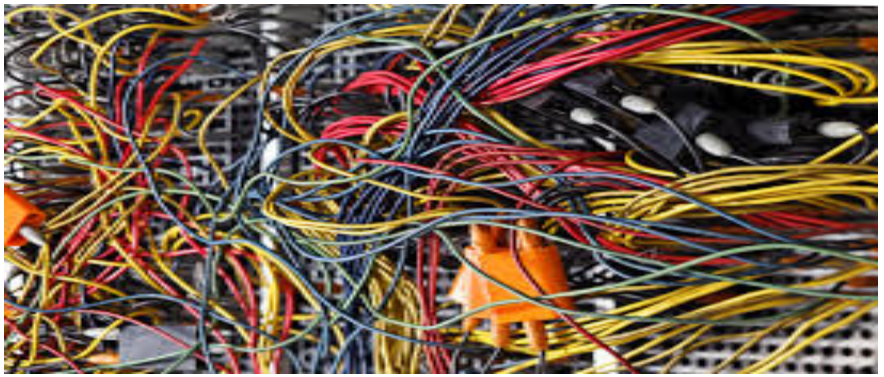
SSD Connectivity – Exploring the Options

Paul Wassenberg

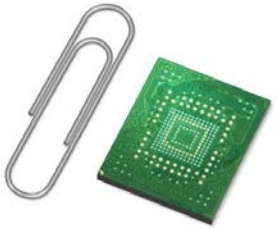
Chair, SNIA Solid State Storage Initiative

SSDs Offer Opportunities, but Beget Complexity

- HDDs have for many years been available in specific form-factors, most recently 2.5-inch & 3.5-inch
- While SSDs are available in those same form-factors, they also come in a wide variety of other shapes and sizes, each with its own connection scheme
- Additionally, the exponentially quicker responsiveness of SSDs has driven the adoption of faster interfaces
- Multi-interface connectors have arisen, providing flexibility, but adding even more complexity

