



## 3D Flash Leads to More Powerful Embedded Applications

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#### **Outline**



- Embedded SSD Unique in Every Way
- The Benefits as migrating to 3D Technology
- The Challenges on 3D NAND





#### Embedded SSD - Unique in Every Way

Validation

Flash Memory Summit

#### ·Read Intensive · Compatibility · Vaulting ·pFail •4K Random ·Pattern scheme ·Mix WL Environment ·SATA Link Loss ·Read Only Mode ·Logging Encryption TRANSPORTATION FACTORY KIOSK/GAMING/ **AUTOMOTIVE** VIDEO AUTOMATION DIGITAL SIGNAGE

SURVEILLANCE

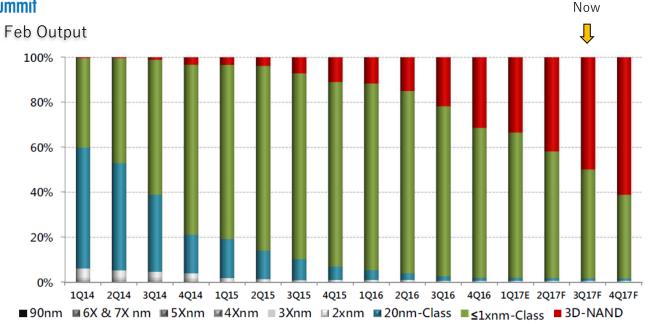
**Usage Behavior** 

**Features** 



#### NAND Technology Trend





- 2D NAND: No more migration after 1Znm process
- 3D NAND: >50% after Q4 17'





### 3D Advantage Over 2D NAND

	2D MLC	3D TLC
Cost per bit	High \$\$	Low \$
Die Density	64Gb and Up	128Gb and Up 🗸
Max Data Rate	333- 400MT/s	400- 533MT/s ✓
Power	=	Up to 22% Power Efficiency 🗸
Endurance	=	= (with LDPC)
Package	=	Footprint match with 2D MLC





#### 3D Implement Challenges

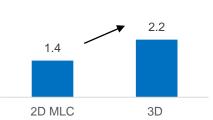
- Challenge 1: **Throughput** impact on small capacity
- Challenge 2: Latency impact due to page # increase





### Potential Impact 1: Throughput

- Problem: 1. Mono density double leads to less chip enable
  - 2. 3D flash program time increases



tprog (ms)

Solution: Full program sequence (FPS) technology
 MB/s per CE speed improvement: 25MB/s → 45MB/s

	2D MLC	3D TLC (w/o FPS)	3D TLC (with FPS)
Performance (32GB)	520/100	550/50	550/90
	(64Gb x 4 → 4CE)	(128Gb x 2 → 2CE)	(128Gb x 2 → 2CE)





#### Potential Impact 2: Latency

- Problem: due to page # per block increase (256 → 768), it prolongs garbage collection time to free up one spare block which result to worse latency performance.
- Solution: Proprietary firmware GC optimization

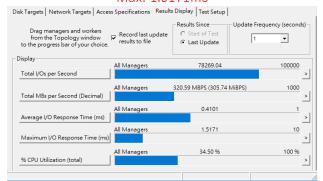
#### 2D MLC 480GB

Avg: 0.4197ms Max: 3.2459ms

Drag managers and workers from the Topology window to the progress bar of your choice.	Record last update results to file	Results Since C Start of Test C Last Update	pdate Frequency (second
Display	All Managers	76250.81	100000
Total I/Os per Second			
Total MBs per Second (Decimal)	All Managers	312.32 MBPS (297.85 Mil	BPS) 1000
	All Managers	0.4197	1
Average I/O Response Time (ms)			
	All Managers	3.2459	10
Maximum I/O Response Time (ms)			
	All Managers	34.79 %	100 %
% CPU Utilization (total)			

#### 3D TLC 480GB

Avg: 0.4101ms Max: 1.5171ms





### Take-Aways



- 3D NAND anticipates continued MLC/TLC bit cost reduction while driving density growth over next years.
- The traditional rule of thumb still intact- Keeping flexibility, responsive, adaptive.
- 3D NAND brings benefits of density, power, endurance.
- Controller vender plays key role for conquering key challenges (throughput and latency) on 3D transition in embedded market.

# For more information on Phison SSD Controllers, please visit us at

Booth #614



- Automotive
- Digital Signage
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# Thank You!