NEA: Multi Gig optical of Automotive CFI consensus building

November 2018

First call report

- Consensus building around the Automotive Optical Multi Gig CFI preparation

- Two calls 18/Oct/18 in different time slot: Total 41 attendees
  - 20 Europe + ASIA
  - 22 Europe + America

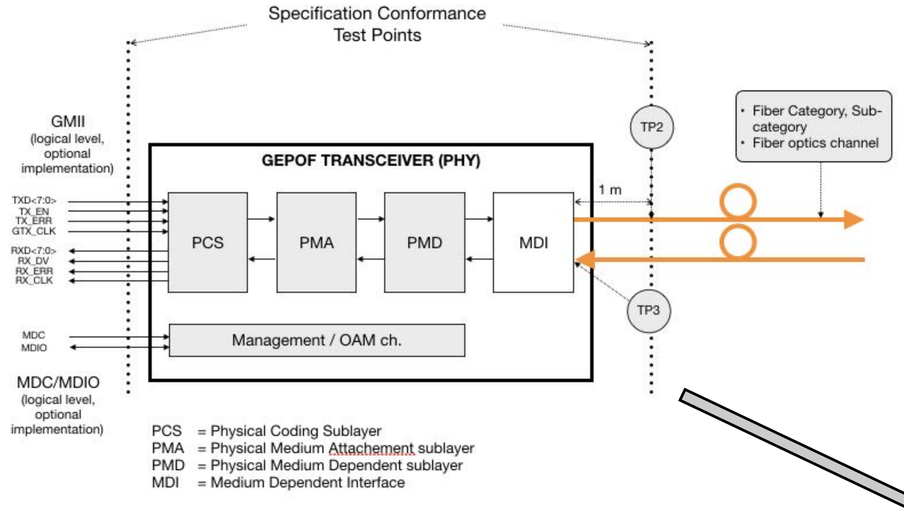
Introduction to optical in Automotive

Optical Communications in automotive

	Speed (Mbps)	Application	Year
D2B	12	Digital audio	1992
MOST	25, 150	Infotainment	2001-2008
Byteflight	10	Safety-critical	2001
Firewire	400	Infotainment	2004

Optical communications are well established in automotive

Gigabit POF: Standardization



IEEE

1000BASE-RH

- PHY definition
  - PCS, PMA & PMD
  - Optical performance

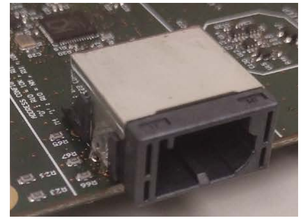
- 1 Gbps
- 15 meters up to 4 in line connectors
- 40 meters
- Automotive qualified POF and light source

ISO JTC1 IEC
INFORMATION TECHNOLOGY STANDARDS

ISO/IEC/IEEE 8802-3
1000BASE-RH

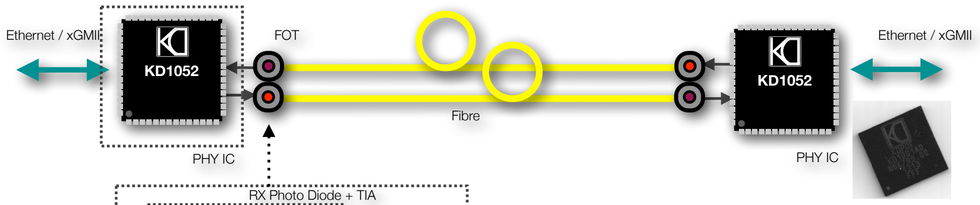
ISO International Organization for Standardization

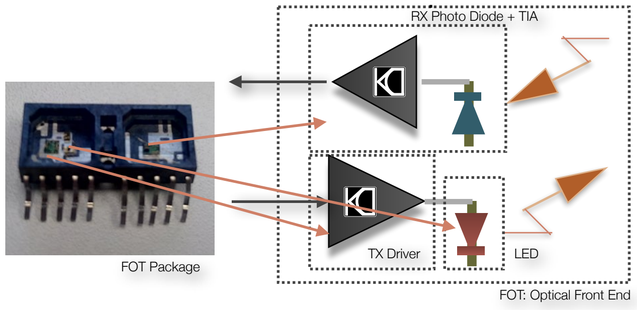
- Wake up and sleep
- Interfaces
- Compliance
- Interoperability
- Harness

