mipi® DEVCON

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Synopsys

Powering Imaging Applications with MIPI CSI-2℠

2017
MIPI ALLIANCE
DEVELOPERS
CONFERENCE

Agenda

- Implementation of MIPI interfaces in mobile applications and beyond

- Advantages of implementing MIPI camera and sensor specifications

- Meeting reliability requirements of automotive applications

- Summary

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MIPI Specifications in New Applications
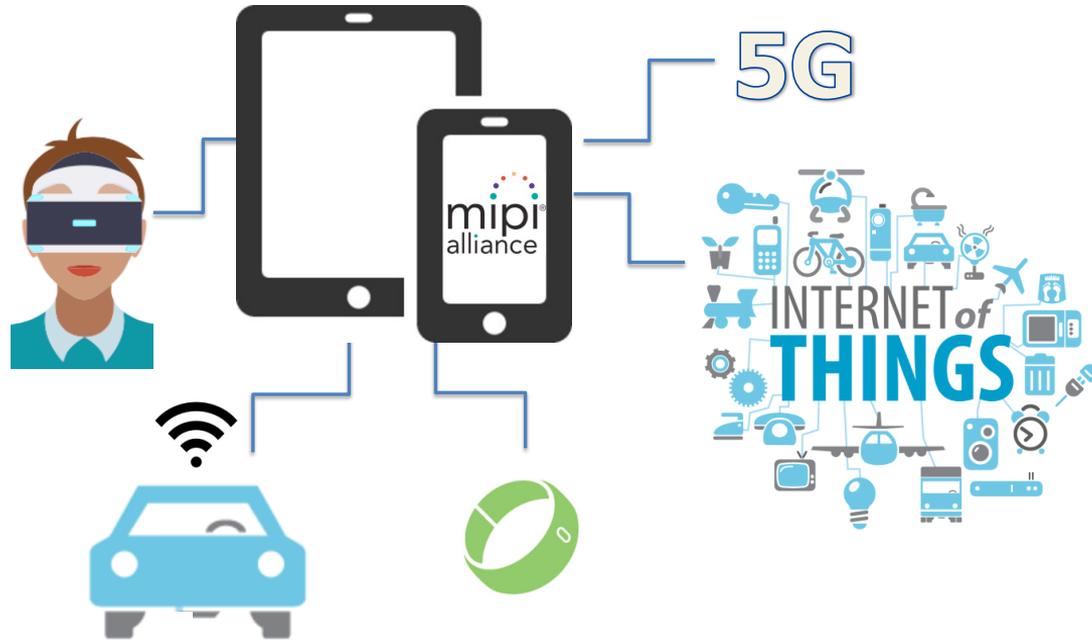
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Industrial, Surveillance Applications

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Example: Multi-Image Sensor Surveillance
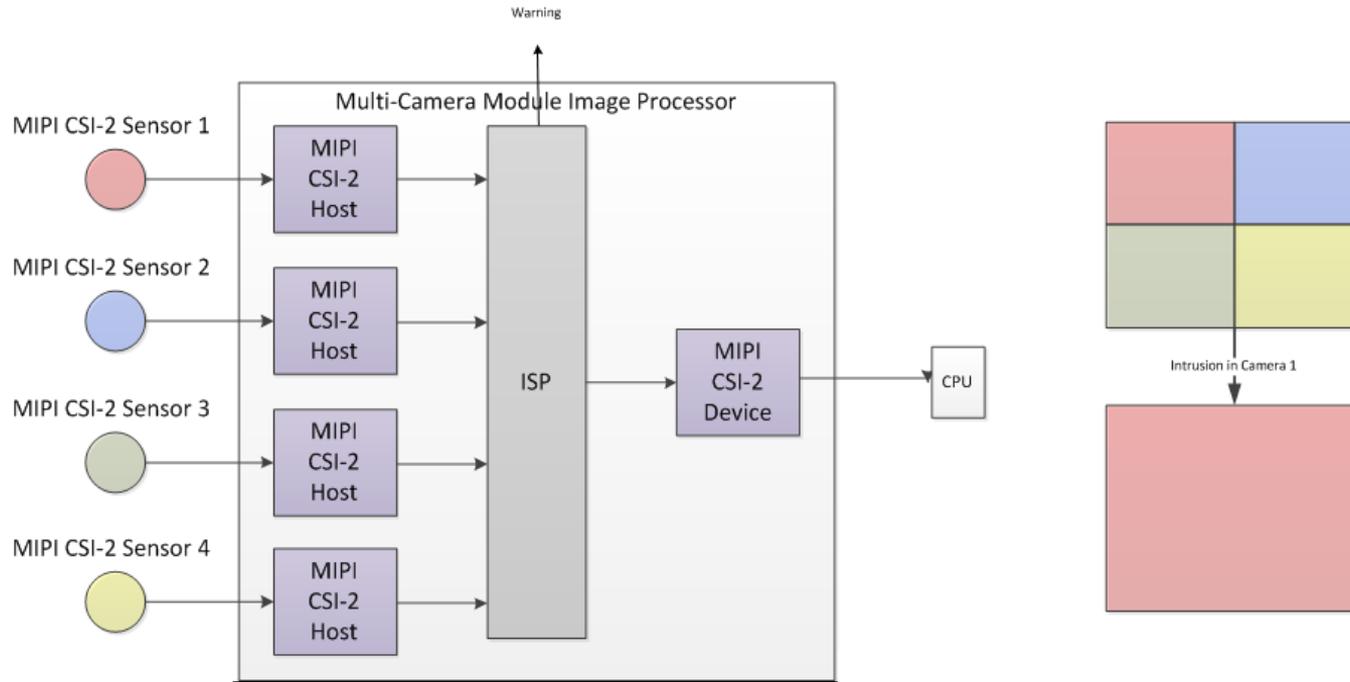
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Advanced Driver Assistance Systems (ADAS)

