



# MDI definition selection based on rational facts

---

Markus Dittmann

# Fiber Optics in Automotive



FO data links used in automotive all based 650nm LED and 1mm SI-POF

- D2B optical (IEC 61030): Infotainment
  - Used in some car types by Mercedes since 1998
  - Ring topology
- ByteFlight: Safety
  - Used in some car types by BMW since 2001
  - Active star topology with bidirectional over simplex POF
- MOST25 / 150: Infotainment
  - Products on the road in series-production cars since 2001
  - Ring topology
  - MDI defined as 1mm; NA=0.5; 650nm; AOP min/max;
  - Connector (receptacle) drawing(s) to define the mechanical interface(s)
  - Butt coupling of fibers with no physical contact allowed by design and tolerances
  - Specification for 150Mbps established in 2007
- 1000BASE-RHC (IEEE Std 802.3bv): Extended temperature, any use cases
  - MDI defined as 1mm SI POF NA 0.5; AOP; TX launch condition restricted by EAF limit
  - Products on the road since 2020
  - Mechanical interfaces defined in ISO 21111-4 (not referenced in IEEE Std 802.3bv)
  - Butt coupling of fibers with no physical contact allowed by design and tolerances

# Concept competition on 5 Gbps

---



Issued by the MOST Cooperation in 2011  
(but MOST Co stopped all activities on new standards around 2015)

Public discussion at the MOST-Forum (Conference) in Esslingen/ Germany in 2013 and 2014 and in automotive electronic magazines

Proposals and discussed points:

- Multimode glass fiber 50 $\mu$ m vs 85 $\mu$ m core diameter
- Trading fiber bandwidth for greater core diameter to gain relaxed alignment precision
- Butt coupling (physical contact) vs expanded beam (molded lenses)
- Reliability of 850nm VCSEL was investigated targeting < 10 FIT over car lifetime
- Reliability of connector – influence of dust particles on insertion loss
- (FOT) package and connector manufacturing and assembly steps

# MDI definition should be included in P802.3cz

---

- MDI definition will influence the link budget PHY to PHY
- Basic decision on butt coupling (physical contact, PC) vs expanded beam optics (EBO) is required
- Contributions proposing PC vs contributions proposing EBO
- Decision should be based on rational facts and scientific proofs as well as relative cost

# Topics to be addressed for MDI decision

---



- Cable harness is almost impossible to be changed if cable and terminal fails!
- Mission profile projecting car's lifetime (service life) requirements are not defined for FO components in automotive yet.
  - It should be assumed to be the same of communications electrical components
  - Mating cycles, robustness to contamination / cleanability
  - Arctic, desert and tropic climate profiles to be taken into account
    - Temperature: min, max, cycles
    - Humidity: cycles, temperature overlay
  - Vibration and shock: frequency, amplitude and incidence
- The connectors have to support assembly requirements: e.g. optical connectors are plugged in the car assembly plant, where oil, grease, dust, and metallic particles are around caused by the assembly process itself
- No meaningful test setups and pass criteria are defined yet to validate fiber cable and FO components in automotive to validate for lifetime reliability. Potential failure mechanisms needs to be addressed by these test setups.

# Data-centers vs. automotive



- Millions of 50 um MM PC connections are used everyday in data-centers and laboratory environments
- Bulkhead and connectors cleaners must be used to either avoid permanent damaging of the interfaces or prevent IL increase
  - E.g. in laboratories, cleaners have to be used with optical test and measurements equipment to avoid very expensive reparations
  - The reality is that the contamination is not just soft particles floating around but it gets usually being attached to interfaces
  - Experience demonstrates contamination is composed by a mix of different materials, not just dust, e.g. metallic particles, grease
  - Contamination composed by hard particles scratches the interface surfaces due to the spring force of the PC connection
- 1mm SI-POF, which has been a success in automotive applications, provides an interface 400 times larger than 50 um MM PC and no contact is permitted
- P802.3cz should leverage 50 um core diameter fibers from the data-centers market to take advantage of the economy scale. Use of thicker fibers is against the receiver sensitivity
- How to fill the gap between data-center and automotive?



Thank you