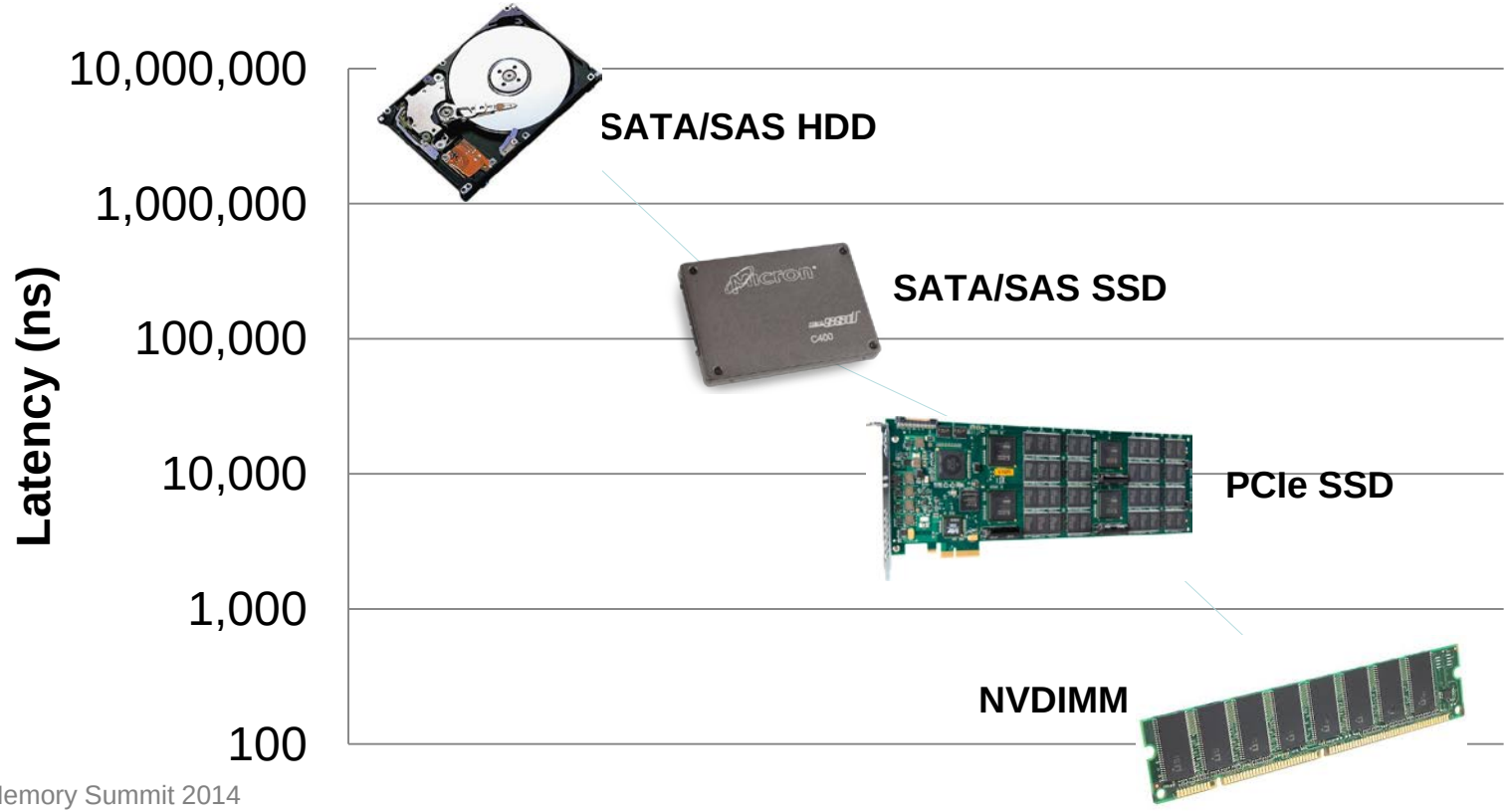


SSDs Come In More Shapes & Sizes



Moving Closer to the Processor

- Because Flash can respond orders of magnitude more quickly than an electro-mechanical mechanism, interface overhead becomes noticeable on an SSD



Just Getting Started

- In order to replace HDDs in certain applications, SSDs were designed in the same form-factor and with the same interface
  - 2.5-inch / 3.5-inch
  - SATA / SAS

- Whether HDD or SSD, connectors and cables are identical and widely available

Next Stop - PCIe

- Traditionally, systems utilized a host bus adaptor with SATA/SAS on one end and PCI Express on the other
- Bypassing the adaptor by putting a PCIe interface on the drive results in significant overhead reduction
- First PCIe SSDs were traditional CEM form-factor

- Newer PCIe SSDs are in 2.5/3.5-inch form-factor

- M.2 SSD supports PCIe (and SATA)

Getting Closer…

- An NVDIMM plugs directly into the memory bus, closer still to the processor
  - Reduces overhead by orders of magnitude
- Basic NVDIMM operates out of DRAM, backs up data to Flash, using a super-capacitor to provide power when system power goes away

