



PCI Express® Futures

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Disclaimer

The information in this presentation refers to specifications still in the development process. This presentation reflects the current thinking of various PCI-SIG workgroups, but all material is subject to change before the specifications are released.

Increased Speed

PCIe Speed Evolution

- Introduced at 2.5GT/sec
 - ✓ Commonly called 2.5GHz
 - PCI-SIG eventually adopts GigaTransfers per Second (GT/s) terminology
 - ✓ 100 MHz reference clock provided
 - Eases synchronization between ends
 - Particularly when Spread Spectrum Clocking is used
 - Optional, but nearly universal in traditional “PC” world
 - ✓ 8b/10b encoding used to provide DC balance and reduce “runs” of 0s or 1s which make clock recovery difficult
- Specification Revisions: 1.0, 1.0a, 1.1

PCIe Speed Evolution (cont'd)

- Speed doubled to 5GT/sec
 - ✓ Reference clock remains at 100 MHz
 - Lower jitter clock sources required vs 2.5GT/sec
 - Generally higher quality clock generation/distribution required
 - ✓ 8b/10b encoding continues to be used
- Specification Revisions: 2.0, 2.1
 - ✓ Devices choosing to implement a maximum rate of 2.5GT/sec can still be fully 2.x compliant!

PCIe Speed Evolution (cont'd)

2 x 5 = ?

PCIe Speed Evolution (cont'd)

2 x 5 = 8 ???

- Speed “doubled” over PCIe 2.x 5GT/sec
- 8GT/sec electrical rate
- Reference clock remains at 100 MHz
 - Very similar requirements to 5GT/sec mode
- Specification Revisions: 3.0
 - ✓ Devices choosing to implement a maximum rate of 2.5GT/sec or 5GT/sec can still be fully 3.0 compliant!

PCIe Speed Evolution (cont'd)

- 128/130 encoding reduces overhead from the 20% loss of 8b/10b
 - ✓ Original plan was scrambling-only for exactly 2x the 5GT/sec bandwidth
 - $5000\text{Mb/sec} / (10\text{bits/byte}) = 500\text{MB/sec per lane}$
 - $8000\text{Mb/sec} / (8\text{bits/byte}) = 1000\text{MB/sec per lane}$
 - ✓ Pure 128/130 encoding is ~1.5% loss

- Scrambling replaces DC-offset and run-length reduction functions of 8b/10b

PCIe Speed Evolution (4.0 Plan of Record)

$$2 \times 8 = ?$$

PCIe Speed Evolution (4.0 Plan of Record)

$$2 \times 8 = 16$$

- 16GT/sec electrical rate
- Reference clock remains at 100 MHz
 - ✓ New option for independently clocked Spread Spectrum mode
- Retains “3.0” enhancements
 - ✓ 128/130 encoding
 - ✓ Link equalization
- Devices with a max rate of 2.5GT/sec, 5GT/sec, or 8GT/sec can still be fully 4.0 compliant!

PCIe Speed Evolution (4.0 Plan of Record)

- When?
 - ✓ Anticipate spec complete around Q4 2015?
- Where is the work being done?
 - ✓ PCI-SIG Electrical Workgroup (EWG)
<http://www.pcisig.com/apps/org/workgroup/pciexpress/electrical/>
 - ✓ PCI-SIG Protocol Workgroup (PWG)
<http://www.pcisig.com/apps/org/workgroup/pciexpress/protocol/>
- Where to find out more?
 - ✓ Watch for Review Drafts to all-members e-mail
 - Respond with feedback!
 - ✓ Watch PCI-SIG Review Zone
http://www.pcisig.com/specifications/pciexpress/review_zone

