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MIPI ALLIANCE DEVELOPERS CONFERENCE
22-23 SEPTEMBER 2020

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MASS: MIPI Automotive SerDes Solutions
Displays Using VDC-M Visually Lossless Compression

Deeper Dive symbol: Extra slides in backup material at the end of the presentation

MOBILE & BEYOND

Part I – MASS Display Use-Cases and Architecture

- Automotive displays undergoing rapid change driven by 5 new trends:
  - Connectivity, Over-the-Air Updates, Electrification, Autonomy and Ride Sharing
  - Increase in the number of displays
  - Increase in size
  - Increase in resolution
- **Massive increase in automotive display bandwidth** requirements.
- Countered with more stringent Power and RF interference constraints

Part I – MASS Display Use-Cases and Architecture

- Automotive engineers need new automotive display system solutions
- **MASS**: MIPI Automotive SerDes Solutions
  - Foundation is the next generation MIPI Automotive-PHY specification
  - Leverages MIPI low-power, low EMI display and camera protocols
  - Includes new End-to-end functional safety and security improvements
- Details in two new MASS Display and Compression whitepapers (Oct 2020)

5 Automotive Industry Trends Driving Display Architectures

Trend	Description	Impact on Display Architecture
Connectivity	5G, V2V and V2X standards will allow passengers to communicate, work, surf the Internet, and access high-bandwidth multimedia throughout the journey.	Increased need for visual bandwidth More, larger, higher resolution displays
Over-the-Air Feature Updates	Software subscription services will be offered to accelerate the pace of automotive hardware and software integration. These shorter innovation cycles will make use of all increased automotive display capability. Displays will be used to change the look-and-feel of the car's interior with downloadable backgrounds and personalized content.	New display form factors to curve and match the style of the interior cabinet More, larger, higher resolution displays
Electrification	The transition to emissions free transportation creates new constraints on in-cabin electrical consumption. The distance traveled on a single charge is directly proportional to the power efficiency of the electrical and electronic sub-systems. The multiple displays required in modern cars car leverage the power efficient techniques pioneered in mobile wireless phones.	Dynamic display power reduction at the hardware protocol level Optimize display bandwidth through compression to reduce power
Autonomy	Full or partial self-driving cars will have a profound impact on the industry. Vehicles that off-load the driving task allow the driver and automobile to interact differently with the potential to use advanced display capabilities for gaming, entertainment and information not related to the task of driving.	Increased use-cases for display content More, larger, higher resolution displays
Car Sharing	Autonomous vehicles will enable highly customized car sharing solutions where driver preferences are automatically configured when the driver starts the car. Future vehicle display interfaces will be highly customizable with a much richer multimedia experience including animations, personalized content, wide colour gamut images and audio.	Customized user experience will travel with driver and individual passengers. Display must adapt to constantly changing requirements

Modern Automotive Cockpit Displays – Close Up

Modern Automotive Cockpit Displays

Display Type	Example Size (Inches)	Example Resolution
Left and Right-Side Mirror Displays	7”	1280x800
Driver Instrument Display (DID)	12.3”	3840x1440
Center Information Display (CID)	12.3”	3840x2160
Extended Co-Driver display (CDD)	12.3”	3840x2160
Lower Control Display	12.4”	3840x2160

