EDGE AI: Innovations in Flash and DRAM

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Agenda

- **Quick Intro**
- **Deep dive into Form Factors for Flash (E1.S + M.2)**
  - Performance
  - Density
  - Thermal design (1U Storage server + Fanless BoxPC)
- **iSLC (Pseudo SLC) technology for Flash**
  - Endurance benefits
  - DRAM usage
- **DRAM for Challenging environments**
  - 1st grade factory die
  - Ultra wide temperature specs
  - Very Low Profile UDIMM with ECC
  - DDR5 customizations
- **Q&A Session**

Quick Intro Dominique + Innodisk / Telerex

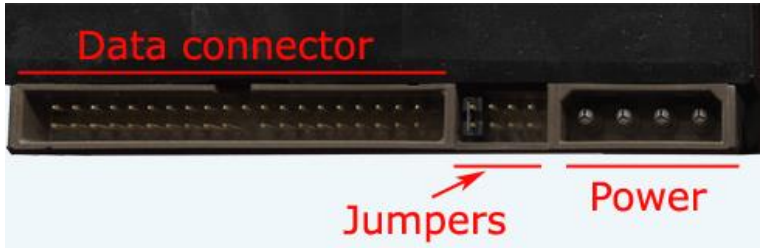
14 years active in Industrial Automation

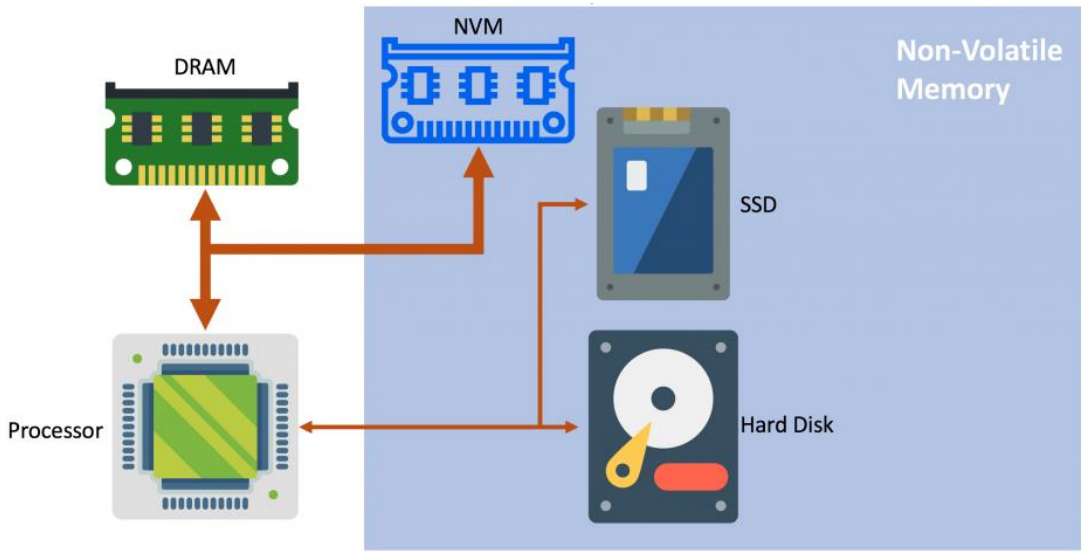
From sensor to systems with a touch of AI ☺

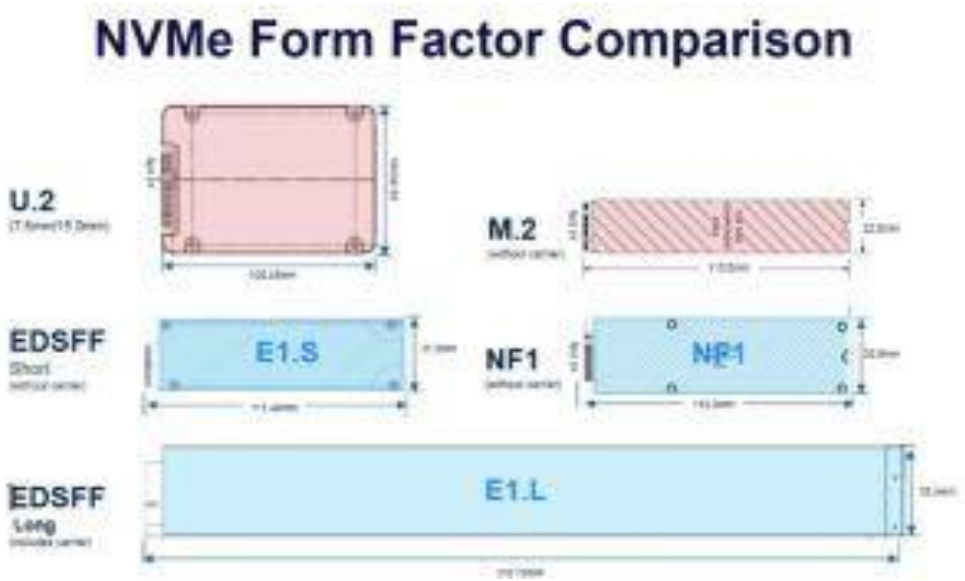
- Isotron Systems – ‘s-Hertogenbosch
- Advantech Europe – Eindhoven
- Scailable, AI startup – Eindhoven
- Innodisk Europe - Eindhoven

