LSI
An Avago Technologies Company

SandForce DRIVEN
LSI

The Next Generation of SSD Validation in a Landscape of Exploding Challenges

By Ross Stenfort

Director of Systems and Solutions Architecture/

Distinguished Engineer, LSI

Overview

- Problem:
  Everybody is busy! How do I scale validation?
- SSD Validation Scaling Challenges
  - Market and Resource Challenges
  - Validation Methodology Limitations
- Keys to Validations
  - Solutions to Scaling

SSD Validation Market and Resource Scaling Challenges

- Market Challenges
  - Increased SSD Form Factors
  - Increased SSD Interfaces and Protocols
  - Increased Test Requirements
- Resource Challenges
  - Increased Number of SSD Programs
  - Equipment
  - Lab Space
    - Where do all the people and equipment go?
  - Budgets
    - What is this really going to cost?

Typical Validation Methodology Scaling Limitations

- No Scaling in SSD Development Life Cycle
  - RTL, Emulation, Validation, Quality Assurance
- No Scaling Across:
  - Form Factors, Interfaces, Protocols
- Lack of Power Capabilities
- Lack of Deterministic and Random Error Injection and Recovery tests
- Many different/incompatible platforms with loosely structured test scripts
  - Fragmented Tool Sets
- Random failures with difficulty to reproduce/validate fixes…

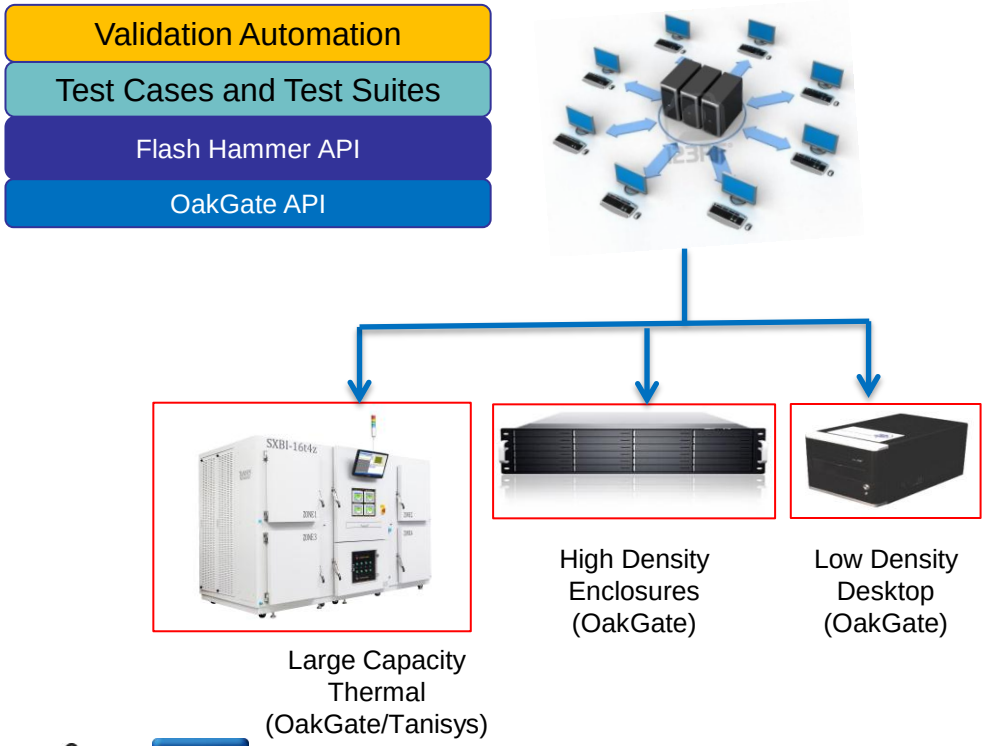
SSD Validation Keys To Scaling

- Resources need to be highly efficient
  - People need to be focused on high value tasks
  - Equipment
- Automation and validation suites need to scale
  - Test platform and suites needs to scale across the SSD development life cycle
  - Across form factors
  - Across interfaces and protocols
    - Leveraged Development with industry transitions
  - Across geographies
- Increased Capabilities
  - Power
  - Error injection/recovery
  - Thermal
  - Debug
- Financial model with capabilities at a defined cost

Validation Solution: Flash Hammer™

- Legacy Validation Solutions
  - Chaotic and non-scalable

- Flash Hammer
  - Scaling For The Next Generation



Flash Hammer Scaling Metrics

Validation Scaling Metrics	Capability
SSD Development Life Cycle	RTL /Emulation /Validation/ Quality Assurance
Form Factors	Yes
Interfaces	SATA/ PCIe
Protocols	SATA/ AHCI/ NVMe
Automation	Yes
Thermal	Yes
Individual SSD Power Control	Measurement and On/Off
Performance	Yes
Error Injection/Recovery	Directed and Random
Debug and Reproducibility	Directed and Random
Individual Drive Traffic Control	Yes

