DisplayPort™ Ver.1.2 Overview

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Agenda

- DisplayPort Version Numbers
- Layered View of Isochronous AV Stream Transport
- DisplayPort Principles
- New Features of DisplayPort Ver.1.2

DisplayPort Version Numbers

- Only one DisplayPort Standard specification version number active at any given time
  - With the publication of DisplayPort Standard Specification Ver.1.2 in JAN 2010, Specification Ver.1.1a document was retired

- As for DPCD Revision Number (at DPCD Address 00000h), multiple revision numbers may co-exist
  - When people casually refer to a “DP1.1a” product, they actually mean a DP device supporting DPCD Revision Number 1.1 only

DisplayPort Standard Version Number *(continued)*

- Link and PHY Compliance Test Specifications following DisplayPort Standard Version Number
  - Ver.1.1a available
    - *NOTE: Link CTS Ver.1.1b with addition of audio transport test to be published in DEC 2010 ~ JAN 2010*
  - Phase 1 of Ver.1.2 covering some of the additional features in DisplayPort1.2 (e.g., HBR2, Audio HBR) going to GMR (General Membership Review) in DEC 2010 ~ JAN 2011

- Other DP-derivative standards (eDP and iDP) have their own version numbers
  - eDP Standard Ver.1.2 published in MAY 2010, Ver.1.3 release expected in JAN 2011
  - iDP Standard Ver.1.0 published in APR 2010

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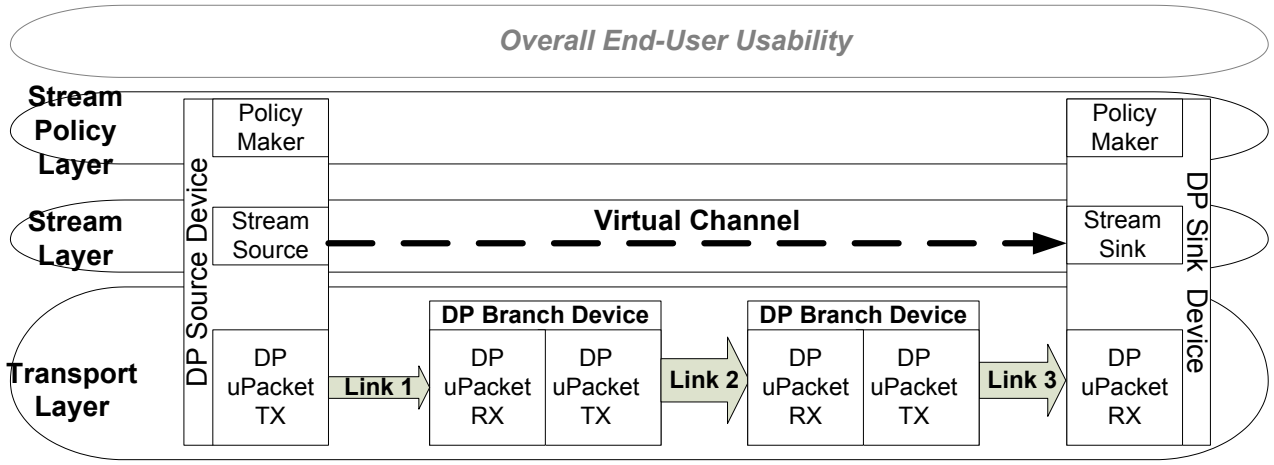
Layered View of Isochronous AV Stream Transport

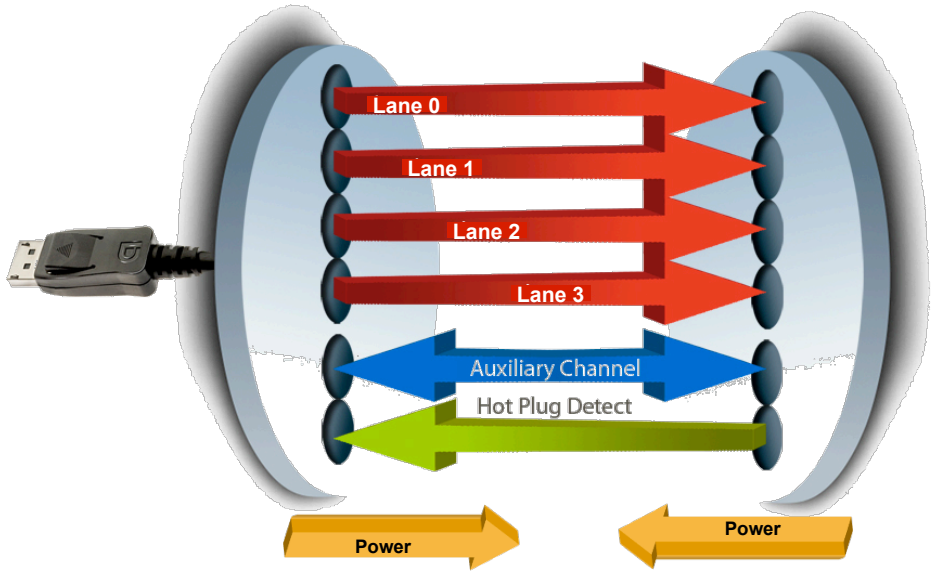
- DisplayPort1.2 defines the Transport Layer serving Stream Layer
  - Distinction between Transport Layer and Stream Layer clarified in DisplayPort1.2 with the addition of MST (multi-stream transport) and MST topology management enhancement



Layers	*Sub-Layers*	*Standard Spec*	*Interop/ Compliance Test Spec*
			A/V Quality Test [*2]
			Interop Test Spec
Stream Policy Layer	Stream Policy	*DP1.2 Sec.5* [*1]	
Stream Layer	Data Format	DMT, CVT,...	
	Data Structure	EDID/DID, MCCS,...	EDID CTS
Transport Layer	Link Policy	DP1.2 Sec.5	Link CTS
	Link	DP1.2 Sec.2	Link CTS
	PHY	DP1.2 Sec.3	PHY CTS
	Mechanical	DP1.2 Sec.4	

NOTE1: DP1.2 Section 5 defines 640x480, RGB18bpp as SAFE MODE
NOTE2: Not available/being developed at VESA

DisplayPort Principles



	Raw Bit Rate (incl. coding overhead)	Application Bandwidth /Throughput
1 x lane	1.62-/2.7-/5.4-Gbps	162-/270-/540-Mbytes/s
2 x lanes	3.24-/5.4-/10.8-Gbps	324-/540-/1080-Mbytes/s
4 x lanes	6.48-/10.8-/21.6-Gbps	648-/1080-/2160-Mbytes/s
AUX CH	1Mbps / 720Mbps (optional)	~ 16 bytes per 0.5ms * / ~ 64 bytes per 1.2 us **

Mandatory

- 1 x Main Link
- AUX CH
- Hot Plug Detect
- Powered Connector (DP_PWR pin)

Optional

- 2 x Main Link

Optional

- 4 x Main Link

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**: Maximum payload size of Manchester Transaction Mode (1Mbps) equal to 16Bytes*
***: FAUX (720Mbps) throughput calculated with the payload size of 64Bytes*