Deep dive into Form Factors for Flash

- *Former Connectors: Pata / IDE, still used in legacy 80x86 systems.*
- *Current (most used) Connectors: Sata - Already different form factors: 2.5” and M.2*
- *New and upcoming NVMe*





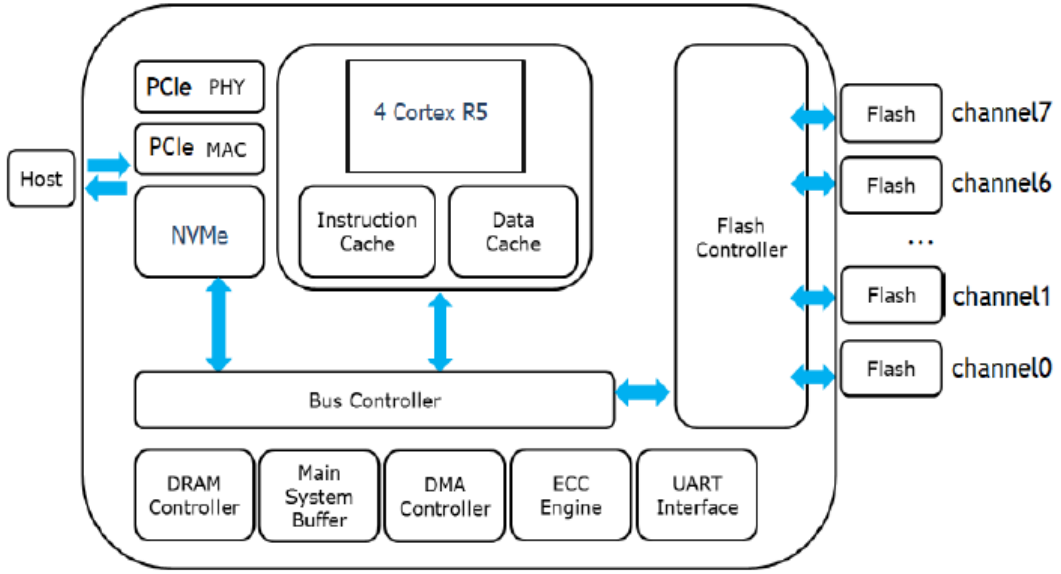


Deep dive into Form Factors for Flash

Performance – IOPS

Table 2: Performance - 112 layers 3D TLC

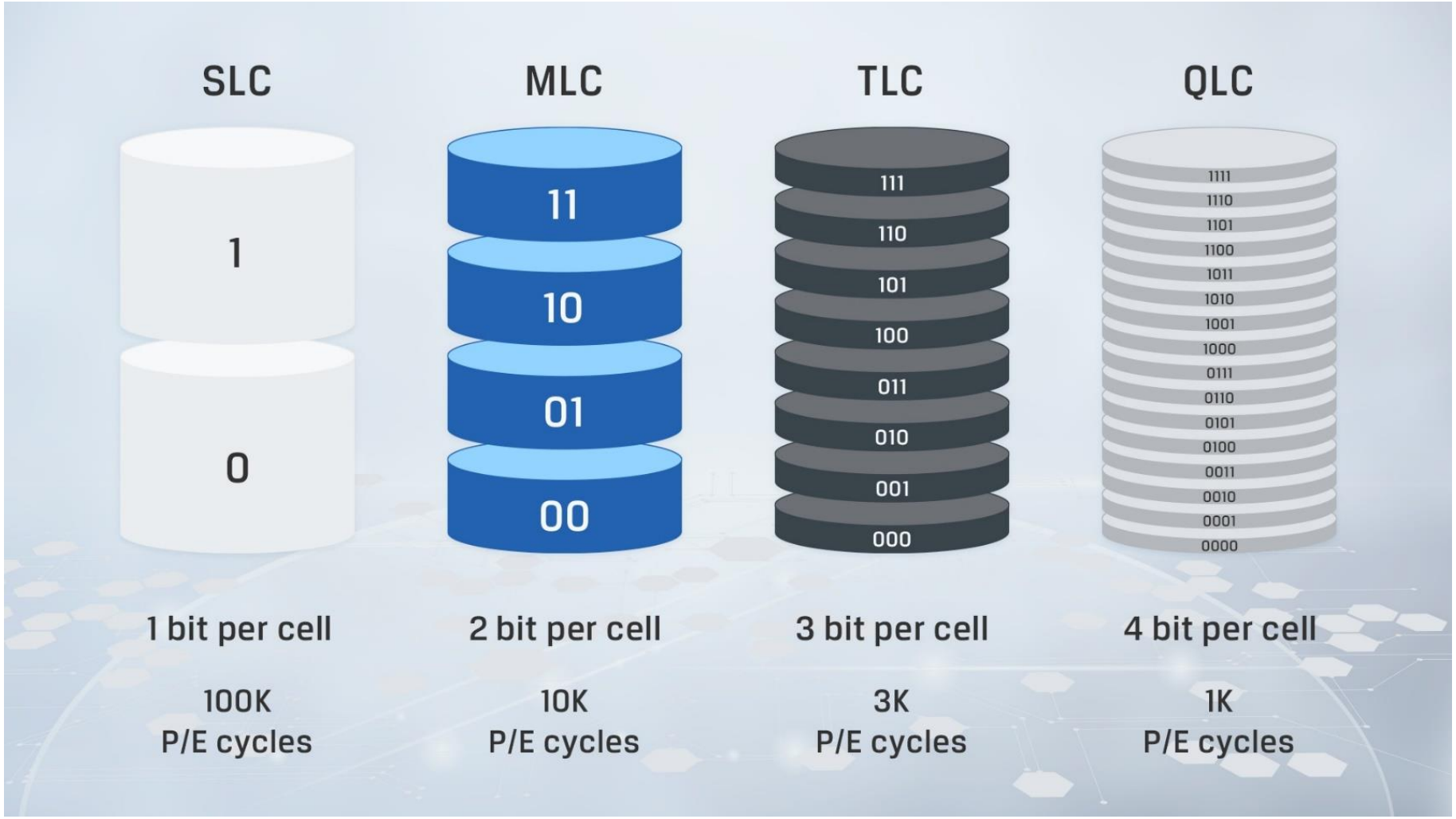
Capacity	Unit	512GB	1TB	2TB	4TB	8TB
Sequential** Read (Q8T1)	MB/s	5,700	6,950	6,650	6,650	6,400
Sequential** Write (Q8T1)		2,250	4,150	4,950	4,950	4,800
Sustained Sequential Read (Avg.)***		1,950	2,450	1,650	2,300	2,000
Sustained Sequential Write (Avg.)***		450	850	2,200	1,750	1,400
4KB Random** Read (Q32T16)	IOPS	478,000	815,000	815,000	821,000	819,000
4KB Random** Write (Q32T16)		594,000	695,000	708,000	722,000	712,000



*$\mathrm{IOPS} \times \mathrm{TransferSizeInBytes} = \mathrm{BytesPerSec}$

Deep dive into Form Factors for Flash

Endurance – P/E Cycles



https://www.kingston.com/en/blog/pc-performance/difference-between-slc-mlc-tlc-3d-nand.

Deep dive into Form Factors for Flash

Reliability – TBW

TBW* (Total Bytes Written) Unit: TB		
Capacity	**Sequential workload**	**Client workload**
512GB	1,363	703
1TB	2,727	1,636
2TB	5,545	3,958
4TB	10,908	7,904
8TB	21,816	16,246

Deep dive into Form Factors for Flash

Reliability – DWPD

DWPD or **DW/D** - Drive Writes Per Day.

GB/day - Gigabytes written per day.

TBW - Total Bytes Written, usually expressed in terabytes - TBW (TB) or petabytes - TBW (PB).