Modern Automotive Cockpit Displays – Rear Screens

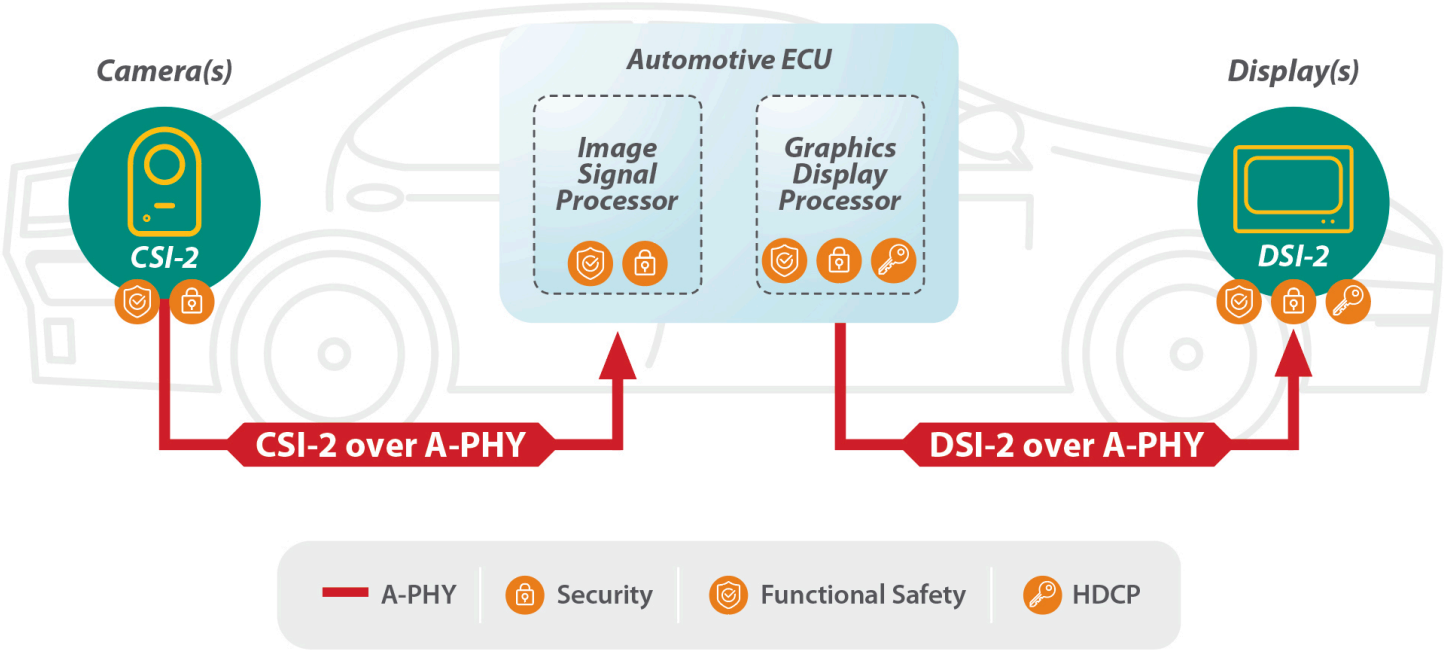
Digital Side View Mirror

Automotive Display Requirements

- Support multiple, high resolution displays from a single Electronic Control Unit (ECU)
  - Up to 15 meters with multiple simultaneous display channels
  - Low power, Electromagnetic Compatibility (EMC) and Ultra-low Packet Error Rate (PER) for safety and video compression support.
- Support scalable daisy-chain and hub-spoke topologies
  - **Daisy Chain Topology**
    - Best suited when central ECU drives multiple inline displays.
    - Dashboard applications
  - **Hub-Spoke Topology** 
    - Best suited when central ECU drives multiple widely dispersed displays
    - Rear screen applications
- **Side-view mirror use-case**
  - External side-mirror camera sensor → ECU → side-mirror display
  - Functional Safety

