First considerations for the 10Mbps@15m channel

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Supporters:
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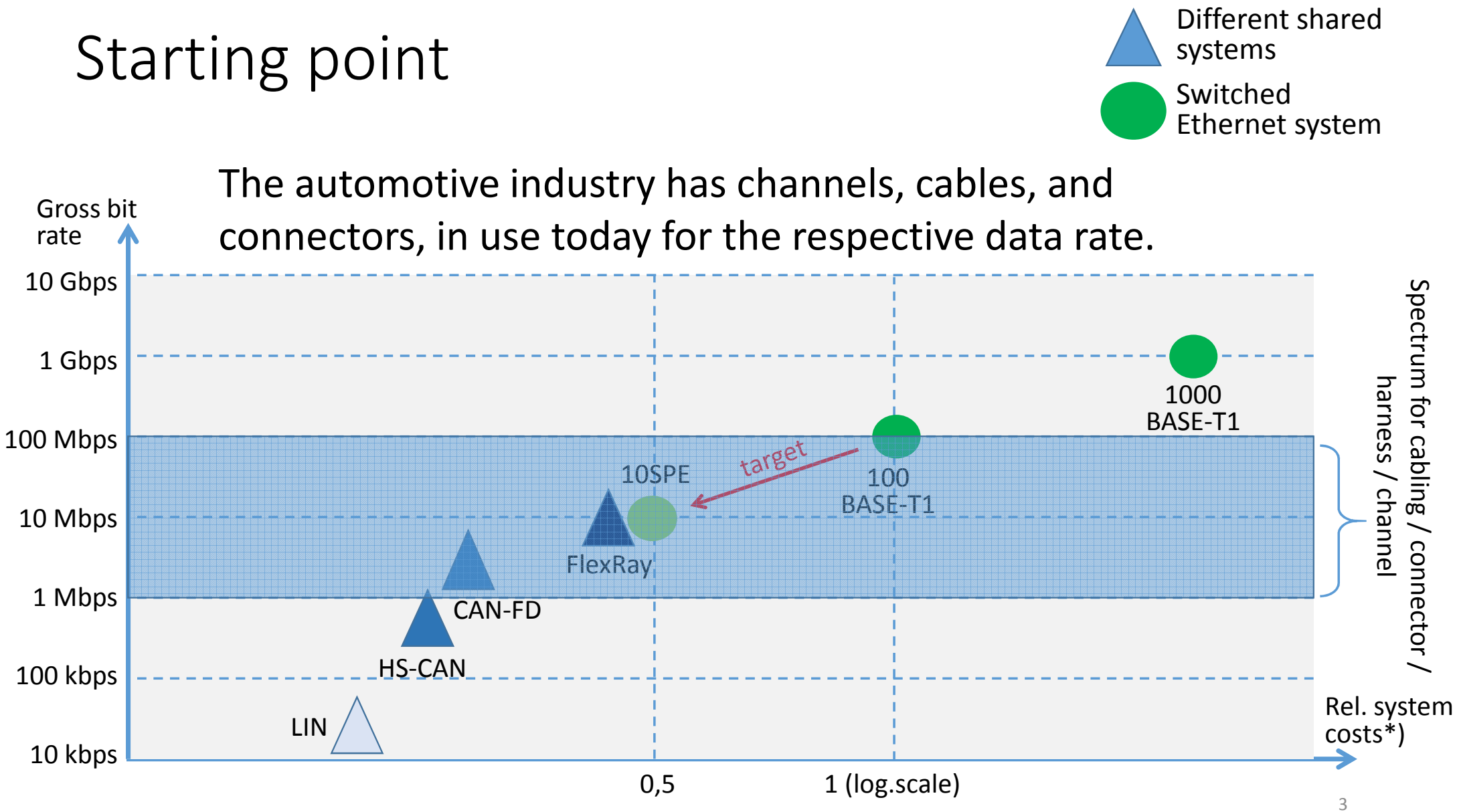
Content

- Basic considerations for the 10Mbps@15m P2P link
- Suitability of the 100BASE-T1 channel for 10SPE@15m P2P
  - 100BASE-T1 channel at lower frequencies
  - Further relaxation
- Recommended frequency range for 10SPE@15m
  - Considerations for 10Mbps@15m Power over Dataline
- Conclusions and open questions

Starting point



*) The cost values are very dependent on the exact topology that is being compared, this chart gives an indication only.