- Passive ADAS
  - Back-up, side mirror, surround view camera


  - Distance alert system

- Active ADAS
  - Back-up camera with ID & braking

 - Collision avoidance
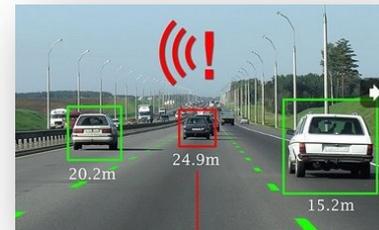
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Surround View Automotive Applications
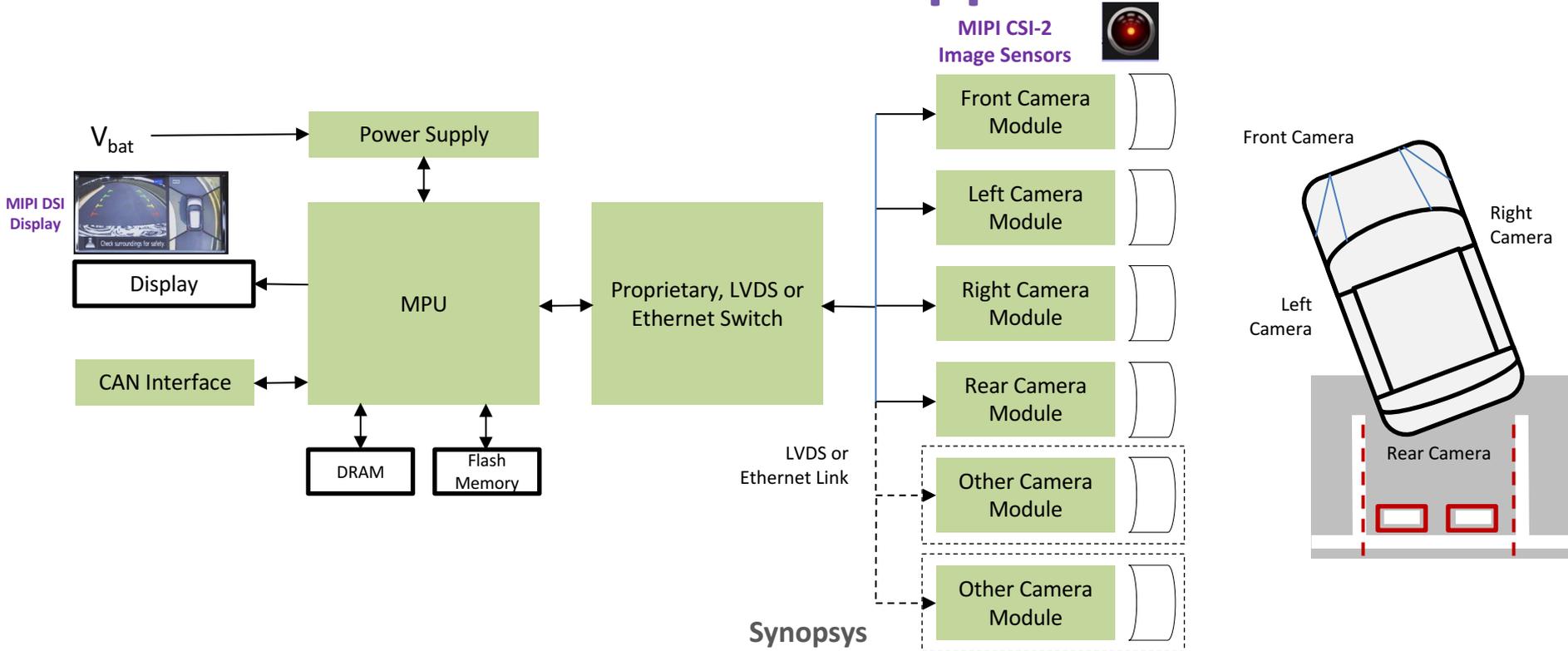
Surround View Automotive Applications

