HDMI Over USB Type-C™

Developer Days 2016

Hong Kong

October 19 – 20, 2016

HDMI Alt Mode for USB Type-C Connector Specification

- What is HDMI Alt Mode for USB Type-C?
- HDMI Market Overview
- Features and Benefits
- Technical
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  - System Overview
- HDMI Compliance

What is HDMI Alt Mode for USB Type-C?

- HDMI Alt Mode for USB Type-C Connector specification released Sept, 2016
- Enables two of the most popular connectivity solutions to come together
- Allows HDMI enabled sources with USB Type-C connector to connect directly to HDMI enabled displays
- Enables native HDMI features to be utilized in source devices with USB Type-C connectors
- Uses a simple USB Type-C to HDMI cable with no adapters or converters

HDMI Market

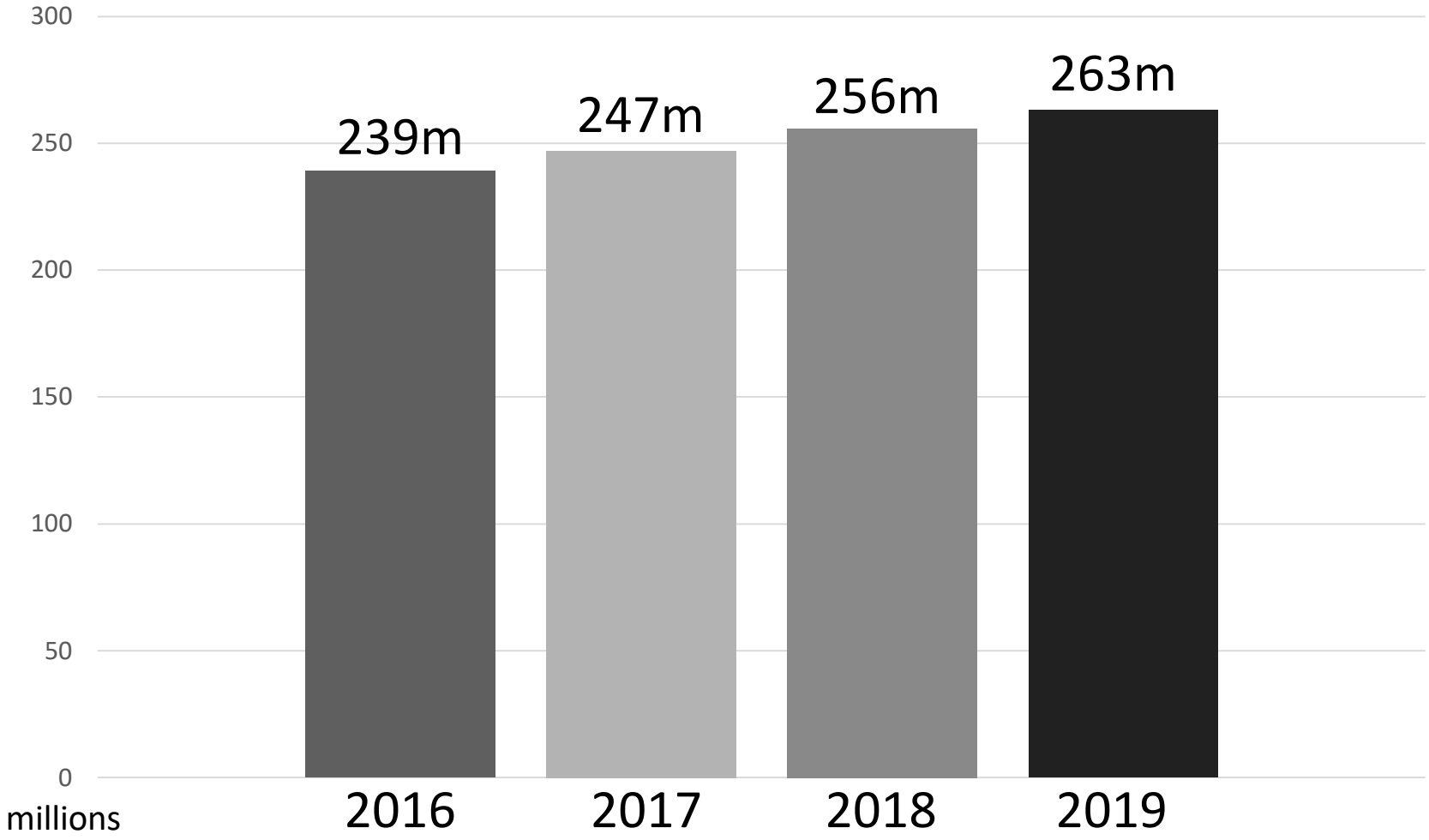
Overview

HDMI Technology—The De-facto Connectivity Standard

- Transmits uncompressed HD and 4K video, multi-channel surround audio, and consumer electronic control (CEC) through a single cable
- Almost **6 Billion** HDMI products have shipped worldwide
- Over **1,600** of the world's largest consumer electronics, PC and mobile device manufacturers include HDMI connectivity in their products

