Future Automotive's Requirements on Nonvolatile Memory Solutions

PRESENTER

Cho, Young eui youngeui.cho@sk.com

Co-Author : Nakchon Sung, nakchon.sung@sk.com

Corresponding Author : Myoung Kwan Cho,

VP of SSD/Solution QRA, myoungkwan.cho@sk.com

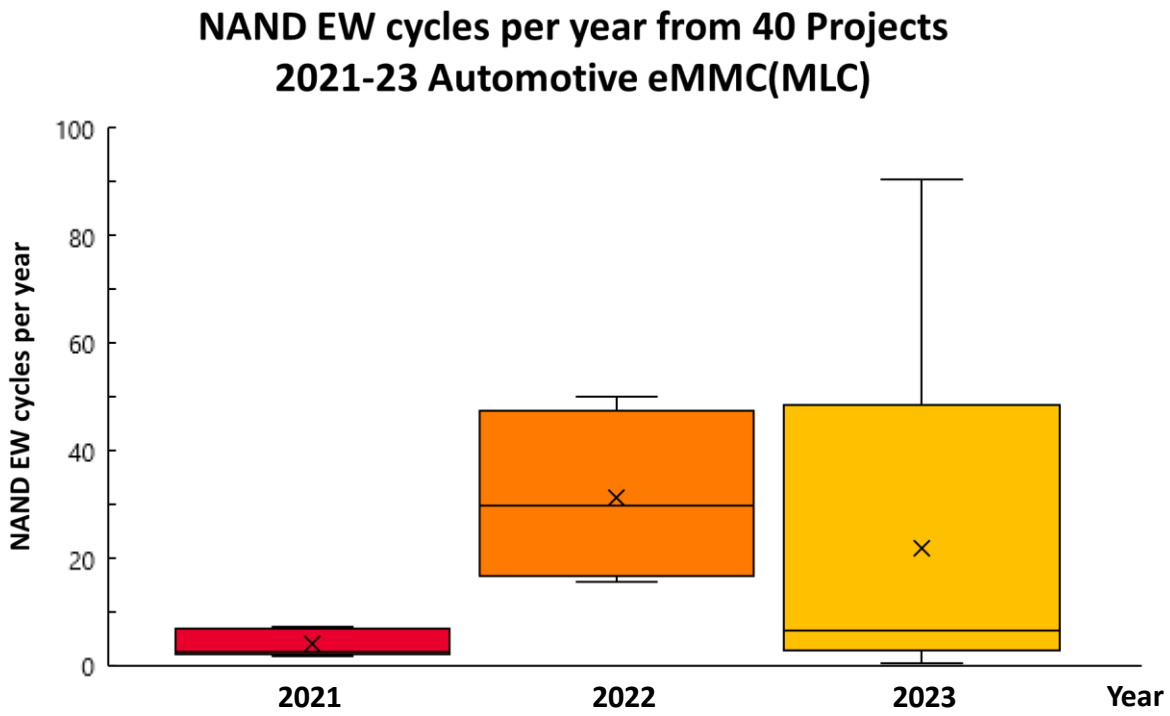
SK hynix

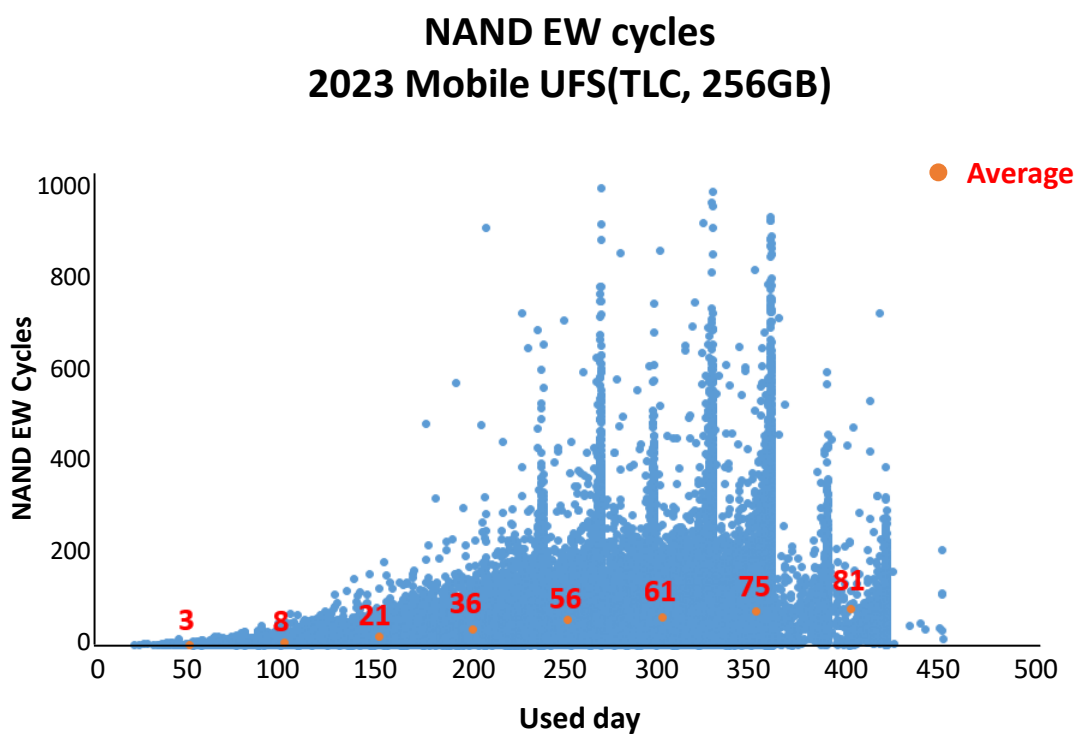
Agenda

- **Introduction**
- **Requirement Change**
