



Why Persistent Memory Matters

How did we get here, and what lies ahead?

Jim Pappas

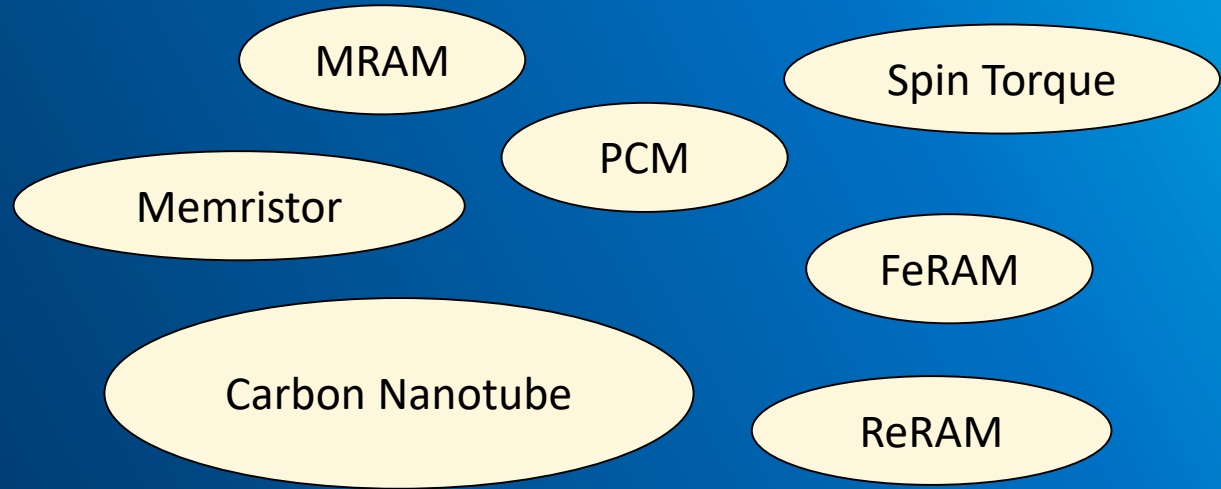
Director of Technology Initiatives, Intel

Vice-Chair, Storage Networking Industry Association (SNIA)

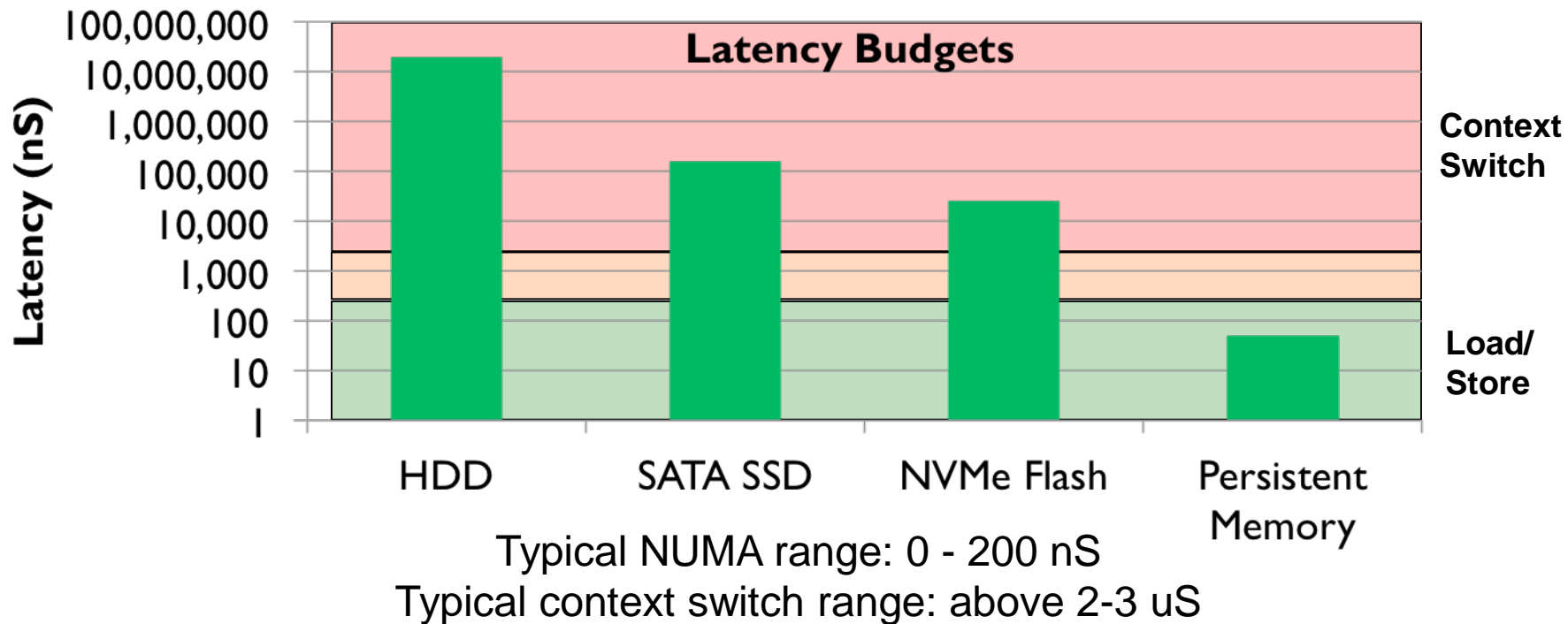
December 07, 2018

jim@intel.com

How did this PM Effort Start?



Storage vs. Memory



Relative media speeds

▶ Memory
(10's ns)



→ 2 KM

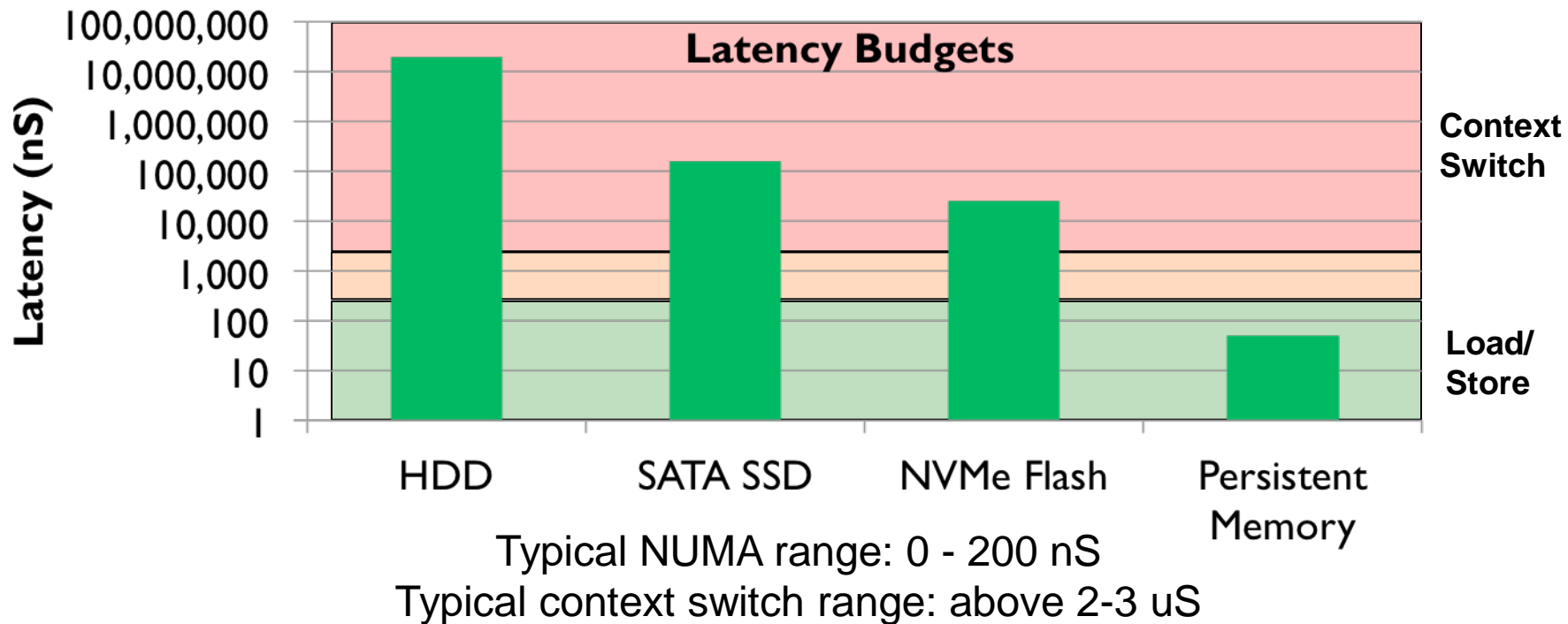
▶ SSD
(10's us)



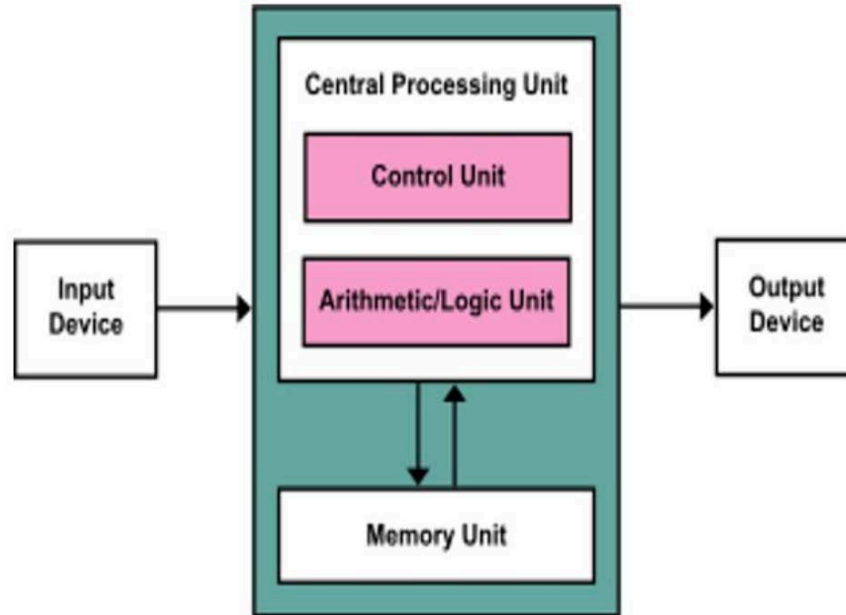
→ 6000 KM

▶ HDD
(10's ms)