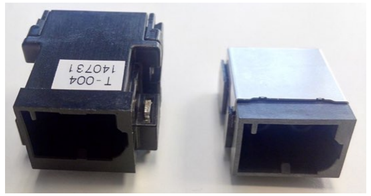


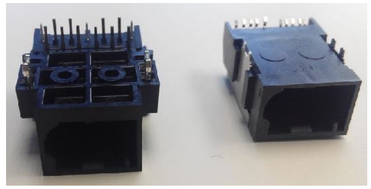
- Connectors
  - Small form factor
  - MOST-150 type

Gigabit POF: Zoom into components

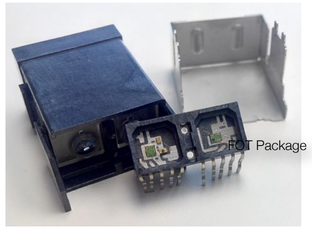




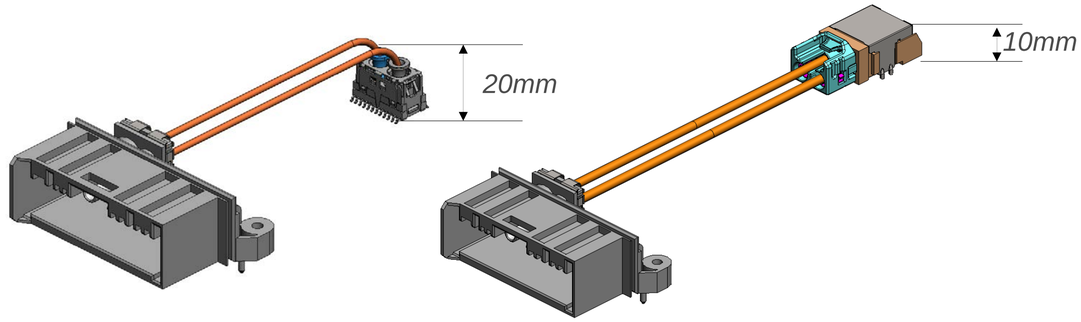




Connector housing



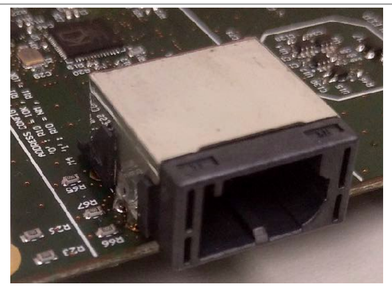
Header connector portfolio to accommodate any board and interconnection topology



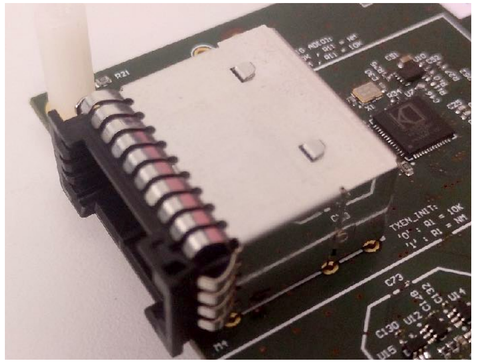
Feature & Advantages

Connector types

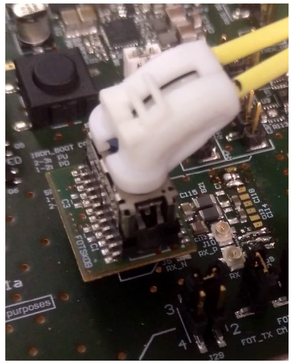
- Small form factor connector



- MOST-150 style connector



- Sky-looker connector



USE CASES

Use Cases

BMS
Galvanic Isolation

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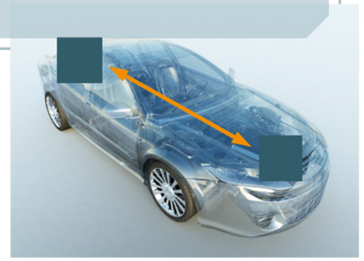
Backbone



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Smart Antenna modules

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Infotainment

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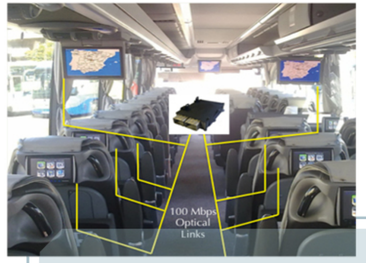