Pedestrian/Obstacle Detection
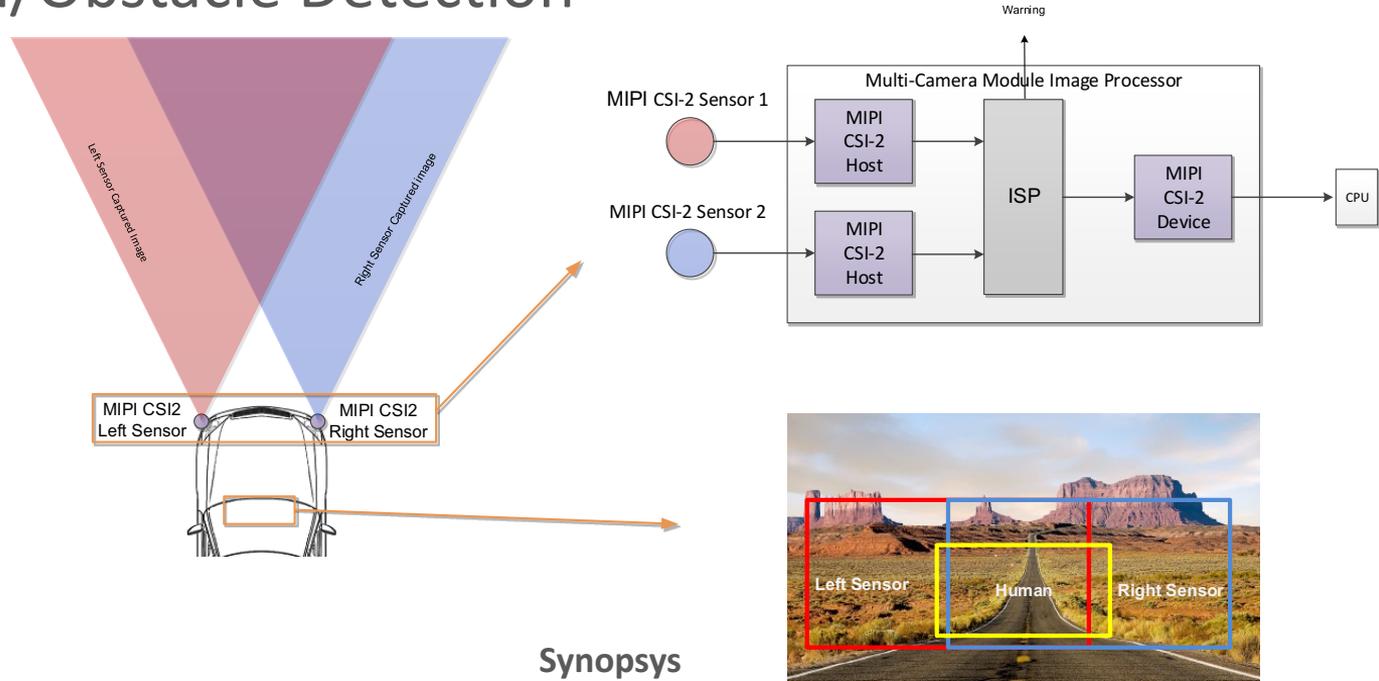
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MIPI CSI-2 Specification

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MIPI CSI-2 Specification – Standardizing Image Sensor Interface in Mobile and Beyond

Evolving Image interface

- MIPI's first problem statement back in 2004!
  - No standard image sensor interface for Mobile
  - Interoperability challenges
  - Camera vendors had to pick and choose which devices/SoCs they developed for
  - Devices/SoCs had to pick and choose partners on the camera sensor side
  - Very difficult from a scalability point of view