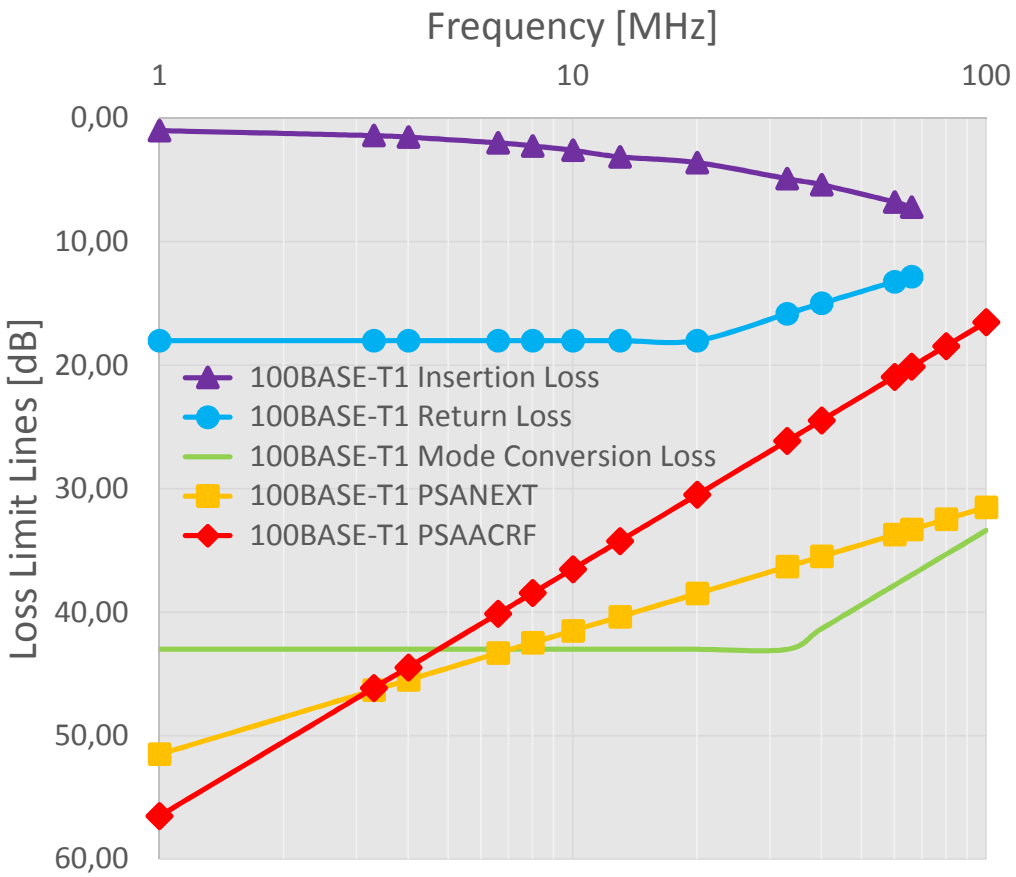
Cables & connectors used

- The starting point for 100BASE-T1 cabling was FlexRay cabling. 100BASE-T1 is UTP used with a smaller twist rate and PP*) instead of PVC.
  - ➢ PP is better temperature resistant and more resistant to XTALK
  - ➢ Smaller twist rate proved better in the mode conversion
- In consequence the 100BASE-T1 cabling is also considered for CAN-FD @2Mbps@BMW.
- For qualification and handling it also has advantages to use the same cabling for different technologies.

➢ It is therefore reasonable to start with the same cabling basis for 10SPE@15m as for 100BASE-T1, i.e. UTP, non-PVC, non-jacketed

*) PP = Polypropylene

100BASE-T1 channel parameters



- Can they be extended to lower frequency ranges?

$$IL = \begin{cases} 1+1.6x(f-1)/9dB & \text{for } 1 \text{ to } <10MHz \\ 2.6+2.3x(f-10)/23dB & \text{for } 10 \text{ to } <33MHz \\ 4.9+2.3x(f-33)/33dB & \text{for } 33 \text{ to } 66MHz \end{cases}$$

$$RL = \begin{cases} 18dB & \text{for } 1MHz \text{ to } 20MHz \\ 18-10x\log10(f/20)dB & \text{for } 20MHz \text{ to } 66MHz \end{cases}$$