Convergence of Storage & Memory

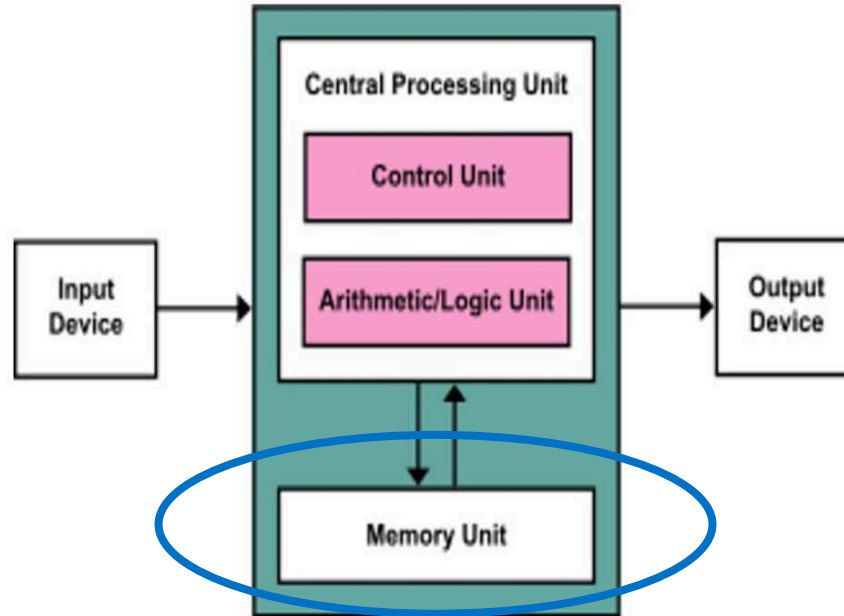


PM Changes the Application View of Computer Architecture.



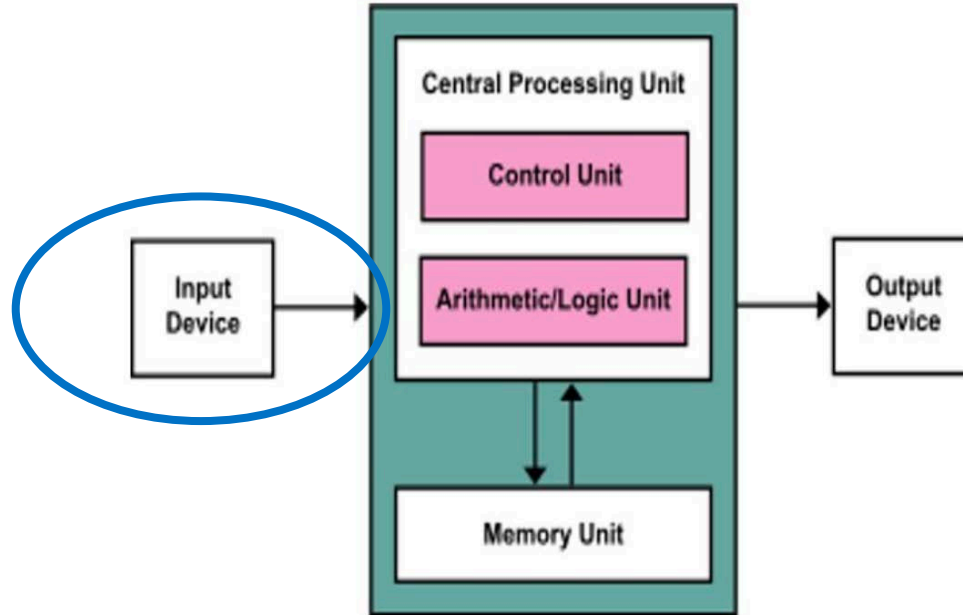
Block Diagram of Von Neumann Architecture

PM Changes the Application View of Computer Architecture.



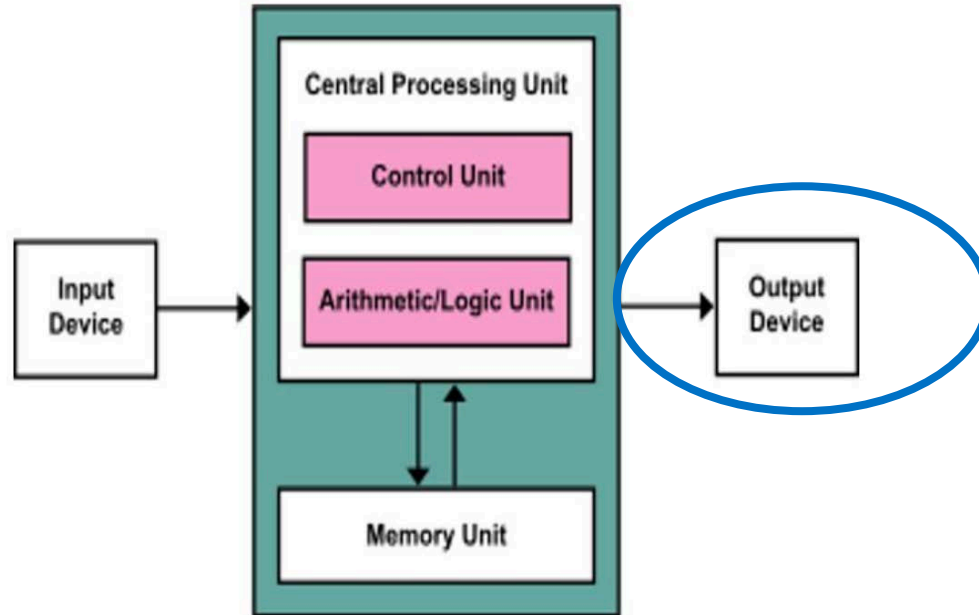
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PM Changes the Application View of Computer Architecture.



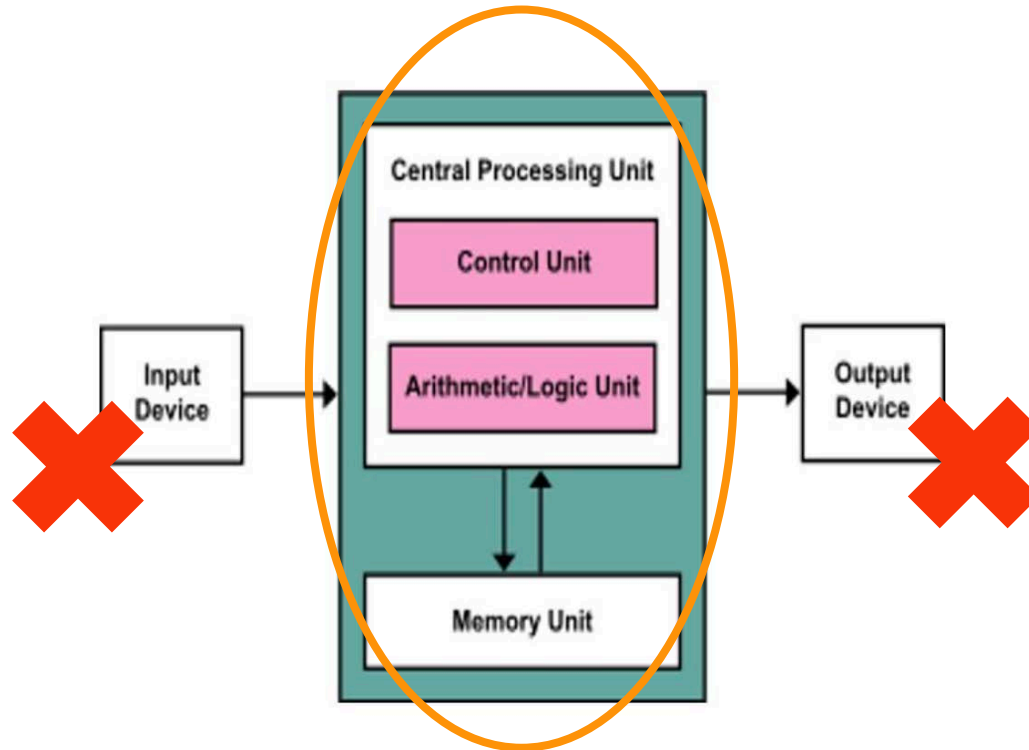
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Block Diagram of Von Neumann Architecture

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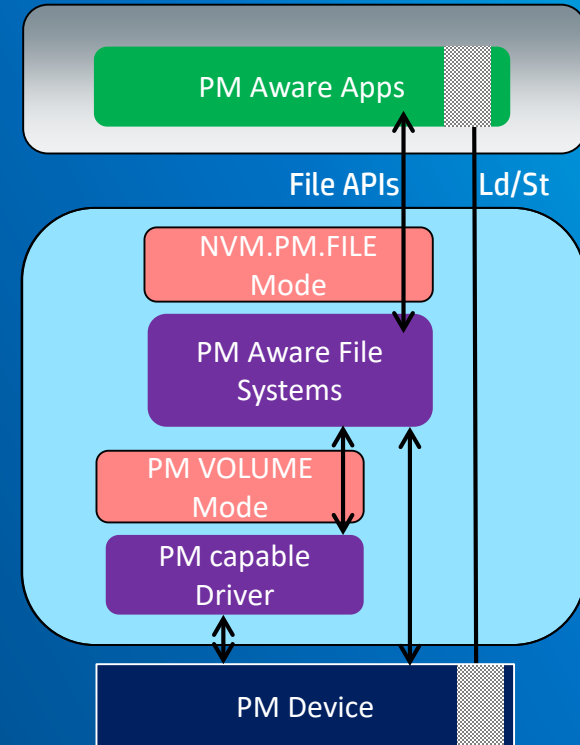
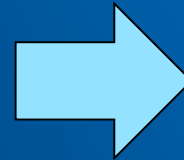
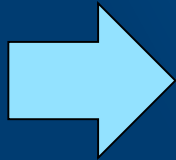


