Lifetime Estimation and Health Monitoring

Support for System Qualification Testing

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Introduction

- Impact of FTL and payload on endurance
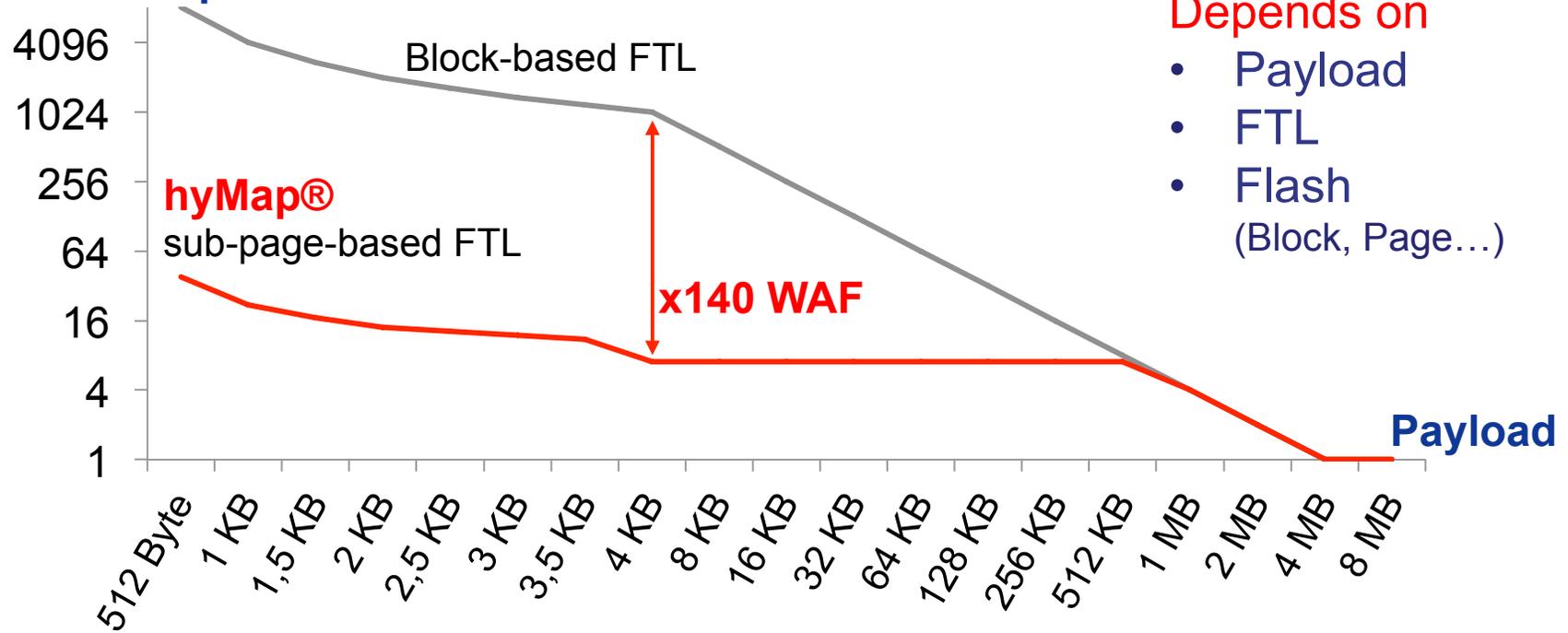- Life-time estimation
- Data retention
- Health monitoring

Some Endurance basics…

- WAF *(workload, FTL, Flash)* = *Bytes written to NAND/Bytes written from Host*

- **TBW** = *Capacity* [*GB*]/1000 ∗ *PE cycles/WAF* = *Capacity* [*GB*] ∗ *PE cycles/*1000 ∗ *WAF*

