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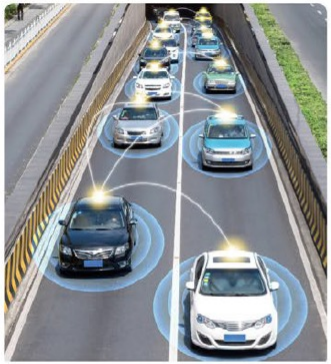
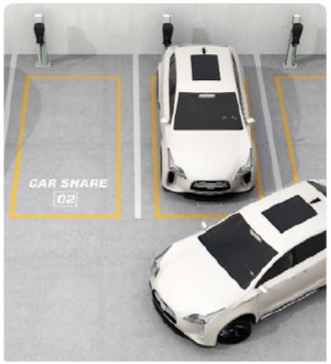
Latest Developments within MIPI Automotive SerDes Solutions (MASS)

Industry Trends Advancing Automotive Functional Safety and Security



Connected

Automated



Shared

Electrified

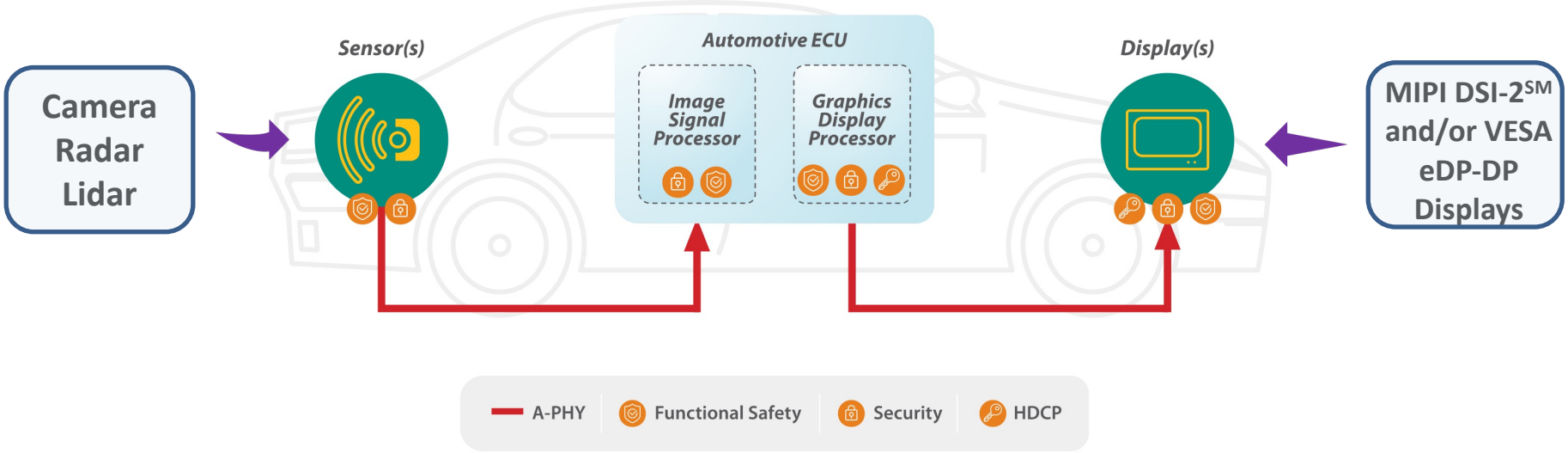
Figure 1 Automotive industry trends defined as "CASE". (Souce: MIPI Alliance)

MASS Functional Safety Application

Digital Side Mirror Replacement

MIPI Automotive SerDes Solutions (MASS)

Vision for Full SerDes Integration



Sensor and display endpoints with integrated long-reach connectivity (integrated A-PHY℠ SerDes) connect to the ECU without intermediate bridges. Application-level functional safety and security data protection. HDCP for protecting premium content.

ISO26262 Part 5: Product development at the Hardware Level

- ISO26262 automotive functional safety standard
  - Reference for automotive safety lifecycle
  - Automotive-specific risk-based analysis for Automotive Safety Integrity Levels (ASILs)
  - Uses ASILs to specific applicable requirements
- Part 5: Hardware level
  - Specification of hardware safety requirements
  - Evaluation of safety goal violations due to random failures
  - ***Annex D: informative guidelines for appropriate safety mechanisms***

ISO26262-5 Annex D – Communications Bus


INTERNATIONAL STANDARD

ISO 26262-5

Second edition 2018-12

Road vehicles — Functional safety —

Part 5: Product development at the hardware level

Véhicules routiers — Sécurité fonctionnelle —

Partie 5: Développement du produit au niveau du matériel

Reference number ISO 26262-5:2018(E)

ISO

Annex D – Communication bus safety mechanisms:

- One-bit hardware redundancy
- Multi-bit hardware redundancy
- Read back of sent message
- Complete hardware redundancy
- Inspection using test patterns
- Transmission redundancy
- Information redundancy
- Frame counter
- Timeout monitoring
- Combination of information redundancy, frame counter and timeout monitoring

Adding Service Extensions Packets (SEPs)

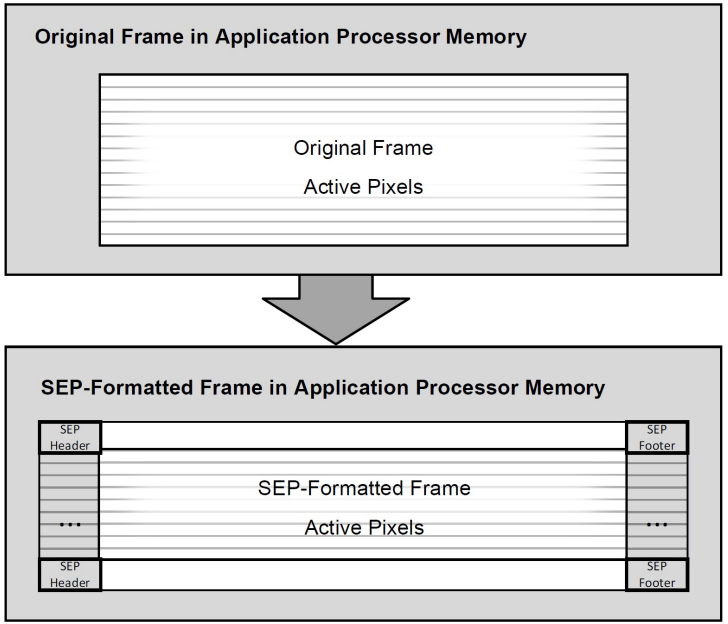


Figure 23 SEP Formatting in the Display Source

MIPI DSE℠ v1.0, MIPI PAL℠/DSI-2℠ v1.0

C.1 Converting DSI-2 Long and Short Packets to SEP

Figure 20 illustrates conversion from a DSI-2 Long Packet to SEP carried within DSI-2 Long Packet.

