Today's Agenda

- VR Head Mounted Device (HMD) Use Cases and Trends
  - Cardboard, high-performance (tethered), all-in-one
  - Dedicated displays provide best user experience
  - Requirement for higher throughput for both video and data for high-end VR and mainstream VR

- MIPI DSI^{SM} delivers high performance for VR configurations
  - MIPI is the main interface for VR displays
  - Architecture examples: DisplayPort is the most common source for VR content
  - Combo MIPI C-PHY^{SM}/D-PHY^{SM} provides system flexibility for optimum performance
  - Leading VR display controller enables top VR headsets by leveraging key MIPI features
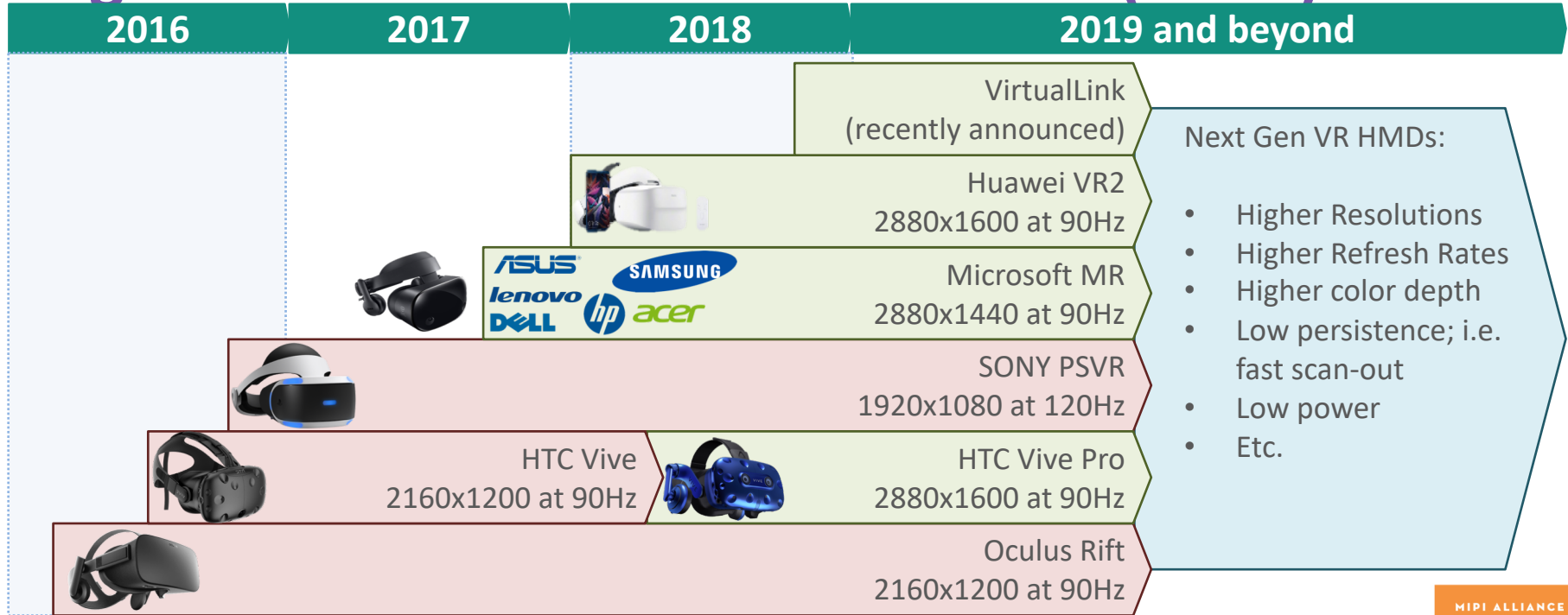
Analogix Semiconductor

