MIPI Alliance Automotive Interface Standards Development Update

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Sony

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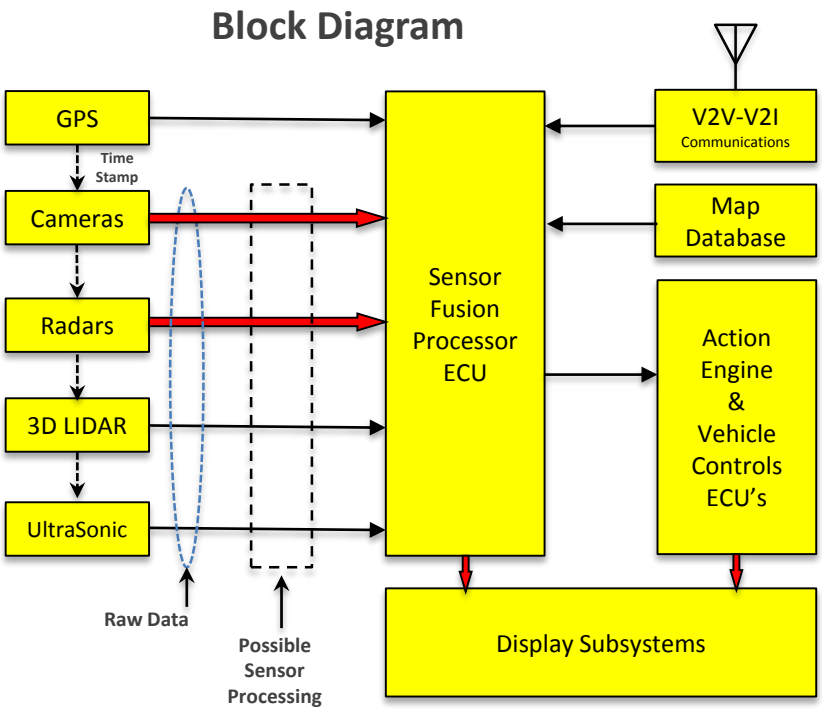
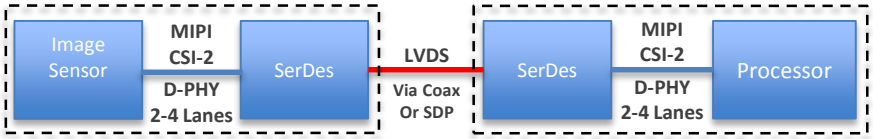
Autonomous Driving System



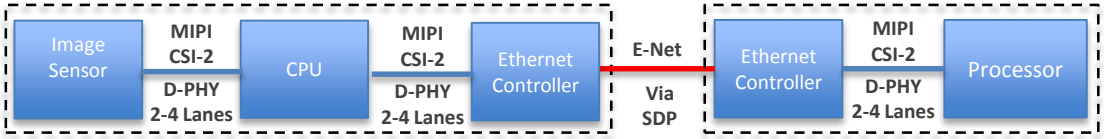
- Central Challenge - transport Raw Image Sensor &/or Radar Data to Fusion Processor, and Processor/other generated data to the Displays
- For Image Sensors, 10Gbps link could support:
  - RAW16 10MP 1 Max Exposure Channel @ 60fps
  - RAW 16 2MP 4 Max Exposure Channel @ 60fps
- For Radar, 12.5Gbps link could support:
  - Four "Typical" 4-RX-Channel (50MS/sec, 12b res)
  - Two "Max" 4-RX-Channel (80MS/sec, 16b res)
- For Display Subsystems, 16Gbps link could support:
  - Ultra-HD 3840x2160 24-bits/pixel RGB 4:4:4 60 Hz

Why MIPI for Automotive?

- MIPI can provide Auto OEMs with a Standard I/F, vs current incompatible proprietary LVDS solutions