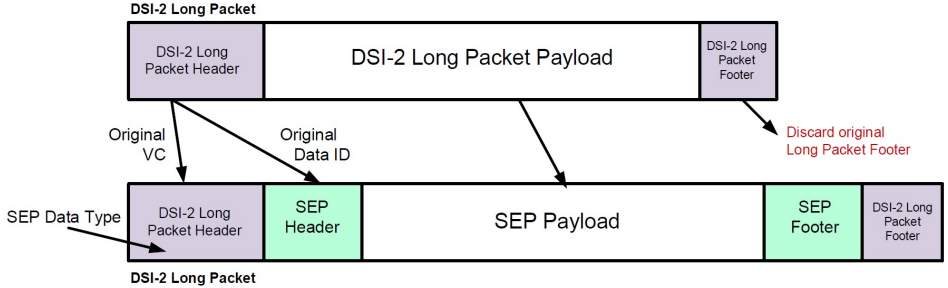


Figure 20 Converting DSI-2 Long Packet to SEP Within DSI-2 Long Packet

Figure 21 illustrates conversion from a DSI-2 Short Packet to SEP carried within DSI-2 Long Packet.

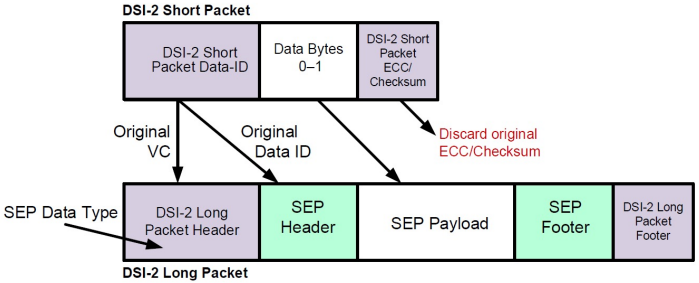


Figure 21 Converting DSI-2 Short Packet to SEP Within DSI-2 Long Packet

MIPI DSE℠ v1.0, MIPI PAL℠/DSI-2℠ v1.0

MASS Display Services Extension (DSE 1.0)
Services Extensions Protocol (SEP) Header and Footer

- eDT – extended Data Type
  - CSI, DSI
  - VESA eDP/DP
- Message Counter
- CRC-32
  - Hamming distance of 3 or more

Table 1 SEP Packet ePH Blocks: Overview

Bits	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ePH[0]	R	eVC							eDT								R	ePFEN	Reserved						ePHEN							
ePH[1]	Reserved																SEP Payload Length															
ePH[2]	Service Descriptor								Reserved								Message Counter															
ePH[3]	Reserved																															
ePH[4]	Reserved																															
ePH[5]	HDCP streamCtr[31..0]																															
ePH[6]	HDCP InputCtr[31..0]																															
ePH[7]	HDCP InputCtr[64.32]																															

Table 2 SEP Packet ePF Blocks: Overview

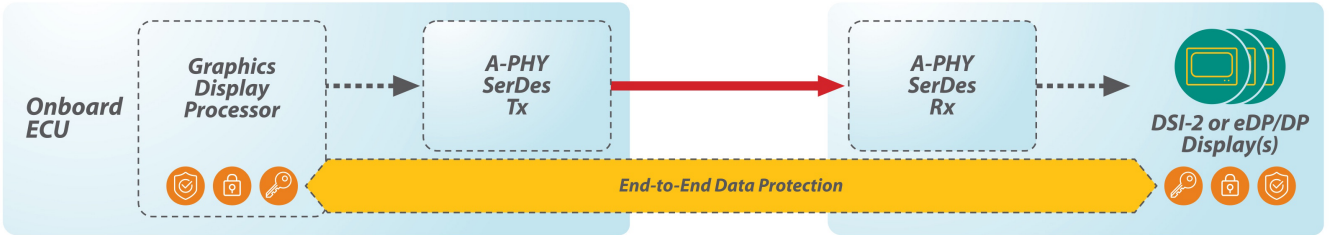
Bits	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ePF[1]	Reserved																															
ePF[0]	CRC-32																															

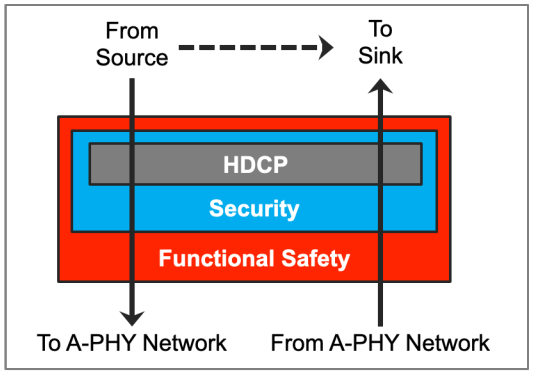
MIPI DSE℠ v1.0

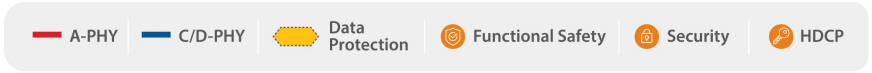
Incorporating Solutions for Data Protection