Main Link Transport

- Uni-directional
  - From an upstream device (e.g., Source) to a downstream device (e.g., Sink)
  - 1, 2, or 4 high-speed lanes (differential pairs)
  - Link established based on the receiver/stream sink capabilities, application bandwidth need, and Link Training result
    - DPCD (DisplayPort Configuration Data) access for receiver capability discovery, and Link Training
    - EDID access for stream sink capability discovery
- Transported data types
  - Main uncompressed video stream (or streams) *1
  - Audio
    - Via SDP (Secondary-Data Packet)
    - Transported with or without the main video stream
  - Metadata
    - Via MSA (Main Stream Attribute) Packet
    - Via SDP

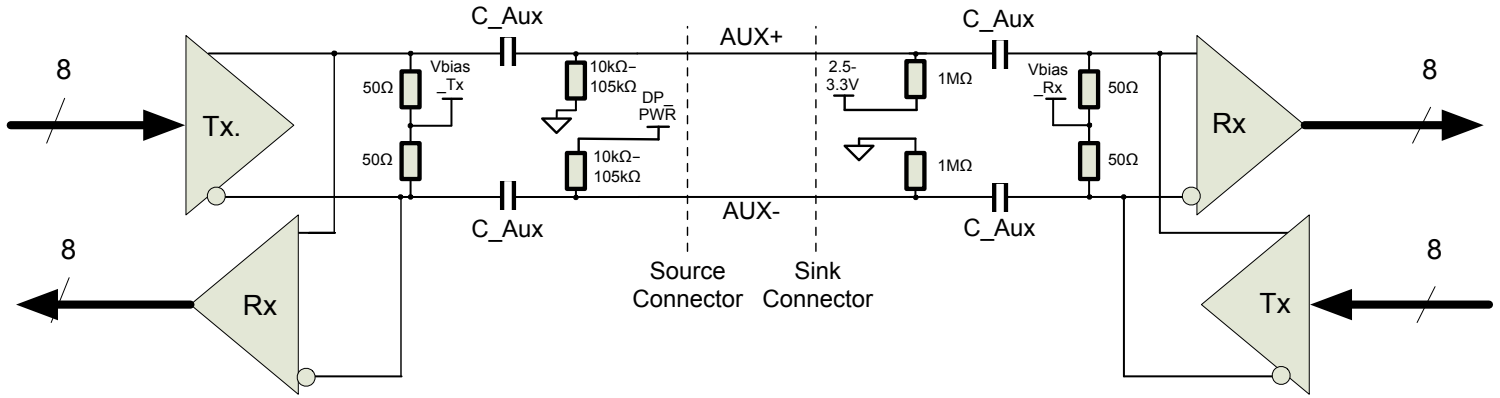
NOTE1: Compressed video may be supported via SDP definition extension

AUX CH Transport

- Half-duplex bi-directional
  - AUX transaction always initiated by an upstream device
  - A downstream device may prompt an AUX transaction via IRQ (interrupt request) pulse assertion over HPD line
- Two transport formats
  - Manchester transport format
    - 1Mbps, Burst transfer = 16 data bytes max
    - Capable of establishing ~ 200Kbps full-duplex link
  - Fast AUX transport format (New in DisplayPort Standard Ver.1.2)
    - 720Mbps, Burst transfer = 64/1024 data bytes max
    - Capable of establishing ~ 200Mbps full-duplex link
- AUX transaction syntax
  - Native AUX, I^2C-over-AUX
  - USB-over-AUX (Fast AUX required; full definition to be completed)
  - Other transport protocol may be mapped over Native AUX syntax
    - E.g., UART

HPD, Upstream Device Detection, DP_PWR

- HPD (Hot Plug Detection)
  - Asserted by a downstream device when it is ready for AUX transaction
    - HPD line also used for an IRQ assertion by a downstream device
  - Used by an upstream device to detect the plugging of a downstream device
- Upstream Device Detection
  - A downstream device monitors AUX+ and AUX- DC voltage levels to detect the presence of an upstream device and its power state



- DP_PWR
  - 3.3V+/-10% / 500mA max, available both on upstream/downstream device connectors
  - Mainly intended for powering cable adaptors
    - Standard DisplayPort cable does not have wire connected on DP_PWR pin

DisplayPort Ver.1.2 New Feature Summary

- Key new DisplayPort 1.2 Features
  - Additional link rate of 5.4Gbps/lane
  - Multi Stream Transport (MST) support
  - MST topology management
  - Additional 3D support
  - Wide color gamut support improvements
  - Audio enhancement
  - FAUX Transaction Mode option over AUX CH

- Provides backward compatibility with existing DisplayPort devices supporting DPCD Revision Number 1.1 only
  - No new pins/wires added to connectors and cables

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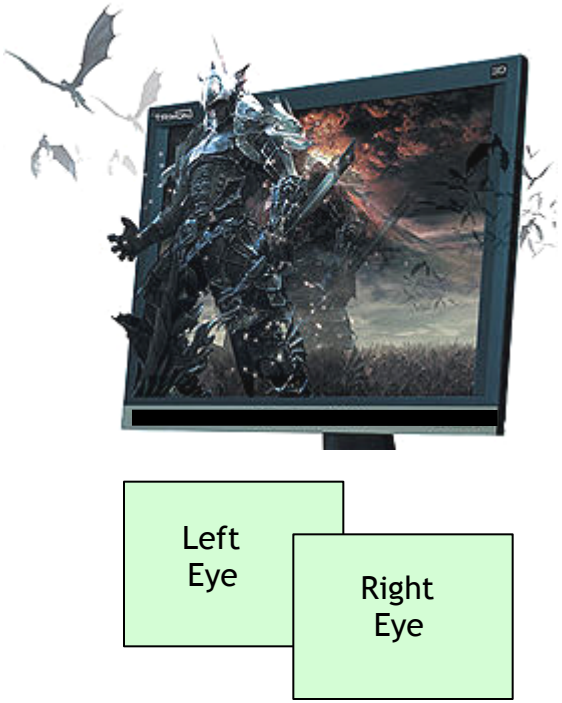
Additional Link Rate of 5.4Gbps/lane

5.4Gbps/lane link rate increase the video data bandwidth to 2160Mbytes/sec, providing support for emerging display applications

3D Stereo



DP v1.2 enables Beyond Full HD Stereo support at 120Hz…

Super Resolution & Color Range

3840

2160

x30bpp

DP v1.2 enables High Color Range Quad Full HD delivered over standard DisplayPort connector…

