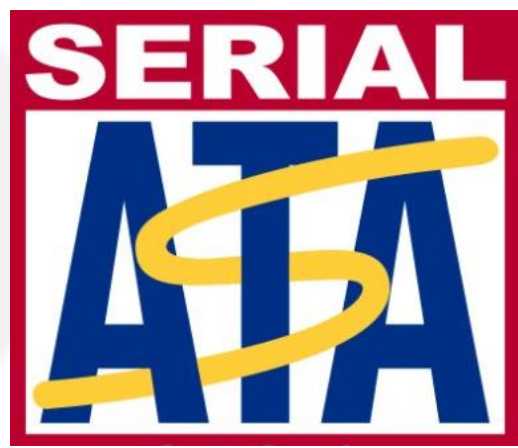




SATA Evolves

SATA Specification v3.2

FMS 2013

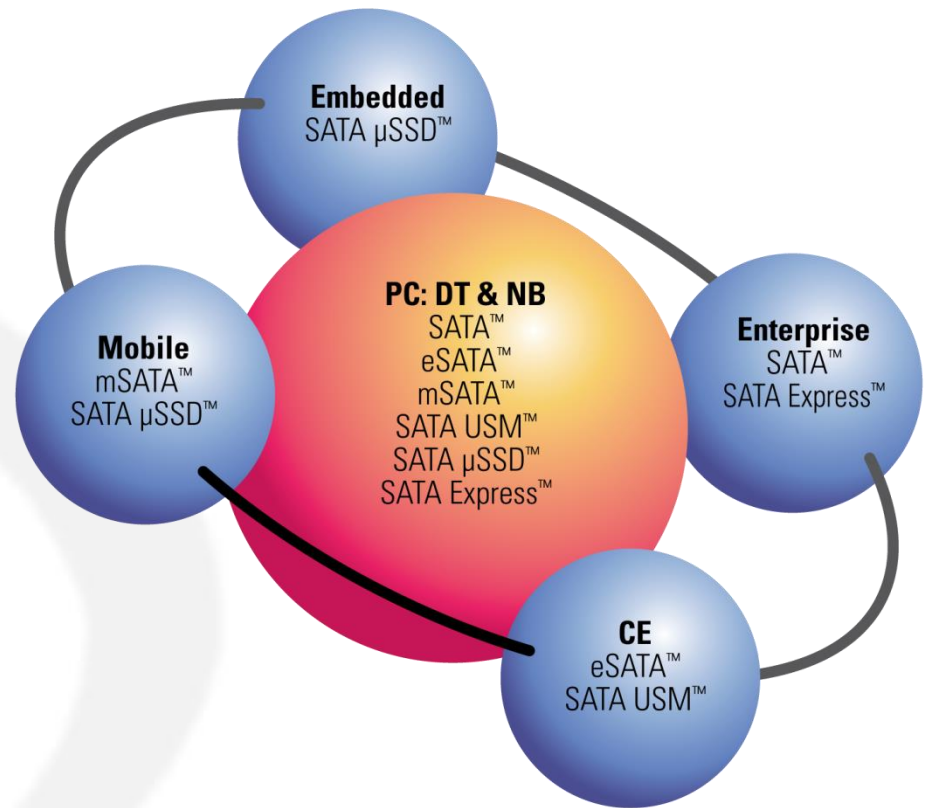




SATA is Everywhere

SATA is the de facto standard for PC storage

Since its introduction, SATA has evolved into new application spaces and now provides storage interface solutions for HDDs, ODDs, SSDs, and Hybrid Drives in client, mobile, enterprise, consumer electronics, and embedded storage markets





Storage Market Evolves

- SSDs continue to grow market share and increase in performance
 - Small form-factor SSD cards used as cache in PCs
 - Use of SSDs in enterprise environments expands
- Solid State Hybrid Drives reemerge & demonstrate almost HDD-like performance
- Reducing power consumption is more important than ever
 - Especially for “Always on, always connected” devices, such as ultrathin notebooks or tablets
- **SATA has evolved to meet market needs**