Given ***S*** - disk capacity in GB and ***T*** - warranty / useful life period in years, conversion between different SSD endurance specifications can be performed as follows:

$$DWPD = GB/day \div S$$

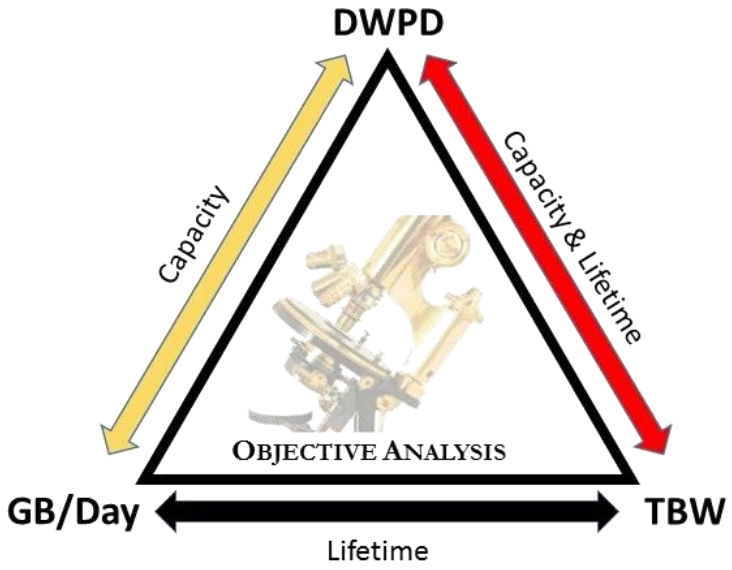
$$DWPD = (TBW_{(TB)} \times 1000) \div (S \times T \times 365)$$

$$GB/day = DWPD \times S$$

$$GB/day = (TBW_{(TB)} \times 1000) \div (T \times 365)$$

$$TBW_{(TB)} = (DWPD \times S \times T \times 365) \div 1000$$

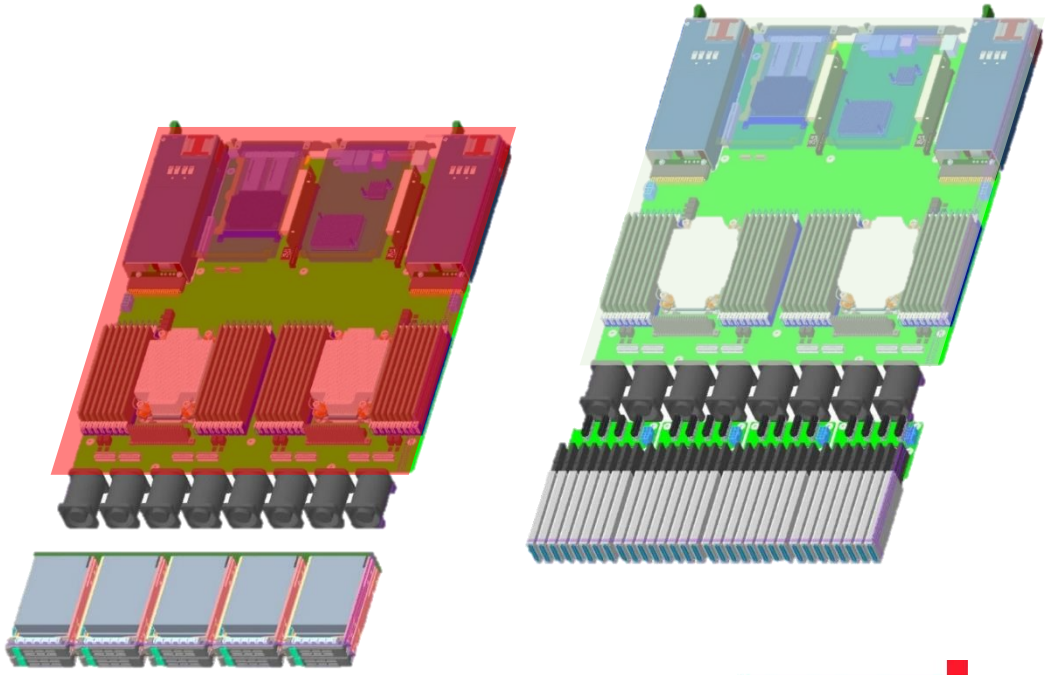
$$TBW_{(TB)} = (GB/day \times T \times 365) \div 1000$$