Full 4K x 2K Support

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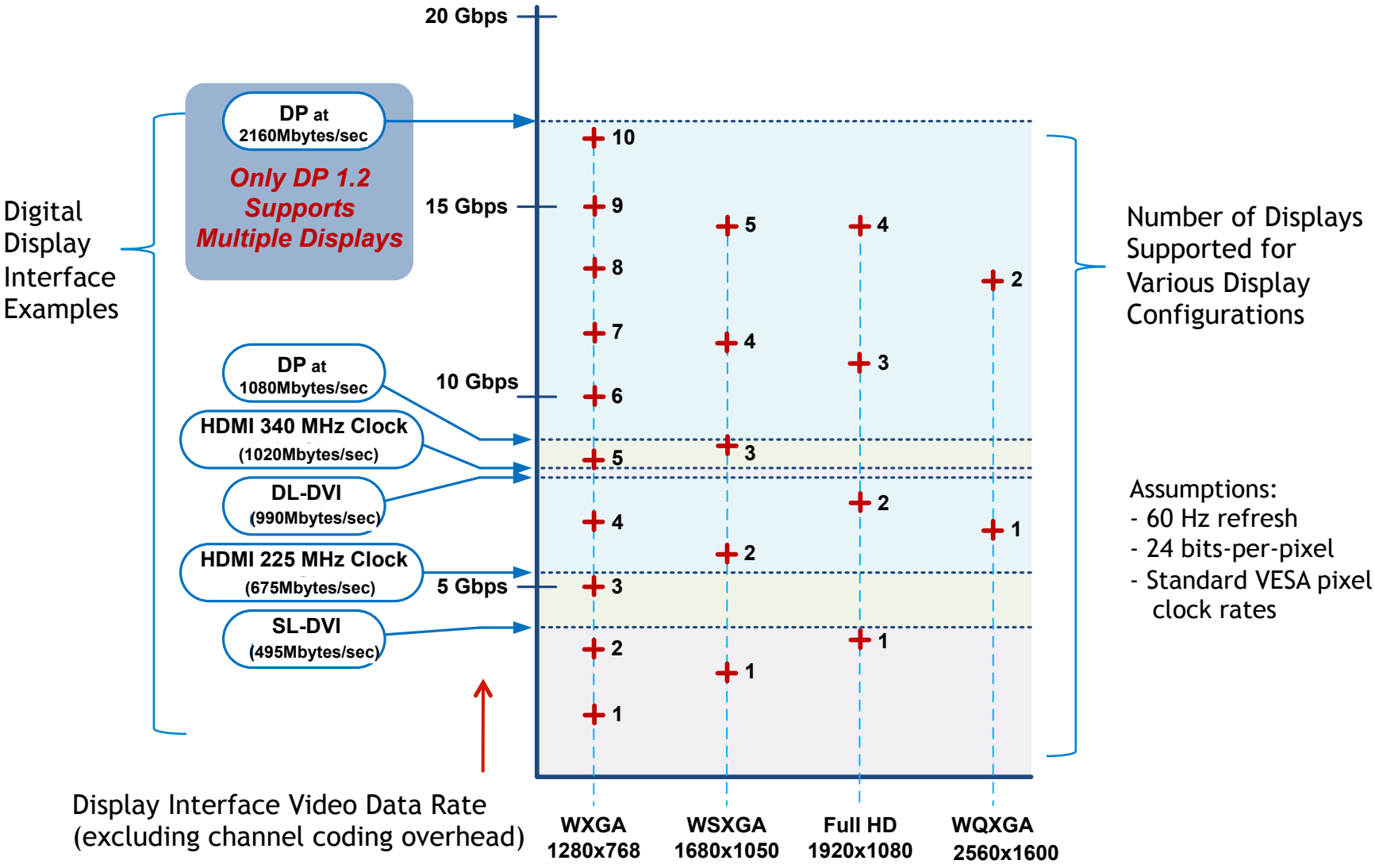
Data Rate vs. Number of Displays



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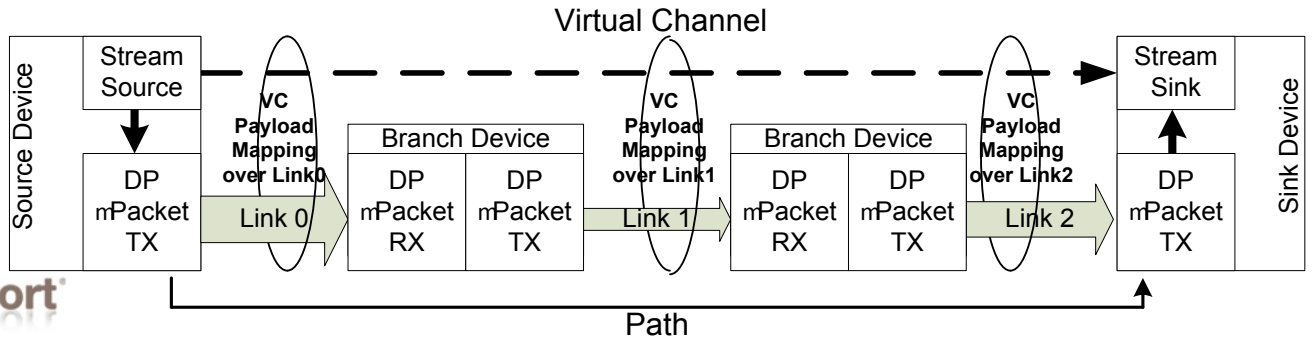
PHY Spec Changes Related to 5.4Gbps/lane

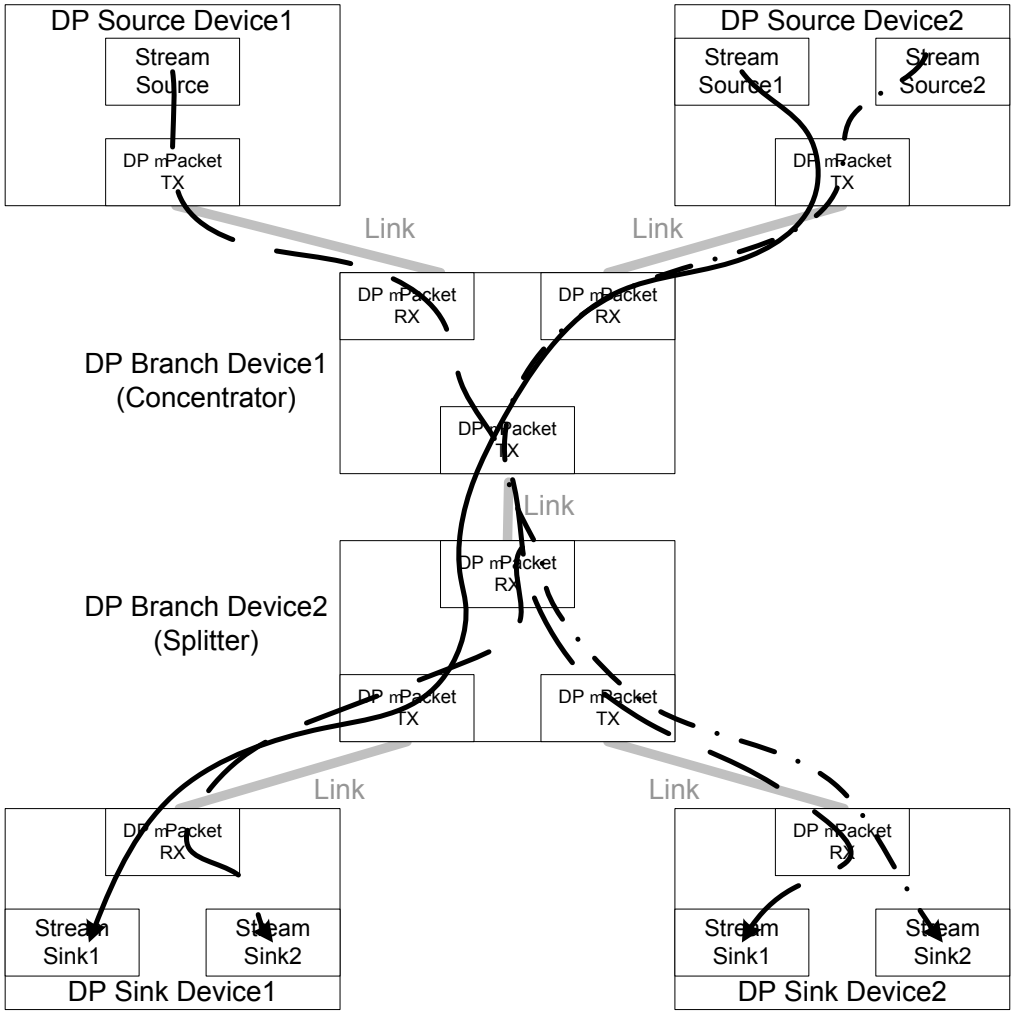
- New training pattern (TPS3, Training Pattern Sequence 3) added to allow for further fine tuning of TX drive setting and RX equalization
- TX EYE measured at TP3_EQ test point a signal analyzer supporting a mathematical cable model, a link CDR PLL emulation, and a reference equalizer
- Stressed signal generator for RX jitter tolerance test calibrated at TP3_EQ with the above signal analyzer