Mobile

Imaging & Vision

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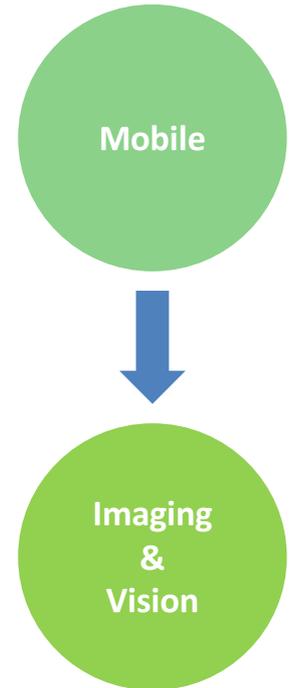
MIPI CSI-2 Specification

| CSI-2 Specification version		1.00 2005	1.01 2011	1.1 2013	1.2 2014	1.3 2014	2.0 2017
RAW 6/7/8/10/12/14 RGB 444/555/565/666/888 YUV 420 8/10-bit YUV 422 8/10-bit		Yes	Yes	Yes	Yes	Yes	Added RAW16/20
Compression for RAW Data Types (Annex E)		-	Yes	Yes	Yes	Yes	Added 12-10-12
MIPI D-PHY	Specification Version	0.58	1.00	1.1	1.2	1.2	2.1
	Speed (Gbps)	1.0	1.0	1.5	2.5	2.5	4.5 – Normal Ch. 6.5 – Short Ch.
	Number of lanes (Typically)	1 to 4	1 to 4	1 to 4	1 to 8	1 to 8	1 to 8
	PPI Interface	8-bit	8-bit	8-bit	8-bit	8-bit	8/16/32-bit
MIPI C-PHY	Specification Version	-	-	-	-	1.0	1.2
	Speed (Gsym/s)	-	-	-	-	2.5	3.5
	Number of lanes (Typically)	-	-	-	-	1 to 6	1 to 6
	PPI Interface	-	-	-	-	16-bit	16/32-bit
CCI : I2C Modes		I2C – FM (400kHz)	I2C - FM	I2C - FM	I2C - FM	I2C - FM	I2C - FM
Data Scrambling (Per-Lane)		-	-	-	-	-	Yes
Extended Virtual Channels		-	-	-	-	-	Yes
Latency Reduction and Transport Efficiency (LRTE):		-	-	-	-	-	Yes

Mobile

Imaging & Vision
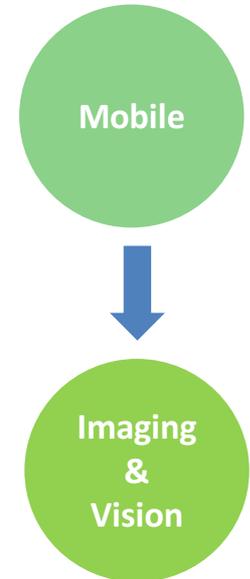
MIPI CSI-2 Over MIPI D-PHY
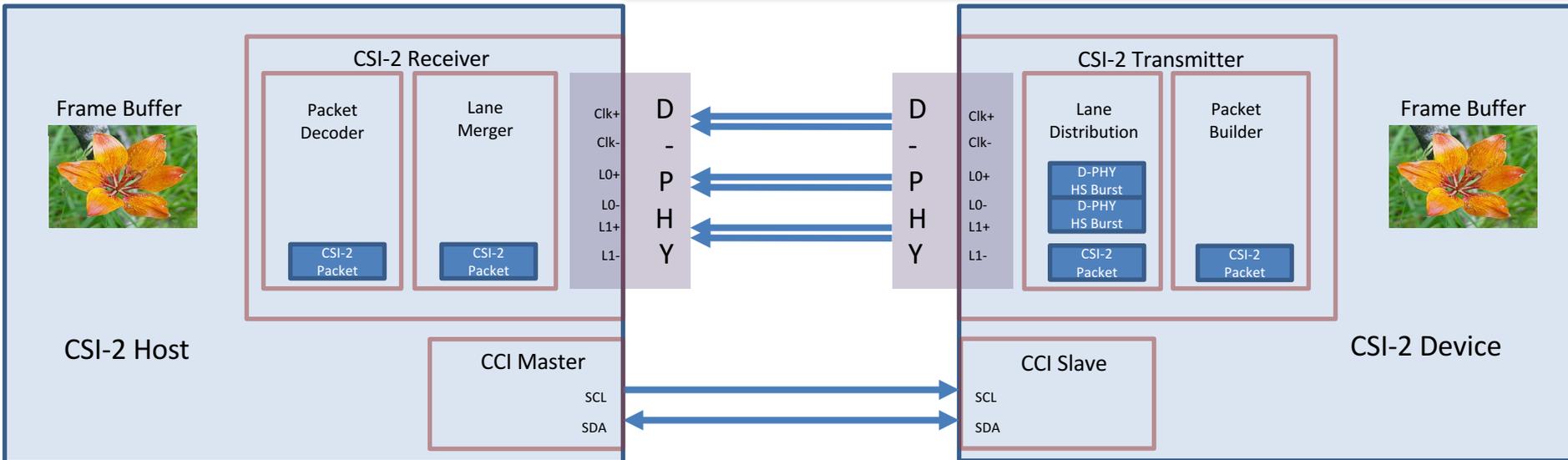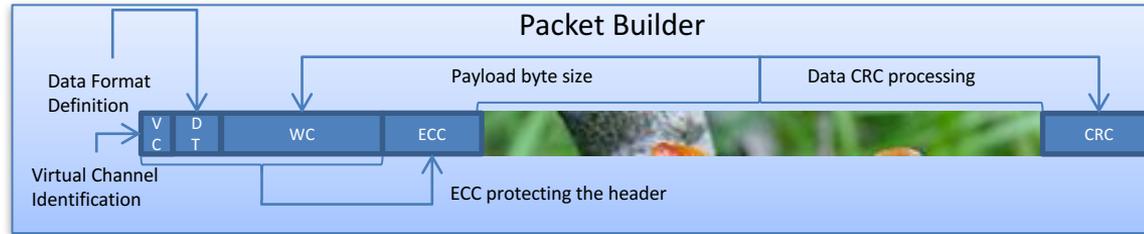
MIPI CSI-2 v2.0 Feature Enhancements