Bridge-to-Bridge Data Protection

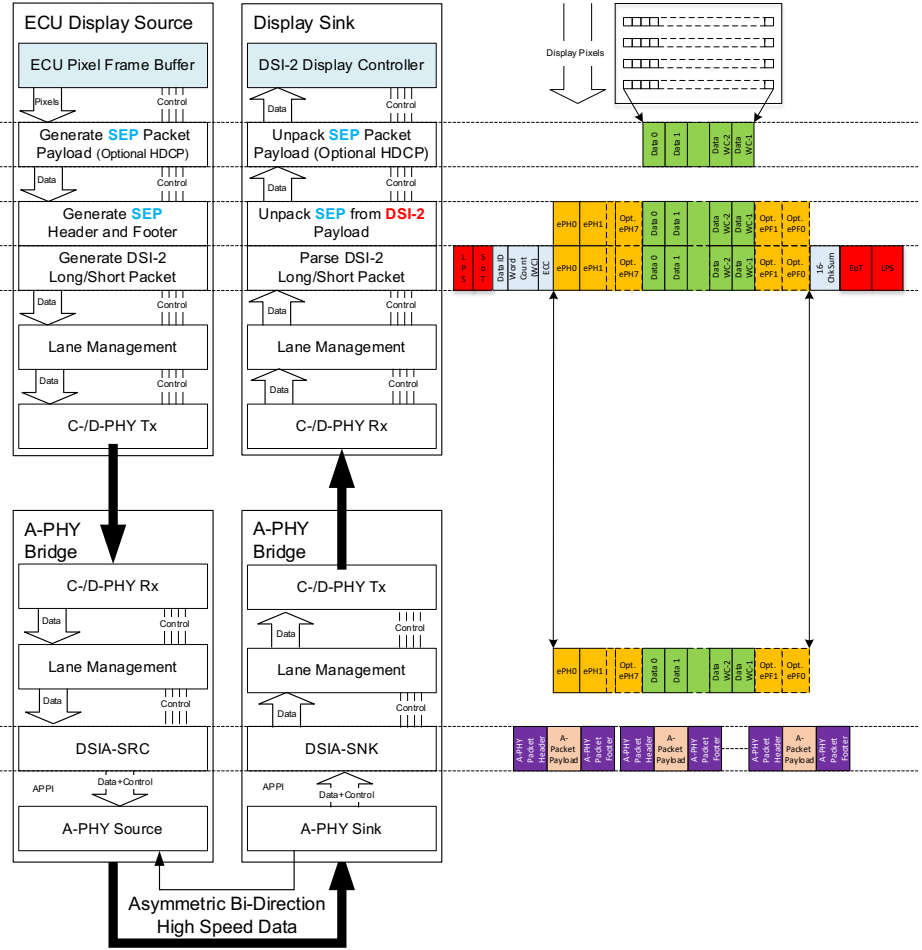
End-to-End Data Protection (Integrated SerDes)