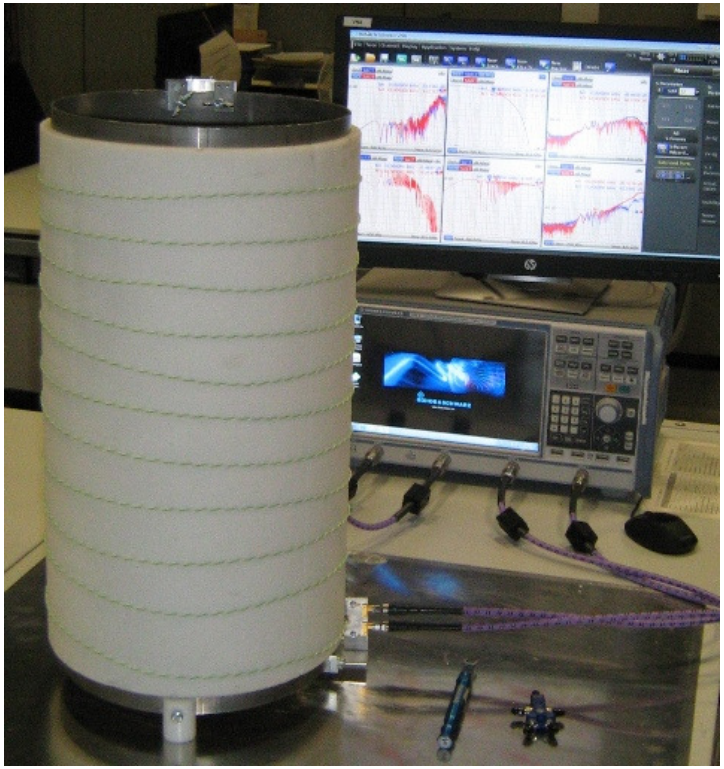
$$MCL = \begin{cases} 43dB & \text{for } 1 \text{ to } 33MHz \\ 43-20x\log10(f/33)dB & \text{for } 33 \text{ to } 200MHz \end{cases}$$

PSANEXT = 31.5-10xlog10(f/100)dB for 1 to 100MHz
PSAACRF = 16.5-20xlog10(f/100)dB for 1 to 100MHz

