Open discussion on objectives

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Introduction

- This contribution is NOT an objectives proposal
- This contribution intends to start open discussion for consensus building on objectives like data-rates, BER, link segment, etc. and others that may result controversial
- In this way, this contribution intends to put on the table some requirements that the automotive industry considers important in the implementation of Ethernet technology in vehicles and are not covered today by IEEE Std 802.3
- These requirements not only affect to the OMEGA SG, but also other 802.3 projects
- The SG should openly discuss these requirements and decide which ones are finally translated to objectives and which ones should be aligned with other projects

Data-rate

- MultiGigabit: 2.5, 5, 10, 25, 50, 100, 200, … 1000 Gb/s
- Set of data-rates to be addressed by the project should be chosen based on:
  - The OEM's requirements in the time (which data-rate, and when)
  - Technical feasibility (today)
  - Economic feasibility (today)
- Uniformity:
  - Same type of optical fibers for different data-rates
  - Same type of optical connectivity
  - Same photonics: light source and the photodiode
  - Same physical layer schemes: encoding, FEC, training, equalization, timing-recovery, etc. but with scaled symbol rate
  - Same technology node with small power leakage and small economic penalties
- Number of lanes:
  - Technical feasibility analysis will determine the max achievable data-rate in one lane
  - The SG should determine the max number of lanes that are economically feasible
- Set of data-rates will be determined by max data-rate per lane, max lanes, and uniformity
- Auto-negotiation? — Not need to be in objectives. To be decided by the TF. Not only rate, but other parameters could be negotiated.

BER (Bit Error Ratio)

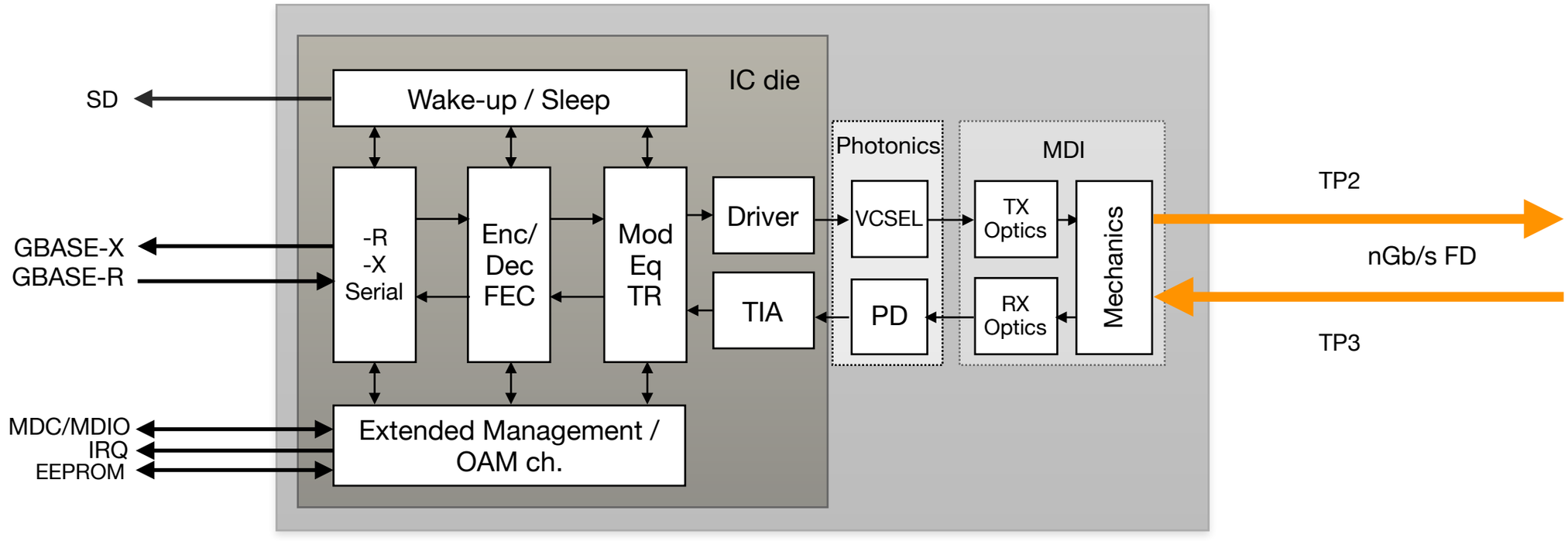
- Different rates may require different levels of BER
- Examples of MM glass optical fiber and backplane:
  - 1000BASE-SX: BER < 10^{-12}
  - 2.5GBASE-KX, 5GBASE-KR: BER < 10^{-12}
  - 10GBASE-SR: BER < 10^{-12}
  - 25/50GBASE-SR: BER < 10^{-12}
  - 25GAUI C2M: BER < 10^{-15}
  - LAUI-2 C2M (50Gb/s): BER < 10^{-15}
- Examples automotive PHYs:
  - 1000BASE-RHC: BER < 10^{-12}
  - P802.3ch, 2.5/5/10GBASE-T1: BER < 10^{-12}
- BER requirement should take into account the most relevant use-case of MultiGigabit in the vehicle: the camera sensor link
  - Sensor demanding so high rate is due to very low latency requirements: re-transmission is not a valid solution
  - Bit errors (blocks of them in general due to FEC failure mode) will produce image artifacts
  - BER requirements should be based on most stringent use cases