VR Head Mounted Device (HMD) Use Cases

Cardboard	Tethered	Standalone
Introduced in 2014 • Entry level, low cost VR system • Smartphone provides graphics engine, display and limited sensor capability • Apps running on smartphone provide VR experience **VR Video Performance** • Limited by smartphone specs; i.e. displays with low resolution and refresh rates • High heat dissipation from smartphone battery	**Introduced in 2016 and 2017; refreshed in 2018** • High-end level HMD with dedicated display(s) and sensors • Requires high-end GPU for video transmission • Primary application is gaming and commercial/retail **VR Video Performance** • Higher resolution and refresh rates than smartphone displays (up to 2880x1600 and 120Hz respectively) • Lighter and lower heat dissipation	**Introduced in 2018** • Mainstream, similar to cardboard predecessor • Similar architecture as smartphones but tuned for VR use cases • Uses higher performance display **VR Video Performance** • Achieves higher resolution and refresh rates than cardboard but still less than tethered HMDs • Lower heat dissipation and lighter than cardboard predecessor
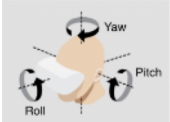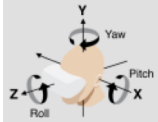
Dedicated VR displays provide the best user experience

MIPI ALLIANCE
DEVELOPERS
CONFERENCE

19 OCTOBER 2018
SEOUL

High-End VR Head Mounted Device (HMD) Trends

2016	2017	2018	2019 and beyond

VirtualLink
(recently announced)

Huawei VR2
2880x1600 at 90Hz

Microsoft MR
2880x1440 at 90Hz

SONY PSVR
1920x1080 at 120Hz

HTC Vive
2160x1200 at 90Hz

HTC Vive Pro
2880x1600 at 90Hz

Oculus Rift
2160x1200 at 90Hz

Next Gen VR HMDs:

- Higher Resolutions
- Higher Refresh Rates
- Higher color depth
- Low persistence; i.e. fast scan-out
- Low power
- Etc.

Higher immersion experience drives the next gen high-end VR headsets

MIPI ALLIANCE
DEVELOPERS
CONFERENCE
19 OCTOBER 2018
SEOUL

Mainstream VR Head Mounted Display (HMD) Trends

Today	Tomorrow	Beyond
VR Performance • 2560 x 1440 @ 90 FPS • 2880 x 1600 @ 90 FPS • 3 DoF only; i.e. head orientation only	**VR Performance** • 2880 x 1600 @ 90 FPS • 3600 x 1800 @ 90 FPS • 6 DoF and Inside-out positional tracking	**VR Performance** • 3600 x 1800 @ 120 FPS • 3840 x 2160 @ 90 FPS • 6 DoF and inside-out positional tracking with room scale setup

6 DoF positional tracking, total immersive interaction, object detection, room-scale setup, etc.

6 DoF positional tracking → head orientation and movement along X, Y, Z axis; inside-out positional tracking

3 DoF Positional tracking → head orientation only

Balance between performance, immersion and power is key for mainstream VR headsets

MIPI ALLIANCE DEVELOPERS CONFERENCE
19 OCTOBER 2018
SEOUL

Case 1: High-End/Mainstream HMD with Standard Connections

ANX7490
USB3.1 Re-timer (10G)

USB3.1/USB2.0 Hub

Sensors, cameras, gyroscope, accelerometers, etc.

ANX7496
DisplayPort Re-timer (8.1G)