HDMI Penetration and Market Position

HDMI-Enabled Flat Panel Global Shipment Growth

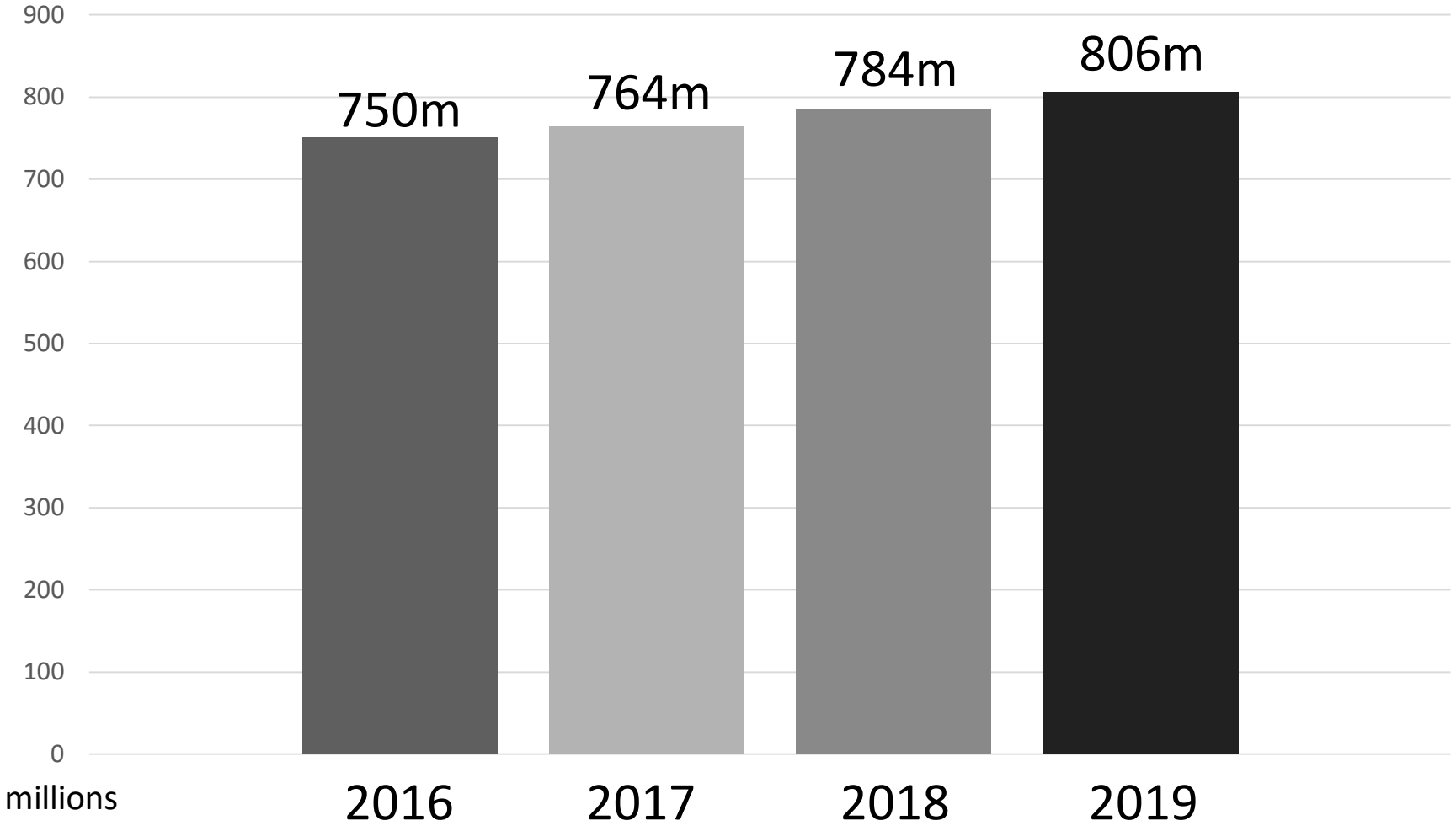


4K TV Shipments Are Growing Too

Annual worldwide 4K shipments to grow 719% from 2014-2019 to 96 million units

IHS Technology 2016

HDMI-Enabled Device Global Shipment Growth



IHS Technology 2016

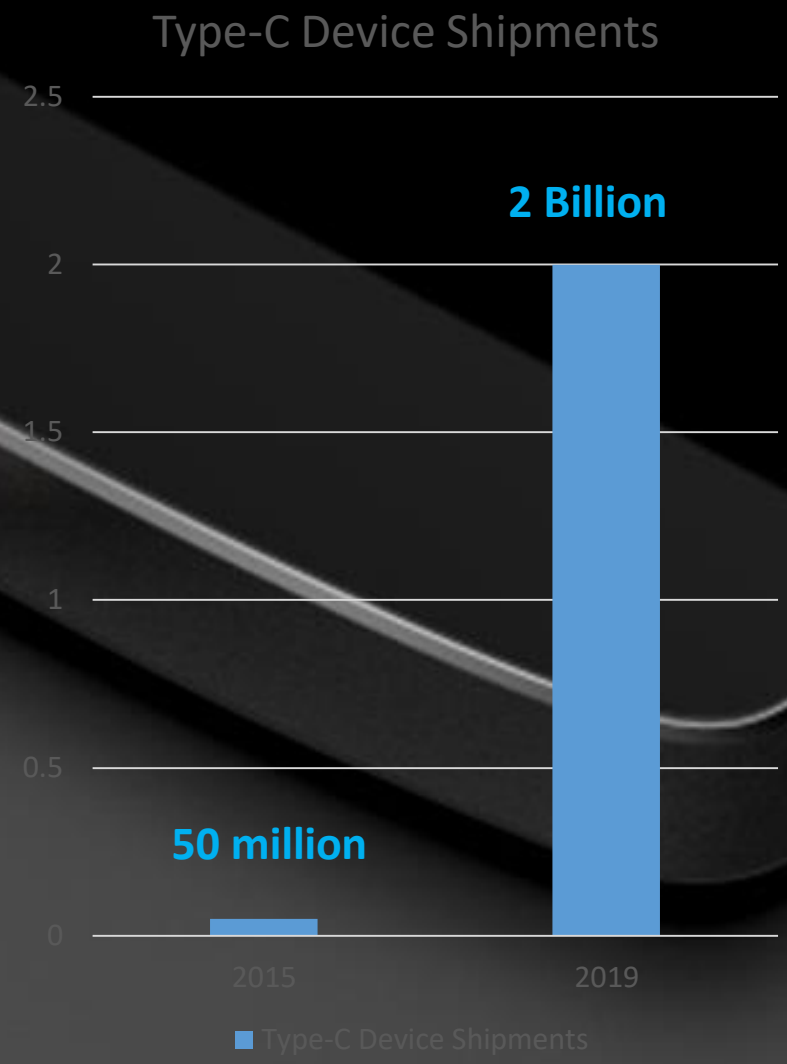
HDMI-enabled devices include:

- Flat panel TV
- DVD & Blu-ray player/recorder
- Projector
- AV Receiver
- Media Stick
- Desktop PC
- Laptop/Notebook PC
- PC/Media Tablets
- Smart Phone
- LCD PC Monitor
- Video game Console
- Set Top Box
- Digital Camera/Camcorder/Wearable
- Discrete Adapter
- Docking Station

Note: Only includes products with HDMI connectors

"USB Type-C connector adoption in the wireless, CE and PC segments should grow rapidly over the next several years, with over 2 billion Type-C devices expected to ship in 2019 alone.

HDMI Alt Mode over Type-C makes perfect sense in the CE segment, where HDMI has traditionally been dominant in many applications, especially TVs" said Brian O'Rourke, Sr. Principal Analyst at IHS Markit.