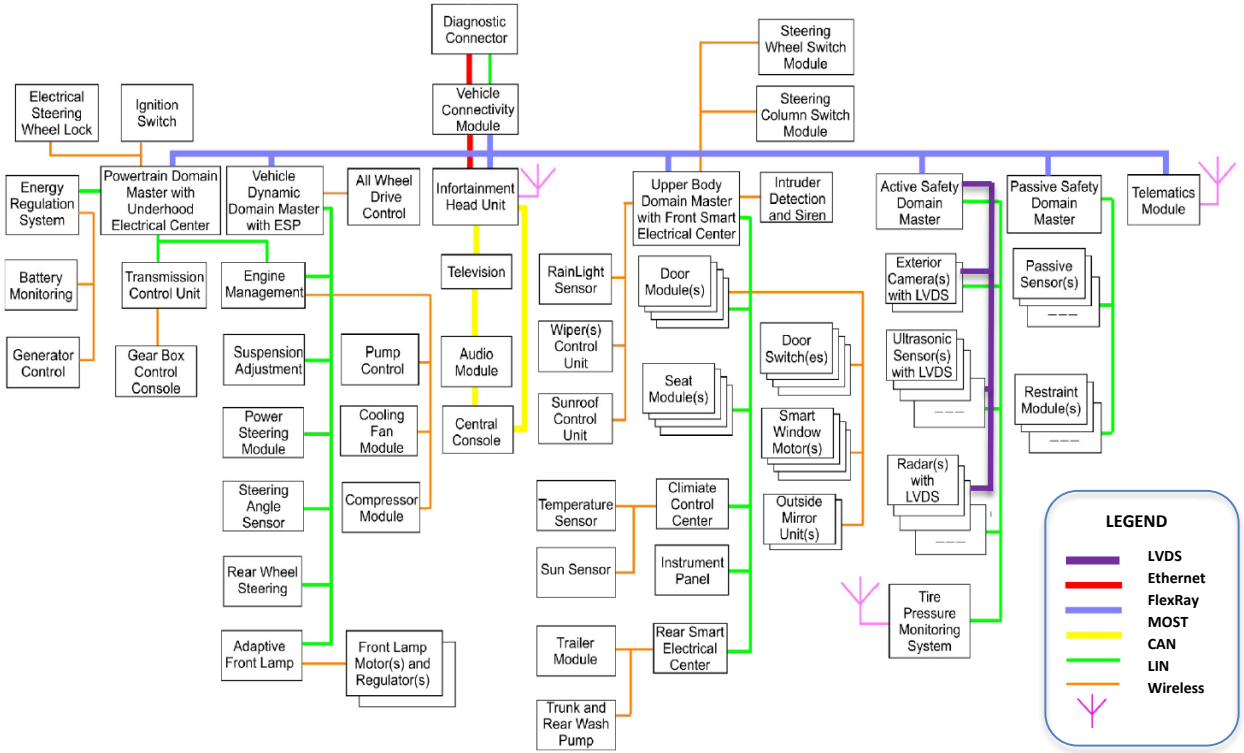


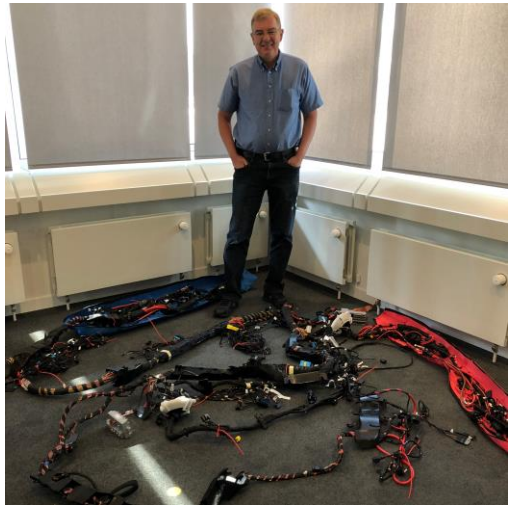
- MIPI Asymmetric & Low Complexity Automotive I/F's <u>complimentary</u> w/ Automotive Ethernet Solution



- High Market Growth, driving MIPI Member Interest. Leverage economies of scale: Mobile -> Automotive
- Physical Layer investigations using Auto Channels (<15m) as targets indicate technically feasible.
- Cautionary Points:
  - *MIPI Alliance Migration from Consumer to Automotive not trivial*
  - *MIPI Alliance not trying to replace existing auto network standards: Auto-E-Net, CAN, LIN, MOST, etc.*
  - *MIPI C/D-PHY, MIPI CSI-2, MIPI DSI currently short range – board level interface for automotive*