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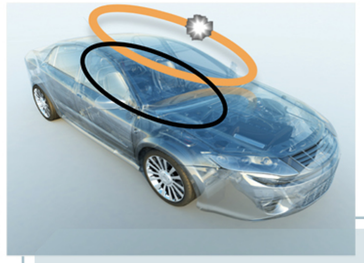
100 Mbps links
EMC-tight



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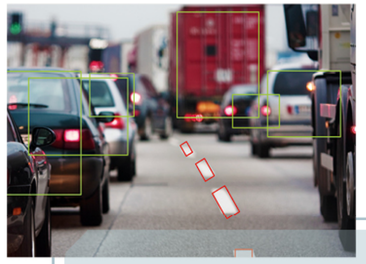
Autonomous driving
safety redundancy



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ADAS camera
interconnection

Where is used today ?

- (Show OEMs brand names with their permission)
- (Show TIER-1/2 brand names with their permission)
- Applications used:
  - Battery Management Systems
  - Network backbone
  - Smart Antenna link
  - ADAS safety redundant links
  - Infotainment

Why is optical being used today?

- Main reasons
  - Galvanic isolation for electrical cars
  - Superior EMC performance
    - EMC in critical areas like antennas
  - Superior EMI performance
    - EMI in very noisy environments like electrical cars
- Other reasons
  - Weight
  - Robust and reliable solution
  - Already qualified cables and connectors
  - Path to very high speeds (x00 Gbps)
  - Copper and optical links co-exist in the same car
    - Different use cases
    - Redundancy for safety requirements

Multi Gigabit

GM / NGAUTO Poll

Surveys – OEM Responses

Cable Types – Should different speeds use the same cable or is it okay if they're different?

- 68.75% of respondents said it is okay to use different cables for different speeds

Is it okay to use optical cable?

- 50% of respondents said they would consider using optical cable

Maximum operating temperature

- 62.5% need 105 C for most or all speeds
- 18.75% need more than 105 C for some or all speeds
- 18.75% say 85 C is sufficient for all speeds

Minimum operating temperature

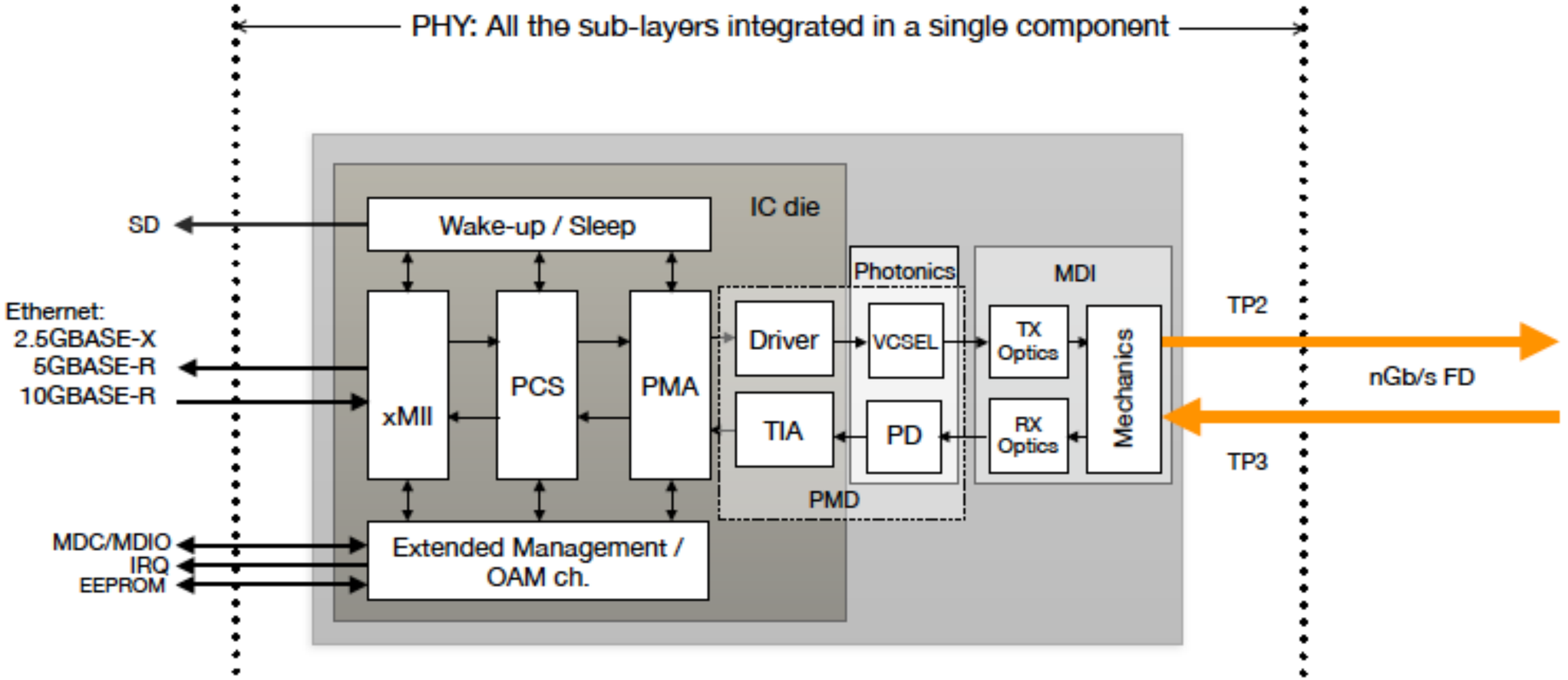
- 100% agree that -40 C is sufficient
- -55 C is required for storage

