

Addressing some “Good Questions for ISAAC Study Group”

V1.0

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Brazil

Camera Link Problem Statement (From CFI)

- Key characteristics:
 1. Efficiently support highly asymmetric data rates:
 - 1Gbps to 10Gbps or more from camera
 - Never more than 100Mbps towards camera
 2. Power constrains solution in camera module, to control temperature in the module
 - Sensor quality degrades exponentially with increased temperature.
 3. Power delivery over the data link
 4. Very cost sensitive – needs an optimized solution
 - Motivates combination of image sensor and transceiver in one package.

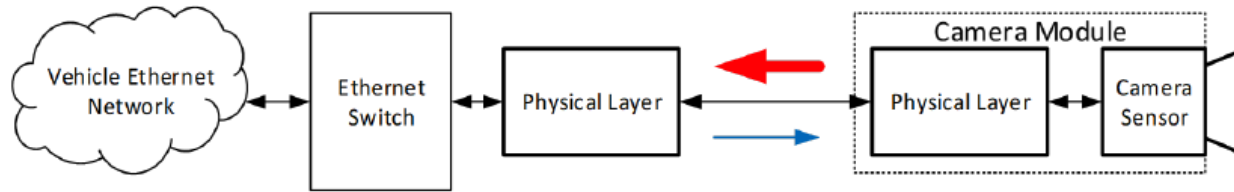
Source: https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf

This presentation addresses items highlighted in blue above

Key elements of Camera Side PHY

Good Question for Study Group – Is the camera side PHY the same as the network side?

Support of Ethernet networking is essential for being future proof. 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 any added heat in camera module
- Power savings are very important
- **Cost and heat are key**

Source: https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf

**Key attribute listed for camera side PHY are cost and heat.
The study group should focus on these aspects.**

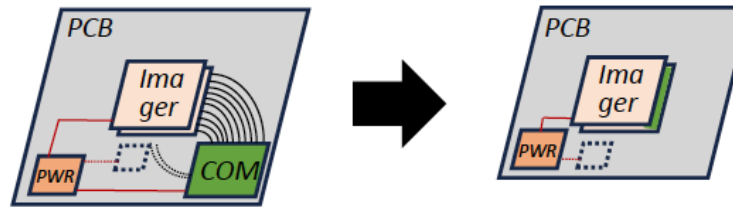
PHY Complexity Matters!

Good Question for Study Group – Can we enable a more efficient Ethernet solution?

A communication standard motivates combination of image sensor and transceiver in one package.

Main camera Bill of Material (BOM) items:

- PCB
- Power supply
- PoC circuitry
- Imager
- Communication chip
- Housing
- Wiring
- Connector
- Lens (barrel)



An efficient communications chip (COM) is essential for competitiveness with the incumbent technologies. A power and **complexity-efficient Ethernet standard** can enable:

- Fewer chip packages on the PCB
- Smaller footprints with fewer communications interfaces, lower power, and reduced cost
- Reduced PCB sizes with fewer layers

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Source: https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf

Lower Complexity enables wider adoption and creates broader market potential

Native Asymmetry is Key

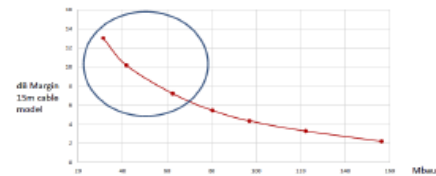
Good Question for Study Group – Do Ethernet PHYs need native asymmetry to compete?

Natively Asymmetric PHYs may offer efficiencies

- Considered in 802.3ch, 802.3cy, and non-802.3 groups
 - Potential to reduce camera-side receiver complexity
- The application is inherently asymmetric
 - Using a symmetric PHY with EEE was thought to be “good enough” – is it?

Impact on high speed receiver by low speed transmitter

- High pass filter out low speed transmit signal (no digital echo)
- Look at margin at high speed receiver for given low speed baud rate

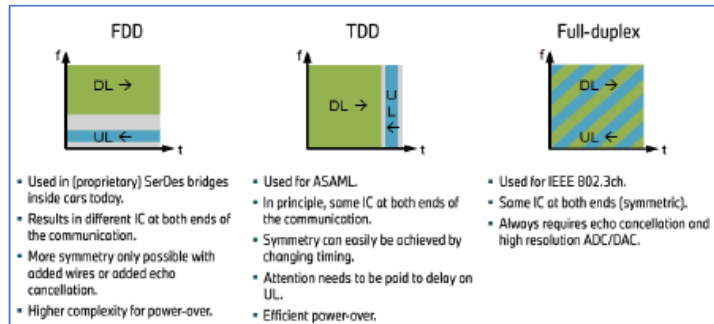


- Recommendation: Modulation of low speed signal to below 70 Mbaud.