ANX7539
DisplayPort to MIPI-DSI

✓ 12-Trios Total
✓ 32.8Gbits @ 1.2Gsps raw bandwidth (BW)
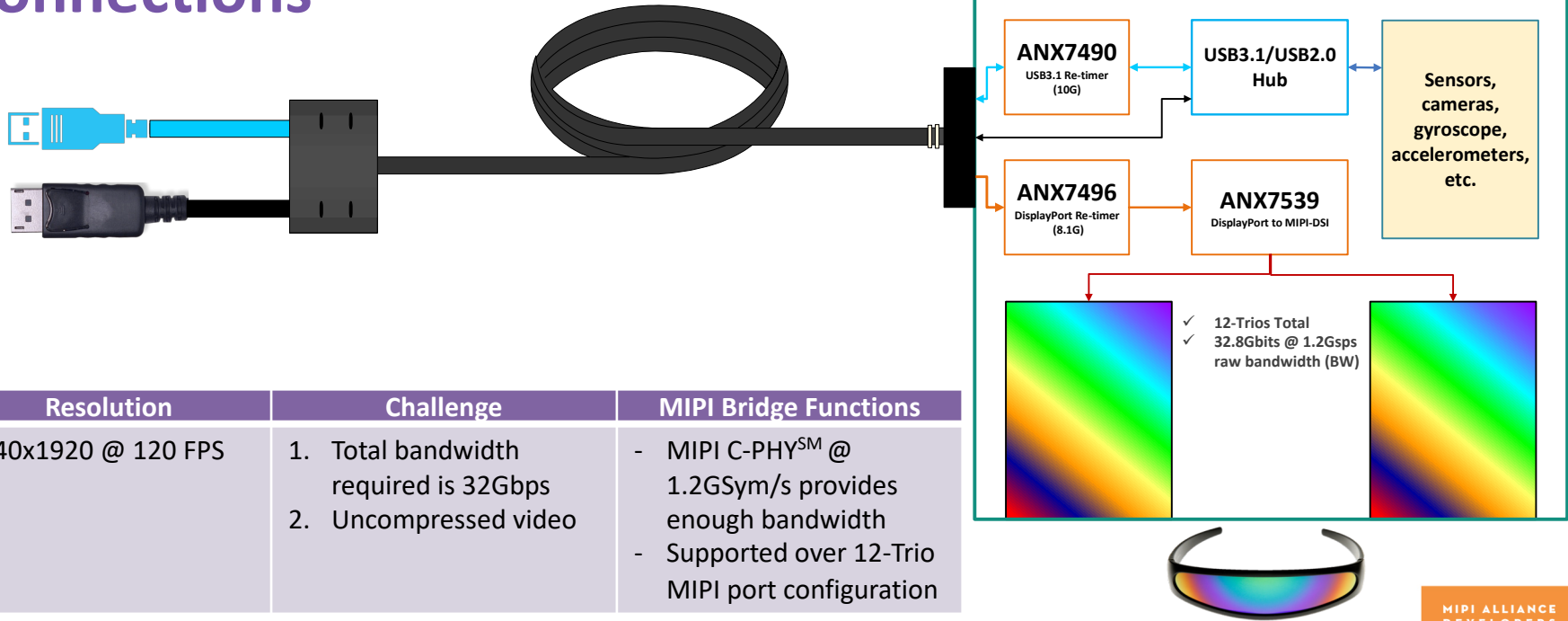
Resolution	Challenge	MIPI Bridge Functions
3840x1920 @ 120 FPS	1. Total bandwidth required is 32Gbps 2. Uncompressed video	- MIPI C-PHY^{SM} @ 1.2GSym/s provides enough bandwidth - Supported over 12-Trio MIPI port configuration

VirtualLink use case bandwidth requirements are similar

Case 2: Mainstream HMD with USB-C Input

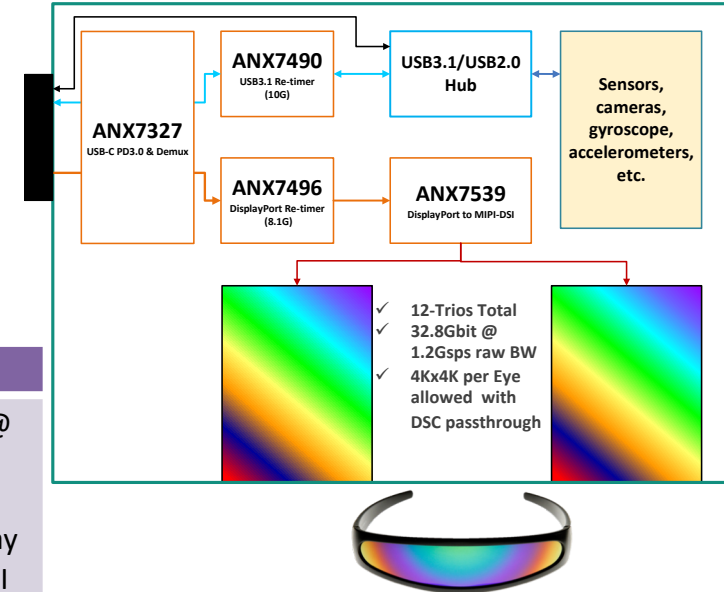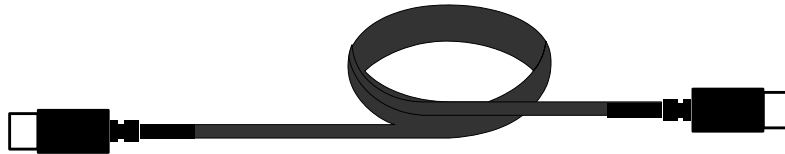| Resolution	Challenge	MIPI Bridge Functions
4800x2400 @ 90 FPS	1. Available input bandwidth: 16Gbps 2. Low persistence requirements for both OLED and LCD panels	- MIPI C-PHY^{SM} @ 1.2GSym/s - Vertical Blanking Interval (VBI) expansion timing for low persistence on LCDs - Supported over 12-Trio configuration

