



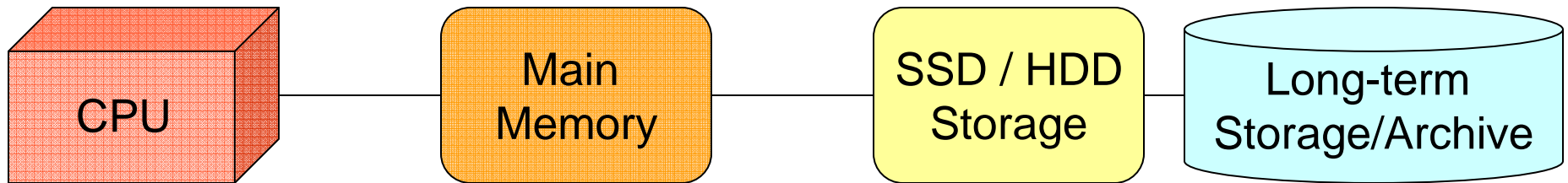
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Disruptive Hybrid Storage: Fusing DRAM and NAND

The State of Things...

Current major focus for future of the industry =>
Universal or “Storage Class Memory”

Current Computing Architecture Paradigm



Coming to a Future Near You...



The State of Things...

Universal or “Storage Class Memory”

...could replace DRAM OR Flash OR Both



Fast
Non-Volatile
Endurance
Cheap
Low Power
Scalable
Dense
Reliable

BUT,

Will it have the speed of DRAM?

Will it be non-volatile like NAND Flash?

The State of Things...

It's just not that easy..

Storage Class Memory (SCM) could replace DRAM and/or Flash some day, but likely not both at the same time.

SCM may have some of the desired characteristics, but likely not most of them right away.

The State of Things...



A key question remains –

When will a non-volatile, reliable memory technology be available in a *speed* and *capacity* that's interesting for main memory and storage applications?

Could be around the corner, could be in 10 years.

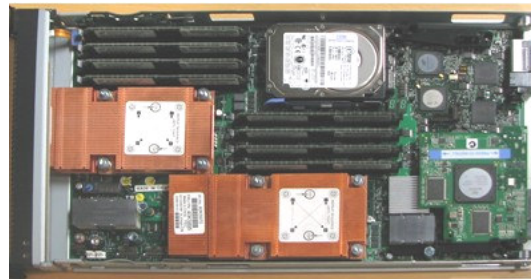
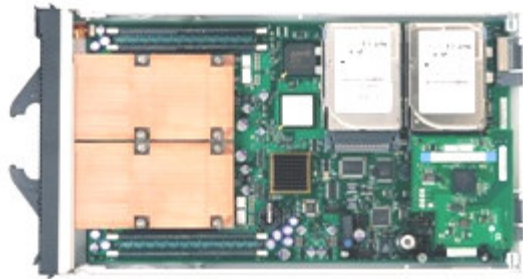
"If I knew I'd be rich." - Fujitsu CTO, Dr. Reger
when asked what was the target after Flash

The State of Things...

Another Question:

Is this type of performance needed now?

The DIMM socket count in mainstream servers have gone from **four** to **eight** to **eighteen** between 2000 and 2010.



Need more memory space to contain application data growth.

The State of Things...

Is this type of performance needed now?

Systems also have growing storage capacity requirements but is now expected to be FAST!
(usually leveraging NAND Flash through SSD's)

A main goal is to attempt to get the highest speed performance a majority of the time, while making very sure to preserve data integrity.

(Be careful not to progress too far without preserving data in non-volatile storage)

The State of Things...

Is this type of performance needed now?

The answer is a **RESOUNDING YES!**

Without these issues solved, system solutions are required to continue to scale in expensive ways.





The State of Things...

As we await better solutions anything
we can do NOW?

“Hybrid Memory” addresses these problems



Memory products with devices of ***one or more*** types of memory technologies that leverage some of the beneficial characteristics of them all.

Today - DDR3 memory module with DRAM and Flash

Hybrid Memory Modules

How is this different from many existing modules, PoP or other multi-tech devices?