Multi-Stream Transport (MST)

- MST (Multi-Stream Transport) added in DisplayPort Ver.1.2
  - Only SST (Single-Stream Transport) was available in Ver.1.1a
- MST transports multiple A/V streams over a single connector
  - Up to 63 streams; not "Stream per Lane"
    - No synchronicity assumed among those transported streams; one stream may be in a blanking period while others are not
  - A connection-oriented transport
    - Path from a stream source to a target stream sink established via Message Transactions over AUX CH's prior to the start of a stream transmission
    - Addition/deletion of a stream without affecting the remaining streams



Multi-Stream Transport



- Source Device1 stream rendered on Stream Sink 2 of Sink Device1 and Stream Sink 1 of DP Sink Device2 (“cloned”)
- Source Device1 stream from Stream Source1 rendered on Stream Sink1 of Sink Device 1
- Source Device 1 stream from Stream Source2 rendered on Stream Sink 2 of Sink Device2
- # of streams is different among the DP links in a given topology
  - 1 ~ 3 streams in this example

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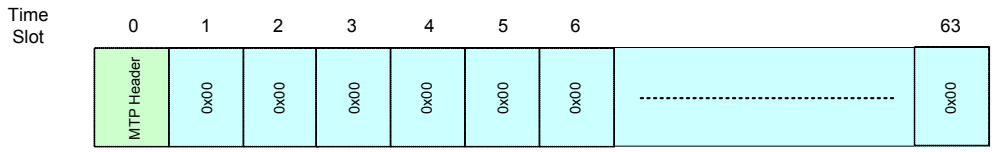
Micro Packet in SST Mode: TU

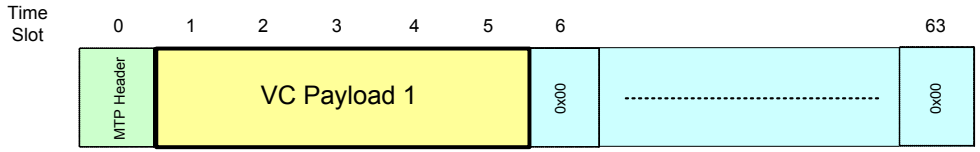
- DisplayPort uses a “micro-packet” as a vessel for transporting stream data
- In SST mode, the micro packet is called TU (Transfer Unit)
  - 32 ~ 64 link symbols per lane
  - Transported only during main video stream active period (that is, DE, or Display Enable, high period)
  - Uses BE symbol and BS symbol sequence to indicate stream active period
    - MSA Packet and Secondary-Data Packet, framed with SS and SE symbols, sent during stream blanking period
  - Number of valid pixel data symbols proportional to the ratio between pixel peak bandwidth and link bandwidth

Micro Packet in MST Mode: MTP

- In MST mode, the micro packet is called MTP (Multi-stream Transport Packet)
  - 64 link symbols per lane; 1st symbol reserved for MTP Header
  - Transported all the time
  - VC Payload established to transport a stream via "ALLOCATE_PAYLOAD" message transaction
    - # of VC Payloads = # of streams transported
    - Allocated time slots for a given VC Payload must meet the pixel peak bandwidth requirement
    - BE/BS/SS/SE transported as part of stream symbols within VC Payload