Block Diagram of Von Neumann Architecture

SNIA NVM Programming TWG

Formed 06-11-2012

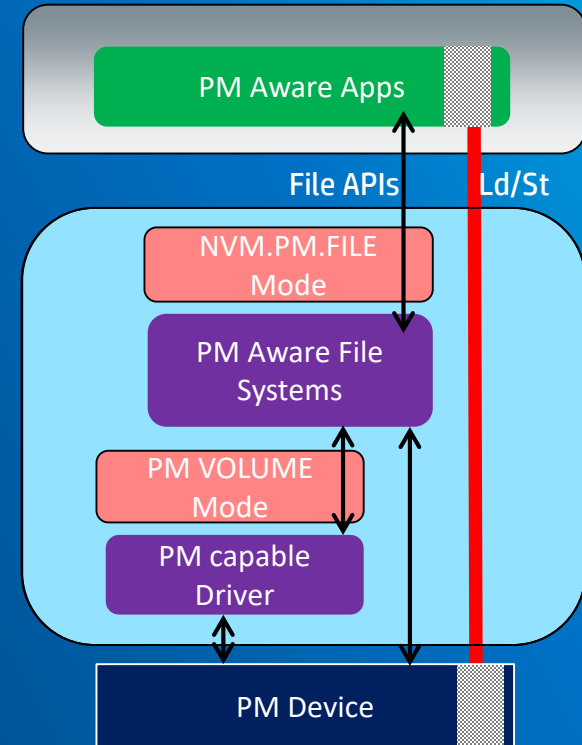
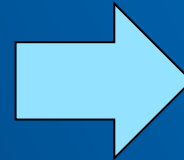
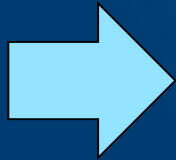
- Dell
- EMC
- Fujitsu
- HP
- Intel
- Netapp
- Oracle
- QLogic



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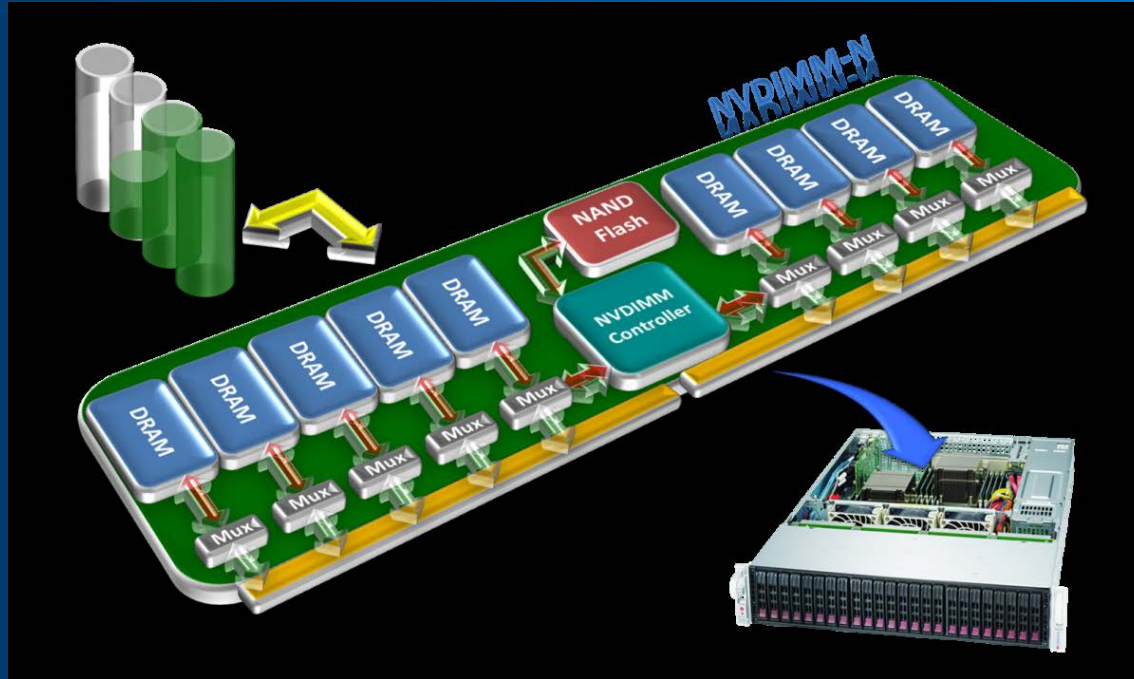
Operating System Support

“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

Persistent Memory support in OS's ahead of volume adoption

PM Usage Launch on NVDIMMs!



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

intel OPTANE™ DC
PERSISTENT MEMORY



Big and Affordable Memory

128, 256, 512GB

High Performance Storage

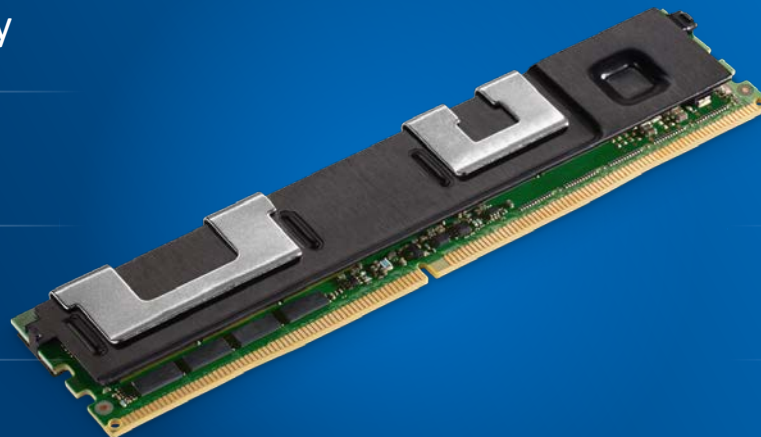
DDR4 Pin Compatible

Direct Load/Store Access

Hardware Encryption

Native Persistence

High Reliability



Now shipping for revenue to select customers



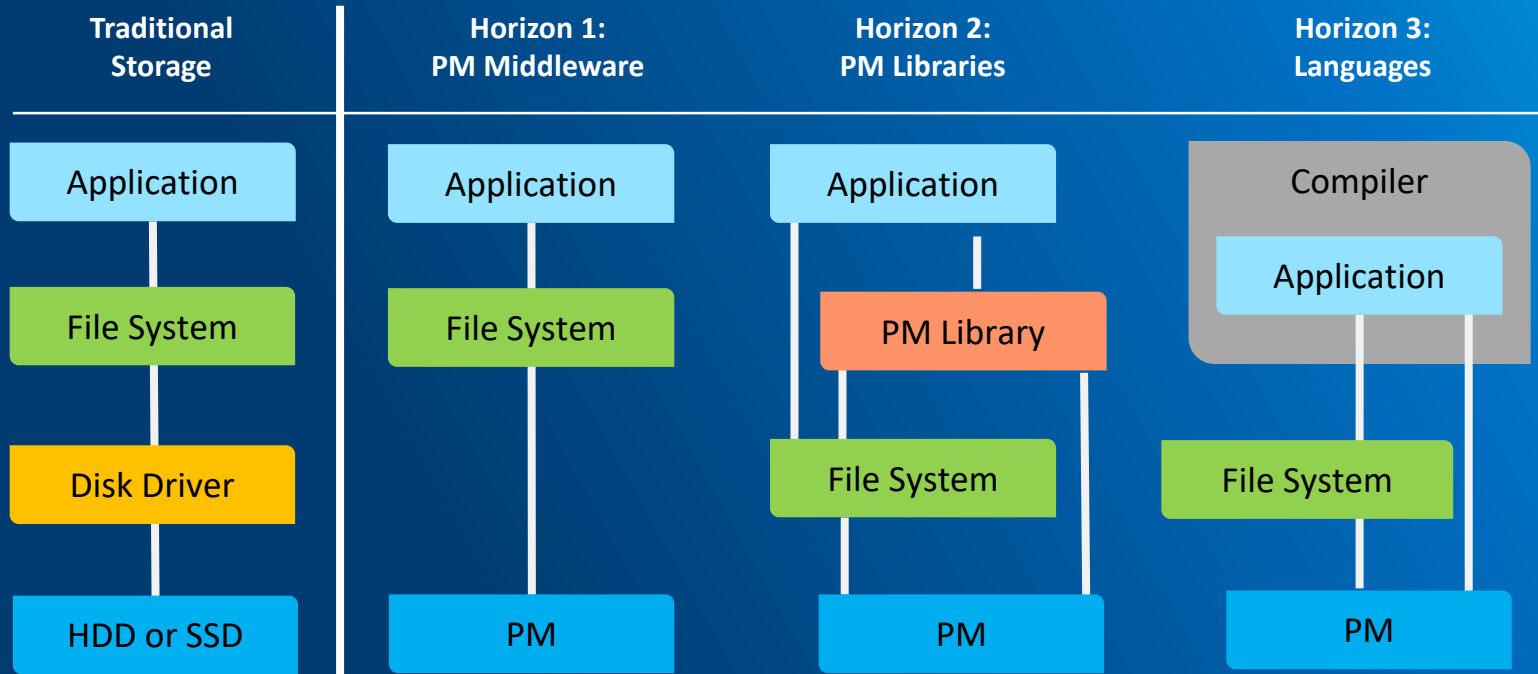
Persistent Memory What's Next?

