Flash Memory Summit

Persistent Memory Architectures: Improving system resilience and recovery

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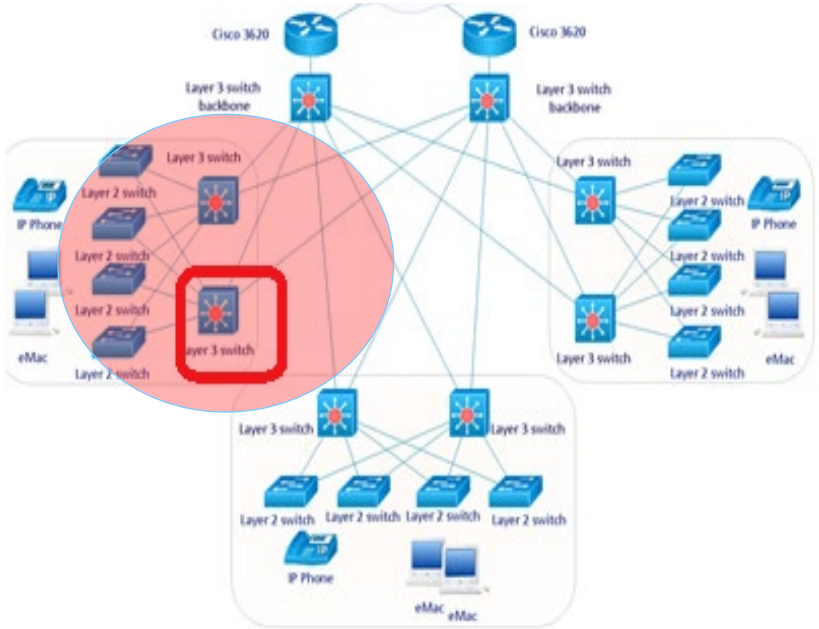
35 YEARS OF NAND FLASH MEMORY INNOVATION

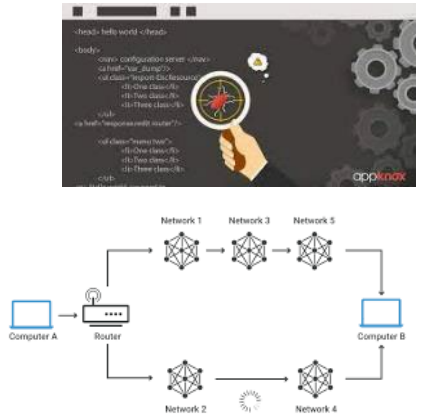
Reducing System Downtime

Hacker

Network Outage

Buggy code or misconfiguration





System Recovery

- Detect Failure
- Limiting the Blast Radius
- Rollback or commit intermediate transaction
- Activate back up
- Distribute load

- Root causing failure
- Patch, Repair or Fix
- Retest the system

Revenue Loss

- Preserve Error logs and security events in real time.
- Preserve transactions in flight.
- Reduce time to retrieve backed up Data.

Source; The GigaSpaces Technologies Blog, Insights into In-Memory Computing and Real-time Analytics

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Time to Recover Data Depends on its Location

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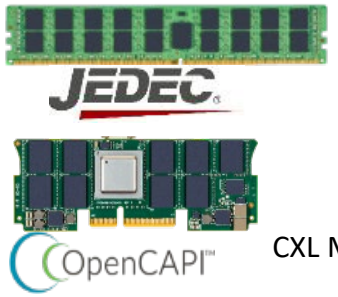
Keep in Mind **Make a Note** **Store in a File Binder**

