



Flash Memory Summit

# Why Persistent Memory Matters

*(A State of the Union on PM)*

Jim Pappas

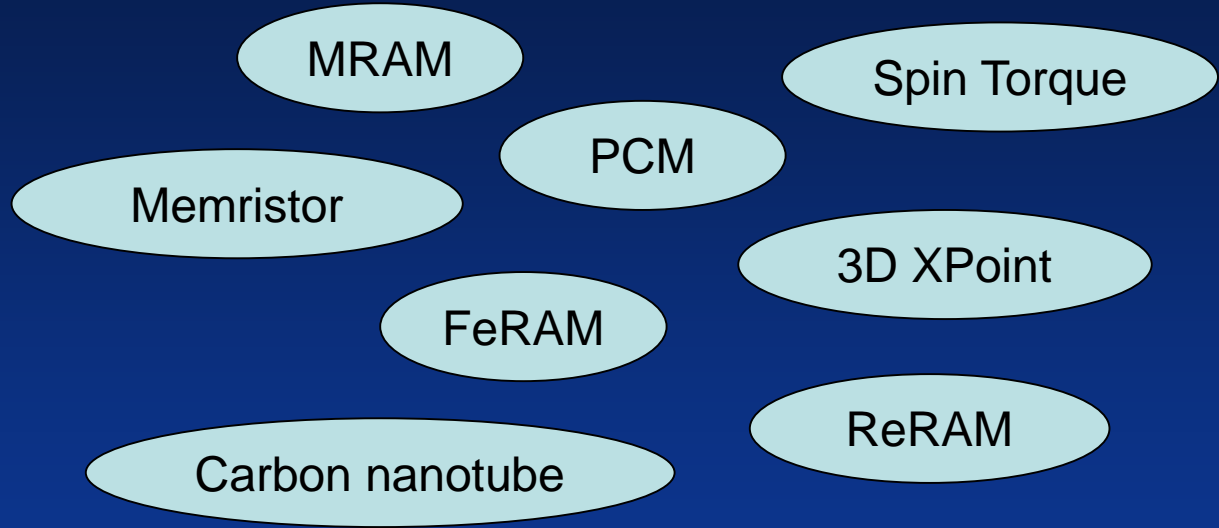
Vice-Chair, SNIA Board of Directors

Director of Technology Initiatives, Intel

[jim@intel.com](mailto:jim@intel.com)