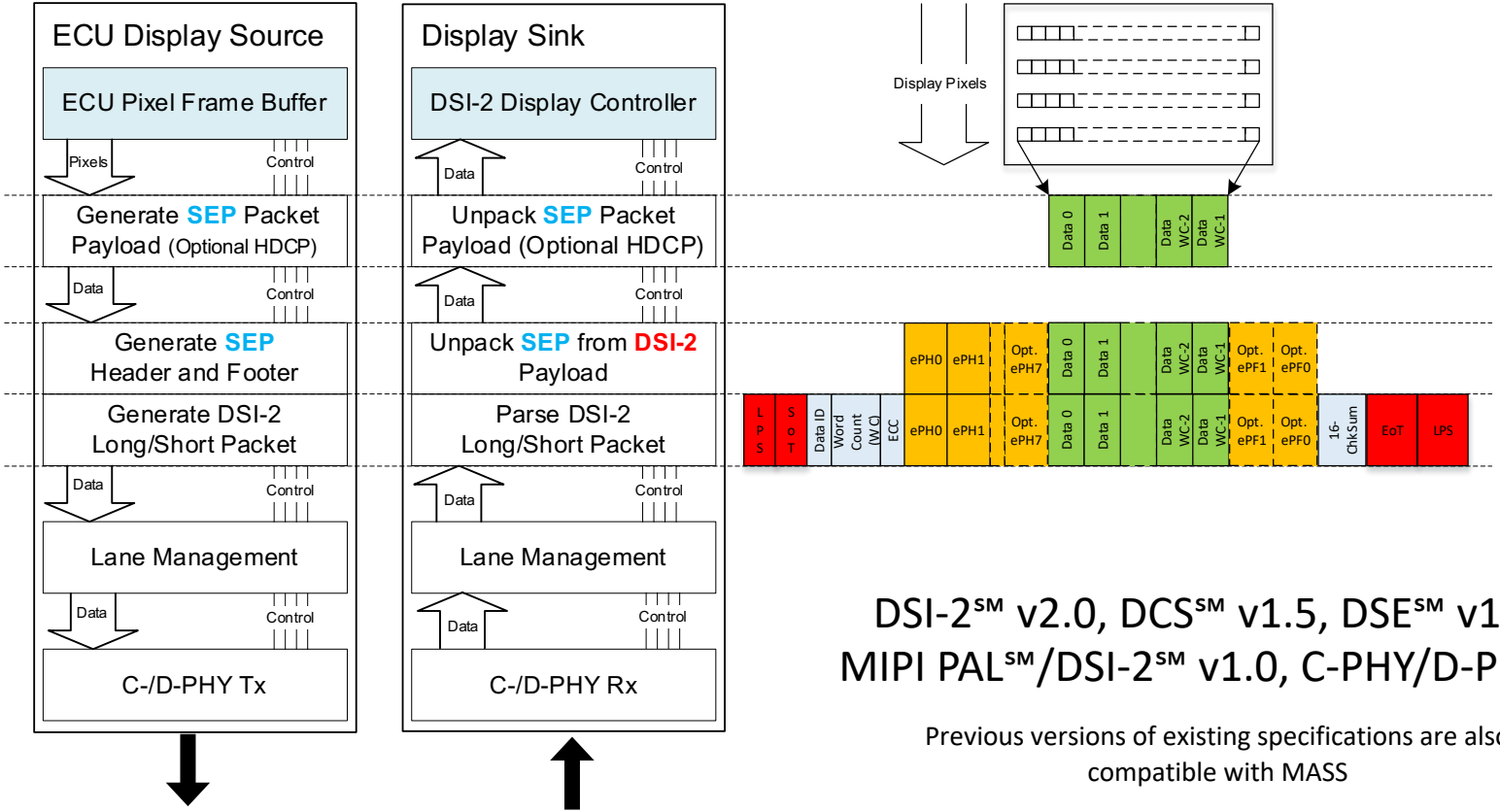




Detailed Display Protocol Stack



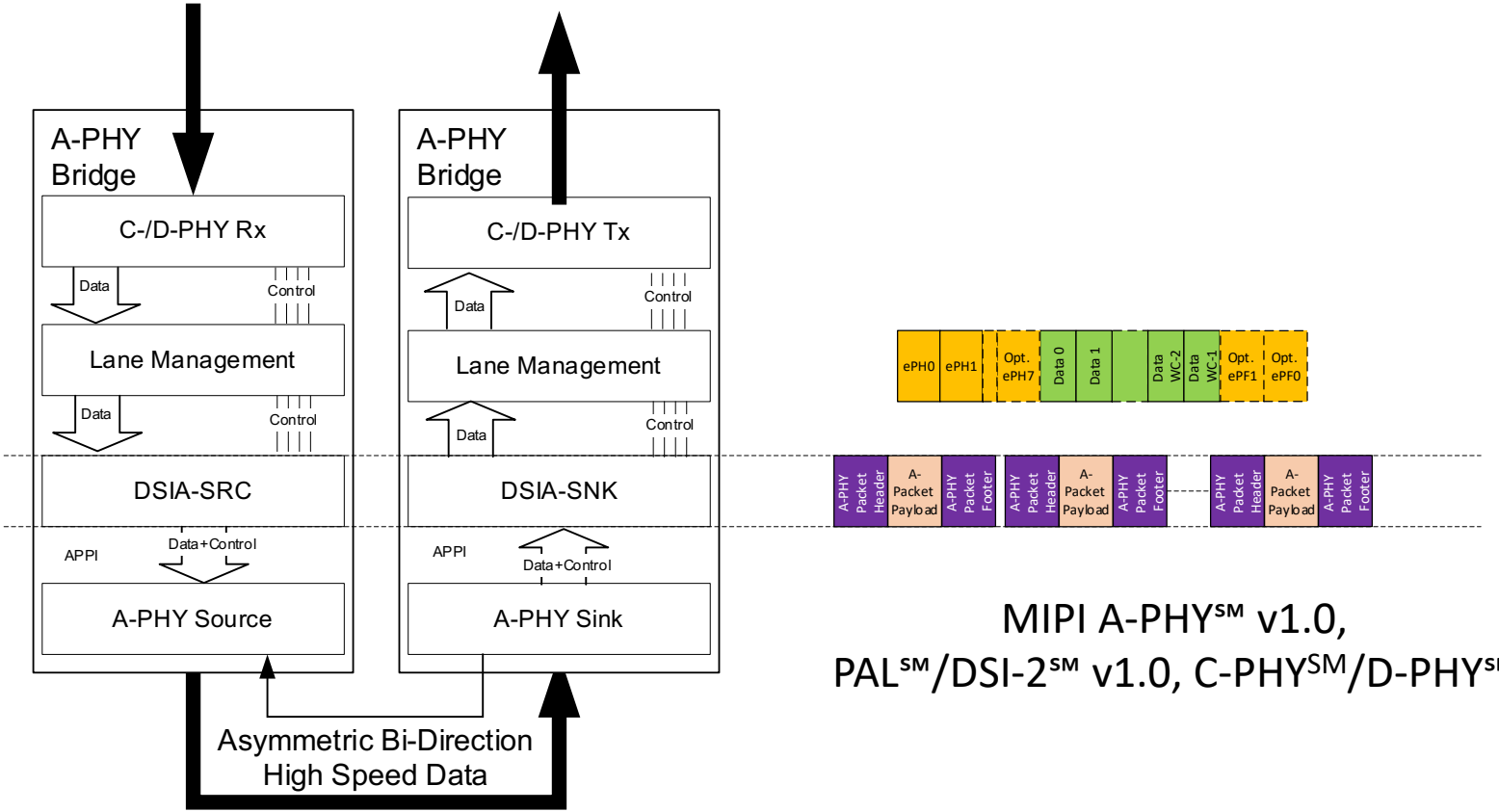
ECU Display Source and Sink



DSI-2℠ v2.0, DCS℠ v1.5, DSE℠ v1.0,
MIPI PAL℠/DSI-2℠ v1.0, C-PHY/D-PHY℠

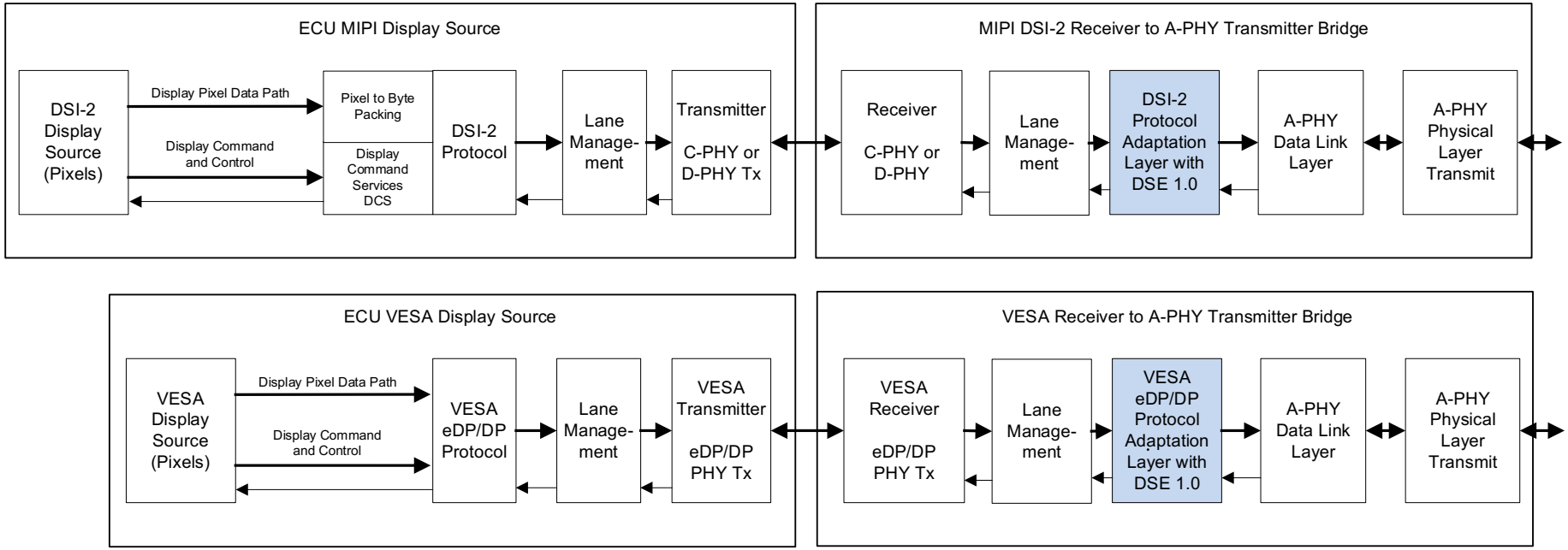
Previous versions of existing specifications are also compatible with MASS