	(Volatile) Memory	Persistent Memory	Storage
Uses	• Frequently used. • Granular access. • **Can be regenerate**	• Frequently used. • Granular access. • **Difficult to regenerate or reconstruct.**	• Infrequently accessed or rarely updated. • Large bulk Data. • **Difficult to regenerate or recover.**
Examples	• **Temporal Data** • Data structures, Packet buffers • Cached instructions	• **Intermediate Data** • Intermediary results, status, or metadata. • Error, security or telemetry logs.	• **Permanent Data** • Images, Videos, maps, audio files, etc. • Application code. Database objects.
Requirements	• Low latency (in 10s of ns) • Byte-level access. • High reliability (low DPPM)	• Low latency • Byte-level access. • High reliability • **Data retention across power-cycles**	• High throughput. • Block level access • **Data retention across power-cycles** • **Low cost**
	  CXL Memory module	 NVDIMM-N  Intel Optane™ PMem 	   nvm EXPRESS

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Persistent Memory Improves Latency & Resilience

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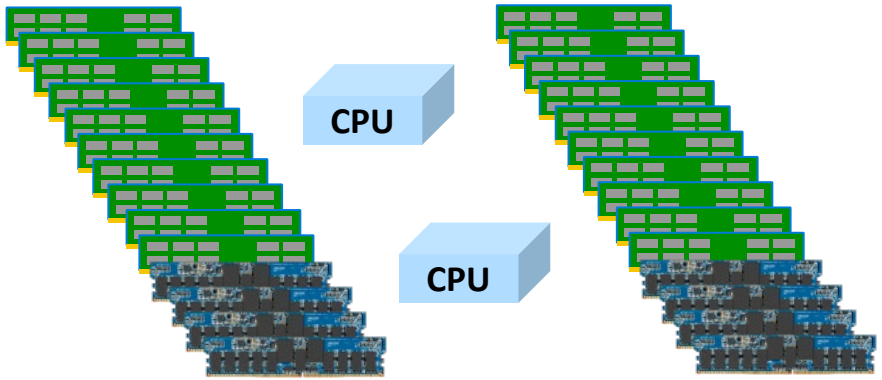
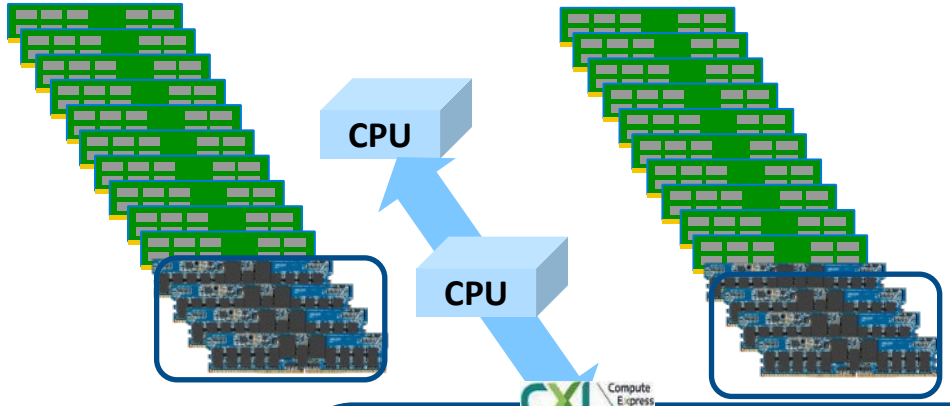
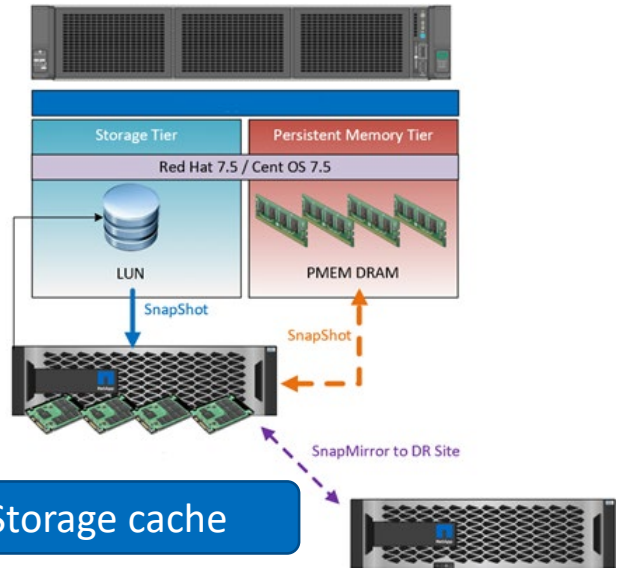
Current Gen Systems
DDR4 and NVDIMM-N