Automotive System Interfaces



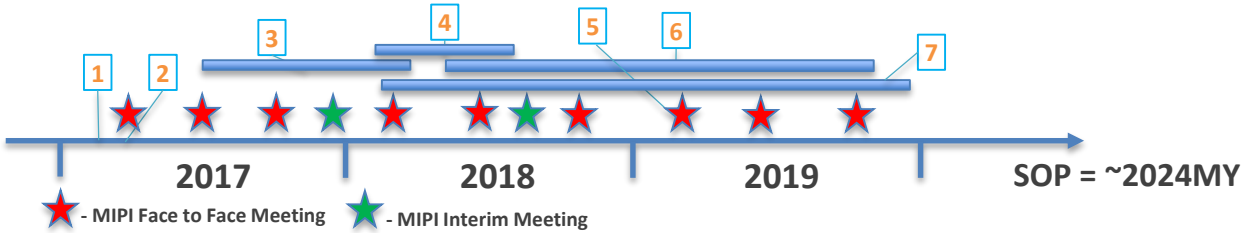


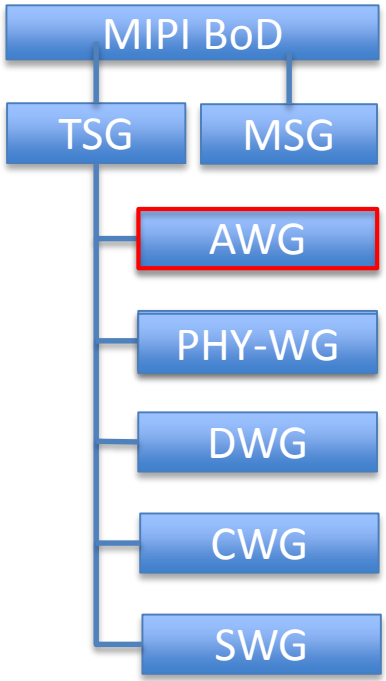
Example BMW Wiring Harness

Network Topology Graphic adapted from Zeng, Khalid, & Chowdhury IEEE Comm, VOL. 18, NO. 3, Q3-2016

MIPI Auto I/F Development Org & Timeline

1. MIPI Automotive Activities Started Jan. 2017
2. Req. Gathering Kickoff Barcelona F2F (March, 2017)
3. MIPI Auto sub-Group opened to non-members (invitations & BoF) for webex's June 2017 ~March 2018
4. MIPI Auto Req. Doc (ARD) to v1.0.1 releases Feb.~July 2018
5. MIPI ARD v1.1 Expected by Montreal FtF Meeting in Mar-19
6. MIPI A-PHY spec development April 2018~End 2019
7. Camera/Display WG protocol spec development 2018~19

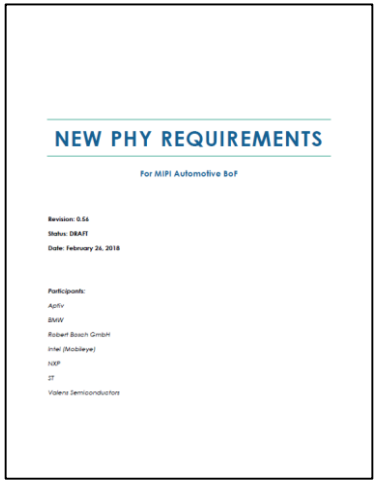




Not approved Org Chart

AWG Chair Team: Matt Ronning (Sony), Uwe Beutnagel-Buchner (Bosch), Michael Kaindl (BMW), Hugo Pereira Santos (Synopsys)

MIPI Automotive Requirements Document Progress



v0.56 Feb. 26, 2018

v0.8 March 28, 2018

v0.9 May 30, 2018

v1.0.1 July 21, 2018

- AWG Currently working on v1.1 of the Specification

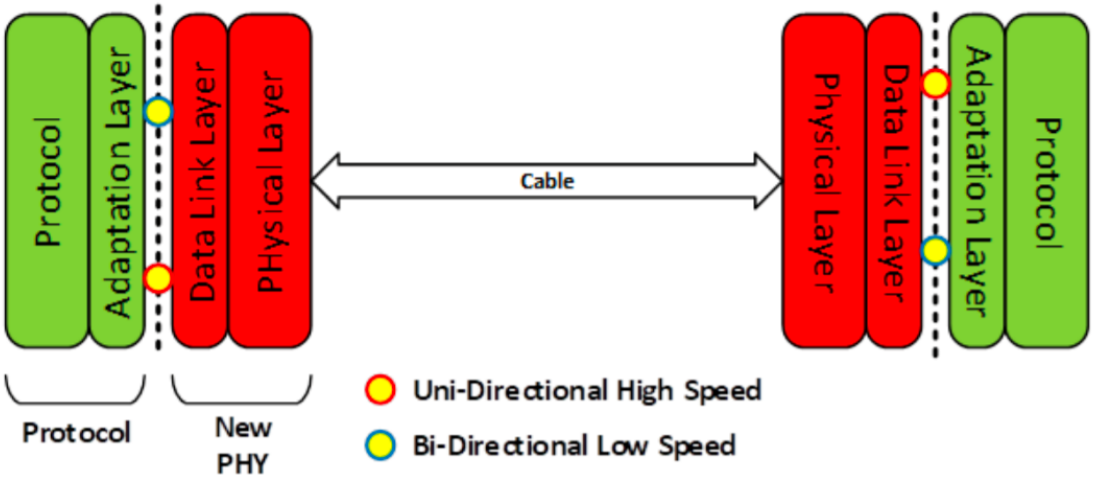
Automotive PHY Requirements Overview

Data and Power Logical Structure

- Focus is on High Throughput Data to & from the system CPU over high speed links with optimal wiring, cost and weight.
- The high speed data, control data, & optional power share the same physical wiring.

