# On the Pros and Cons of adding 1Gbps Downstream data rate

## Contribution to 802.3 ISAAC Study Group

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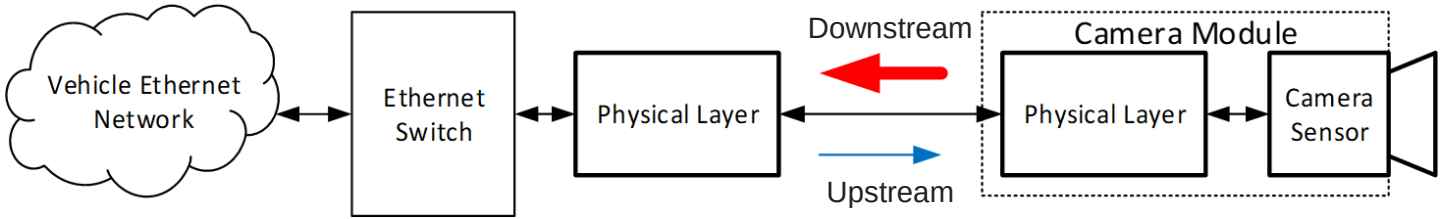
# Introduction

- All camera applications supported by 1Gbps downstream can be supported by 2.5Gbps downstream or existing 1Gbps symmetric Ethernet
- Adding support for 1Gbps downstream will potentially provide minuscule relative cost saving on camera side and increase relative cost of multi-mode PHYs on network side
- Adding support for 1Gbps downstream can potentially provide some minimal power saving, mainly on the network side, but will increase complexity of qualification and provisioning the camera network
- Adding support for 1Gbps downstream will potentially add complexity in standards development

# Network vs Camera Side



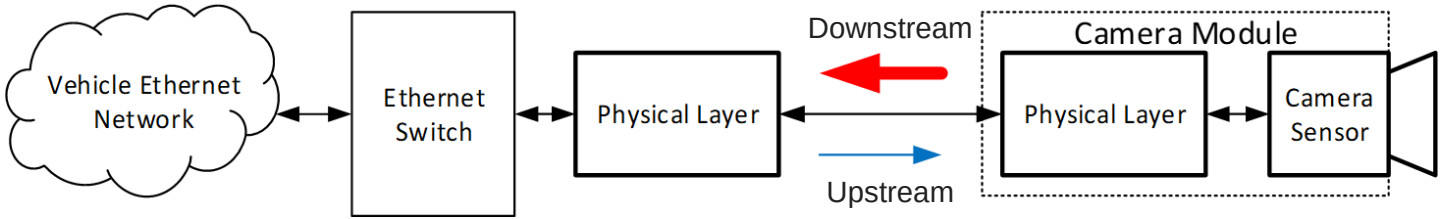

## Network Side:

- Transmitting at 10-100Mbps
- Receiving 2.5-10Gbps (1-25Gbps)
- **Ethernet integration is key**

## Camera Side:

- Transmitting at 2.5-10Gbps (1-25Gbps)
- Receiving 10-100Mbps
- **Cost and heat/power are key**

