

# Enabling MLC in Industrial and Embedded Storage

Tools & features to making the right choice

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Need for ...

- Endurance
- Power-Fail robustness
- Data Retention
- Health monitoring

... and for cost-reduction

# Industrial/Embedded Requirements

- Endurance
- Power-Fail robustness
- Data Retention
- Health monitoring

SLC	MLC
	
	
	
	

- Reduce WAF
- Paired Page
- Refresh Data



favorable



unfavorable

# Endurance

- Need significant reduction of WAF: Unlike in SSD mapping cannot be stored in DRAM and controllers need to be robust and low-cost
- **hyMap approach**
  - Sub-page-based-mapping FTL
  - Mapping entirely stored in NAND
  - Transaction oriented with minimal overhead
  - Built-in redundancy to protect against sudden power-fail

# Lifetime Estimation

- 2 chips 2x nm SLC, 60K P/E, 16K page, 4MB Block, 16GB device
- 9% Over Provisioning
- 1 drive write per day

## hyMap<sup>®</sup>

Cluster	WAF	TBW	Life [years]
512b	39	24.9	4.3
4K	8	127.5	21.8
4M	1	960	164.4

## Block Based Mapping

Cluster	WAF	TBW	Life [years]
512b	8192	0.1	0.02
4K	1024	0.9	0.2
4M	1	960	164.4

# Lifetime Estimation

- 2 chips 1y nm **MLC**, 3K P/E, 16K page, 4MB Block, 16 GB device
- 9% Over Provisioning
- MLC reliable mode**
- 1 drive write per day

## hyMap<sup>®</sup>

Cluster	WAF	TBW	Life [years]
512b	41	1.2	0.2
4K	10	5	0.9
4M	3	16	2.7

## Block Based Mapping

Cluster	WAF	TBW	Life [years]
512b	8192	0.005	0.001
4K	1024	0.05	0.01
4M	1	48	8.2

# Lifetime Estimation

- Same configurations
- Comparing hyMap with MLC and BBM with SLC

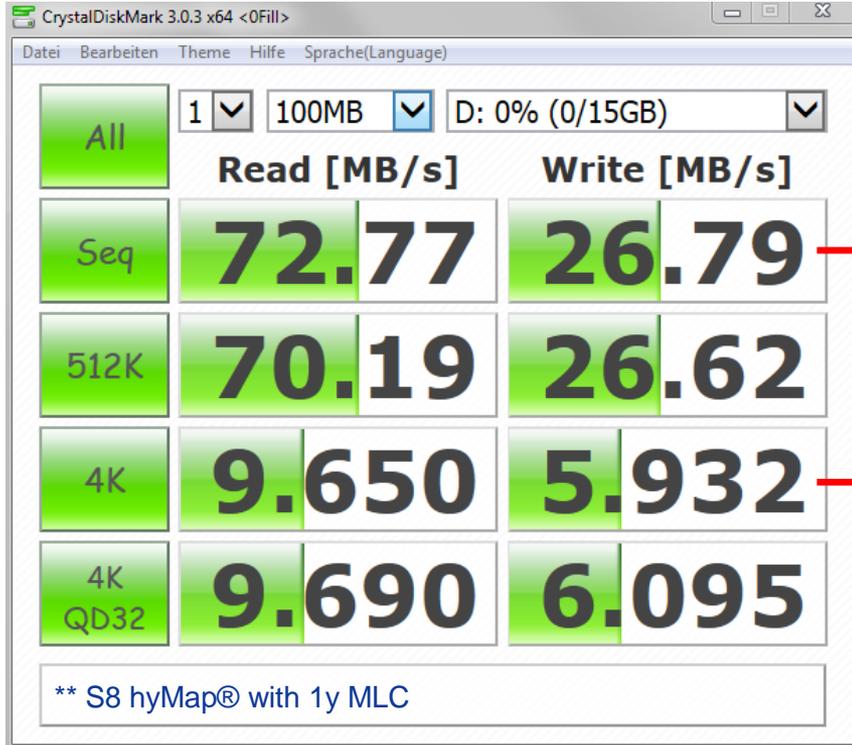
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# Endurance & Performance

