MSFT, Intel, WDC

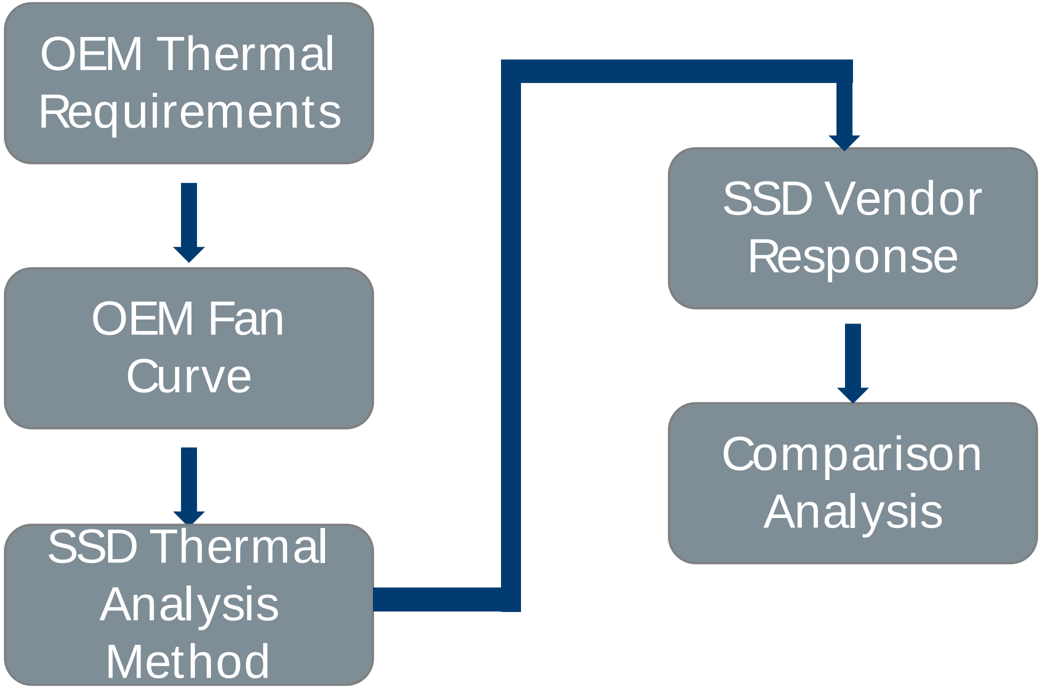
OCP 2020: E1.S THERMAL METHODOLOGY WORKGROUP

Feb 13, 2020

Goals of Standard to Develop

- How do OEM's communicate SSD Thermal requirements?
  - Reference framework for the system (environmental conditions as function of platform)
- How do we report SSD thermal metrics? (Vendor response – curves)
- How do we compare SSD's thermally in a platform? (Table or Chart)
- How do characterize and report findings? (Methodology/Metrology physical characterization)