Remote Persistent Memory

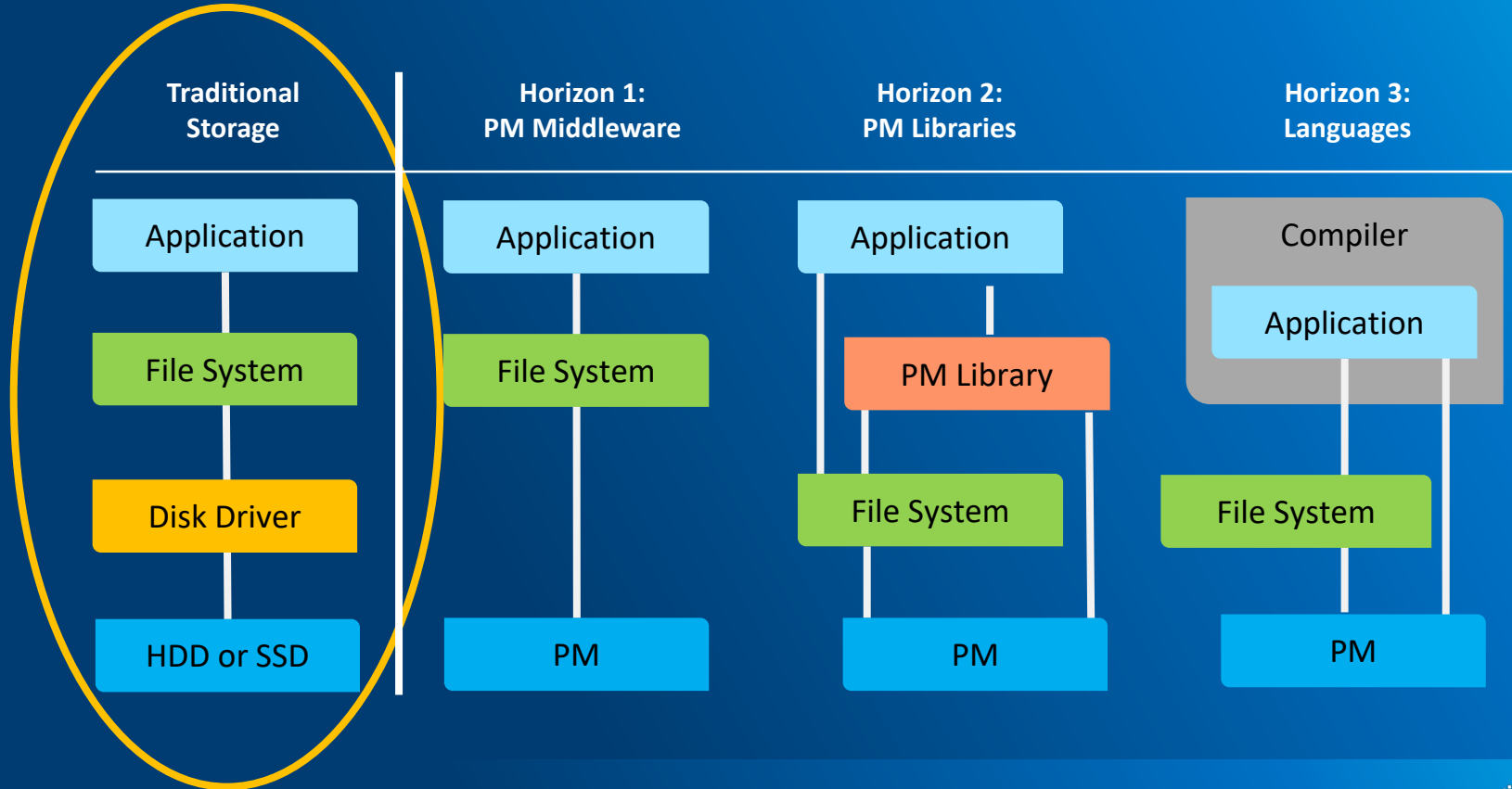
- Remote Persistent Memory (RPM) allows the programming model to extend beyond a single node, to datacenter (or beyond) scalability.
 - RPM is the basis for a relationship between Open Fabrics Alliance (OFA) and SNIA.
 - The first use case (High Availability) defined and spec in progress
 - New usage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