Supports VirtualLink configurations as well

Case 3: High-End HMD with High Resolutions

Resolution	Challenge	MIPI Bridge Functions
8000x4000 @ 90 FPS 6000x3000 @ 120 FPS	1. Requires DSC compression at DisplayPort input and MIPI VR displays	- MIPI C-PHY^{SM}/D-PHY^{SM} @ 1.2GSym/s - DSC compression passthrough to VR display - Supported over quad-DSI or 12-Trio configuration

Diagram labels:
- ANX7327 — USB-C PD3.0 & Demux
- ANX7490 — USB3.1 Re-timer (10G)
- USB3.1/USB2.0 Hub
- Sensors, cameras, gyroscope, accelerometers, etc.
- ANX7496 — DisplayPort Re-timer (8.1G)
- ANX7539 — DisplayPort to MIPI-DSI
- ✓ 12-Trios Total
- ✓ 32.8Gbit @ 1.2Gsps raw BW
- ✓ 4Kx4K per Eye allowed with DSC passthrough

Analogix Semiconductor

MIPI ALLIANCE DEVELOPERS CONFERENCE
19 OCTOBER 2018
SEOUL

MIPI DSI^{SM} Enables High-Performance Video

	MIPI C-PHY^{SM} Effective Bandwidth over 12-trios			MIPI D-PHY^{SM} Effective Bandwidth over 16-DSI		
Signal Speed	1GHz	1.2GHz	1.5GHz	1GHz	1.2GHz	1.5GHz
Total bandwidth	27.36 Gbps	32.83 Gbps	41.04 Gbps	16 Gbps	19.2 Gbps	24 Gbps
Typical VR Resolutions						
3840 x 2160 @ 120Hz	Uncompressed	Uncompressed	Uncompressed	Compressed	Compressed	Compressed
3840 x 2160 @ 90Hz	Uncompressed	Uncompressed	Uncompressed	Compressed	Uncompressed	Uncompressed
4800 x 2400 @ 90Hz	Uncompressed	Uncompressed	Uncompressed	Compressed	Compressed	Compressed