Methodology Flow

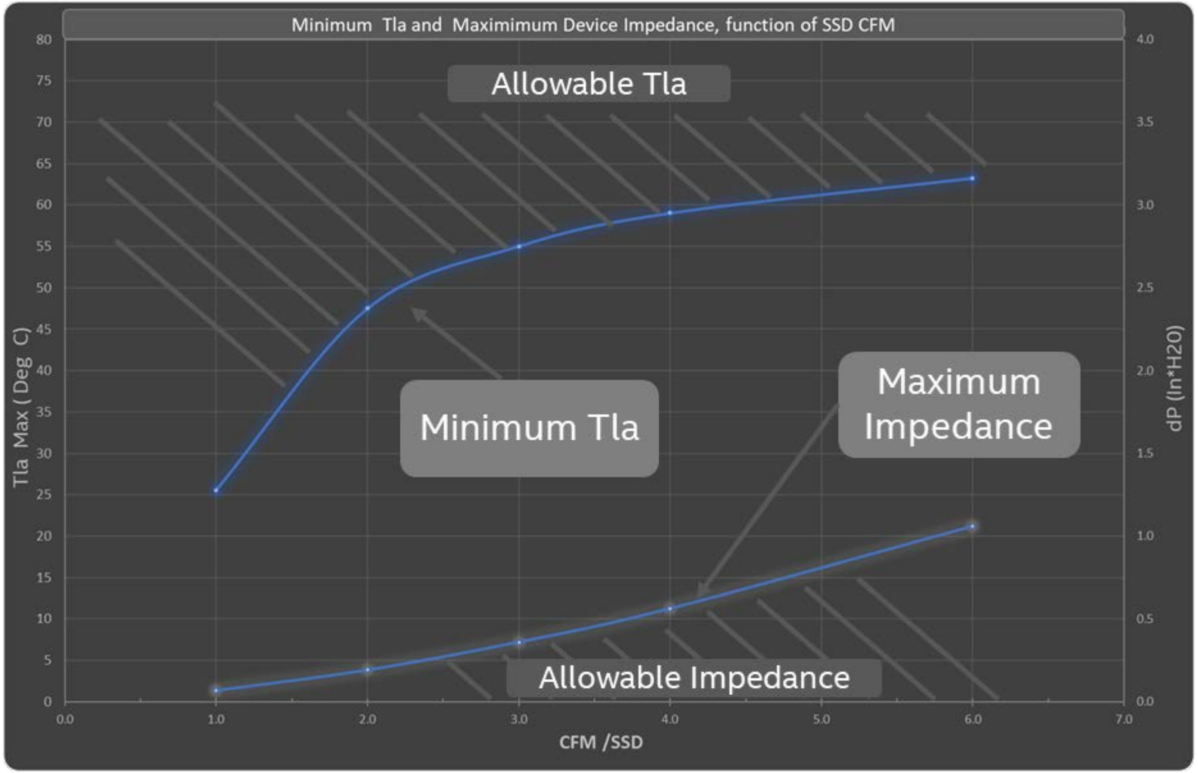


OEM Specifies: Workload, Tla Curve, Impedance Curve

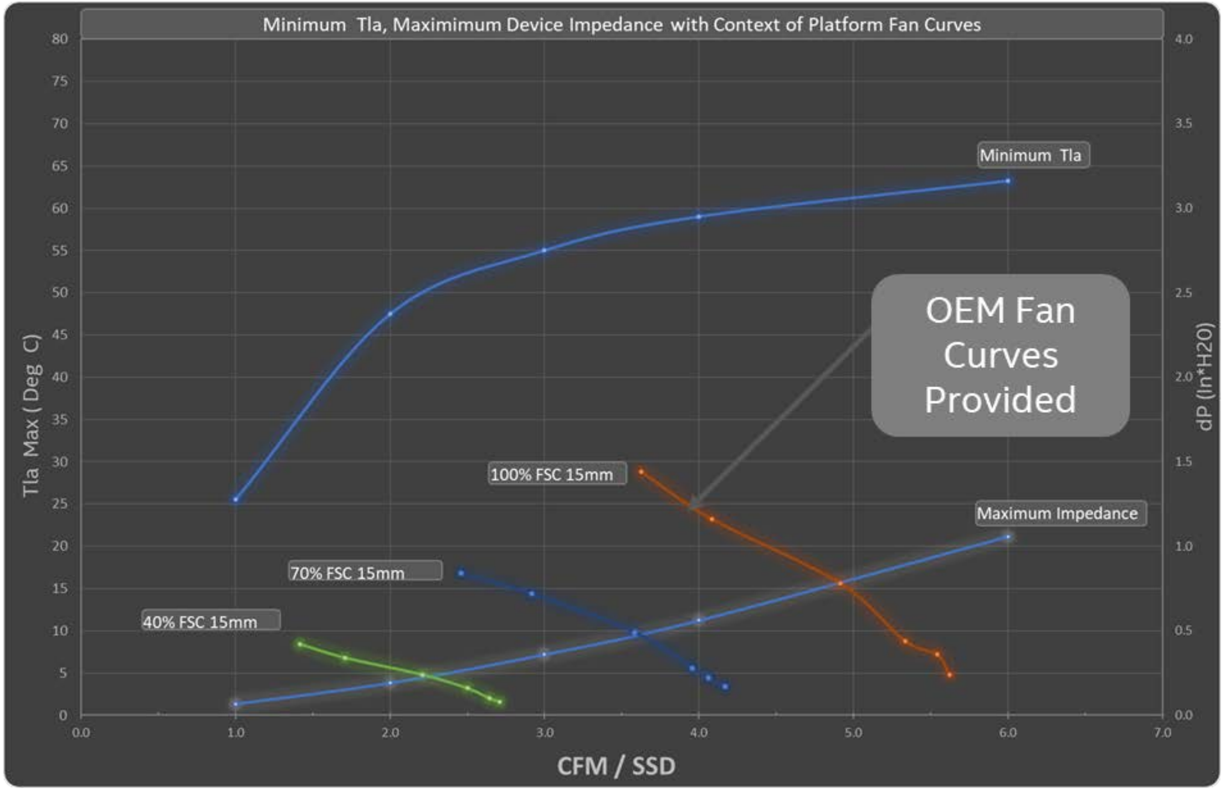
- **Specify Minimum Tla** (temperature local ambient air (or entrance temperature) drive must support.

