

# Server SSD Form Factor

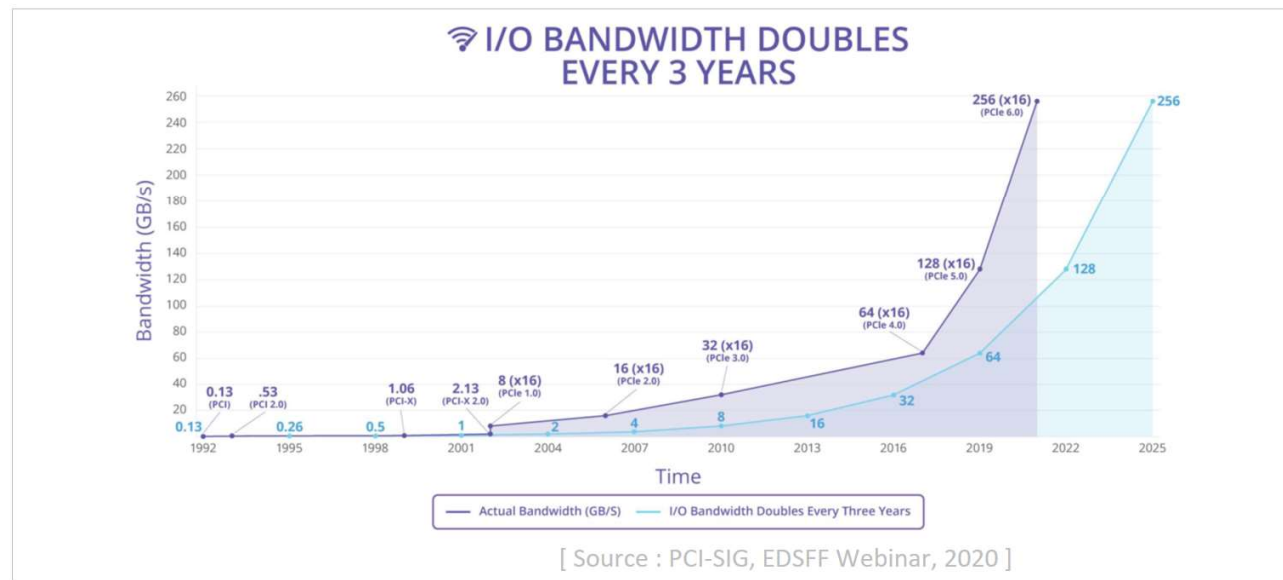
What's New in 2021?

Dec. 2021

**SAMSUNG**

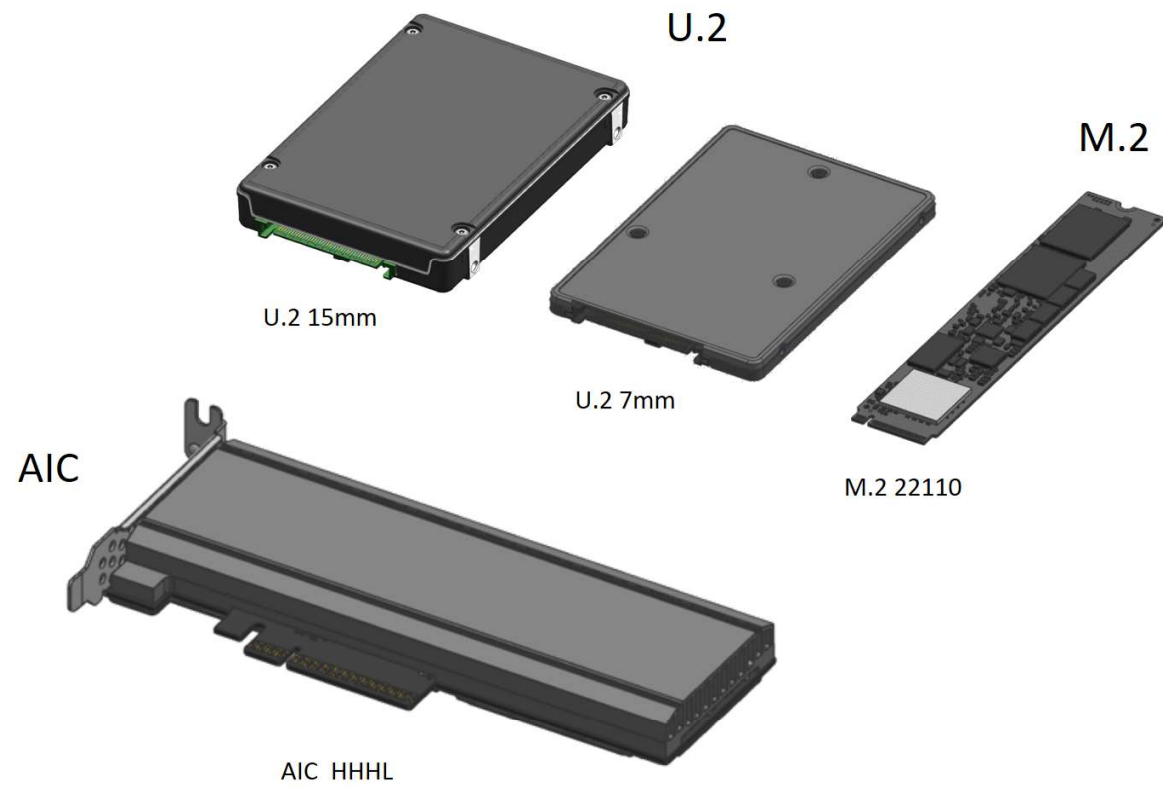
# PCIe Generation

- Performance doubles, Power Increases, and F/F evolves.