- **Combo MIPI C-PHY^{SM}/D-PHY^{SM} provides system flexibility for uncompressed and compressed video support at VR specific resolutions**
- **Higher resolutions and frame rates can be achieved with MIPI C-PHY^{SM} + compressed video**
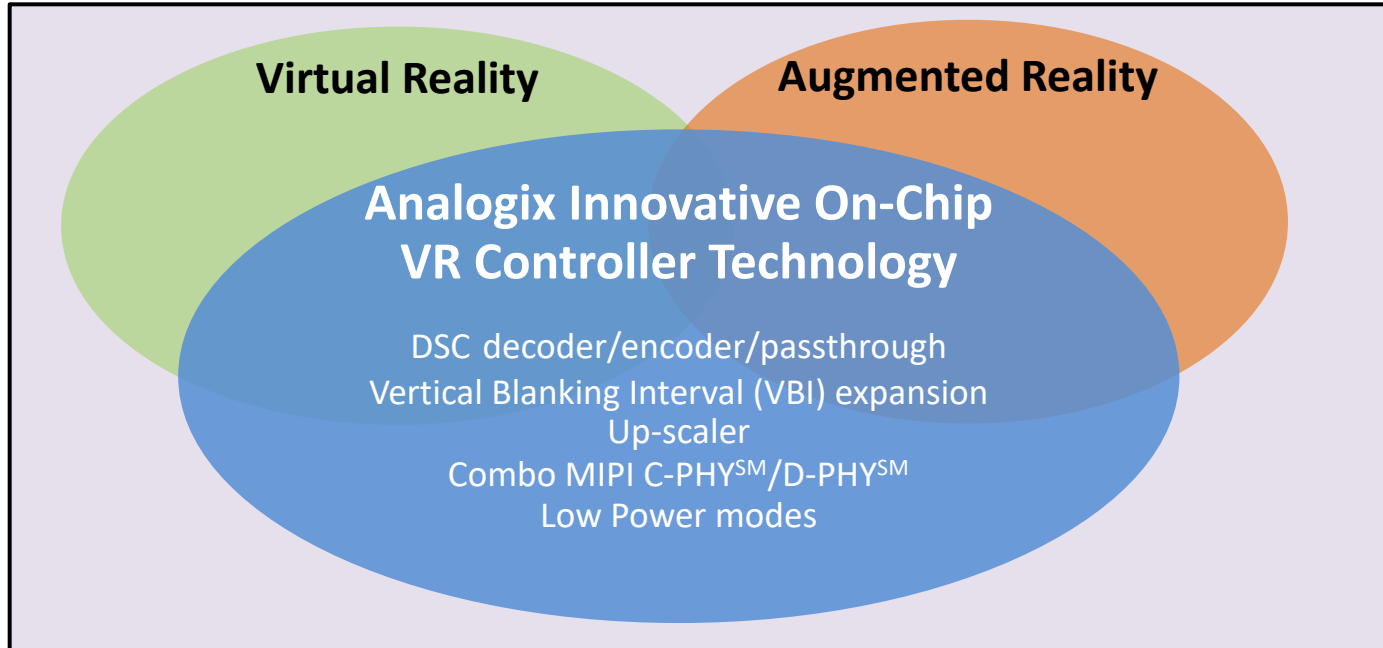
Notes:
- Additional blanking will result in higher bandwidth requirements; above assumes very little blanking
- 4K @ 120 resolutions cannot be supported without compression (VESA DSC) for MIPI D-PHY^{SM}
- ANX7538/39 is the only VR HMD controller that can support uncompressed 4K2K @ 120 FPS including extended blanking for low persistence
- Higher resolutions (greater than 3K per eye) requires DSC passthrough

Achieve the optimum power & performance with MIPI Combo MIPI C-PHY^{SM}/MIPI D-PHY^{SM}
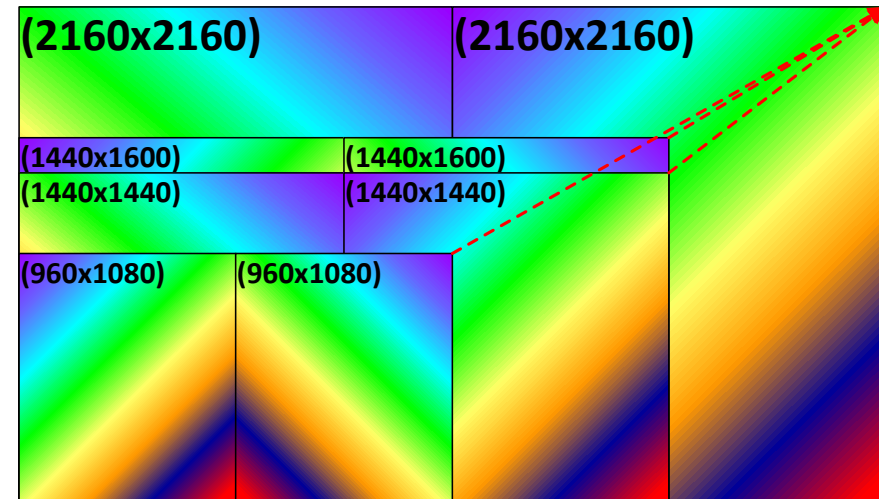
Analogix Semiconductor

