„Unifying Automotive Zonal E/E Architectures"

IEEE ISAAC Study Group Meeting, September 14, 2023

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Introduction

This Study Group is called „Ethernet for Automotive Imaging Sensors". However, there are more applications within Automotive that can benefit of an efficient asymmetric automotive Ethernet

This presentation wants to

- Show other automotive applications besides cameras that could benefit of an energy efficient asymmetric automotive Ethernet
- Highlight differences and similarities relative to the camera use-cases and derive basic requirements
- Address the industry's needs for migrating towards asymmetric Automotive Ethernet

The presentation does not aim to be all-embracing, nor covering all technical details. It aims to give an overview of automotive architecture transition and how this impacts the choice of communication technologies

Contributions

Authors:

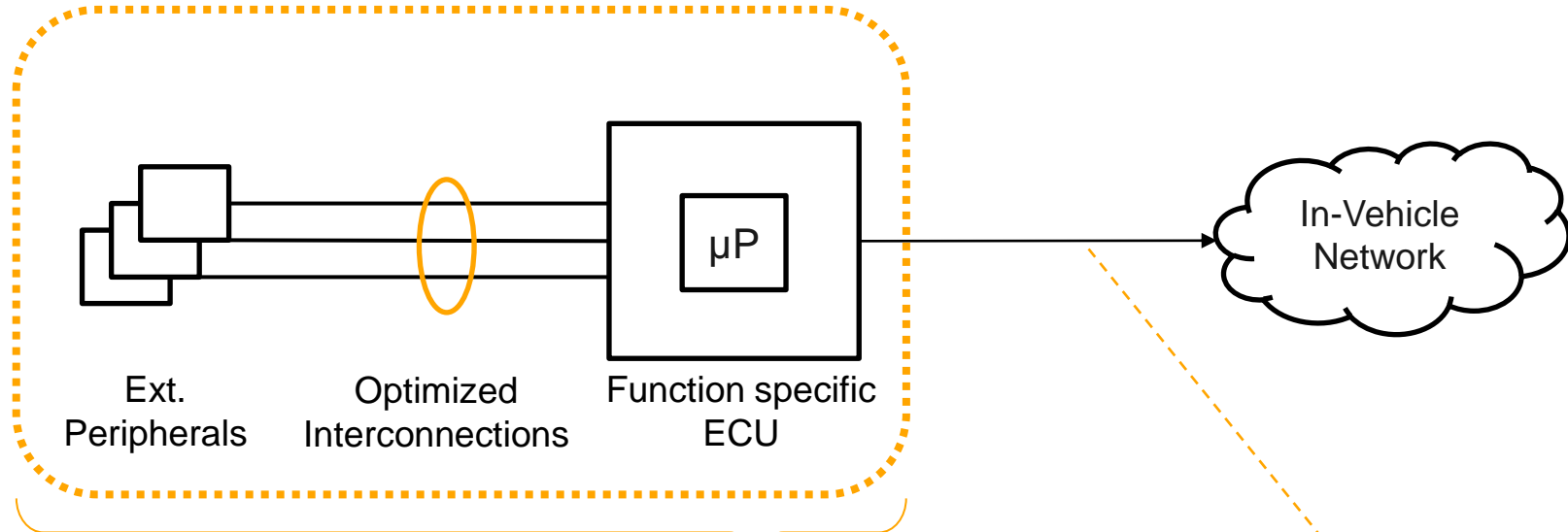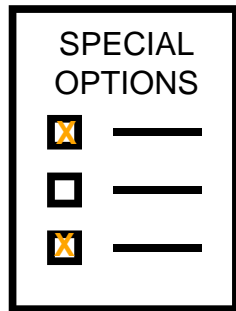› Christoph Arndt – Continental Automotive Technologies GmbH

Contributors:

› Daniel Hopf – Continental Automotive Technologies GmbH

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Supporters:

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Zonal transformation
A migration towards Ethernet and a story of legacy hardware

SPECIAL OPTIONS

Ext. Peripherals — Optimized Interconnections — Function specific ECU — μP

In-Vehicle Network

A tickmark in a checkbox for a special option…

…translates into the installation of a subsystem, specifically designed and optimized to provide the wanted application.