Persistent Memory Applications

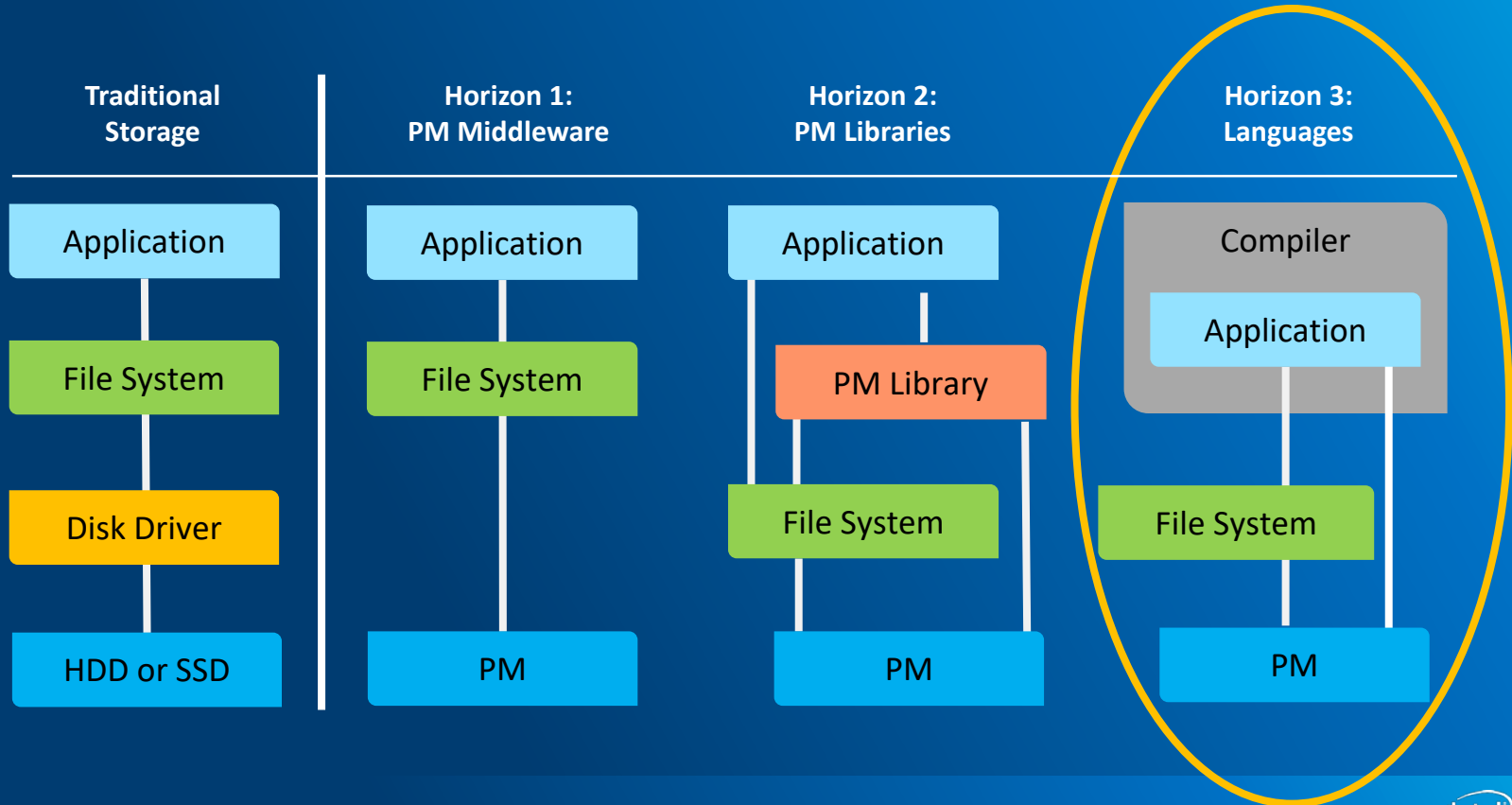
Application Horizons



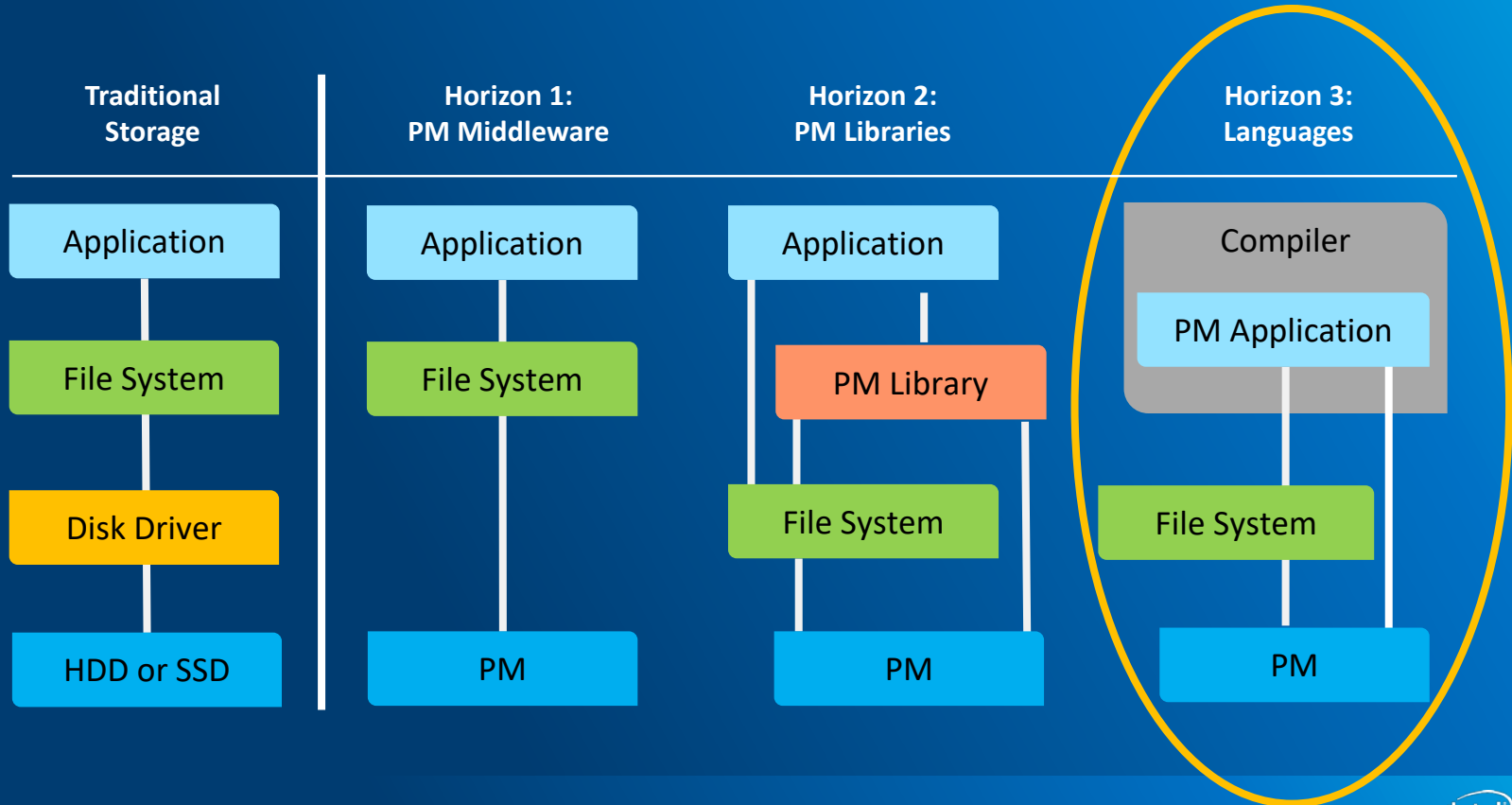
Application Horizons - Today



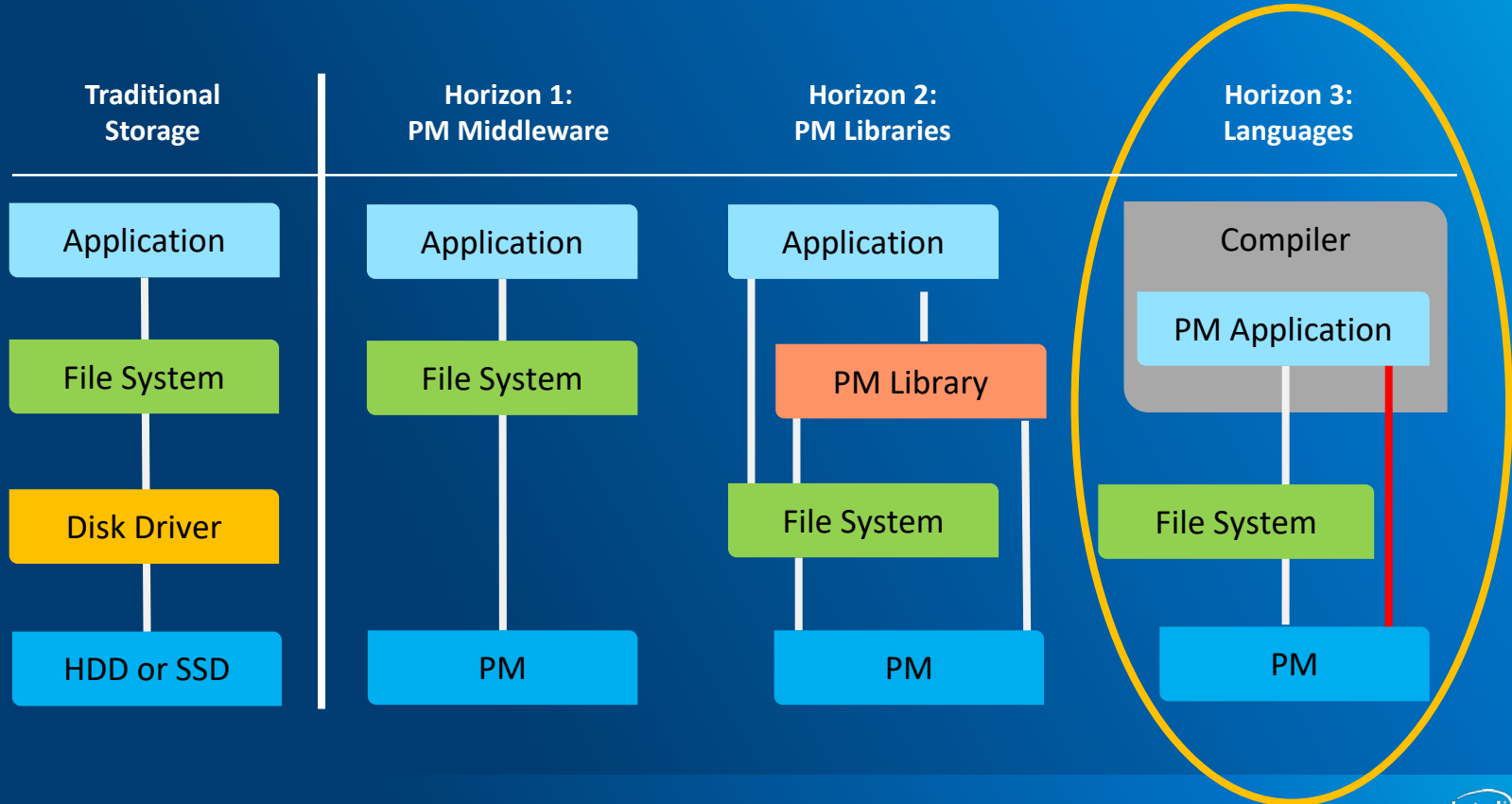
Application Horizons – Ultimate Goal



Application Horizons – Ultimate Goal



Application Horizons – Ultimate Goal



Early PM System Support & Applications



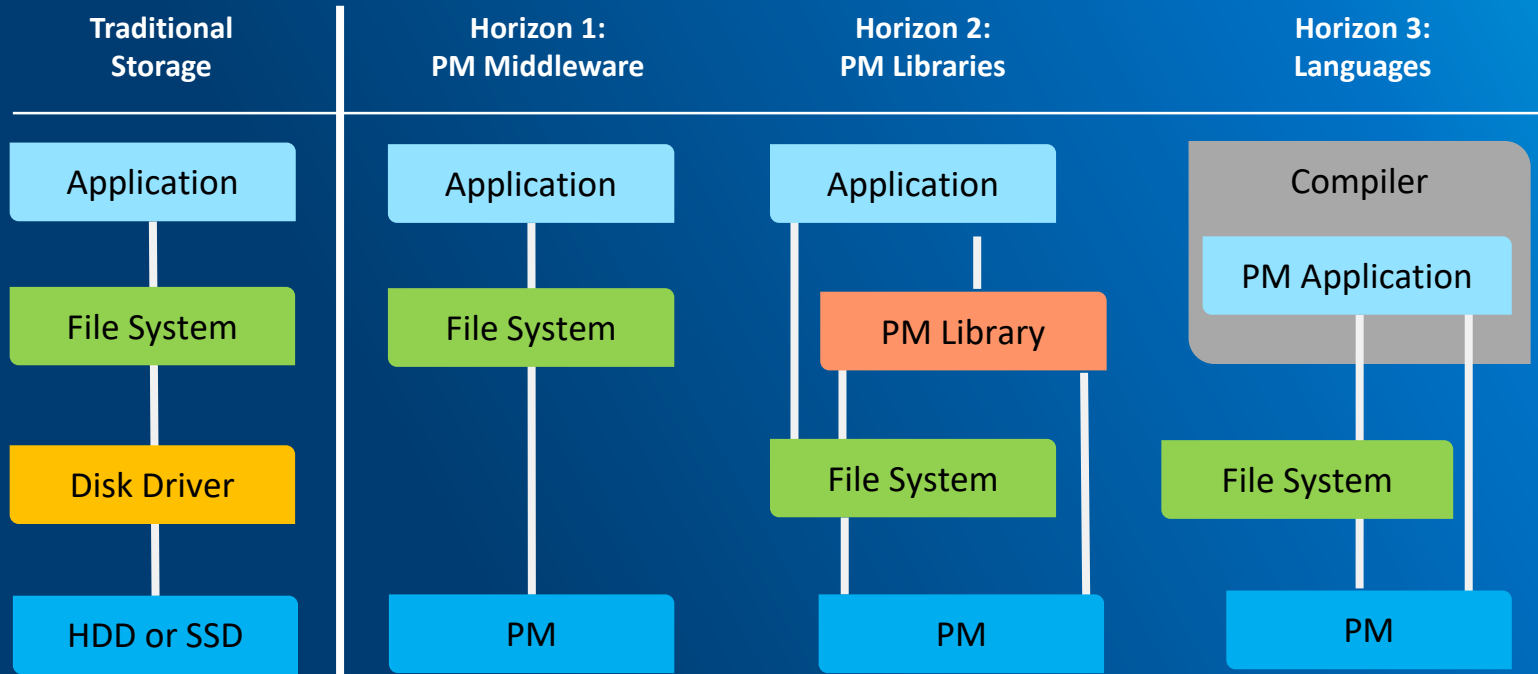
A sample of companies publically showing PM support