- RAW-16 and RAW-20 color depth

- Latency Reduction & Transport Efficiency (LRTE)

- Differential Pulse Code Modulation (DPCM) 12-10-12 compression

- Scrambling to reduce Power Spectral Density (PSD) emissions

- Expanded number of virtual channels from 4 to 32

Source: MIPI Alliance

Image Quality/HDR - Latency - Reliability - Aggregation

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MIPI CSI-2 v2.0 Feature Enhancements

- CSI-2 1v3 color depths are sufficient for Mobile. Visually, there is almost no change between RAW14 and RAW16/20.
- RAW-16 and RAW-20 color depth bring advanced vision capabilities to Automotive and Industrial applications
  - Improves image capture when the environment changes suddenly and dramatically, for example in a big change in lighting condition.

Raw vs JPEG

Raw 4 Vs Raw 8

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MIPI CSI-2 v2.0 Feature Enhancements

- To accommodate the larger number of image sensors and their multiple data types
- To support multi-exposure and multi-range sensor fusion for ADAS

| Virtual Channel 0 – Line 0 |
| Virtual Channel 0 – Line 1 |
| Virtual Channel 0 – Line 2 |
| Virtual Channel 0 – Line 3 |
| Virtual Channel 0 – Line 4 |
| Virtual Channel 0 – Line N |

| Virtual Channel 1 – Line 0 |
| Virtual Channel 1 – Line 1 |
| Virtual Channel 1 – Line 2 |
| Virtual Channel 1 – Line 3 |
| Virtual Channel 1 – Line 4 |
| Virtual Channel 1 – Line M |
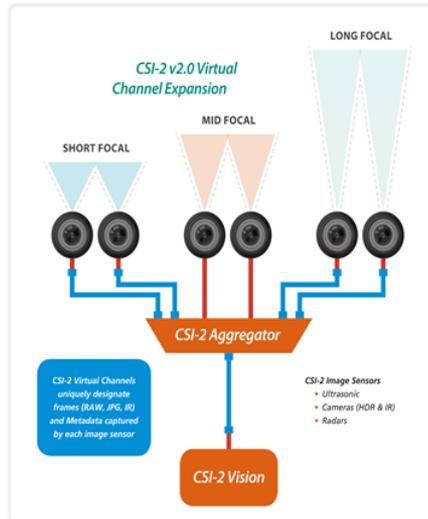
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MIPI CSI-2 v2.0 Feature Enhancements

Added Latency Reduction and Transport Efficiency (LRTE)