The subsystem is connected to the rest of the vehicle with a common bus system.

Most recently this has been Ethernet in many cases.

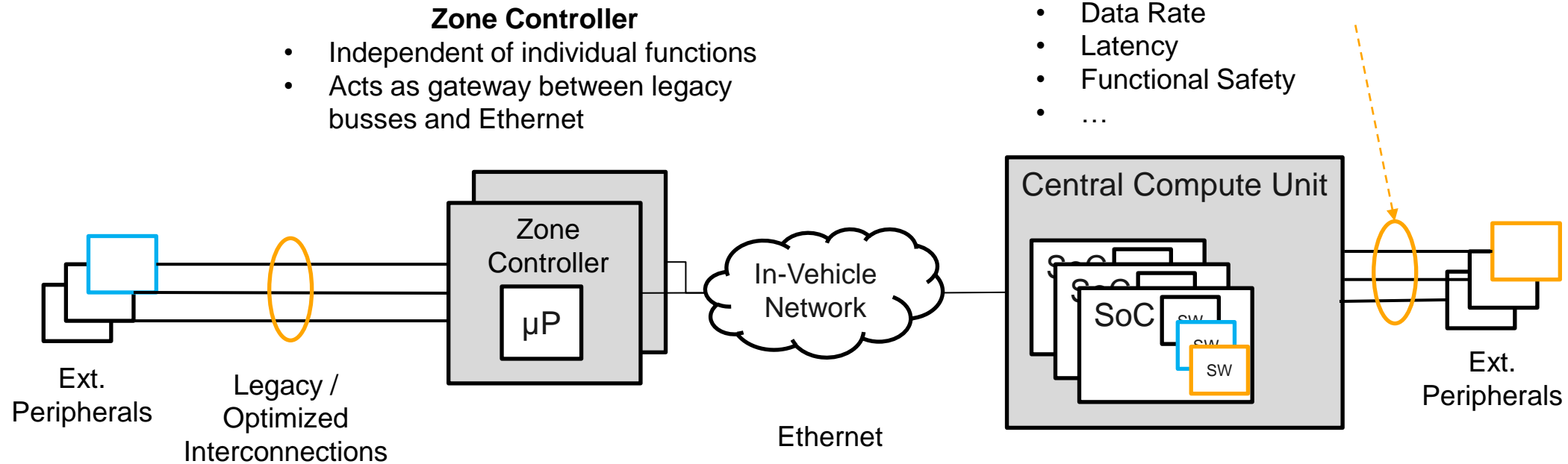Legacy In-Vehicle Architectures are the result of multiple special options tick-marked.

Zonal transformation
A migration towards Ethernet and a story of legacy hardware

Point-to-point connections to central compute units
Some peripherals remain directly connected because:
- It is already existing legacy periphery
- The application has special requirements in terms of
  - Data Rate
  - Latency
  - Functional Safety
  - …

Zone Controller
- Independent of individual functions
- Acts as gateway between legacy busses and Ethernet

Ext. Peripherals

Legacy / Optimized Interconnections

Zone Controller

μP

In-Vehicle Network

Ethernet

Central Compute Unit

SoC

SW

SW

SW

Ext. Peripherals

Zonalization is an evolutional process leading to a mixture of legacy and new network designs