- It operates as a system together vs. individual components
- Leverages beneficial device characteristics of both technologies to provide advantages to a shared system interface

Hybrid Memory Modules

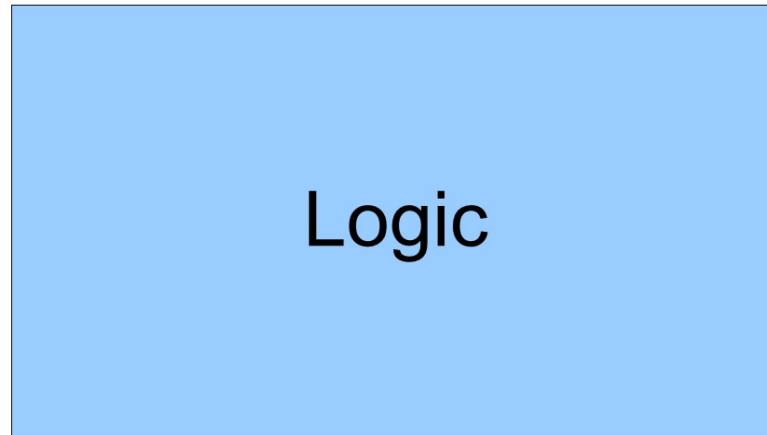
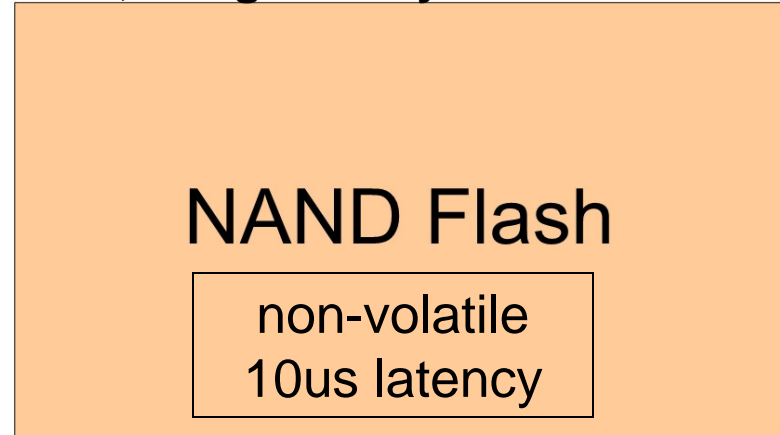
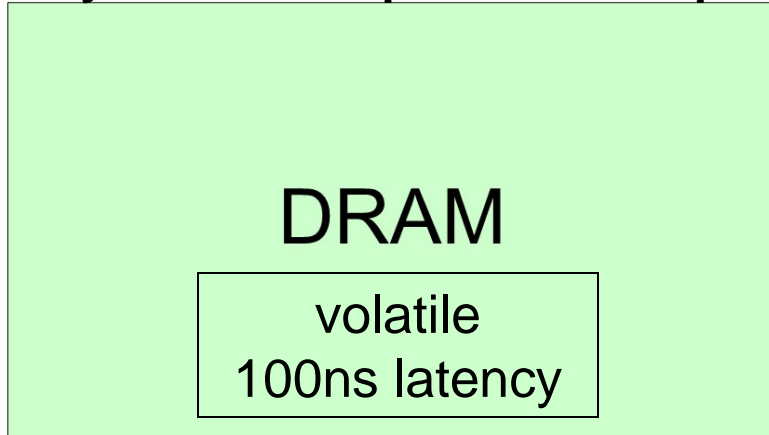
Hybrid Modules should be used by systems **today** to take advantage of both the speed of DRAM and non-volatility of Flash.

This new persistence of data can be leveraged into very big advantages for many applications.