- LRTE reduces frame transport latency & leakage power due to frequent "high speed - low power" transitions.
- This will enhance image sensor aggregation and multi exposure for real-time perception and decision making applications
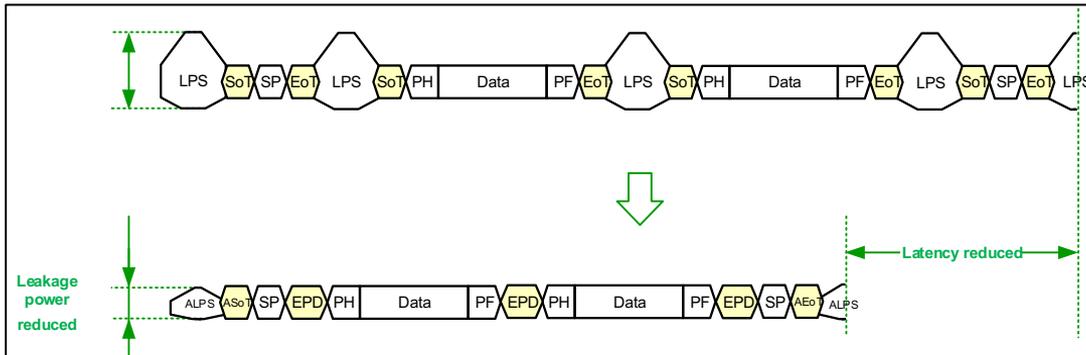

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MIPI CSI-2 v2.0 Feature Enhancements

Added scrambling and compression scheme

- Galois Field Scrambling reduces power spectral density (PSD) emissions
  - Minimizes PSD emissions from aggressor components, which are particularly beneficial when placed near sensitive receivers

- New DPCM 12-10-12 compression to further boost image quality
  - Superior SNR using reduced bandwidth PHY
  - Removes more compression artifacts when comparing with previous CSI-2 1v3 compression mode

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CSI-2 over D-PHY PSD emission reduction
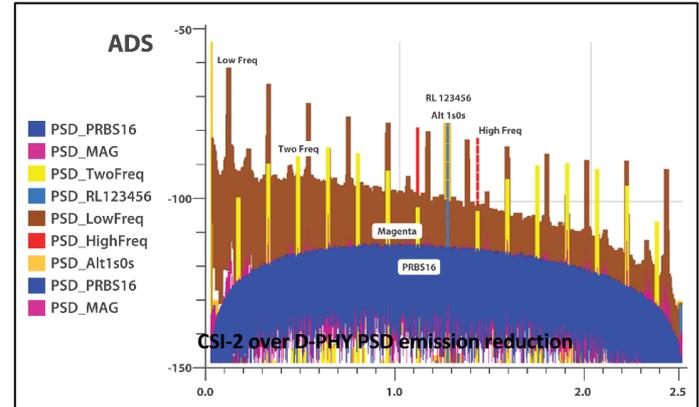

PCM Errors

DPCM 12-8-12 vs DPCM 12-10-12

MIPI Specifications Beyond Mobile

- Tackling the evolving imaging and vision applications in the automotive platform

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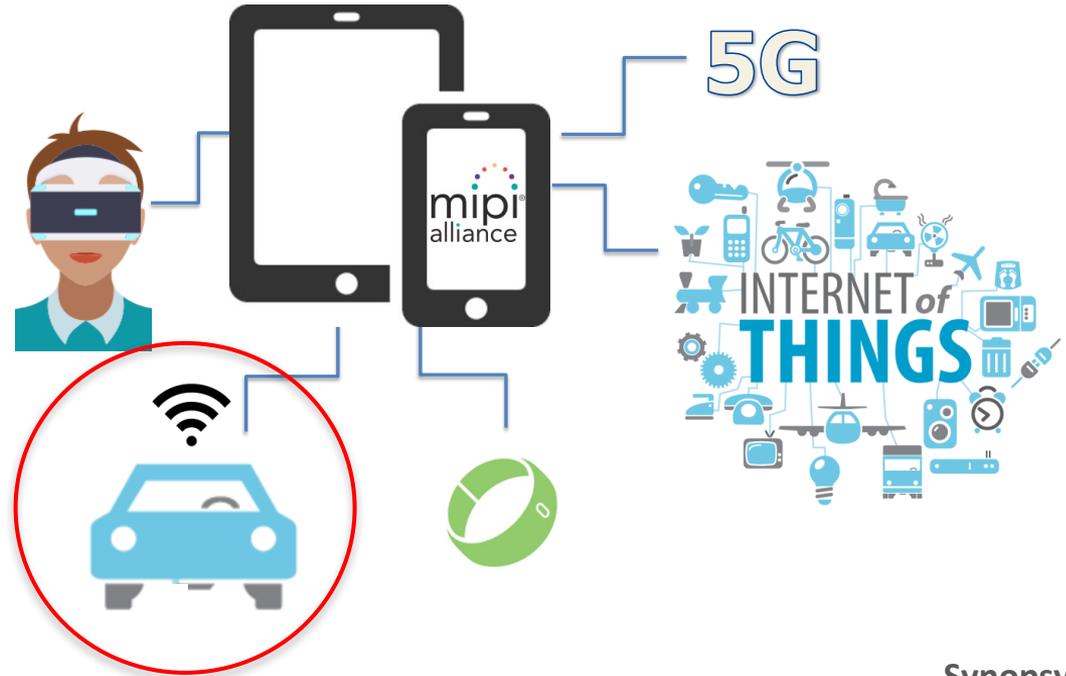
MIPI Specs for Multimedia, Storage, Sensor & Wireless Connectivity in Automotive Applications

