SDC
STORAGE DEVELOPER CONFERENCE
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PCI Express® Architecture: Driving the Future of Storage I/O

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Agenda

- **Recent Storage Industry Trends**
- PCIe™ Technology as Storage Interconnect
- Summary & Call to Action

Storage Industry Trends

- Massive growth in data driving SSD adoption
  - Anticipated growth to $10B by 2018

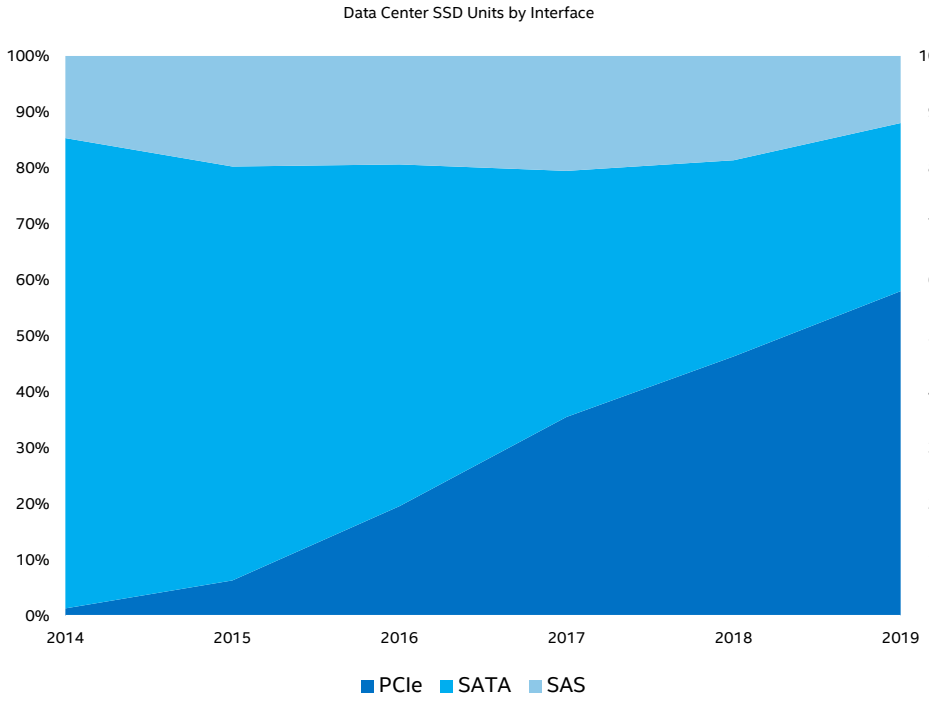
- Robust growth in Data Center Storage TAM
  - SSD adoption growing at faster than 40%

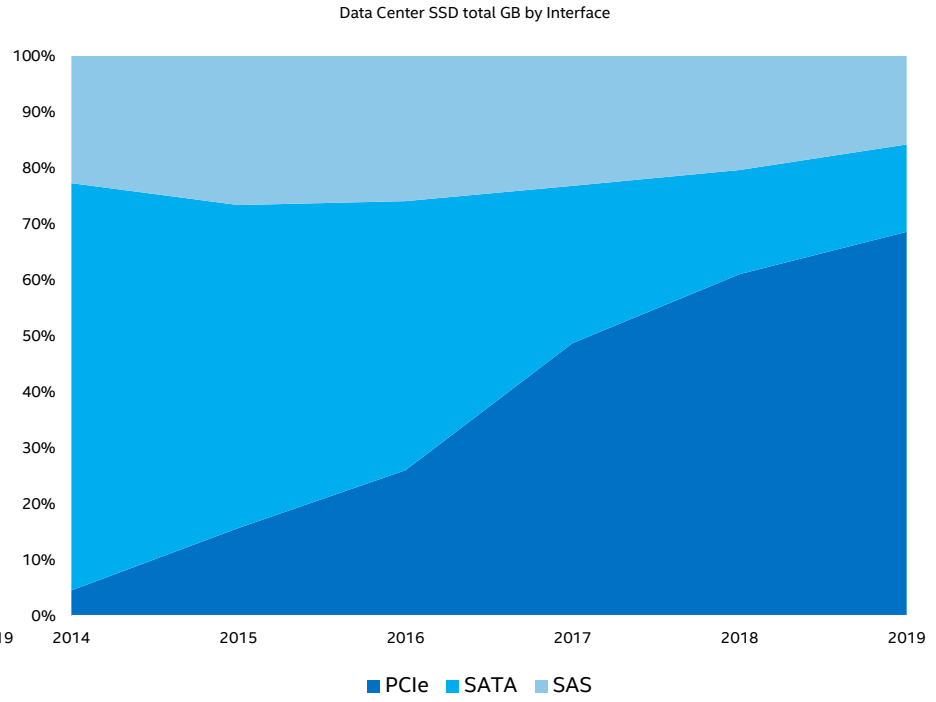
- Accelerating NVMe* adoption in Data Center
  - Over half of Data Center SSDs by 2017