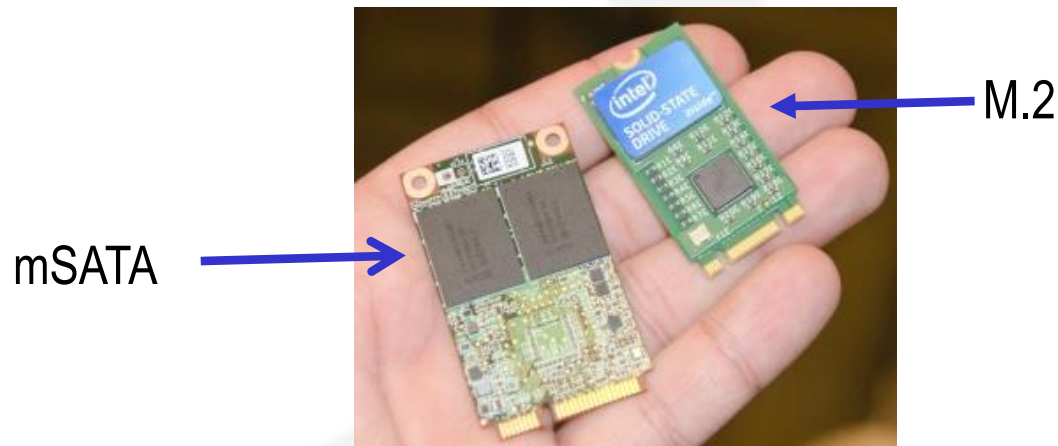


SATA Specification v3.2

- SATA-IO recently announced the ratification of SATA specification v3.2
- This latest specification includes:
 - New, faster interface
 - Additional form-factors
 - Optimization for Solid State Hybrid Drives
 - Power management enhancements
 - SATA improvements for enterprise applications

M.2 (formerly known as NGFF)

- M.2 is a small form factor card that supports applications such as WiFi, WWAN, USB, PCIe & SATA, as defined in an upcoming PCI-SIG spec
 - An M.2 card with a SATA or PCIe interface will typically be an SSD, suitable for low profile devices such as ultrathin notebooks or tablets
 - v3.2 specification standardizes the SATA M.2 connector pin layout





SATA microSSD

- The SATA microSSD standard enables developers to produce a single-chip SATA SSD for embedded storage applications





SATA Universal Storage Module

- SATA Universal Storage Module specification enables developers to incorporate connector slots into computers and consumer electronics
 - Slots accept powered storage modules with integrated SATA interfaces for expanding storage capacity
 - SATA v3.2 introduces USM Slim, which reduces the thickness of the module from 14.5mm to 9mm





SATA Power Management

- DevSleep provides another level of power management where the drive is almost completely shut down
 - Enables devices to be always on and always connected without unnecessarily reducing battery life
- Transitional Energy Reporting recognizes that there is an energy cost to moving between power management modes
 - Provides the host with detailed information about the SATA storage device, allowing the host to make more informed decisions on minimizing power consumption



SSHD Optimization

- A Solid State Hybrid Drive (SSHD) is an HDD containing a Flash cache to enhance performance
- The Hybrid Information feature provides a mechanism wherein a host can tell the drive which data to cache, further enhancing performance

Enterprise Applications

- When a drive in a RAID configuration fails due to excessive data errors, data on the failed drive can be reconstructed from the remaining drives
 - This function is called a Rebuild
- The Rebuild Assist function speeds up the rebuild process in the following manner:
 1. The host reads all the recoverable (good) data on the failed drive before it is removed from the RAID
 2. When a new drive is installed, the host writes the recovered data to the new drive
 3. The rebuild then only needs to reconstruct the unrecoverable data, which reduces the rebuild time