Infotainment

- Navigation
- Audio/Video
- Entertainment

Driver Information

- Instrument clusters
- Voice recognition
- Hi-def displays
- Surround view
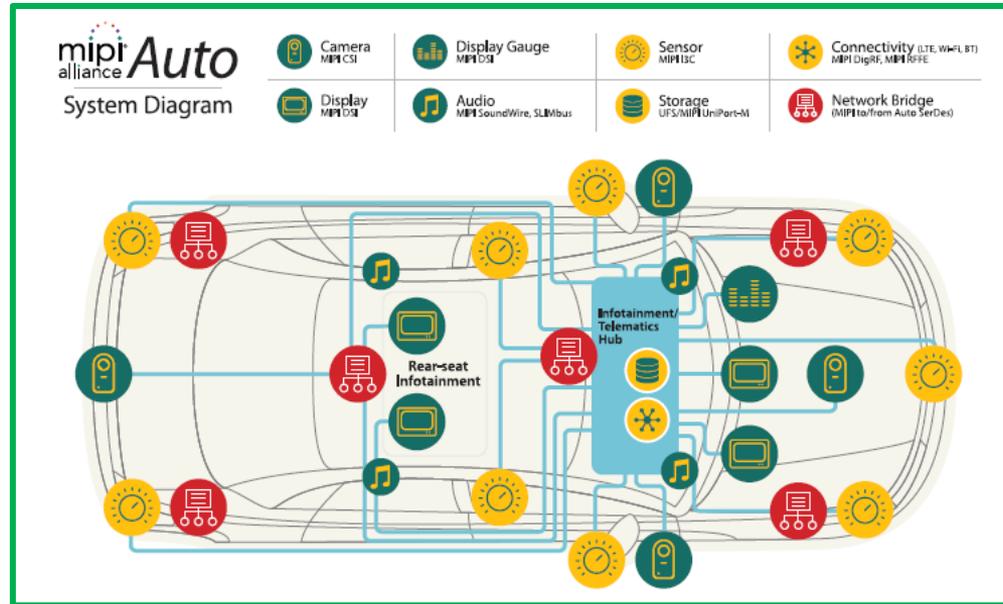
Vehicle Networks & V2X

- Real time video & data network
- Gateways
- Telematics
- V2V
- V2I
- Security

Driver Assistance

- Parking assist
- Lane departure warning & Lane keep aid
- Pedestrian detection & correction
- Automatic emergency braking

mipi alliance Auto
System Diagram

| Camera MIPI CSI | Display Gauge MIPI DSI | Sensor MIPI I3C | Connectivity (LTE, WiFi, BT) MIPI DigRF, MIPI RFFE |
| Display MIPI DSI | Audio MIPI SoundWire, SLIMbus | Storage UFS/MIPI UniPort-M | Network Bridge (MIPI to/from Auto SerDes) |

