

Why DRAM Really Matters Inside SSDs

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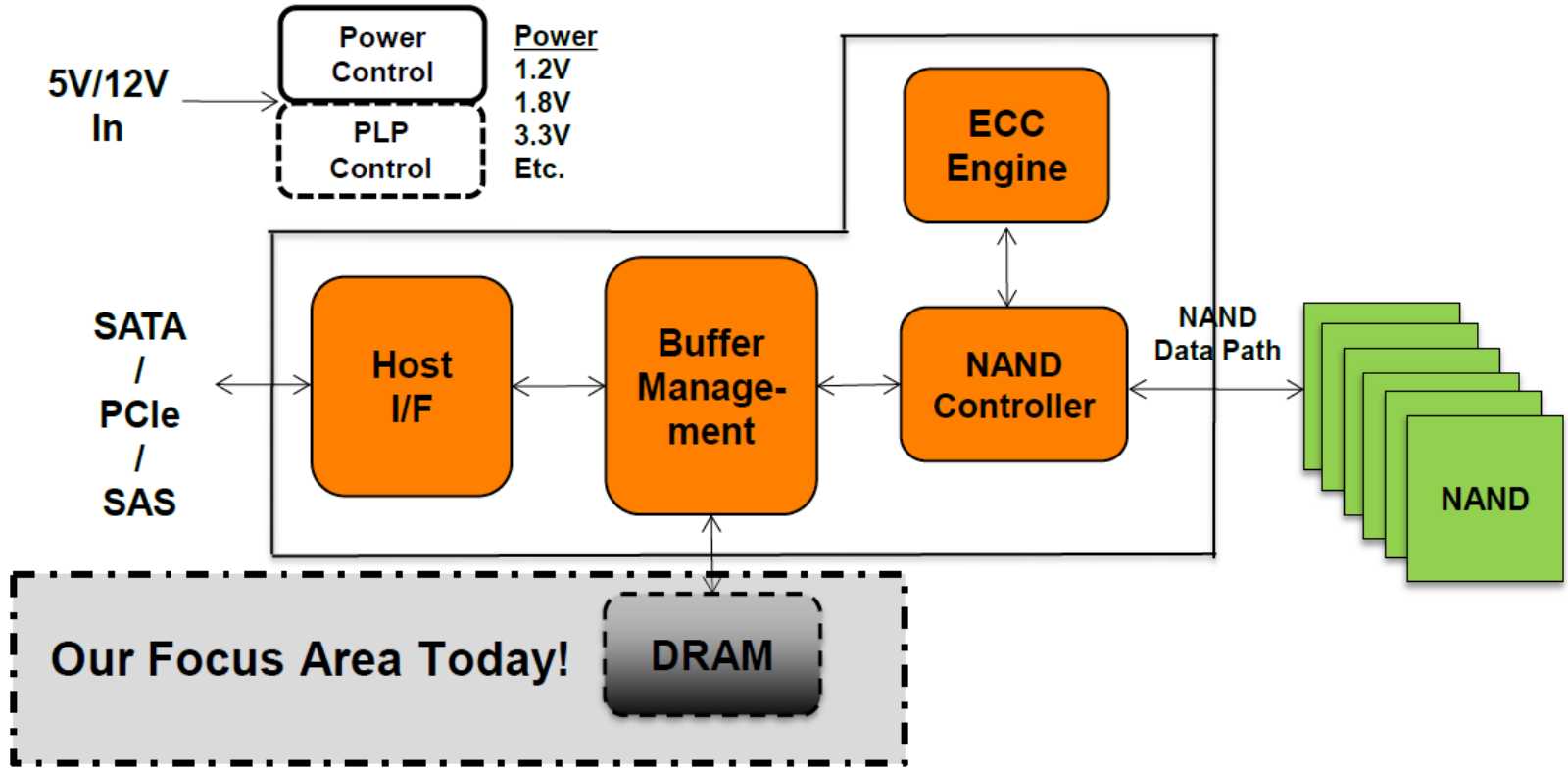
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Why DRAM Really Matters Inside SSDs