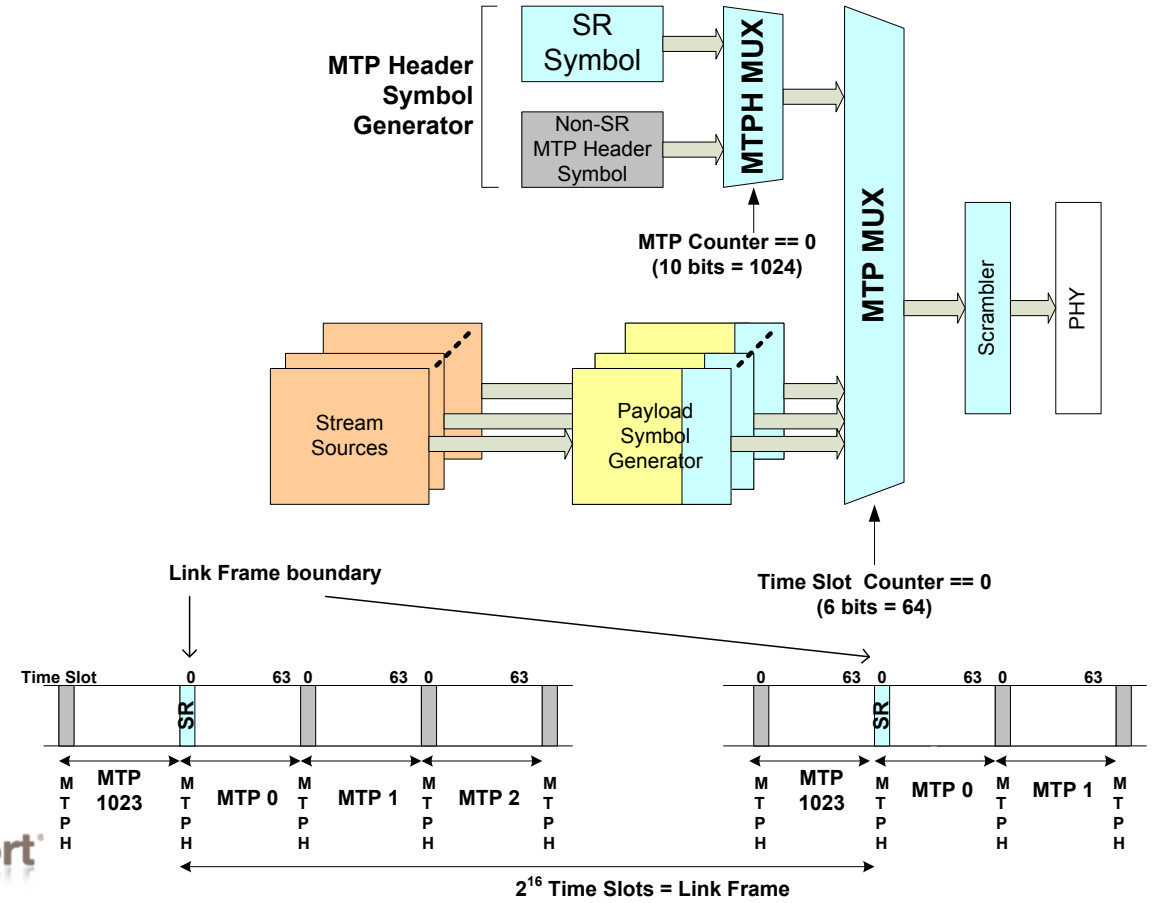
No Time Slot allocated to a VC Payload



Time Slots 1-5 allocated to VC Payload 1

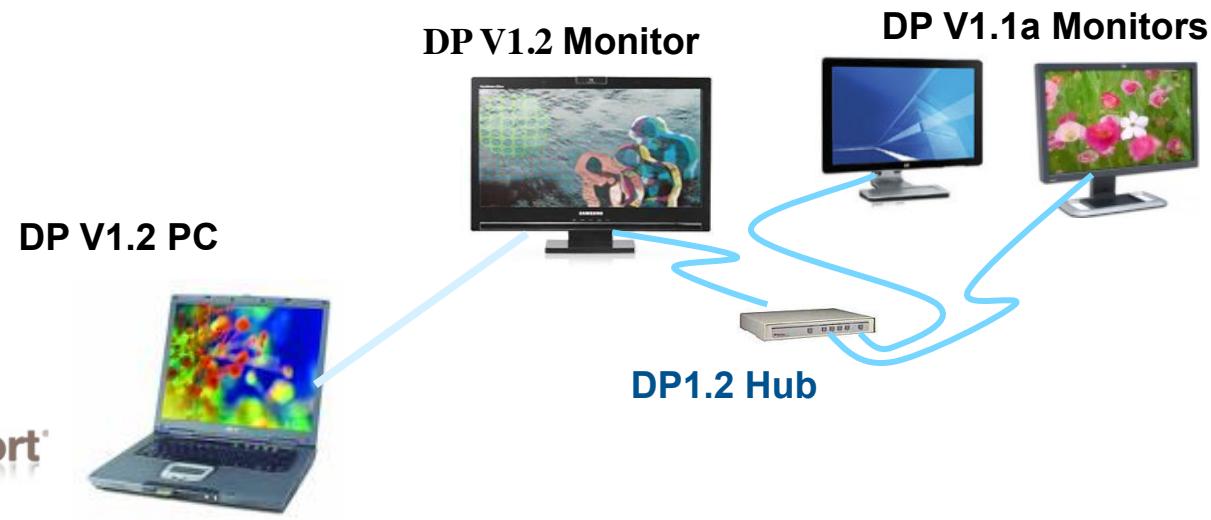
Link Timing Generation in MST Mode

- MTP transported all the time
- Link Frame period = 2^{16} time slots long, agnostic to timings of streams
  - Predictability of transmission pattern
    → Improved robustness of multi-link topology



MST Topology Management

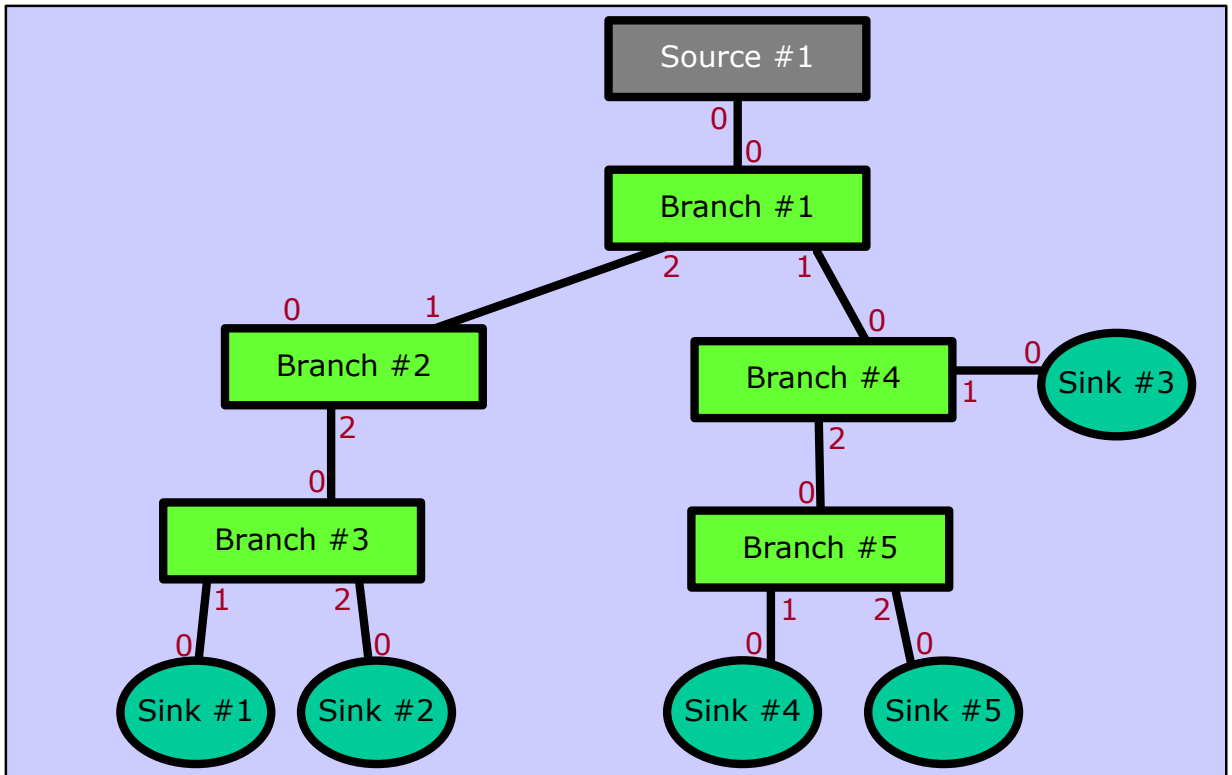
- Node addressing through discovery procedure
  - Topology Manager (typically, a DP Source device) discovers the path to the other DP devices in the topology
  - Attachment/detachment of a device handled without resetting the address set of the entire link
- Enables remote DPCD/EDID/MCCS access
  - Transaction routed to a target DP device
- Supports topology containing multiple DP Source and Sink Devices
  - Initial main focus: a single DP Source device driving multiple displays



Device Types

- Primitives
  - uPacket TX / uPacket RX / Branching Unit (BU) / Stream Source / Stream Sink
- Connection type
  - Between uPacket TX and uPacket RX = Physical Connection
  - Between BU and Stream Source/Sink/Another BU = Logical Connection
- Branch device
  - BU with at least one uPacket TX and at least one uPacket RX
- Source device
  - One or multiple stream sources plus at least one uPacket TX, no uPacket RX
  - Source device with MST mode = MST Source device
- Sink device
  - One or multiple stream sinks plus at least one uPacket RX, no uPacket TX
  - Sink device with multiple stream sinks with BU = MST Sink device
- Composite device
  - Branch device with stream source(s) and/or sink(s)

Relative Address (RAD)