HDMI Alt Mode

Features & Benefits

Supports All HDMI 1.4b Features

- Resolutions up to 4K
- Audio Return Channel (ARC)
- Surround Sound
- 3D (4K and HD)
- HDMI Ethernet Channel
- Consumer Electronic Control (CEC)
- Deep color, x.v.Color, and content types
- High-Bandwidth Digital Content Protection (HDCP 1.4 and HDCP 2.2)

HDMI Alt Mode for USB Type-C

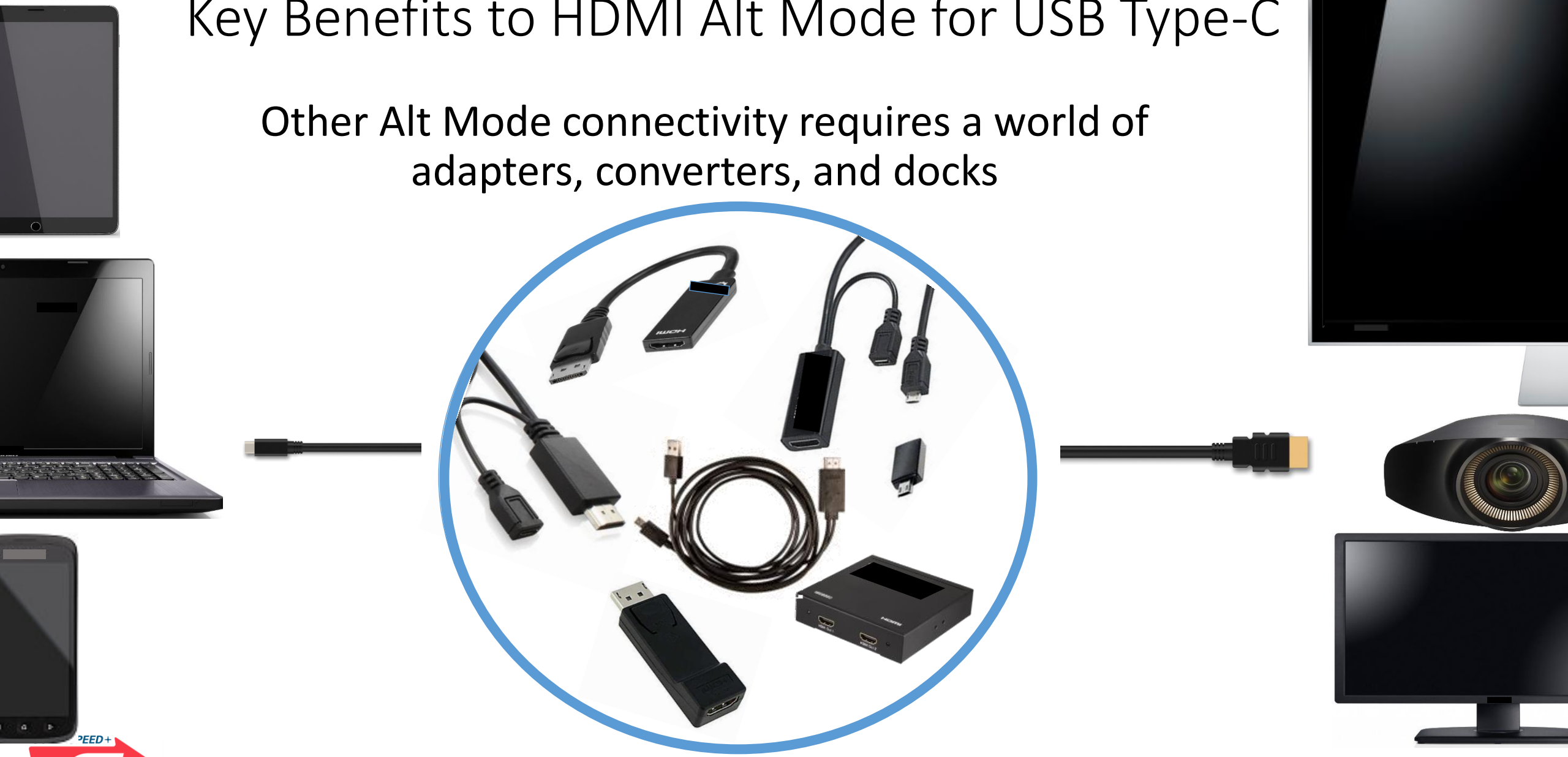
- Follows all necessary Alt Mode USB Type-C specification requirements
- Auto-detects HDMI Alt Mode source devices and HDMI-enabled displays
- Requires no adapters to connect from an HDMI source to an HDMI display
- Source output is AC coupled for HDMI Clock and Data lanes

“USB Type-C is quickly becoming the connector of choice for many types of consumer electronics products wanting a single solution for audio, video, data and power,” said Jeff Ravencraft, USB-IF President and COO.

“Easily connecting devices with USB Type-C to the huge installed base of HDMI-enabled TVs is a substantial benefit to consumers.”

Key Benefits to HDMI Alt Mode for USB Type-C

Other Alt Mode connectivity requires a world of adapters, converters, and docks



Key Benefits to HDMI Alt Mode for USB Type-C

HDMI Alt Mode

No Adapters. No Converters.