Session Objectives

- DRAM's Place Inside an SSD
- SSDs Features and DRAM Requirements
- Main DRAM Functions within SSDs
- Choose the Right DRAM for SSD Capacity
 - Case Study : DRAMs for 2017 Large Capacity Enterprise SSD
- Choose the Right DRAM for SSD Performance & Power
- Other Key DRAM attributes:
 - Organization
 - Form Factor
 - Reliability
 - Cost
- DRAM Longevity
- Conclusions & Call to Action

Typical SSD – Functional Block Diagram



SSDs Features and DRAM Requirements

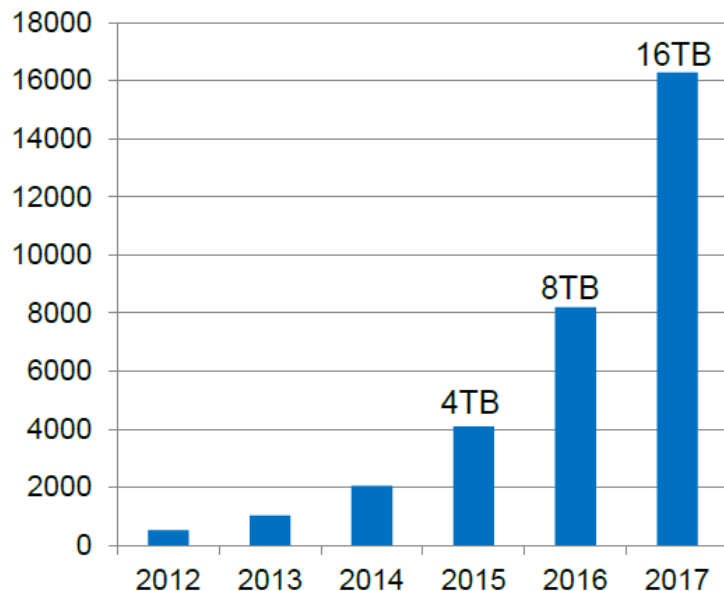
- Capacity: Max Capacity
- Performance (IO): IOPS/MBPS/Latency/QoS
- Performance (Others): POR/SPOR/Resume
- Power: Active/Idle/Low Power Modes
- Others
 - Longevity
 - Cost
 - Reliability

Features	Client SSD	Enterprise SSD
Capacity	Low	High
OP (Over provisioning)	0%	>= 7%
DRAM Cache	Yes (Optional on Low-End SSDs)	Yes
Performance (IO)	Lesser consistency across workload, Latency less critical	Higher Sustained steady state Perf. Lower latency
Performance (others)	POR timing, Resume timing	POR/SPOR timing
Data Retention (Power-off)	1 year, 30°C	3 months, 40°C
Power	Low Low power modes support	High
PLP (Power Loss Protection)	No	Yes (Hot plug use case)
End-to-End Data protection	No	Yes
DWPD (Endurance)	30 GB/day (client workload)	0.4 to 3 (Enterprise workload)
UBER (Uncorrectable BER)	10 ⁻¹⁵	10 ⁻¹⁷
MTBF	1.2 Mhr	2 Mhr

Choosing the Right DRAM: Capacity

- In a typical SSD, DRAM are used for:
 - FTL (Flash Translation Layer) Map Table
 - Logs
 - Data Buffering
 - Journaling
- General Rule of Thumb:
SSD Capacity : DRAM Capacity = **1000 : 1**
- Example: 1920 GB SSD requires ~2GB DRAM
- If Dynamic FTL implemented for Low End SSD
→ DRAM size can be drastically reduced

SSD Max Capacity (Physical) in GB



Case Study : Upcoming 16 TB Enterprise SSD

- By 2017, Largest Enterprise SSDs = 16 Terabytes Capacity (Estimate)
- Using Rule of [SSD : DRAM Capacity] = [1000 : 1], this SSD requires 16GB total DRAM
- Given max. DDR4 density is 1GB today, this would require 16 FBGA devices
- NOT FEASIBLE for thermal reasons & physical space to fit 16 DRAMs in 2.5" SSD