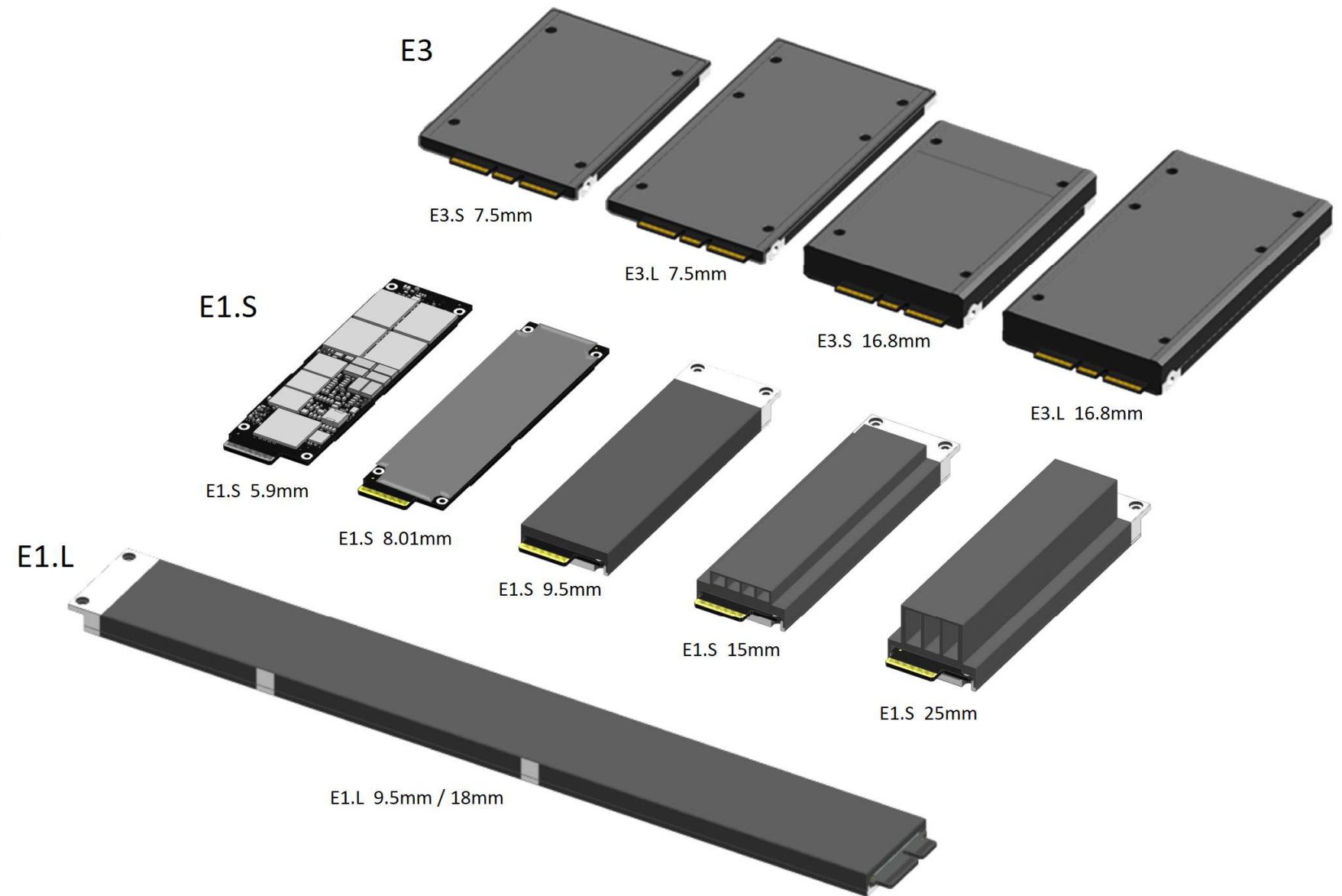


# Server SSD Form Factor (for Datacenter and Enterprise)

## U.2 / M.2 / AIC



## EDSFF



# Standardization Organization



Electrical
Protocol
SFF (U.2)
M.2 (Mini)
AIC (CEM)
Serial Enabling
OC Link
F/W
...

SFF-TA
Object Drive
NVM Programming
Scalable Storage Management
Computational Storage
Cloud Storage
Green Storage
Solid State Storage
...

Server
Storage
Rack & Power
Security
H/W Management
DC Facility
Networking
Telco
...

Management Interface
Interoperability and Compliance
ZNS
Fabric and Multi-Domain
KV
Computational Storage
Fabrics Linux Driver
Refactoring
...

JC-11 : Mechanical
JC-14 : Quality and Reliability
JC-15 : Thermal
JC-16 : Interface
JC-42 : Solid State Memories
JC-45 : DRAM Modules
JC-63 : Multiple Chip Package
JC-64 : Embedded /Removable
...



# Server SSD Form Factor (for Datacenter and Enterprise)

	M.2/U.2/AIC				EDSFF											
F/F	M.2 22110	U.2 7mm	U.2 15mm	AIC HHHL	E1.S 5.9mm	E1.S 8.01mm	E1.S 9.5mm	E1.S 15mm	E1.S 25mm	E1.L 9.5mm	E1.L 18mm	E3.S 7.5mm	E3.S 16.8mm (2T)	E3.L 7.5mm	E3.L 16.8mm (2T)	
																
Width	22 x	69.85 x	69.85 x	68.90 x	31.5 x	31.5 x	33.75 x	33.75 x	33.75 x	38.4 x	38.4 x	76.0 x	76.0 x	76.0 x	76.0 x	
Length	110 x	100.45 x	100.45 x	167.65 x	111.49 x	111.49 x	118.75 x	118.75 x	118.75 x	318.75 x	318.75 x	112.75 x	112.75 x	142.2 x	142.2 x	
Thickness	3.85mm <small>* D5</small>	7.0mm	15mm	14.47mm <small>* Single Slot</small>	5.9mm	8.01mm	9.5mm	15mm	25mm	9.5mm	18mm	7.5mm	16.8mm	7.5mm	16.8mm	
Max Power	11.55W	25W	25W	25W	12W	16W	20W	25W	25W	25W	40W	25W	40W	40W	70W	

