

VESA – DisplayPort™ Alternate Mode on USB-C®

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USB Developer Days 2019 – Taipei, Taiwan

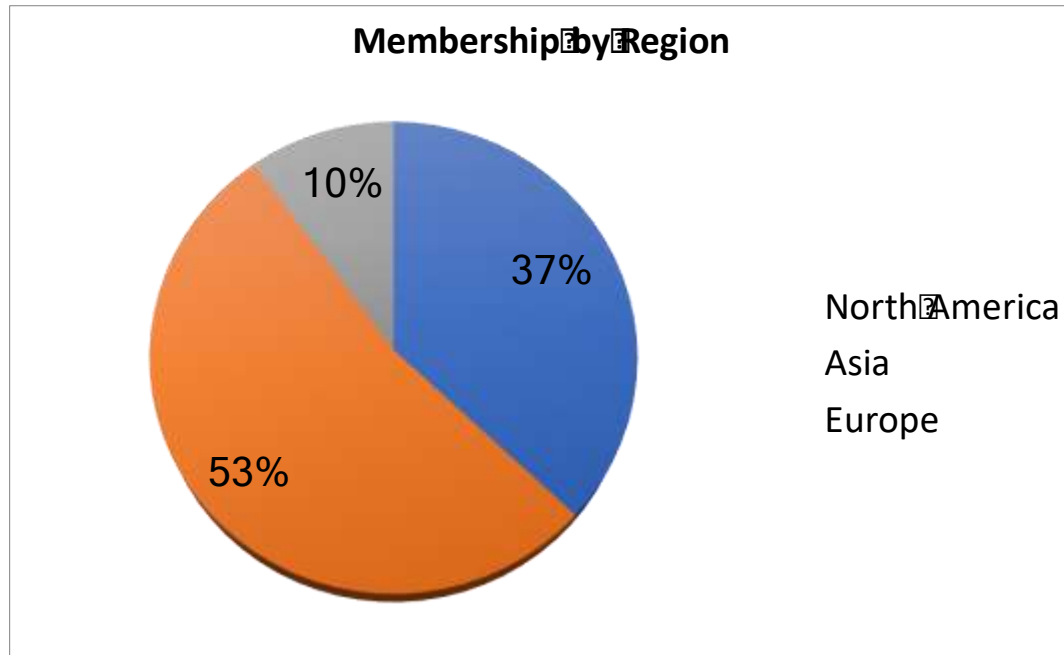
November 20, 2019



Agenda

- **VESA Overview**
- DisplayPort Overview
- DisplayPort Alternate Mode on USB-C®
- Compliance Testing
- USB4™ DisplayPort™ Considerations
- Summary

About VESA



- Global industry alliance with more than **290** member companies
- Leading PC/computer, display, hardware, software, and component manufacturers worldwide
- Mission to develop, promote and support ecosystem of vendors and certified interoperable products for the electronics industry
- Develops Open standards, contribution is open to all companies at all stages of development as well as promotion and marketing

VESA Standards Enable Many Market Segments...



Monitors, PCs and laptops



Gaming consoles and headsets



Smartphones and tablets



Automotive



Digital projectors



Digital signage / kiosks

...As Well as Many Aspects of Display Technology

Display Interfaces

- DisplayPort
- DisplayPort over USB-C (DisplayPort Alt Mode)
- Embedded DisplayPort