Relative Address of Devices Accessible from Source 2

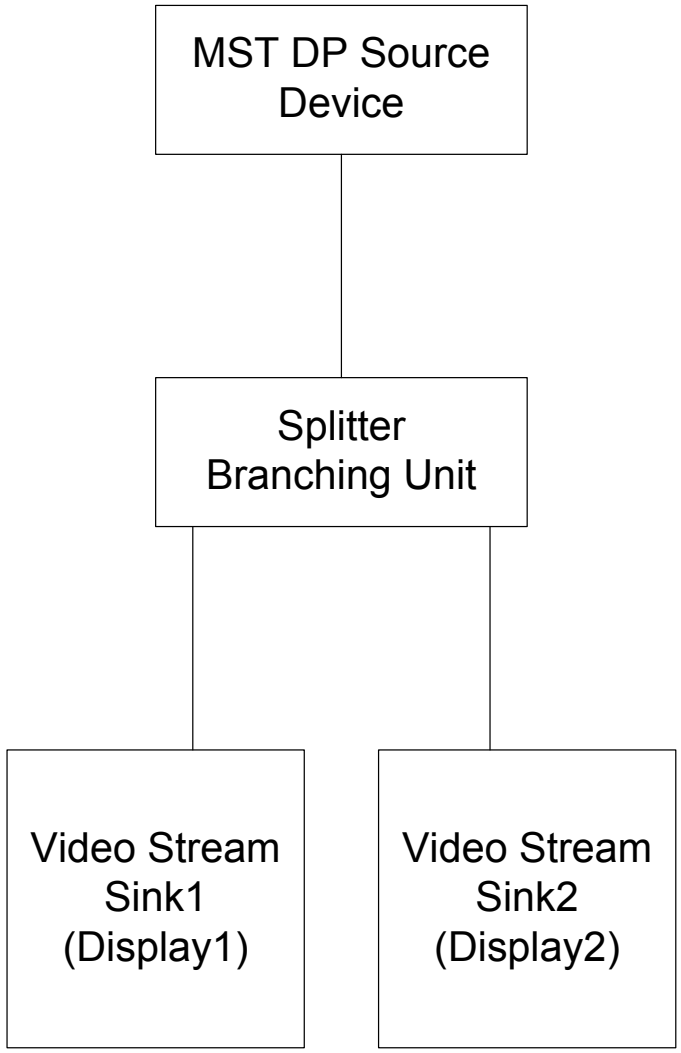
Device	Relative Address
Branch 1	0
Branch 2	0.2
Branch 3	0.2.2
Sink1	0.2.2.1
Sink 2	0.2.2.2
Branch 4	0.1
Sink 3	0.1.1
Branch 5	0.1.2
Sink 4	0.1.2.1
Sink 5	0.1.2.2

- Topology Manger (Source#1) establishes the topology map of relative addresses of devices in the topology with LINK_ADDRESS message transactions
- Port# Bit 3
  - 0 for Physical Port
  - 1 for Logical Port
- Devices with BU act as Topology Assistant
- GUID (Globally Unique ID) used by Topology Manger to handle a topology with parallel paths or a loop

DPCD Fields for MST Capability/configuration

- uPacket RX capability: DPCD Address 00021h (MSTM_CAP)
  - Bit 0 = MST_CAP
    - 1 – Supports MST transport format and has a Branching Unit, and therefore supports Message Transaction/Sideband MSG handling
    - 0 – Does not support MST transport format and has no Branching Unit, and therefore does not support Message Transaction/Sideband MSG handling
- uPacket TX configuration: DPCD Address 00111h (MSTM_CTRL)
  - Bit 0 = MST_EN (indicates the transport format over Main Link)
    - 1 – Upstream Port will transmit audio/visual data in Multi-Stream Format
    - 0 – Upstream Port will transmit audio/visual data in Single Stream Format
  - Bit 1 = UP_REQ_EN (indicates the support of Message Transaction)
    - 1 – Allows the Downstream uPacket RX to originating/forwarding an UP_REQ message transaction.
    - 0 – Prohibits the Downstream uPacket RX from originating/forwarding an UP_REQ message transaction.
  - Bit 2 = UPSTREAM_IS_SRC
    - 1 – Set to 1 by a DP Source device to indicate to the Downstream device the presence of a Source device, not a Branch device
    - 0 – Upstream device is either a Source device predating DP Standard Ver.1.2 or a Branch device

Base Topology in Usage Case Example Guide



- Volume 1 will be published in DEC 2010 ~ JAN 2011
- DisplayPort Standard explains the frame work of MST transport and topology management
- Usage Example Guideline document uses a practical example to describe the operation sequence of a Source device and a Branch device (Splitter)
- More volumes with additional topology examples will be added in the future

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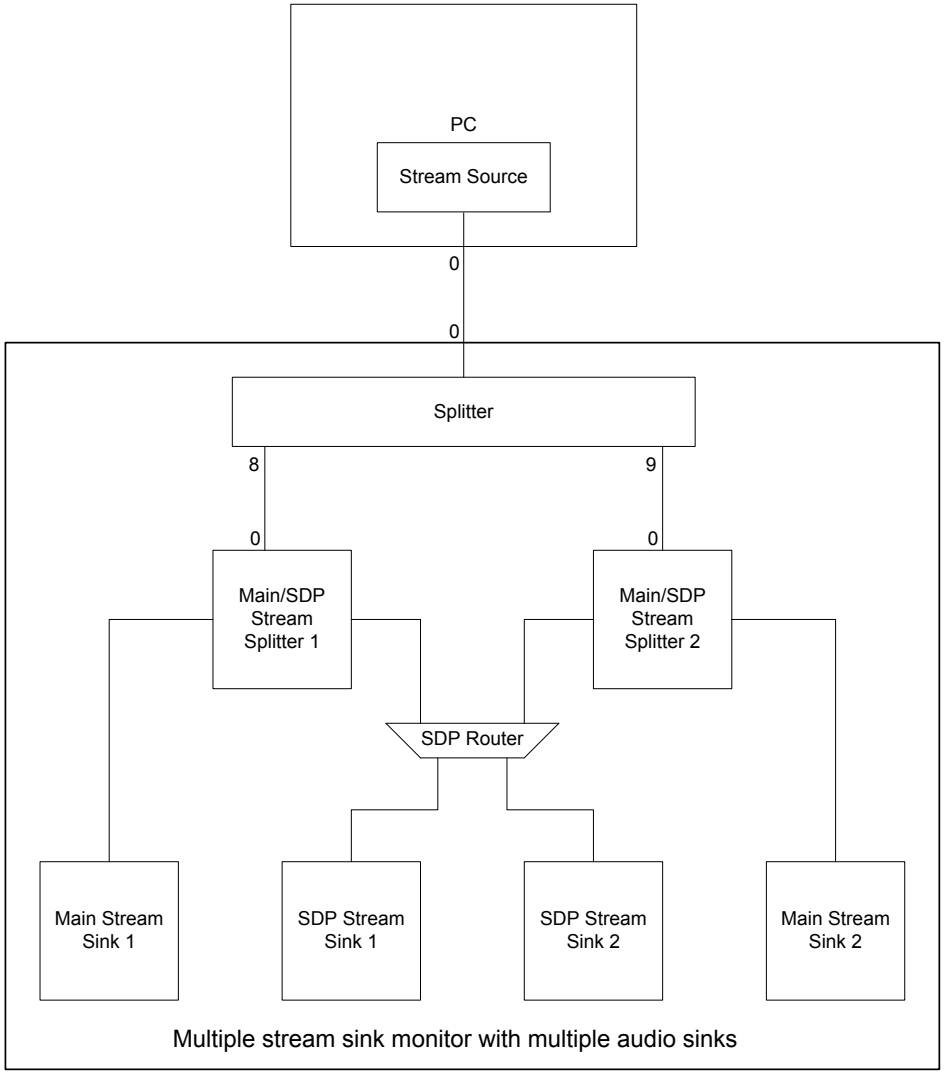
Topology with Audio Stream Sinks in the Guide