  - TBW (Total Byte Written)
  - Temperature
  - Performance
- **Reliability defense algorithm breakthrough**
- **Prediction of Retention limit**
- **Conclusion**

Introduction

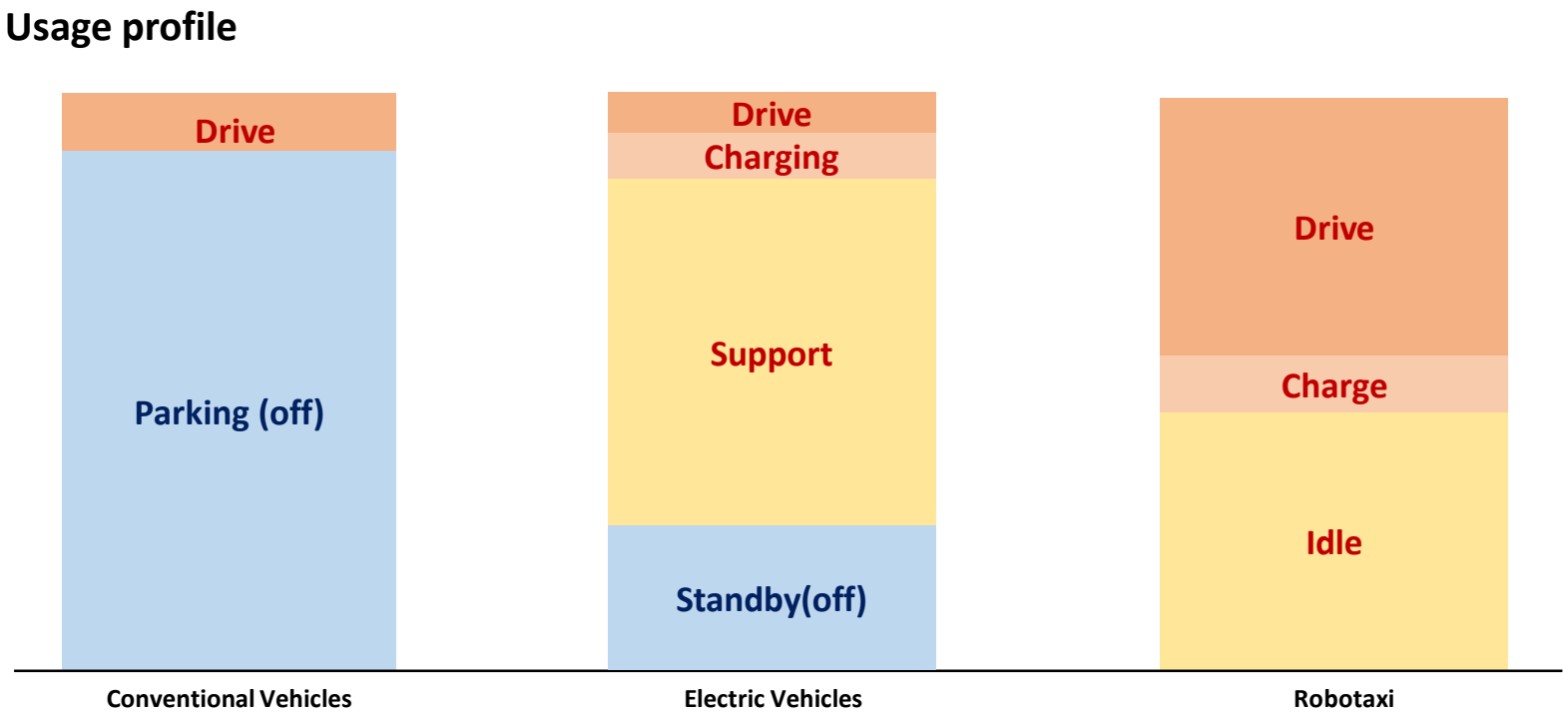
- **Until now, Automotive has focused on Reliability, Mobile targeted Speed and TBW**
- **Is this approach still valid in the future Automotive?**