High Dynamic Range

- DisplayHDR

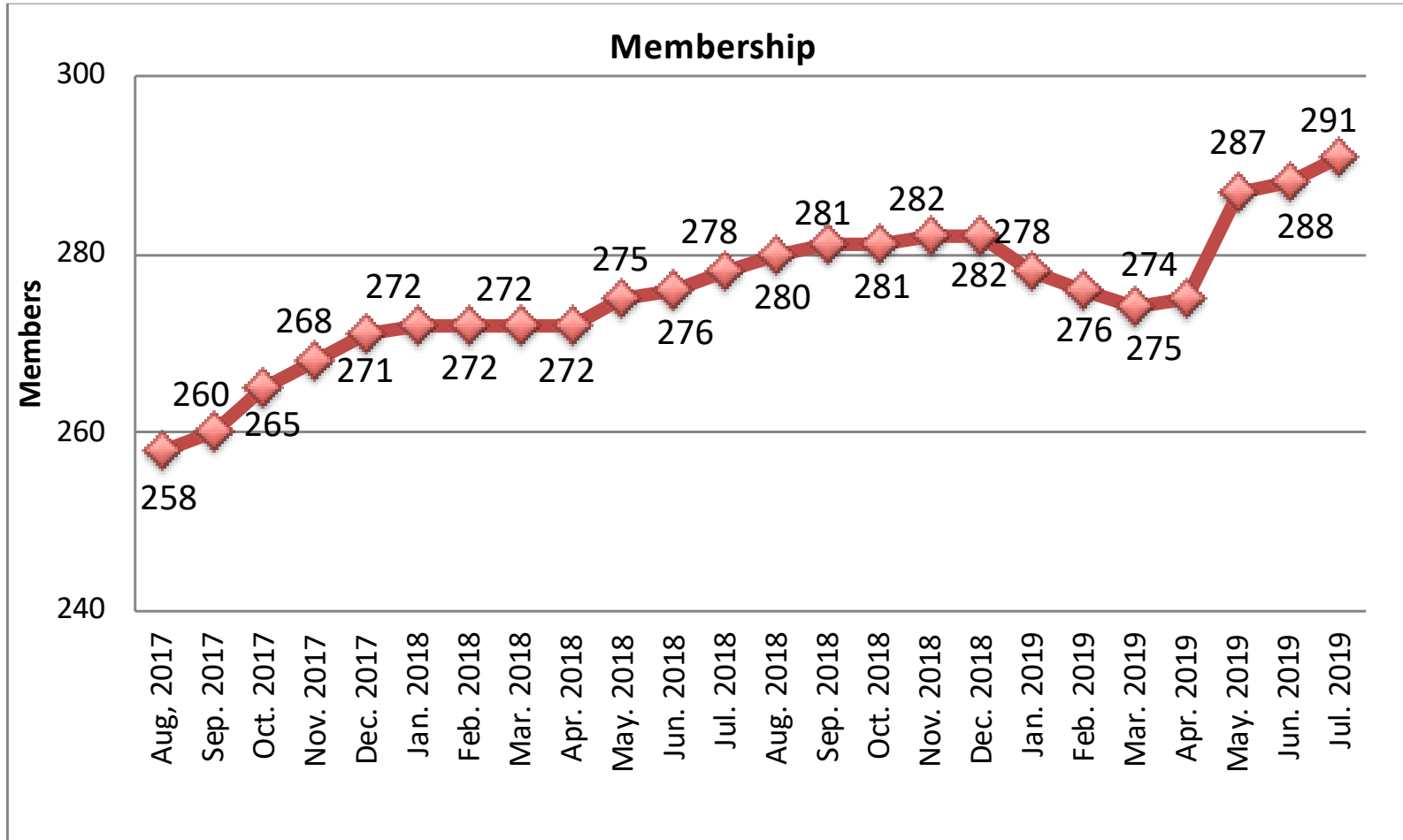
Display Data Compression

- Display Stream Compression (DSC)
- VESA Display Codec for Mobile (VDC-M)

Display Capability Parameters

- DisplayID
- Extended Display Identification Data (EDID)
- Multi-Display Interface

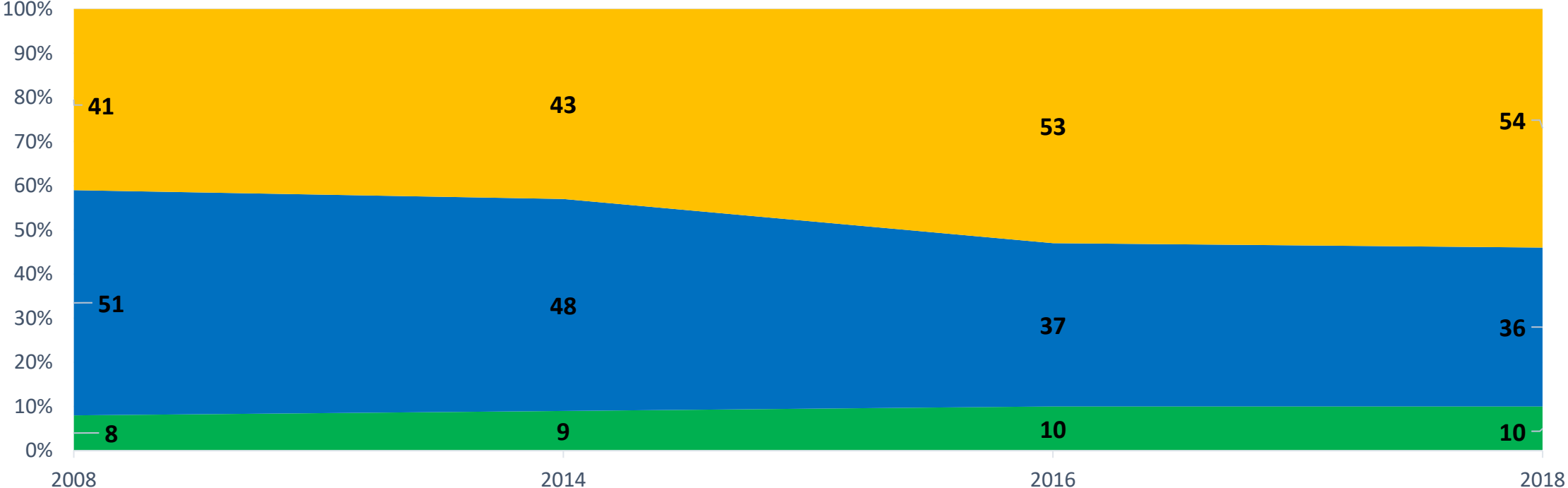
VESA Membership Continues to Grow



Historical Membership by Region

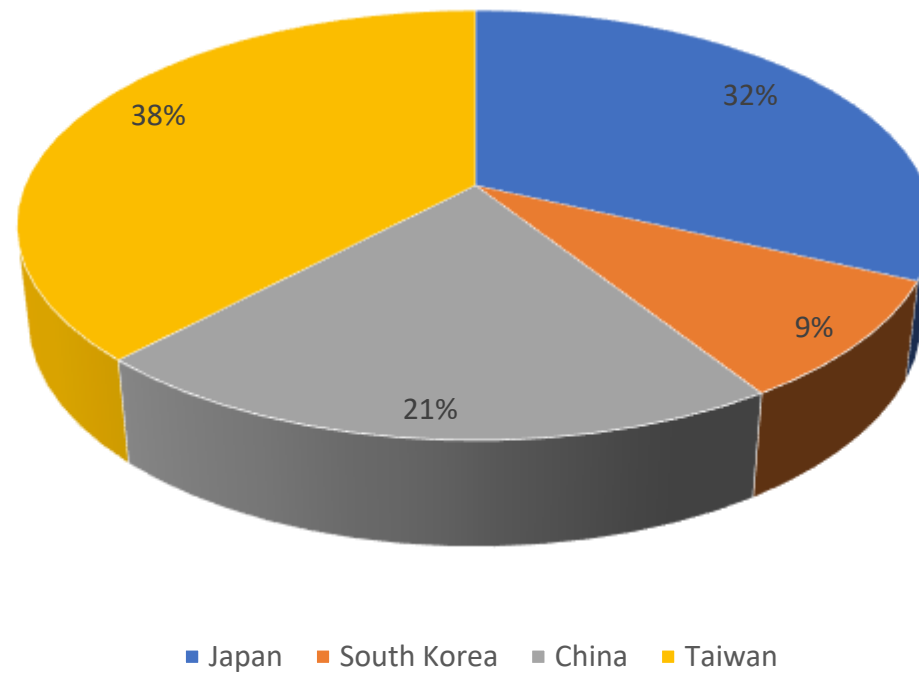
10 Year Flip from US to Asia Dominant

■ Europe ■ US ■ Asia



VESA Asia Membership

Asia Member Distribution of 150 Members



VESA Local Asian Support Capability

- VESA has long had a dedicated Japan Task Group with charter to promote the development of design tools and reference guides, PlugTests, educational seminars, and other activities for the benefit of VESA member companies, particularly those in Japan.
- **NEW:** VESA has added to its local support to Asia to address growing regional membership needs
- China (Mainland) and Taiwan are the fastest growing areas for VESA's membership.
- **Kellen** is VESA's Representative for all Chinese speaking areas of Asia
- This partnership will provide members with a communication option in their native language. Kellen will handle membership related activities including, new membership requests, renewals, PlugTest and event support and translation of VESA member messaging, etc.