Independent Reference Clocks with Spread Spectrum

Independent Reference Clocks with Spread Spectrum

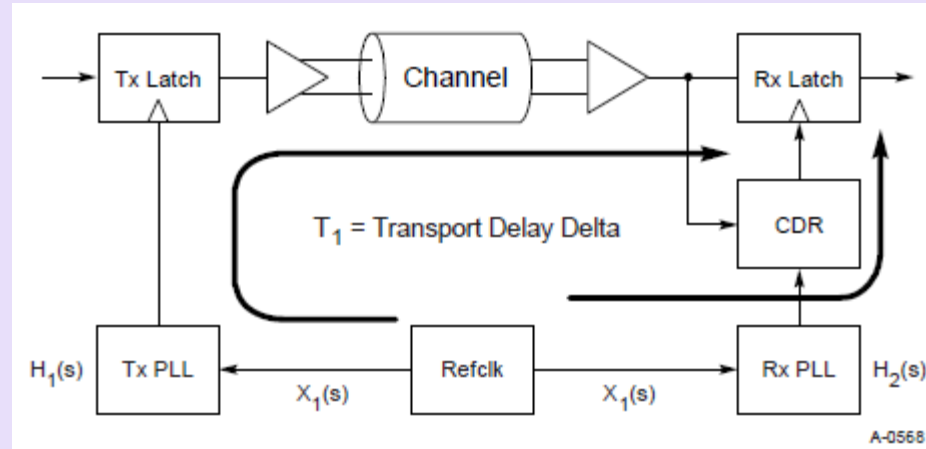
- Base Specification Defines Independent Clocking Mode today
 - ✓ RefClk not used between upstream and downstream components
 - ✓ Explicitly forbids Spread Spectrum Clocking (SSC)
- Cabled environments need SSC, want to NOT carry RefClk
 - ✓ PCI-SIG Small Footprint Cable
 - ✓ Other cable specs

Independent Reference Clocks with Spread Spectrum

- Requires Base Specification changes
 - ✓ Larger elasticity buffer
 - ✓ More frequent insertion of SKIP ordered set
 - ✓ Non-trivial receiver changes in Clock Data Recovery (CDR) logic
- Released as ECN to 3.0

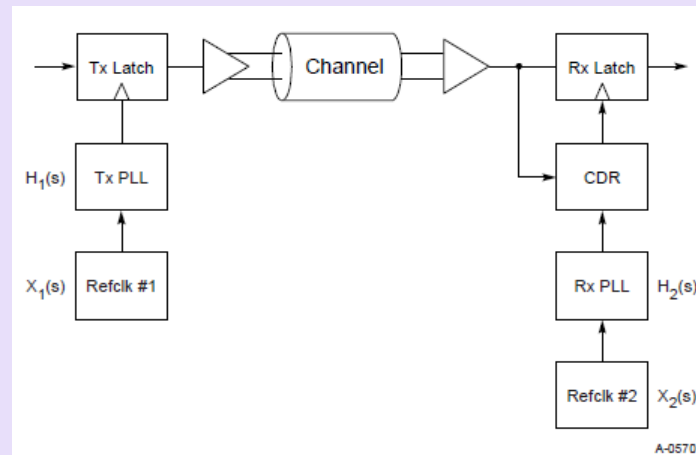
Independent Reference Clocks with Spread Spectrum

- Today's Common Clock mode



- Independent RefClk mode

✓ Today: No SSC



Independent Reference Clocks with Spread Spectrum

- When?

- ✓ Available NOW

- http://www.pcisig.com/specifications/pciexpress/specifications/ECN_SRIS_2012_10_Jan_2013.pdf

Link State Power Enhancements

Link State Power Enhancements

- Add new “sub-states” of L1 to provide more power savings
 - ✓ Allow port to turn off its PLL and receiver/transmitter
 - ✓ Goal is to hit μW of power per lane vs mW today
- In-band and Out-of-Band mechanism options
 - ✓ In-band: new low-frequency signaling mechanism
 - ✓ Out-of-band: Use CLKREQ# pin bidirectionally to enter/exit new lower power L1 sub-states
 - Pin exists in miniPCle form-factors
 - Repurpose a reserved pin on CEM form-factor
- Use requires LTSSM changes
- PHY design changes to leverage power savings

Link State Power Enhancements

- When?

- ✓ Out-of-Band ECN complete now

http://www.pcisig.com/specifications/pciexpress/specifications/ECN_L1_PM_Substates_with_CLKREQ_23_Aug_2012.pdf

- ✓ Possible In-Band *TBD*

- Where is the work being done?

- ✓ PCI-SIG Protocol Workgroup (PWG)

<http://www.pcisig.com/apps/org/workgroup/pciexpress/protocol/>

- Where to find out more?

- ✓ Watch for ECR Review to all-members e-mail

- Respond with feedback!