MIPI ALLIANCE
DEVELOPERS
CONFERENCE
19 OCTOBER 2018
SEOUL

Leading VR/AR HMD Display Controller Provides Complementary Features to MIPI DSI^{SM}

Virtual Reality

Augmented Reality

Analogix Innovative On-Chip VR Controller Technology

DSC decoder/encoder/passthrough
Vertical Blanking Interval (VBI) expansion
Up-scaler
Combo MIPI C-PHY^{SM}/D-PHY^{SM}
Low Power modes

ANX7539 is the Industry's First VR/AR controller with VBI, Scalar, MIPI C-PHY^{SM} and compression

MIPI ALLIANCE
DEVELOPERS
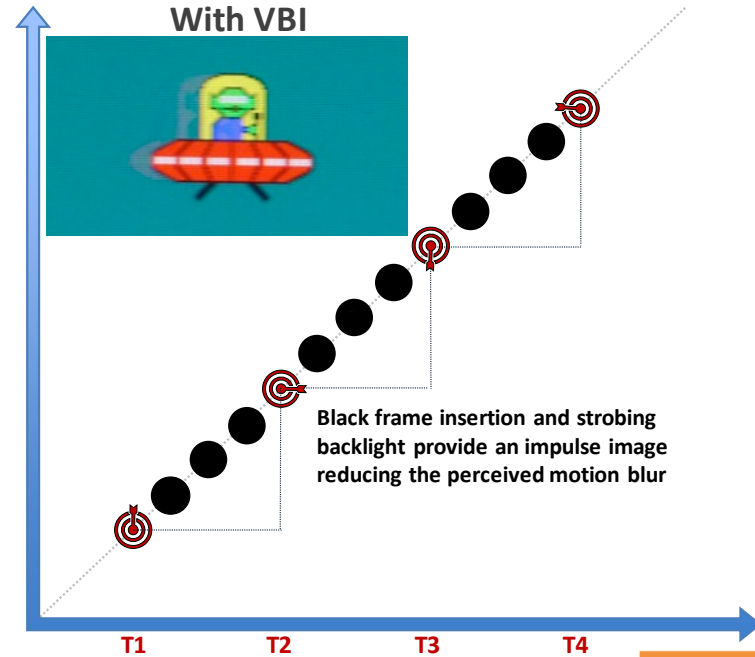CONFERENCE
19 OCTOBER 2018
SEOUL

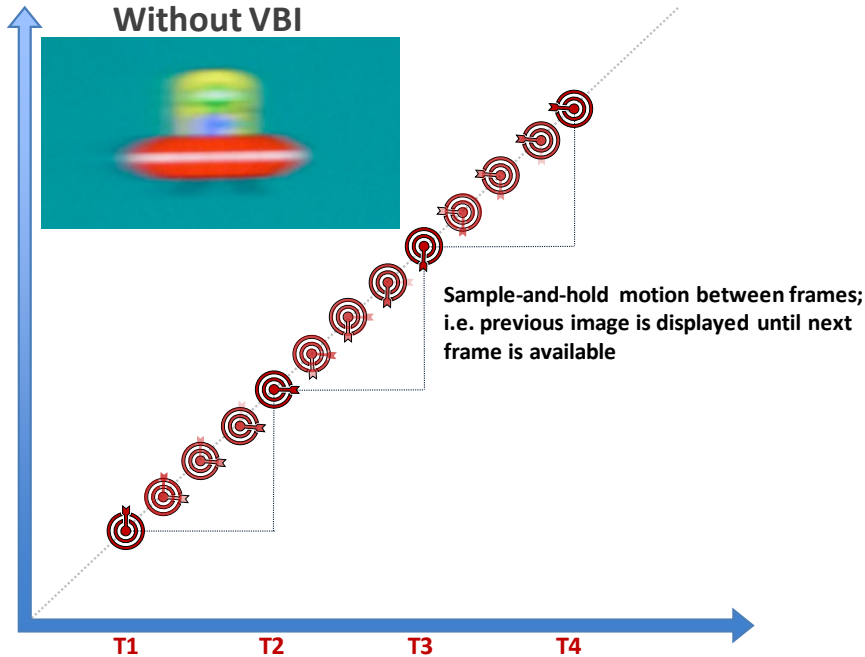# On-Chip Video Scaler Supports VR Display Resolutions