Agenda

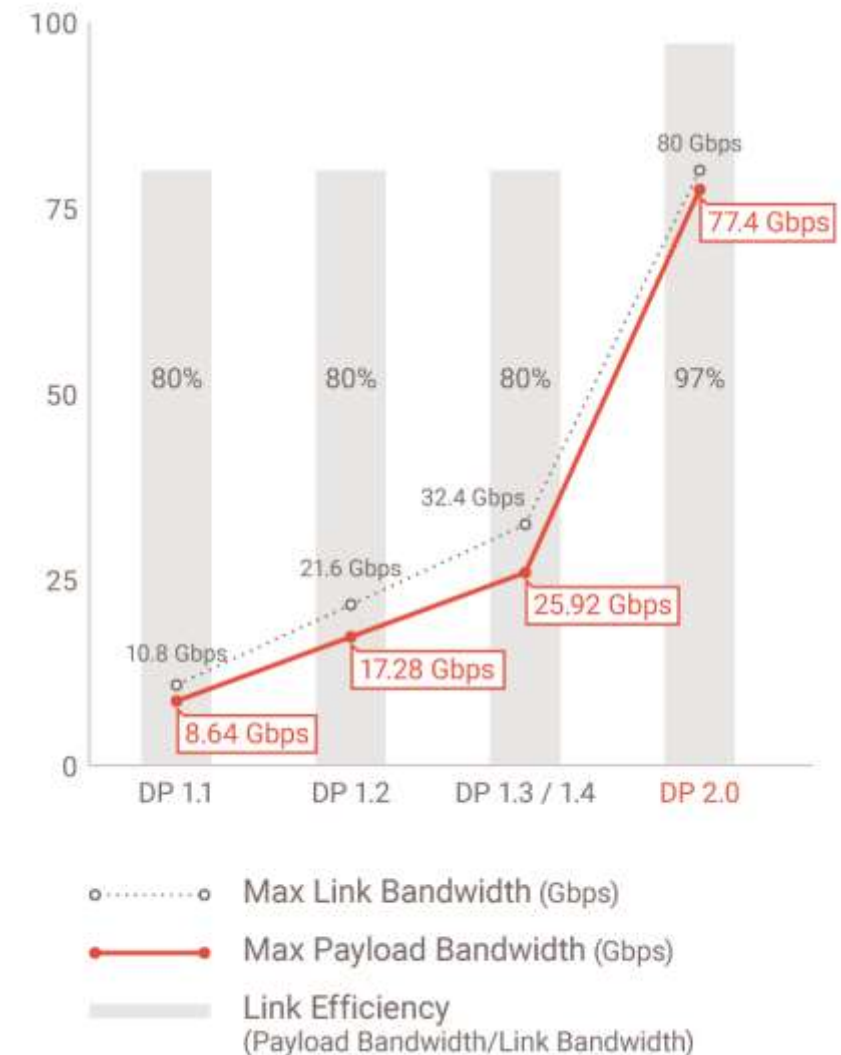
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DisplayPort 2.0 Summary

- DisplayPort v2.0 was released in June 2019
- Major features added:
 - Increase in data bandwidth performance (almost 3X)
 - DSC support mandated
 - MST (Multi-Stream Transport) is now standard protocol
 - Expanded Tunneling capability
 - Panel Replay, similar to PSR (Panel Self Refresh) used for eDP

DisplayPort 2.0 Summary

- DisplayPort 2.0 enables up to 3X increase in video bandwidth performance
- First standard to support 8K resolution (7680 x 4320) at 60 Hz refresh rate with full-color 4:4:4 resolution, including with 30 bits per pixel (bpp) for HDR-10 support
- Beyond 8K resolutions achieved with maximum link rate to up to 20 Gbps/lane and more efficient 128b/132b channel coding



New DisplayPort Link Rates

Parameter	DP 1.4a Published April 2018	DP 2.0 Published June 2019	Notes
Supported Link Rates (Gbps, each lane)	1.62 2.7 5.4 8.1	1.62 2.7 5.4 8.1 10 13.5 20	8b10b coding 8b10b coding 8b10b coding 8b10b coding 128b132b coding 128b132b coding 128b132b coding
Max payload rate (4 lanes)	25.92 Gbps	77.36 Gbps	Speed increase x2.98

DisplayPort 2.0 is backward compatible with DP 1.4a and all earlier versions.

DisplayPort 2.0 Resolution Capability (Single Display Examples)

Port Configuration	DisplayPort 1.4a	DisplayPort 2.0
No Compression		
4 Lanes, max link rate	5K (5120x2800)@60fps 24bpp	10K (10240x4320)@60fps 24bpp
2 Lanes, max link rate	4K (3840x2160)@60fps 24bpp	8K (7680x4320)@30fps 30bpp
With Compression (DSC)		
4 Lanes, max link rate	8K (7680x4320)@60fps 30bpp	16K (15360x8460)@60fps 30bpp
2 Lanes, max link rate	5K (5120x2800)@60fps 24bpp	10K (10240x4320)@72fps 30bpp

Notes:

- 2 Lane configuration is common for USB-C DP Alt Mode
- All above modes assume full 4:4:4 color encoding
- 30bpp is required for DisplayHDR operation

Key:

- DSC = Display Stream Compression
- fps = frames per second
- bpp = bits per pixel

DP 2.0 Mandates Support for Display Signal Compression (DSC)

- VESA released DSC 1.2a in January 2017.
- DSC is now the industry standard data compression across the display interface.
- DSC was purposely designed to offer low latency, low complexity codec for visually lossless image compression to increase the amount of data carried by a display interface data rate, saving power.
- Key features include
- Native 4:2:0 and 4:2:2 coding, Up to 16 bits per color, High Dynamic Range (HDR)
- DSC is mandated in DP 2.0 specification and is a powerful feature to allow designers to optimize BW, performance and power for Native DP, DP Alt Mode products and tunneled DP over USB4.