But what impedance will be ok for the platform???

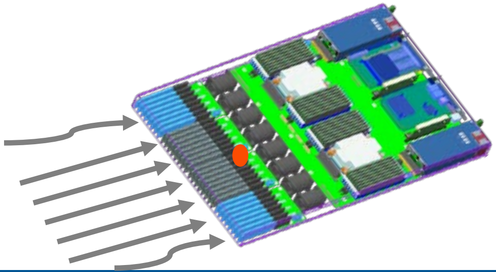
- **Provide an allowable impedance** allows vendors to meet platform requirements.



TLA vs Flowrate and dP, Example for 15mm Width E1.S



- OEM adds platform fan curves
- Multiple Fan Curves provide context for SSD design:
  - Ideal operation fan curve
  - Maximum fan curve
  - Minimum operating curve
  - Fan Curve at 100% w/ Fan Failure
- Fan curves provide necessary information to design for platform operation, at multiple fan conditions.



SSD Thermal Analysis – Detailed Workflow to get final results

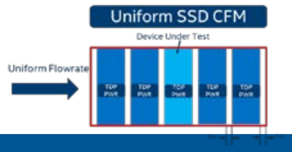
Goal is to analyze a form factor width or device design with boundary conditions that are realistic to platform integration.

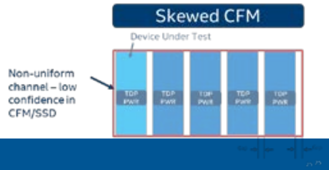
Boundary Conditions

- Width of Carrier or platform - definition
- Drive Pitch options
- # of Drives in platform

SSD Analysis

- Thermal design in keeping volume
- Analysis at uniform flow channel
- Analysis including Skewed flow Channel