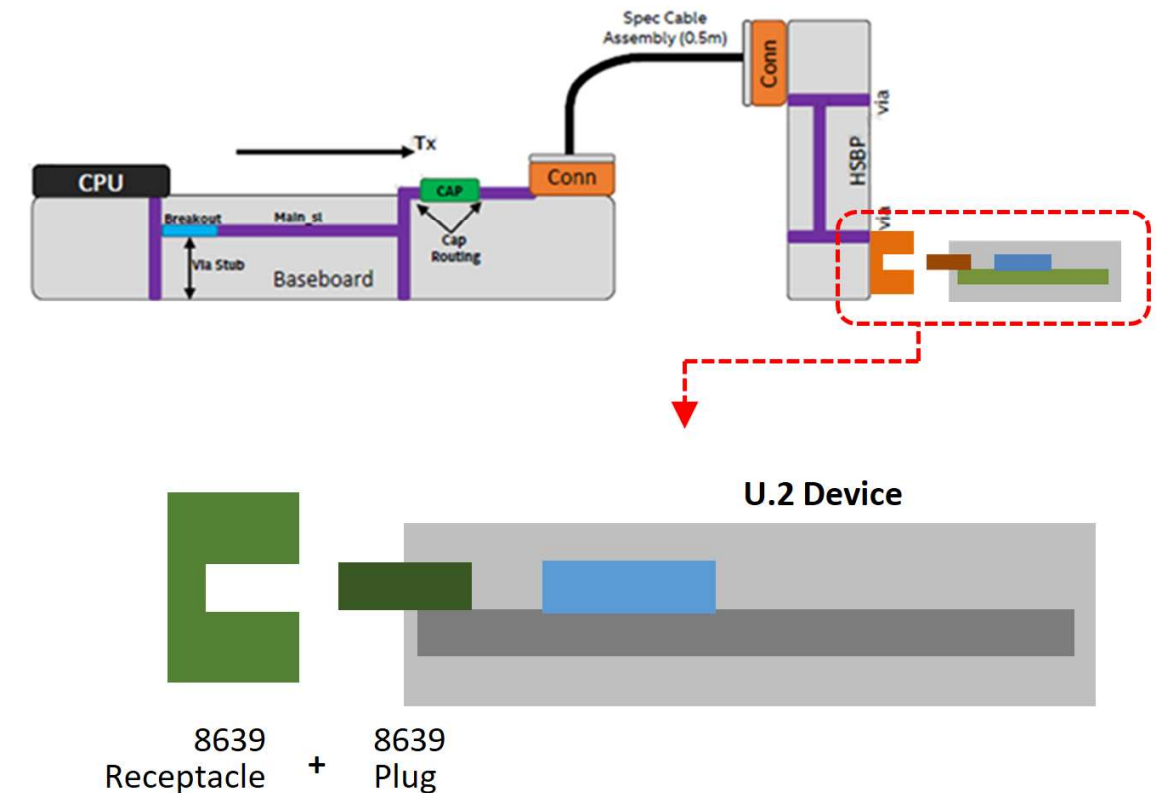
# U.2

- What happened in 2021?
  - There was a voice of proposal to maintain SFF-8639 at PCIe GEN4.
  - **But it was concluded to proceed SFF-8639 PCIe GEN5.**
- Discussion Background [ Source : PCI-SIG SFF-8639 WG, 2021.04 ]
  - SFF-8639 was never intended to run at PCIe Gen5 frequencies
  - There is significant concern that interoperability between receptacles and plugs from different suppliers
  - Power and thermal limitations may limit full performance of Gen5 x4
  - Market interest is shifting to a form factor with a longer expected lifespan
  - There are other SSD form factors that were designed to support PCIe Gen 5 / Gen 6 (and beyond)

# U.2 PCIe GEN5 Spec Status

	Draft 0.3	Draft 0.5	Draft 0.7	Draft 0.9	Final 1.0
SFF-8639 Module Spec Rev 4.0		Q2 2020	Q3 2020	Q4. 2020	April 2021
SFF-8639 Module Spec Rev 5.0	Q3 2021	<b>Q4 2021</b> <b>WIP</b>	Q1 2022	Q2 2022	Q2~Q3 2022

- Major Discussion Items
  - Connector SI (Mated)
    - TBD
  - Add-in-card Insertion Loss Budget
    - 6.5dB? (at 16GHz)
  - Power
    - 25W? (1.5A/Pin?)
  - I3C?
  - Connector Interoperability
    - receptacles and plugs from different vendors