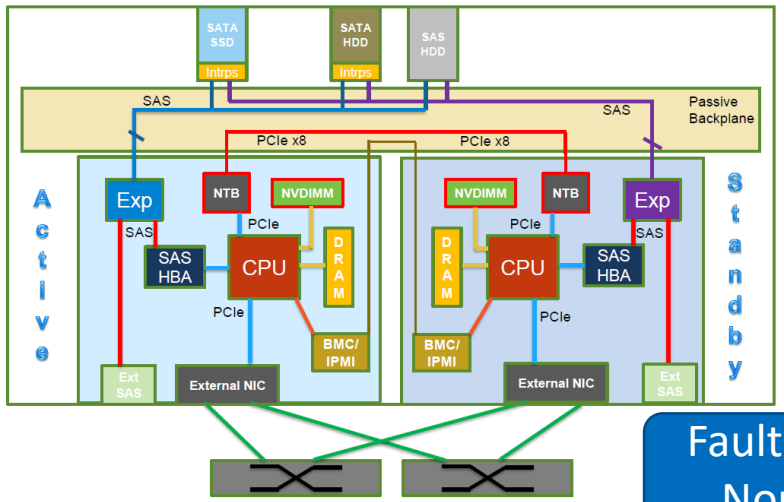
CXL Compute Express Link

Next Gen Systems
DDR5 NVDIMM-N and CXL NV-XMM





As Storage cache



Fault tolerant, Byte Addr.
Non-volatile Memory

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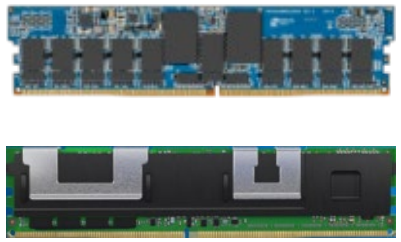
Form-factors for Persistent Memory



Persistent Memory in DIMM form-factor

- Low latency as directly attached to processor bus
- CPU and Platform dependent.
- Memory capacity limited by Thermal and PCB.
- May bring down the performance of entire DDR channel if not running at speed with other DIMM.

Persistent Memory in EDSFF (E1.S or E3.S)

- CPU and Platform Agnostic
- Scalable and Hot pluggable. Improves serviceability
- Capacity limited by Thermal and PCB space constrains

Persistent Memory in PCIe CEM form-factor

- CPU and Platform Agnostic
- Very High Memory capacity. (In Tera Bytes)
- Enables multi sourcing of DIMM and Technology.
- Limited serviceability. Hot Plugging not supported

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Comparing Persistent Memory Architectures