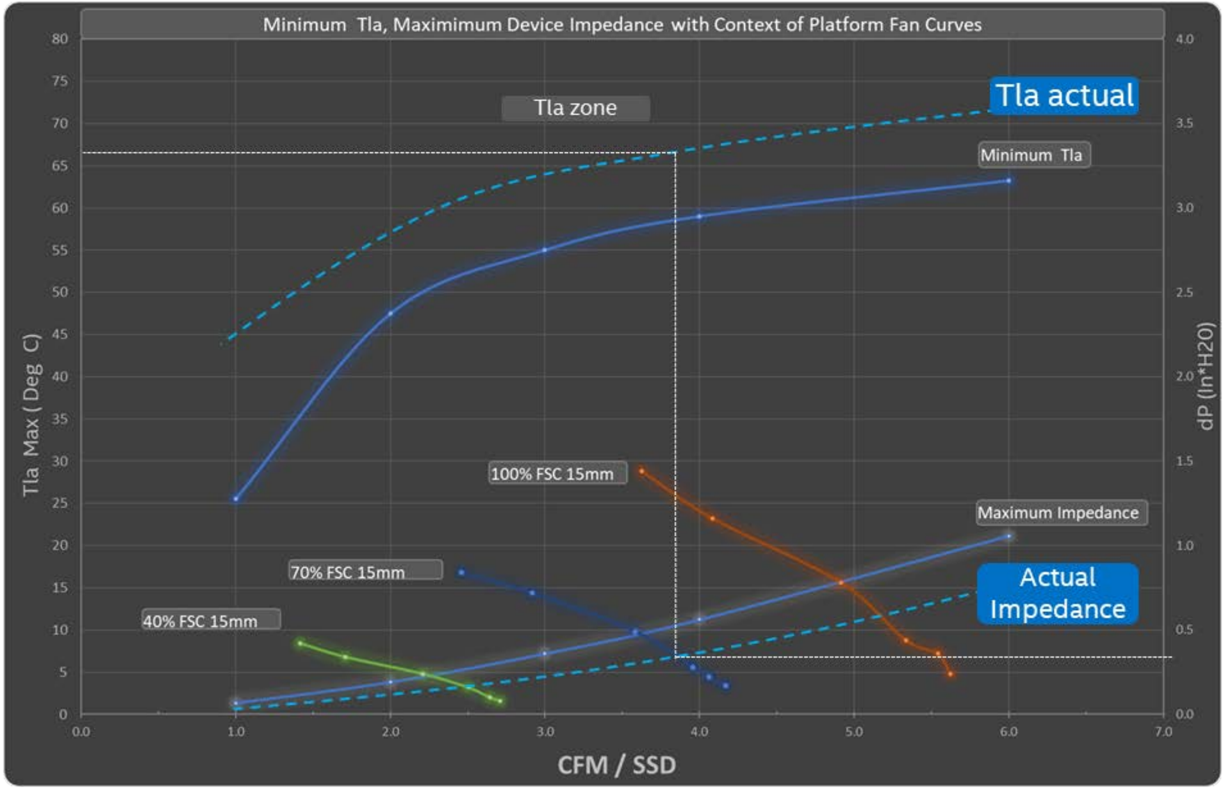


Platform Analysis

- Comparison of Analysis results against platform fan curves
- Feeds into platform metrics (comparison of drive FF)

SSD / Device Vendor Response to Specification

- **Actual Tla operating curve** – meets requirement
- **Impedance** shown **meets allowed condition**
  - Platform airflow is not limited by SSD
- **Fan / Impedance operating point**:
  - An idea of SSD CFM in platform quantified.
  - An Estimation of SSD impedance effect on platform airflow
- **Analysis allows drives to be compared in the context of platform integration (chart).**



Tla and Flowrate - How do Designs Compare @ fixed 20W SSD PWR

	Width	Fin Offset	SSDs / Platform	Fin Thk / Gap	CFM/SSD	Tla	dP SSD (in-H2O)	Platform CFM	PWR/SSD*	Total SSD PWR	Air T-rise
A	9.5	n/a	32	n/a	2.4	45	.62	76.8	20	640	16.3
C	15	5	24	1 / 1.9	3.6	57	.5	86.4	20	480	10.8
D	25	5	16	1/1.9	6.0	62	.24	96	20	320	6.5

Multiple Thermal designs are evaluated against platform integration scenarios and compared, in a common set of metrics

Power Capability of the Drive, fixed Tla, at platform fan curve operation.