- Lifetime *[Years]* = *TBW* ∗ 1000/*Write Budget per Day* [GB] ∗ 365

- **DWPD** = *TBW* ∗ 1000/*Warranty* [*Years*] ∗ *Capacity* [*GB*] ∗ 365 = ***PE cycles/WAF****(workload, FTL, Flash)* ∗ *Warranty* [*Years*] ∗

  365

Write Amplification

Write Amplification Factor

Depends on
- Payload
- FTL
- Flash

(Block, Page…)

4096

1024

256

64

16

4

1

Block-based FTL

hyMap®
sub-page-based FTL

x140 WAF

Payload

512 Byte · 1 KB · 1,5 KB · 2 KB · 2,5 KB · 3 KB · 3,5 KB · 4 KB · 8 KB · 16 KB · 32 KB · 64 KB · 128 KB · 256 KB · 512 KB · 1 MB · 2 MB · 4 MB · 8 MB

Impact of Workloads

Write Amplification Factor

4096
1024
256
64
16
4
1

Block-based FTL

hyMap®
sub-page-based FTL

Enterprise Workload

Client Workload

Content & Read-Only

Payload

512 Byte | 1 KB | 1,5 KB | 2 KB | 2,5 KB | 3 KB | 3,5 KB | 4 KB | 8 KB | 16 KB | 32 KB | 64 KB | 128 KB | 256 KB | 512 KB | 1 MB | 2 MB | 4 MB | 8 MB

