More speed. Less energy.
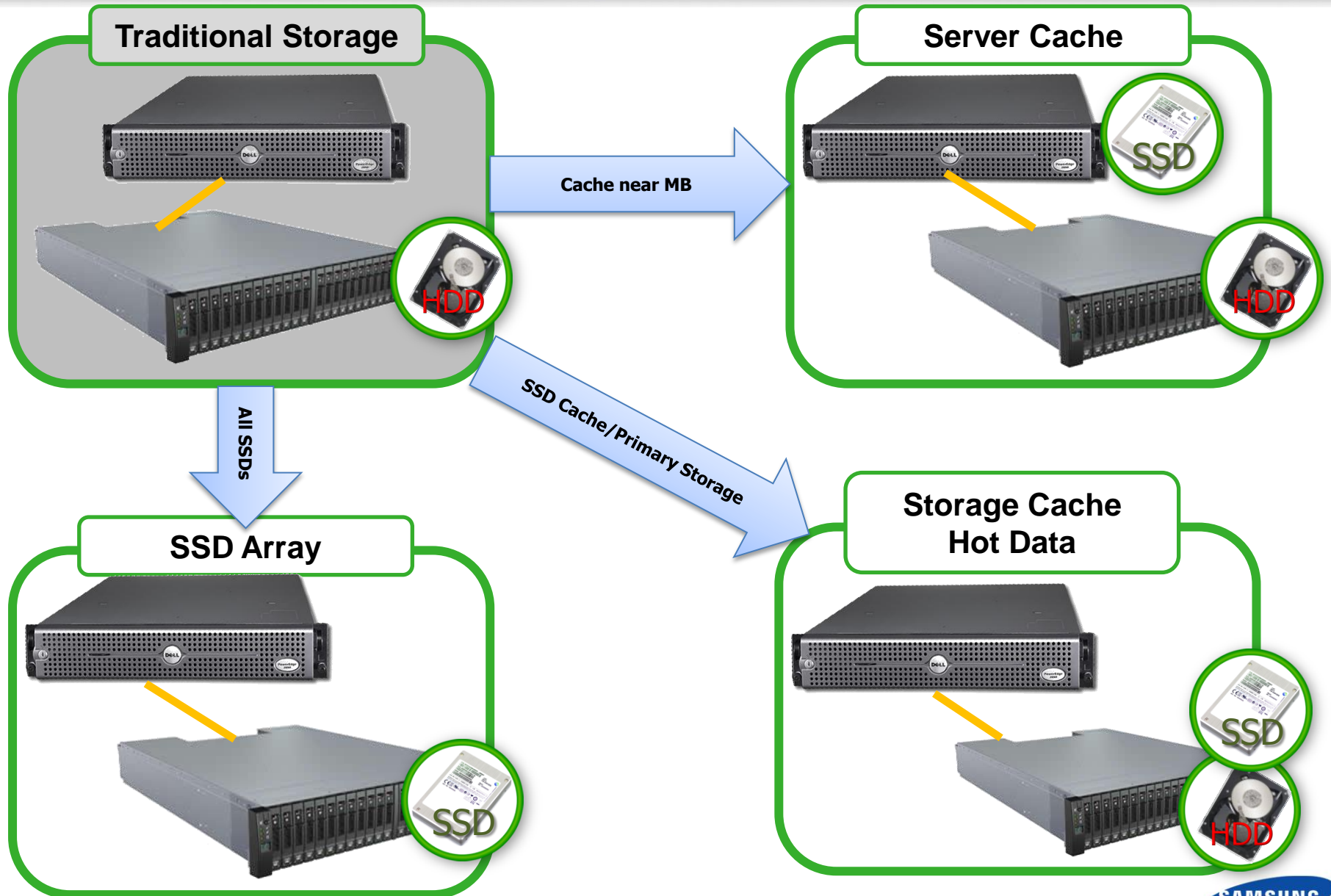
Hybrid Storage Systems
HDD + SSD

Ryan Smith
Sr. Manager – SSD Product Marketing, Samsung Semiconductor, Inc.