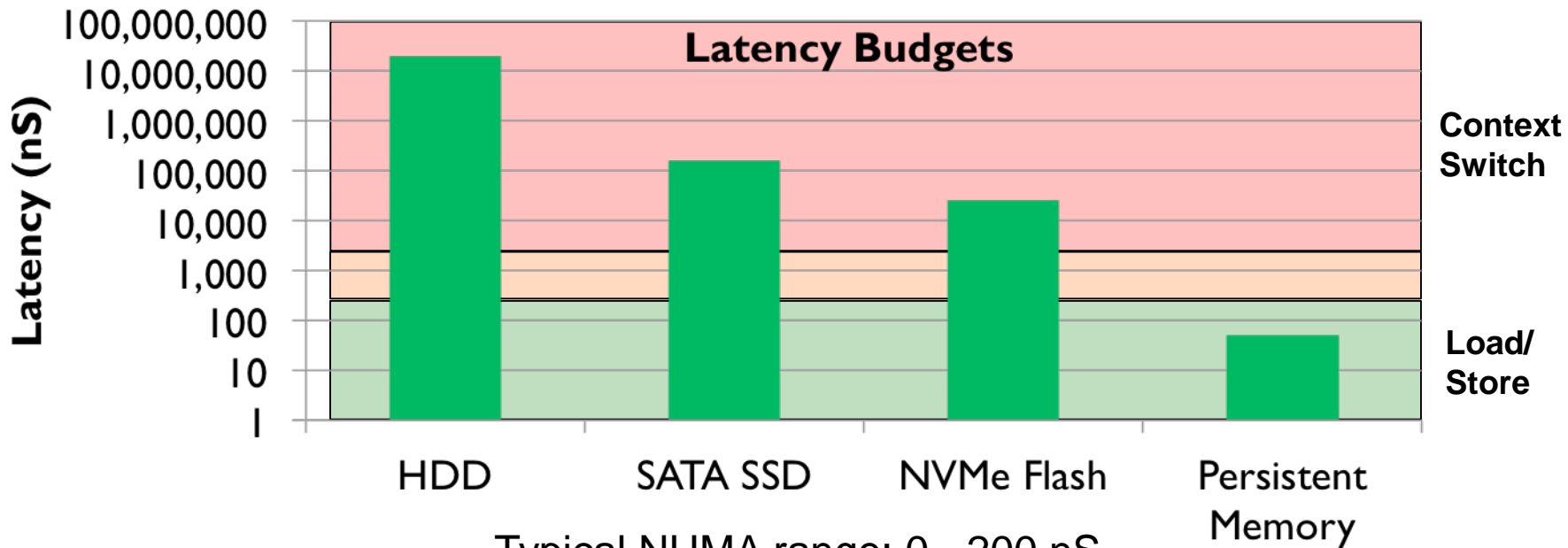


# How did this PM Effort Start?





# Storage vs. Memory



Typical NUMA range: 0 - 200 nS  
Typical context switch range: above 2-3 uS

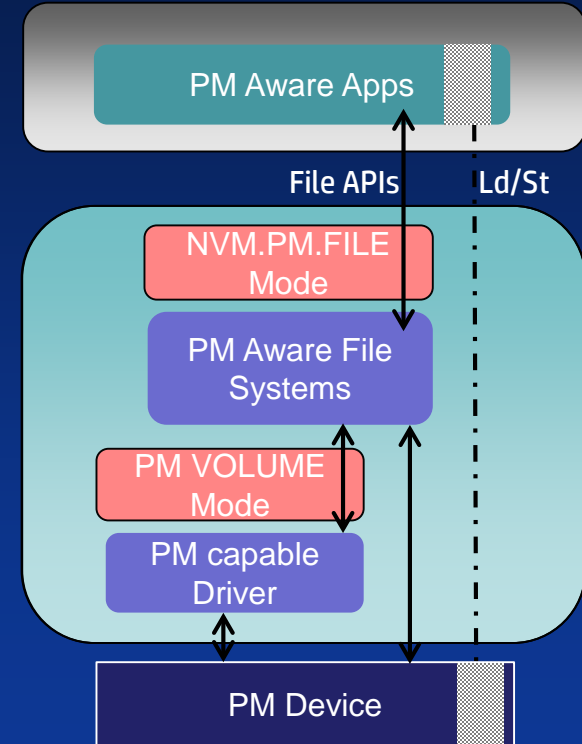
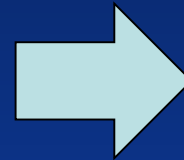
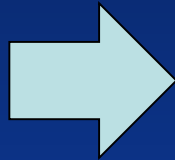