IEEE 802.3ch Task Force 6 30 Jan 2019 AXONNE

Source:

https://www.ieee802.org/3/ch/public/adhoc/Lo_3ch_01_adhoc_0119.pdf



Source: https://auto-serdes.org/wp-content/uploads/2022/10/20220912_Matheus_AutoSens.pdf

Asymmetrical Transmission - Method 2

- Achieve Asymmetrical link operation by putting one direction of the link in PERMANENT EEE state

QUIET > REFRESH > WAKE > DATA > REPEAT

Send DATA within REFRESH signal (if DATA is available from MAC)

Else send normal REFRESH signal

- Periodicity of REFRESH (containing DATA) determines peak bandwidth of the low-bandwidth side of the link
- For systems requiring only an initial burst of data (for example - reading camera or display attributes), the mechanism allows MAC to send a burst of DATA and then allows PHY to send Normal Refresh
- For systems requiring ongoing data transfer in the low-bandwidth direction, the method allows for flexible or fixed data rate by adjusting the period of Refresh signal

Source:

https://www.ieee802.org/3/ch/public/sep17/dalmia_3ch_01_0917.pdf

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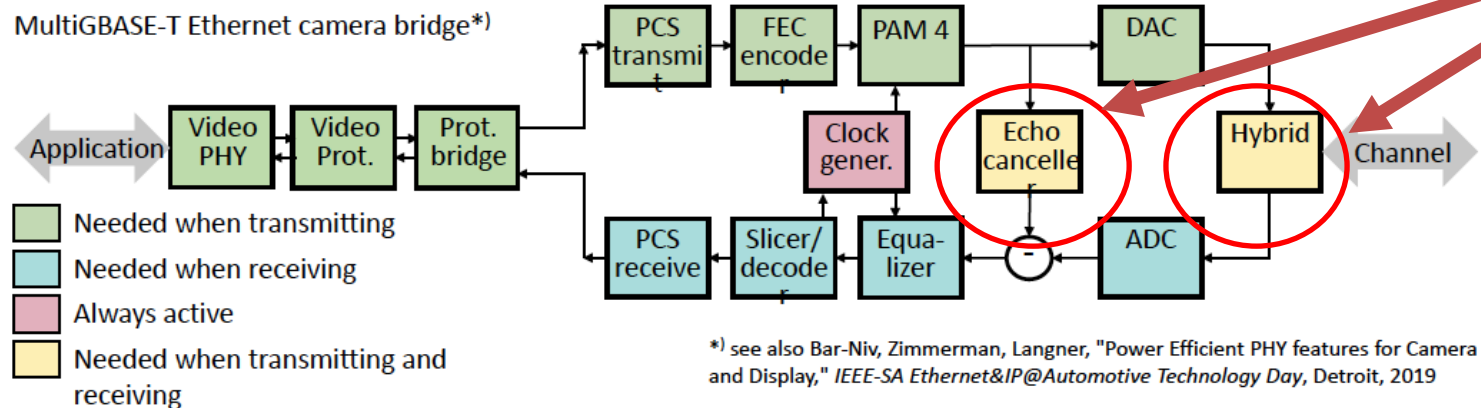
Source: https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf

EEE uses Symmetric PHY as a basis. It is NOT “natively Asymmetric”

Echo Cancellation and Hybrid are not needed

Good Question for Study Group– Can we adapt 802.3ch/quiet-refresh to meet the need?

The power consumption of symmetric IEEE 802.3ch can be reduced with help of (asymmetric) EEE



Not needed
For TDD

Power consumption of blocks not needed may be reduced with EEE.

Whether the power reduction of the existing EEE is sufficient to make symmetric IEEE 802.3 PHYs competitive or whether it must/can be improved sufficiently, needs to be confirmed.

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The change in power consumption, however, does not change the complexity of the PHY as such, which impacts aspects such as size, cost, and integrate-ability into the imager.

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Using TDD Scheme Optimizes The PMA/PMD Complexity for Single Pair Asymmetric Communication - Example: ASA-ML

- Small Area and Low Power – Requirements Met!
 - No need for Echo Canceller or hybrid
 - No need for high resolution ADC or DAC on the camera side
 - The camera side equalizer: low complexity → upstream uses only PAM2
 - The camera side FEC Decoder is of very low complexity and low speed
 - PHY Tx complexity is low on the camera side for all speed grades.

ASA-ML PHY: The right solution for the Camera Side

Lowers the complexity of the PHY as well as reduces power consumption.

- It provides an optimized solution: lowest power, size, cost.
- Well suited for integrate-ability into the imager.