# Network vs Camera Side



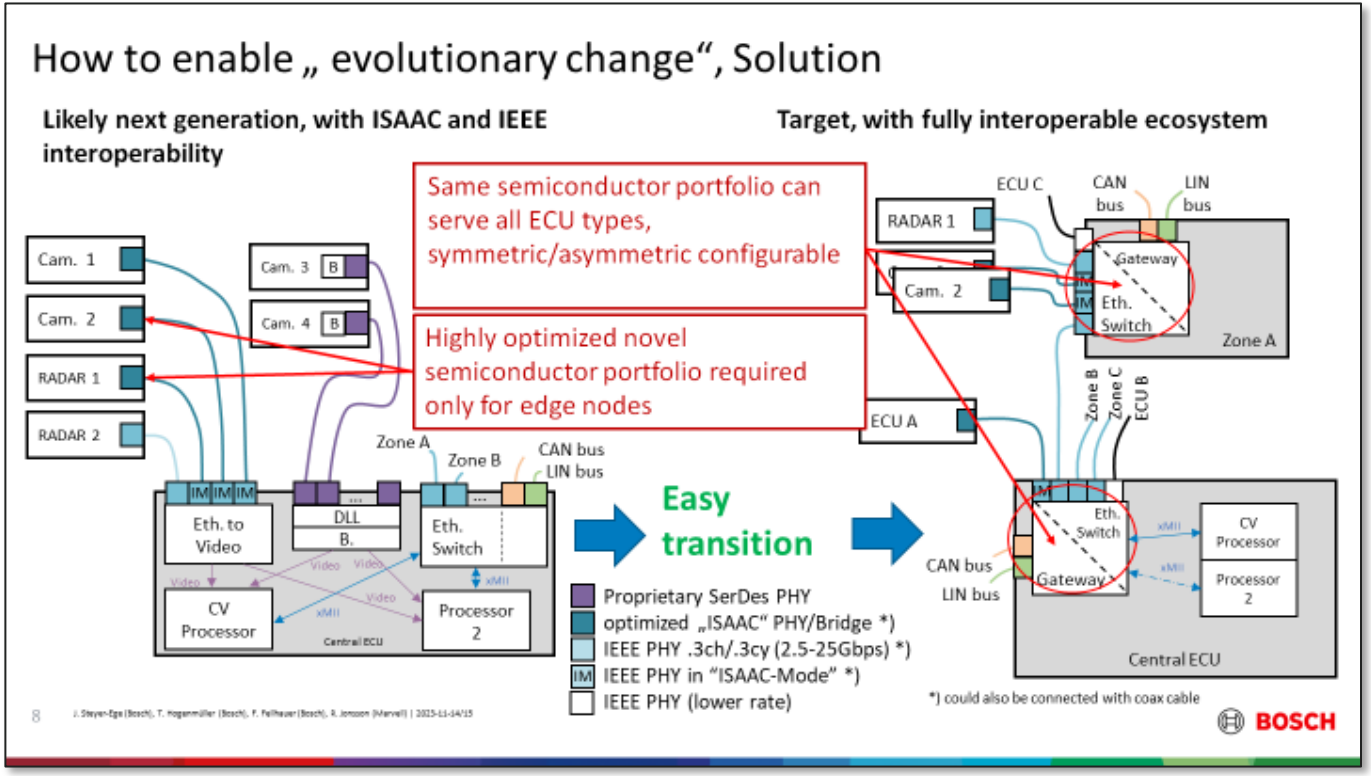

**Network Side:**

- Transmitting occasionally
- Receiving most of the time
- Less heat constraint
- Power savings desirable
- **Ethernet interoperability is key**

**Camera Side:**

- Transmitting most of the time
- Receiving occasionally
- Important to control heat in camera module
- Power savings are very important
- **Relative cost and heat are key**

# Fully Interoperable Ethernet Ecosystem




**KEY Points:**

The camera ISAAC PHY will be optimized

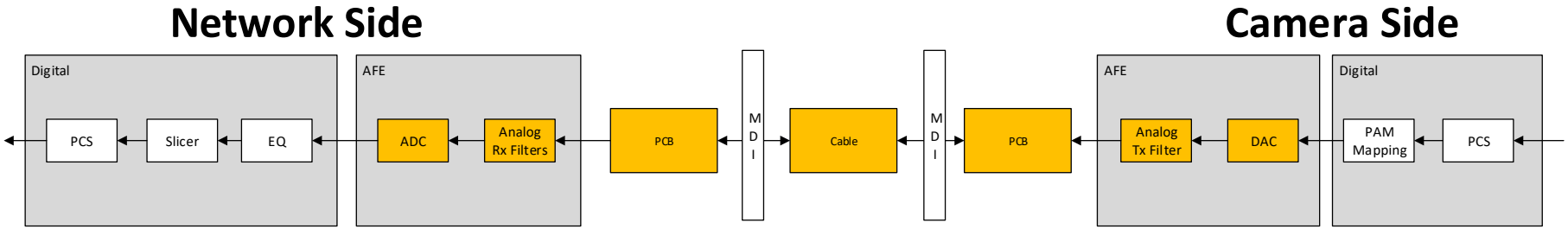
The network side ISAAC PHY will be multi-mode

The ISAAC PHY will eventually replace proprietary PHY

From https://www.ieee802.org/3/ISAAC/public/1123/20231114_On_the_need_for_25Gbps_updated_post_presentation.pdf