SoC – System on Chip: A powerful processor, typically derived from the mobile industry with special interfaces for connecting cameras and driving displays
μP – Microprocessor: A powerful microcontroller, typically optimized for automotive with various automotive specific I/Os and bus-interfaces
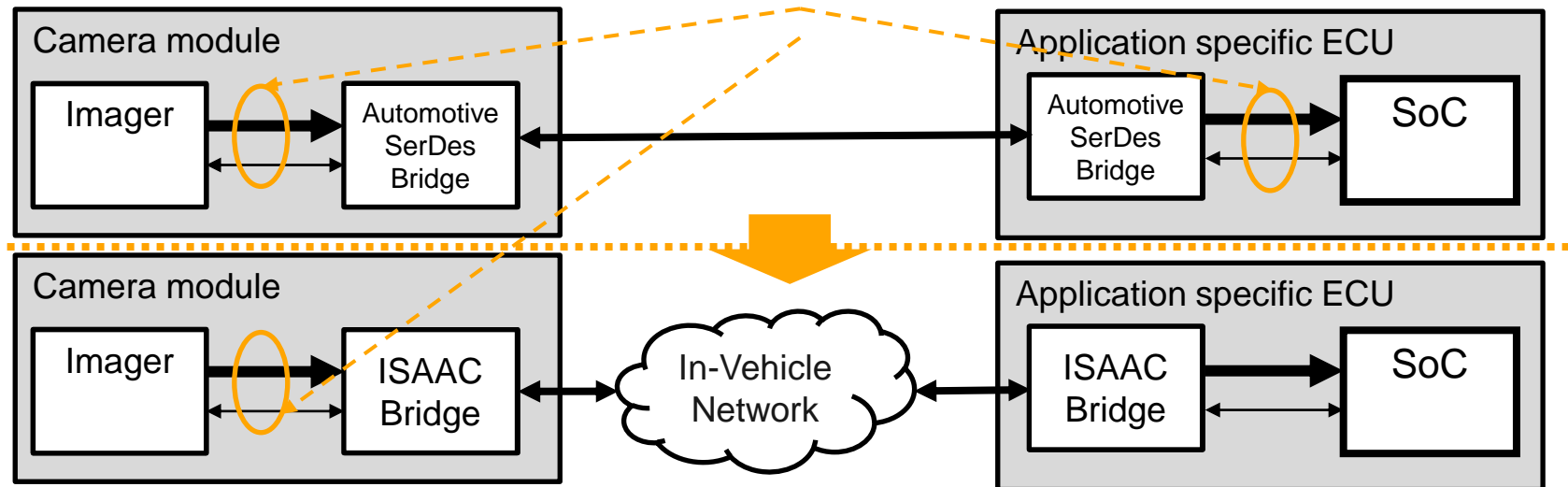
Asymmetrical Automotive Applications
Camera

In the presentation „*What does the evolution to zonal architecture need?*" by Kirsten Matheus, the block diagram of a camera system is already well covered:

https://ieee802.org/3/ISAAC/public/082823/20230825_Matheus_GoingZonal_verA.pdf

Camera Imager Interface
- Downstream e.g. MIPI CSI-2/D-PHY
- Upstream e.g. I2C

The change inside the ECUs must be as little as possible. Additional processors are undesirable

ECU – Electronic Control Unit
SoC – System on Chip: A powerful processor, typically derived from the mobile industry with special interfaces for connecting cameras and driving displays
MIPI CSI-2/D-PHY – MIPI standardized Camera Serial Interface

