DisplayPort Technology Update

Jim Choate
VESA Compliance Program Manager
June 11, 2015
Agenda

- VESA Overview
- DisplayPort 1.3
- DisplayPort™ over USB-C™ Overview
- Product implementation solutions (Parade)
- eDP (Parade)
- Summary
About VESA

VESAs the Video Electronics Standards Association

Global industry alliance with more than 230 member companies

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

Facilitates display related standards development, publication and compliance testing, as well as promotion and marketing
VESAMembership is Diverse

Membership by Sector

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

VESPA Membership Continues to Grow!

![Membership Chart]

- May. 2013: 199
- Jun. 2013: 203
- Jul. 2013: 205
- Aug. 2013: 206
- Sep. 2013: 209
- Oct. 2013: 211
- Nov. 2013: 207
- Dec. 2013: 206
- Jan. 2014: 207
- Feb. 2014: 204
- Mar. 2014: 208
- Apr. 2014: 212
- May. 2014: 213
- Jun. 2014: 220
- Jul. 2014: 221
- Aug. 2014: 224
- Sep. 2014: 223
- Oct. 2014: 226
- Nov. 2014: 228
- Dec. 2014: 231
- Jan. 2015: 220
- Feb. 2015: 223
- Mar. 2015: 226
- Apr. 2015: 223
- May. 2015: 228
VESA DisplayPort Product Certifications

Total Products Certified over the last four years

Certified Products

- 2012: 500
- 2013: 1500
- 2014: 2500
- 2015: 3000

Certifications over the last four years:

- 2012: 500
- 2013: 1500
- 2014: 2500
- 2015: 3000
The VESA DisplayPort Standard, Version 1.3, was released on Sept 15, 2014

- Replaces DisplayPort Version 1.2a for new designs
- Backward compatible, offers new optional features
- Compliance tests expected mid 2015
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 VESA
  - Non-disclosure and IP policies protect contributing companies when presenting new technology and provide a productive work environment
Development of Base DisplayPort Standard

- Development of Electrical Interface for Chips, Connector and Cables

<table>
<thead>
<tr>
<th>Design Goals</th>
<th>Solution</th>
<th>DisplayPort</th>
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</thead>
<tbody>
<tr>
<td>Lower system costs/complexity</td>
<td>To enable system level integration of display interface without the need for separate interface circuits</td>
<td>Same as USB, PCI Express, SATA and other widely adopted interfaces</td>
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<td>Design Re-Use</td>
<td>To enable common interface design, and have multi-purpose chip interfaces</td>
<td>Transmitter and Receiver make adjustments to optimize communication</td>
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<td>Future Performance</td>
<td>To enable future higher speeds</td>
<td>Transmitted data is randomized to reduce concentration of interference</td>
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<tr>
<td>Reduce interference</td>
<td>Reduce interference with device wireless services</td>
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</table>

VESAl Logo
DisplayPort Logo
Development of Base DisplayPort Standard

- Development of Interface Protocol

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<thead>
<tr>
<th>Design Goals</th>
<th>Solution</th>
<th>DisplayPort</th>
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</thead>
<tbody>
<tr>
<td><strong>Interconnect independent</strong></td>
<td>DisplayPort A/V packets can be sent over different transports including wireless and optical, and mixed with other data types as done with Thunderbolt and USB-C</td>
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<td>To enable DisplayPort A/V transport beyond DP connectors and cables</td>
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<td>eDP +</td>
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<td>To allow different wire counts depending on application, such as embedded vs. external</td>
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<td><strong>Expansion of capabilities</strong></td>
<td>Support for VGA, DVI, and HDMI protocol adaptors</td>
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<td>Enable ability to easily add new features and services without breaking backward compatibility</td>
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<td><strong>Enable Adapters</strong></td>
<td>AUX Channel used for link training and system configuration</td>
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<td>Enable DisplayPort-enabled interfaces to support legacy displays</td>
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<tr>
<td><strong>Aux Channel</strong></td>
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<tr>
<td>Increase capability of Source and Sink to determine optimum mode of operation and system configuration</td>
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</tbody>
</table>
Summary of DisplayPort Standard