Detailed A-PHY Bridge PAL

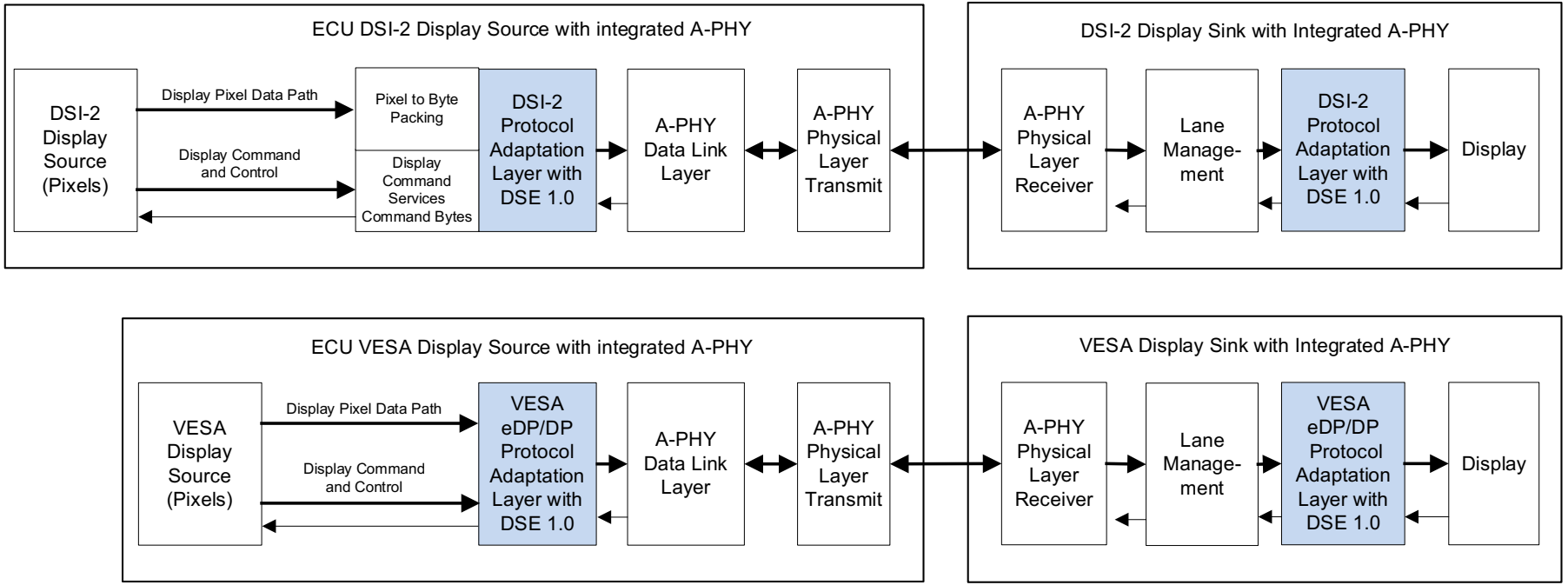


MIPI A-PHY℠ v1.0,
PAL℠/DSI-2℠ v1.0, C-PHY℠/D-PHY℠

MASS Legacy ECUs with an External A-PHY Bridge

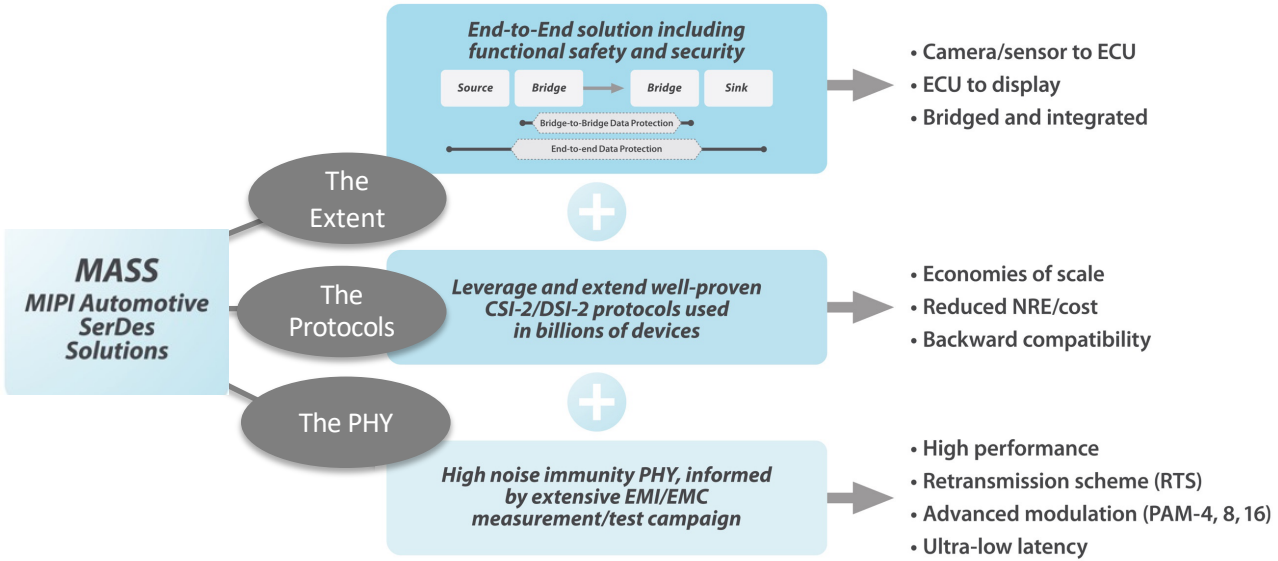


MASS New ECU with Integrated A-PHY

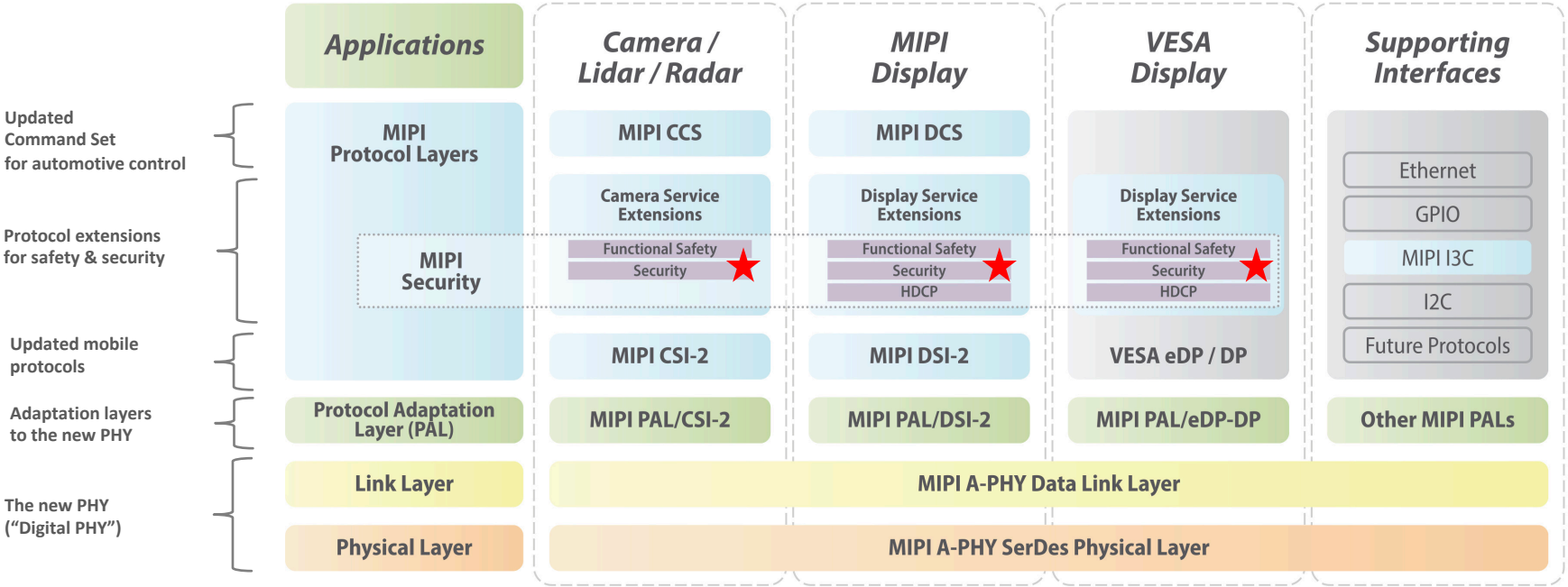


Security within the MASS Guiding Principles

- MASS Guiding Principles
  - The Extent
  - The Protocols (CSI-2^{SM}, DSI-2^{SM})
  - The PHY (A-PHY^{SM})
- MIPI Security is implemented as extensions to CSI-2 and DSI-2 protocols.
- This enables the Security to achieve an “end-to-end” extent, or reach.



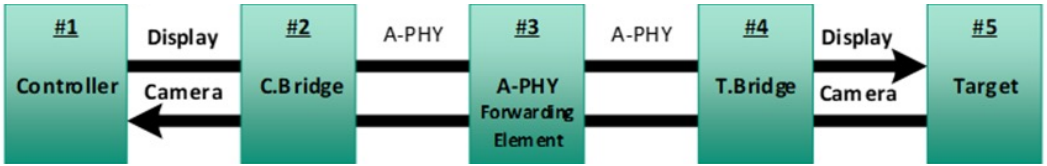
MASS Collection of Specifications



★ Primary current developments:
- MIPI CSE℠, MIPI DSE℠ specifications add security with target completion mid-2022.

