Considerations for a 1 Gbps downlink PHY (Continued)

IEEE 802.3

ISAAC Study Group

January 9, 2024

Kirsten Matheus, BMW Group

Motivation

- During the November plenary, the following presentation was given addressing the market potential of a 1 Gbps downlink https://www.ieee802.org/3/ISAAC/public/1123/matheus_ISAAC_01_14112023.pdf
- In the ensuing straw poll 24 individuals would have supported a respective straw poll, 10 opposed, 8 abstained and 15 requested more information.
- To thus provide more information this presentation addresses a first qualitative complexity comparison with
  - 1000BASE-T1, 100BASE-T1
  - An ISAAC solution with 2.5Gbps/100Mbps

Recap of market potential for 1 Gbps/100 Mbps*)

Cameras:

- Today, >90% of the automotive satellite cameras use <1 Gbps.
- 2033 it is expected that still a third of the cameras need <1 Gbps.
- With the camera market tripling in the same timeframe, the absolute number is expected to remain at the same high level.

Radars

- Today, all radars are intelligent radars requiring << 100 Mbps.
- Satellite radars are a new development with the timeframe of adoption open.
- Short and mid-range radars represent the vast majority of the radar market today and will continue to do so in 2033. As satellite radars they are planned with < 1 Gbps data rate today. (Long range radars are likely >> 1 Gbps)

*) https://www.ieee802.org/3/ISAAC/public/1123/matheus_ISAAC_01_14112023.pdf

Comparison with 1000BASE-T1/100BASE-T1 (1)

	100BASE-T1	1000BASE-T1
Link segment	15m UTP	15m jUTP
PHY transmission**)	Full-duplex	Full-duplex
X-level signaling	2D-PAM3	2D-PAM3
Nyquist freq.	33.33 MHz	375 MHz
Error correction	n/a	Reed Solomon
A/D conversion*)	> 6 bits	> 7 bits
DFE*)	Up to 32 taps	Up to 64 taps
FFE*)	Up to 8 taps	Up to 32 taps
Echo canceller*)	> 20 taps	> 135 taps
Power consumption ***)	x	~2x

There is a noteworthy increase of complexity from 100BASE-T1 to 1000BASE-T1

*) Based on best design practice
**) Here really PHY level is meant, not MAC level, as usual in IEEE
***) Only core functionality is considered, other PHY/SoC features will affect the total power number

Comparison with 1000BASE-T1/100BASE-T1 (2)

- Even though 1000BASE-T1 with Type A link segment was designed for jacketed UTP, in practice, 1000BASE-T1 is used with STP.
- As it was, however, designed to be usable with jUTP, complexity was added to increase the robustness for a UTP channel. This can be reduced for a solution that targets a shielded channel.
- Both 100BASE-T1 and 1000BASE-T1 are full-duplex and need an echo canceller. An inherently asymmetric system might be designed such that an echo canceller is not needed.
- This leads to more implementation choices (analog, digital, mixed signal processing, etc.).
- The expectation is that relevant savings can be realized for an inherently asymmetric PHY in comparison with 1000BASE-T1.

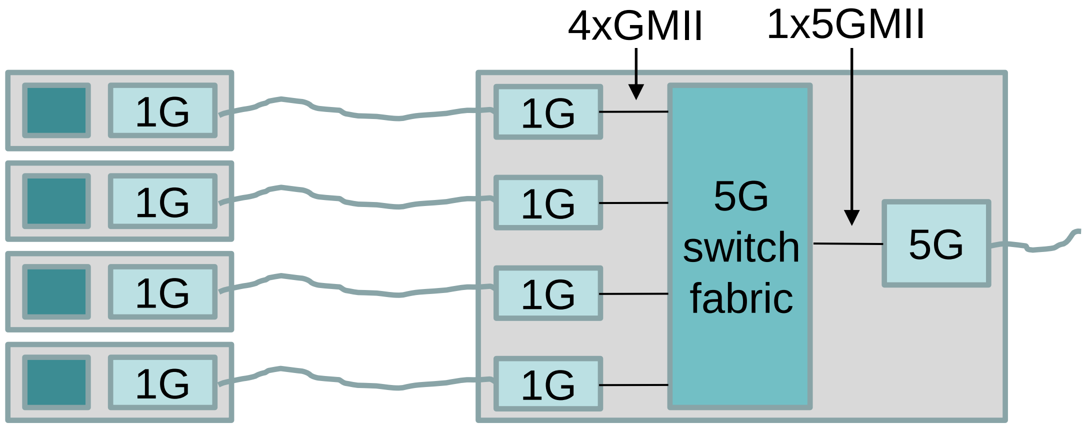
Comparison with 2.5 Gbps/100 Mbps (1)