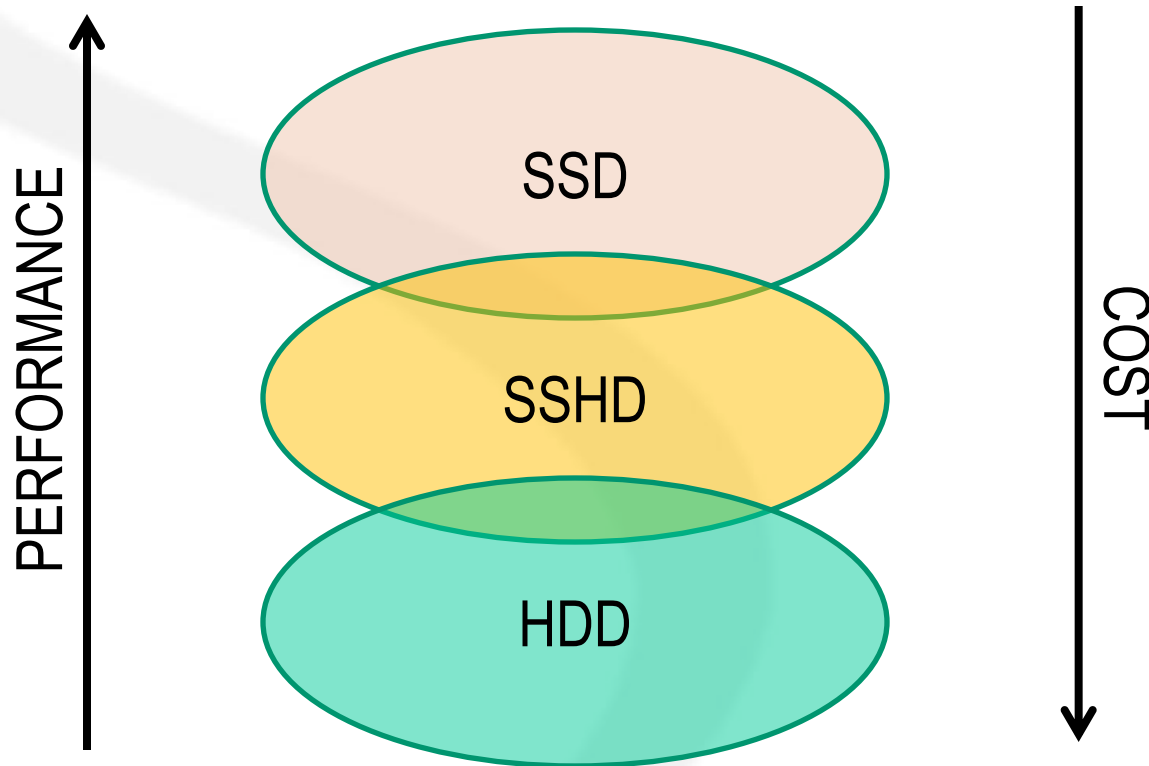
SATA Express PCIe Client Storage

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A Need for More Speed

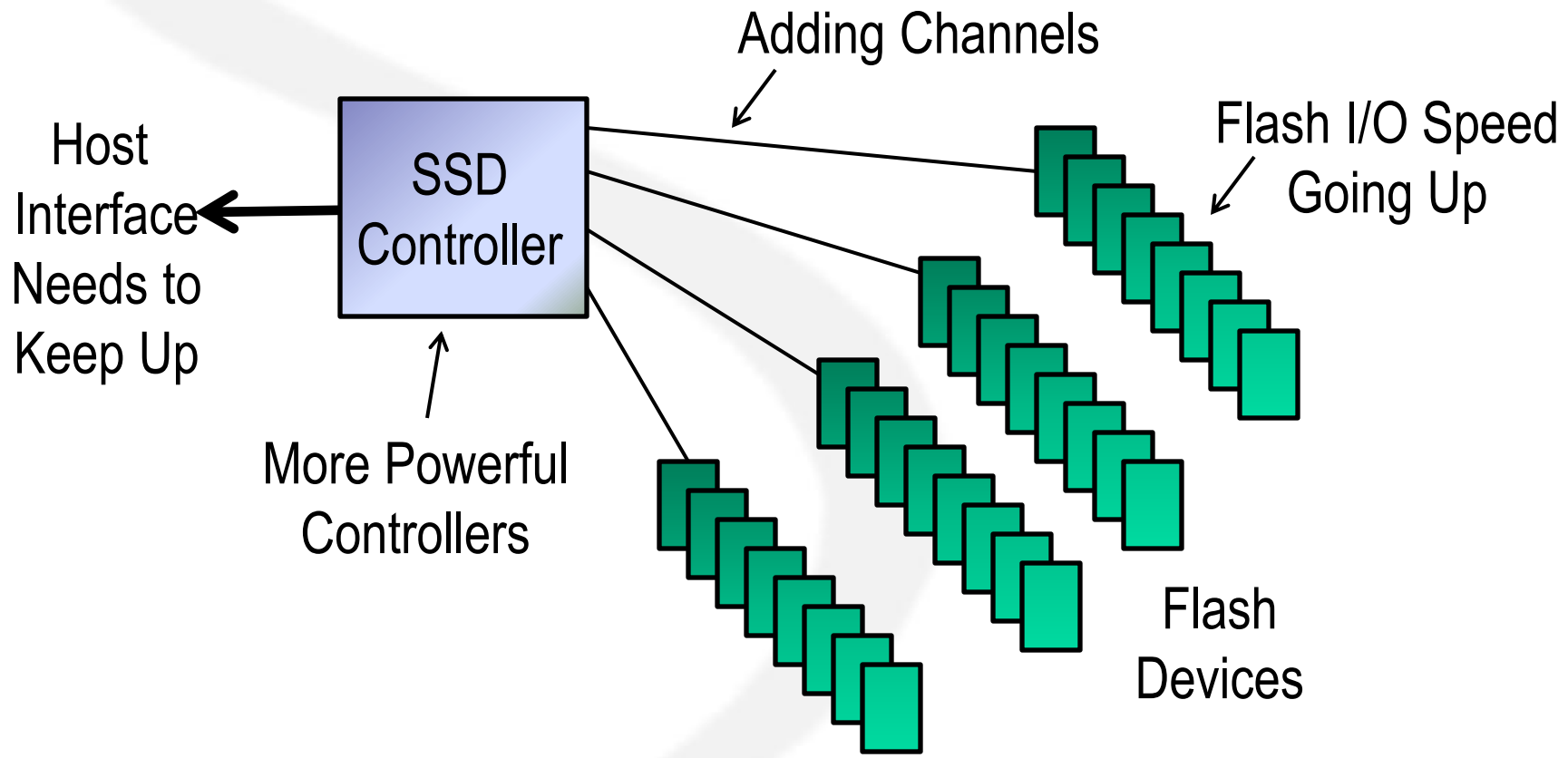
- SSDs and Hybrid Drives are driving performance