Solution: Collaborate with DRAM Suppliers on matching your SSD Roadmaps to our Higher Density, Smaller Package Memories

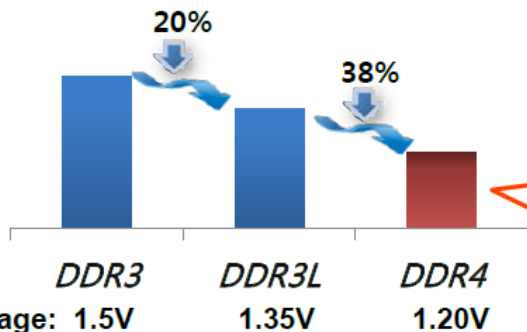
Choosing the Right DRAM : Performance

- **DRAM Provides SSDs Improved bandwidths**
 - DRAM Rule of thumb: *Target 2X Interface Bandwidth*
- **Performance Improvement Realized from DDR4**
 - Higher IOPS & Lowering latencies
 - Improved QoS (Quality of Service)
 - DDR4 can operate with 16 banks for higher concurrency
- **DDR4 supports highest datarates: 2133, 2400, 2667**
 - By 2016, DDR4 @ >2667 speeds are expected in MP
 - DDR3 max. speed = 2133

Choosing the Right DRAM : Power

- Higher performance & 38% reduction in component power by choosing DDR4 over DDR3/L
 - DDR4 has Low power & Temperature-Controlled auto refresh modes not available in DDR3/L

DDR4 Energy Efficiency (Component level)



※ Conditions

1) 3sigma IDD used

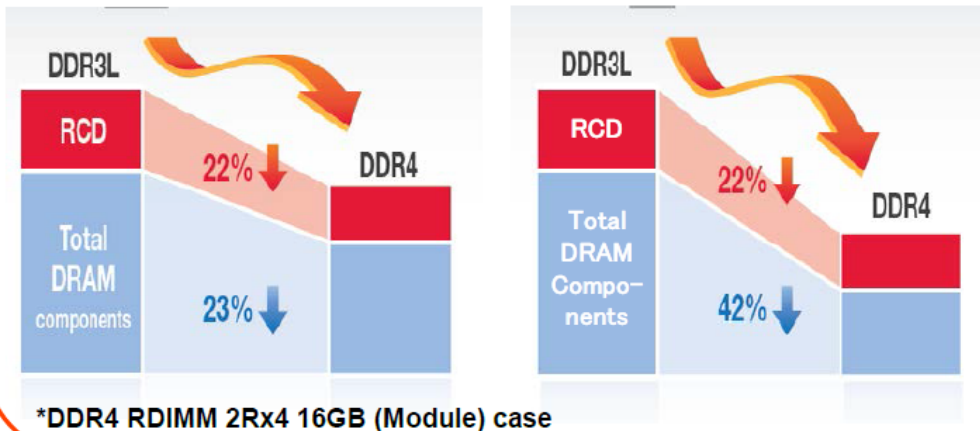
2) Calculation method :

$IDD4R*60\%+IDD4W*30\%+IDD2P*10\%$

Power Savings from DDR4

22.5% reduction at 1DPC

38% reduction at 2DPC



Choosing Right DRAM : DDR4 Advantages

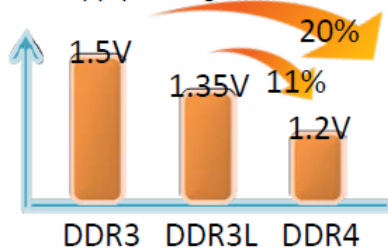
Reliability

Error Detection at CMD & Data Bus

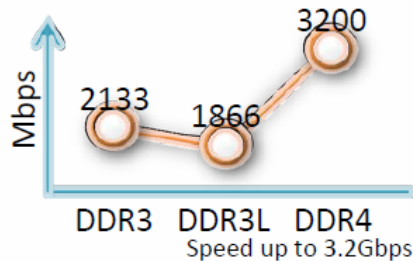


Lower Power

Supply Voltage Reduction



Speed



- Besides DRAM, as NAND density includes , power consumption increases

Choosing the Right DRAM – Org. & Size

Organization

- X4: Simpler routing → less #pcb layers
- X8, x16: Consumer/IT grade easier to procure versus X4

