DisplayPort Technology Update

Jim Choate
VESPA Compliance Program Manager
June 15, 2016
Agenda

- VESA Overview
- DisplayPort™ 1.4
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- DisplayPort over USB-C™ Overview
- DisplayPort over USB-C™ Certification
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
About VESA

• Global industry alliance with more than 230 member companies

Mission to develop, promote and support ecosystem of vendors and certified interoperable products for the electronics industry

Facilitate DisplayPort standards development, publication and compliance testing, as well as promotion and marketing
VESAs Membership is Diverse

Membership by Sector

- Cables/Conn.: 35%
- Displays: 15%
- Graphics: 7%
- Mounting: 6%
- Panel Makers: 5%
- PC OEM: 5%
- Projector: 4%
- Silicon: 3%
- Software: 3%
- Test Center: 2%
- Test Equip.: 2%
Quick Fact

VESAA Membership Continues to Grow!

![Membership Graph]

Membership

Members

- Apr. 2014: 206
- May. 2014: 207
- Jun. 2014: 212
- Jul. 2014: 220
- Aug. 2014: 221
- Sep. 2014: 223
- Oct. 2014: 224
- Nov. 2014: 226
- Dec. 2014: 231
- Jan. 2015: 228
- Feb. 2015: 225
- Mar. 2015: 228
- Apr. 2015: 229
- May. 2015: 230
- Jun. 2015: 231
- Jul. 2015: 236
- Aug. 2015: 237
- Sep. 2015: 239
- Oct. 2015: 230
- Nov. 2015: 239
- Dec. 2015: 239
- Jan. 2016: 239
- Feb. 2016: 239
Overview of Base DisplayPort Standard

- Starting ~2005, major suppliers in the personal computer industry set off to define the next generation display interface
  - PC, Display, Semiconductor and Connectivity OEMs drove development
- Overall objectives
  - Open standard, contribution open to all companies
  - Future proof in both performance and features
  - Applicable over a wide range of applications
- Development was done within the Video Electronics Standards Association
  - None-disclosure and IP policies protect contributing companies when presenting new technology and provide a productive work environment
Agenda

- VESA Overview
- **DisplayPort™ 1.4**
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- DisplayPort over USB-C™ Overview
- DisplayPort over USB-C™ Certification
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
DisplayPort 1.4 Summary

- The VESA DisplayPort Standard, Version 1.4, was released on February 23, 2015

- Adds new features and capabilities such as Display Stream Compression (DSC), Forward Error Correction (FEC) and enhanced Multi-Stream Transport (MST) feature

- Backward compatible, offers new optional features

- New Silicon supporting HBR3 and new features are under development

- Compliance testing expected during second half of 2016
# DP Link Rate Increase

<table>
<thead>
<tr>
<th>DP Version Introduction</th>
<th>Link Rate Name</th>
<th>Bit rate</th>
<th>Max Resolution Support (24 bpp, 60Hz Refresh, 4:4:4 format)</th>
<th>Max Resolution Support (24 bpp, 60Hz Refresh, 4:2:0 format)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP 1.0</td>
<td>RBR</td>
<td>1.62 Gbps</td>
<td>1920x1080</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP 1.0</td>
<td>HBR</td>
<td>2.7 Gbps</td>
<td>2560x1600</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP 1.2</td>
<td>HBR 2</td>
<td>5.4 Gbps</td>
<td>4K x 2K</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP 1.3/1.4</td>
<td>HBR 3</td>
<td>8.1 Gbps</td>
<td>5K x 3K</td>
<td>8K x 4K</td>
</tr>
</tbody>
</table>

8.1 Gbps link rate, per lane
\[ \times 0.8 \] to account for 8b/10b transport coding overhead
\[ \times 4 \] maximum number of available lanes
25.92 Gbps total usable data transfer rate
Optimization for Shared Interface Use

• Numerous specification enhancements to simplify the use of DisplayPort as an ingredient in the following interface examples:
  – The USB Type-C connector, using the DisplayPort Alt Mode
  – VESA DockPort Standard
  – VESA Mobility DisplayPort Standard (MyDP)
  – VESA Embedded DisplayPort Standard (eDP)
  – ThunderBolt
  – Future wireless interfaces
DisplayPort 1.4 Continues to Support Other Features that are Unique to DisplayPort