August 22, 2012

SAMSUNG
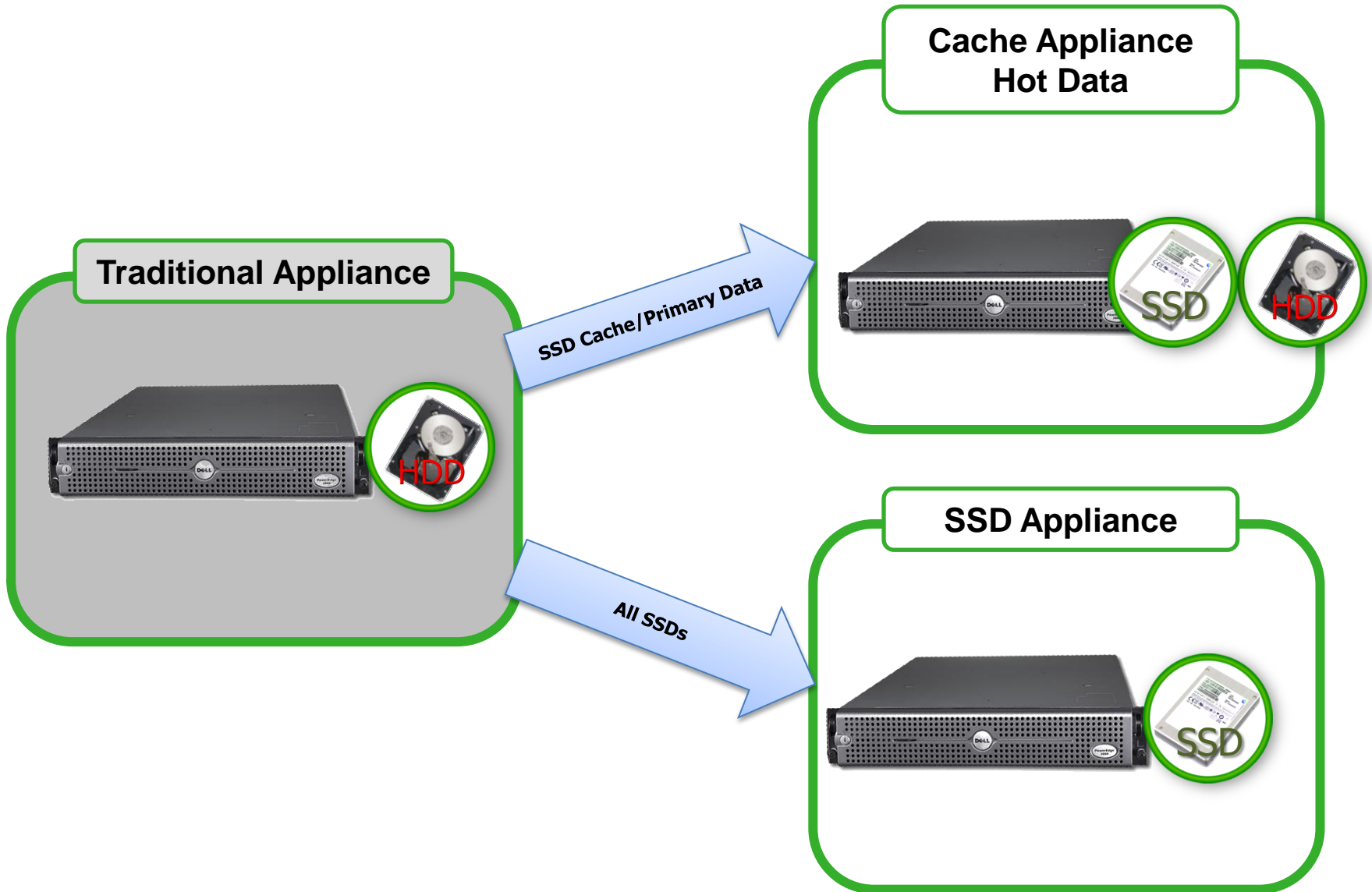
Adding Flash: External Storage

Traditional Storage

HDD

→ Cache near MB →

Server Cache

SSD

HDD

↓ All SSDs ↓

SSD Array

SSD

↘ SSD Cache/Primary Storage ↘

Storage Cache
Hot Data

SSD

HDD

Traditional Appliance

HDD

SSD Cache / Primary Data

Cache Appliance Hot Data

SSD   HDD

All SSDs

SSD Appliance

SSD

SAMSUNG

- **Examine the trade-offs of each choice**

Solution	Cost	SW Complexity	Performance
All HDD	$	Low	Average
MB SSD Cache + SSD	$$	Medium	Fast
HDD + SSD Cache	$$	High	Fast
SSD + Comp/Dedup	$$$	Highest	Fast
All SSD	$$$$	Low-High	Fastest

- **Do you want to use SSDs as primary storage or cache?**

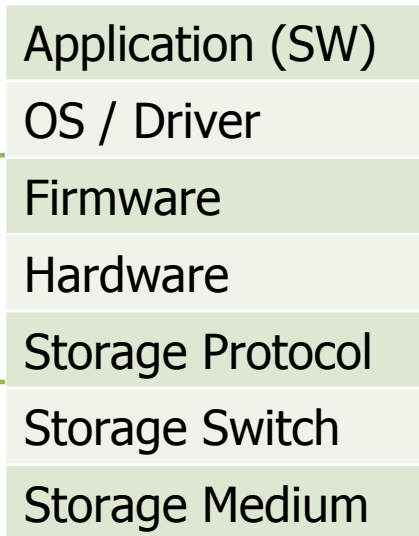| Primary Storage	Cache
What percent SSD? (could impact complexity)	Read-only? Write-through?

- **Match your expertise-level with your selection**

Know your bottlenecks

- **Existing architectures designed around existing bottlenecks!**
  - **Typically the HDD**
- **Replacing with faster SSDs will expose other bottlenecks**
- **Know all aspects of your I/O path**

Example

| Application (SW) |
| OS / Driver |
| Firmware |
| Hardware |
| Storage Protocol |
| Storage Switch |
| Storage Medium |

Know IO limits of each!

SAS Controller	Max IOPS	HDDs (400 IOPS)	SSDs (50K IOPS)
PCIe 2.0 SAS 6Gb x 8	290,000	>700 HDDs	<6 SSDs
PCIe 3.0 SAS 6Gb x 8	600,000	>1500 HDDs	<12 SSDs

SSDs are not created equal

- **So many choices!**

NAND Flash
TLC
MLC
E-MLC
SLC

Host Interface	HA Support
Fibre Channel	Yes
SAS	Yes
SATA	No
PCIe	No

- **Influencers:**
  - **Your architecture**
  - **Performance Requirements**
  - **High Availability Requirements**
  - **Driver Support**
  - **Amount of writes/day, desired warranty period**

- **Test your workload!**
  - **Performance: Throughput, IOPS, Latency (Max/Avg)**
  - **Life: TBW, WAF calculations**
  - **Failure: Power-loss behavior**

- **Vendor support**
  - **Continuity of supply**
  - **Issue resolution**
  - **Quality of supply**
  - **Return rates**