Infotainment/Telematics Hub

Rear-seat Infotainment

Safety-Critical ADAS Applications

Requiring ISO 26262 certification for target ASILs
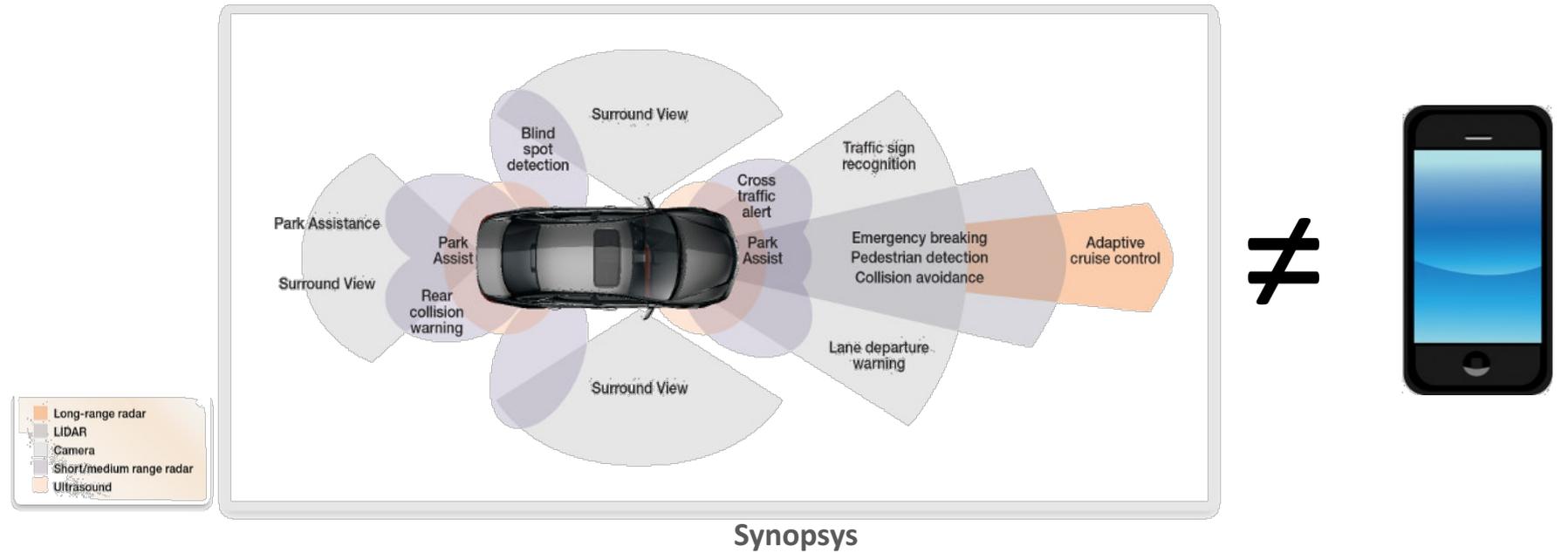
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Key Requirements of Automotive-Grade IP

Functional Safety

Accelerate ISO 26262 functional safety assessments to help ensure designers reach target ASIL levels

Reliability

Reduce risk & development time for AEC-Q100 qualification of SoCs

Quality

Meet quality levels required for automotive applications

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DesignWare ASIL Ready ISO 26262 Certified CSI-2 IP

- Complete camera, display and sensor interface IP solutions from a single vendor
- MIPI CSI-2, MIPIJ D-PHY and MIPI I3C℠ protocols
  - Automotive grade1 and grade2 D-PHYs
- Enables new set of applications in automotive, AR/VR, IoT markets
  - Lowers integration risk for application processors, bridge ICs and multimedia co-processors
- Future proof IP supporting variety of speeds, proven in silicon
  - Reduces cost and power for multiple instantiations
 - Testability features enable low cost manufacturing

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High-End Processor

DSI Device Controller

D-PHY

CSI-2 Host Controller

MIPI D-PHY

CSI-2 Host Controller

D-PHY

Image Signal Processing

CSI-2 Device Controller

D-PHY

DSI Host Controller

D-PHY

I3C
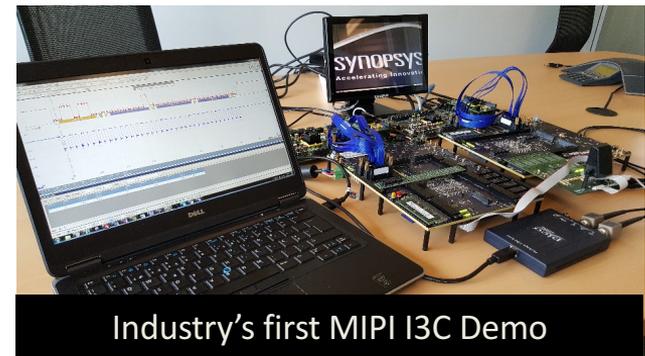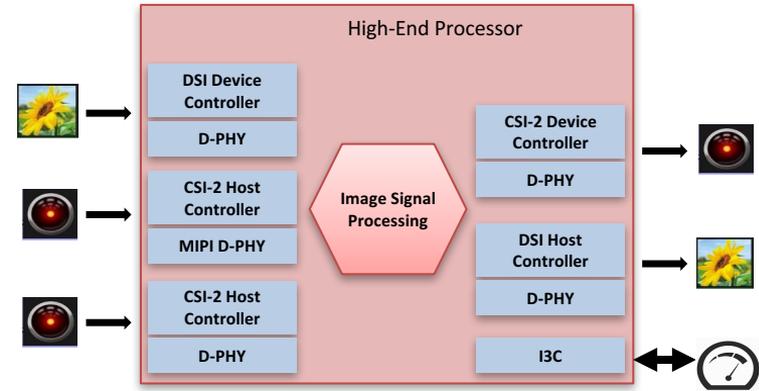
Industry's first MIPI I3C Demo

Synopsys® DesignWare® MIPI IP Portfolio

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