

# Input - Automotive Use-cases and Requirements Multi Gigabit

IEEE 802.3 Multi Gigabit Automotive Optical PHY Study Group

## Supporters (Volvo Cars):

Björn Bergqvist  
Jerker Fors  
Lennart Casparsson  
Magnus Eek  
Samuel Sigfridsson

# Purpose

- Provide initial OEM recommendations / input and use-cases to IEEE 802.3 Multi Gigabit Automotive Optical PHY Study Group.
- Presentation covers
  - Use cases
  - Requirements

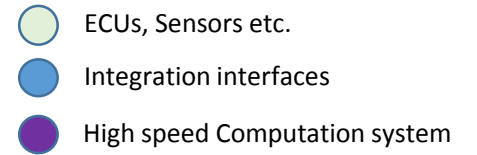
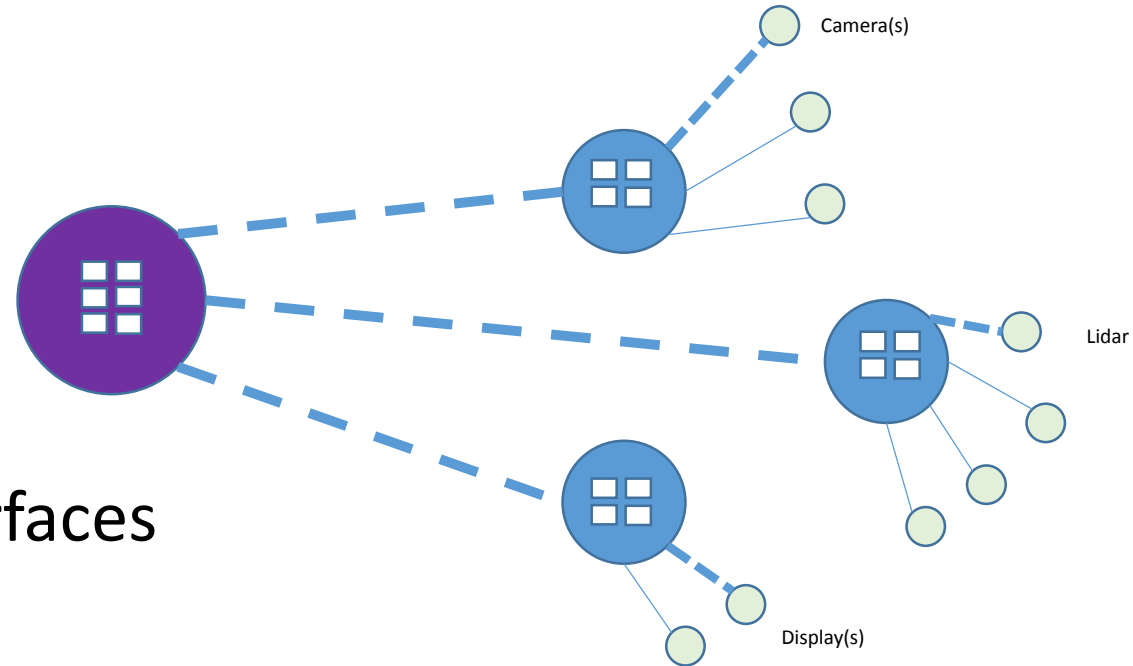
# Use-Cases