Asymmetrical Automotive Applications
Radar
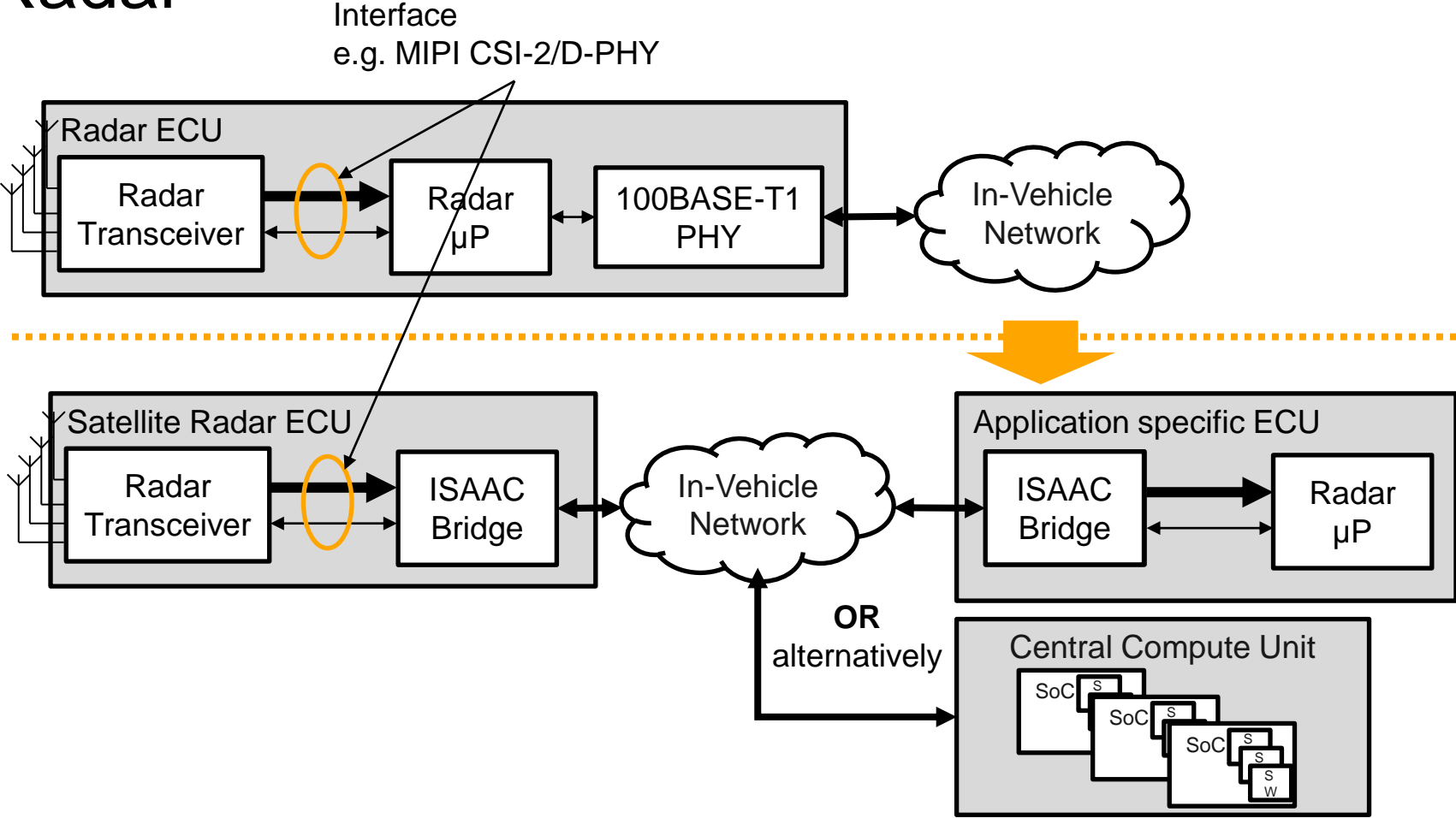
Standalone Radar ECU
All-in-one Box:
- Signal generation and transmission
- Signal reception, processing and object detection
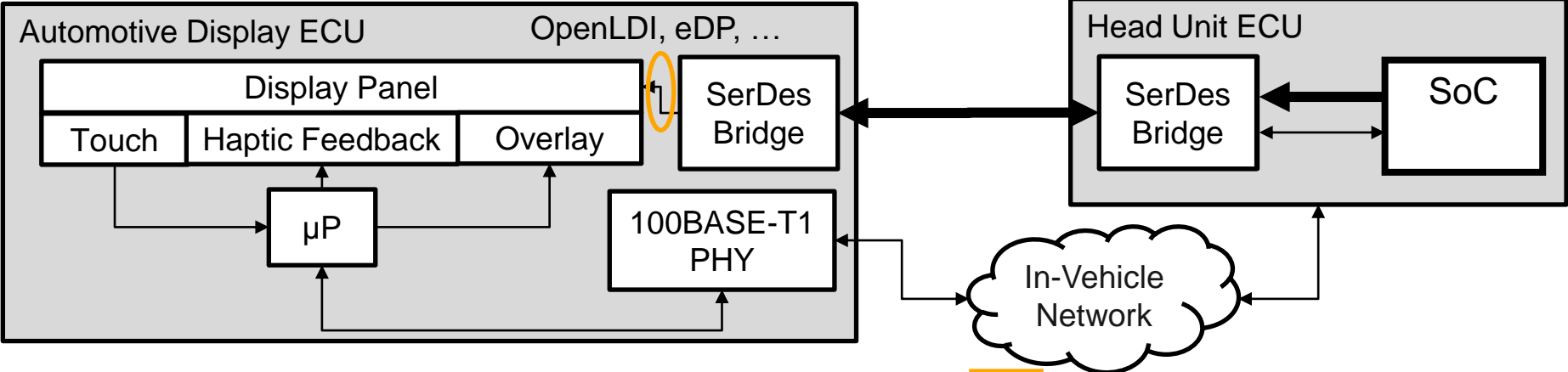
Satellite Radar
- Signal generation, transmission and reception in the satellite
- Signal processing and object detection in a separate unit