Flash Memory Summit

# SNIA NVM Programming TWG

Formed 06-11-2012

- Dell
- EMC
- Fujitsu
- HP
- Intel
- Netapp
- Oracle
- QLogic





Flash Memory Summit

# 2013: Operating System Support

## “The obvious next focus”

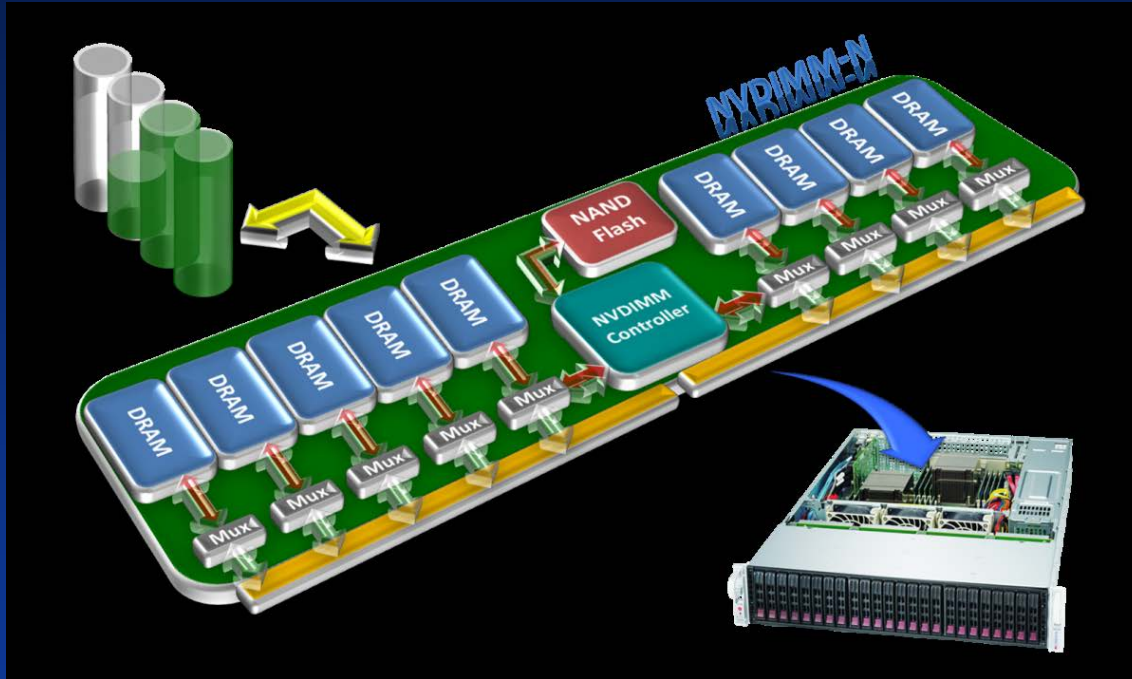
- Both Linux and Microsoft joined the SNIA effort to help steer the direction of PM.
  - Applications have direct Load/Store access to PM
  - End result: Both OS's are structured almost identically (ex: DAX)
- VMWare has also offered support for PM

Native Persistent Memory Support in OS's



Flash Memory Summit

# 2015: PM Usage Launch on NVDIMMs!



FMS Persistent Memory Track Presented By:





# NVDIMMs

- NVDIMMs become the first HW available to run PM Applications.
  - Success stories emerge highlighting the application benefits of PM.
  - Example: “Tail of Log” for SQL Server
- Alliance formed between JEDEC and SNIA to effectively drive adoption of the technology

**NVDIMMs Prove the Benefits of PM**



Flash Memory Summit

# 2019: Native Persistent Memory Media

- Persistent Memory initiative was formed on the expectation of next-generation memory to be successfully launched.
  - PM platforms now shipping.
  - Significant increase being seen in new application vendors requesting enabling in application development.