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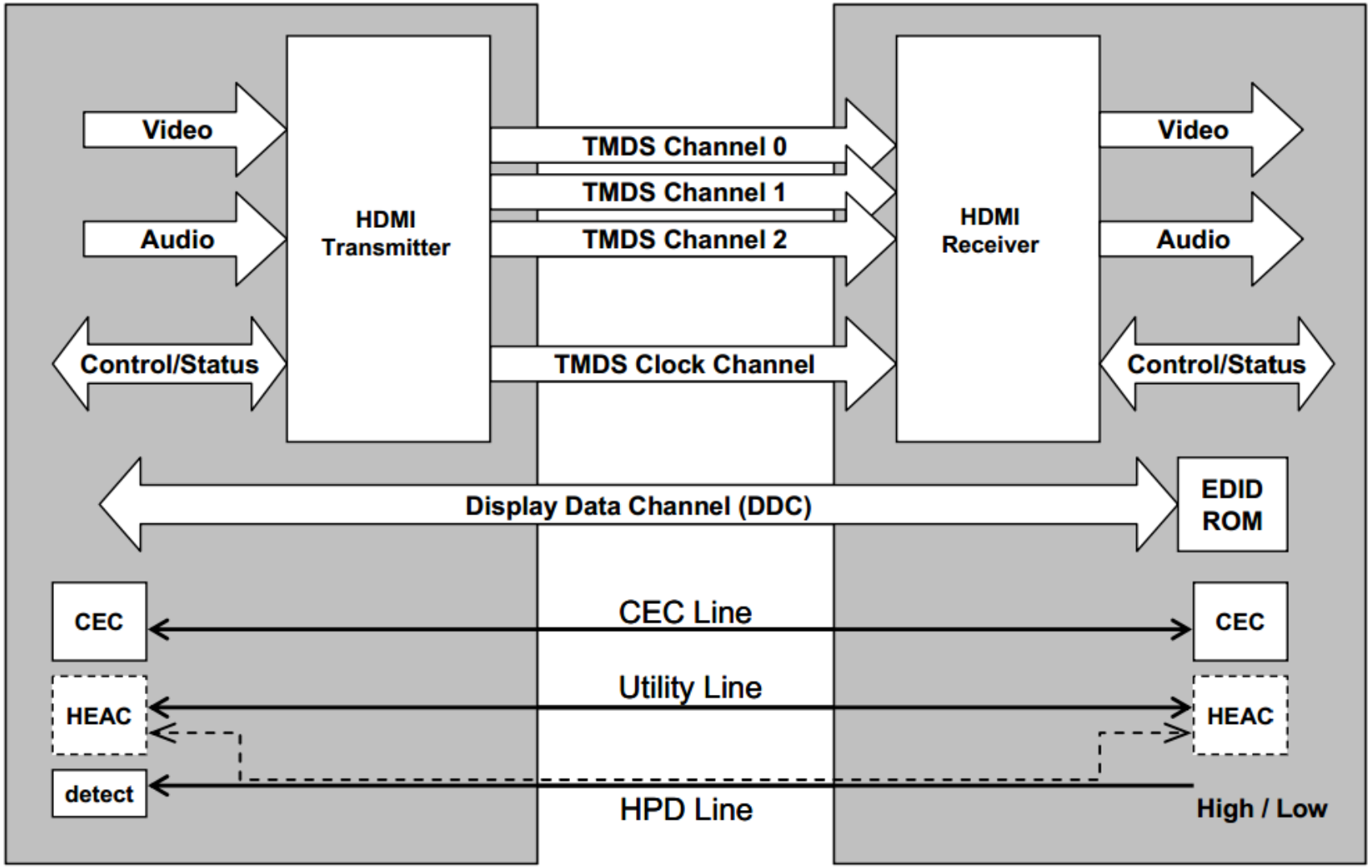
Key Benefits to HDMI Alt Mode for USB Type-C

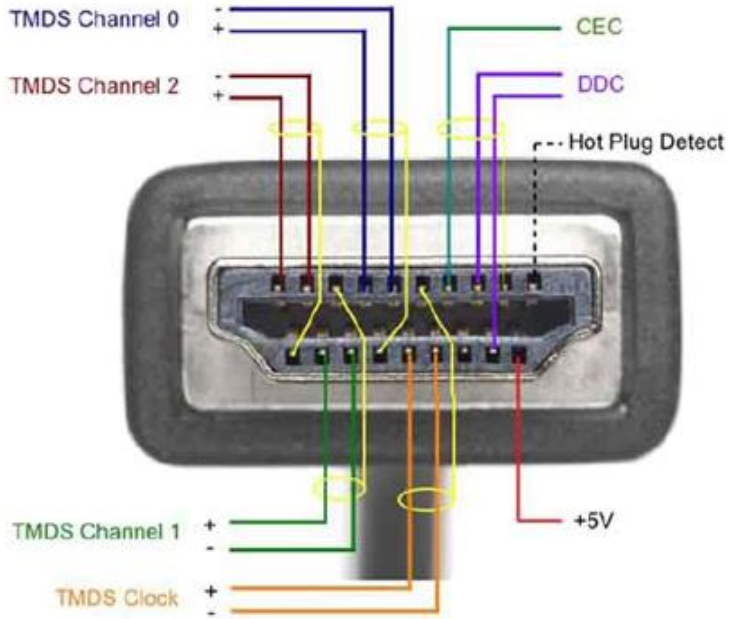
- Enables HDMI source devices to utilize USB Type-C connector
- USB Type-C connector is reversible, small form factor, multi-purpose, and gaining penetration in the mobile and PC markets
- Source manufacturers can now utilize native HDMI features along with USB Type-C connectors
- More source devices will now incorporate HDMI technology
- Consumer familiarity with very little consumer education required

HDMI Basics

HDMI Basics



HDMI Basics



- **HDMI**
  - An uncompressed audio/video interface that uses TMDS (8b/10b) encoding
  - Native connectors uses 19 pins
- **HPD**
  - Hot Plug Detect pin dedicated to monitor power up/down and plug/unplug events
- **DDC**
  - Display Data Channel based on I2C specification
  - Used for EDID data, Metadata/InfoFrame, and HDCP communications
- **CEC**
  - Consumer Electronics Control is a single wire bidirectional bus that allows remote control of other CEC enabled devices over the HDMI connection
- **HEAC**
  - HDMI Ethernet and Audio Return Channel feature adds Ethernet and Audio Return capability to HDMI devices
  - Uses the Utility and HPD lines for signal transmission. Utility is used for HEAC+ and HPD is used for HEAC-
- **ARC**
  - Audio Return Channel allows for audio to be transmitted from HDMI Sink to HDMI Source (reverse) over the single HDMI connection
- **HEC**
  - HDMI Ethernet Channel feature enables IP based bidirectional Ethernet communication at 100 Mbit/s
  - 100BASE-TX signals are used over single twisted pair (Utility/HEAC+, HPD/HEAC-)