- Low voltage, AC coupled interface compatible with sub-micron process geometry, simplifying integration
- Data scrambling and fixed link rates simplify EMI and RFI mitigation
- Scalable to resolutions of 8K and beyond
- Multi-Stream mode enables support of multiple monitors
- Support of protocol converters to VGA, DVI, or HDMI
- Support of high-definition audio formats
- Adaptable to other interface types
Main New Features for DP 1.3

- 50% Increase in video data transfer rate
  - supports higher resolutions
  - deeper colors
  - higher display refresh rates

- Further optimized for use on shared interfaces including DP Alt Mode on USB Type-C or DockPort

- “Living Room Friendly” features added to enhance applicability for consumer displays including digital televisions
## DP 1.3 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>
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<tr>
<td>DP 1.2</td>
<td>HBR2</td>
<td>5.4 Gbps</td>
<td>4K x 2K</td>
<td>Not supported</td>
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<tr>
<td>DP 1.3</td>
<td>HBR3</td>
<td>8.1 Gbps</td>
<td>5K x 3K</td>
<td>8K x 4K</td>
</tr>
</tbody>
</table>

Total useable data transfer rate for DP 1.3 = 25.92 Gbps

8.1 Gbps link rate, per lane
x 0.8  to account for 8b/10b transport coding overhead
x 4    maximum number of available lanes
25.92  Gbps total usable data transfer rate
Expected DisplayPort 1.3 Deployment

- Availability of devices supporting new features such as HBR3 or 4:2:0 is expected in 2016

- DP 1.3 is expected to be enabled in both native DP devices and devices using DisplayPort over USB-C

- DisplayPort-to-HDMI 2.0 converters are expected in 2015. May require a firmware update for existing DP 1.2a systems

- DP 1.3 CTS development has begun
DisplayPort over USB-C Overview and Certification
VESDA 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](http://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
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)**

- **Cable Ground**
- **Cable Bus Power**
- **For Sideband Use (not used for USB)**
- **Plug Configuration Detection**
  - One becomes $V_{CONN}$, for cable or adaptor power
  - CC is used for USB-PD communication
Example USB Type-C Configurations

Either end can serve as USB Host, USB-PD Power Consumer, and DisplayPort Video Source (these services are independent of other.)

- Device Charging
- USB 2.0 or 3.1 Data
- Display Data
- Device Supplying Power

USB
Dock
A passive Full Feature USB Type-C to Type-C cable can carry up to four DisplayPort lanes
  - Offers the same performance and feature capability as a standard DisplayPort connection, and even faster in the future

- DisplayPort can be combined with USB 3.1 operation over the same USB Type-C cable
  - Can assign to two high speed pairs for DP (using two lane DP operation), and two high speed pairs for USB 3.1 – Useful for docking stations, or Displays with USB hubs

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

VESA® DisplayPort®
DisplayPort Alternate Mode
Compliance Test Plan

- VESA is developing the DP Alternate Mode compliance test in coordination with the USB-IF
- Compliance test specification work has begun
- 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
Event and CTS scheduling

- Current VESA schedule for activities and CTS work

VEESA Activities &
DisplayPort over USB Type C Compliance Test Specification Schedule

- VESA releases DP over USB C Alternate Mode specification
  - Sept. 22, 2016
- DP Alt Mode CTS draft start
- DP Alt Mode CTS rev 0.5
- DP Alt Mode CTS 0.9
- GigaTRX Embassay Suites
  - Milpitas, CA
  - Mar 23-26, 2016

CTS development in VESA DP on USB-C Subgroup (open to all VESA members to participate)
- Certification test plan development
- Member Review
- ATCs begin certification testing

DisplayPort
Summary

- DP 1.3 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 early second half of 2015
- Next VESA PlugTest events schedule for September 14 in Milpitas CA
Implementation of DisplayPort™ over USB-C™

Cathy Yeh
Strategic Marketing Manager
Parade Technologies
Cable for USB-C to USB-C

For sending DisplayPort from one USB-C device to another USB-C device, a standard passive USB-C is used