- Multiple monitors using Multi-Stream
- High-definition audio formats
- Adaptive Sync
- Protocol converters to VGA, DVI, or HDMI
- Low voltage, AC coupled interface compatible with sub-micron process geometry, simplifying integration
- Data scrambling and fixed link rates simplify EMI and RFI mitigation
- **Royalty free standard** available to VESA members
Expected DisplayPort 1.4 Deployment

- HBR3 (32.4 Gbit/s) as introduced in version 1.3 still remains the highest available mode
- DP 1.4 is expected to be enabled in both native DP devices and devices using the USB Type-C interface with the DisplayPort Alternate Mode
- DP 1.4 Devices are under development today
- DisplayPort-to-HDMI 2.0 converters are available today
- DP 1.4 CTS development has begun
  - Tests under development cover HBR3, DSC, FEC and HPD/IRQ_HPД response testing
PlugTests have significant value to member companies. Particularly as new capabilities and products are deployed.

- VESA hosted three successful PlugTests in 2015
- VESA plans to host three PlugTests in 2016

**Objectives of 2016 PlugTests**

- Demonstrate and improve Traditional Interoperability
  - Particularly important for new product capabilities
- Test DP 1.4 and DP Alt Mode over USB Type-C™ products
  - HBR3 and other new capabilities
- Verify Test Equipment Correlation

**Dates/Locations:**
- **Done:** March 21-24\textsuperscript{th} 2016, Taipei Taiwan
- **Scheduled:** September 12-16, 2016 Burlingame CA
- **TBD:** Taiwan/US November 2016?
Top DP Compliance Test Issues

- **Reduced Lane Fallback Requirements**
  - DP 1.4 clarified reduced lane count fallback requirements
  - GRL and Allion have been performing informative tests for last 6 months
  - QD and Unifgraf have implemented tests
  - Will require as certification test in 2017

- **Link Training PHY test automation**
  - Working on new test methodology for testing PHY during link training
  - Will be part of PHY 1.4 CTS

- **HBR3 Compliance Testing**
  - Test tools and CTS are being updated to support HBR3 products when they are ready
  - Plan is to create “early product certification plan” for early adopters
Agenda

- VESA Overview
- DisplayPort™ 1.4
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- DisplayPort over USB-C™ Overview
- DisplayPort over USB-C™ Certification
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
Agenda

- VESA Overview
- DisplayPort™ 1.4
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- **DisplayPort over USB-C™ Overview**
- DisplayPort over USB-C™ Certification
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
DisplayPort Over USB-C Summary

• The VESA DisplayPort Alt Mode Standard, Version 1, was released on Sept 22, 2014
  ▪ Enables the use of the USB Type-C interface for DisplayPort
  ▪ Alternate Mode functional extension of the USB Type-C interface
  ▪ Developed in liaison with the USB 3.0 Promoter Group
Introduction of USB Type-C

USB Type-C information is provided as an informative overview only, please refer to the USB Type-C Cable and Connector Specification available at www.usb.org for more information.

• New generation of USB connector developed to serve the market for next 20 years
• Thin profile suitable for both ultra portable devices and larger devices
• Reversible plug orientation & cable direction
  – USB 3.1 Gen 2 (10Gbps)
  – USB Power delivery, up to 100 watts
  – Supports DisplayPort Alternate Mode

USB Type-C will be the only interface you will need

- High speed, secure data
- Display connection
- System Power
USB Type-C Receptacle Pins

Below is a diagram of the pins defined for system or device receptacle:

- **High Speed Data Path (TX for USB, or for DP Alt Mode)**
- **USB 2.0 Interface**
- **High Speed Data Path (RX for USB, or TX for DP Alt Mode)**

**Plug Configuration Detection**
- One becomes $V_{CONN}$, for cable or adaptor power
- CC is used for USB-PD communication

- **Cable Ground**
- **Cable Bus Power**
- **For Sideband Use (not used for USB)**
Example USB Type-C Configurations

Either end can serve as USB Host, USB-PD Power Consumer, and DisplayPort Video Source (these services are orthogonal to each other).
USB Type-C Connector Function Extension
DisplayPort Alternate Mode

• A passive Full Feature USB Type-C to Type-C cable can carry up to four DisplayPort lanes
  – This will offer the same performance and feature capability as a standard DisplayPort connection
  – This will also allow DisplayPort data rates to increase in the future, since the USB Type-C connector has very high data rate capability