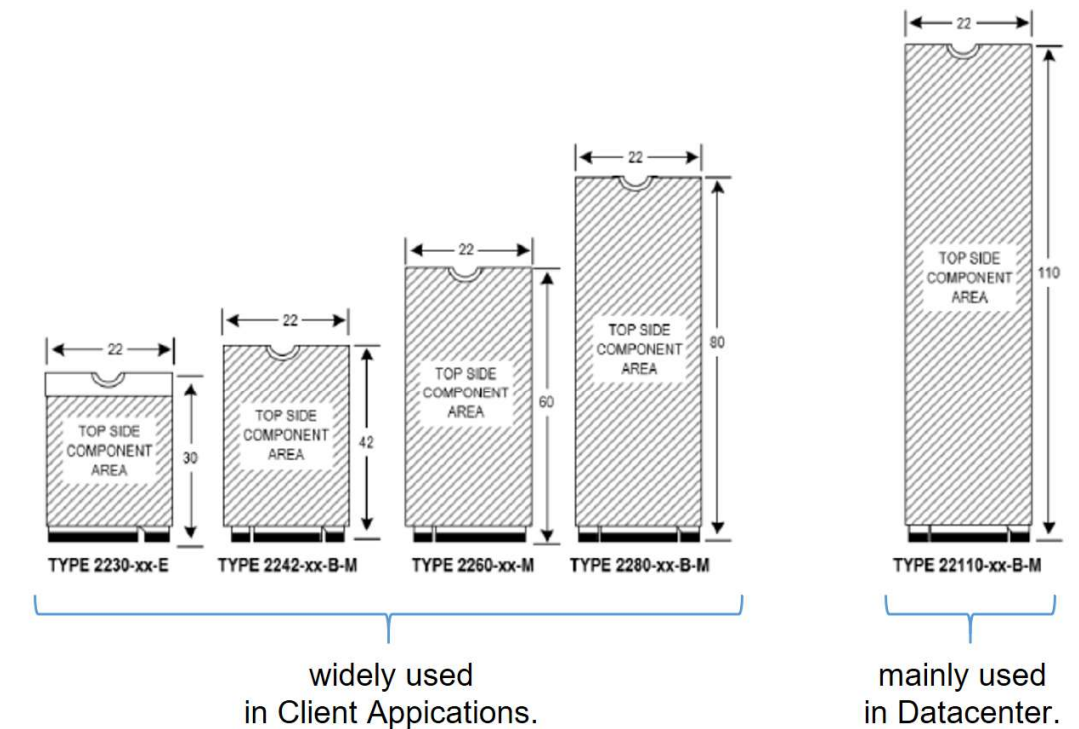




# M.2

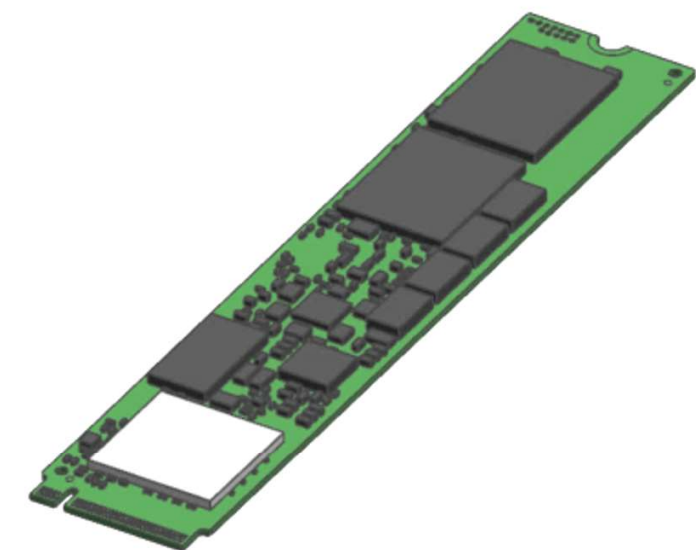
- M.2 Form Factor

- M.2 is widely adopted in Client applications.
  - Laptop, Desktop, etc
- Thus, M.2 PCIe GEN5 spec is going on smoothly.
- In DC/EP applications, M.2 22110 is mainly used.



- Limitation of M.2 in Datacenter/Enterprise

- Limited number of NAND die placements (4 with use of PLP)
- Limited power envelope (11.55W)
- Limited thermal envelope
- No hot-plug support

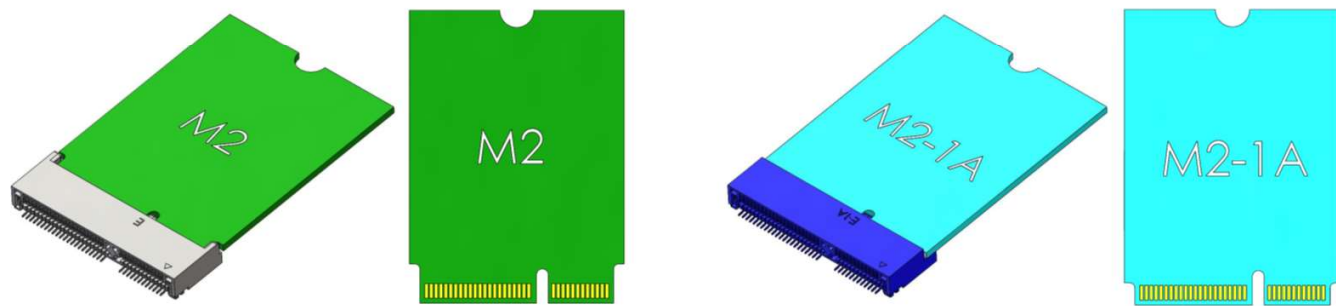




# M.2

- What's new in 2021
  - There is a voice of needs about Higher Power

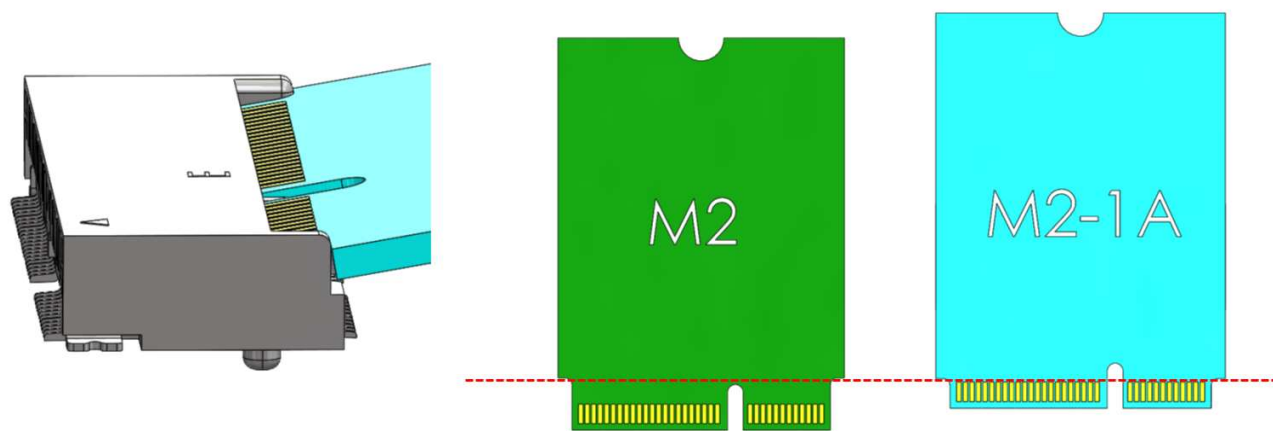
**M.2 vs. M.2-1A** [ Source : PCI-SIG, Intel, 2021 ]



**Power Increase (0.5A/pin → 1A/pin)**

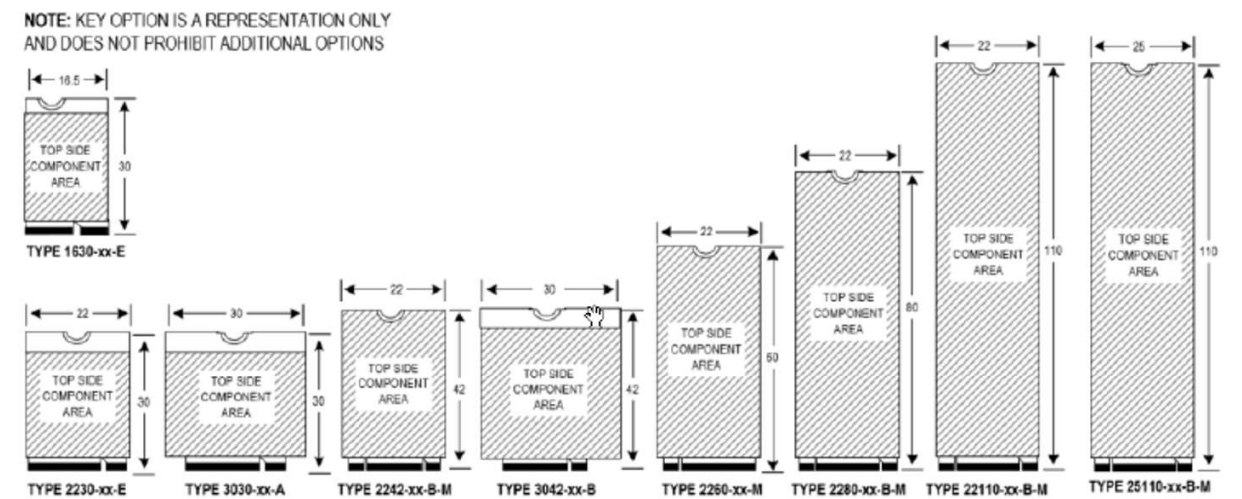
	No. of Power Pins	Current per Pin	Max Power (3.3V Nominal)	Current Per Pin
Socket 1	4	0.5 A	6.6 W	1.0 A
Socket 2	5	0.5 A	8.25 W	1.0 A
Socket 3	9	0.5 A	11.55 W	1.0 A