MASS: MIPI Automotive SerDes Solutions

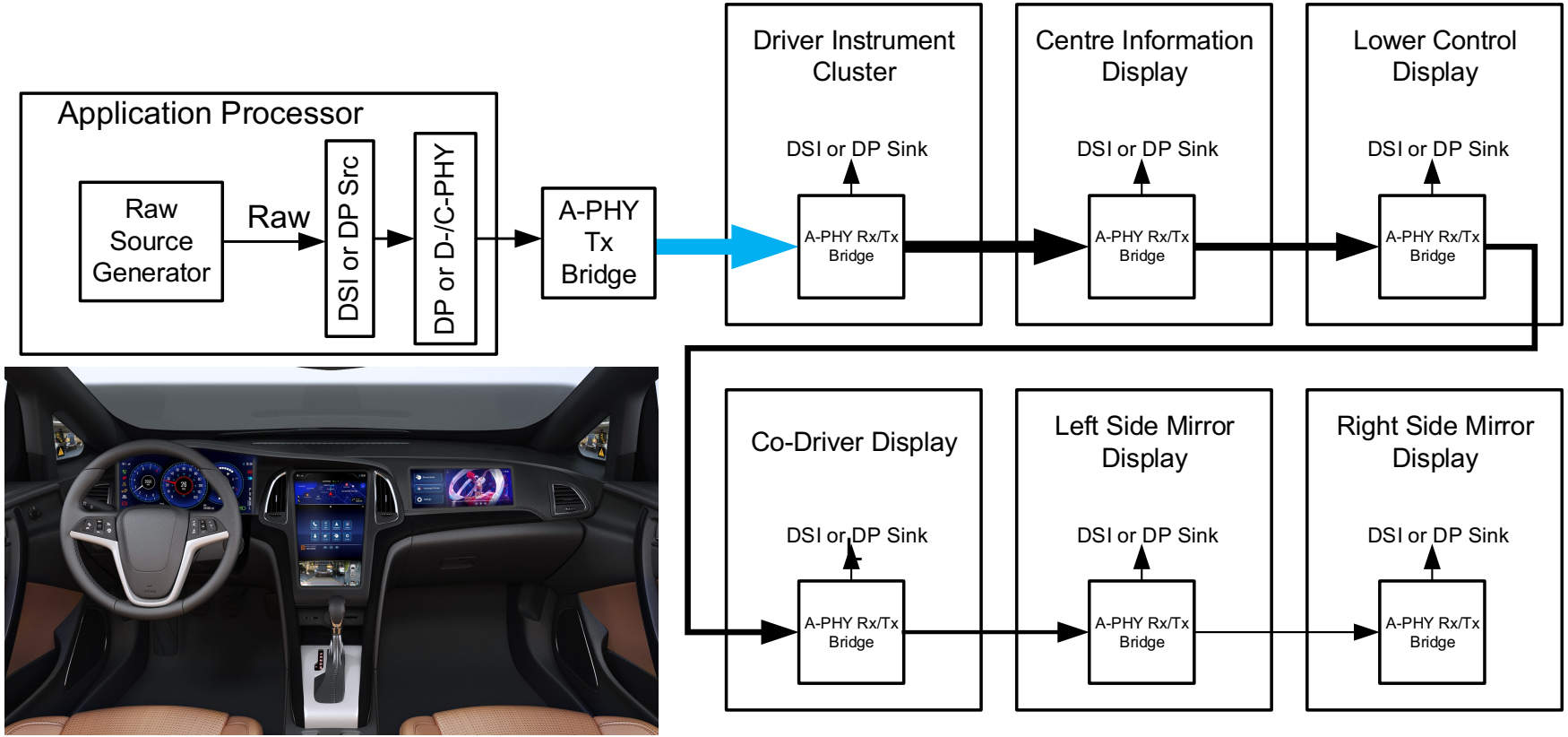
High-Level Conceptual Diagram



MASS: MIPI Automotive SerDes Solutions

A vision for End-to-End Systems

MASS Display Daisy Chain Topology



Part II –DSI-2 Display Bandwidth Compression

- Evaluate 7 different display automotive use-cases
- Calculate raw and compressed bandwidth requirements
  - Use the most aggressive **VDC-M 6:1 compression** ratio
  - 30-bits per pixel (bpp) uncompressed -> 5 bpp compressed
  - 24-bpp uncompressed -> 4 bpp compressed
- Explain MIPI Automotive Compression Study
- Analyze and report visual quality results