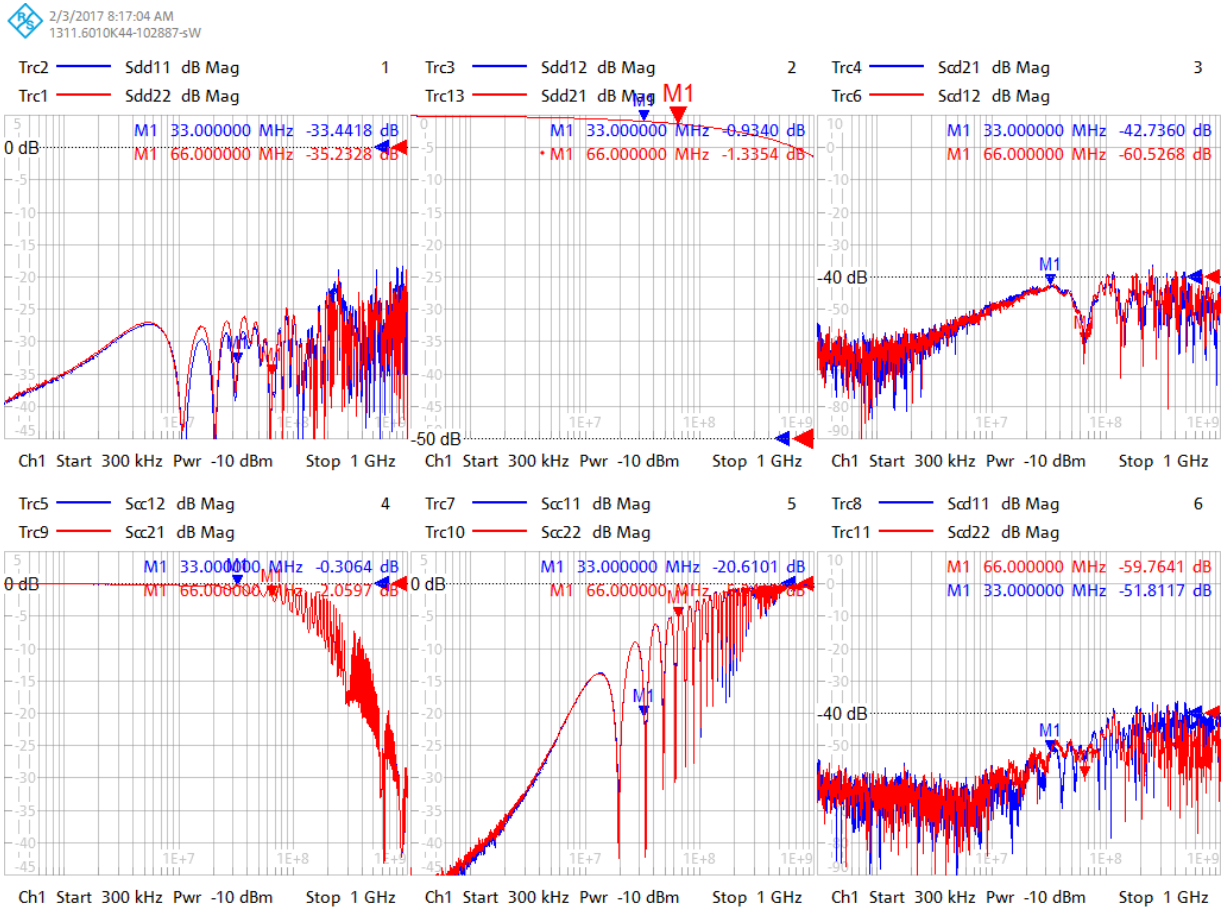
Measurement set-up

VNA S-parameter measurements

- DUT 100BASE-T1 UTP cable 0,35mm² PP, 10m
- Starting at 300kHz
- Drum measurement according to OPEN Alliance channel component specification, Cdim 200 Ohm



Measurement results



No unexpected non-linear behavior for S-parameters below 1MHz

XTALK in respect to CAN, CAN-FD, FlexRay. Model for frequencies <1MHz? Necessary?

Can the requirements be further relaxed?*)

- Is it possible to relax the twist rate?
- Is it possible to relax the connector pinning requirements (see next slide)?
- Is it possible to relax the untwist area requirements?

=> Choose appropriate frequency range to easy implementation

*) In comparison to what has been defined for 100BASE-T1 in “OPEN Alliance BroadR-Reach® Definitions for Communication Channel”, Version 2.0

Pinning requirements

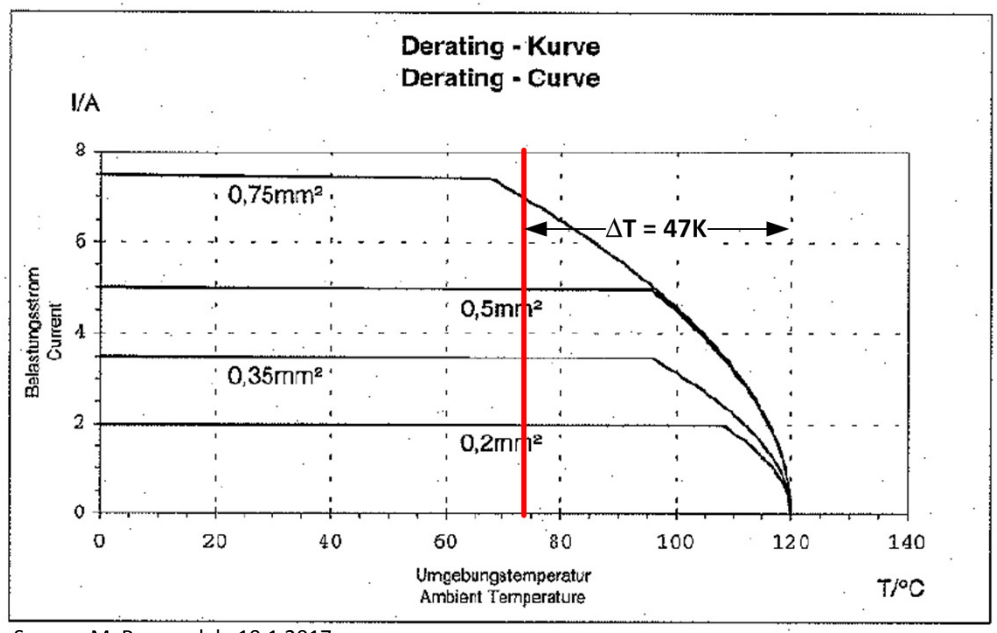
To allow more flexible pinning configurations in multi-pin connectors, there should be a reasonable add-on for the connector RF parameters.

- Allow various multi-pin connectors as well with higher pitch, e.g. 5mm (TBD)
  → increased Impedance mismatch@connector, higher RL@high frequencies
- Allow using “higher” rows in right angled multi pin connectors.
  → increased IL for connector
- Allow more flexible pinning configuration for adjacent channels (no spare pins, etc), pins on different rows of a right angled connector, relaxation of untwist length requirements for connector assembly
  → increased crosstalk and mode conversion@higher frequencies
  (can be overcome by decreased upper frequency limit)

Measurements from connector vendors (or other contributors who are able to measure a connector) to estimate reasonable increase of RF parameters is necessary.