Capacity	TBW	DWPD
512GB	703	1.4
1TB	1,636	1.7
2TB	3,958	2.0
4TB	7,904	2.0
8TB	16,246	2.1

Deep dive into Form Factors for Flash

- *Density + Thermal 1U server*



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THE SAFEST CHOICE
TELEREX

Deep dive into Form Factors for Flash

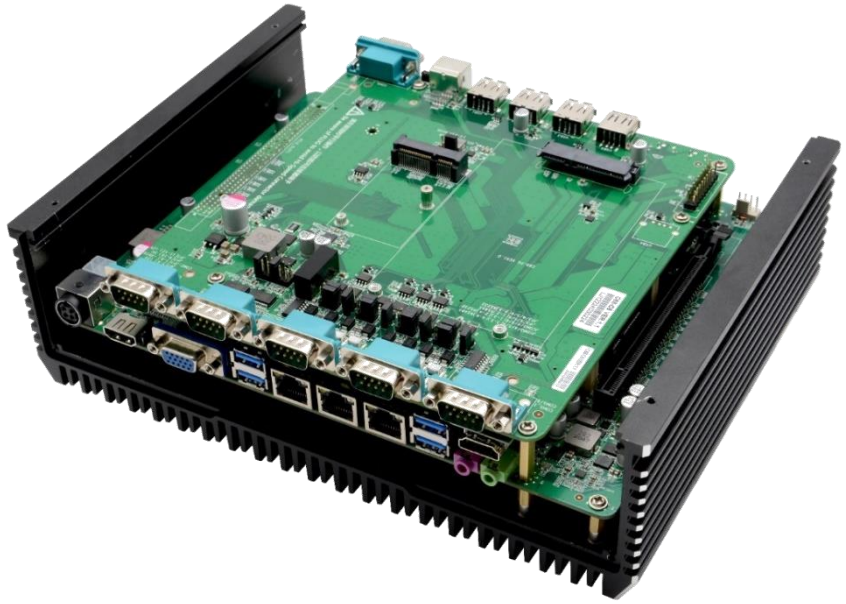
- *Thermal Design / Power Consumption Fanless-BoxPC*

Mode	Power Consumption (W)
Read (RMS)[1]	2.1
Write (RMS)[1]	2.0
Idle	1.0
Boot Up	5.5

* Target 2.5" SATA SSD 3TE7 2TB

Mode	Power Consumption (W)
Read	8.9
Write	7.2
Idle	2.4
Power-on peak	10.9

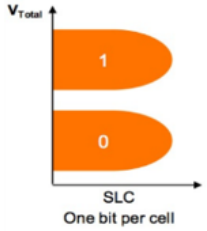
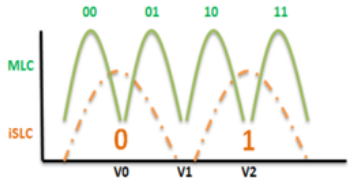
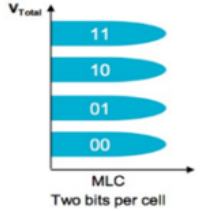
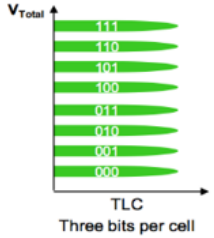
Target: 4TB M.2 (P80) 4TG2-P