Automotive Display Bandwidth Requirements

Display Parameters							Total Bandwidth				MIPI PHY		
Display Config	Driver Instrument Display (DID) 12"	Centre Information Display (CID) 10.2"	Lower Control Display (CLD) 10.2"	CoDriver Display (CDD) 12"	Left Side Mirror 3.6"	Right Side Mirror 3.6"	Src 24-Bit	Src 30-bit	VDC-M Comp 24-bit (6:1)	VDC-M Comp 30-bit (6:1)	Minimum A-PHY Gear Required	Minimum D-PHY 2.5 Required	Minimum C-PHY 2.0 Required
Level 1	1280x720	1280x720	None	None	None	None	2.846	3.558	0.474	0.593	G1	1-lane	1-lane
Level 2	1920x720	1920x720	1920x720	None	None	None	6.405	8.007	1.068	1.335	G1	1-lane	1-lane
Level 3	3840x1440	3840x1440	3840x1440	3840x1440	None	None	33.46	41.824	5.577	6.971	G3	2-lane	1-lane
Level 4	3840x2160	3840x2160	3840x2160	3840x2160	640x390	640x390	50.97	63.694	8.495	10.616	G4	2-lane	1-lane
Level 5	5120x2160	3840x2160	3840x2160	5120x2160	640x390	640x390	59.156	74.136	9.859	12.356	G4/G5	3-lane	1-lane
Level 6	5120x2160	7680x2800	3840x2160	5120x2160	None	None	78.954	98.89	13.159	16.482	G5/G5-2 lane	4-lane	2-lane
Level 7	7680x2800	7680x2800	7680x2800	7680x2800	640x390	640x390	133.242	166.558	22.207	27.760	G5 2-lane	N/A	2-lane

Uncompressed Rates

Automotive Display Bandwidth Requirements

Display Parameters							Total Bandwidth				MIPI PHY		
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Level 7	7680x2800	7680x2800	7680x2800	7680x2800	640x390	640x390	133.242	166.558	22.207	27.760	G5 2-lane	N/A	2-lane

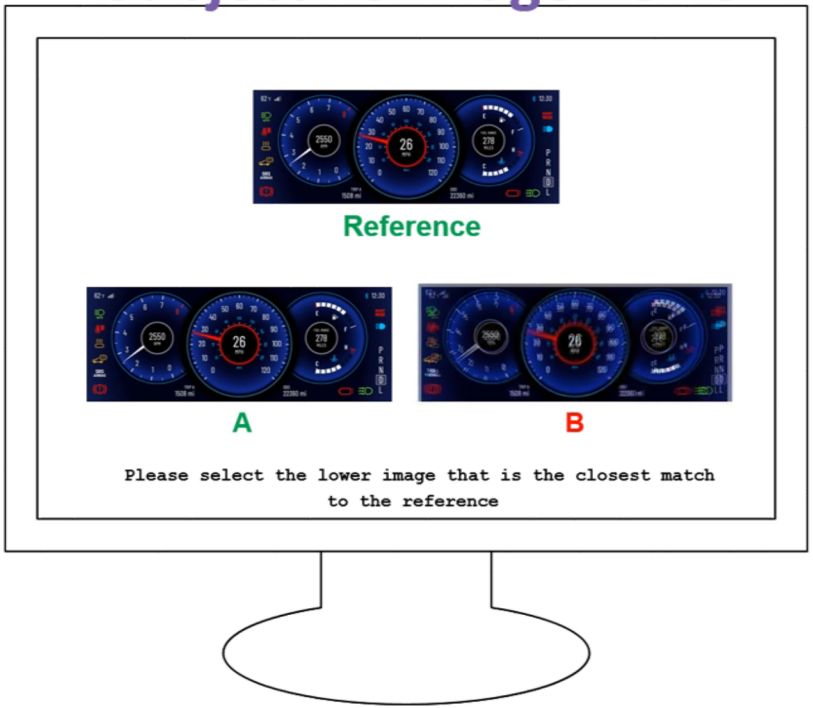
Compressed Rates

MIPI Automotive 6:1 Image Compression Study

1. MIPI automotive dashboard images
2. Selected ISO/IEC 29170-2:2015 Subjective Trials protocol
   - Optimized for low-impairment compression visual quality analysis
3. Expert reviewers evaluated images
4. Generated report results
   - All images **passed** a limited expert review