High-Level System and Security Requirements

- Security includes:
  - Device authentication, message integrity, confidentiality (encryption).
- We refer to data protections according to the MIPI 1:5 Model shown below (more on next page).
- Security is managed by the Controller engaging with each Component 1:1, this is not a “peer-to-peer” model of security (n-to-m)
- For example:
  - Display security may be initiated from #1 or #2 and terminated in #4 or #5.
  - Camera security may be initiated from #5 or #4 and terminated in #2 or #1.



MIPI 1-5 Topology Model

MASS System Model: The 1:5 Model

Security Model Components

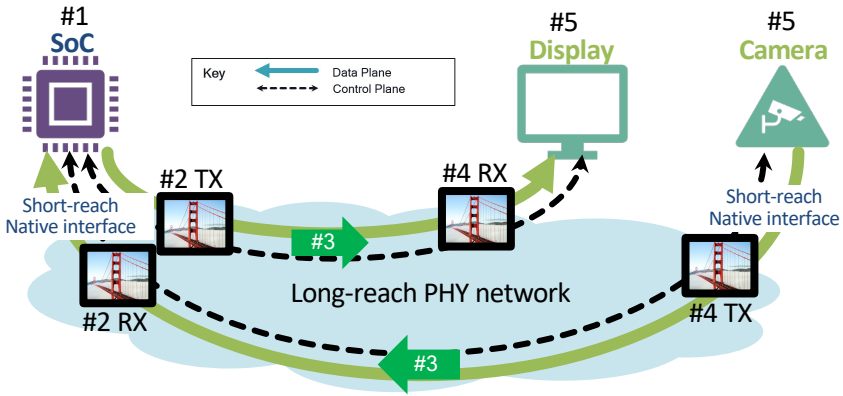
- #1: Controller (SoC)
- #2: Controller Bridge (C.Bridge)
- #3: Forwarding Element (aka Repeater)
- #4: Target Bridge (T.Bridge)
- #5: Target (Camera or Display)