Impact of Workloads

Write Amplification Factor

Do you know your workload?
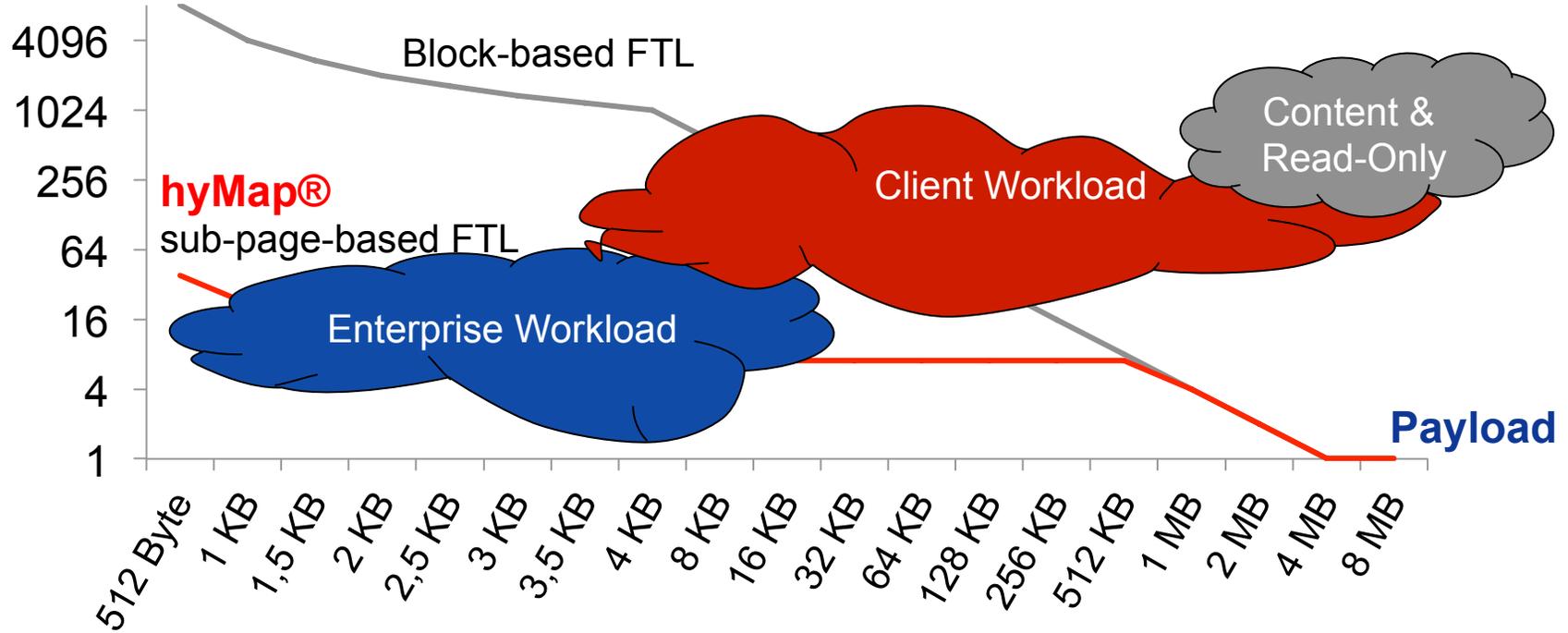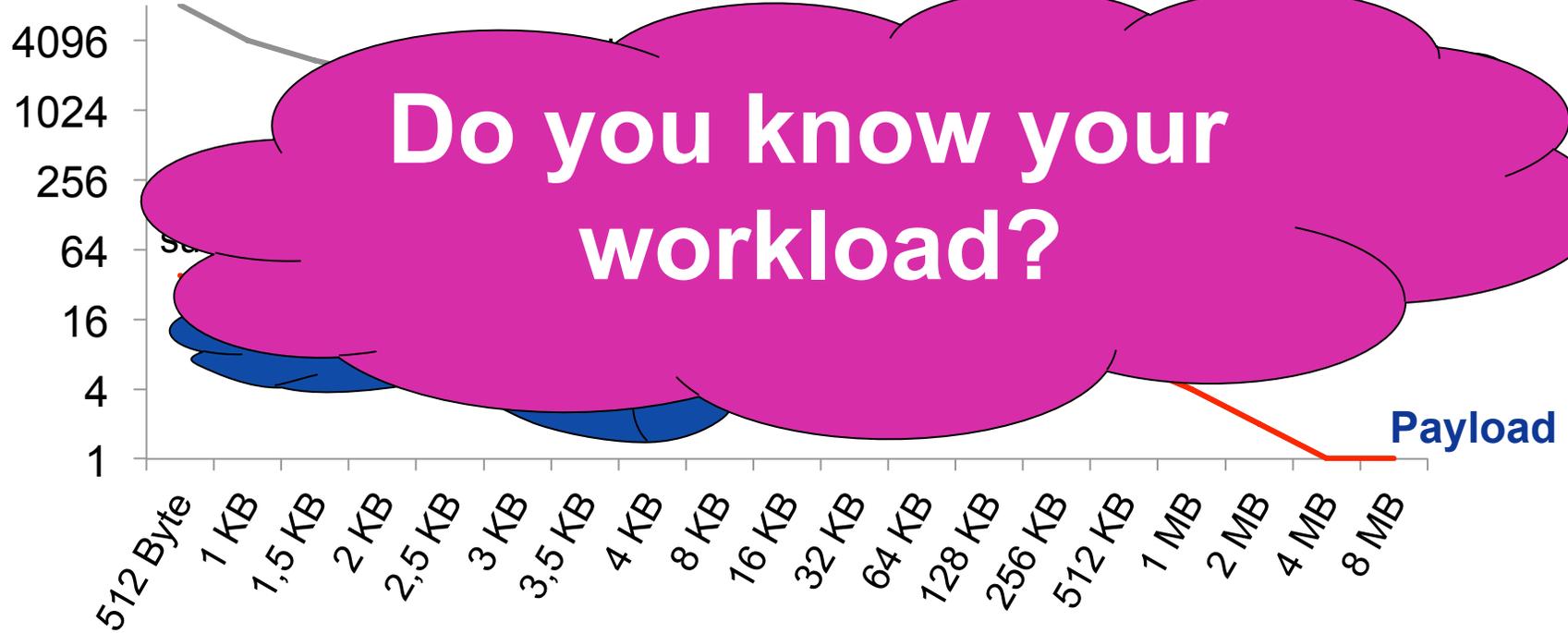
Lifetime Estimation

1y-nm MLC - 256Gbit, 16k page, 8192k blk, 3000 P/E ▼

Number of Chips

2 ▼   ← **Selected configuration**

Over Provisioning [%]

10

Selected FTL

Early Acknowledge on?