Automotive PHY Requirements Overview

High Level A-PHY Structure

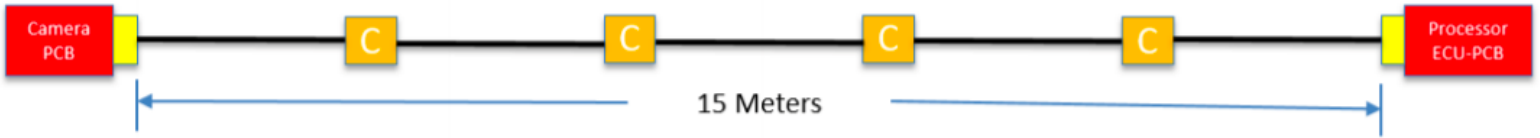


- A-PHY design shall include a generic Data Link Layer & shall accommodate different protocol adaptation layers (i.e. MIPI and non MIPI).
- A-PHY Use Cases include: Camera Module to ECU, Camera ECU to ECU, Lidar, Radar, Display including Touch & Controls, & A-PHY Links Over PCB Interconnect.

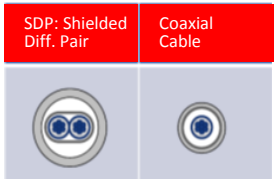
Automotive PHY Requirements Overview

Cable Type & Topology

MIPI Automotive Coax Topology “A”



MIPI Automotive STP/SPP Topology “B”



- Topology “A”: 50 Ω Coax cable up to 15 m, with up to 4 inline connectors with minimum segment of 30 cm.
- Topology “B”: 100 Ω SDP cable up to 10 m, with up to 4 inline connectors with minimum segment of 30 cm

Automotive PHY Requirements Overview

Channel Throughput

- Forward Channel Throughput & Gear Definition

Gear	Raw Data Rate	Effective Data Rate
1	≤ 2 Gbps	≥ 1.6 Gbps
2	≤ 4 Gbps	≥ 3.2 Gbps
3	≤ 8 Gbps	≥ 6.4 Gbps
4	≤ 12.5Gbps	≥ 10 Gbps
5	≤ 16 Gbps	≥ 12.8 Gbps

- Reverse Channel, which shall operate in full duplex with forward channel, shall support the following data rates:
  - Low Speed: 20 Mbps (Aimed for camera and sensors products)
  - High Speed: 100 Mbps (Aimed for display and touch-screen products)

Automotive PHY Requirements Overview

Miscellaneous Other Requirements

- Bit Error Rate shall be less than 10^{-12} for both data & control streams
- Latency (Data Link Layer to Data Link Layer) shall be less than 16 µSec
- Design shall support DC power over the data lines with a maximum current limit of 0.5 A
- System shall operate with GND voltage offsets of up to ±1.0 V
- A-PHY shall provide the following modes: Shutdown, Start-up, Active, Sleep, & Safe State
- The A-PHY Data Link Layer shall be agnostic to the higher-level protocols & with an overhead of 20% maximum
- Protocol Adaptation Layer shall MIPI protocols w/ minimal changes needed
- It shall be possible to aggregate multiple links for increased HS data BW
- A-PHY solution shall support BIST & System Diagnostics (eg. Link Quality)
- A-PHY shall support system designs at the ASIL D level according to ISO26262:2018
- System clock shall be both embedded & asynchronous (i.e. decoupled from data rate clock)
- System cabling shall meet certain IL, RL, & Coupling Requirements
- System operation shall be supported with specified Automotive EMC requirements.

Current Areas of Work

- Updating of Automotive Requirements Document to v1.1
- Derived Channel Requirements, including Noise & Interference
  - Including Testing of Coax: BCI (ISO11452-4), Fast Transient (ISO7637-2), RF Ingress (ISO11452-2), Coupling Attenuation (IEC62153-4-7), Aging; On PCB Alien XTALK for multiport connectors
- Link & Adaptation Layer Requirements
- Functional Safety Req's (ISO26262)
- Requirements for Higher Data Rate Interfaces: 16Gbps → 24Gbps
- Sensor Working Group (I3C) Discussions Starting

Additional Resources

- https://mipi.org/automotive
- https://mipi.org/groups/automotive-working-group