Mode	Power Consumption (W)
Read	10.0
Write	10.9
Idle	2.8
Power on peak	15.4

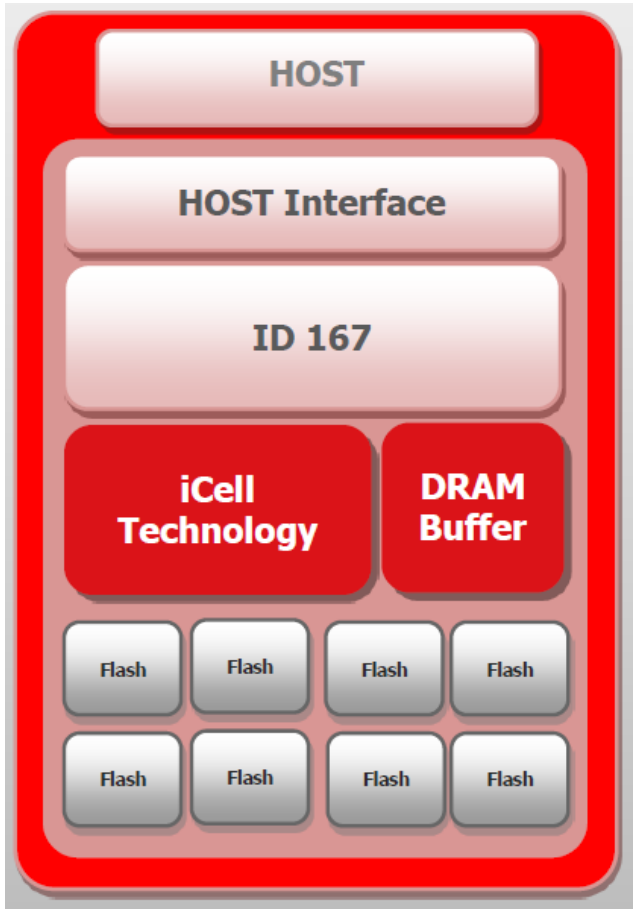
Target: 4TB E1.S 4TG2-P

iSLC (Pseudo SLC) technology for Flash

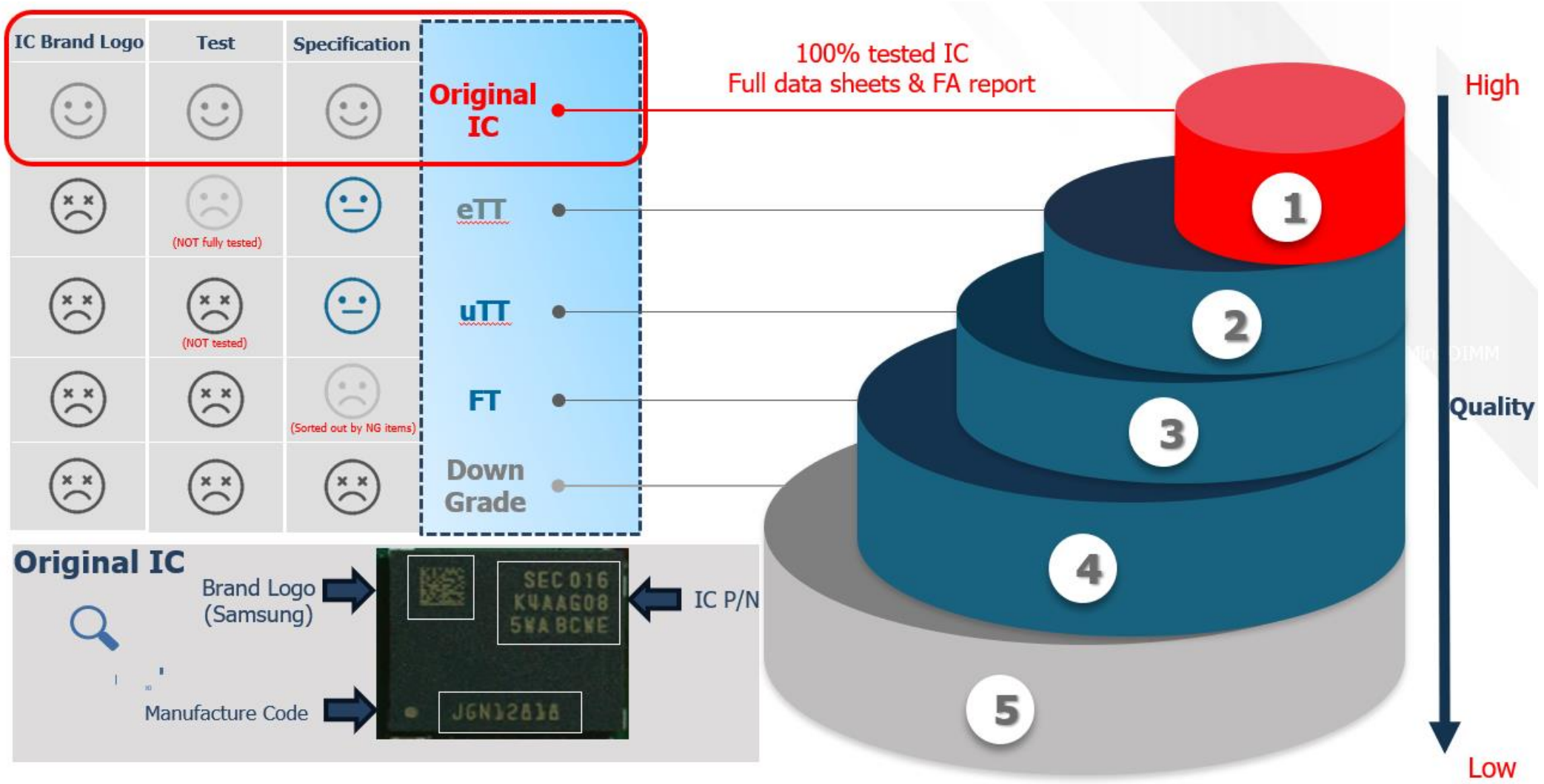
Item	SLC Single Level Cell	iSLC Inno SLC mode		MLC Multi Level Cell	3D TLC Triple Level Cell	
Architecture	SLC Flash has only two states: erased (empty) or programmed (full). 	Enhance iSLC, algorithm & Enhance ECC 		MLC Flash has four states: erased (empty), 1/3, 2/3, and programmed (full). 	3D TLC Flash has eight states and multiple stacking layers. 	
Performance	★★★★★	★★★★		★★★	★★	
ECC Requirement (per KB)	24 bit	MLC (2D NAND 40 bit	TLC (3D NAND) 120 bit	40 bit	120 bit	
Endurance (P/E Cycles)	60K	20K	30K (100K*)	3K	**Industrial** 3K	**Enterprise** 10K
Data Retention @ Initial	10 Years	10 Years		10 Years	10 Years	5 Years
Data Retention @ Life End	1 Year	1 Year		1 Year	1 Year	4 Month
Density	3D TLC> iSLC(3D) = MLC> iSLC(2D) >SLC					