Application Development Enabling

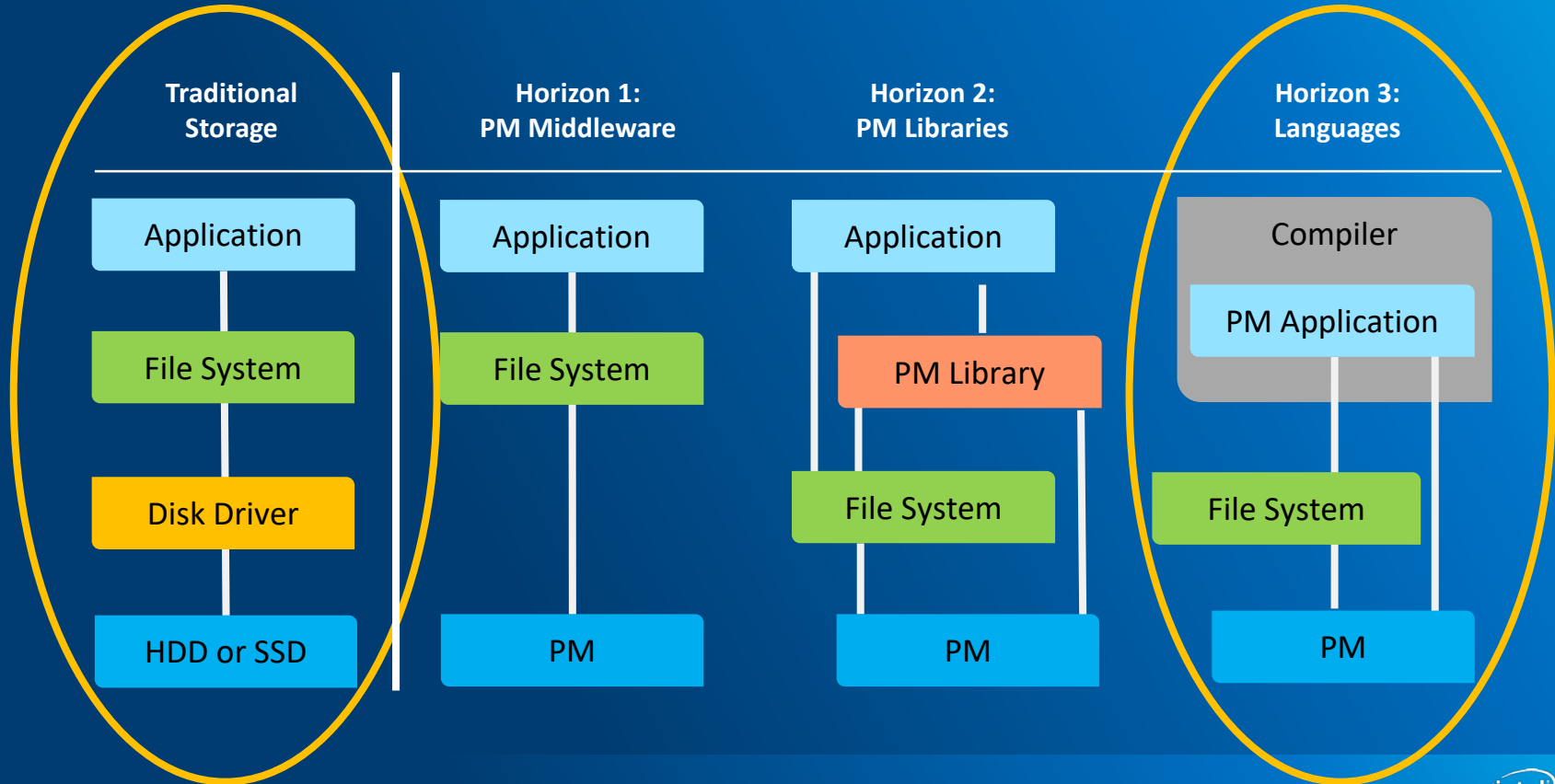
- SNIA PM Application Enabling
 - A program is needed to enable the application development community to build native PM applications
 - Early planning stages... expected program in '19
- PMDK continues to be a key enabler for new applications

