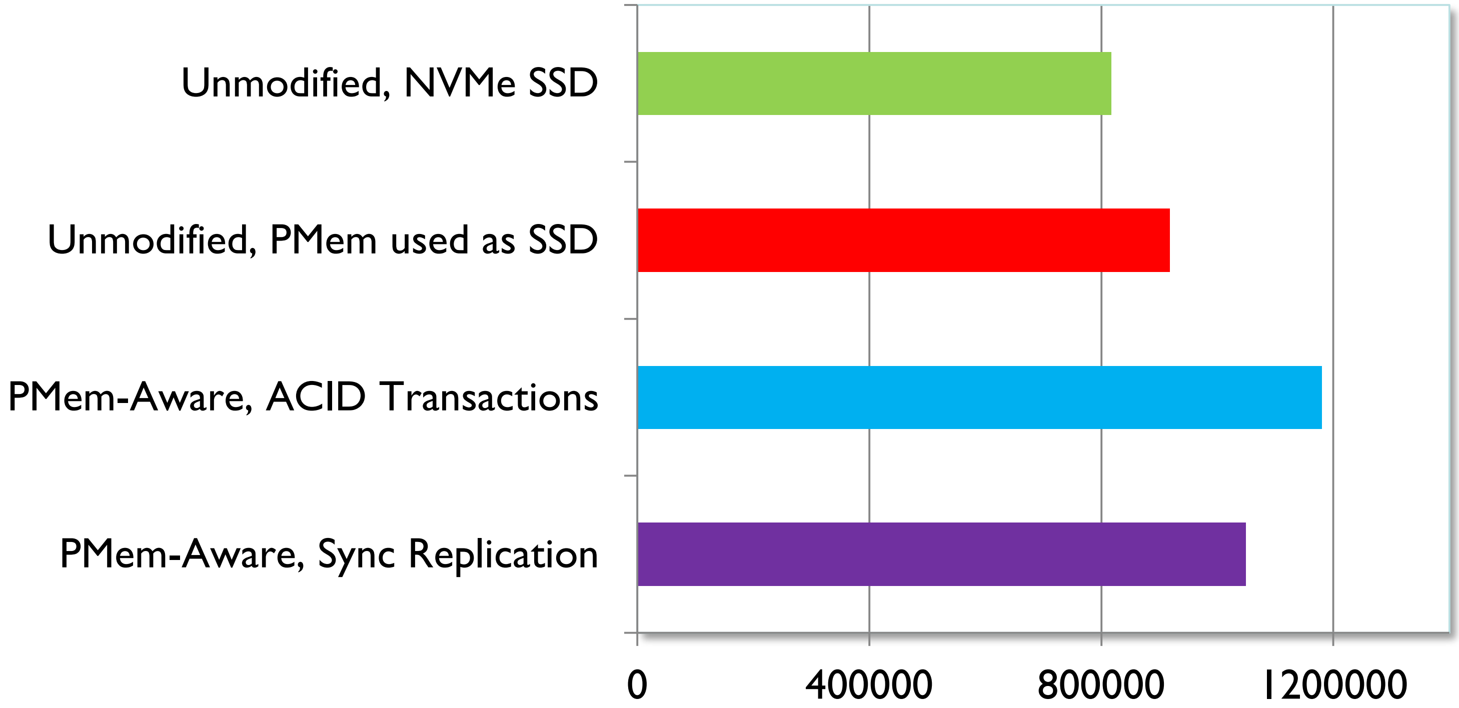
Get free emulation vehicle; free support from VMware & NVDIMM partner

Reference ISV (e.g. quote, logo, etc.)

A Tryst with Redis

- Redis
  - Keeps all data in memory, saves periodically to persistent media
  - Time for in-memory image warm up is proportional to DB size
  - Used in production by Github, Twitter, Pinterest, etc.
- PMem-aware Redis
  - Stores entire database directly in persistent memory
  - No background save thread any more
  - Nice performance improvement and instant restart after crash
  - Implemented synchronous replication for high availability

Performance of PMem-aware Redis



Summary

- Enable NVDIMM hardware
- Help legacy VMs with unmodified guest and applications
- Expose byte-addressable virtual NVDIMM to VM
- Simplify management of cluster of machines with NVDIMMs
- Preview NVDIMM performance using Redis