HDMI Alt Mode

Technical

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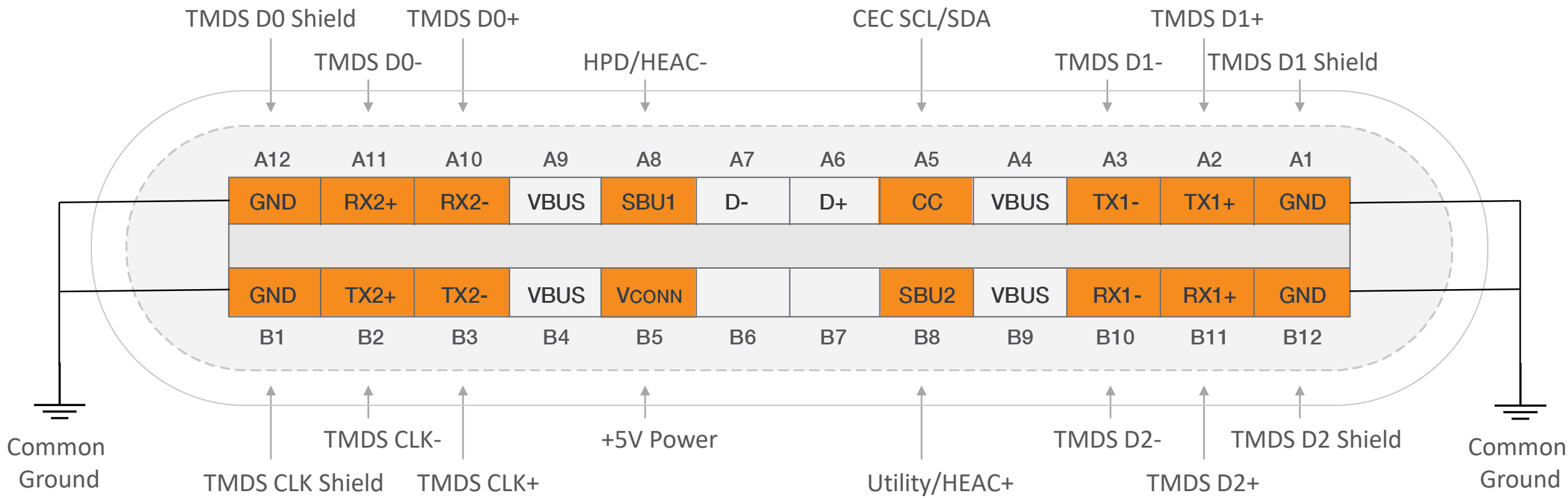
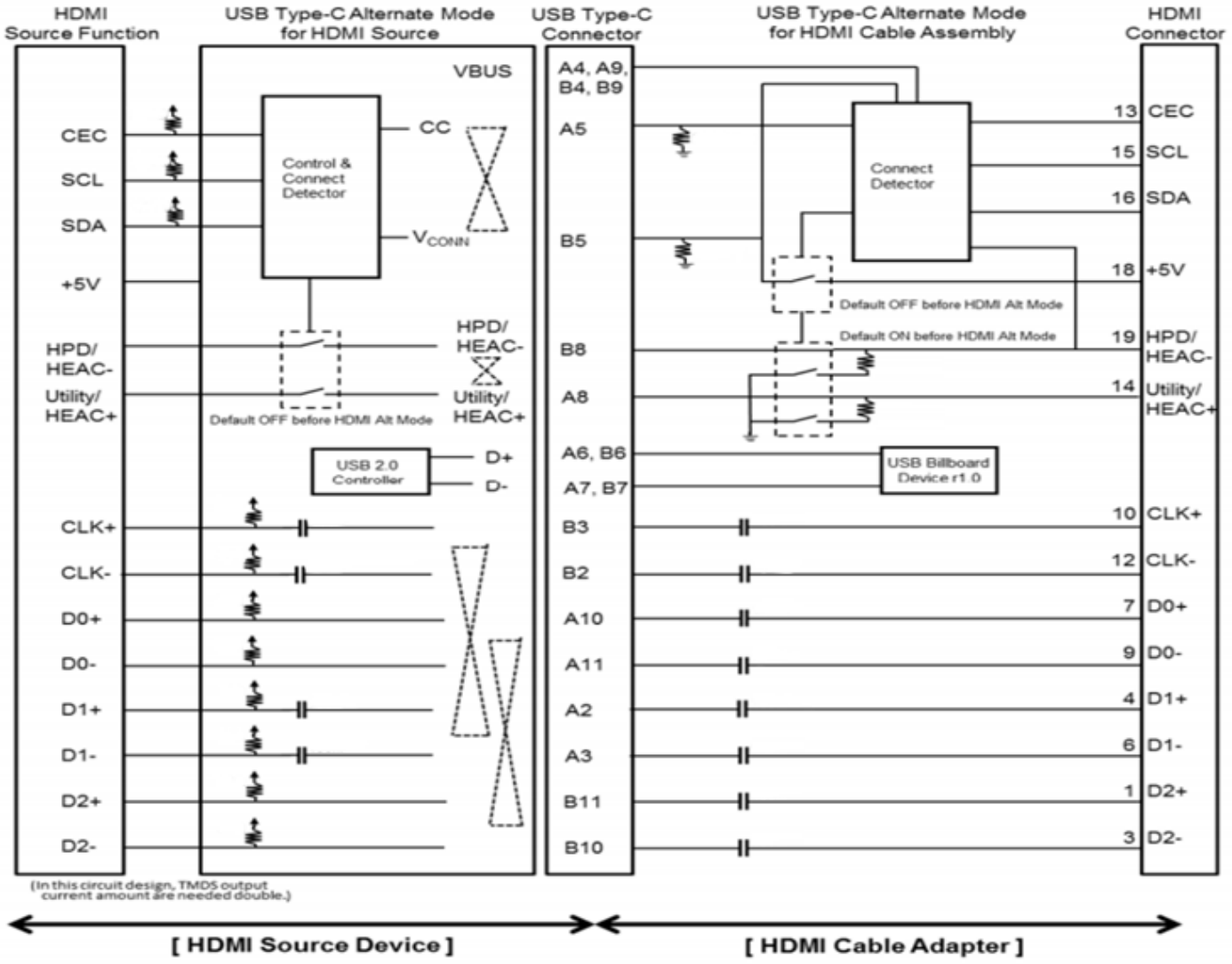
HDMI Alt Mode for USB Type-C Pin Mapping