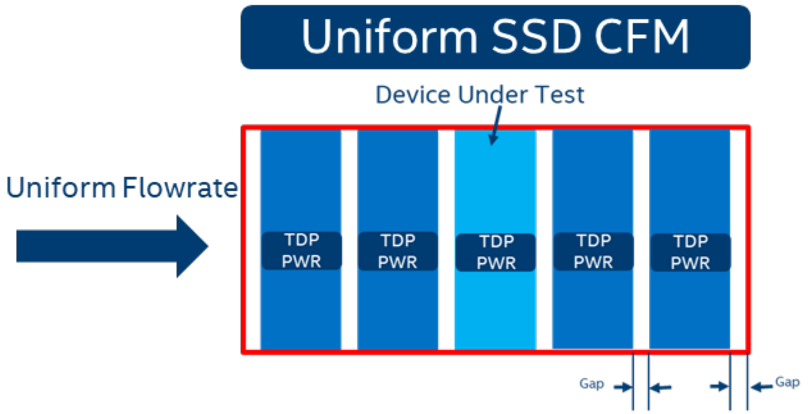
	Width	Fin Offset	SSDs / Platform	Fin Thk / Gap	CFM/SSD	Tla	dP SSD (in-H2O)	Platform CFM	Max PWR/SSD*	Total SSD PWR	Air T-rise
A	9.5	n/a	32	n/a	2.4	35	.62	76.8	25	800	20.3
C	15	5	24	1 / 1.9	3.6	35	.5	86.4	35	840	19
D	25	5	16	1/1.9	6.0	35	.24	96	45	720	14.6

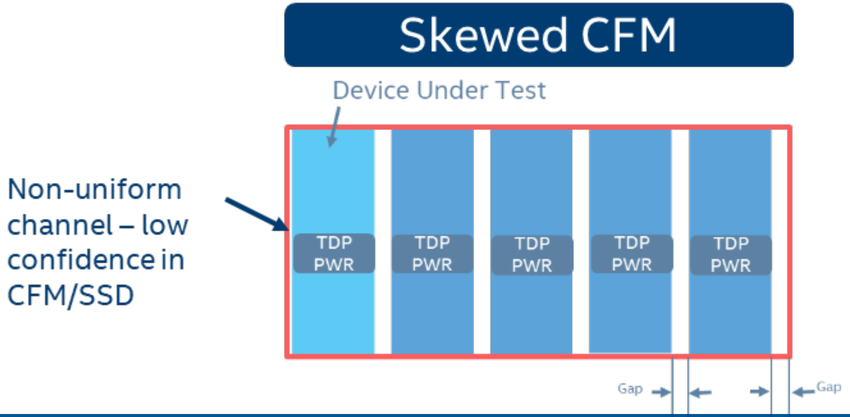
- 9.5mm
  - Great 1U capacity – 32 SSDs
  - Cross Modular with 25mm
- 15mm
  - Great 1U total power – 840W
  - Good 1U capacity – 24 SSD
- 25mm
  - Lowest impedance – down stream thermal advantage
  - Best SSD power capability (45)
  - Best SSD thermal advantage