Multi Gigabit applications

- Back-bone
  - Symmetric trafic. Full duplex.
  - May be in redundancy configuration for safety systems
  - 1 to 6 links per car
  - Mixed data type (Control, Multimedia, ADAS, Sensors data, raw video, etc)
  - Aggregation of all data generated in the car
  - Very high speed redundant links with ADAS system
- Camera & Display
  - Very asymmetric trafic
  - 1 to 5 display links per car
  - 1 to 8 camera links per car
  - Raw video data type
  - Need of unidirectional link
  - Upstream can be done via other links (10_SPE)

Single component PHY approach

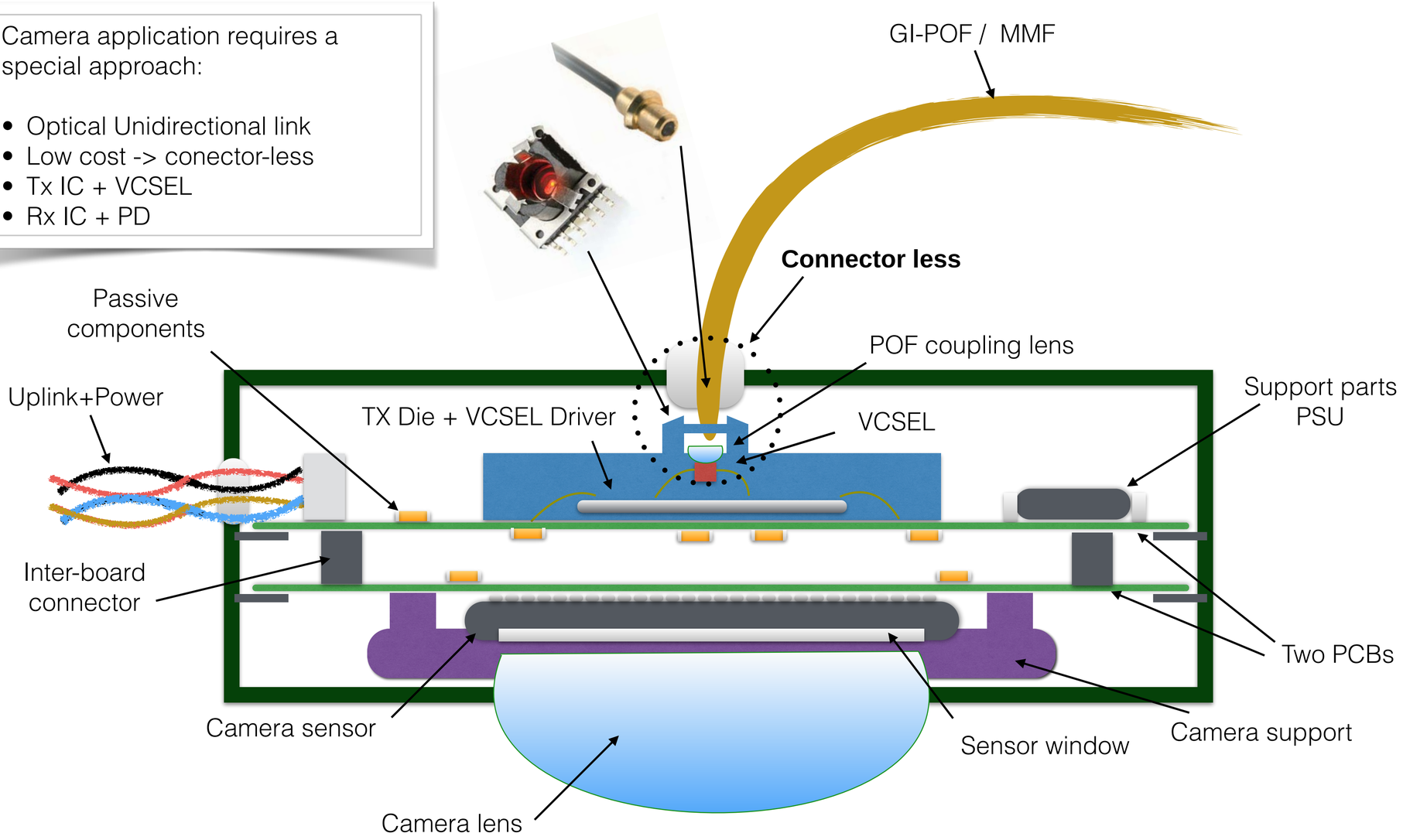
- Due to speed requirements a single component PHY is needed