• DisplayPort can be combined with USB 3.1 operation over the same USB Type-C cable
  – Implemented with two high speed pairs for DP (using two lane DP operation), and two high speed pairs for USB (USB 3.1 only uses two high speed lanes for normal operation)
  – Useful for docking stations or hubs, or for adding docking station functionality to a display

• USB 2.0 and USB Power Delivery is available in all configurations
  – Because USB 2.0 and USB Power Delivery use dedicated wires in the USB Type-C cable, both of these services are always available, even when using all four USB Type-C high speed pairs for DisplayPort
Supported Cable Types

- **USB-C to USB-C**
- **USB-C to DP**
- **USB-C to Protocol converter**
- **USB-C to Docking station or embedded hub solution**

- **USB-C to DP** cables must include logic to support USB PD and DP connection detect protocols.

- **Protocol converters** must support some optional features in DP 1.3 specification
  - Protocol converters translate source DP signals to the respective protocol supported.
Wide Range of Adapters Shipping Today

- USB-C™ to USB A Receptacle
- USB-C™ to USB A Plug
- USB-C™ to USB-C™
- USB-C™ to DP
- USB-C™ to HDMI

VESATM, DisplayPort™ logos.
DisplayPort Alternate Mode Compliance Test Plan

- VESA is developing the DP Alternate Mode compliance test in coordination with the USB-IF

- VESA DisplayPort over USB Type-C Compliance Test Specification (CTS) is under member review
  - Expected to publish CTS mid 2016 after member review period is completed

- The objective is to enable compliance testing for USB Type-C, and the DP Alt Mode for USB Type-C, at the same ATCs enabling the use of a single test station
Agenda

- VESA Overview
- DisplayPort™ 1.4
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- DisplayPort over USB-C™ Overview
- **DisplayPort over USB-C™ Certification**
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
DP over USB-C Product Certification

• Development phase – new products are ready to ship before compliance test programs are complete.

• Conformance testing is still important to help ensure a smooth rollout and good user experience with early products.

• For DP Alt Mode products we created an early product certification plan to enable and promote certified products.

• Certification testing includes significant number of test requirements for USB 3.1 and USB PD certification testing coverage.

• Allion and GRL are authorized and performing certification for early DP Alt Mode products today. This will expand to all ATCs and Self Testers when the DP Alt Mode CTS and MOIs are published.
# DP over USB-C Product Example Certification Tests

**USB Type-C Docks shall perform the following tests:**

<table>
<thead>
<tr>
<th>Test Item</th>
<th>Test Name</th>
<th>Description</th>
<th>Requirement</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3 #1</td>
<td>DP PHY TX</td>
<td>DP PHY TX tests up to maximum supported data rate on all DP DFPs</td>
<td>Pass DP TX tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 #2</td>
<td>USB 3.1 Tests</td>
<td>USB 3.1 Electrical, Crosstalk, Functional, Link and Interop</td>
<td>Pass if supported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 #3</td>
<td>PD/USB Power</td>
<td>USB PD Power test requirements</td>
<td>All PDOs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 #4</td>
<td>Sink Tests</td>
<td>RX JTOL tests for four lanes up to Max supported rate</td>
<td>Pass JTOL tests in section 3.2 of DP Alt Mode CTS</td>
<td></td>
<td>Normal orientation</td>
</tr>
<tr>
<td>6.3 #5</td>
<td>USB-PD Protocol</td>
<td>Verify compliance with USB-PD protocol test requirements</td>
<td>Pass USB PD Protocol Testing</td>
<td></td>
<td>Normal orientation</td>
</tr>
<tr>
<td>6.3 #6</td>
<td>USB-PD PHY</td>
<td>Verify compliance to USB-PD PHY specification requirements</td>
<td>Pass USB PD PHY Testing</td>
<td></td>
<td>CC1 and CC2</td>
</tr>
<tr>
<td>6.3 #7</td>
<td>Display Interop</td>
<td>Using a reference DP Alt Mode source (supporting 4xHBR2) verify that a all external display connection display functions correctly at the required resolutions</td>
<td>Pass interoperability testing</td>
<td></td>
<td>Normal and Inverted orientation</td>
</tr>
<tr>
<td>6.3 #8</td>
<td>Vconn and Vbus</td>
<td>Dock tests for proper implementation of Vconn and Vbus rules</td>
<td>Pass Vbus and Vconn tests</td>
<td></td>
<td>Normal and Inverted orientation</td>
</tr>
<tr>
<td>6.3 #9</td>
<td>USB Billboard</td>
<td>Test compliance of USB Billboard functionality and PHY testing</td>
<td>Pass USB Billboard tests</td>
<td></td>
<td>Normal orientation</td>
</tr>
<tr>
<td>6.3 #10</td>
<td>Aux and HPD tests</td>
<td>USB Type-C Dock must perform all AUX and HPD tests in section 9, upstream and downstream facing ports.</td>
<td>Pass AUX and HPD tests</td>
<td></td>
<td>Normal orientation</td>
</tr>
</tbody>
</table>