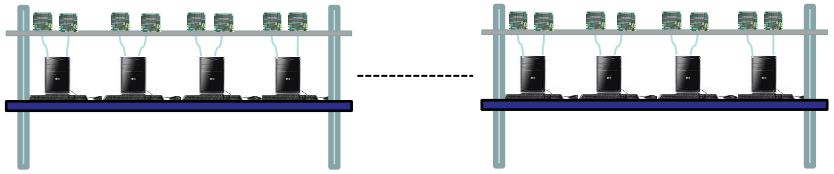
Flash Hammer RTL Simulation

Flash Hammer
Rack of 96
SATA Drives

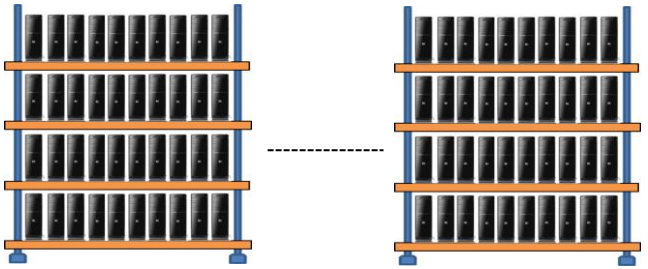
Lab & Power Density Improvement

Legacy Infrastructure

Bench Based: 8x3, 12 + Benches



High Density Shelves: 4x3, 4 Shelves



Flash Hammer Infrastructure

SATA

44U Rack
96 SATA SSDs
OakGate

PCIe

44U Rack
256 PCIe SSDs
OakGate

Thermal

10.5x5.5 Box
1024 SATA SSDs
512 PCIe x4 SSDs
OakGate/Tanisys

Flash Hammer Improvements

Up to a 14X Lab Density Increase
Up to 25X Power Density Increase

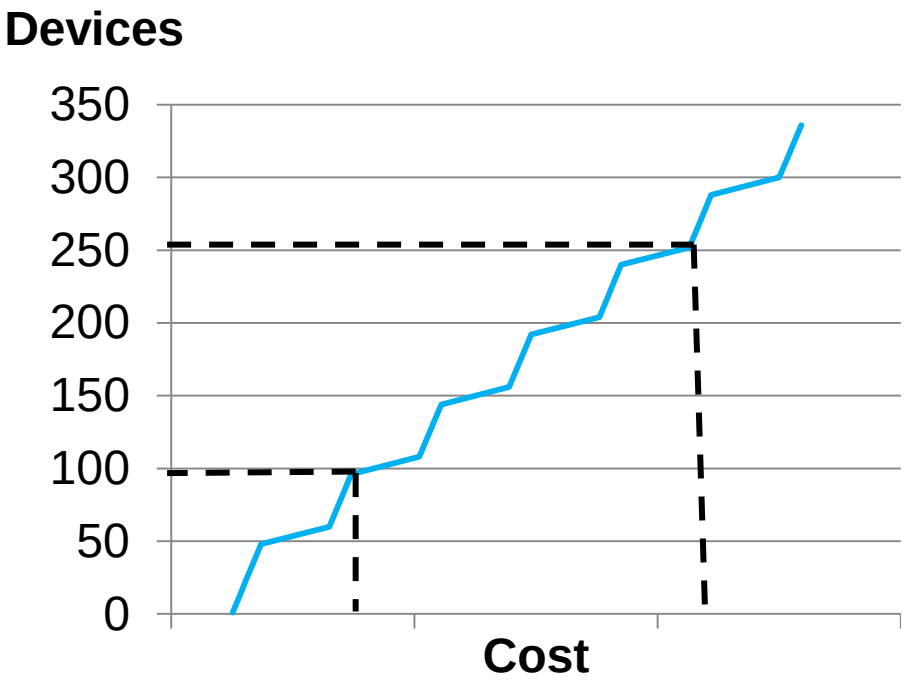
Interface	DUT's per SQ/FT / Infrastructure Power per DUT			
	Legacy SSD's		Flash Hammer	
	Bench	Shelf	HD Rack	Thermal
SATA	3 / 50	6.67/ 50	16/ 7.3	17.7/ -
PCIe	3 / 50	6.67/ 50	42.6/ 2.1	8.8/ -

LSI
An Avago Technologies Company

SandForce DRIVEN LSI

Flash Hammer Cost Structure

Flash Hammer Infrastructure allows a financial model with capabilities at a defined cost



Total Infrastructure Cost

Flash Hammer Summary

Validation Capability Metric	Pass/ Fail
SSD Development Life Cycle	✓
Form Factors	✓
Interfaces	✓
Protocols	✓
Automation	✓
Power	✓
Thermal	✓
Individual SSD Traffic Control	✓
Error Injection/Recovery	✓
Debug and Reproducibility	✓

Validation Resource Challenges	Criteria	Pass/ Fail
People	Efficient	✓
Labs and Equipment	Density Improvement – Up to 14X	✓
Budget	Predictable Cost	✓
Geographies	Able to use 24x7	✓

SSD Market Challenges	Pass/ Fail
Increased SSD Form Factors	✓
Increased SSD Interfaces and Protocols	✓
Increased Test Requirements	✓

- Flash Hammer Leading Edge Validation For The Future
- Evaluating Enabling Customers With This Capability