Yes ▼

hyMap® ▼

MLC Mode

Performance ▼

Write Budget [MB/day]

65536

Life-Time →

Share of Static Data [%]

30

Payload (k)	WAF (Avg.)	TBW	Estimated Life (Years)
0.5	36	5.4	0.2
1	20	9.7	0.4
1.5	14	13.4	0.6
2	12	16.4	0.7
2.5	10	19.0	0.8
3	9	21.3	0.9
3.5	8	23.2	1.0
4	5	40.8	1.7
8	5	40.8	1.7
16	5	40.8	1.7
32	5	40.8	1.7
64	5	40.8	1.7
128	5	40.8	1.7
256	5	40.8	1.7
512	5	40.8	1.7
1024	5	40.8	1.7
2048	3	68.6	2.9
4096	2	96.0	4.1
8192	1	192.0	8.2
JEDEC enterprise	6.4	38.0	1.6

Data Retention
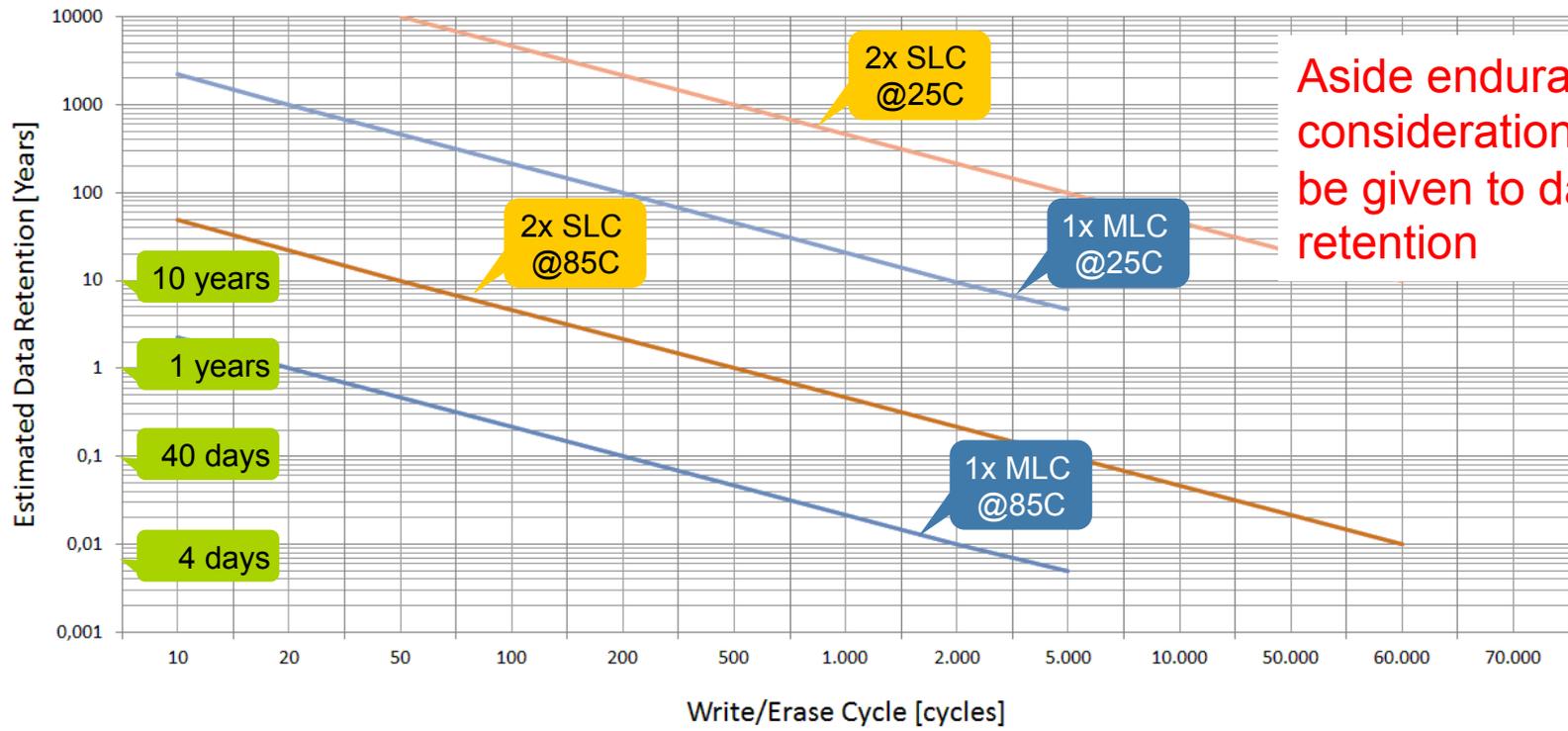
Aside endurance, consideration should be given to data retention