Solid State Hybrid Drive (SSHD) = HDD with Flash Cache

Getting Faster

- SSD speeds are increasing





How Do We Get There?

- SSDs and Hybrid Drives will soon need an interface faster than today's SATA 6Gb/s
- Doubling the speed of SATA would have
 - Been a lengthy development
 - Required many changes
 - Been more costly and higher power than desirable
- PCI Express (PCIe) is an established standard already present in client systems
 - Max speed of 1GBytes/s per lane; faster than SATA
 - Enables use of multiple lanes to scale performance
 - PCIe provides higher performance for less power than 12Gb SATA



The Decision

- Considering all the factors...
 - Performance – PCIe enables faster data transfers
 - Time-to-market – PCIe is an established standard
 - Power – PCIe is power-efficient

- SATA-IO decided to create SATA Express



What is SATA Express?

- The SATA Express specification defines host and device connectors that support SATA or PCIe
- Provides an ecosystem in which SATA & PCIe can coexist



Client PCIe Device

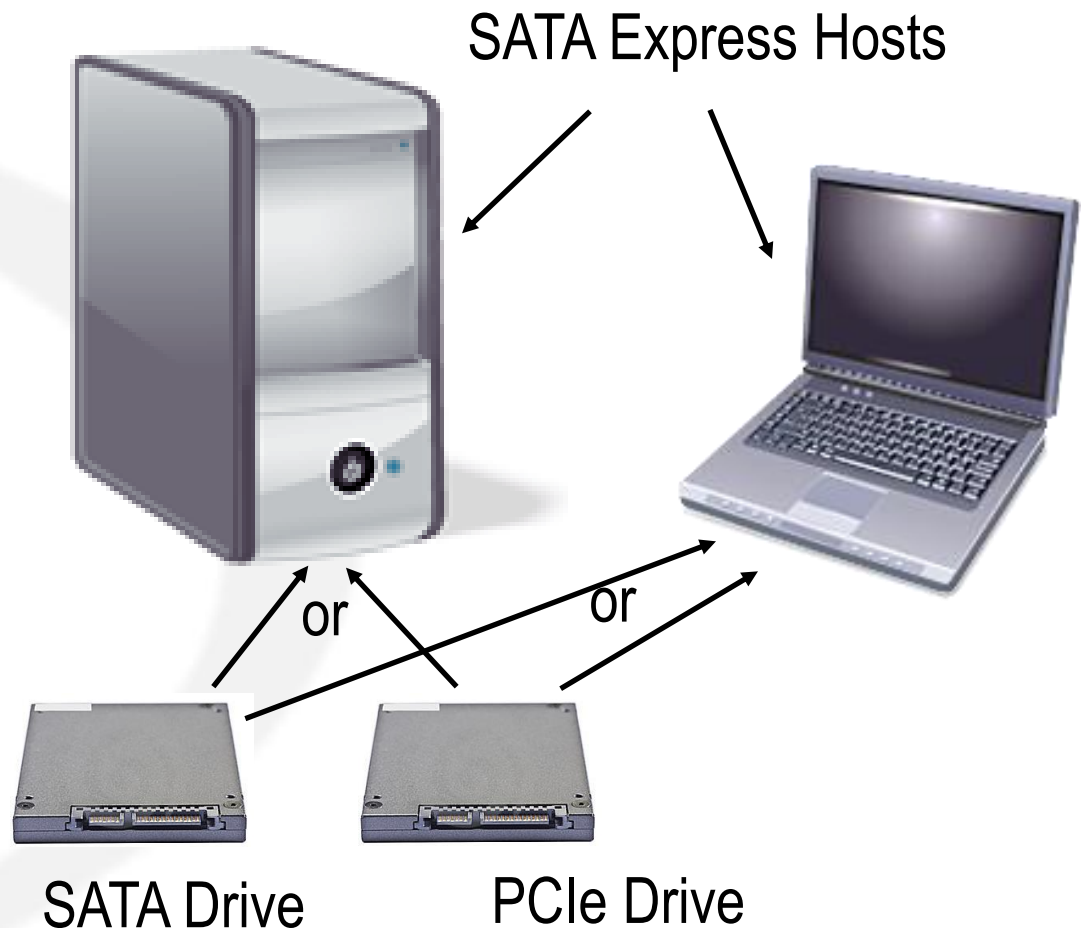
- SATA Express enables a client PCIe storage device containing a SATA Express device connector in an HDD-type form factor, e.g. 2.5-inch
- SATA Express device connector
 - Supports up to two PCIe lanes or one SATA port
 - Pins are multiplexed, so only PCIe or SATA can be active at a time



