Agenda

• VESA Overview
• DisplayPort™ 1.4 Early Certification
• DisplayPort over USB-CTM Certification
• Summary
VES A OVERVIEW
DisplayPort Technology Update

About VESA

- Global industry alliance with more than 250 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
VESPA Membership is Diverse

DisplayPort Technology Update

- Cables.Conn.: 35%
- Displays: 15%
- Graphics: 15%
- Mounting: 9%
- Panel Makers: 6%
- PC OEM: 4%
- Projector: 7%
- Silicon: 5%
- Software: 6%
VESPA Membership Continues to Grow
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
### Mobile Computing Shipment Forecast

**STRATEGY ANALYTICS**  
Research, Experts, and Analytics

#### Mobile Computing Device Enabling Technologies Shipment Forecast 2012-2021

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Mobile Computing Device Shipments (Millions of Units)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>1980.7</td>
<td>2119.7</td>
<td>2256.2</td>
<td>2274.8</td>
<td>2222.4</td>
<td>2519.7</td>
<td>2%</td>
</tr>
<tr>
<td><strong>DisplayPort Mobile Computing Device Shipments (Millions of Units)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>80.4</td>
<td>90.1</td>
<td>115.4</td>
<td>101.3</td>
<td>116.4</td>
<td>733.8</td>
<td>36%</td>
</tr>
<tr>
<td>Penetration Rate</td>
<td>4%</td>
<td>4%</td>
<td>5%</td>
<td>4%</td>
<td>5%</td>
<td>29%</td>
<td></td>
</tr>
<tr>
<td><strong>Type-C USB Mobile Computing Device Shipments (Millions of Units)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>6.7</td>
<td>153.8</td>
<td>1924.1</td>
<td>52%</td>
</tr>
<tr>
<td>Penetration Rate</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
<td>76%</td>
<td></td>
</tr>
</tbody>
</table>

**Date:** June 2017

© 2017 Strategy Analytics | www.strategyanalytics.com
## Mobile Computing Device Enabling Technologies Shipment Forecast 2012-2021

### Total Handset Shipments (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>1580.9</td>
<td>1685.0</td>
<td>1812.7</td>
<td>1870.6</td>
<td>1849.9</td>
<td>2111.9</td>
<td>2%</td>
</tr>
</tbody>
</table>

### DisplayPort Handset Shipments (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>0.7</td>
<td>6.4</td>
<td>21.0</td>
<td>15.3</td>
<td>12.0</td>
<td>412.6</td>
<td>80%</td>
</tr>
<tr>
<td>Penetration Rate</td>
<td>0%</td>
<td>0%</td>
<td>1%</td>
<td>1%</td>
<td>1%</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

### Type-C USB Handset Shipments (Millions of Units)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>5.7</td>
<td>104.8</td>
<td>1567.6</td>
<td>57%</td>
</tr>
<tr>
<td>Penetration Rate</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>6%</td>
<td>74%</td>
<td></td>
</tr>
</tbody>
</table>

**Date:** June 2017
“Strategy Analytics estimates that 5% of laptops, tablets, and handsets shipped in 2016 are DisplayPort capable (including DisplayPort AltMode), with the figure rising to 29% by 2021...”

Factors driving increased DisplayPort adoption rates are:
• Demand for high-quality video (4K UHD and higher)
• VR/AR
• Increased adoption of USB-C and Thunderbolt 3
• Mobile device docking solutions
DISPLAYPORT™ 1.4
DisplayPort 1.4 Summary

- The VESA DisplayPort Standard, Version 1.4, was released on February 23, 2015
- Added 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 is shipping and new features are under development
- Compliance testing began in 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 (24bpp, 60Hz Refresh, 4:4:4 format)</th>
<th>Max Resolution Support (24bpp, 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>HBR2</td>
<td>5.4 Gbps</td>
<td>4K x 2K</td>
<td>Not supported</td>
</tr>
<tr>
<td>DP 1.4</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 1.4 = 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
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
  • Virtual and Augmented Reality Technologies
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) still remains the highest available mode and is shipping today. Early certification of HBR3 Silicon/end products started 2H’2016
- 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 CTS development is underway
  - Tests under development cover HBR3, DSC, FEC and HPD/IRQ_HPDP response testing
  - Updates to Link Layer CTS and PHY Layer CTS documents are in progress and expected to be published in 2H’2017
VESAn PlugTest Events

- PlugTests have significant value to member companies. Particularly as new capabilities and products are deployed.
- Demonstrate and improve Traditional Interoperability
- Test DP 1.4 and DP Alt Mode over USB Type-CTM products
  - HBR3 and other new capabilities
  - Verify Test Equipment Correlation
- VESA hosted three successful PlugTests in 2016
- VESA plans to host three PlugTests in 2017
  - March 2017 Burlingame CA, USA: Completed
  - June 26th Taipei Taiwan: Scheduled
  - Oct/Nov PlugTest TBD
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 a year
  • QD and Unifgraf have implemented tests
  • Will be require as certification test in 2H’2017

• Sink Bit Error Count Registers not implemented correctly
  • These are important so that DP Sources can detect marginal or failing link and take corrective action (re-initiate link training)
  • Will be required and tested in 2H’2017
Top DP Compliance Test Issues

- HBR3 Compliance Testing
  - Test tools and CTS are being updated to support HBR3 products with final correlation testing during June Taiwan PlugTest event
  - “Early Product Certification Plan” is being used for early adopters. Several reference chipsets have been certified.
    - AMD, Nvidia: HBR3 DP Sources
    - Realtek, Mstar: HBR3 DP Sinks
DISPLAYPORT OVER USB-C™ OVERVIEW
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

- 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 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.
Introduction of USB Type-C

- USB Type-C will be the only interface you will need
  - High speed, secure data
  - Display connection
  - System Power

