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

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<th>SATA Express Host Cable Receptacle</th>
<th>SATA Express Device Cable Receptacle</th>
<th>SATA Express Host Receptacle</th>
<th>SATA Cable Receptacle</th>
<th>SFF-8639 Backplane Receptacle</th>
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**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
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