Link segment

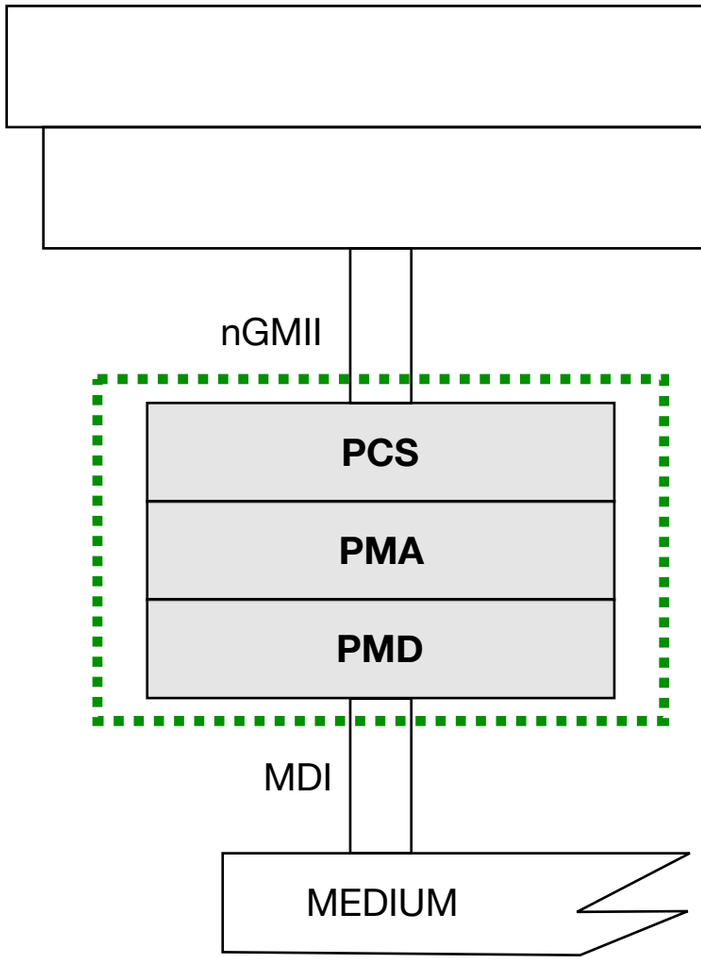
- Link segment length may impact in the technical feasibility analysis depending on the modal dispersion, chromatic dispersion and insertion loss of the considered optical fiber
- Number of inline connections will also impact the technical feasibility: insertion loss and back reflections (i.e. RIN increase)
- Real use cases and broad market potential should define the link segment requirements
- MM optical fibers may open the opportunity to address other use cases where longer distances are needed: very low attention and very high bandwidth, compared with copper
  - Busses, tracks
  - e.g. 40 meters with 4 inline connections
- Different rates are expected to cover different use cases: different link segment requirements should be expected per rate
  - Very important not only for technical and economic feasibilities, but for TF