The satellite ECU should be kept as minimalistic as possible with no additional processors

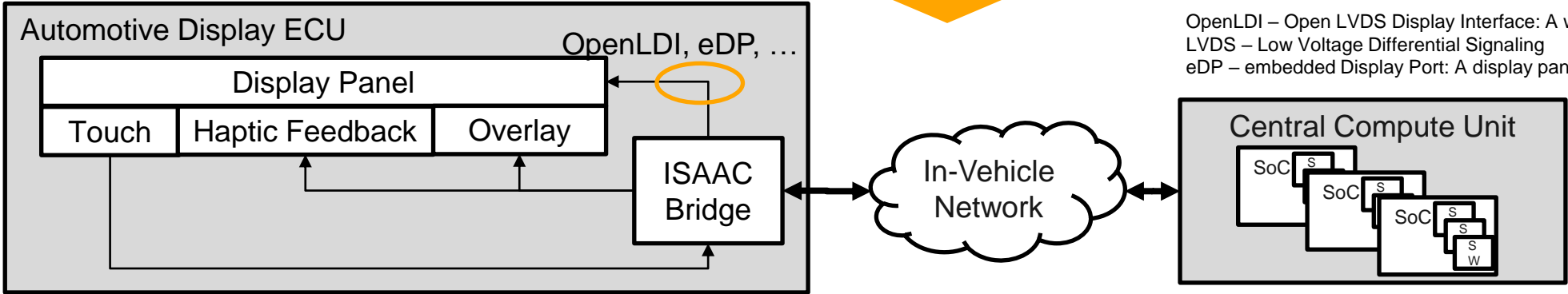MIPI CSI-2/D-PHY – MIPI standardized Camera Serial Interface

Asymmetrical Automotive Applications
Display

Automotive Display

- Display content is transmitted point-to-point
- Display "peripherals" like touch, haptic feedback, indicators etc. are exchanged via In-Vehicle Network (e.g. CAN or Ethernet)

OpenLDI – Open LVDS Display Interface: A widespread interface for display panels
LVDS – Low Voltage Differential Signaling
eDP – embedded Display Port: A display panel interface

Display applications would need specific bridging chipsets

Basic requirements of presented applications

	Camera	Radar	Display
Location	Interior & Exterior	Exterior	Interior
Housing	Very small	Very Small	Large
Chip temperature rating	125 °C	105 °C	105 °C
Overall power consumption	Ca. 2 ... 5 W	Ca. 5 … 25 W	Up to ca. 100 W for large displays
Data rate downlink	0.5 … 10 Gbit/s, potentially rising	1 … 10 Gbit/s	Some would exceed 25 Gbit/s - content compression can reduce this approximately by factor 3
Data rate uplink	< 100 Mbit/s	< 100 Mbit/s	< 1 Gbit/s
Latency requirements	N/A	< 1 ms	N/A
Security	Authentication + Encryption	Authentication + Encryption	Encryption

> Low power consumption is crucial for all these applications to add as little as possible to the already high ECU internal temperatures