DisplayPort Market Penetration

- DisplayPort adoption grew significantly in 2019
- DisplayPort and DisplayPort Alternate Mode over USB-C
 - The common monitor interface for personal computers
 - Commonly supported on the USB-C interfaces supporting USB 3
 - Mandated for USB4 and Thunderbolt
- Embedded DisplayPort (eDP)
 - ~95% penetration in notebook PCs, used in many high-end tablets and now automotive

Optimization for Shared Interface Use

- Numerous specification enhancements to simplify the use of DisplayPort™ as an ingredient in the following interface examples:
 - The USB-C® connector, using the DisplayPort Alt Mode
 - VESA Mobility DisplayPort Standard (MyDP)
 - VESA Embedded DisplayPort Standard (eDP)
 - Thunderbolt™ 3
 - Wireless interfaces

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VESA DisplayPort™ Alternate Mode on USB-C® Summary

- The VESA DisplayPort Alt Mode Standard, Version 1.0b , was released on Nov 3, 2017
- Update to VESA DisplayPort Alt Mode Standard, Version v2.0 is under final review
 - Incorporation of SCRs
 - Update to DP v2.0
 - Current USB related specifications and requirements
 - Updated passive USB-C-to-DP cable electrical parameters to include UHBR10

DP Alt Mode over USB-C® Ecosystem is Mainstream



USB-C Tablets



USB-C Laptops



USB-C Displays



Multi Function Adapters

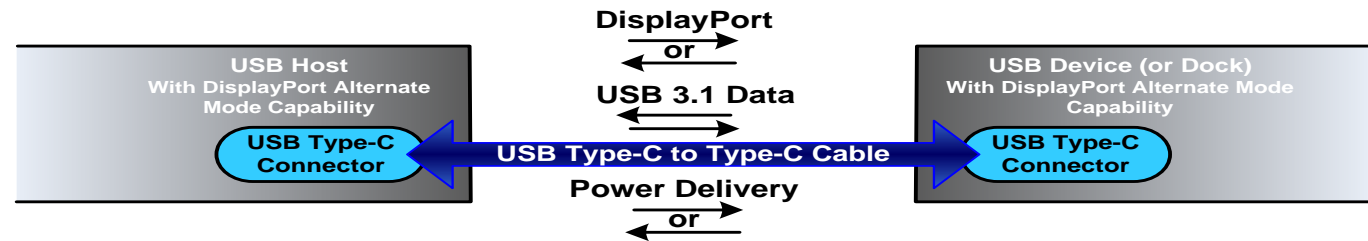
All types of certified adapters available

- USB Type-C to DP adapters, Multifunction docks
- USB Type-C protocol converters (HDMI, VGA, DVI) using DP Alt Mode

More are certified every week

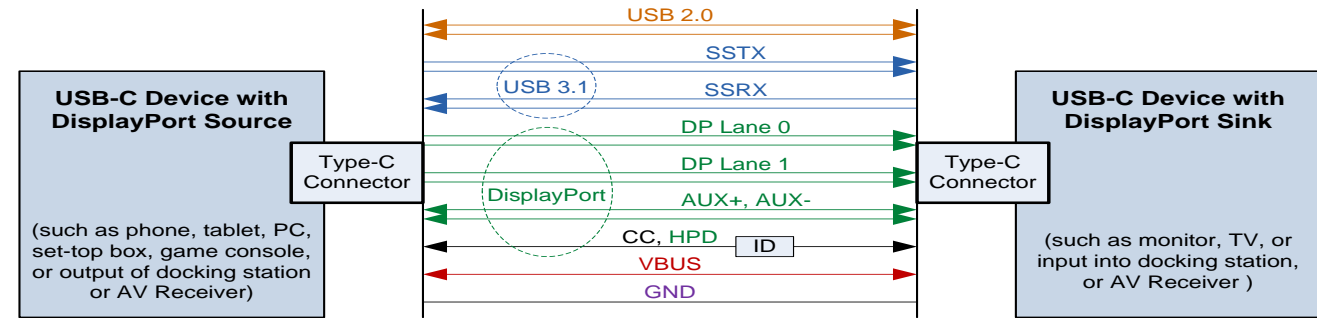
- Major PC OEMs continue to launch new products with DP Alt Mode over USB-C
- Major Display OEMs continue to add USB-C inputs to their products

USB-C[®] Connector Functional Extension DP Alt Mode



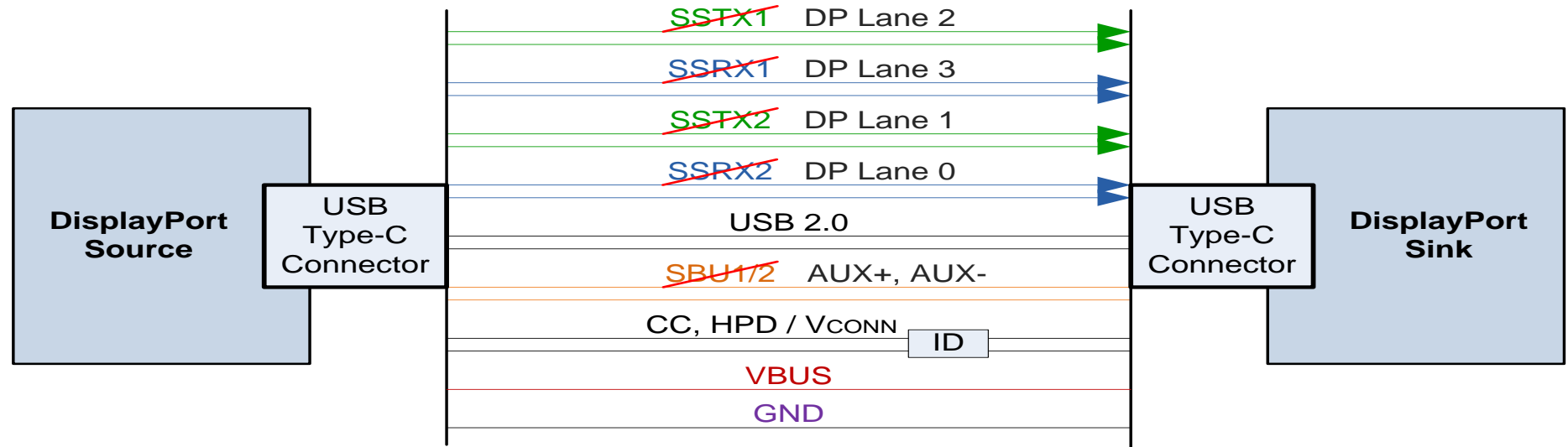
- A passive Full Feature USB Type-C to Type-C cable can carry up to four DisplayPort™ lanes
 - Same performance and features as a standard DisplayPort connection
 - Allows DisplayPort data rates to increase in the future, since the USB Type-C connector has very high data rate capability
- DisplayPort can be combined with USB 3.2 operation over the same USB Type-C cable
- USB 2.0 and USB Power Delivery is available in all configurations