- Backbone

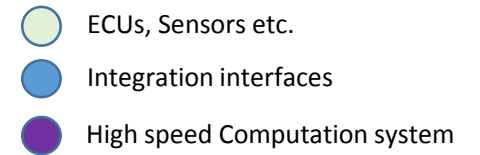
- Integration Interfaces

- ECU sensors

- E.g. Camera, Lidar & Displays

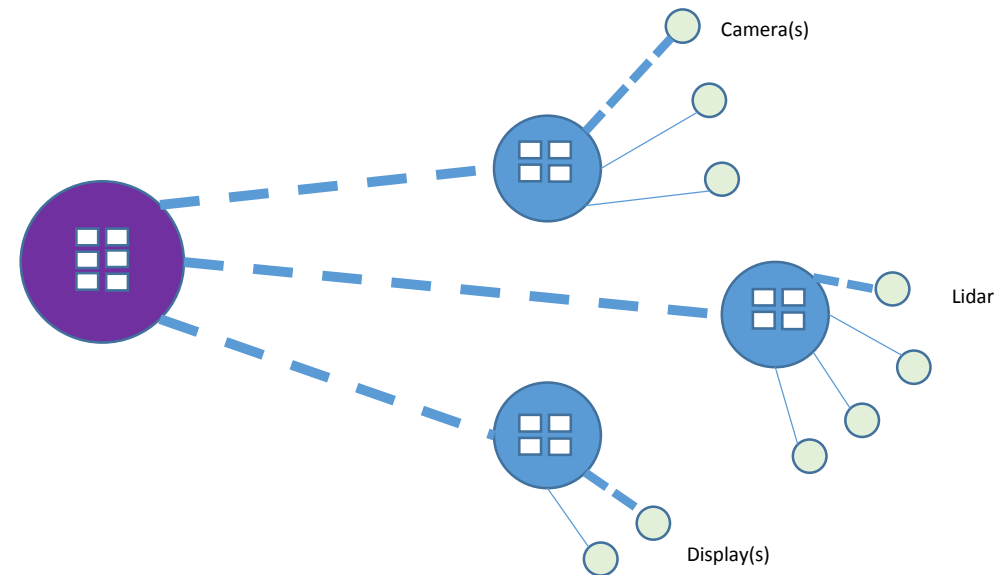


# Use-Cases - Bandwidth



What potentially drives more bandwidth?

- ECU sensors
  - Cameras
    - Today:  $\leq 6$  Gbps LVDS links
    - Tomorrow:  $> 6$  Gbps ?
  - Lidar/radar
    - Today:  $\leq 1$  Gbps Ethernet
    - Tomorrow:  $> 1$  Gbps ?
  - Displays



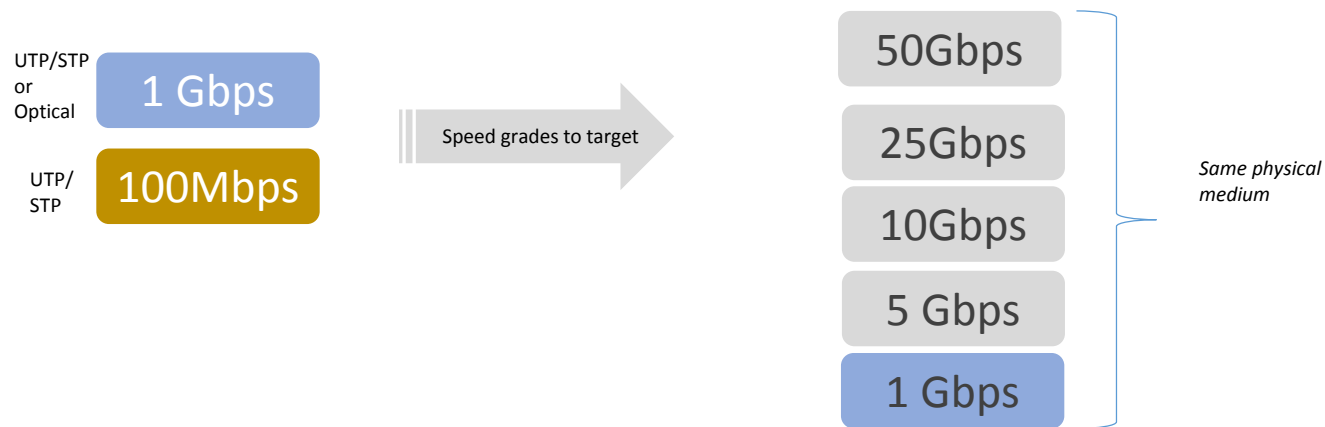
*"Tomorrow: one the day after today"*

# REQUIREMENTS

- Speed
- Optical Physical Medium & Connectors
- Power Requirements
- Network capabilities
- Settings
- Electromagnetic Compatibility (EMC)
- Lifetime on components
- Other

# Speed Requirements

Potential speed grades for future

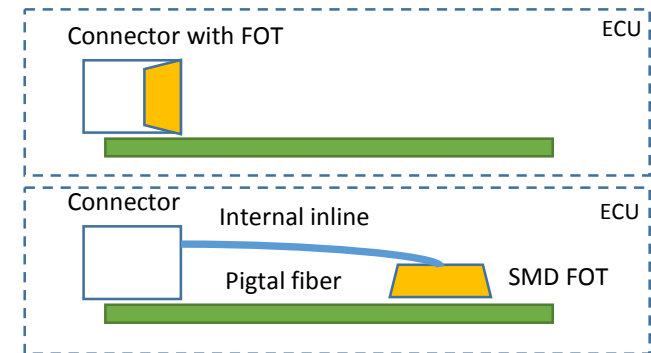
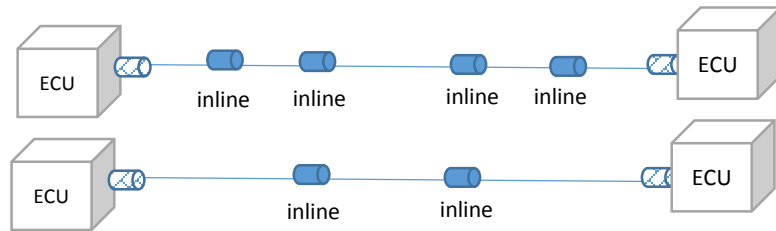