Additional 3D Stereo Display Support

- DisplayPort Ver.1.1a already natively supported 3D Stereo display transport
  - 1080Mbytes/sec bandwidth over standard cables
    - Sufficient for Stereo Display modes: 1080p 60Hz per EYE
  - MSA packet provides for in-band metadata for frame-sequential 3D Stereo transport format (MISC1 field bits 2:1)
    - 00: No stereo video transported
    - 01: The next (upcoming) video frame is RIGHT eye
    - 10: Reserved
    - 11: The next (upcoming) frame is LEFT eye
- DisplayPort Ver.1.2 provides for:
  - Link bandwidth sufficient for 1080p 120Hz per EYE
  - Additional 3D Stereo transport format indicated by a new VSC (Video Stream Configuration) SDP
    - Stacked top bottom
    - Stacked left right
    - Line interleave
    - Pixel interleave
- DisplayID Standard as an extension block of EDID Ver.1.4 being extended for better description of 3D rendering capability of a display

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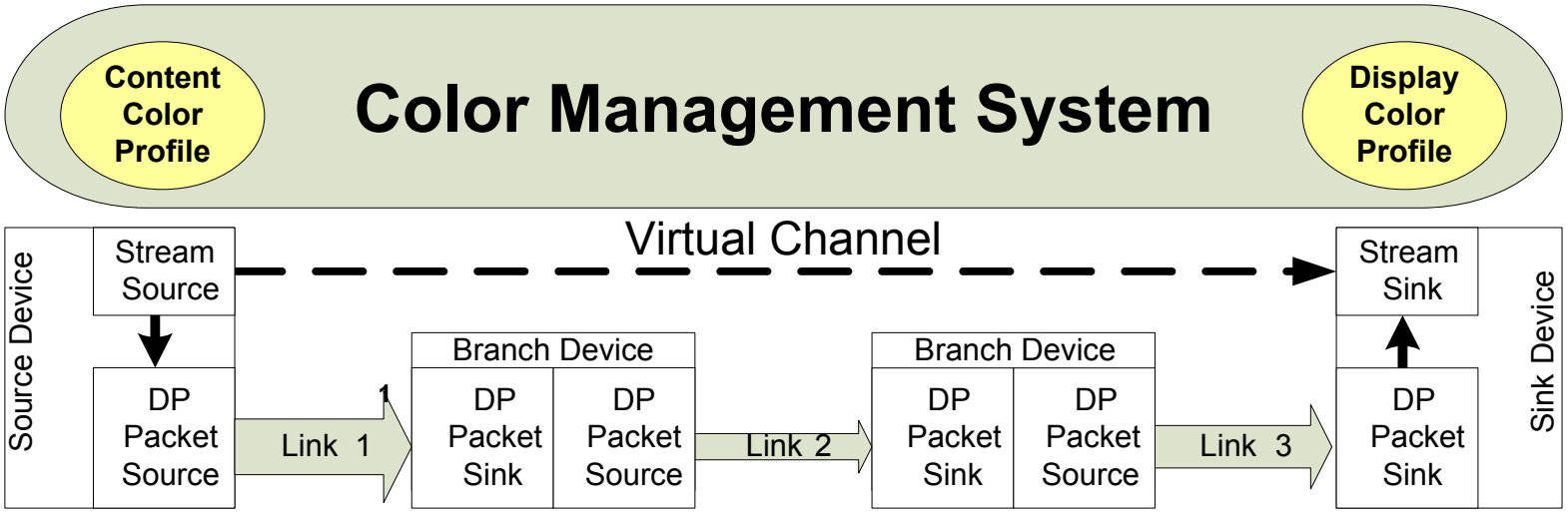
Standards Extension for Wide Color Gamut Support Improvement

- Enhancement of DP1.2, DisplayID (as an EDID extension block), and MCCS so as to address the “Color Issues” for:
  - Consistent Color
  - Accurate Color
    NOTE: The consistent and accurate color may not be achievable in some scenarios (e.g., content gamut larger than display gamut)
- Layers of Standards
  - DP1.2: Link (or Transport) Layer
  - DisplayID/EDID and MCCS: Stream (or Application) Layer
  - Compliance test/enforcement should be comprehended even though it may be outside the scope of Link Layer/EDID CTS documents

Main Goals of Standards Extensions

- Expose both native and emulate-able color space/gamut of Display (i.e., a Sink device) to a Source device
  - Color management system needs to know both content and display color profiles
- Allow the Source device to indicate the color space /gamut of choice to Display based on content color profile and capability of the Display
  - Permit a Source device to disable/specify color-space emulation by Displays



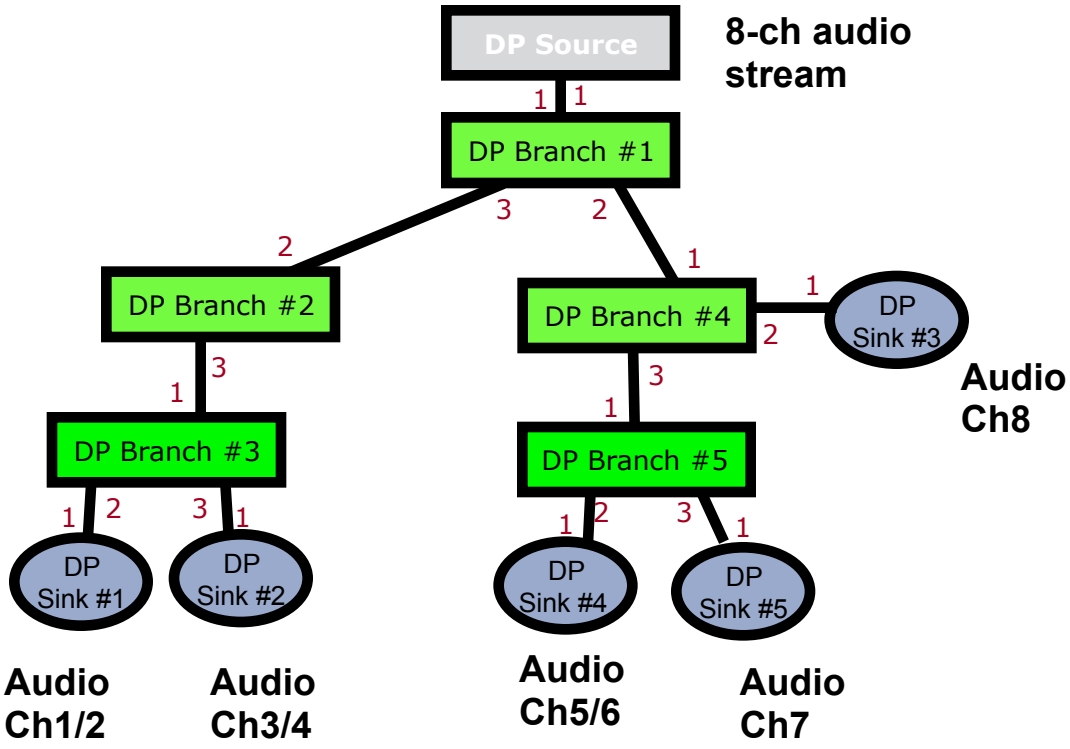
DisplayPort Ver.1.2 Extension for Wide Color Gamut