> With TSN, Ethernet has the potential to cover many application specific requirements

Remote Power Supply
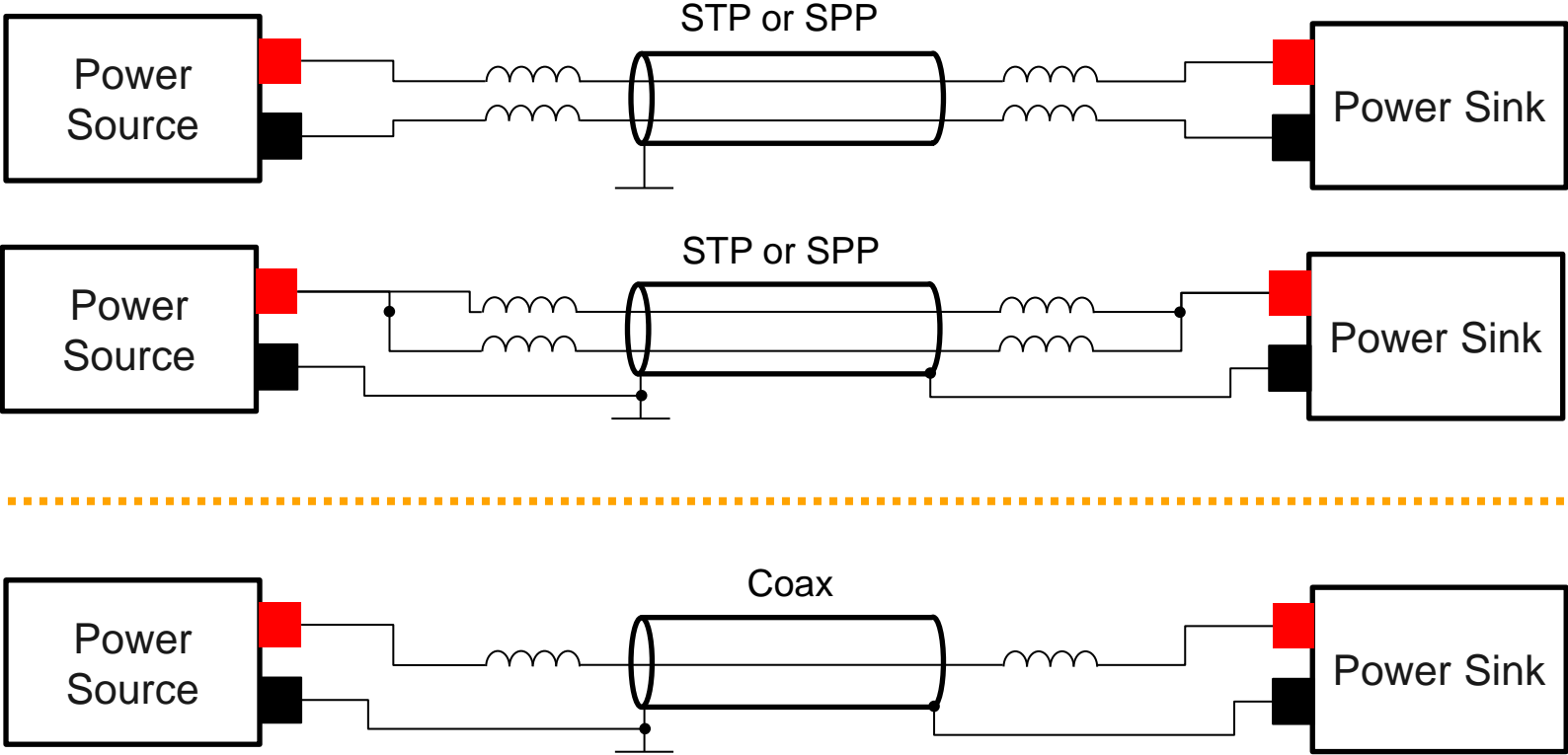
STP – Shielded Twisted Pair / SPP – Shielded Parallel Pair

Thank you!