iSLC and capacitors (iCell) in Flash Technology

- *iSLC for better Endurance*
- *DRAM: Faster and more efficient*
- *Capacitors: Sudden shutdown of systems*

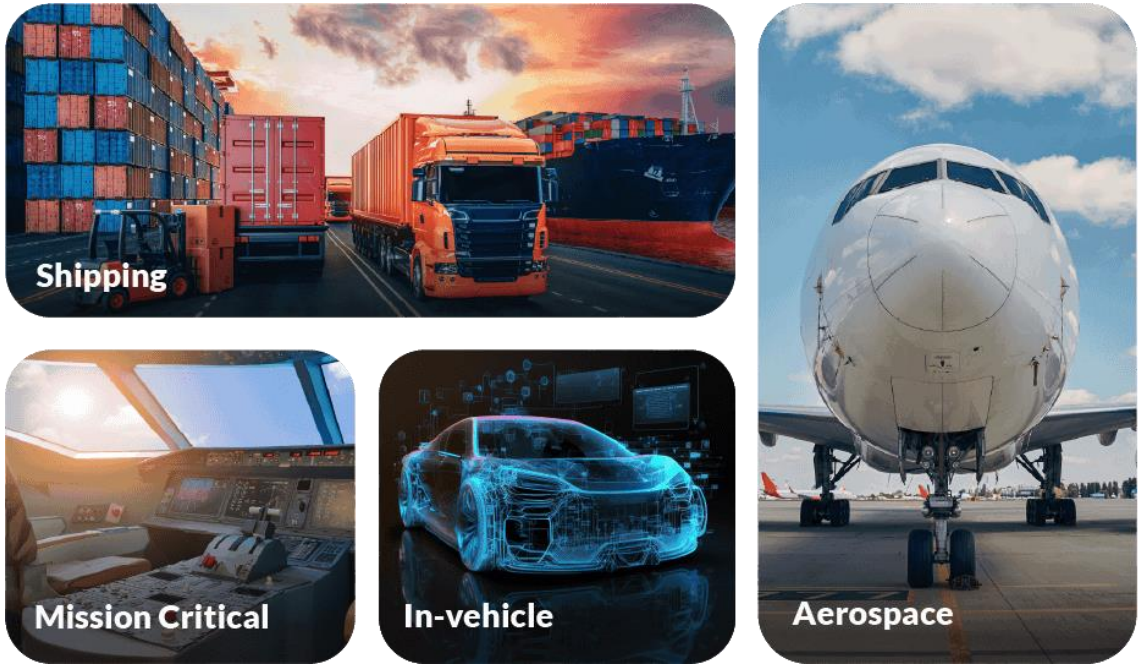


DRAM for Challenging environments



DRAM for Challenging environments

- *Ultra Temperature DRAM Modules offer robust performance in extreme conditions.*
- *Extensive operating temperature range of -40 to 125℃ for DDR4 and -40 to 105℃ for DDR5*