## Backward Compatibility



M.2 + M.2-1A Socket : ok  
 M.2-1A + M.2 Socket : not working

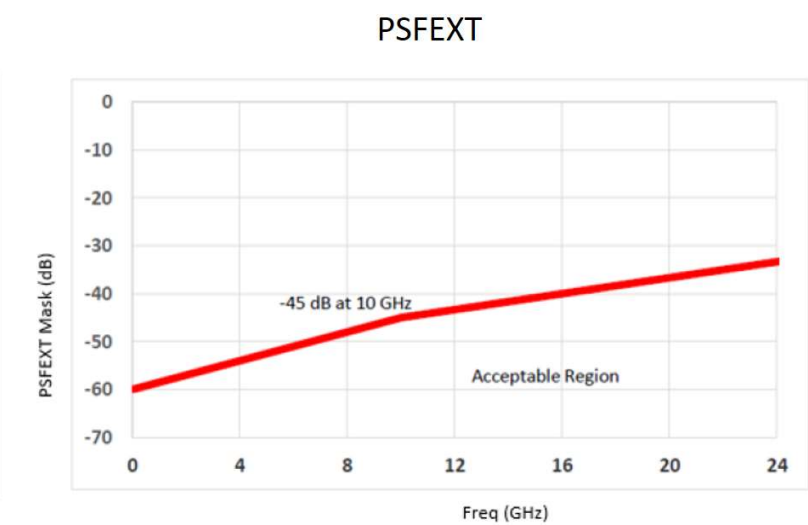
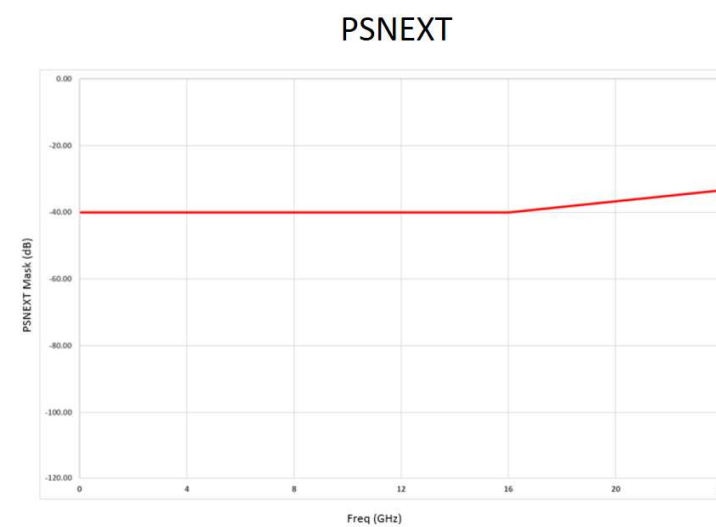
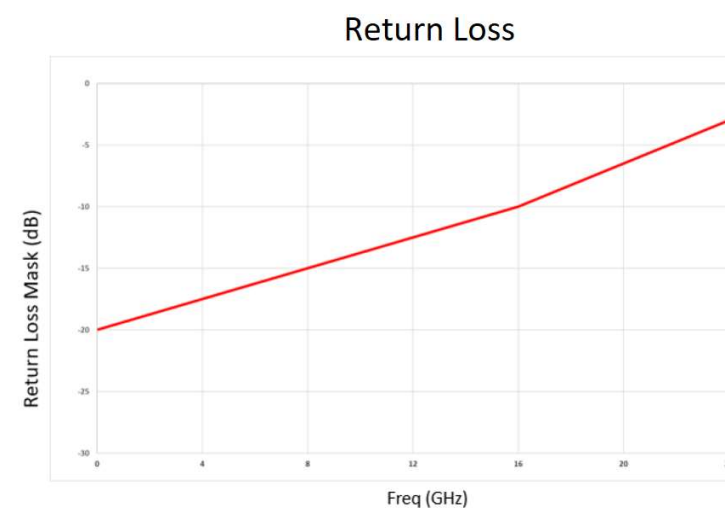
## Works for all M.2 Cards



# M.2 PCIe GEN5 Spec Status

	Draft 0.3	Draft 0.5	Draft 0.7	Draft 0.9	Final 1.0
M.2 Specification Rev 4.0		Q1 2019	Q1 2020	Q3 2020	Nov. 2020
M.2 Specification Rev 5.0	Q2 2021	Q3 2021	<b>Q4 2021</b> <b>WIP</b>	Q1 2022	Q2 2022

- Major Discussion Items
  - SI discussion was almost done.