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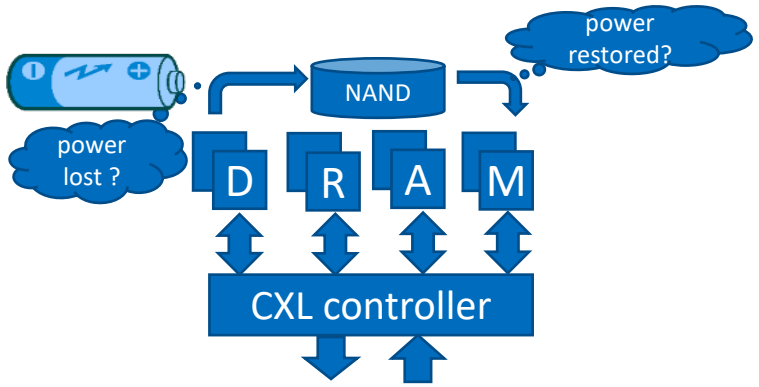
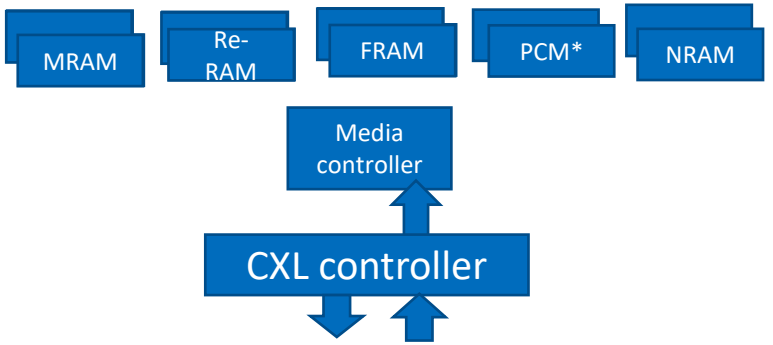
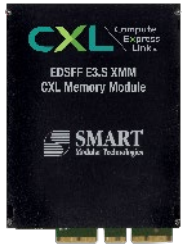
	Persistent Memory with DRAM with backup power (like NVDIMM-N)	Persistent Memory with Non-volatile proprietary media (like Intel Optane™ PMem DIMM)
Architecture		 * PCM: Phase Change Memory
Examples	NVDIMM-N   NV-XMM	Intel Optane™ PMem DIMM   Kestral Add-in-card
Features	○ Byte addressable ○ Data retention ○ Low latency (RTT < 50ns) ○ High endurance ○ Limited capacity	• Byte addressable • Data retention • High capacity • Moderate latency • Limited endurance

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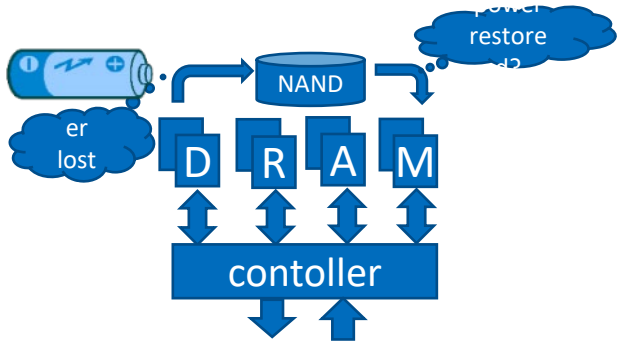
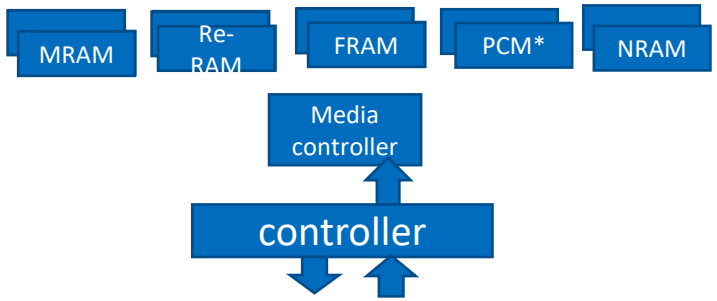
Takeaways

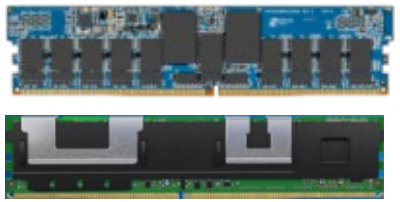
- Persistent Memory preserves critical data in flight
  - Reduces recovery time
  - Limits blast radius

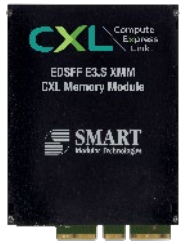
- Selecting right Persistent Memory architecture determine benefits like Latency, Capacity and Endurance





- CXL™ is enabling Persistent Memory in new form-factors





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Q/A

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