SATA Express Host

- A SATA Express host utilizes a SATA Express connector to connect to and function with a SATA or a PCIe storage device

- SATA Express host connector
 - Supports up to two PCIe lanes or two SATA ports
 - A separate signal, driven by the device tells host if device is SATA or PCIe

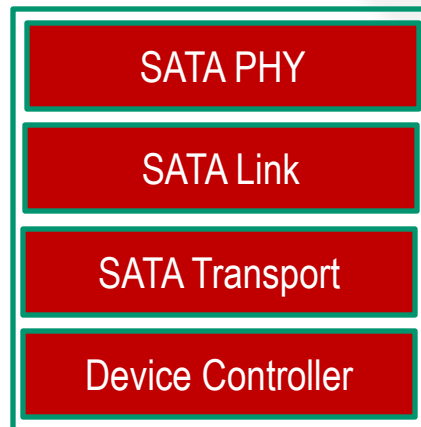




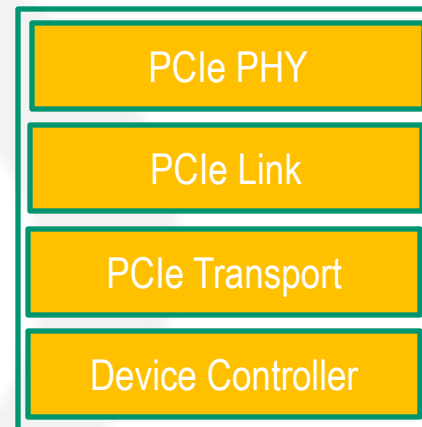
SATA Express is PCIe

- The SATA Express environment is pure PCIe
- There is no SATA link or transport layer, so there's no translation overhead
- Users will see the full performance of PCIe

SATA Device



PCIe Device





Performance

- When comparing performance, data transfer rate (GB/s) is what matters, NOT the interface bit rate (Gb/s)
- PCIe 3.0 uses a more efficient encoding scheme, so translating from bit rate to data transfer rate uses a different formula than SATA or PCIe 2.0/1.0
- As defined by SATA Express, a client PCIe device supports up to 2 lanes of PCIe
 - Two PCIe 3.0 lanes provide 2GB/s; one lane = 1GB/s
 - Two PCIe 2.0 lanes provide 1GB/s
- Whereas 6Gb/s SATA = 0.6GB/s



RefClock Options

- Until recently, PCIe **required** a 100MHz Reference Clock to be carried across the interface
- A PCIe storage device using a cable would need an expensive shielded cable to minimize noise
- Separate RefClock with Independent SSC (SRIS) was added to the PCIe spec
- Provides a mechanism for a PCIe device to:
 - Not require RefClock from the host (SRIS mode) for cabled configurations
 - Accept a host-supplied RefClock if a cable is not used (e.g. drive is plugged directly into a backplane)



SATA Express Software Architecture

- Although not defined by the specification, there are two choices for a PCIe storage device register interface/command set:
 1. AHCI, which is used for SATA, would enable a PCIe device to be compatible with SATA software environments
 - AHCI is supported in most major operating systems
 - But AHCI is not optimized for SSD performance
 2. NVMe Express is architected for high performance PCIe SSDs
 - But NVMe does not provide SATA software compatibility
 - Drivers for Windows, Linux, and other operating systems are available at www.nvmexpress.org



Summary

- PCIe is needed as a device interface for high performance SSDs and solid state hybrid drives
- SATA Express enables a migration path to PCIe, while enabling coexistence with SATA
- SATA 6Gb/s is adequate for most storage devices, including HDDs for the foreseeable future
- It will continue to be enhanced with new features as needed for new markets and applications



For More Information...

- Visit the SATA Express page on the SATA-IO site at:
www.sata-io.org/sata-express