2xDisplayPort and USB 3.2 over a Standard USB-C® Cable



- Uses a standard “Full Feature” USB-C to USB-C cable which is designed to include DisplayPort™
- The above configuration uses two high-speed lanes each for DisplayPort and USB 3.2
 - Ideal for docking stations, or for displays or TVs that include USB 3.2 functions
- DisplayPort performance provided by two lanes
 - DP v1.2 (HBR2 Source devices): Two 1080p displays, or one 4k@30Hz
 - DP v1.4 (HBR3 Source devices): 4K@60, or HDR 4K@60 using 4:2:0 and 12bpp

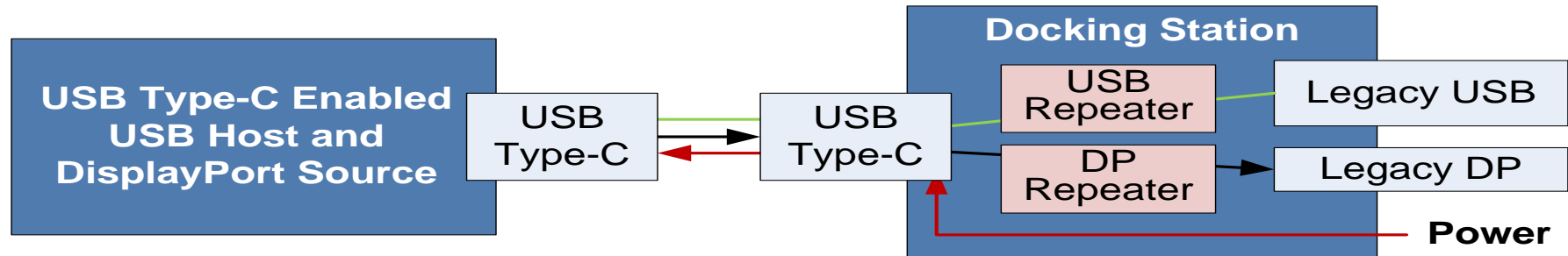
4xDP Over a USB Type-C[®] to USB Type-C Full Feature Passive Cable



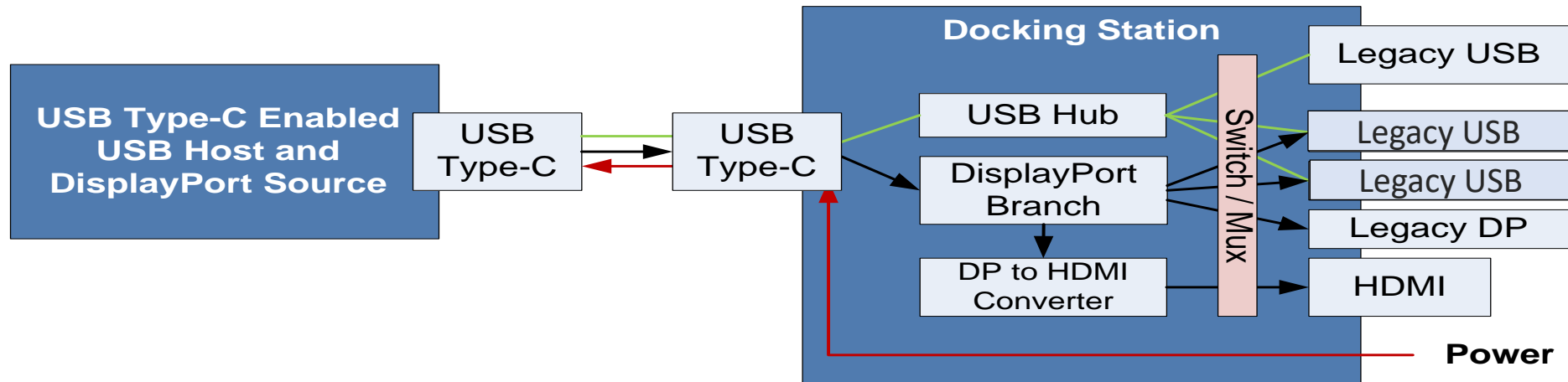
- Utilizes optional DP Alt Mode capability of USB Type-C connector
- DisplayPort™ can use all four high speed lanes to deliver full DisplayPort performance
- The DisplayPort AUX Channel uses the SBU pins
- The DisplayPort HPD / IRQ is transmitted over the CC pin using the USB-PC protocol
- USB 2.0 and USB Power Delivery always available

Example Docking Configurations using the USB Type-C[®] DisplayPort[™] Alternate Mode

Simple Docking Configuration



More Complex Docking Configuration



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DP Alt Mode Compliance Test Specification

- The DP Alt Mode on USB Type-C® CTS Version 1.0, was released Jan 24, 2017.
- Over 200 DP Alt Mode products have been certified over last two years
 - Products include Sources, Sinks, Adapters and Docks

Certification Test Coverage

Test plan and CTS covers all features and supported pin assignments.