- This is called a “Type-C Full Feature Passive Cable”
- A special DisplayPort Alt Mode cable is not needed in the case
  - This is a unique feature of the DisplayPort Alt Mode
- Both devices must support the DisplayPort Alt Mode
- Full DisplayPort performance is supported
DisplayPort Over a USB Type-C to Type-C Full Feature Passive Cable

Please refer to the VESA DisplayPort Alt Mode on USB Type-C Standard for more information

- DisplayPort can use all four high speed lanes to deliver full DisplayPort performance
  - 5K video with 60 frames per second with no compression
- USB 2.0 and USB Power Delivery always available
Cable for USB-C to DP, or DP to USB-C

For either of the following display connections:

- DisplayPort from **USB-C Source** to a **native DP Display**
- or -
- DisplayPort from a **native DP Source** to a **USB-C Display**

A USB-C to DisplayPort Adapter Cable is used

- The adapter is designed to work in either direction
- The USB-C device must support DP Alt Mode
**USB-C to DisplayPort Adapter Cable**

- Cable is reversible, works in either direction; four lanes of DisplayPort
- Supports legacy DisplayPort Source and Sink Devices
The Support of Other Display Interfaces using USB-C

- USB-C video adapters and adapter cables are available to support other display types

- USB-C to HDMI
- USB-C to VGA
- USB-C to DVI
Type-C to HDMI Converters will support HDMI 2.0 and CEC

Parade Technologies is a major chip supplier for HDMI, VGA, and DVI protocol adapters
Protocol Converter in USB-C Dock

- A USB-C Dock can also utilize a protocol converter to support other display interface outputs.
Addressing Demand for Better Display Quality

According to a recent survey by 3M in the US:

- 90% of Americans still seek better display quality in electronic devices

A main emphasis of new products is often display quality
- Display resolution has been the main focus
- Color quality is becoming a new focus
# Display Trends and DisplayPort Roadmap

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**Notebook PC**

- **Display Port**
  - **DP 1.0-1.1**
    - Up to Quad HD
  - **DP 1.2**
    - Up to 4K 60Hz, 10 bit color
  - **DP 1.3**
    - Up to 5K
  - **DP 1.4**
    - Up to 8K
  - **DP 1.5**
    - Up to 8K 120Hz
  - **DP XX**
    - Up to 8K 120Hz

**Television**

- **1080p**
- **4K 60Hz**
- **5K 60Hz**
- **8K 60Hz HDR**
- **8K 120Hz HDR**

**PC Monitor**

- **1080p**
- **4K 60Hz**
- **5K 60Hz**
- **8K 60Hz HDR**
- **8K 120Hz HDR**

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**Display Trends and DisplayPort Roadmap**

- **2006**
  - **2007**
  - **2008**
  - **2009**
  - **2010**
  - **2011**
  - **2012**
  - **2013**
  - **2014**
  - **2015**
  - **2016**
  - **2017**
  - **2018**
  - **2019**
  - **2020**

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**DisplayPort Roadmap**

- **2018**
  - **2019**
  - **2020**

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**DisplayPort**

- **2.7 Gbit/sec**
  - **5.4 Gbit/sec**
  - **8.1 Gbit/sec**
  - **10 Gbit/sec**
System Design Challenges with Higher Resolution

- Higher resolution requires higher speed signals
- Higher speed signals are more subject to signal loss
  - This limits usable PCB trace length

<table>
<thead>
<tr>
<th>Link Rate</th>
<th>Max trace length</th>
<th>Resolution (4 lanes, 60Hz Frame rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.62 Gbps (RBR)</td>
<td>18 inches</td>
<td>1080p, 1920x1200</td>
</tr>
<tr>
<td>2.7 Gbps (HBR)</td>
<td>12 inches</td>
<td>2880x1880</td>
</tr>
<tr>
<td>5.4 Gbps (HBR2)</td>
<td>8 inches</td>
<td>4K</td>
</tr>
<tr>
<td>8.1 Gbps (HBR3)</td>
<td>5 inches</td>
<td>5k, or 2x 4K</td>
</tr>
<tr>
<td>10 Gbps (Future)</td>
<td>3 inches</td>
<td>8K (using low compression ratio)</td>
</tr>
</tbody>
</table>
Repeaters Needed to Extend PCB Trace Length