# Methodology

- For simpler comparison, this presentation focuses on comparing the benefits of adding new 1Gbps downstream rate, versus using the already agreed 2.5Gbps rate
- The comparison does not assume any specific modulation, but assumes that there is minimal interference/echo between the two transmit directions
- The comparison assumes that the camera is transmitting the downstream data and the network side is receiving the downstream data



# Power and cost saving approaches

- The presentation will consider potential saving by using the following approaches for the 1Gbps data rate:
  a) Simpler FEC
  b) Lower symbol rate
  c) Lower constellation size (e.g., PAM2 vs PAM4)
  d) Shorter transmit bursts (e.g., TDD/EEE)
- Options b, c, and d are mostly mutually exclusive
- Options a and d are mutually exclusive
- Option d could be used to support 1Gbps data rates on 2.5Gbps link

# Power saving for 1Gbps - Camera PHY

Reducing the camera PHY transmit rate from 2.5Gbps to 1Gbps might yield some power reduction because

- Lower symbol rate would potentially reduce the switching rate in the digital
- It might be possible to reduce the line signal transmit power levels if the lower insertion loss at lower frequency improves the relative SNR

However, similar power savings should be possible by using 2.5Gbps and mechanism similar to EEE, where the transmitter is active less than half the time (shorter transmit bursts)

# Power saving for 1Gbps - Network side PHY

Reducing the network side PHY receive data rate from 2.5Gbps to 1Gbps might yield some power reduction because

- Lower symbol rate would simplify the receiver, because equalization is easier for lower bandwidth signals
- Lower symbol rate would reduce the switching rate in the digital logic

However, similar power savings should be possible by using 2.5Gbps and mechanism similar to EEE, where the receiver is active less than half the time (shorter transmit bursts)

# Relative cost saving for 1Gbps - Camera PHY

Reducing the camera PHY transmit rate from 2.5Gbps to 1Gbps might yield some miniscule relative cost reduction if

- The modulation uses simpler FEC for 1Gbps
- The modulation chosen for 1Gbps is PAM2 and 2.5Gbps uses PAM4
- The analog front end can be simplified because of lower symbol rate or because of smaller constellation size

While each of these simplifications could potentially provide some relative cost saving, such saving would always be miniscule relative to the cost of the overall camera module

# Relative cost saving for 1Gbps - Network side PHY

Reducing the network side PHY receive rate from 2.5Gbps to 1Gbps might yield some relative cost reduction for **single-mode PHY** if

- The modulation uses simpler FEC for 1Gbps
- The modulation chosen for 1Gbps is PAM2 and 2.5Gbps uses PAM4
- The analog front end can be simplified because of lower symbol rate
- The signal processing can be simplified because of less bandwidth or because of smaller constellation size

For **multi-mode PHY**, adding 1Gbps modulation will complicate design, qualification and provisioning, and result in increased relative cost

# Pros and Cons of adding 1Gbps Downstream

**Pros:**

- Potentially some power saving on network side
- Potentially a minuscule relative cost saving on camera side
- Potentially minor power saving on camera side

**Cons:**

- More complex multimode PHY on network side
- More PHY variants will increase design and qualification efforts
- More effort to develop standard, especially since 1Gbps MII has different structure from the multi-gig MII

**All camera applications supported by 1Gbps can be supported by 2.5Gbps, with minimum difference in relative cost and power**

# Comparing benefits of adding 1Gbps or 25Gbps

**Adding 1Gbps:**

- No new camera applications will be supported
- Standards development will be complicated by fundamental differences between 1Gbps and multi-gig MII

**Adding 25Gbps:**

- Will allow support of data rates above 10Gbps
- Minimal complication to standards development because the MII for multi-gig and 25Gbps is very similar

**It is much more beneficial to add support for 25Gbps than 1Gbps**

# Summary

- There is limited benefit from adding 1Gbps downstream to the ISAAC project
- All camera applications supported by 1Gbps can be supported by 2.5Gbps, with minimal power penalty
- Adding 1Gbps to the ISAAC project will complicate the standards development
- Adding 1Gbps to the ISAAC project will complicate multi-mode PHYs on the network side
- It would be more beneficial to add support for 25Gbps to the ISAAC project objectives, than to add 1Gbps to the project objectives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