Multi-Gig optical link for cameras. Implementation example

Camera application requires a special approach:

- Optical Unidirectional link
- Low cost -> conector-less
- Tx IC + VCSEL
- Rx IC + PD



10GBASE-SR

- IEEE Std 802.3 already includes the 10GBASE-SR specification that may be considered as starting point to develop multi-gigabit optical solution for automotive applications.
  - However, is it really good enough for automotive applications?
- Difference between 10GBASE-SR and the Automotive requirements:
  - Temperature range: Tj = -40ºC -> 105ºC/125ºC and 15 years of operation with 0 ppm failures
    - So VCSEL current density needs to be reduced to achieve reliability and target temperature range
    - VCSEL Bandwidth will be highly reduced
    - Relative intensity noise will increase
  - Insertion Loss will be increased due to:
    - 4 inline connectors with much higher estimated losses per connector due to vibrations, aging, dust, etc
  - Cost and power consumption restrictions are different
    - Is it possible to have high yield manufactured components (Connectors, VCSEL, PD, etc) with the new requirements meeting cost needs ?
    - Is it possible to have a low power implementation with improved reliability, and implementable in a car ?
  - OAM channel is needed
  - System needs to be adaptive to cope with:
    - dynamic changes of temperature
    - large parametric variation with manufacturing processes and temperature

Proposed CFI

Speed / Operation

- Backbone:
  - Today backbones are 100 Mbps / 1 Gbps
  - **10 Gbps** should be the natural step
  - **2.5 Gbps and 5 Gbps** should also be provided. Lower power consumption and lower MAC/system requirements
  - Is 25 Gbps, 50 Gbps, 100 Gbps needed ?
    - Some OEMs has communicated the need of 25 & 50 Gbps. Justification under preparation.
  - FULL DUPLEX

- Automotive camera requires:
  - High resolution (Today 1 -2 Mbpx is used. Future is targeting 4/8 Mbpx)
  - High dynamic range per pixel (See in the dark, no saturation of camera, etc)
  - High frame rate (Fast ADAS reaction)
  - No/minimal compression to avoid loss of information and increase of latency and power consumption
  - 4/8 Mbpx x 24 bppx x 60 fps = 6/12 Gbps
  - Required speed: **10 Gbps / 12.5 Gbps**
  - **SIMPLEX (Unidirectional)**

Type of fibre

- MMF glass fibre: OM1 to OM5 (50um/125um)
  - Very high volumes
  - High temperature (125ºC)
- GI-POF: (80um/400um)
  - Robust
  - Flexible
  - Larger
- PCS / HCS / GI-HCS
  - Robust
  - Lower bandwidth
  - High temperature (125ºC)

  - **Two develop single PMD per speed. Different fibres may be qualified according to PMD power budgets**

Cable Requirements

- 15 m + 4 in-line
- 40 m

- Key parameter is the amount of inline connectors.
- Length is less critical

Technical feasibility

- Simulation provides enough link budget
  - More than 10 dB of link budget at 12.5 Gbps & VCSEL Tj = 125 ºC

Proposed Calendar

- CFI: Target date: July 2019 meeting
- Task Force: End 2019 / Beginning 2020
- Publication: Early 2022