- USB PD Compliance Testing
 - Demonstration of proper functionality/behavior for DP Alt Modes
 - A device must pass DP Alt Mode USB-PD certification tests to receive DP certification
- TX and RX Electrical testing of all supported modes with PHY test fixtures
 - USB PHY electricals
 - USB 3.2 5G
 - USB 3.2 10G (if supported)
 - USB 2.0 480Mb/s
 - DP PHY electricals (DP 1.4a PHY CTS)
 - RBR, HBR, HBR2, HBR3
 - Aux Channel

DP Alt Mode Discovery and USB PD Tests

- Section 10 of the DP Alt Mode CTS includes specific USB PD tests for DP Alt Mode products
- These include:
 - DP Alt Mode on USB-C® tests for UFPs
 - Enter Mode Response
 - Status Update Commands
 - DP Alt Mode on USB-C tests for DFPs
 - Discover SVIDs
 - Enter Mode Sequences
 - Status Update
 - Field checks
 - VBUS/VCONN/HPD timings
- Additional tests have been added to fix issues discovered in the field
 - Pin assignment tests, cable adaptor tests and HPD propagation latency checks
- All tests included in Section 10 must be run in addition to passing USB PD certification by USB-IF

Certification Test Coverage (continued)

- USB 3.2 Interop testing (functional)
- USB 3.2 Link testing
- DP certification testing
 - Interoperability testing
 - Interop testing with a required matrix of products and adapters that are available.
 - Link layer testing
 - EDID testing
 - MST testing if supported
- USB Billboard tests
- Certification testing of USB: VESA requires product vendor provide USB-IF Compliance Test ID

NEW Compliance Test Areas

- DSC Link Layer Compliance Test Specification SCR v1.0 (July 1, 2019)
 - Adds source and sink DSC compliance tests
 - Support for DSC is mandated in DP v2.0
- DP 1.4a Link Layer Consolidated CTS v1.0 (June 12,2019)
 - Updated tests to meet DP 1.4a requirements
 - Added additional audio and video tests
 - Added FEC source and sink tests. FEC required when DSC enabled
- DP PHY CTS updates
 - VESA DFE tool has been completed
 - Tool created using Matlab and exe provided to PHY TE vendors to solve PHY test correlation issue using DFE
- DP 8K cable certification – test requirements and tools directly based off of USB-C cable test.

Compliance Certification Process

- Step 1: read/understand DP 2.0 Specification
- Step 2: read/understand relevant VESA Compliance Test Specifications (Link, PHY, EDID, DisplayHDR, etc)
- Step 3: pre-test products with approved test equipment and procedures
- Step 4: submit products to approved ATC for certification
- Step 5: ATC submits certification results t& family model info to VESA CPM
- Step 6: If review process is satisfactory VESA CPM approves submission
- Step 7: ATC informs customer test results are approved
- Step 8: Customer completes logo/trademark license agreement and uses logo on product(s)

VESA PlugTest Events

- Provide significant value to member companies, particularly as new capabilities and products are deployed.
- Demonstrate and improve Traditional Interoperability
 - Test Native DP and DP Alt Mode over USB Type-C™ products
 - HBR3, DSC, FEC, DisplayHDR and other new capabilities
 - Verify Test Equipment Correlation
- VESA hosted two successful PlugTests in 2019 (Taiwan and US)
- VESA plans to host at least two PlugTests in 2020
 - Taipei, Taiwan: **Q1 2020 (Tentative)**
 - Burlingame, CA: **Q3 2020 (Tentative)**

DSC Compliance Testing

- VESA released DP 1.4a DSC CTS v1.0 in July 2019
- Compliance testing of DSC began in October 2019 for sources and sinks that support this feature
- Updates and increased test coverage are included in DP 1.4a DSC CTS v1.1 that will release this month.
- DSC is a powerful capability to optimize shared interface BW as well as optimize power versus BW useage

VESA Synchronization with USB-IF Compliance Test Program

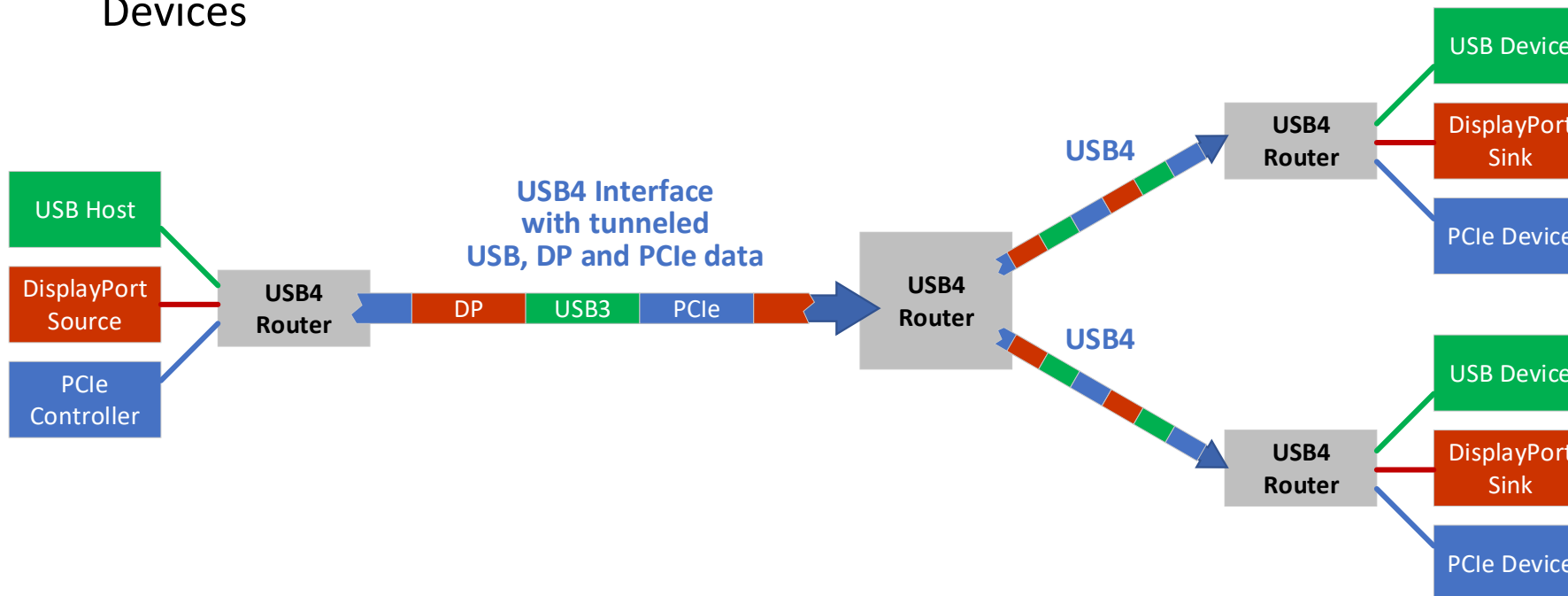
- Coordinate certification plans, test coverage and timing for early products
- Avoid scheduling conflicts
- Avoid testing overlaps and inconsistencies