Goal: Accelerate Development of PM Applications

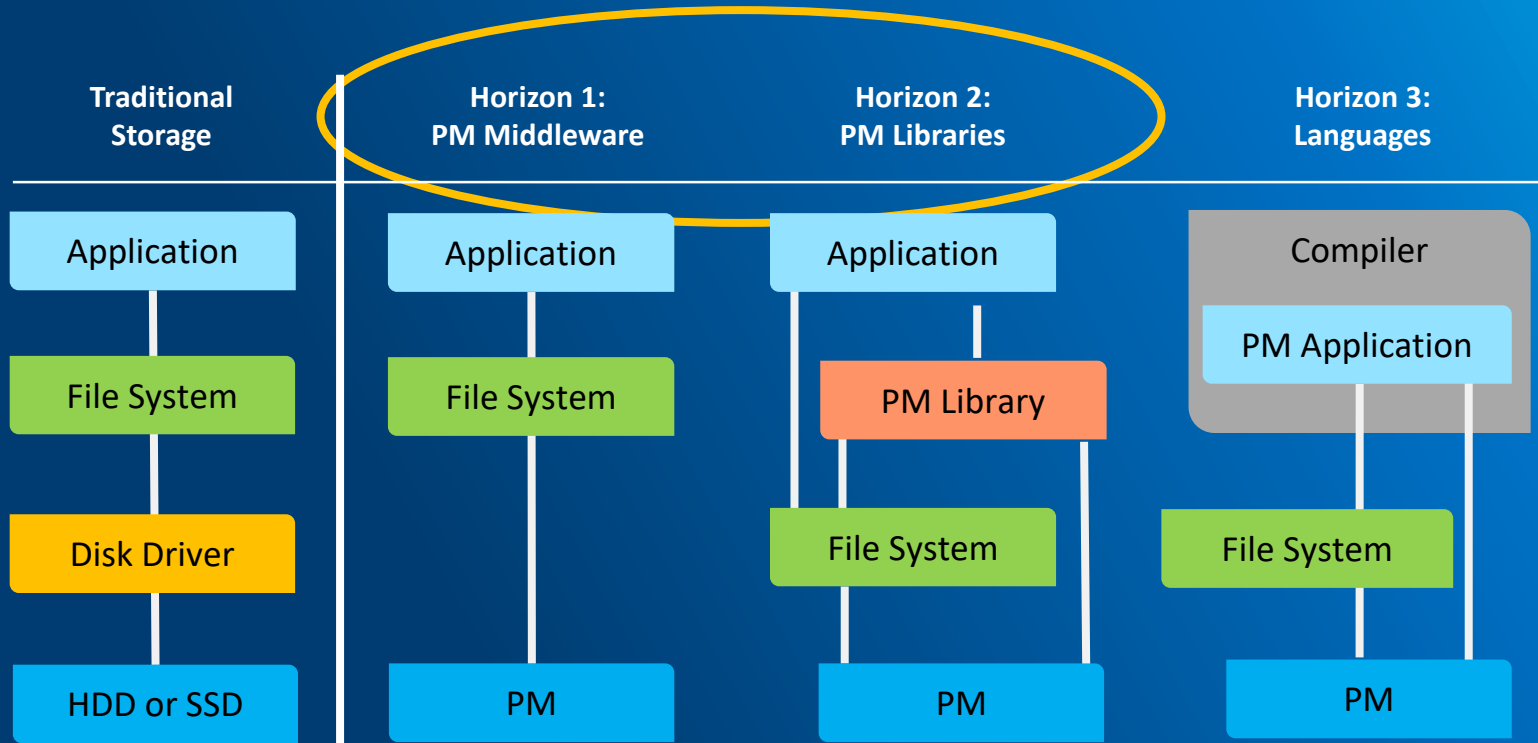
Application Horizons



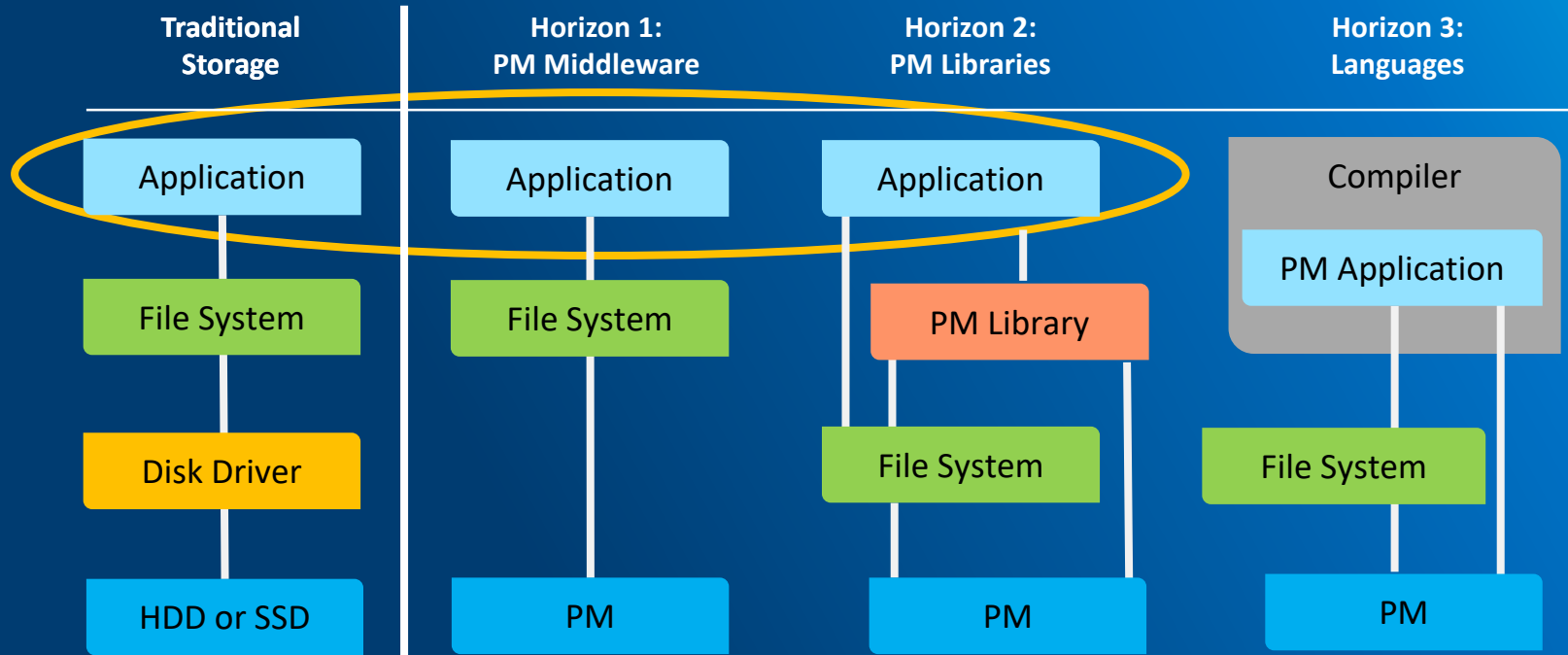
Application Horizons



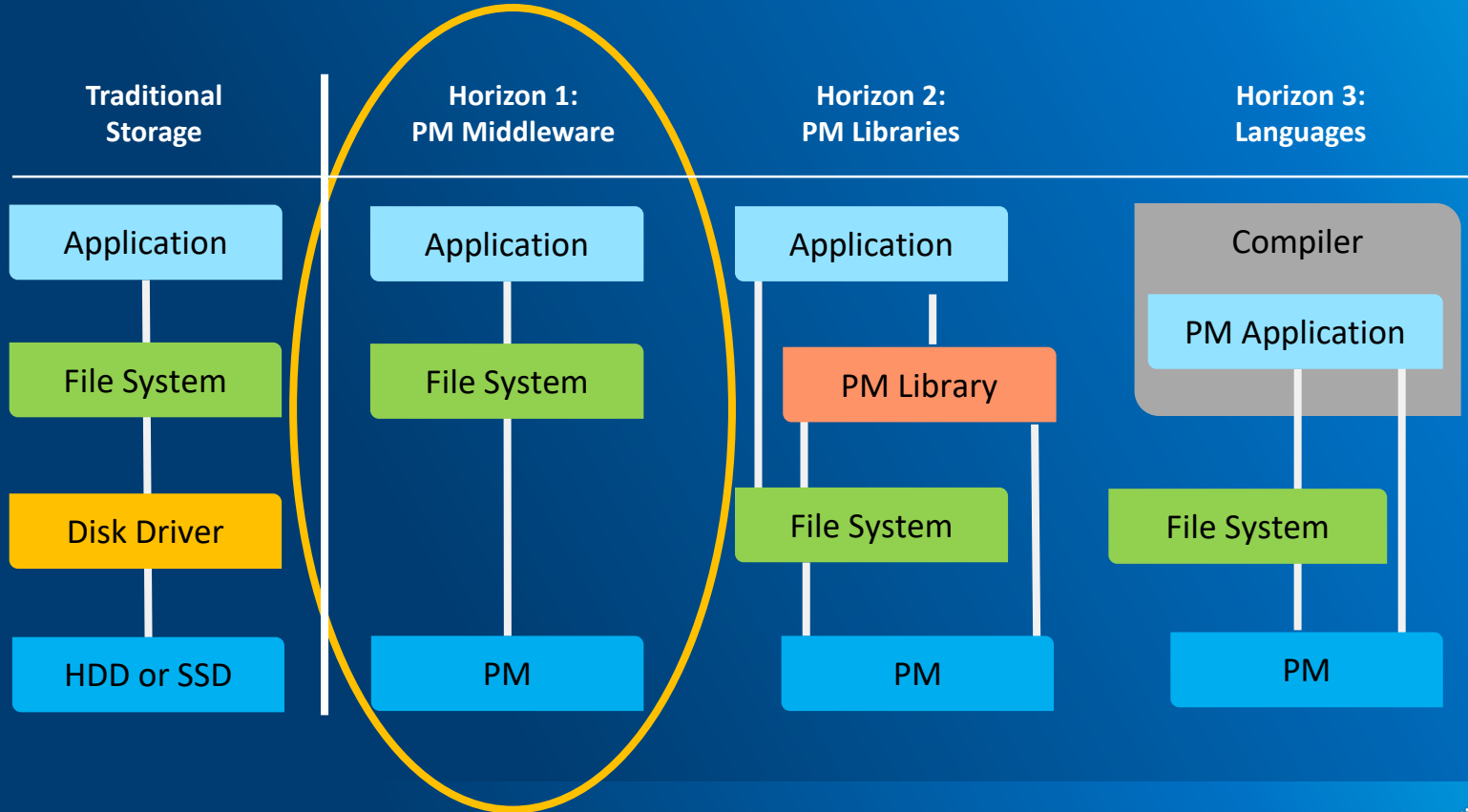
Application Horizons



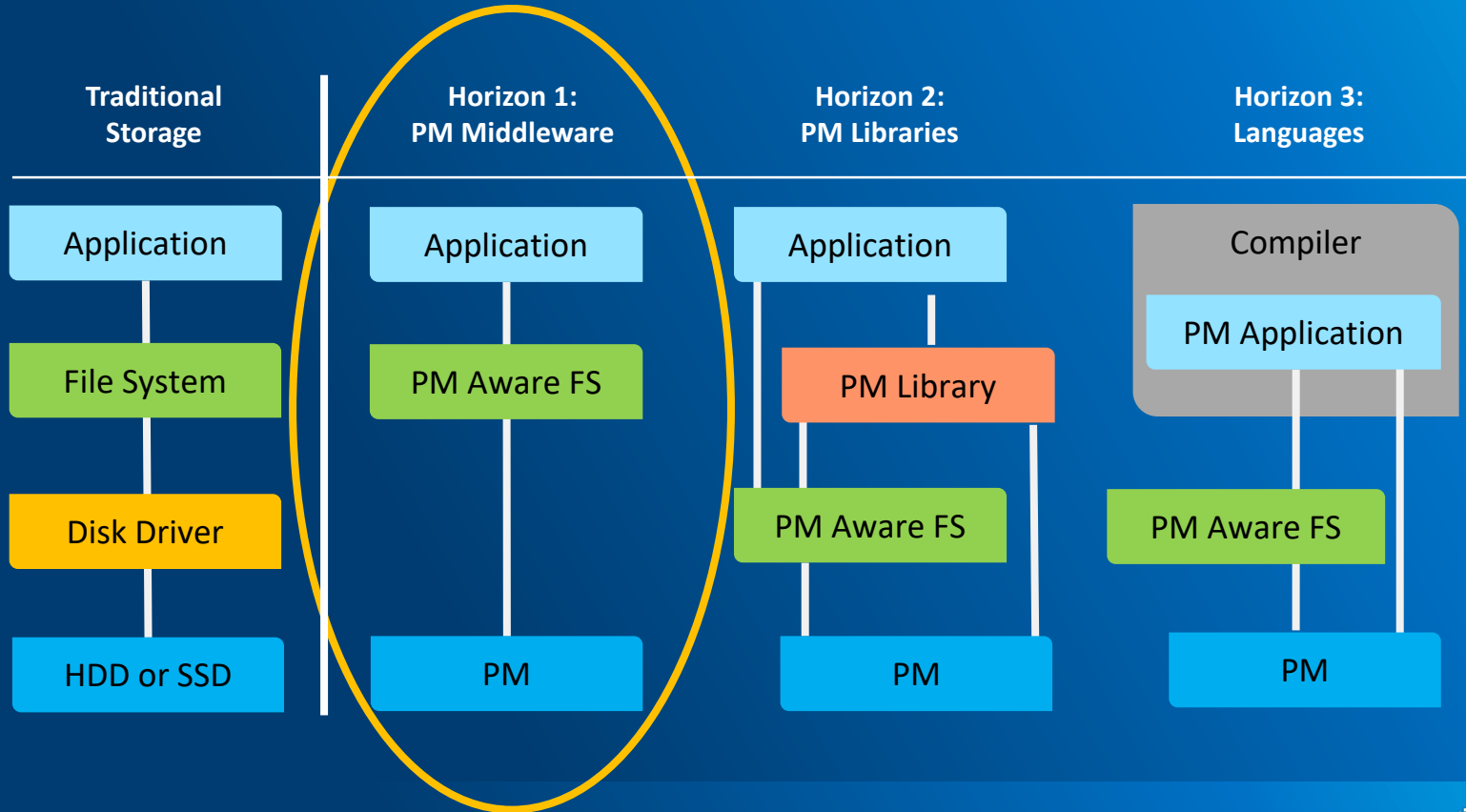
Application Horizons



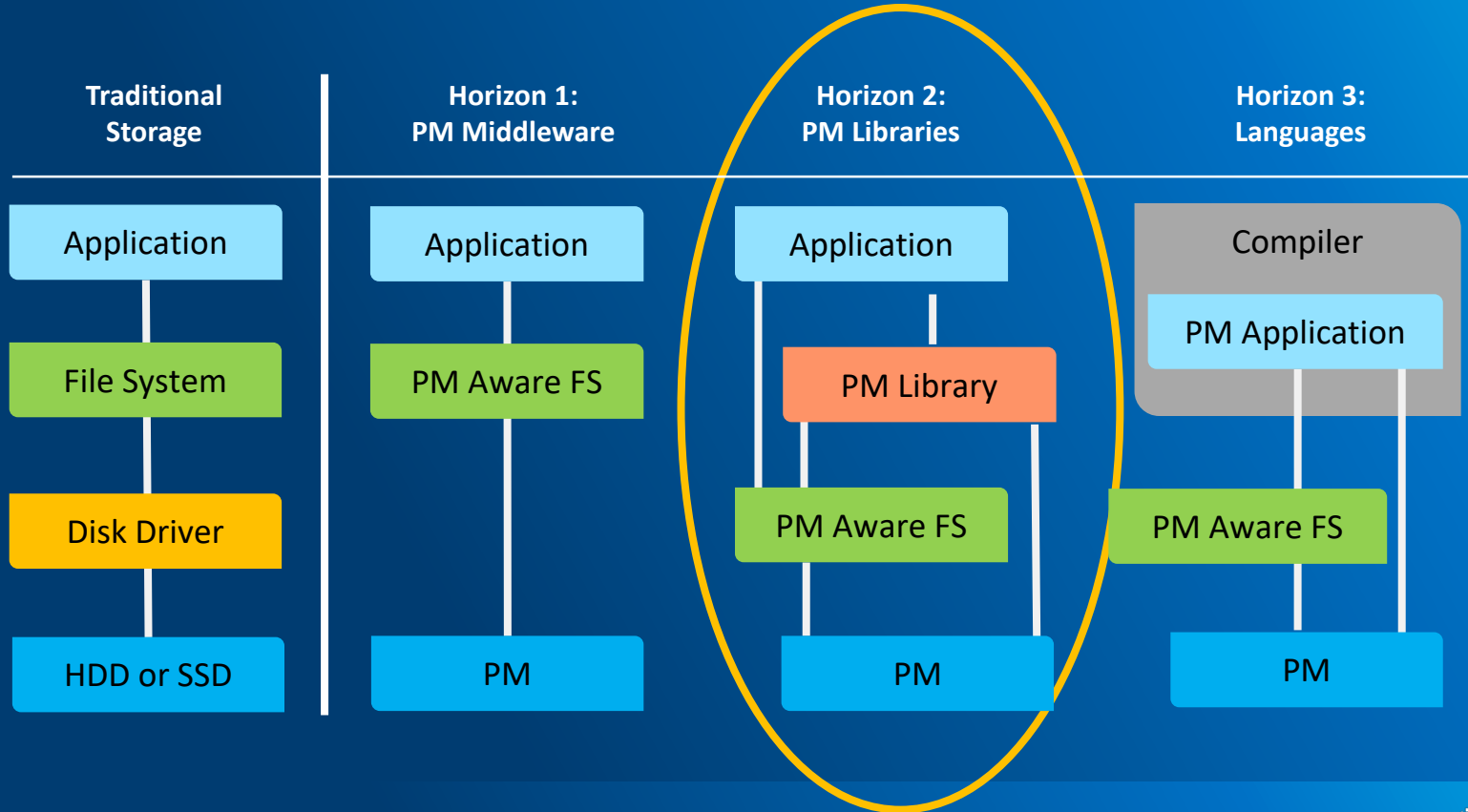
Application Horizons



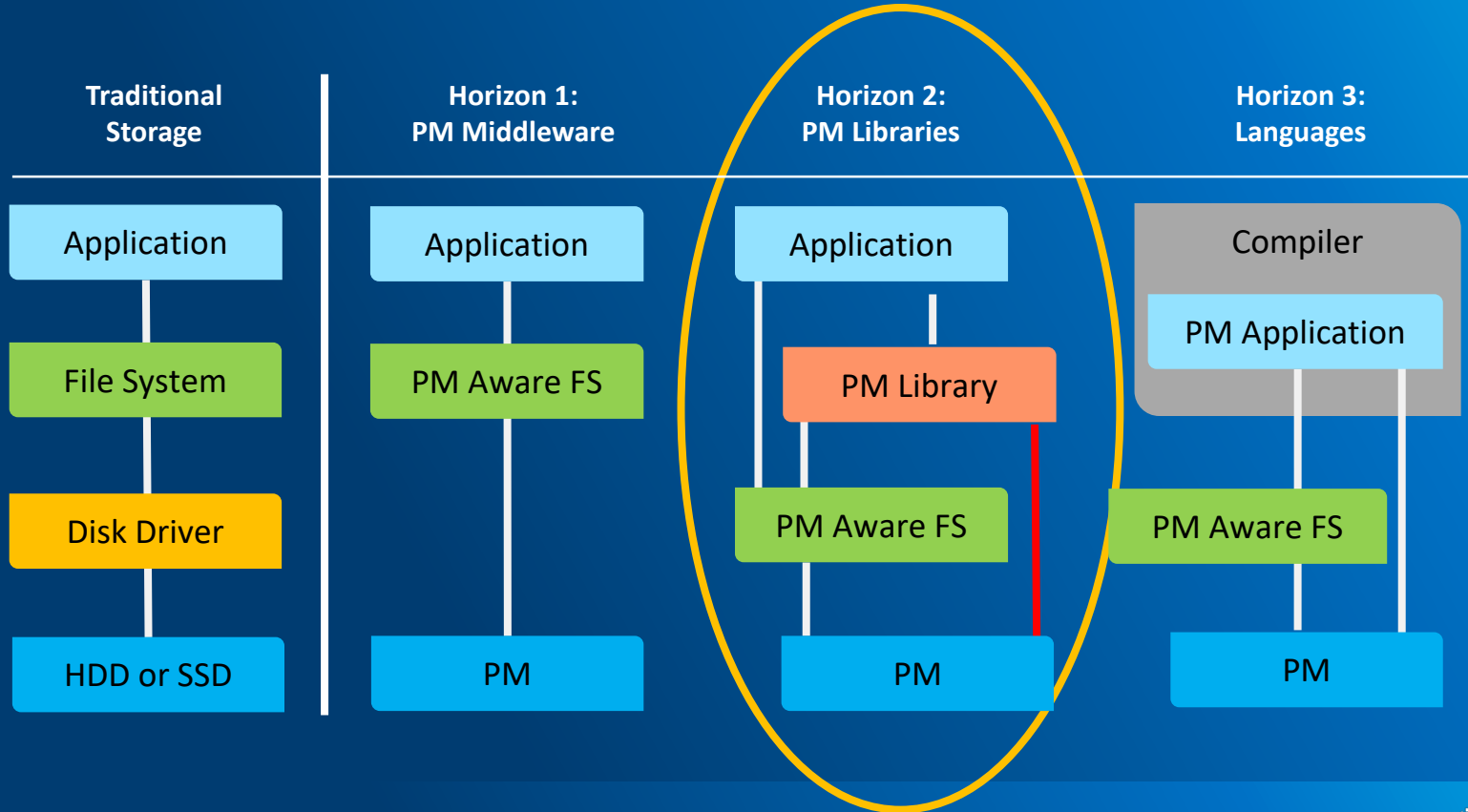
Application Horizons



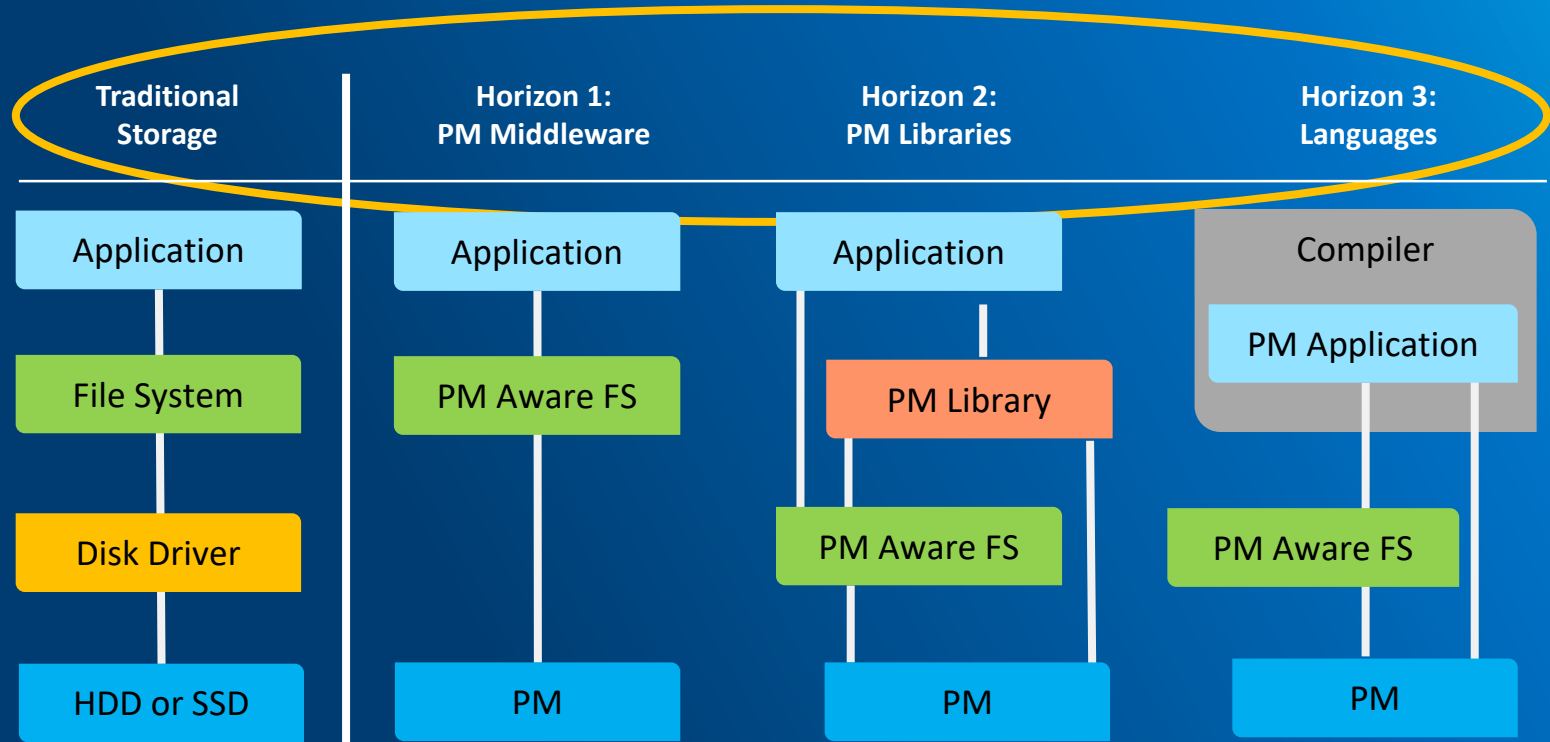
Application Horizons



Application Horizons



Application Horizons



Summary

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Why Persistent Memory Matters

Learn More

- SNIA PM Summit
 - January 24, 2019 (Santa Clara Hyatt)
- OFA Annual Workshop
 - March 19-21 2019 (Austin Tx)

Get Involved

- SNIA (www.snia.org)
- JEDEC (www.jedec.org)
- OFA (www.openfabrics.org)

Thank You!
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