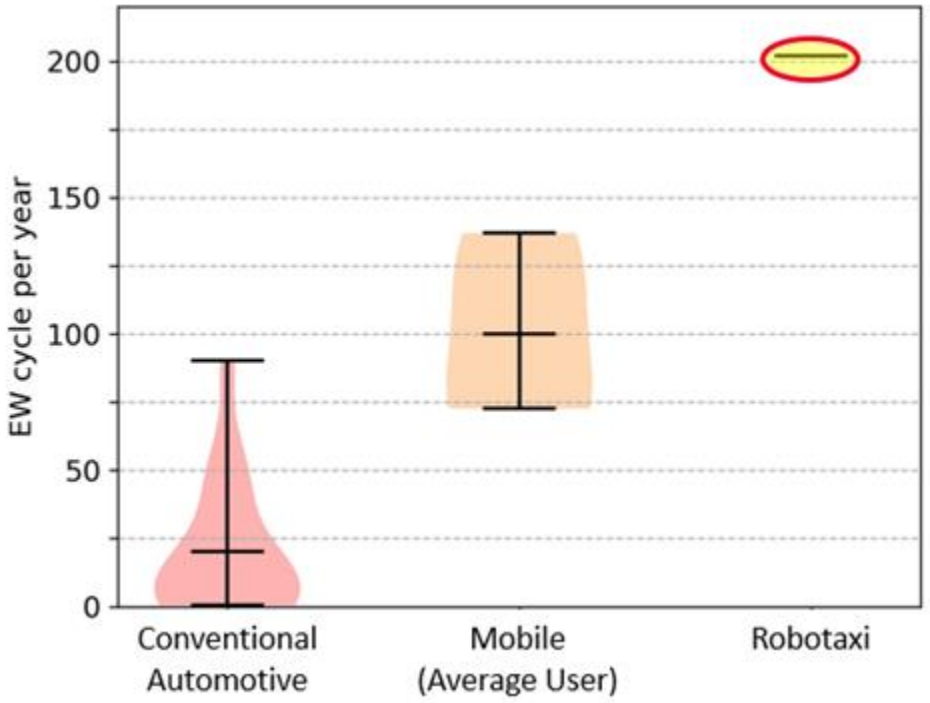
Introduction

- **EVs, Autonomous driving, and Robotaxis are driving a major paradigm shift.**
- **This transformation is more than just change of engine type,**
  The car is evolving into a data-driven, high performance computing platform.