- Existing content format can leverage larger resolution VR displays with MIPI DSI^{SM} interfaces

- Allows upscaling to larger native VR display resolutions; it prevents
 - Pillarboxing, letterboxing
  - No video in some cases

(2160x2160) (2160x2160)

(1440x1600) (1440x1600)
(1440x1440) (1440x1440)

(960x1080) (960x1080)

Analogix Semiconductor

Vertical Blanking Interval (VBI) Expansion

Without VBI

Sample-and-hold motion between frames; i.e. previous image is displayed until next frame is available

T1   T2   T3   T4

With VBI

Black frame insertion and strobing backlight provide an impulse image reducing the perceived motion blur

T1   T2   T3   T4

VBI helps reduce power on DisplayPort interface while maximizing MIPI DSI^{SM} bandwidth

MIPI ALLIANCE DEVELOPERS CONFERENCE
19 OCTOBER 2018
SEOUL

ANX7539 Ideal for High-End VR HMD Applications

Item #	Input Resolution, FPS	ANX7539	
	Left + Right Eye Views	On-chip VBI Expansion (% of input frame)	Video Input Uncompressed/Compressed
1	4800x2400 @ 90 FPS	0%	Uncompressed
2	3840x2160 @ 90 FPS	20%	Uncompressed
3	4800x2400 @ 90 FPS	50%	DSC 2:1
4	4320x2160 @ 90 FPS	50%	DSC 2:1
5	4176x2160 @ 90 FPS	50%	DSC 2:1
6	3840x2160 @ 90 FPS	50%	DSC 2:1
7	6000x3000 @ 120 FPS	0%	DSC 3:1 bypass
8	8000x4000 @ 90 FPS	0%	DSC 3:1 bypass
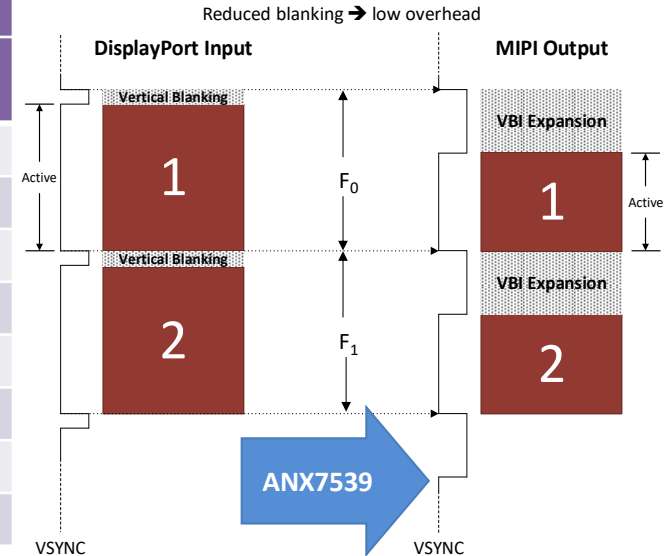
Analogix Semiconductor

In Summary

- MIPI DSI^{SM} interface provides the necessary feature set to enable today's and tomorrow's high-performance displays

- Immersion and user experience continues to drive the performance requirements for VR HMDs

- Intelligent VR and AR display controllers will power the next generation of HMDs

- Analogix leads with innovative technology and products for AR/VR by leveraging and maximizing industry standards (MIPI DSI^{SM}, DisplayPort, USB-C, etc.)

Analogix Semiconductor

ADDITIONAL RESOURCES

- www.analogix.com/en/solutions/vrarheadset

- www.analogix.com/en/dp-mipi-converter

- www.analogix.com/en/system/files/AA-005715-PB-2-ANX7539_Product_Brief.pdf

Analogix Semiconductor