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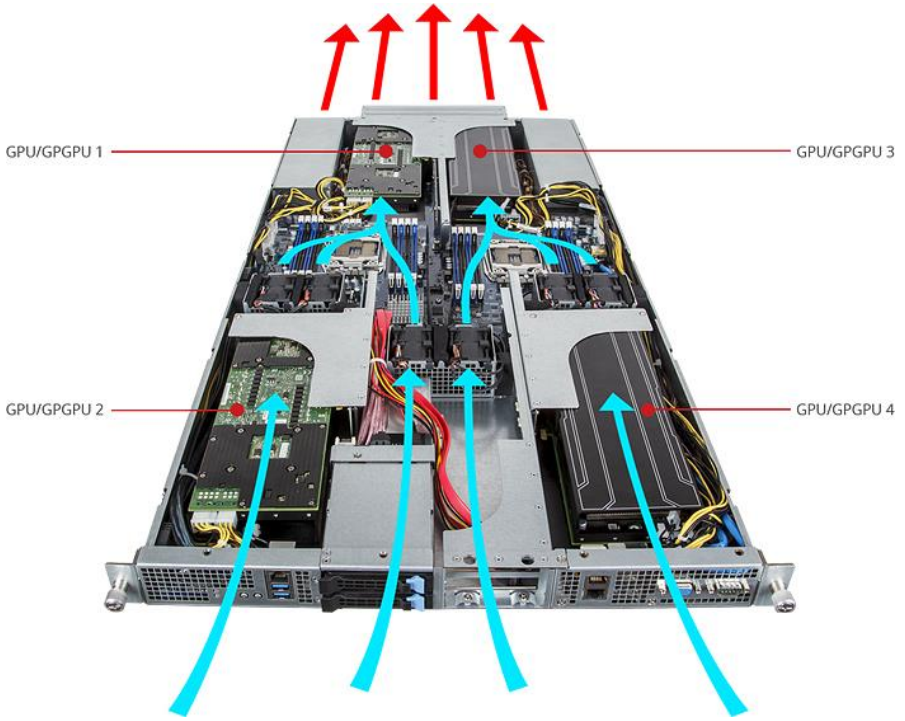
Very Low Profile UDIMM with ECC

- *DDR4 UDIMM*

- *DDR4 VLP*

- *DDR4 VLP Mini*



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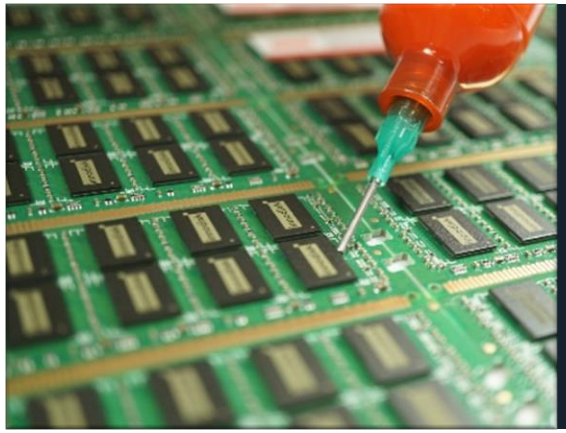
DDR5 customizations

Anti-Sulfuration

Anti-sulfuration resistors against sulfide

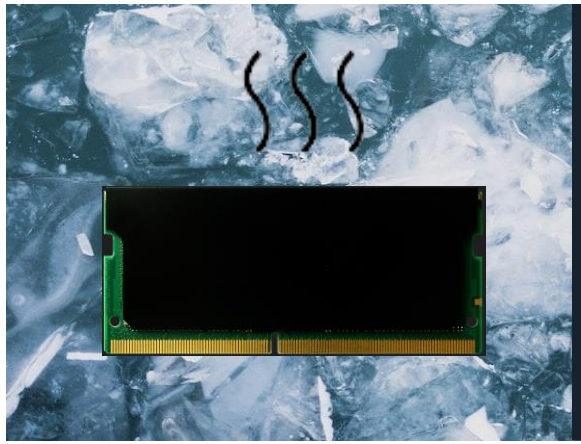
Automatic Conformal Coating

Against humidity, dust contaminants and chemicals



Side Fill

Better equipped for tough situations and thermal extension



Heat Spreader

2 solutions offered:
Aluminum (plate)
Carbon nanotube (sheet)

Q&A Session

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SCAN FOR LINKEDIN