**Native PM Platforms Drive Aggressive PM App Development**





Flash Memory Summit

# Persistent Memory Applications



Flash Memory Summit

# Early PM System Support and Applications

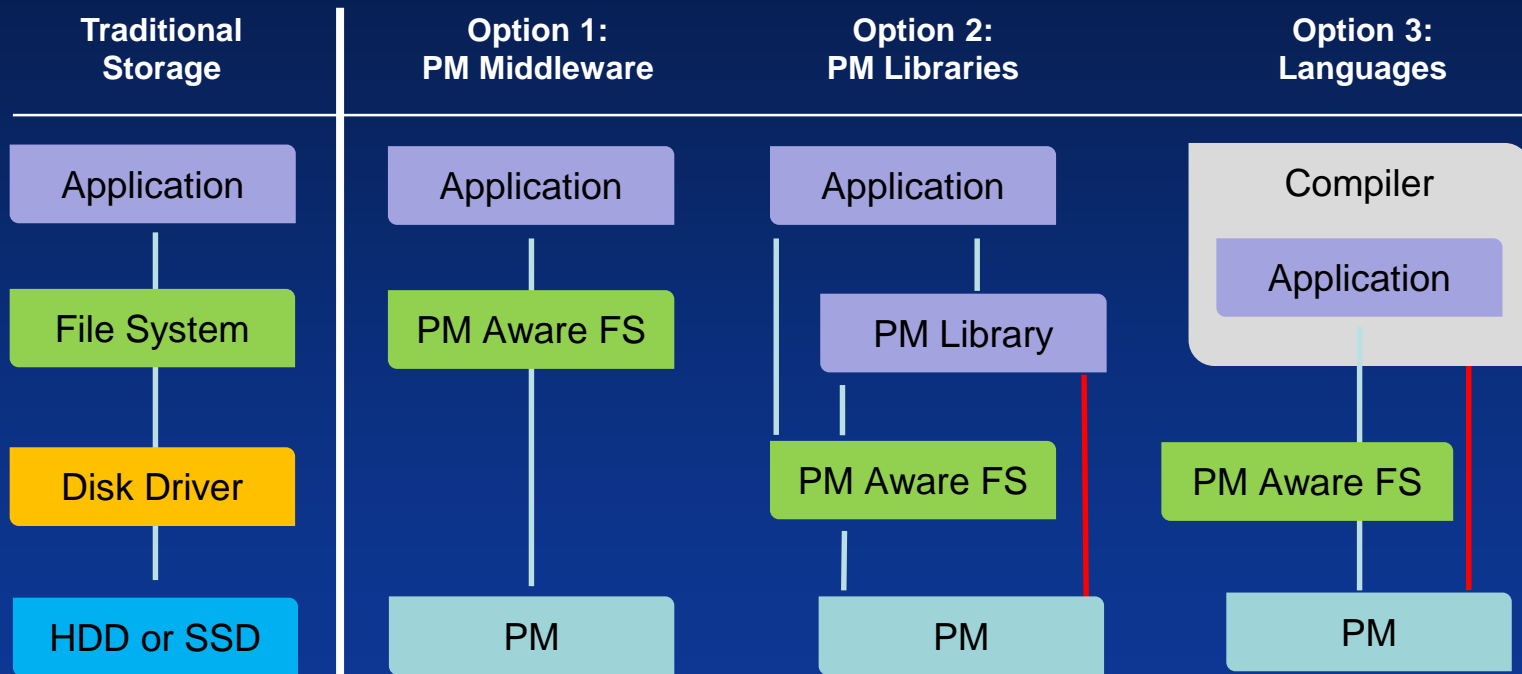


A sample of companies publically showing PM support



# Application Options

Flash Memory Summit

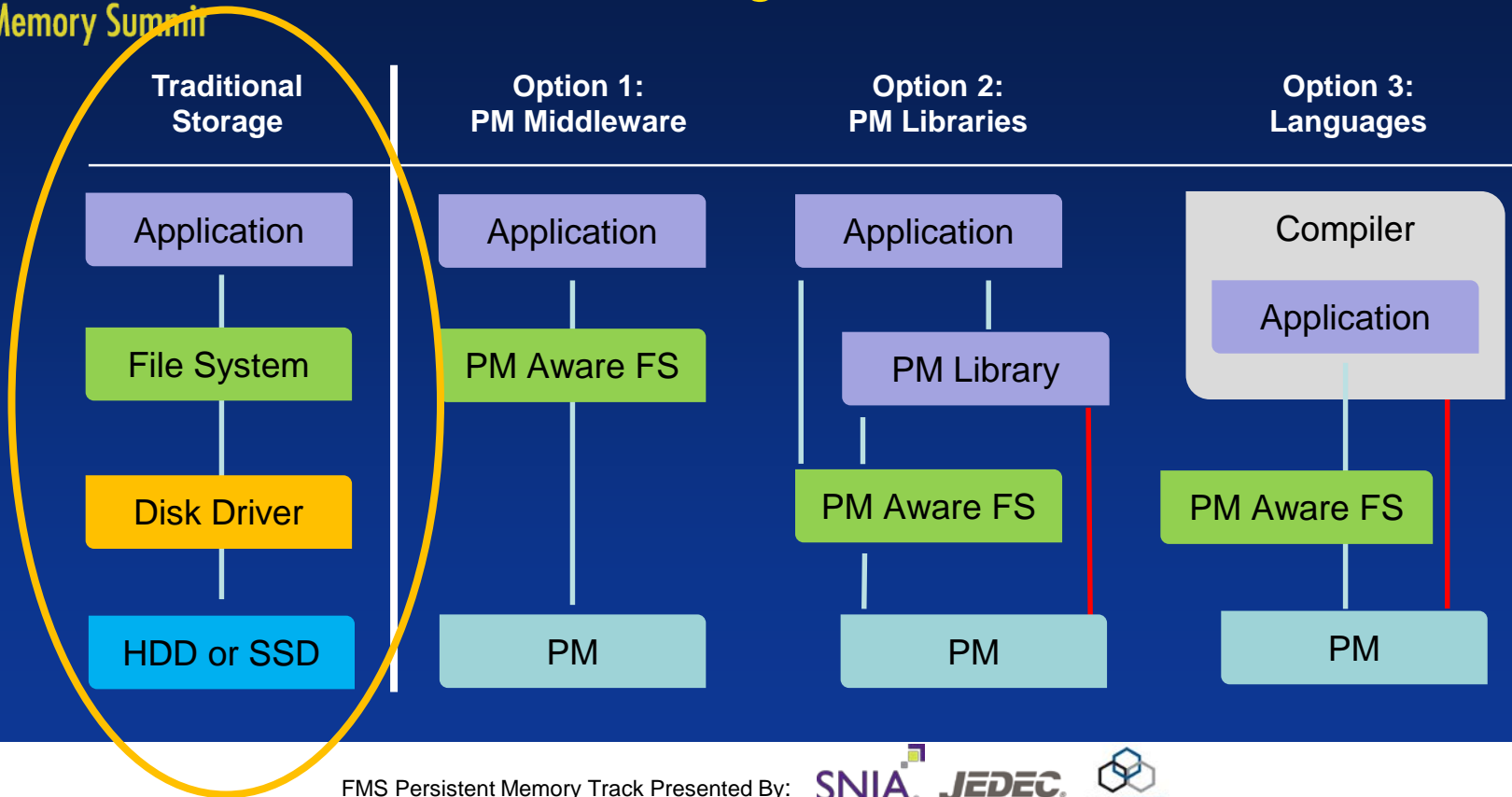




# Application Options

## - Traditional Storage

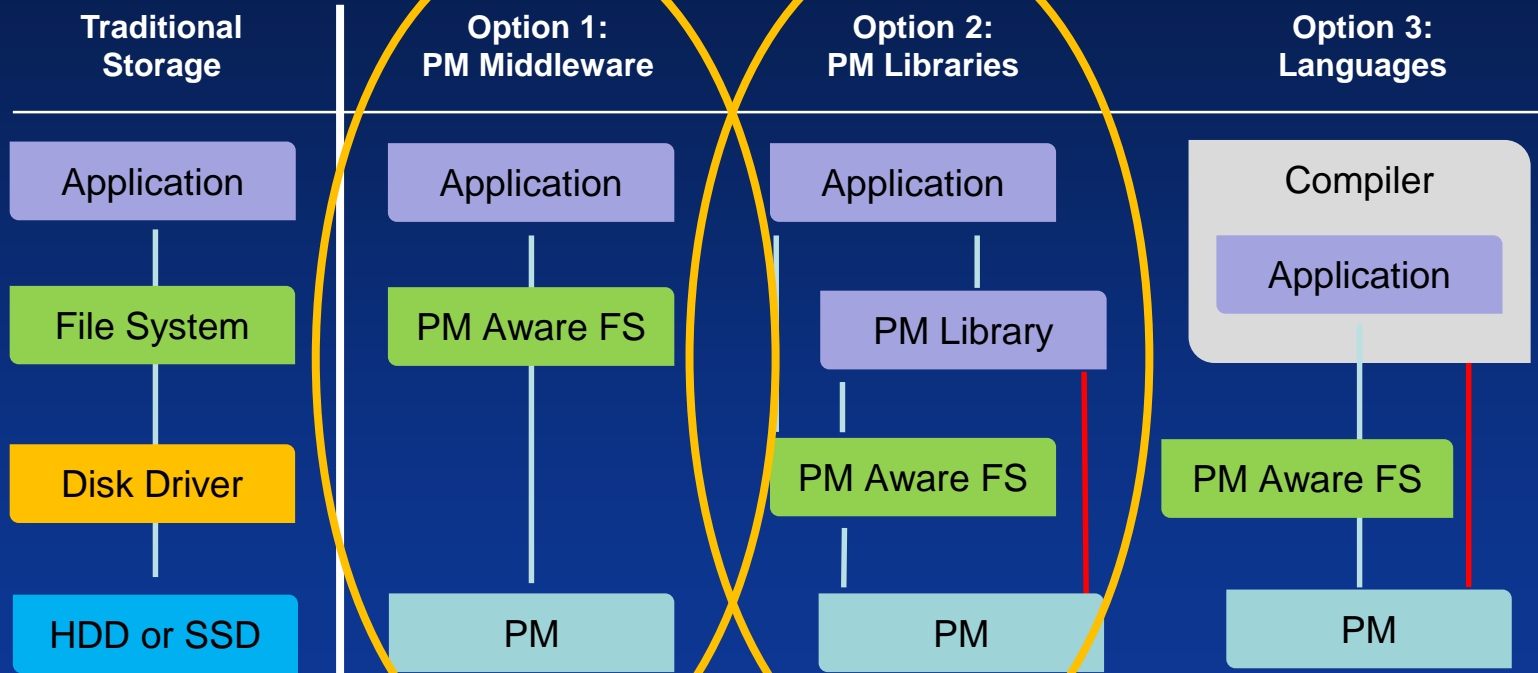
Flash Memory Summit





# Application Options

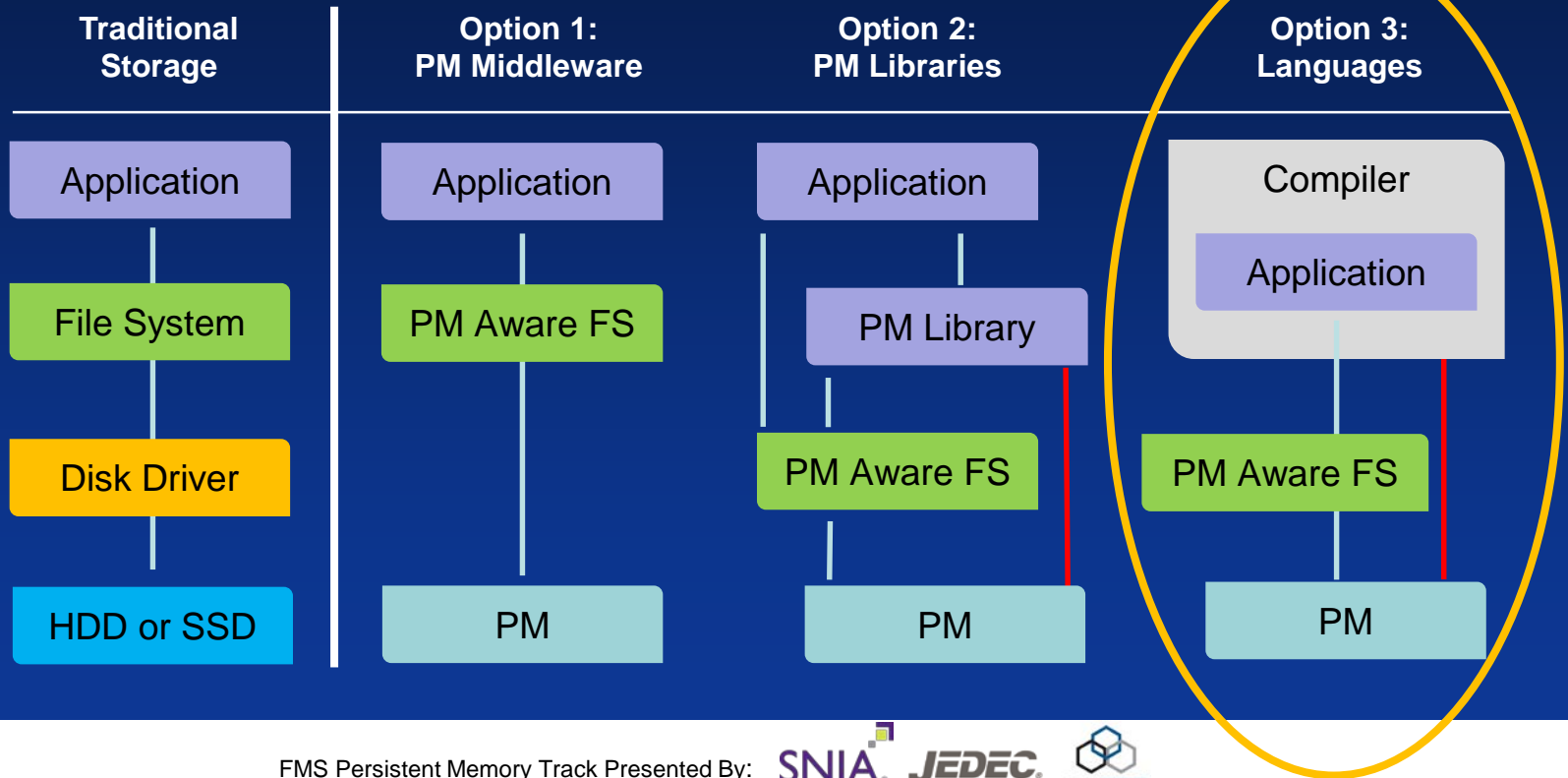
## - Unchanged Applications





# Application Options

## - New PM Applications





Flash Memory Summit

# Application Development Programs

- **Hackathon/Workshop**
  - PM Summit, January; NVMW, March - DONE
  - Flash Memory Summit, August – three day PM hackathon with evening meetup & recording of tutorial
  - SDC, September - Programming and workload analysis
  - Two or Three China hackathons