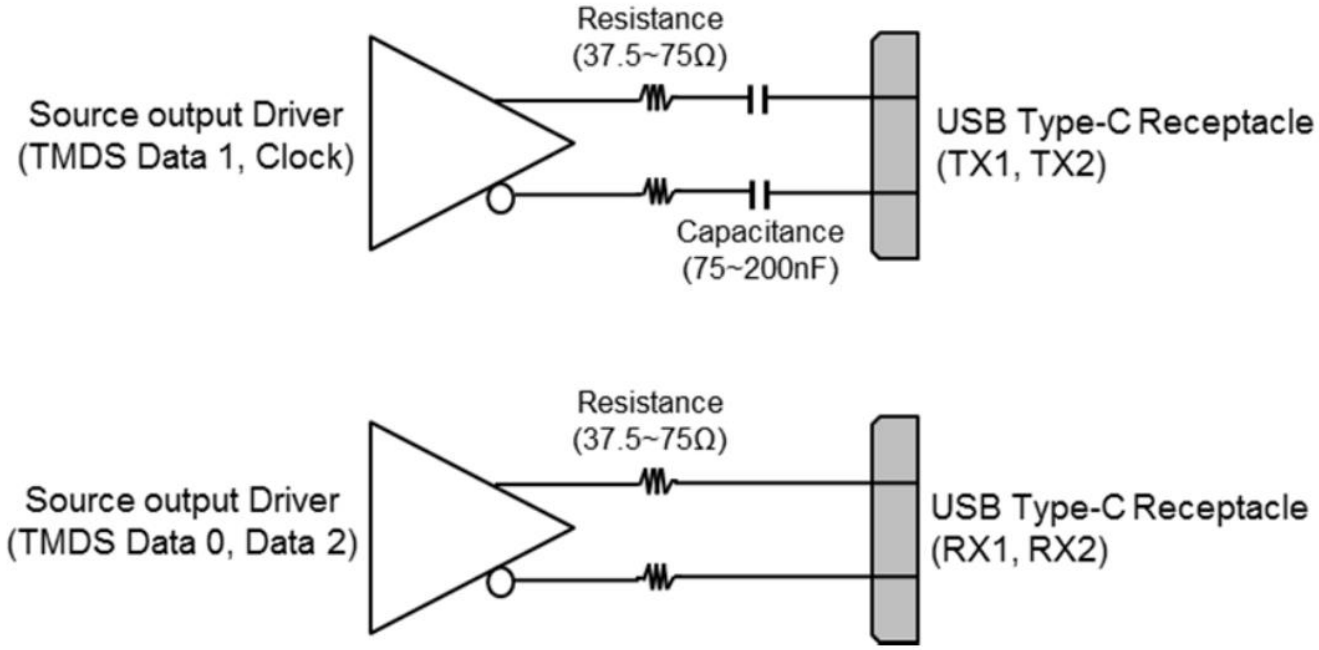


System Overview



System Overview

- Source output is AC coupled for HDMI Clock and Data lanes
- An example of implementation of Source TMDS Clock and Data lanes



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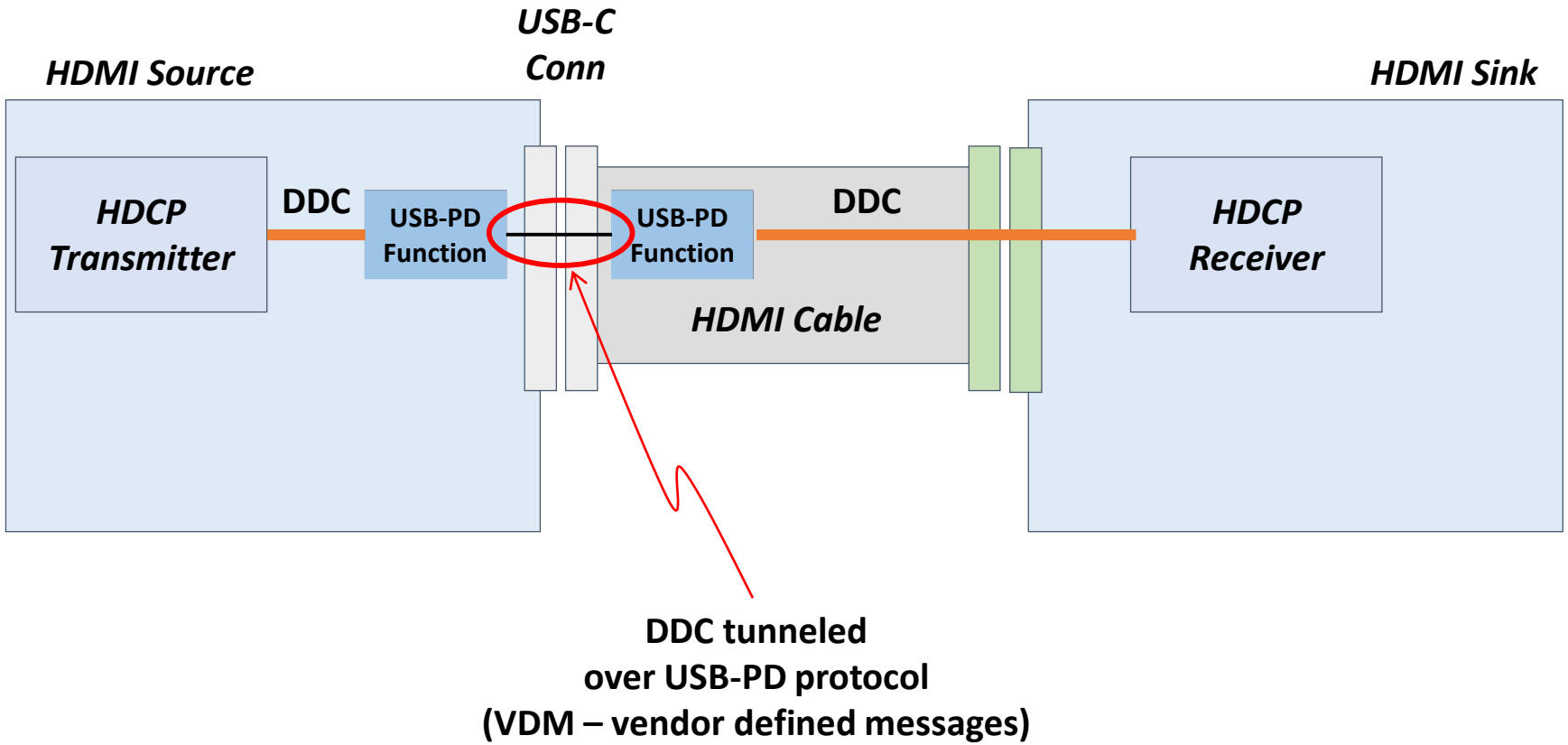