Source: Forward Insights Q1'15

Storage Industry Trends

- PCIe adoption pace makes it *the* interconnect for storage
  - Outpacing other interconnects in both units and bandwidth/capacity





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PCIe I/O for Storage – Performance

- PCIe 4.0 specification
  - 16GT/s performance w/ high-volume manufacturability
  - Backwards compatible to PCIe 1/2/3
  - Standardized repeater for long channels (>10”, 1 connector)
  - Base spec on track for rev0.7 maturity by 4Q’15-1Q’16

	Raw Bit Rate	Link BW	BW/Lane/Way	Total BW x16
PCIe 1.x	2.5GT/s	2Gb/s	~250MB/s	~8GB/s
PCIe 2.x	5.0GT/s	4Gb/s	~500MB/s	~16GB/s
PCIe 3.x	8.0GT/s	8Gb/s	~1GB/s	~32GB/s
PCIe 4.0	16GT/s	16Gb/s	~2GB/s	~64GB/s

- Near-0 link idle power
  - L1 Sub-states ECN published in 2014

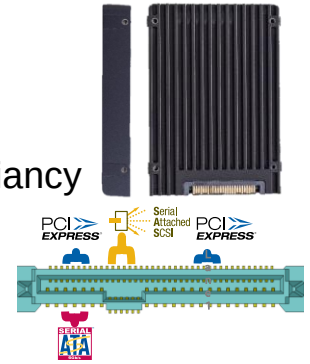
Sub-state		Status			Targets	
Link	PHY	PLL	Tx/Rx	CM	1-Lane Power	Exit Latency
L1	P1	On/Off	Off/Idle	On	~10mW	<5µs
L1.1	P1.1	Off	Off	On	<500µW	<20µs
L1.2	P1.2	Off	Off	Off	<10µW	<70µs

- ½ swing spec for lower link active power
  - Available since PCIe 1.1 (circa 2004)

- M-PCIe™ for PCIe functionality where M-PHY* exists

PCIe I/O for Storage – CEM++ Expansion

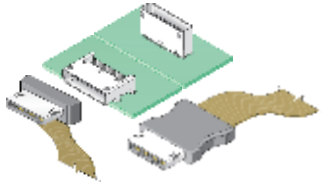
- SFF-8639 (U.2)
  - Dense packing 2.5” SSDs, hot-plug, serviceable, x1/x2/x4, multi-topology, compliancy



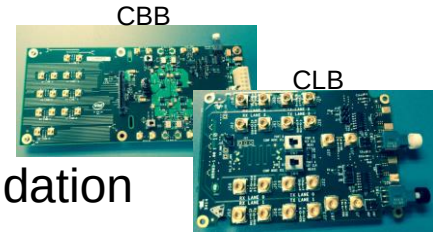
- M.2
  - 42/80/110mm, boot or max storage density, client & server compliancy, compliancy

- BGA
  - For volume-constrained mobile platforms, saves 0.5-1.5mm on Z-height and ~20% on area

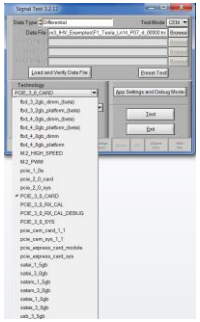
- OCuLink w/ SRIS
  - Low-cost, low EMI, x1/x2/x4, internal cabling for SATA transition



PCIe I/O for Storage – Compliance



- Industry-leading compliance program
  - MB & AIC test fixtures – Test channels for silicon validation
  - Sigtest – Jitter/voltage noise separation for signal integrity
  - CV – Configuration space verifier



- SFF-8639 (U.2) & M.2 also supported
  - PCI-SIG extending its C&I program to SFF (U.2) & M.2
  - Initial SFF (U.2) C&I testing completed in August 2015
  - Future C&I workshops will integrate M.2 testing

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Summary

- SSD attach is transitioning to PCIe interconnect
- PCIe architecture is all you need for storage applications in any device or system topology
  - PCI-SIG has numerous form factors for increased flexibility in storage I/O expansion
  - PCI-SIG has robust compliance program for end-to-end interoperability
- PCIe 4.0 architecture provides unbeatable performance headroom with low power features

Visit www.pcisig.com for more info on PCIe technology!