Backup Slides

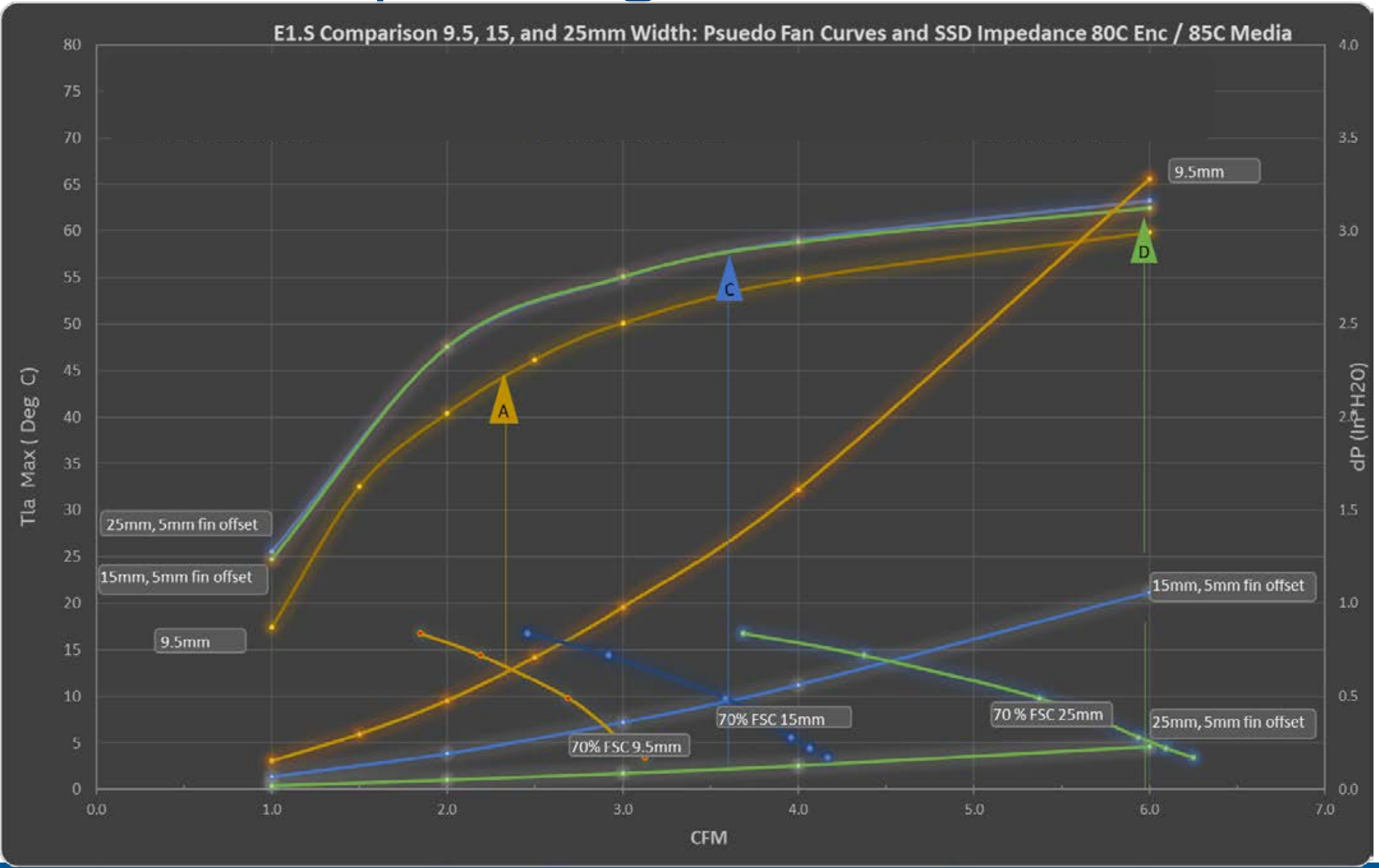
Evaluating the Form Factor – Thermal Potential!

- **Goal: Consistent method across industry** to compare thermal performance of SSD thermal design(s)
- **Approach** – achieve **uniform flowrate through channels** – "simple comparison"
    - Some platform configurations can skew flowrate if not uniform channel thickness.
- **Minimum 3 drives** ISO powered, focus on middle drive thermal response.
    - T-rise contribution included – real power dissipated.





What does all this mean – comparison? Looking at 9.5, 15, and 25mm FF impedance: @ 80C Enc / 85C Media

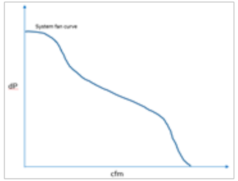


Trend: Increasing width achieves better system airflow, higher Tla, naturally achieves higher flow on the fan curve.

Methodology “Strawman”

Focus on realistic operating point – increasing accuracy beyond iso-CFM

Existing Platform Fan Curve



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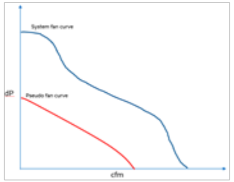
Fan Curve Derating Pseudo Fan Curve



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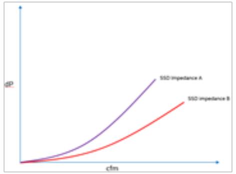
SSD Design – Impedance Curves



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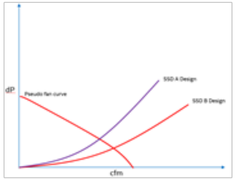
Pseudo Fan Curve Intersects SSD Impedance Curve



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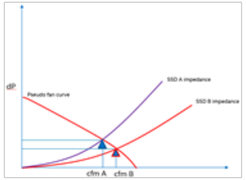
True operating point of SSD’s



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Compare Thermal Capability – Operating points