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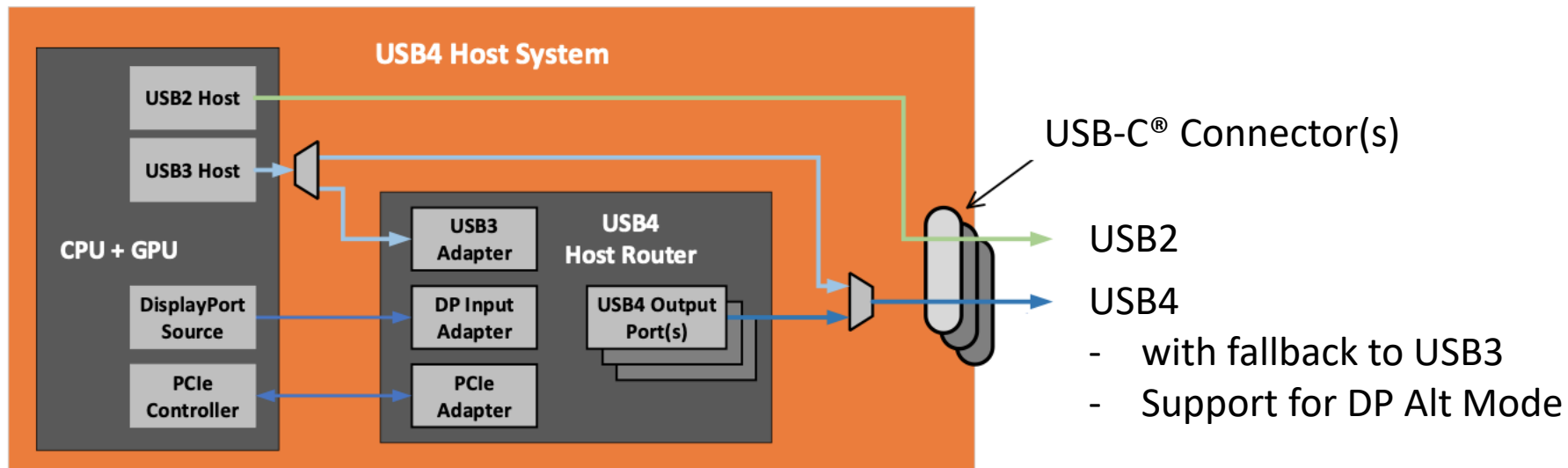
USB4™ DisplayPort™ Considerations

- This presentation focuses only on USB4 DP requirements. Other requirements are covered in earlier presentations and the USB4 specification.
- There are three USB product types of interest for DisplayPort
- USB4 Host, USB4 Hub and USB4 Device
 - USB4 Hosts and Hubs must support DP Protocol Tunneling, with support optional for USB4 Devices



USB4™ Host – DisplayPort™ Requirements

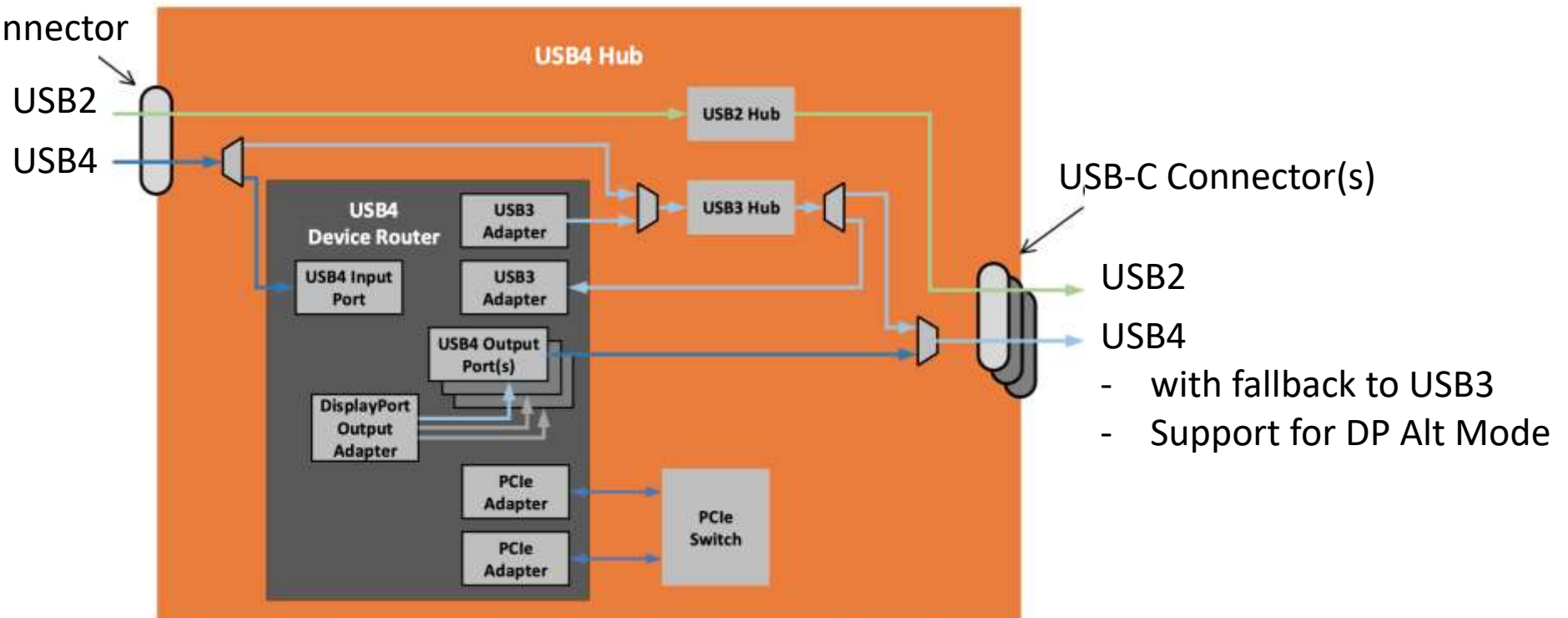
- USB4 Host DisplayPort requirements are fairly straight forward
- USB4 Host **Must** Support:
 - USB4 Fabric Configuration: Minimum of 2 lanes at 10 Gbps (Gen 2 x 2)
 - USB 3.2 Data Transport, USB 2.0 Native
 - DisplayPort
 - DisplayPort tunneling through USB4
 - DisplayPort Alt Mode on all of it's DFPs