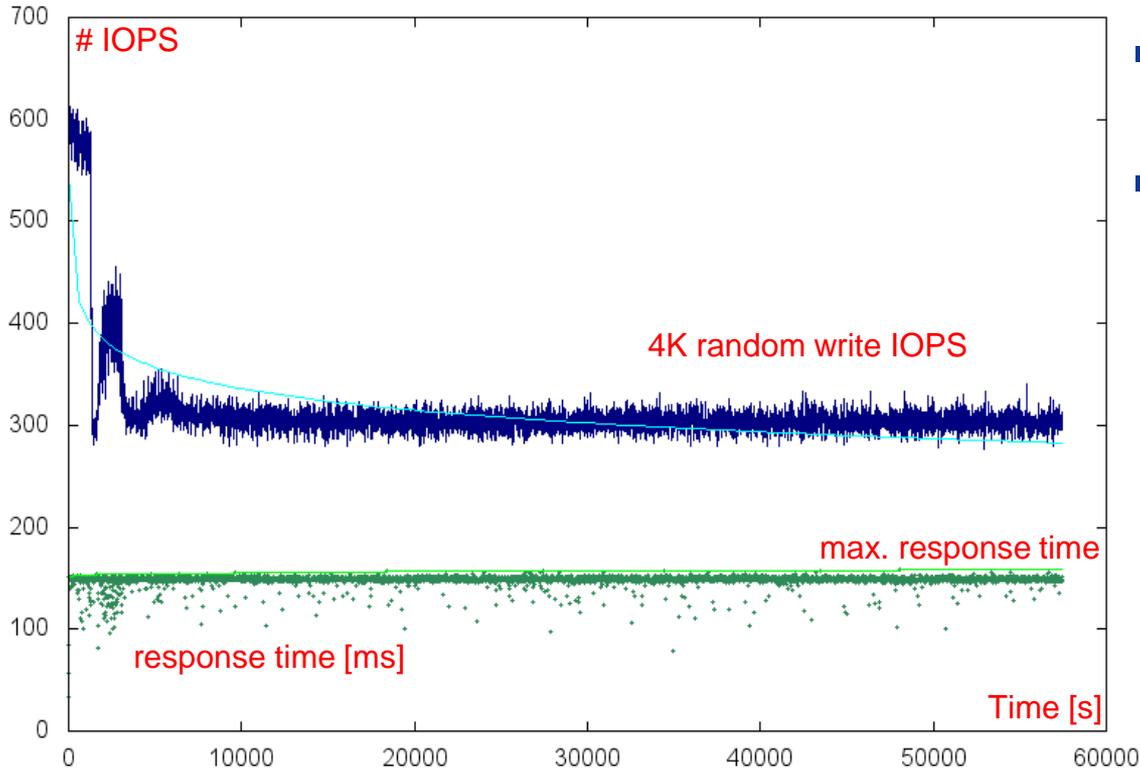


Sequential write WAF ~1

Random 4K WAF ~4.5

~1480 IOPS

# Endurance & Performance



- About 320 steady state 4K random write IOPS
- About 150 ms maximum response time

\*\* S8 hyMap® with 1y MLC

# Data Retention

- Embedded systems are not regularly powered, not all areas are frequently read, and temperature requirements need to be considered
- **hyMap approach ...**
  - Up to 96-Bit/1K ECC
  - Read Retry
  - Near Miss ECC
  - Dynamic Data Refresh

# Summary

- Endurance
- Power-Fail robustness
- Data Retention
- Health monitoring

SLC	MLC
	
	
	
	

 favorable

 unfavorable

# Summary

- Endurance
- Power-Fail robustness
- Data Retention
- Health monitoring

SLC	MLC

- hyMap
- MLC reliable mode
- Dynamic Data Refresh
- VCs & hySMART



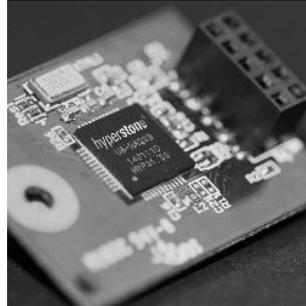
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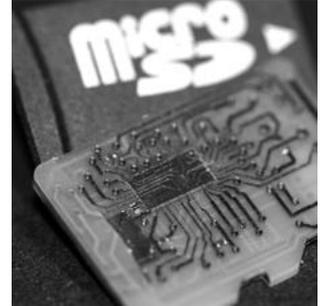
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# Hyperstone Products

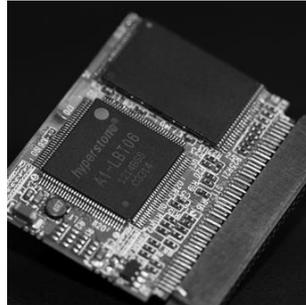
**USB**



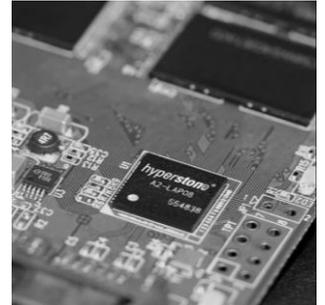
**SD/eMMC**



**CF/PATA**



**SATA**



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Thank you!

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*hyperstone*®