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.
USB Type-C Receptacle Pins

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

- **GND**: Ground
- **TX1+**, **TX1−**: High Speed Data Path (TX for USB, or for DP Alt Mode)
- **VBUS**: Power (not used for USB)
- **CC1**, **D+**, **D−**: USB 2.0 Interface
- **SBU1**: For Sideband Use (not used for USB)
- **RX2−**, **RX2+**: High Speed Data Path (RX for USB, or TX for DP Alt Mode)
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)
Example USB Type-C Configurations

Samsung 8 uses USB-C for charging

or

Samsung 8 Phone + DEX dock acts as USB2 Host, USB-PD Power Consumer, and DisplayPort Video Source
USB Type-C Connector Function Extension DisplayPort Alternate Mode

- DisplayPort can be combined with USB 2.0 and/or USB 3.1 operation over the same USB Type-C cable. With 2 lanes of DP 1.4 HBR3 can drive 4K60hz display.
  - 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
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
Supported Cable Types

- USB-C to DP Plug cables must include logic to support USB PD and DP connection detect protocols.
- Protocol converters must support some optional features in DP 1.4 specification
  - Protocol converters translate source DP signals to the respective protocol supported
Wide Range of Adapters Shipping Today

- USB-C™ to USB A Plug
- USB-C™ to USB-C™
- USB-C™ to USB A Receptacle
- USB-C™ to DP
- USB-C™ to HDMI
DISPLAYPORT OVER USB-C™ CERTIFICATION
DisplayPort Alternate Mode - Compliance Test Plan

- VESA developed the DP Alternate Mode compliance test in coordination with the USB-IF to ensure interoperability of products across supported standards
- VESA DisplayPort over USB Type-C Compliance Test Specification (CTS) v1.0 was released January 2017
- Certification of DisplayPort Alternate Mode products is still increasing with dozens of products certified over the last year
### DisplayPort Technology Update

**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 DPPs</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>Normal orientation</td>
<td></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>Normal orientation</td>
<td></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>CC1 and CC2</td>
<td></td>
</tr>
<tr>
<td>6.3 #7</td>
<td>Display Interop</td>
<td>Using a reference DP Alt Mode source (supporting 4xHBR2) verify that all external display connection display functions correctly at the required resolutions</td>
<td>Pass interoperability testing</td>
<td>Normal and Inverted orientation</td>
<td></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>Normal and Inverted orientation</td>
<td></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>Normal orientation</td>
<td></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>Normal orientation</td>
<td></td>
</tr>
</tbody>
</table>

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

- 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.
Top DP Alt Mode Compliance Test Issues

- Pin Assignment Testing
  - Issues with proper implementation pin assignment E support and source device selection have been uncovered
  - New tests have been implemented by test equipment to verify correct implementation of pin assignments
- DP Alt Mode CTS pin assignment test updates V4 SCR is under General Member Review (GMR) ending July 10, 2017
- USB PD Protocol failures
  - Use certified USB PD controllers and passing fw
DP Alt Mode CTS pin assignment test updates

Table of Contents

Section 10 – Pin Assignment Test updates ................................................................. 3
10.2.3 Time from Vbus/Vconn on to UFP Ready (Informative) ........................................ 3
10.2.4 Time from HPD event to PD message (Informative) .............................................. 5
10.2.5 Proper Pin Assignment Support for Receptacle-based Video Sinks (Normative) ..... 6
10.2.6 Proper Pin Assignment Support for C to DP adaptor cables (Normative) .............. 6
10.2.7 Proper Pin Assignment Support for adaptor cables with protocol converters (Normative) 7

DisplayPort Alt-Mode Tests for USB DFPs................................................................. 8
10.3.11 Proper pin assignment selection for DFP_U / DFP_D connected to receptacle (Normative) ................................................................. 8
10.3.12 Proper pin assignment selection for DFP_U / DFP_D connected to plug (Normative) ... 9
10.3.13 Proper pin assignment selection for DFP_U / UFP_D connected to receptacle (Normative) ................................................................. 10
10.3.14 Proper pin assignment selection for DFP_U / UFP_D connected to plug (Normative) ... 11
Example: DisplayPort Alt Mode Tests for DFPs

Table 10-1: DFP_D connected to receptacle

<table>
<thead>
<tr>
<th>Line no.</th>
<th>Tester Presents Receptacle Indication</th>
<th>Tester Presents UFP_D Pin Assignments presented</th>
<th>Tester Presents Multi-Function Preferred bit</th>
<th>UUT pin assignment selection (in DP Configure message) shall be:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Receptacle</td>
<td>C, D, E</td>
<td>No</td>
<td>C or D</td>
</tr>
<tr>
<td>2</td>
<td>Receptacle</td>
<td>C, D, E</td>
<td>Yes</td>
<td>C or D</td>
</tr>
<tr>
<td>3</td>
<td>Receptacle</td>
<td>C, E</td>
<td>No</td>
<td>C</td>
</tr>
</tbody>
</table>

When DP Alt Mode Source is connected to Receptacle based Sink it must never select pin assignment E!
Top DP Alt Mode Compliance Test Issues

- 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
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
  • VESA has certified two OEM products that meet all specification requirements
Summary

- DP 1.4 provides over 50% increase in performance among other improvements
  - Enables 4K120Hz, 8K@30Hz and 2 lane 4K60Hz for DP Alt Mode
- DisplayPort over USB-C is a game changer for small form factor and portable products
- DP Alt Mode CTS published in January of 2017
- Testing and certification of DP Alt Mode products is comprehensive and underway
- Next VESA PlugTest event scheduled week of June 26th in Taipei Taiwan
Questions?
Demo Station Overview
THANK YOU
displayport.org
vesa.org