- ✓ Watch PCI-SIG Review Zone

http://www.pcisig.com/specifications/pciexpress/review_zone

Low Power Signaling “M-PCIe”

Low Power Signaling “M-PCle”

- Much interest in dramatically lower power per lane
 - Mobile and tablet form-factors
 - Ultra-thin laptops
- ECR has been proposed to carry PCIe over the MIPI M-PHY
 - Preserves Link and Transaction layers
 - Optional (doesn't obsolete “traditional” PHY)

Low Power Signaling “M-PCle”

- When?
 - ✓ ECR in cross-workgroup review
- Where is the work being done?
 - ✓ PCI-SIG Protocol Workgroup (PWG)
<http://www.pcisig.com/apps/org/workgroup/pciexpress/protocol/>
- Where to find out more?
 - ✓ Watch for ECR Review to all-members e-mail
 - Respond with feedback!
 - ✓ Watch PCI-SIG Review Zone
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Small Footprint (was “c-Link” now “OCuLink”) Cabling

“OCuLink” Cabling

- New workgroup formed Q4'11
- Goal to develop smaller footprint cabling than existing PCIe Cable
 - ✓ Internal version
 - ✓ External version
 - ✓ Lower cost
- Desire to eliminate RefClk from cable
 - ✓ Would require adoption of Independent Reference Clocks with Spread Spectrum mode

“OCuLink” Cabling

- When?
 - ✓ 0.5 Revision completed member review
http://www.pcisig.com/members/downloads/PCI_Express_OCuLink_v05_1August2012.pdf
 - ✓ 0.7 coming soon for general member review
- Where is the work being done?
 - ✓ PCI-SIG OCuLink Cable Workgroup
<http://www.pcisig.com/apps/org/workgroup/cable/>
- Where to find out more?
 - ✓ Watch for Review Drafts to all-members e-mail
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PCIe Storage Connector

PCIe Storage Connector

- New workgroup formed in Q1'12
- Partnership between PCI-SIG and SFF
- Leveraging work on SFF-8639 connector
- PCI-SIG electrical experts assisting with development and validation
- Goal is to support 8GT/s and future 16GT/s PCIe

PCIe Storage Connector

- When?
 - ✓ Workgroup meeting now, schedules TBD
- Where is the work being done?
 - ✓ PCI-SIG Connector Workgroup

<http://www.pcisig.com/apps/org/workgroup/connector/>
- Where to find out more?
 - ✓ Watch for Review Drafts to all-members e-mail
 - Respond with feedback!
 - ✓ Watch PCI-SIG Review Zone

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PCIe Mini CEM Evolution “M.2”

PCIe Mini CEM Evolution “M.2”

- PCI Express Mini Card Electromechanical Specification Revision 2.0 defines
 - ✓ Mini CEM & Half-Mini CEM form-factors
 - ✓ Supports 2.5 GT/s and 5 GT/s link rates

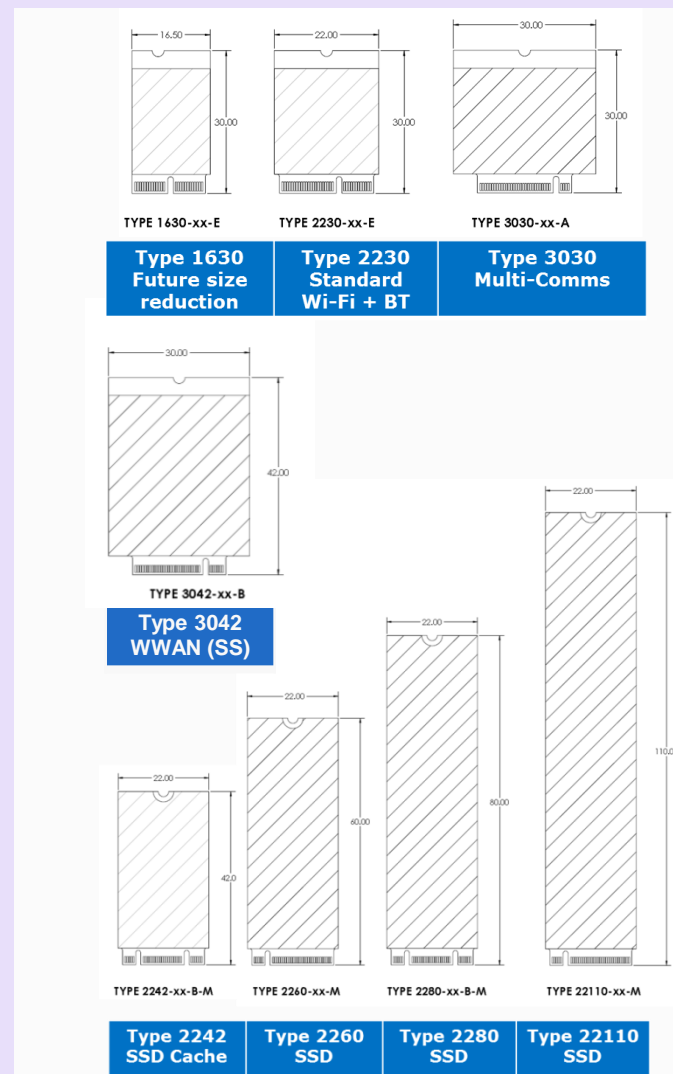
http://www.pcisig.com/members/downloads/PCI_Express_Mini_CEM_2_0.pdf
- Market asking for thinner, smaller, and larger variations!
- New “M.2” Specification
 - ✓ Evolved from, but not replacing, Mini CEM
 - ✓ Provides many more form-factors
 - ✓ New keying mechanisms