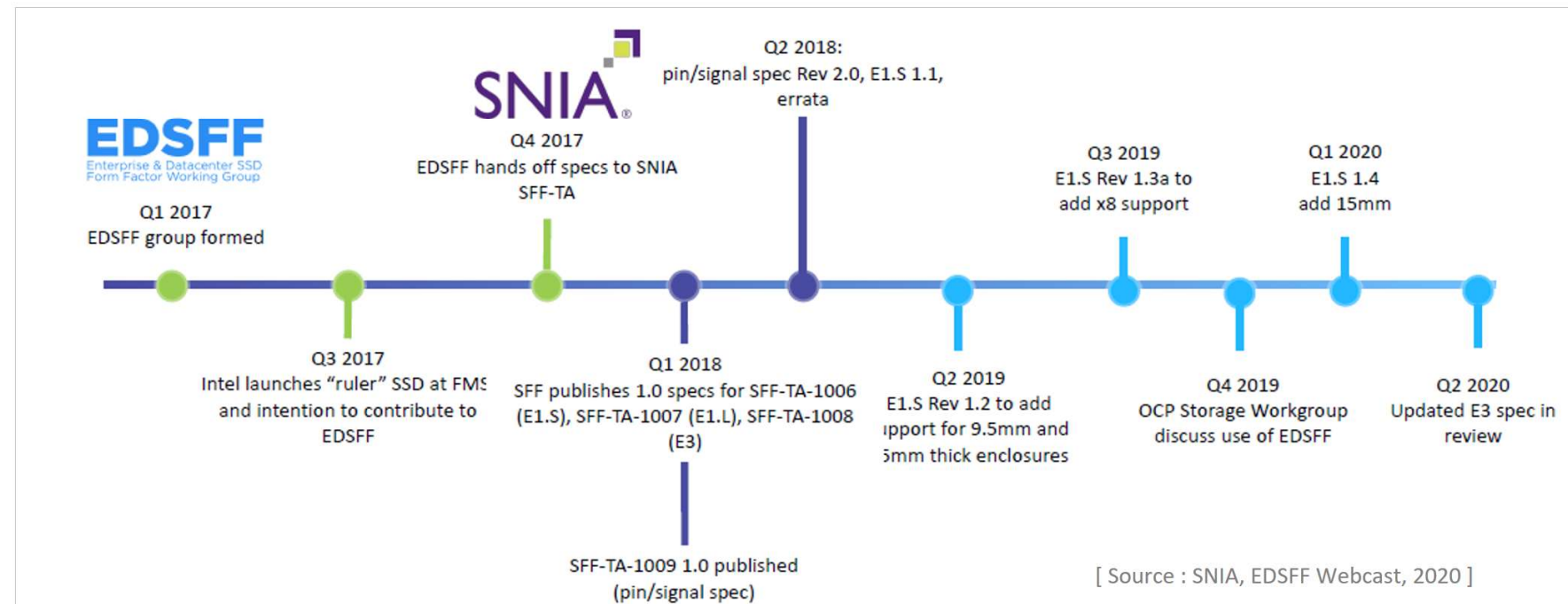
# Name “EDSFF”

- As-was (2017~2020) : Enterprise and Datacenter SSD Form Factor
- As-is (2021~) : Enterprise and Datacenter **Standard** Form Factor

*This specification originates from **Enterprise and Datacenter SSD Form Factor Working Group (EDSFF)**. Based on non-SSD devices also using EDSFF and agreement from the EDSFF Working Group, the SFF TA TWG agreed changing EDSFF to **Enterprise and Datacenter Standard Form Factor**.*

- cf. SFF has meant “Small Form Factor” since it came out in 1990, but it is not anymore now. Nowadays, SFF is just SFF.

- EDSFF Brief History





# EDSFF Specification Documents

- Specification Documents
  - Electrical, PHY, Channel, Link, Retimers, Transaction, Config :
    - PCIe<sup>®</sup> Base Specification
  - Pinout, Power, SI
    - SFF-TA-1009 : Enterprise and Datacenter Standard Pin and Signal Specification (EDSFF)
  - Form Factors
    - SFF-TA-1006 : Enterprise and Datacenter 1U Short SSD Form Factor (E1.S)
    - SFF-TA-1007 : Enterprise and Datacenter 1U Long SSD Form Factor (E1.L)
    - SFF-TA-1008 : Enterprise and Datacenter SSD Form Factor (E3)

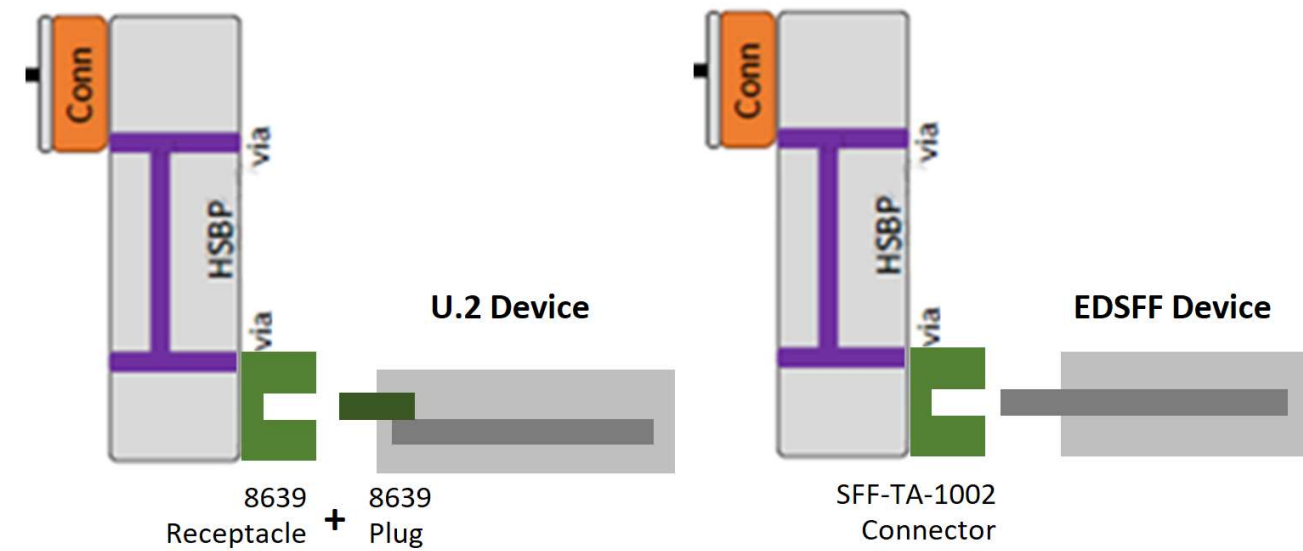
## ***New in 2021***

- Thermal
  - SFF-TA-1023: Thermal Characterization Specification for EDSFF Devices



# EDSFF

- Benefits
  - Designed to overcome conventional device limitations
  - Improves thermals, power, and scalability
  - Various power options - 25W, 40W, 70W
  - Various PCIe lane options - x2, x4, x8, x16
  - Advantageous for high-speed interface (< PCIe Gen5)
  - Built in LEDs, carrier-less design



# EDSFF

- Benefits

- E1 and E3 based system can increase the performance and density
- Have more flexibilities than a traditional system



U.2 SSD x 10ea

VS.



E1.S SSD x 32ea



U.2 SSD x 24ea

VS.