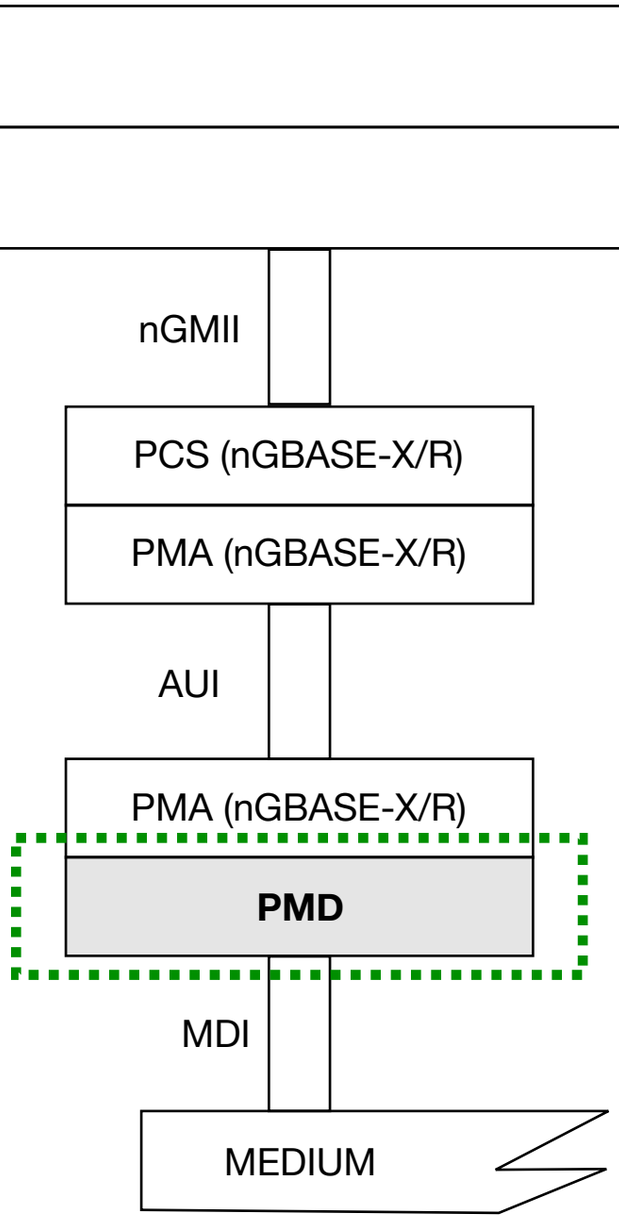
Single components, serial AUIs

- Most technically suitable implementation will consist in a single component that integrates full functionality with two I/Fs: serial electrical I/F and optical connector
- High levels of integration improves SI, PI, EMI/EMS, power consumption, heat dissipation, as well as drive to reduce relative cost
- Serial AUIs:
  - Serial AUIs (C2C and C2M) are not specified for some rates: 2.5, 5 Gb/s (KX, KR exceeds the requirements)
  - Some others (i.e. XAUI) are not longer implemented
- Most likely, 802.3ch and B10GAUTO ICs will use serial interfaces too
- Should AUIs be addressed by the project? — Not need to be in objectives. To be decided in TF. Usually implementations are based on industrial electrical interfaces (e.g. XFI with 10 Gb/s). AUI is only defined in very high speeds.



Full PHY or just PMD specification?





- Not need to be in objectives.
- To be decided by TF.
- Either option may be valid, provided that allow full PHY specification.

Asymmetric max data-rates (different TX/RX bit-times)

- OEMs want to have any sensor, actuator, and processing unit accesible (addressable) from any node in the automotive network
- Camera application is the real driver of MultiGigabit rates and should be connected by Ethernet car network
- Camera-to-ECU rates requirements: from e.g. 2.5 to 25 Gb/s
  - Very low latency and high quality video stream
- ECU-to-camera rates requirements: e.g. 10 Mb/s, 100 Mb/s
  - Configuration, FW upgrade, status, dependability, …
- Camera module is very constrained in size, power consumption, heat dissipation and complexity
- In xGb/s PHYs, the most part of complexity and power consumption is produced by the receiver side (DSP, equalization, FEC decoder, etc.), which in case of the ECU-to-sensor direction is not needed
- From the MAC and RS, the asymmetric rates are currently supported:
  - EPON asymmetric data-rates (bit-times)
  - Rate-matching in EFM
  - FD new MAC (Annex 4A)
- SG has to decide if asymmetric max data-rates should be included in the objectives.

Hybrid media

- In cameras connected by optical media, an optimal solution may be based on optical camera-to-ECU direction, UTP ECU-to-camera direction and (optional) PoDL to supply power to the camera from the ECU
- Different media for each direction: different PHYs? two MACs or only one?
- Link establishment issue:
  - The link is established based on local reliable reception and transmission (remote reliable reception) after training phase
  - Some states diagrams may depend on RX and TX states
  - In general, a set of state variables should be shared between both PHYs
- OAM channel issue:
  - Both PHYs have to share the same protocol and MDIO registers interface
- TX and RX sides of optical PHYs are quite independent, only a few control signals are shared
- However, in copper PHYs, TX and RX are strongly related due to same medium is shared with echo cancelling or time-division
- SG has to decide if hybrid media topic should be included in the objectives
- Open discussion that can affect the project scope (because not only optical)

Thank you