USB4™ Hub – DisplayPort™ Requirements

- A USB4 hub is required to support DisplayPort Alt Mode on all of its DFPs.
- To connect to DisplayPort Sink, a USB4 hub contains a DP OUT Adapter that receives Tunneled DisplayPort traffic from a USB4 Port and sends it to a DisplayPort Sink via DP OUT Protocol Adapter

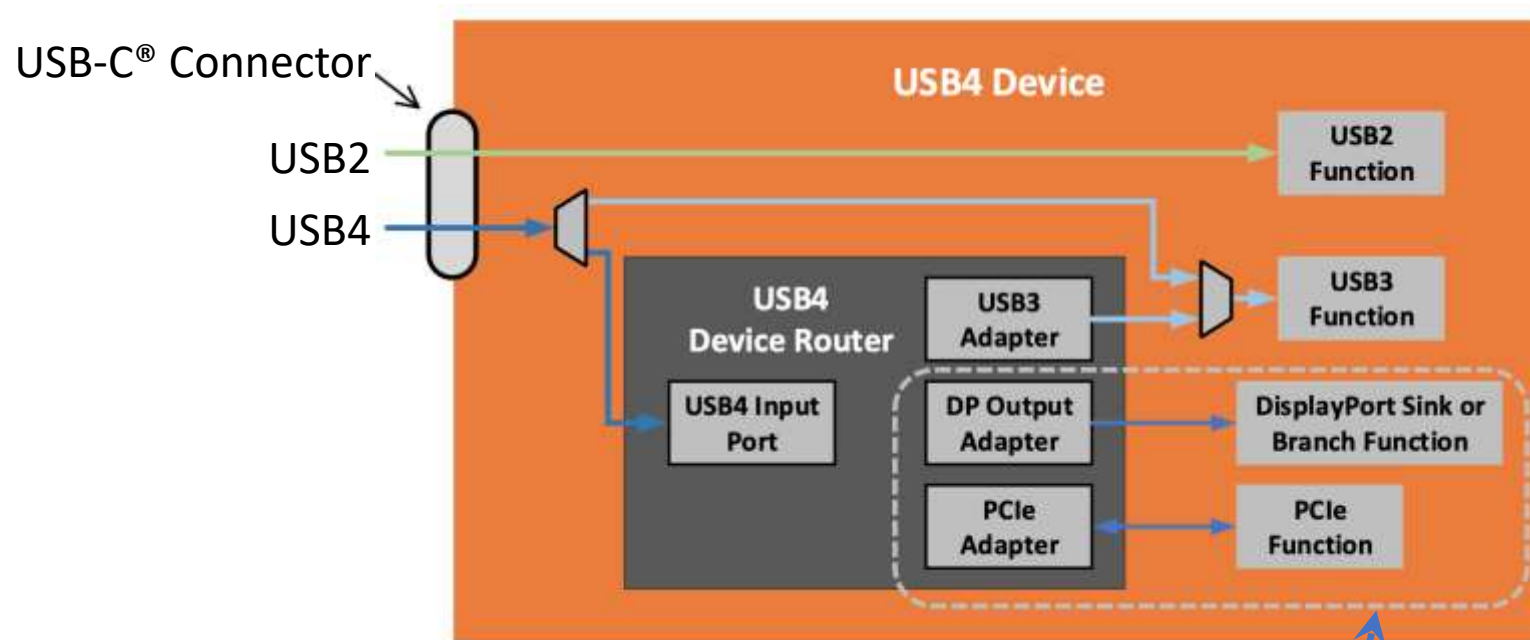
USB-C® Connector



- with fallback to USB3
- Support for DP Alt Mode

USB4™ Device – w/DisplayPort™ Supported

- A USB4 peripheral device must support 20G USB4 operation (Gen2x2) and optionally 40G USB4 operation (Gen3x2)
- Testing the DP Sink Link Layer will offer new challenges for compliance testing



These functions are optional and depend on device features

Summary

- DP v1.4a products are certified and shipping with these new features.
- DP v2.0 product development and certifications expected in 2020.
- These same features will live on into the USB4™ ecosystem from the get-go offering compelling capabilities for end user products.
- Millions of Certified DP Alt Mode over USB-C® products are shipping with many more in development so continued support for backward compatibility is critical, and will be achieved.
- Compliance testing of DisplayPort™ functionality will be complex and will take close collaboration with the USBIF to ensure we get it right.
- DP Alt Mode over USB-C is a huge success and I believe USB4 will accelerate this success to benefit product developers and end users.

One More Thing.... DP 2.0 Enhancements Improve DP Tunneling Performance with USB4™

- USB4 tunneling architecture is designed to combine multiple protocols onto a single physical interface.
- DP v2.0, released June 26, 2019, includes many enhancements that will improve USB4 DP Tunneling performance.
 - New UHBR rates increases the per-lane bandwidth to 3x of HBR3
 - Raw lane rate increase plus channel coding efficiency improvement leveraging USB4 PHY
 - **DSC support mandated** that reduces the isochronous DP bandwidth, enabling allocation of more USB4 bandwidth to other functions
 - **Panel Replay** based on Panel Self Refresh of eDP, reducing the isochronous DP bandwidth when enabled, providing more USB bandwidth to other functions
- For DP Alt Mode over USB-C®, DP 2.0 carried over the USB-C connector enables simultaneous higher-speed USB data transfer while offering 3x display transport performance.

Questions?

DisplayPort over USB-C

The most advanced display connection now uses the most versatile connector.

[Learn More](#)

[Go to www.displayport.org](http://www.displayport.org)



VESA Links

- <https://vesa.org/>
- <https://www.displayport.org/>
- <https://displayhdr.org/>

Time for Q&A