E3.S SSD x 40ea



SmartSSD

E3.S SSD

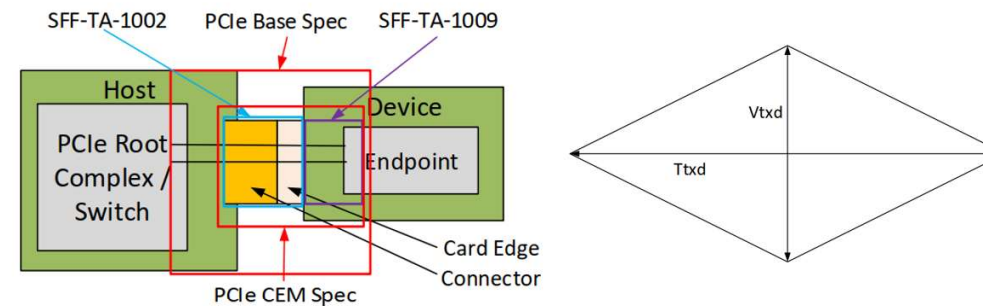
CXL Memory

NIC

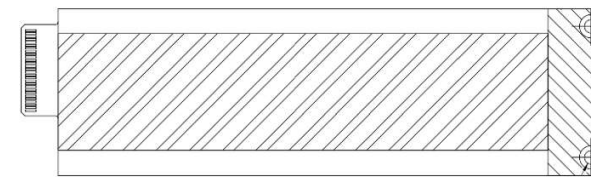
# Recent EDSFF Spec Changes

- SFF-TA-1009 Rev **3.0** (Pin/Signal Spec)
  - Rev 2.0 (18/05/22) → Rev 3.0 (21/03/19)
  - Electrical Requirements for 16 and 32 GT/s
  - Lots of clarifications, cleanup, errata fixes

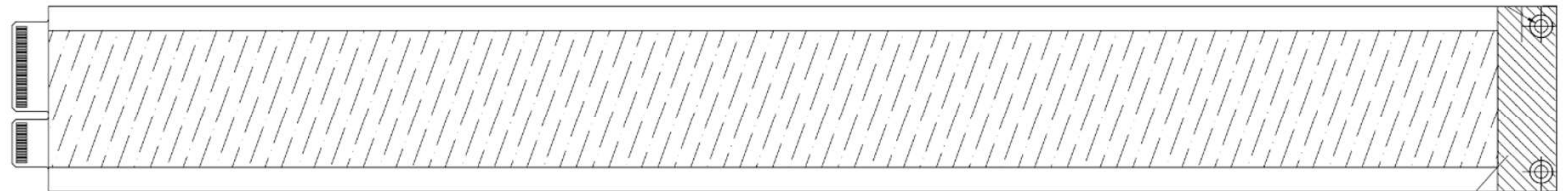
\* Note : Rev 3.0a (21/10/08)



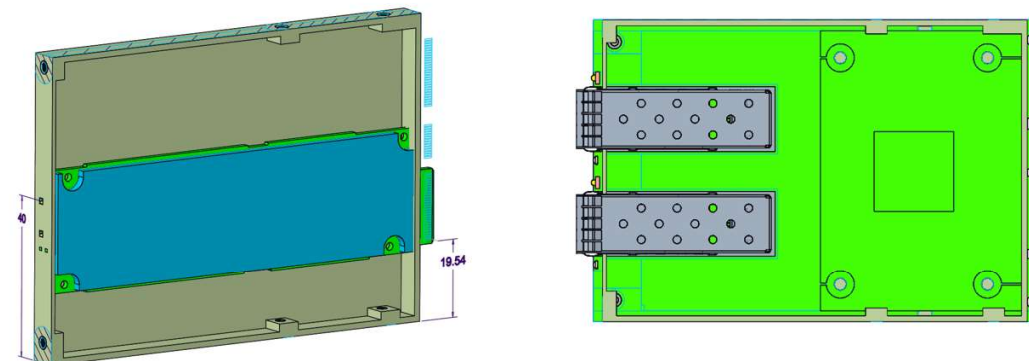
- SFF-TA-1006 Rev **1.5** (E1.S Spec)
  - Rev 1.4 (20/03/27) → Rev 1.5 (21/08/06)
  - Power/thermals update, general cleanup



- SFF-TA-1007 Rev **1.2** (E1.L Spec)
  - Rev 1.1 (19/03/11) → Rev 1.2 (21/07/09)
  - Power/thermals update, general cleanup



- SFF-TA-1008 Rev **2.0** (E3 form factor)
  - Rev 1.0 (18/03/30) → Rev 2.0 (20/11/06)
  - Length, connector position change
  - Power/thermal update
  - Connector aligned to OCP NIC 3.0