Physical size

- For 1.8”, M.2 and smaller form factors, FBGA packaged DRAM saves pcb space
 - PoP packages are smaller but harder to manufacture & not as reliable as discrete BGA

Form
Factor
Trend



7000mm²

7mmt



1500mm²

4mmt



1760mm²

2.5mmt



320mm²

2mmt

+

Solid State Cards



Half Height & Low Profile PCIe

Choosing the Right DRAM : Density & Cost

Golden rule: As SSD capacity increases so must the DRAM density

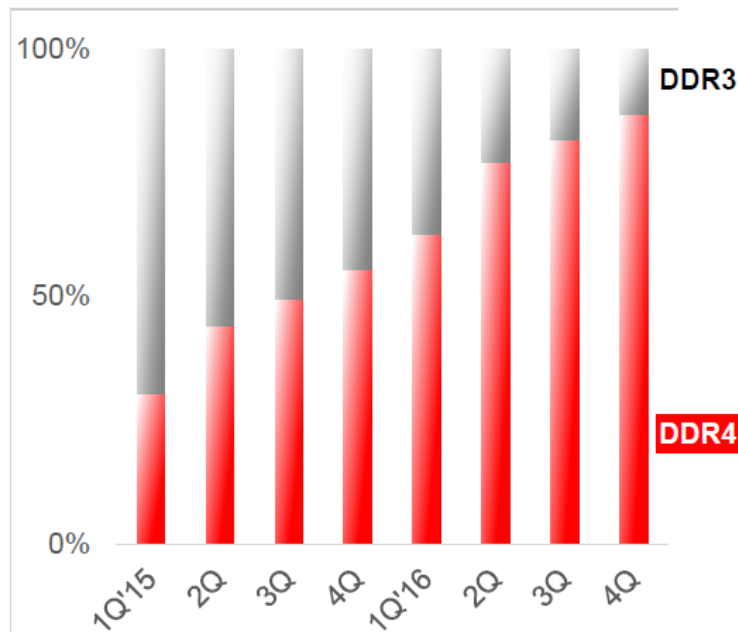
Density:

- SK hynix supports mainstream DDR3 and DDR4 densities to enable entire SSD product line
- Increased flexibility to utilize different SSD SoC controllers

Cost:

- DDR4 retains small price premium over DDR3
- DDR3 vs. DDR4 crossover expected sometime in CY2016 (Depends on market)
- 8Gb vs. 4Gb DDR4 crossover also expected in CY2016 (Depends on market)

DDR3/DDR4 market outlook



Choosing the Right DRAM : Longevity

2015-16 DDR3 & DDR4 DRAM Roadmap

Product & Density		2H 2015	2016
DDR4	8Gb	x4/x8	x4/x8/x16
	4Gb	x4/x8/16	
DDR3	4Gb	x4/x8/16	

- Need new technologies? LPDDR4? 16Gb DDR4? → talk to your DRAM supplier

Why DRAM Really Matters Inside SSDs

- Conclusions & Call to Action:
 - For client SSDs, where low idle & sleep power, lowest cost, low capacity are important, DDR3/DDR3L provides the best solution
 - For enterprise SSDs, where high sustained performance and large capacity are important, DDR4 is recommended
- Advancements in Capacity & Performance for Enterprise SSD will drive solutions beyond 8Gb DDR4 – Talk with your DRAM suppliers directly

Thank You

Questions on this presentation?

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