Connectivity - Tying It All Together

- SSDs in a card form-factor typically plug into a motherboard connector

CEM plugs into a PCIe slot

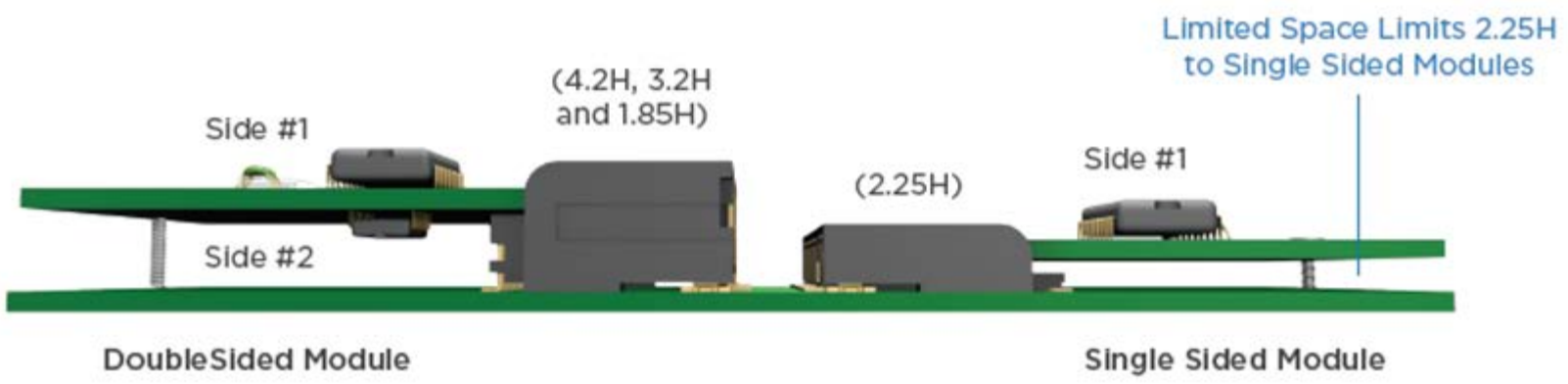
NVDIMM plugs into a DIMM connector

M.2 plugs into an M.2 connector

- 2.5/3.5-inch form-factor SSDs can plug directly into a backplane connector or via a cable

M.2 Connectivity

- M.2 SSD supports one SATA port or up to 4 lanes of PCIe
- The M.2 card is defined to be single or double-sided, enabling designers to optimize for space or capacity
- M.2 plugs into a motherboard connector, parallel to the motherboard to minimize height



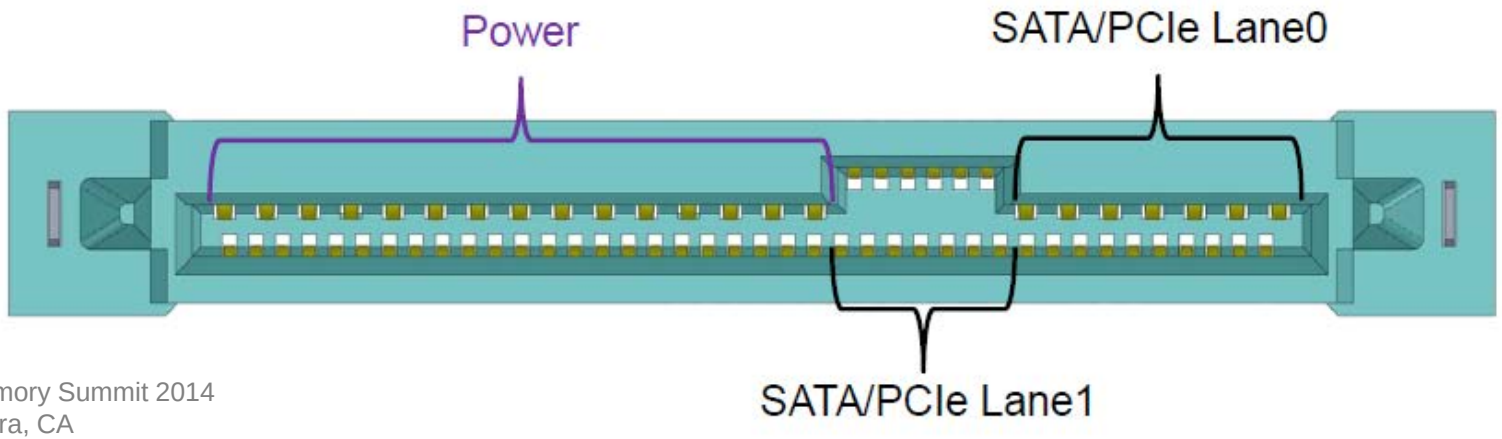
Drawing is courtesy of TE Connectivity

2.5/3.5-inch Connectivity

- 2.5/3.5-inch form-factors imply the use of cables in some implementations
  - Cables offer mechanical flexibility, but electrical challenges
- The SATA/SAS connectivity infrastructure is well established
- Although not a new technology, PCIe is a new storage interface
- New interfaces (and the 2.5/3.5-inch form-factors) require new connectors