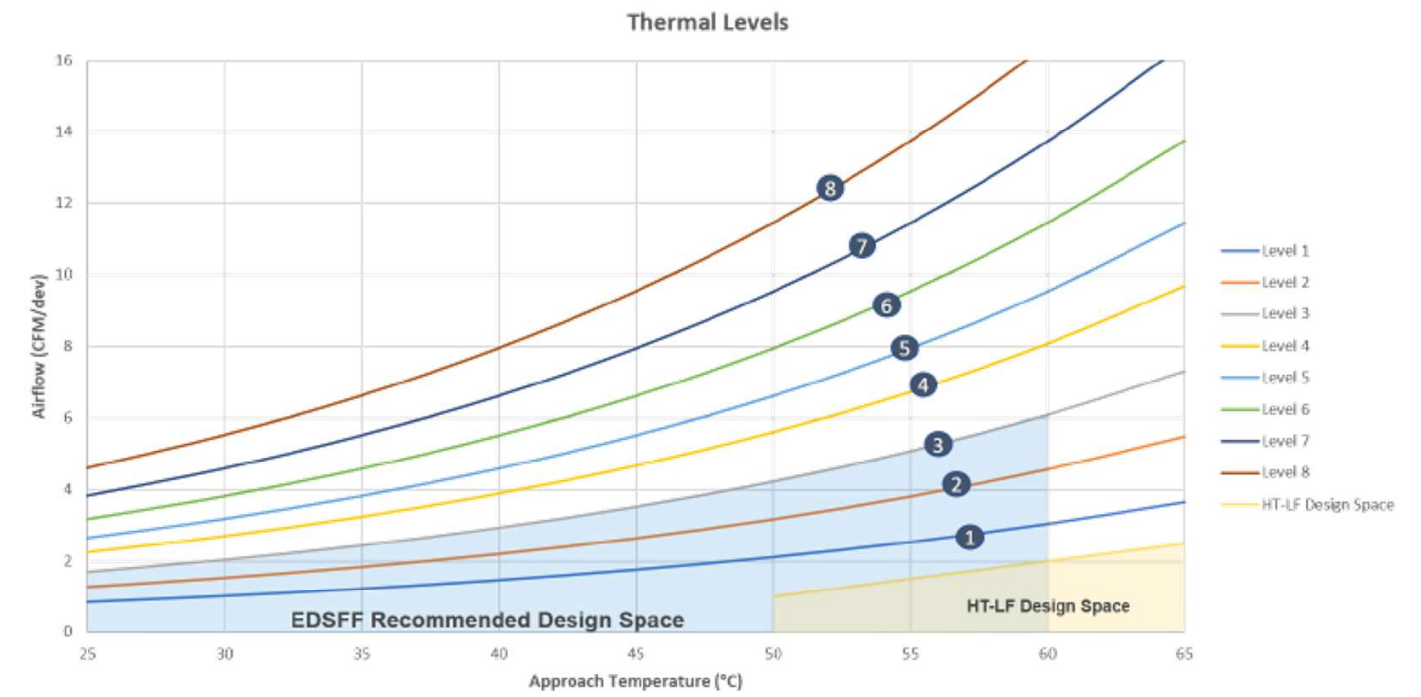
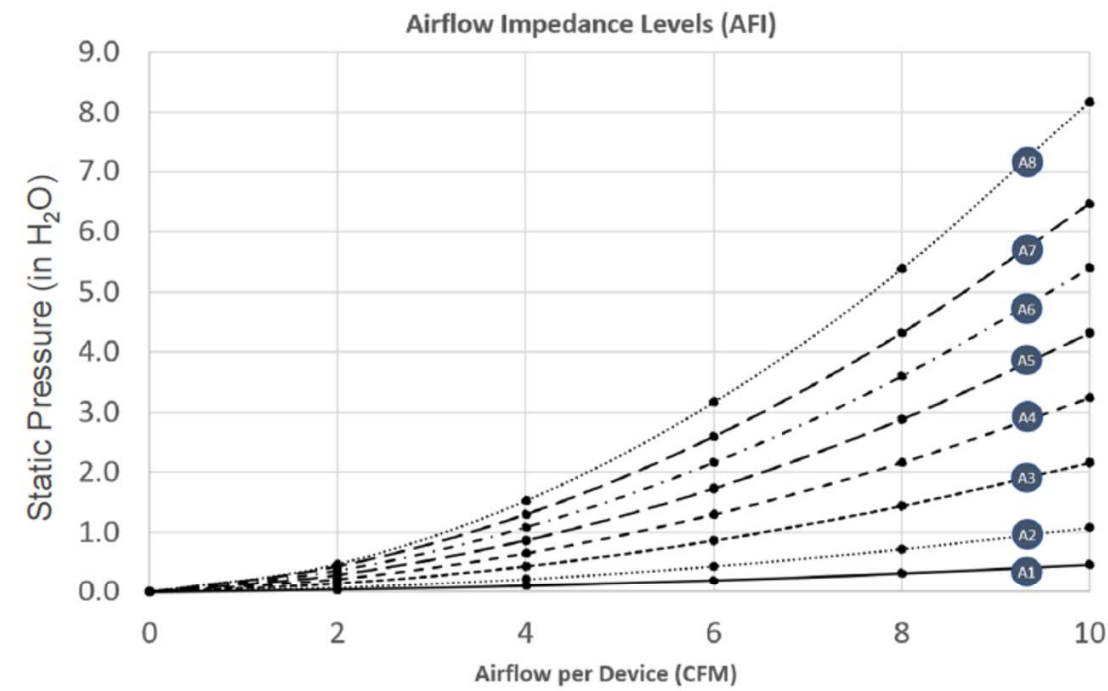


[ Source : SNIA, SDC21\_SFF, 2021 ]



# SFF-TA-1023

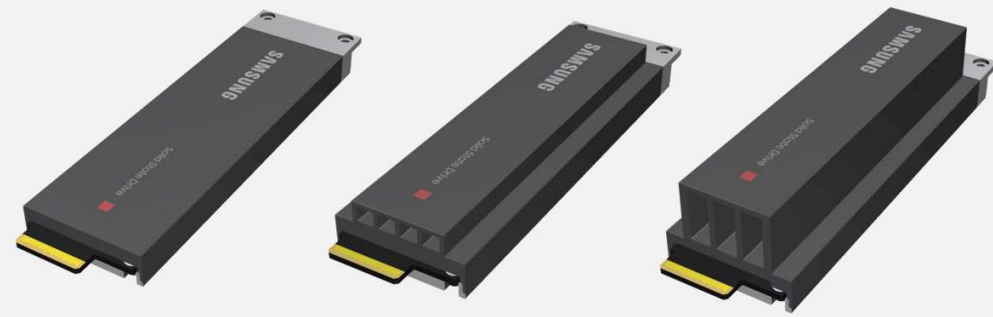
- SFF-TA-1023 Rev **1.0** (Thermal Characterization)
  - Proposal (20/06/22) → Rev 1.0 (21/10/25)
    - \* Note : Rev 1.0a (21/10/27)
  - Defining Wind Tunnel for each EDSFF F/F
  - Defining Air Flow Impedance Levels
  - Defining Thermal Levels





# Samsung Server SSD

## EDSFF



E1.S 9.5mm

E1.S 15mm

E1.S 25mm



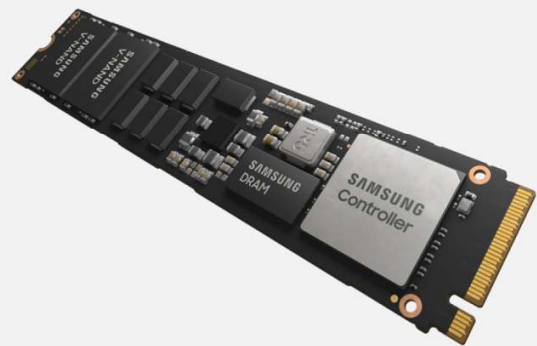
E1.L 9.5mm



E3.S 7.5mm

E3.S 16.8mm

## M.2 / U.2 / AIC



M.2



U.2 7mm



U.2 15mm



AIC HHL

**Thank You**