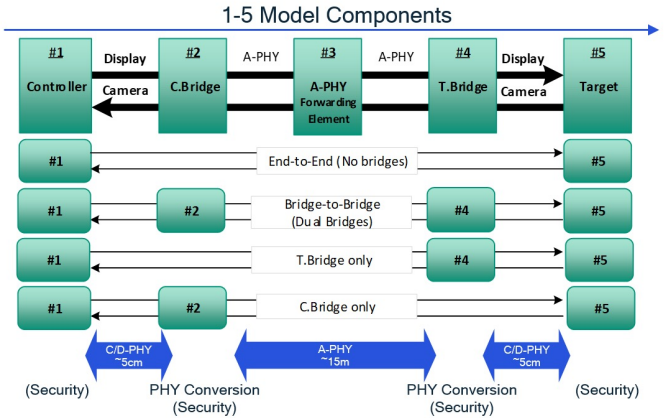
Security Requirements

- Device Mutual Authentication (SoC as Root-of-trust)
- Message Integrity (MAC)
- Confidentiality (encryption)

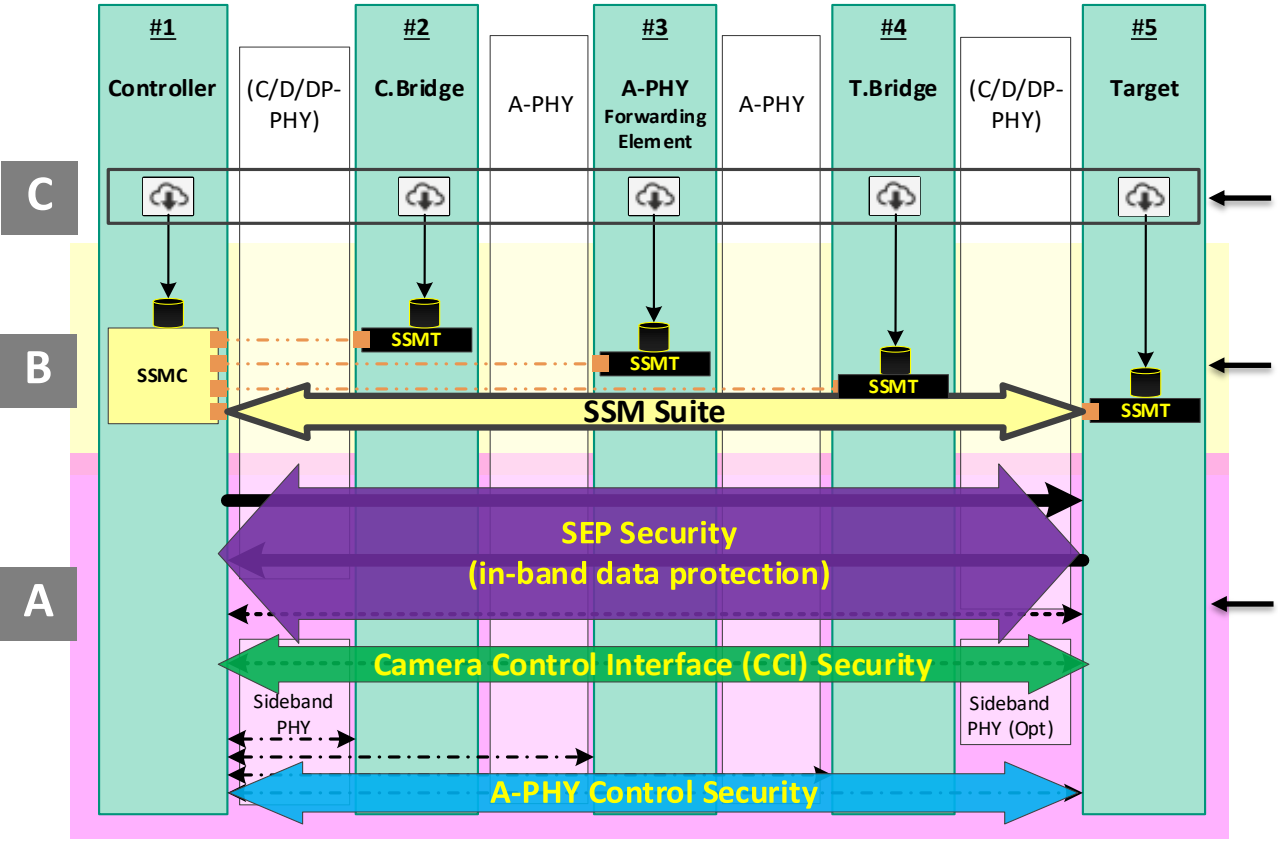
System Requirements (End-to-end)

- Multiple system topologies (e.g., 15, 1245, 145, 125)
- End-to-end extent via protocol extensions
- Security for Data plane, and Control plane in-band/sideband
- Highly flexible operation, such as Heterogenous operation for displays, supporting DSI-2 and DP on a daisy chain.





MIPI Security Framework



C-Level provisions authentication credentials (an Integrator function)

B-Level (SSMC, System Security Management Controller) manages the capabilities, algorithms, and session keys.

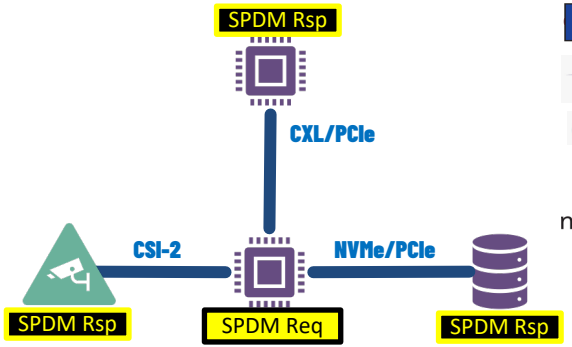
A-Level executes the data protection under control of the **B-Level**.

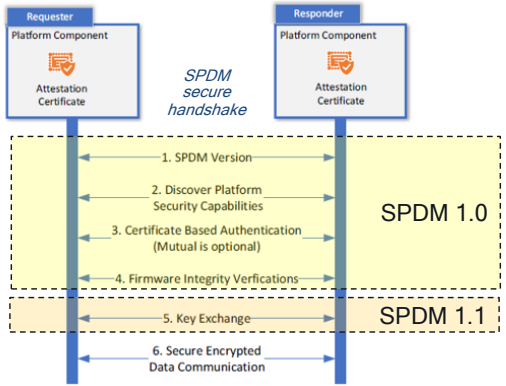
- SEP provides in-band data plane security
- CCI and A-PHY security are also provided.