M.2 Socket Family

- Socket 1: Wi-Fi and Wi-Fi based combos
 - ✓ Multiple card sizes to support needed functions; single connector for any of the sizes

- Socket 2: WWAN/SSD/Other
 - ✓ Shared socket for lower attached devices
 - ✓ Multiple SSD form factors allow various storage capacities to be reached

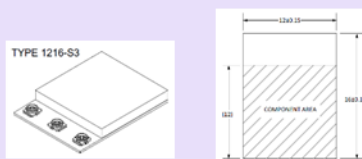
- Socket 3: Performance SSD
 - ✓ SSD Drive capacities
 - ✓ High performance throughput capable using PCIe x4



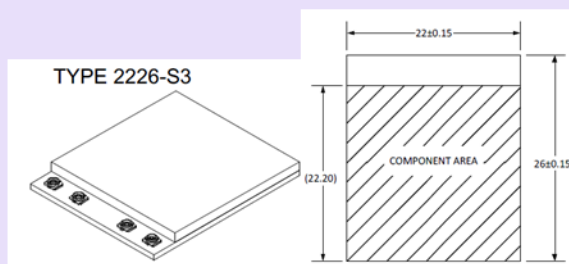
M.2 Soldered Down Options

- The M.2 Specification defines several Wi-Fi centric, soldered down options
 - ✓ Type 1216
 - ✓ Type 2226
 - ✓ Type 3026
- All have flexibility to support WiFi and additional radios
- Flexibility is provided with standardized pinouts

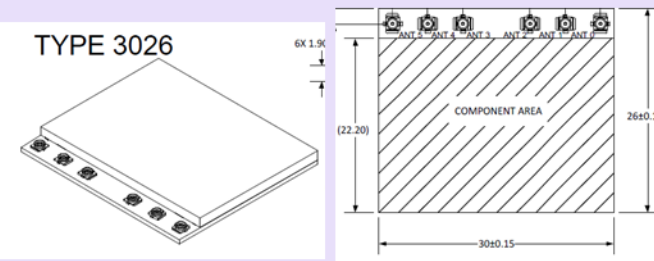
Type 1216



Type 2226



Type 3026



M.2 Specification

- When?
 - ✓ Revision 0.7 out for member review *NOW*
 - http://www.pcisig.com/members/downloads/M.2_Rev0.7a_02022013_Clean.pdf
- Where is the work being done?
 - ✓ PCI-SIG Mini CEM Workgroup
 - <http://www.pcisig.com/apps/org/workgroup/pciexpress/miniexpress/>
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Base Specification Dot Release

Base Spec Dot Revision

- Typically do X.Y spec revision to rollup ECNs
- When?
 - ✓ TBD – not likely earlier than Q2 or Q3'13
- Where is the work being done?
 - ✓ Technical Writing Team
 - ✓ PCI-SIG Protocol Workgroup (PWG)

<http://www.pcisig.com/apps/org/workgroup/pciexpress/protocol/>
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PCI-SIG Developers Conference
Europe 2013

For more information please go to
www.pcisig.com