Important:

- It shall be possible to use the same physical medium.
- PHY (Transceiver) support of multiple speed grades is interesting. However, cost optimization important.

# Optical Physical Medium & Connectors

- 4 inline connectors on total length 15m (e.g. SMD FOT with pigtail (internal inlines within ECU) to connector and 2 in lines within vehicle)



- **Connectors**

- **Sealed** (water tight, dust protection, temperature etc.) -> e.g. cameras
- **Unsealed** (dust protection, temperature etc.)
  
- Single connector(s)
- Multi-pin connectors (Multiple Optical connectors AND Optical + UTP harness)

Challenges: connector size

# Optical Physical Layer & Transceiver

- Operating temperature (ambient) range challenge-> Optical Physical Medium & PHY (transceiver, FOT):
  - $T_{\min} - 40^{\circ}\text{C}$
  - $T_{\max} +105^{\circ}\text{C}$   
Note. There are surfaces / areas which might require higher temperatures .  $T_{\max} +125^{\circ}\text{C}$
- Bending attenuation challenge
  - POF -> bending diameter  $90^{\circ}$  that has 25 mm radius without no rise in attenuation
  - Next Physical medium: Bending diameter  $90^{\circ}$  bending that has less than 10 mm radius without no rise in attenuation.

- Interesting harnesses

- Single Optical (full duplex) 

- Full duplex 

- Hybrid cable 



# Optical Wakeup - Power Requirements

- Support of Optical Wakeup and Sleep
  - Established link (“link up”) in less than 100ms
- Transceiver: 35uA in sleep at 12v (Vbat)

# Settings

- Auto-Negotiation
  - Keep as optional feature.
  - Default: Disabled to save booting time.
  
- Speed grade
  - Forced by configuration
    - Symmetric
    - Asymmetric (e.g. configurable speed of backchannel for control data for e.g. a camera.)

# Network capabilities

- Interesting capabilities
  - Time Sensitive Networking (TSN)
  - “Tunneling” PCIe
  - Datalink security

# Electromagnetic Compatibility (EMC)

- The optical link and components shall be capable to support radiated immunity test

Limits 200 - 18000 MHz

Band	Frequency Range [MHz]		Test level [V/m]	Modulation
5	200 - 800		200	CW, AM 80% Pulsed PRR = 18 Hz, PD = 28 msec
6	800 - 6000		140	CW, Pulsed PRR = 217 Hz, PD = 0.57 msec
7	1200 - 1400		1200	
8	2700 - 3100		1200	
9	8500 - 10500		600	Pulsed PRR= 300 Hz, PD = 3 usec, gated by a pulse PRR=1 Hz, PD=200 msec
10	15700 - 17700		300	

# Lifetime on components

Operation state	Operation condition	Operational time
Life time		≥ 15 years FIC C functions ≥ 10 years FIC A/B functions
Continuous feed or activity	OC1	≥ 131 500h FIC C functions ≥ 88 000h FIC A/B functions
Driving, (In vehicle usage)	OC2	≥ 20.000 h FIC C functions, ≥ 13.500 h FIC A/B functions available. Loads may be restricted.
Preconditioning only	OC3	≥ 6.000 h
Traction battery vehicles "Plugged in" charging/preconditioning	OC4	≥ 30.000 h
Connected functionality	OC5	> 1.500 h
Other functionalities active in non-driving states		Not specified

FIC = Function Important Classification  
 Level of availability needed of a functionality while driving a vehicle.  
 Level C is essential to the safe operation and control of the vehicle.

# Components other

- EMC Radiated Immunity
- Radiated Emissions
- Bulk Current Injection
- Conducted Immunity
- Conducted Emissions
  
- Material testing
- Vibration
- Thermal Shock
- Electrical Testing
- Mechanical Testing
- Temperature
- Humidity
- Rain
- Salt Fog/Spray
- Sand & Dust