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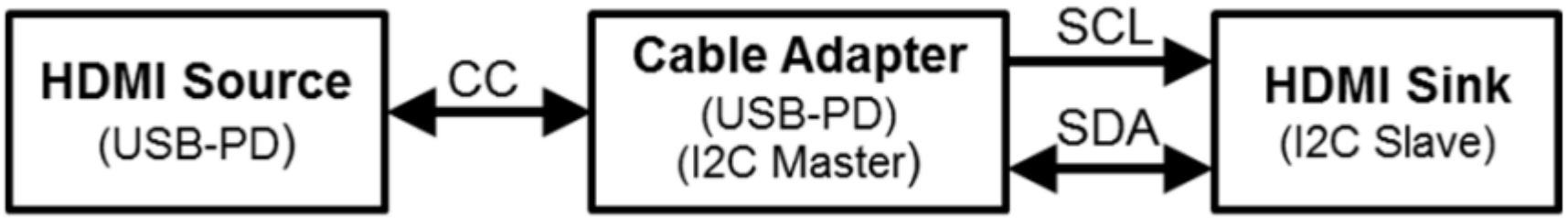
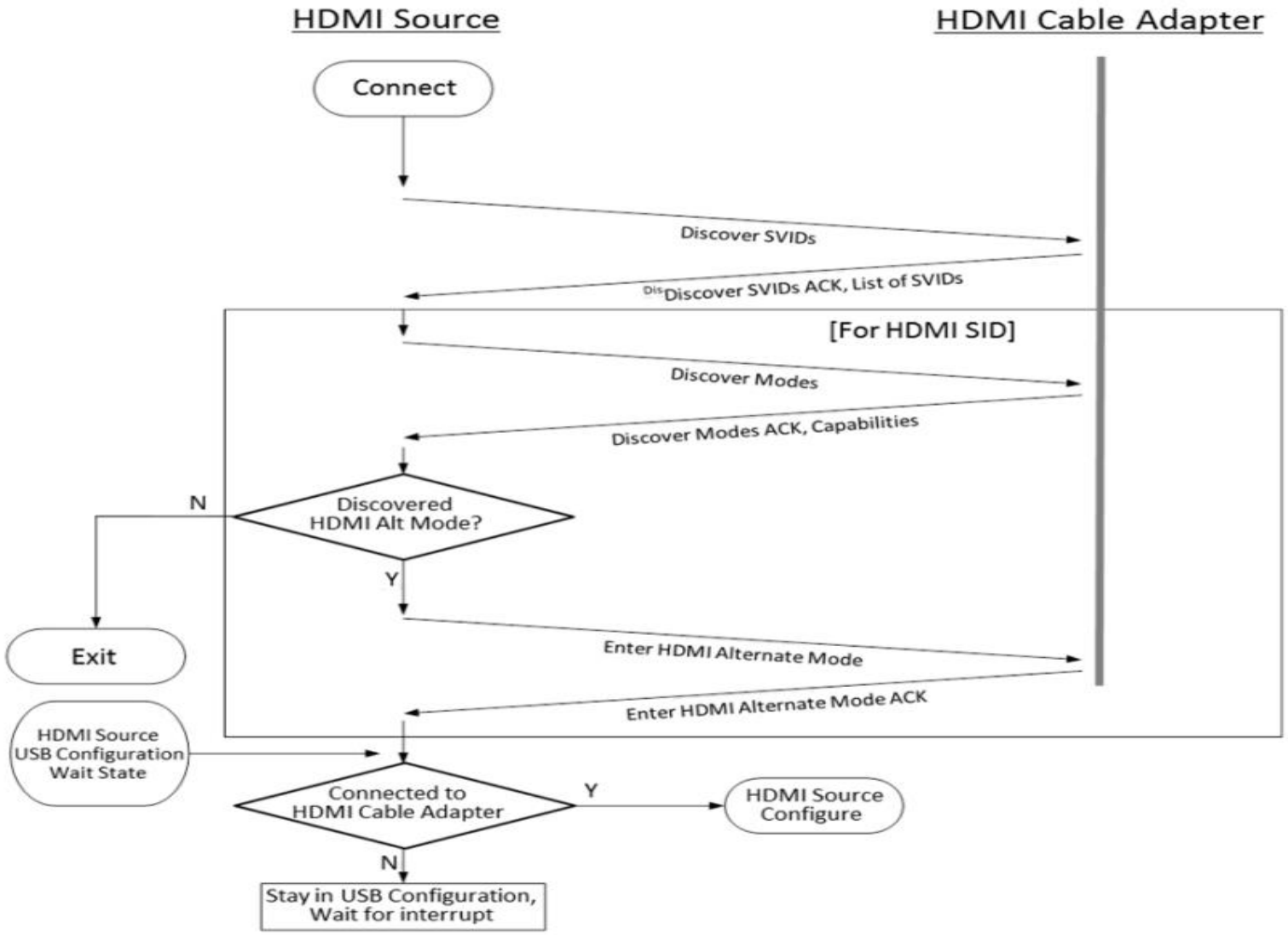


- The HDMI USB Type-C cable will act as the USB-PD node and handle all read/write messages from the HDMI Source
- The HDMI USB Type-C cable will also act as the DDC master and relay the USB-PD command it received from the HDMI Source to the HDMI Sink