*Table 6-4: USB Type-C Dock test requirements*
DP over USB-C Product USB Certification Tests

- USB compliance tests are conducted to achieve certification of DP Alt Mode products to ensure that functionally the USB features of those products provides a good user experience.
- Devices that support USB functionality shall conduct the USB tests included in the compliance test summary tables for each product category.
- Completing USB-IF certification testing and receiving USB-IF TID will be sufficient to show that those tests have been completed and pass.
DisplayPort Alt Mode over USB-C
Early Product Certification Program Results

• Nearly a dozen tablets, laptops and monitors have been certified through the pilot phase of the early certification program
  – Intel (Skylake reference design)
  – Dell, HP tablets and laptops
  – LG and Asus displays
  – StarTech dock

• Several dozen more certified products are expected to be available by the end of the year
Top DP Alt Mode Compliance Test Issues

- **USB Billboard**
  - Test Setup hard to obtain. Test sw is still under development
  - All DP Alt Mode sinks and dual role sources required to support USB Billboard

- **USB PD Protocol failures**
  - Use certified USB PD controllers and passing fw

- **2xDP/2xUSB 3.1 configuration testing**
  - Cross talk between USB 3.1 lines and DP lines can degrade the link

- **USB Type-C to DP Plug adapter reversibility**
  - USB Type-C to DP plug adapters must work connected in both directions
USB Billboard Test setup

- AsMedia USB-C xHCI Host Installed in available PCIe Slot
  - AT1027, Rev3.10
  - No Alt Mode
  - USB-C connector
- Windows 8.1/10 PC
- USB3CV Tool from USBIF

USB3CV Tool

The USB3CV tool Ver. 2.1.0.0 (March 28, 2016) is available here. Download USB3CV for 32-bit Windows or USB3CV_x64 for 64-bit Windows. In order to use USB3CV, User Account Control (UAC) must be turned off. After turning off UAC, the system must be rebooted. If you are running on 64-bit Windows, you must install the 64-bit CV. If you have any questions, please contact susbcompliance@usb.org.

NOTE: The USB3CV tool is supported on Windows 7 and above.
Issues with Billboard

- USB-C XHCI host not yet commercially available
- CTS and Test SW not complete
- Products don’t update to released/passing fw versions

Call to Action: VESA will consider sponsoring a build of the AT1027 XHCI host card with sufficient pre-orders. Contact VESA if interested.
DP Alt Mode Certification Policies

• USB Type-C to HDMI protocol converters
  – DP Alt Mode spec states they must support HDMI 2.0 among other requirements
  – These requirements can be waived until 2018 for certification

• USB PD controller certification
  – Prior to submission of product for DP Alt mode over USB Type-C certification all products must have gotten the USB PD controller used certified by USB-IF.
Agenda

- VESA Overview
- DisplayPort™ 1.4
- Why you need DisplayPort Early Certification and Allion's update for DP 1.4
- DisplayPort over USB-C™ Overview
- DisplayPort over USB-C™ Certification
- GRL’s Experience in DisplayPort over USB Type-C (tm) Testing
- Summary
- Q&A + Demos
Summary

• DP 1.4 provides over 50% increase in performance among other improvements

• DisplayPort over USB-C is a game changer for small form factor and portable products

• **DP Alt Mode CTS will be available in early Q3 of 2016**

• Testing and certification of DP Alt Mode products is comprehensive and underway

• Next VESA PlugTest event scheduled in September 2016 in Burlingame CA
QUESTIONS?

DEMO STATION OVERVIEW
• Keysight - DP Alt Mode over USB-C Transmitter test demo
• Tektronix – HBR3 transmitter test
• Allion – HBR3 Jitter tolerance demo
• GRL- USB PD compliance testing
• Luxshare – ICT USB-C test fixtures
Thank you!

www.displayport.org
www.vesa.org