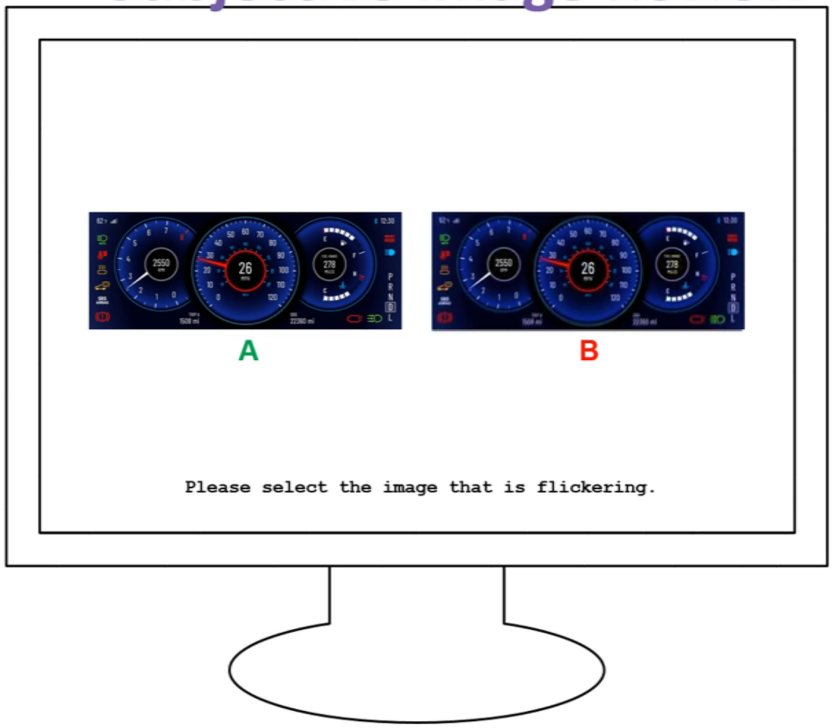
- MIPI study images are available for member experimentation. Please contact the MIPI executive team.