- When using high speed signals, a repeater enables the trace length to double or more
  - Repeaters are becoming more important for higher display resolutions

- The repeater can also improve performance of the transmitted signal
  - This can provide additional margin for longer or damaged cables

![Diagram of Repeater System]
Typical Repeater Application in Motherboard Design
New Challenges with DisplayPort over USB-C

- DisplayPort over USB-C has a greater signal loss problem
  - The port configuration switch matrix adds even more signal loss
- Another challenge is the support of different signal types (USB and DP) on the same channels, and the direction change (two channels need to support both USB RX and DisplayPort TX)
Active USB-C Switch Matrix for DisplayPort over USB-C Source Devices

- The solution is to integrate the repeaters with the switch matrix
  - The repeaters compensate for both switch matrix loss and PCB trace loss
  - The PS8740 from Parade Technologies is an example
Active USB-C Switch Matrix for DP over USB-C Dock or Display Devices

- A similar problem exists in a USB-C display or dock device
- The PS8742 from Parade addresses these applications
Update on Embedded DisplayPort
Update on Embedded DisplayPort

- Embedded DisplayPort (eDP) is replacing LVDS as the internal panel interface in Laptops, All-in-Ones, and many tablets

- For tablets, eDP is preferred over MIPI for resolutions above 2560 x 1600
  - Lower wire count
  - Similar power draw when using eDP 1.4
eDP 1.4a

- Latest version of eDP is eDP v1.4a
  - Released in January 2015
- Supports VESA DSC (Display Stream Compression)
- Supports 8K resolution using DSC
- Supports 5K resolution with no compression
- Supports PSR (Panel Self Refresh) with Selective Update
- Supports Segmented Panels, an architecture optimized for Chip on Glass
eDP 1.4b

- eDP 1.4b will be published later this year
- Includes some refinements and clarification of the eDP 1.4a standard
- Will be the production version of eDP 1.4

Product availability
- eDP 1.4b system prototypes will be in 2016
- eDP 1.4b production is expected in 2017
Thank you!

www.displayport.org
www.vesa.org
Q&A
PlugTests

- PlugTests have significant value to member companies. Particularly as new capabilities and products are deployed.
- VESA plans to host three PlugTests in 2015.

Objectives of 2015 Plugtests
- Demonstrate and improve Traditional Interoperability
  - Particularly important for new product capabilities
- Test DP 1.3 and DP Alt Mode over USB Type-C as devices become available
- Verify Test Equipment Correlation
- Dates/Locations:
  - Done: March 23-26\textsuperscript{th} 2015, Milpitas CA
  - Scheduled: September 14\textsuperscript{th} 2015, Embassy Suites Milpitas
  - Tentative: Taiwan Q4’15
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

• Example enhancements to DP 1.3:
  – Improved link training to accommodate more varied and complex video transport topologies, along with the higher link rate of HBR3
  – The addition of link-trainable repeaters to increase performance and reliability across complex topologies (such as docking station + Hub + active cable)
  – Unified device register set to simplify implementation and allow devices to support various interface types
USB Type-C Plug Orientation Reversing is Supported by a Connector PHY Switch

- Example for USB Type-C receptacle that supports USB modes only
- A similar switch is needed at the Device end
- Switch can be integrated with USB function
Switching mechanism

- Rp (pullup resistor) and Rd (pulldown resistors) on CC1/CC2 determine polarity
- Receptacle responsible to switching pin-out to match plug orientation and features
Power Contract/Alt mode detection

- After orientation detection and switching CC line is used for USB PD negotiation
- BMC controllers negotiate power and Alt Mode support
- Vbus for legacy devices
USB Type-C Connector PHY Switch for Supporting DisplayPort Alternate Mode

- Example for interface that supports USB and DisplayPort Alternate Mode
- Similar switch needed at the Device end
- Switch can be integrated along with the USB and DisplayPort functions