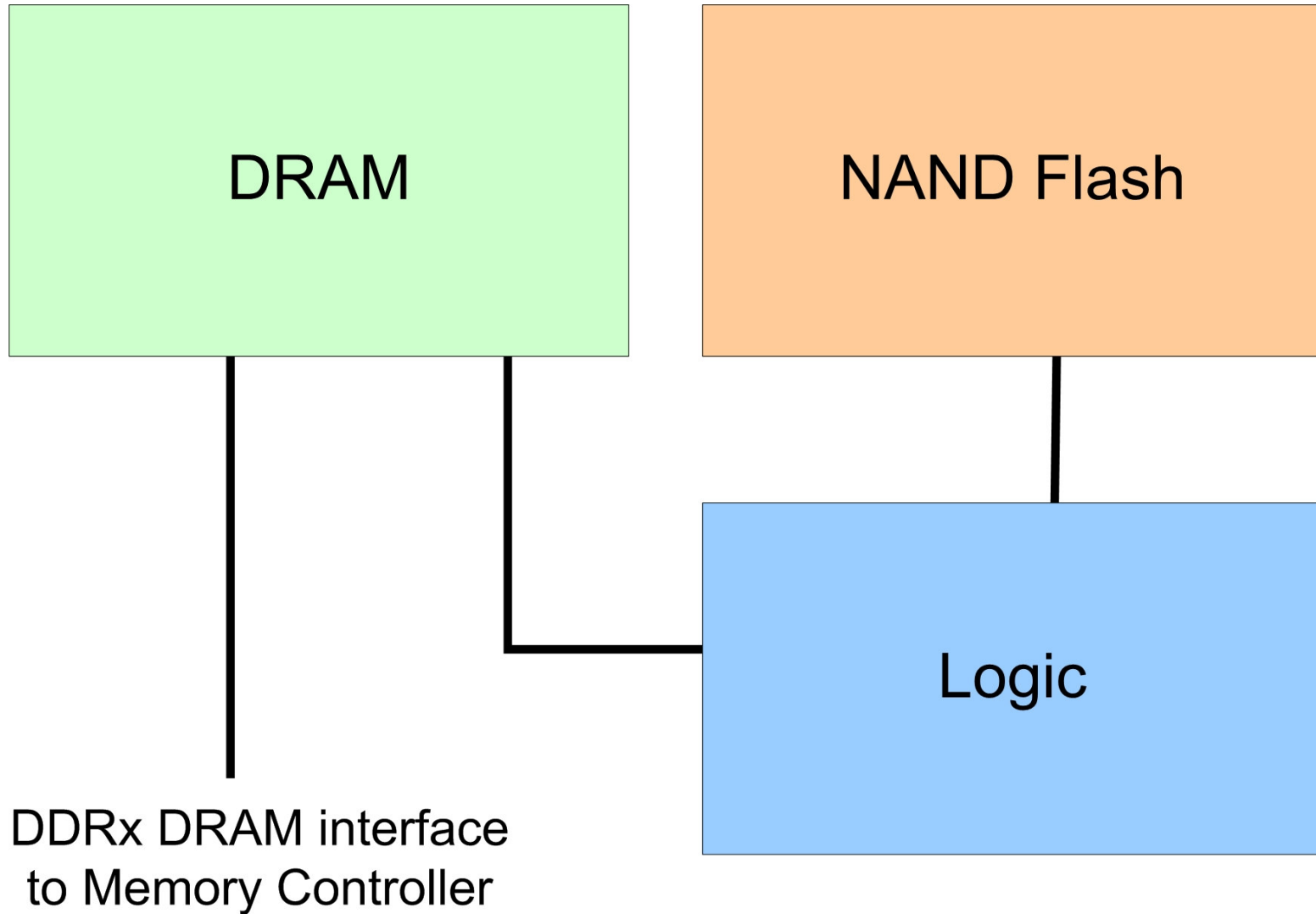
No need to commit cached application data to I/O storage, metadata is safe, and programs can stay in memory.

Hybrid Memory – Key Components (example)

Many different implementation possibilities, but generally consists of:



Hybrid Memory – One solution



Hybrid Memory

Applications:

- Provides alternative to battery-backed DIMM's as well as large UPS holding up processors, storage, etc.
- Provides significant value to:
 - Storage
 - Server systems / Appliance Servers
 - SBB (Storage Bridge Bay) Storage Servers
- Enables interesting future applications work to be done



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