  - Exploring Japan, Europe, Israel, and online opportunity for FY 2020
- **PIRL Conference, July - Two-day meetup of leading PM Programmers**
- **NVDIMM Programming Contest**
  - Will kick off summer, run through end of year or beyond
  - Invite programmers to write for NVDIMM and PM, offer programming challengers
  - Contest winners will get online and PM Summit opportunities to show work



SNIA 2019 PERSISTENT MEMORY  
HACKATHON



Flash Memory Summit

# Persistent Memory What's Next?

FMS Persistent Memory Track Presented By:







# Remote Persistent Memory

- Remote Persistent Memory (RPM) allows the programming model to extend beyond a single node, to datacenter (or beyond) scalability.
  - RPM is the basis for a relationship between Open Fabrics Alliance (OFA) and SNIA.
  - The first use case (High Availability) defined and spec in progress
  - New usage models are in the queue... example, pooled PM and memory-centric architectures.



Flash Memory Summit

# CXL Compute Express Link

FMS Persistent Memory Track Presented By:





# Broad Industry support for CXL

Flash Memory Summit



CXL consortium - Currently 75 companies and growing

[www.computeexpresslink.org](http://www.computeexpresslink.org)



# Representative CXL usages

## Caching Devices / Accelerators

- Usages:
- PGAS NIC
  - NIC atomics
- Protocols:
- CXL.io
  - CXL.cache



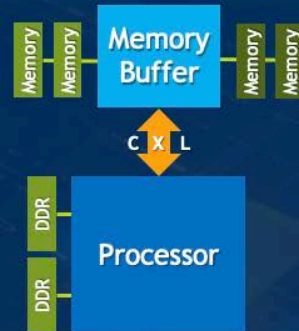
## Accelerators with Memory

- Usages:
- GPU
  - Dense Computation
- Protocols:
- CXL.io
  - CXL.cache
  - CXL.memory



## Memory Buffers

- Usages:
- Memory BW expansion
  - Memory capacity expansion
  - Persistent Memory
- Protocols:
- CXL.io
  - CXL.mem



All Information Confidential (CXL Consortium)



# Representative CXL usages

## Caching Devices / Accelerators

- Usages:
- PGAS NIC
  - NIC atomics
- Protocols:
- CXL.io
  - CXL.cache



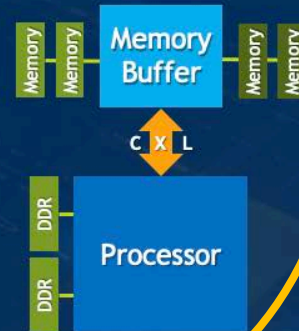
## Accelerators with Memory

- Usages:
- GPU
  - Dense Computation
- Protocols:
- CXL.io
  - CXL.cache
  - CXL.memory



## Memory Buffers

- Usages:
- Memory BW expansion
  - Memory capacity expansion
  - Persistent Memory
- Protocols:
- CXL.io
  - CXL.mem



All Information Confidential (CXL Consortium)





Flash Memory Summit

# Summary



Flash Memory Summit

# Summary

## Why Persistent Memory Matters



## Flash Memory Summit

# Learn More

- FMS PMEM 101, 102, 201, 202 – (Tues & Wed)
- FMS Experts Table – Beer & Pizza (Tonight 7:30)
- FMS Hackathon (today and tomorrow) & Meet-up (Wednesday evening – 7 pm)
- FMS CXL Session (Wednesday at 3:20 pm)
- SNIA Storage Developers Conference  
Sept 23 – 26 (Santa Clara Hyatt)
- SNIA PM Summit
  - January 23, 2020 (Santa Clara Hyatt)
- OFA Annual Workshop
  - March 17-19 2020 (Ohio State University)





Flash Memory Summit

# Get Involved

- SNIA ([www.snia.org](http://www.snia.org))
- JEDEC ([www.jedec.org](http://www.jedec.org))
- OFA ([www.openfabrics.org](http://www.openfabrics.org))



Flash Memory Summit

# Thank You