Subjective Image Review



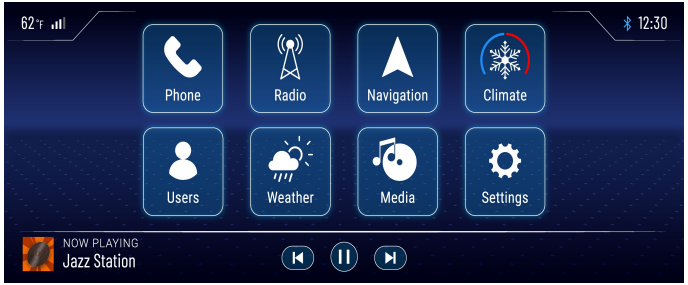
Exaggerated Static Image Comparison

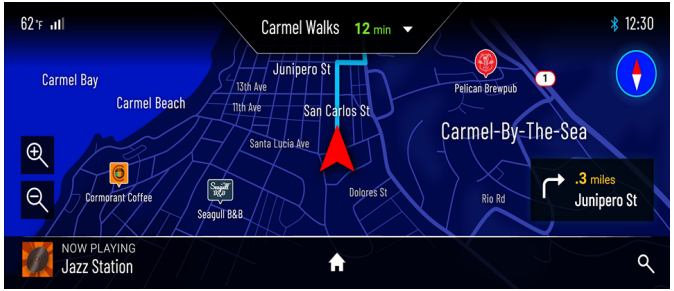
Subjective Image Review

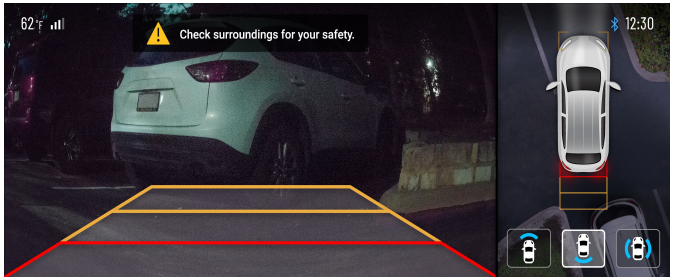


Exaggerated 5 Hz Flicker Image Comparison

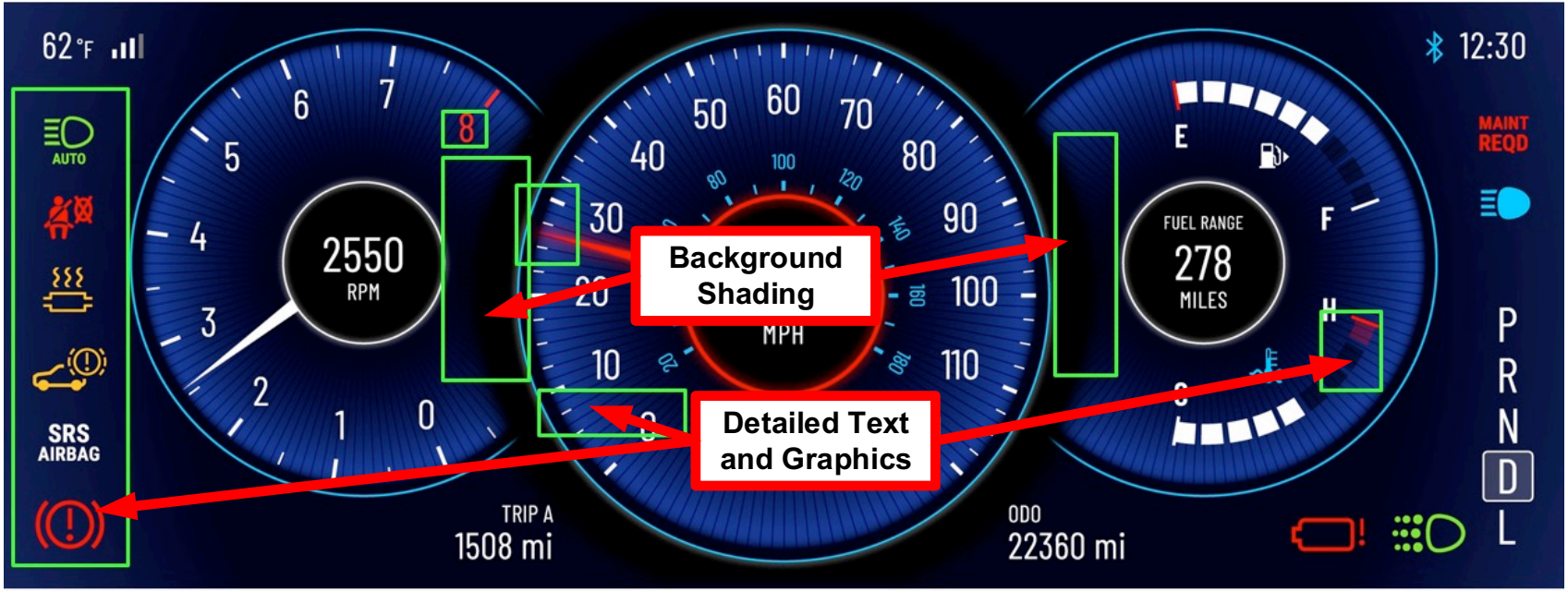
Summary of MIPI Commissioned Test Images







Key Focus Areas



ISO Quality Results Report

Image Name	Pass or Fail
MIPI_Screen_Renders_01_InstrumentCluster_Day	Pass
MIPI_Screen_Renders_01_InstrumentCluster_Day-NoTelltales	Pass
MIPI_Screen_Renders_01_InstrumentCluster_Day-WhiteRing	Pass
MIPI_Screen_Renders_01_InstrumentCluster_Night	Pass
MIPI_Screen_Renders_01_InstrumentCluster_Night-NoTelltales	Pass
MIPI_Screen_Renders_01_InstrumentCluster_Night-WhiteRing	Pass
MIPI_Screen_Renders_02_EntertainmentControls_Day	Pass
MIPI_Screen_Renders_02_EntertainmentControls_Night	Pass
MIPI_Screen_Renders_03_NavigationMap_Day	Pass
MIPI_Screen_Renders_03_NavigationMap_Night	Pass
MIPI_Screen_Renders_04_BackupCamera_Day	Pass
MIPI_Screen_Renders_04_BackupCamera_Night	Pass
MIPI_Telltale_Icons	Pass

Summary

- Automotive displays are increasing in:
  - Number, Size and Resolution
- Driven by 5 new trends:
  - Connectivity, Over-the-Air Updates, Electrification, Autonomy and Ride Sharing
- Result: **Massive increase in automotive display bandwidth**
- **MASS**: MIPI Automotive SerDes Solutions
  - End-to-End Camera->ECU->Display Architecture
  - Leverages Display DSI-2 Compression
- MIPI DSI-2 Compression for Automotive Display Study
  - Compression for Visually Lossless Automotive MASS Displays

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THANK YOU

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