Health monitoring

Measuring actual status of your drives' health

- Erase counts
  - Minimum
  - Maximum
  - Average
  - Per stripe and logical channel
- Spare block count
- Read Disturb Management status
- Global Wear Leveling status

- Total correctable ECC errors
- Total number of LBAs read/written
- Power-on count
- Firmware status
- User defined thresholds to generate yellow & red warnings

Supports qualification and preventive maintenance

hyperstone ®

Health Monitoring

① Remaining spare blocks

② Block erase count

③ Corrected errors

Health Monitoring

① Remaining spare blocks

② Block erase count

③ Corrected errors

hyperstone

Health Monitoring

① Remaining spare blocks

② Block erase count

③ Corrected errors

Health Monitoring

1. Total LBAs read/written

2. Wear-level spread

3. Read disturb refresh

4. Read retry count

Enabling remote monitoring of field data health

Summary

- Use cases with random writes benefit from sub-page based FTL

- Web based Lifetime Estimation helps to reduce cost

- Health Monitoring to verify payload assumptions and schedule preventive maintenance and replacement

- Visit our booth to see a life demo of our tools

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Questions ?

INDUSTRIAL/EMBEDDED

Quality **Reliability** Data
Health FIT Retention
Monitoring Long-Term Cost Extended
Performance Supply SMART Temperature
Low alpha 8D Power Fail CF/PATA TCO
SSD Life-Cycle Support eUSB eMMC SD
MTBF

ENTERPRISE

Low Latency
Speed IOPS
NVMe SCM
RAID High Storage
Performance
Climate Capacity tiers
controlled PCIe Cost
SAS SATA

MOBILE & CONSUMER

Short life-cycle 3D
SD Capacity
SSD Cost TLC
Performance
eMMC
SATA USB

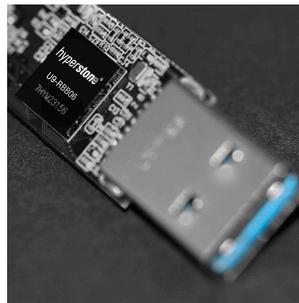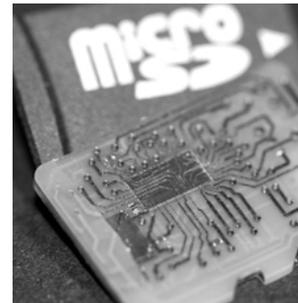# Lifetime Estimation and Health Monitoring

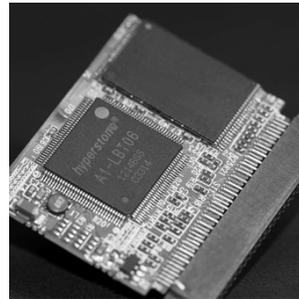## Thank You!

Axel Mehnert, VP Marketing

Hyperstone Products

USB

SD/eMMC

CF/PATA

SATA