Analysis of TBW Change

- **In future electric vehicles, NAND EW cycles will be**
  - **10x higher than conventional vehicles**
  - **2x higher than mobile devices**



Comparison of NAND EW cycles by applications

	Host Write (% of TBW)	WAF	TBW Usage Ratio	Lifetime	Source
Conventional Automotive (ADAS)	~10% (Lifetime)	2~5 (eMMC)	~50% (Lifetime)	15 years	OEM's usage profiles
Mobile (Worst)	Various (~10%)	2~4 (UFS/SSD)	~40% (Per year)	5 years	Field health data analysis
Mobile (Average)	1.2%		**3.5%** (Per year)		
Robotaxi	2.3%		**7%** (Per year)	12 years	OEM's usage profiles

Changes in Temperature/Performance

- **Performance requirement of EVs is getting faster, same as mobile devices.**
- **Temperature : Autonomous driving makes engines always on. This causes operating temperature elevated.**
- **High Speed and Robust Retention Characteristics are required.**

		Conventional Automotive	Future Electirc Automotive	Mobile Devices
Performance		Slow	**Fast**	
Average temperature		Approximately 70℃	**Approximately 80℃**	55℃ (JEDEC)
HTDR bake	**1 year equivalent**	125℃ 50hours	**125℃ 150hours**	125℃ 10hours

* Ea 1.1eV

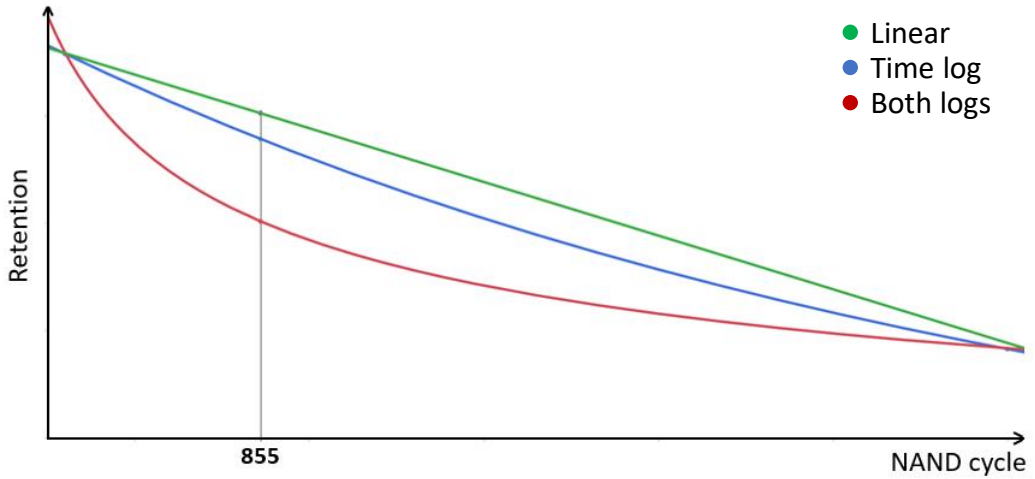
Reliability defense algorithm breakthrough

- **Limits of Silicon improvements**
  - Upto now, automotive NAND storage has focused on reliability rather than performance, from now on both are necessary.
  - It is almost impossible to guarantee the reliability by cell structural dimensions beyond the 300-layer of 3D NAND.

- **Reliability defense algorithm breakthrough**
  - To overcome the retention problems, defense algorithm breakthrough is key factor.
  - It is critical to catch the Read Reclaim or Refresh chance in defense algorithm. For that, close communication between NAND and EV makers is essential.

Prediction of Retention limit

NAND manufacturer provide the reliability characteristics of NAND.



NAND Cycle-Retention Curve

EV makers provide operating profiles.

Mission Profile

Temperature	Time ratio
-10℃	6%
55℃	65%
85℃	20%
100℃	8%
105℃	1%
Using the Arrhenius Acceleration Model	**T = 65.5℃**

Usage Profile

Use case (TLC)	Value
Data Processing	10GB
Usage per year	365cyc
WAF	4
NAND Write per year	14600GB
Total Write for 15 years	219000GB
EW Cycle for 256GB	**855cyc**

- **Retention limit can be predicted, based on “Reliability characteristics” and “Profile”.**
- **Derived data is used to optimize the reliability defense algorithm.**

Conclusion

- **NAND storage for Future electric vehicle facing new demands : More reliability, performance and Heat tolerance.**
- **Si geometry for reliability is limited as stack layer increased. The breakthrough in defense algorithm is essential.**
- **In future Automotive systems, collaboration between NAND storage supplier and EV company is important.**
- **SK hynix is ready to cooperate.**