MIPI Security leverages DMTF.org SPDM Spec

SPDM: Security Protocol & Data Model

- DMTF now used within multiple Org specs
  - PCI-SIG, CXL, NVMe, and MIPI
- SPDM – Modeled after TLS.
  - Fundamentally used to establish authenticated session keys
    - **KEY_EXCHANGE** flow: based on certificates and/or raw public keys
    - **PSK_EXCHANGE** flow: based on PSKs, no DHE, constrained devices
  - Session-key keys can then be used to secure data.
- SPDM messages are carried across DSI-2, CSI-2 and CCI (I2C) to protect each transport individually.

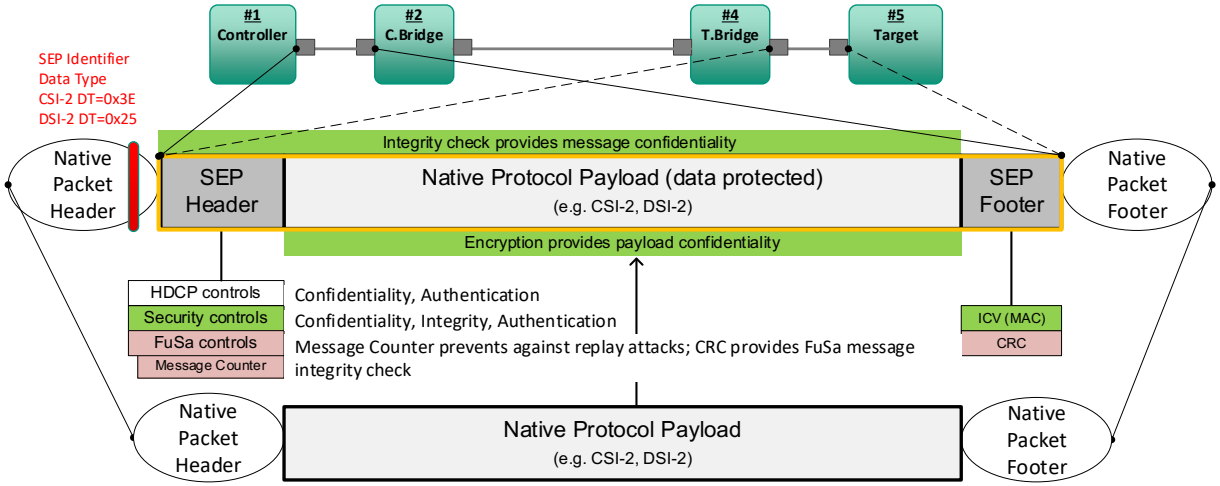




MIPI SEP Format (Service Extensions Packet)

SEP Format consists of a SEP Header and SEP Footer that encapsulate the payload, where:

- Header identifies all security controls
- Footer includes the MAC (and CRC for functional safety).
- The payload nominally consists of a single CSI-2/DSI-2 packet and may be transmitted immediately.



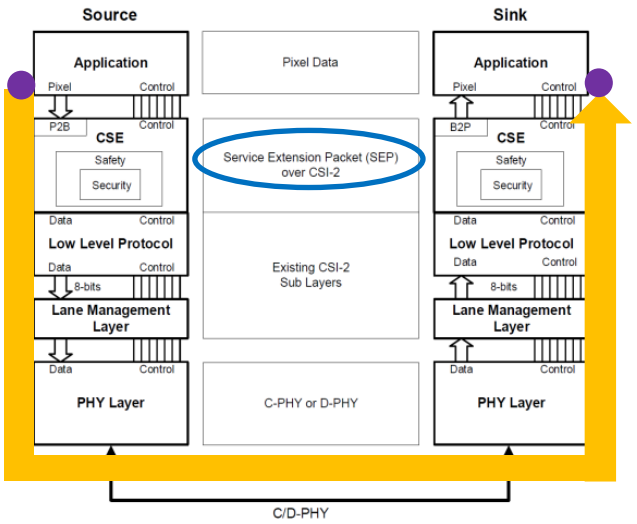
SEP Data Protection

End-to-End Application-Level Safety & Security

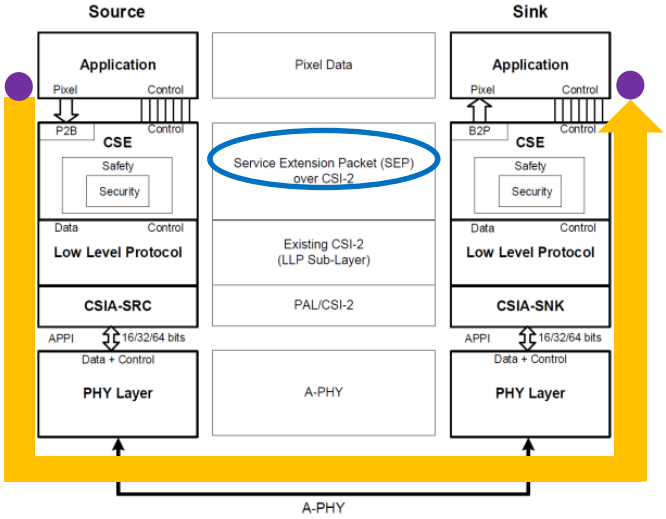
MIPI leverages TLS security principals and places the MIPI Service extensions at the application layer source/sink.

- Essentially as “end-to-end” as possible, from the pixel-source to the pixel-sink.

Safety & Security over Native C/D-PHY



Safety & Security over A-PHY



Summary

- The MASS specifications provide functional safety solutions for automotive cameras and displays within the first versions of MIPI CSE and DSE.
  - These specifications are complete and available to MIPI members.
- The CSE v1.0 and DSE v1.0 specifications are being updated to support security (device authentication, message integrity and optional encryption) over MIPI CSI-2, DSI-2 and CCI (I2C) sideband.
- Placement of security *in the CSI-2/DSI-2 protocols* allows end-to-end data protection with or without intermediate bridges.
  - This allows application layer security like TLS, contrasted to link layer security like MACsec.

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THANK YOU!