	1 Gbps/100 Mbps
Basic link segment	If 2.5 Gbps/100 Mbps meets a 15m channel with 4 inline connectors on either Coax or STP, 1 Gbps/100 Mbps can meet the same channel requirements as well.
Possibility to add another link segment	It might be considered to discuss UTP cabling for a 1 Gbps/100 Mbps solution. However, considering that 1000BASE-T1 was designed for UTP but is used with STP (and that some car manufacturers even use STP for 100BASE-T1), this should not be the prime focus. A 1Gbps/100 Mbps might consider longer link segments.
Link margin	The lower data rate allows to reduce the frequency (→ less insertion loss) and/or to reduce the PAM level (→ more margin) and/or the effort spent on error protection
PHY complexity	As a consequence the PHY complexity (PCS and PMA) and/or power consumption can expected to be less.
Interface to MAC	Different speed and xMII interface requires some effort to include, either as dual headed RS & MII or as client based interface with symmetrical xMII

Assumption: Each PHY will be developed/optimized separately, i.e. a 2.5 Gbps does not carry the burden of the same PCS and PMA as the 5 Gbps or 10 Gbps PHYs. Note that this is different from 2.5, 5, and 10GBASE-T1, where between the speeds, more or less only frequency and interleaving is changed.

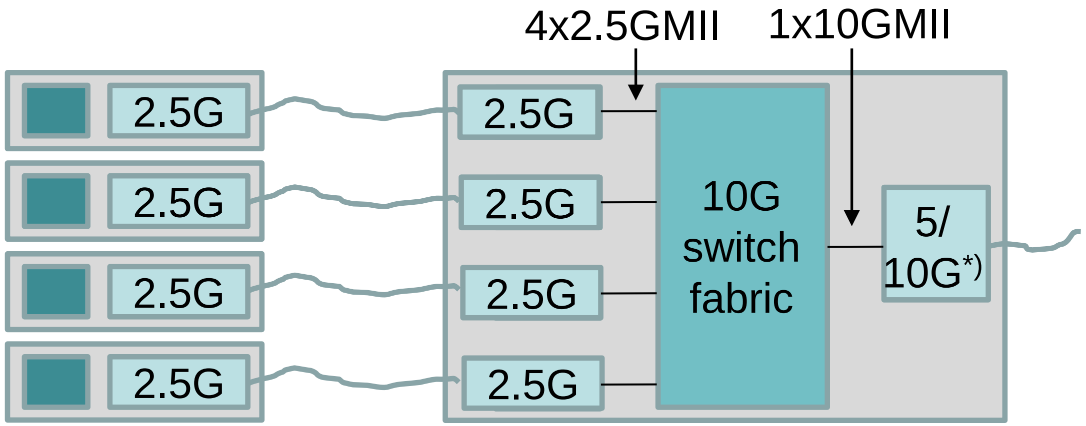
Comparison with 2.5 Gbps/100 Mbps (2)

Example aggregation system with dedicated 1 Gbps/100 Mbps link



Independent from the potential savings in every dedicated 1 Gbps/ 100 Mps PHY, such a PHY allows to optimize the aggregation.

Using a 2.5 Gbps/100 Mbps, even though < 1 Gbps is needed



*) 5G if not integrated, 10G if integrated

2.5 Gbps/100 Mbps for 1 Gbps/100 Mbps simplifies 1 Gbps/2.5 Gbps multi-speed implementations, but burdens the aggregation with not-needed processing capacities.

Summary and conclusion

- An asymmetric PHY supporting a 1 Gbps downlink would address a significant market share of camera and sensor use cases also in 2033 (see https://www.ieee802.org/3/ISAAC/public/1123/matheus_ISAAC_01_14112023.pdf)
- This presentation provided information on technical differentiation potential.
- It is expected that an inherent 1 Gbps/100 Mbps solution can achieve a relevant complexity reduction compared with 2.5 Gbps/100 Mbps as well as compared with 1000BASE-T1.
- If the standard does not include an optimized solution for 1 Gbps/100 Mbps, the proprietary solutions will cover that market until the low speed is obsolete.
- This might slow overall adoption as users face mixed link technologies in their system.
- Some add. specification effort needs is required in order to support the GMII.

Thank You!