SATA Express = Client PCIe

- SATA Express defines an ecosystem where PCIe & SATA coexist
- PCIe drive with a SATA Express connector supports up to two lanes of PCIe
- SATA Express host supports PCIe or SATA drives
- To keep cables inexpensive, carrying 100MHz PCIe RefClock is optional (SRIS)



SATA Express Connectivity

	SATA Express Host Cable Receptacle	SATA Express Device Cable Receptacle	SATA Express Host Receptacle	SATA Cable Receptacle	SFF-8639 Backplane Receptacle
SATA Express Host Plug	✓			✓	
SATA Express Device Plug		✓	✓		✓ b
SATA Device Plug		✓	✓	✓	✓ c

Legend: ✓= **Mates & is functional** **Blank = Does not mate**

Notes:

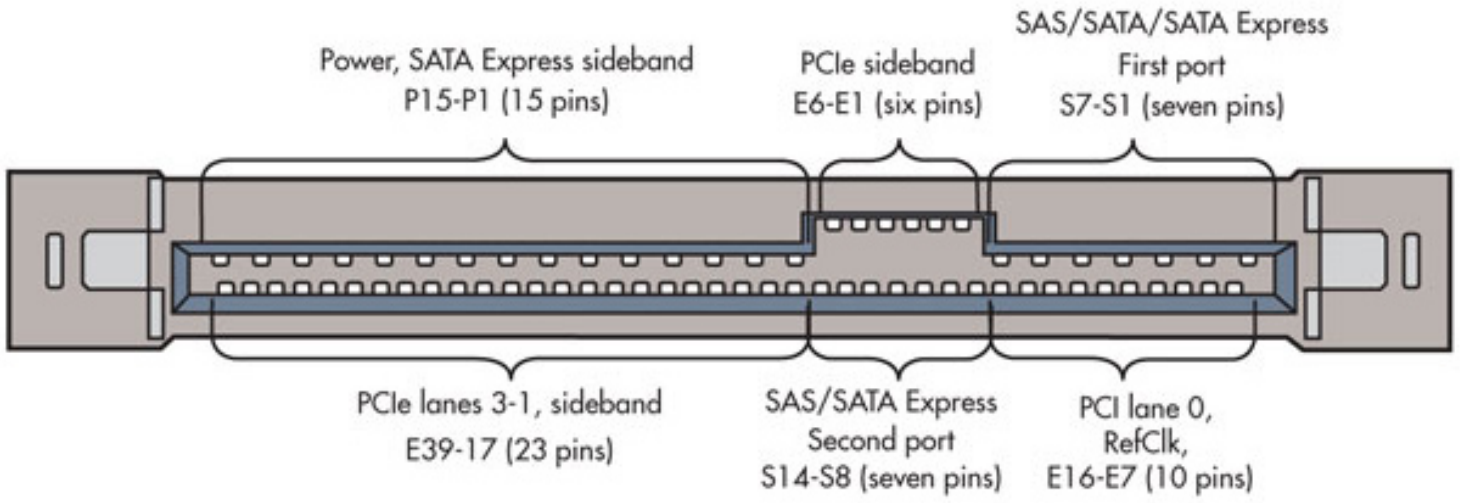
a. SATA Express host supports PCIe and SATA devices

b. Will be functional only if the host supports PCIe devices

c. Will be functional only if the host supports SATA devices

SFF-8639 Connector

- Connector used on enterprise PCIe SSDs in 2.5/3.5-inch form-factor
- Supports SATA, SAS, and up to 4 lanes of PCIe
- Host connector is compatible with SATA Express



Summary

- SSDs have driven the creation of many options
  - Interfaces: SATA, SAS, PCIe
  - Form-factors: 2.5/3.5-inch, cards
  - Connectors: SATA Express, SFF-8639, card-edge

- Having many options can cause confusion, but a thorough understanding of those options will provide designers with the flexibility they require