System Overview



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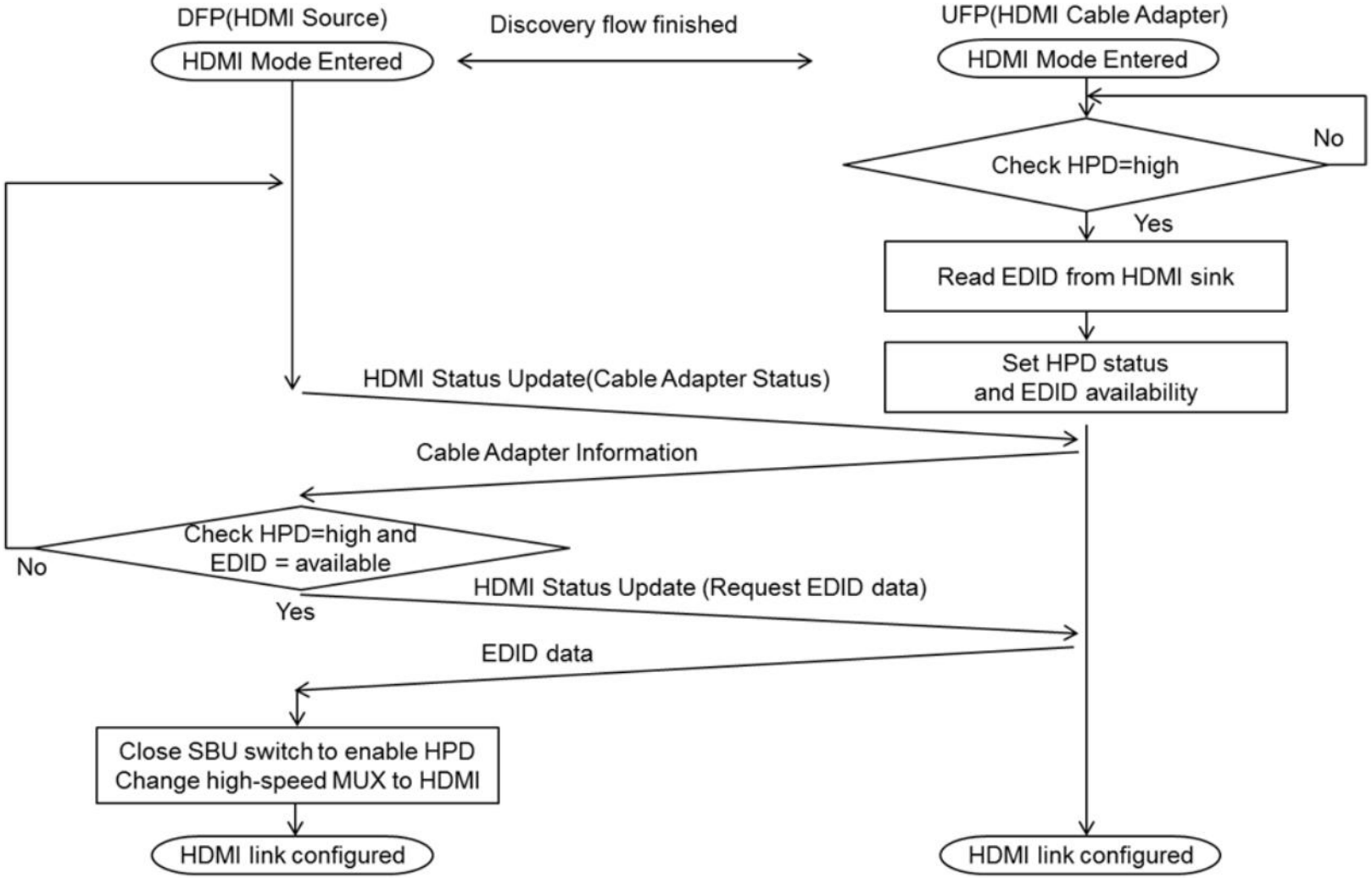
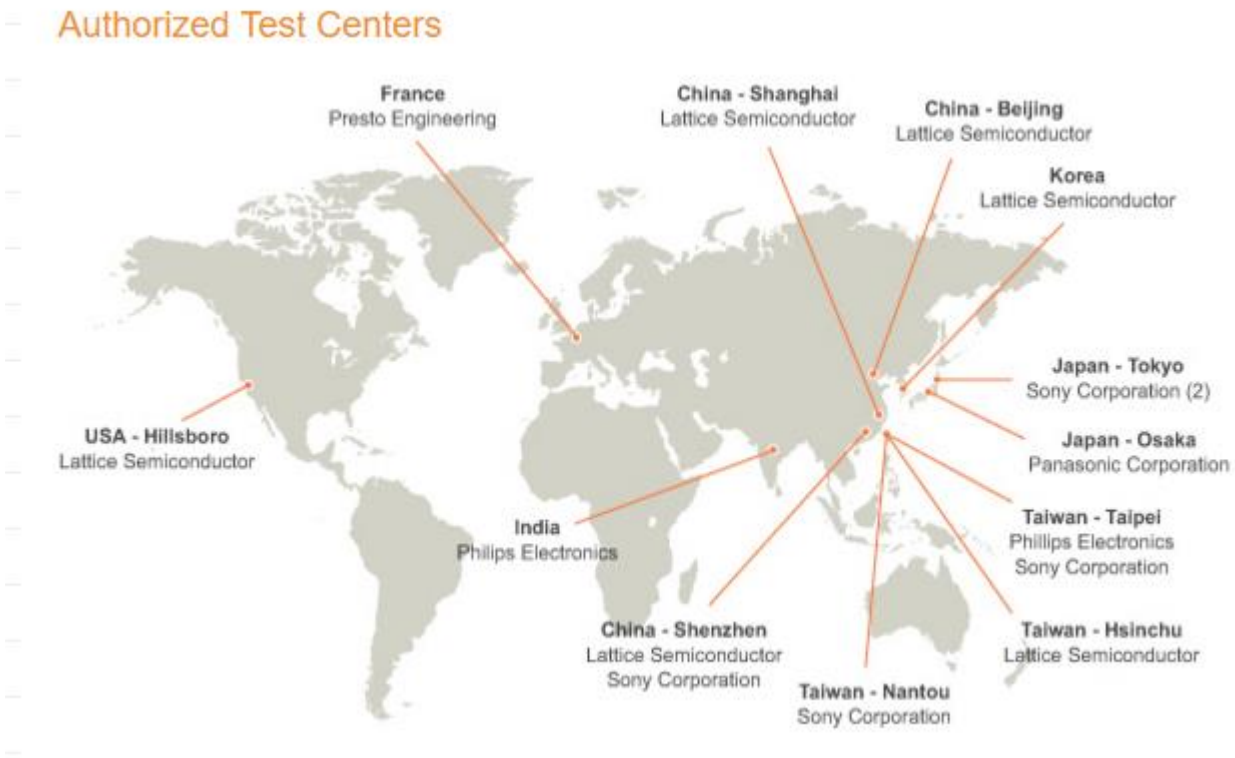


HDMI Compliance

- To ensure all HDMI devices work together, all HDMI devices are required to meet all HDMI compliance requirements
- In addition to meeting the USB-IF compliance requirements for USB Type-C, HDMI enabled USB Type-C devices will also be required to meet HDMI compliance requirements
- The HDMI 1.4b Alt Mode on USB Type-C Specification specifies all the minimum compliance requirements for HDMI enabled USB Type-C devices
- Self-testing and ATC testing options available to HDMI Adopters

HDMI Compliance



- 15 HDMI ATCs worldwide
- Offers both HDMI and HDCP compliance testing

HDMI Compliance: USB Type-C Source

- USB Type-C Connector Tests
- EDID/DDC/HPD Tests
- Electrical Tests
- Protocol Tests
- Video Format Tests
- Audio Format Tests
- Advanced Features Tests (3D, Deep Color, 4K, HBA, etc)
- CEC Tests
- HEAC Tests
- HDCP Tests (if supported)

HDMI Compliance: USB Type-C Cable

- USB Type-C Connector Tests
- HDMI Cable Assembly Tests
- Cable Electrical Tests
- Cable Parametric Tests
- Cable Performance Tests

HDMI Logo Program

- All HDMI compliant products have the option to use the HDMI logo
- Consumers are already very familiar with the HDMI logo
- The HDMI logo can help consumers easily identify which products supports the HDMI technology
- Available to all HDMI Adopters at no additional cost

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Specification

- The HDMI 1.4b Alt Mode on USB Type-C Specification is available to all HDMI Adopters at no additional cost
- The specification document is available on the HDMI Adopter Extranet
- The specification document also include the required HDMI compliance requirements for HDMI enabled USB Type-C devices

Summary

- Enables two of the most popular connectivity solutions to come together
- Uses a simple USB Type-C to HDMI cable with no adapters or converters
- Comprehensive HDMI compliance program
- HDMI Logo program to help consumers easily identify products
- Provides USB Type-C devices native access to billions of devices within the HDMI ecosystem

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Thank you

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Q&A