- MSA MISC0/MISC1 field extension
  - A Source device indicates color space, color data representation format, and color bit depth of the content it is transmitting

	MISC1	MISC0			
MSA bits	**[7]**	**[2:1]**	**[3]**	**[4]**	**[7:5]**
RGB unspecified color space (legacy RGB mode)	**0**	**00**	**0**	**0**	**000, 001, 010, 011, 100 (6, 8, 10, 12, 16 bits/color, respectively)**
sRGB	**0**	**00**	**1**	**0**	
AdobeRGB1998	**0**	**00**	**1**	**1**	**000, 001, 010, 011, 100 (6, 8, 10, 12, 16 bits/color RGB, respectively)**
DCI-P3	**0**	**11**	**1**	**0**	**011, 100 (12, 16 bits /color RGB, respectively)**
RGB wide gamut fixed point (XR8, XR10, XR12)	**0**	**11**	**0**	**0**	**001, 010, 011 (8, 10, 12 bits/color, respectively)**
RGB wide gamut floating point (scRGB)	**0**	**11**	**0**	**1**	**100 (16 bits/color)**
Y-only	**1**	**00**	**0**	**0**	**001, 010, 011, 100 (8, 10, 12, 16 bits /luminance, respectively)**
YCbCr (ITU601/ITU709)	**0**	**01 = 422 10 = 444**	**1**	**0 = ITU601 1 = ITU709**	**001, 010, 011, 100 (8, 10, 12, 16 bits/color, respectively)**
xvYCC (xvYCC601/xvYCC709)	**0**	**01 = 422 10 = 444**	**0**	**0 = ITU601 1 = ITU709**	
Simple Color Profile	**0**	**11**	**1**	**1**	**000, 001, 010, 011, 100 (8, 10, 12, 16 bits/color RGB, respectively)**

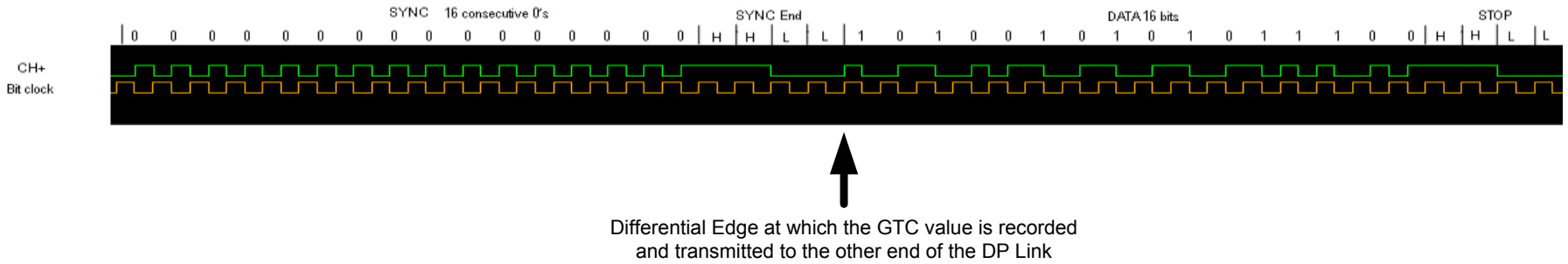
Audio Enhancement

- Audio Copy Protection, Category Code
  - Call out the Copy protection details
- DRA, Dolby MAT, DTS HD
  - High Def Audio formats supported in Blu-Ray and HD-DVD
- Synchronization assist
  - AV Lip sync
  - Audio inter-channel sync among multiple DP Audio Sink Devices, with sub-us precision /accuracy via GTC (Global Time Code) synchronization



GTC

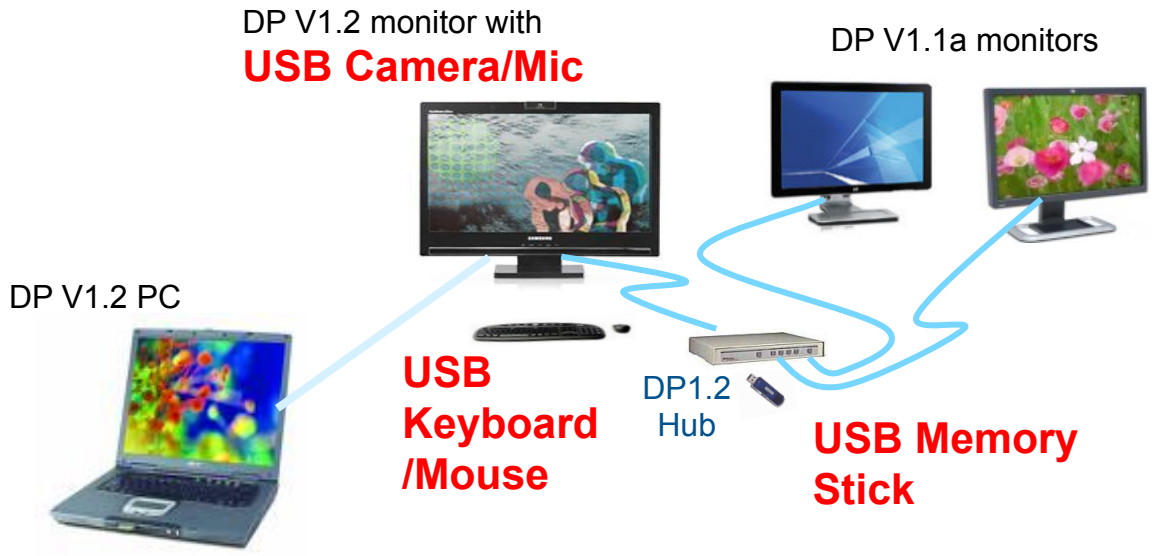
- Either an upstream device or a downstream device can be a GTC master
  - Source device is the GTC master by default
  - GTC accumulator of a GTC master: Free-running
  - GTC accumulator of a GTC slave: Retains lock to that of a GTC master using the first differential edge at the end or following the AUX_SYNC pattern as a reference point



- A stream source sends a GTC value representing a presentation time of the beginning of an audio frame (consisting of 192 audio samples) using a channel status field

FAUX Transaction Mode over AUX CH

*Optional higher speed auxiliary channel enables bi-directional bulk data transfer over a **single** DisplayPort cable…*



Fast AUX application

- USB peripheral device data transfer
- Microphone audio transfer
- Camera video transfer

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FAUX Transaction Mode over AUX CH

- Half-duplex, bi-directional channel
- Turn-around delay 200ns or below for a high throughput
  - Excess turn-around delay wastes the peak bandwidth
  - 12-symbol pre-amble including “Squelch” pattern
- An upstream device may fall back to Manchester Transaction Mode any time
  - A downstream device must be able to detect Manchester Transaction Mode

Thank You


SUBWAY
eat fresh.