Impact of frequency range on 10Mbps Power over Dataline

40W (@Ubatt=12V) possible with
0,35mm² cables and MQS/nMQS @3,5A



Source: M. Respondek; 19.1.2017;

To allow PoDL to operate with reasonable, the lower frequency limit should be at least comparable to 100BASE-T1. If the communication of 10SPE 15m is shifted to lower frequencies the size and cost of the parts increases.

Appropriate frequency range

- If the lower frequency is should at least comparable to 100BASE-T1, transient disturbers from EV‘s (electrical vehicles) can be avoided.
- The higher frequency limit may be reduced somehow (relaxed crosstalk requirements for connectors, reduced EMC burden, relaxation of untwist length).

=> For EMC reasons, there is a “sweet spot” between
~2 MHz and 38MHz, because there are no applications which require stringent emission requirements (immunity and basic emission requirements still apply). See following slides

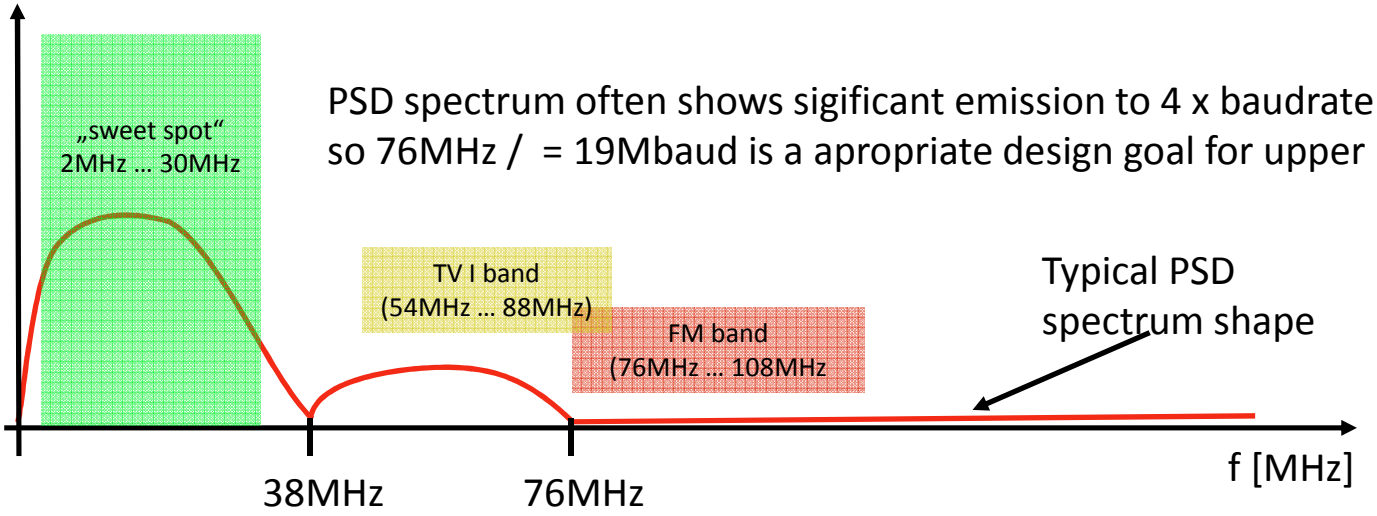
Channel considerations – „sweet spot“ (1)

- Stringent EMC limits apply to the following bands:
  - MW band (0,52MHz – 1,73MHz)
  - [KW49m (short wave) band (5,8MHz…6,3MHz)] today not in use.

  - Here is the gap for 10SPE

  - [TVI band (54MHz – 88MHz)],
    TVI no longer in use today, but probably for new applications?
  - **FM band** **(76MHz – 108MHz) most critical**
  - TVII band (99MHz – 108MHz)
  - **DAB** **(174MHz – 241MHz) most critical**

Channel considerations – „sweet spot“ (2)



A frequency range between roughly 2MHz…30MHz seems to be a „sweet spot“ for 10SPE@15m in terms of emission and low frequency immunity/PoDL. This range would also allow for acceptable relaxation of limits in the higher frequencies to allow freedom of implementation for channel (connector). Remark: Immunity and basic emission requirements still apply.

Conclusion

- The cabling choices for CAN-FD/100BASE-T1@BMW are a good starting point for the channel definition for 10SPE@15m
- As both are the same, the channel model for 100BASE-T1 provides a basis for the 10SPE@15m channel
- First measurements of S-parameters show no unexpected, non-linear behavior for frequencies between 300kHz and 1MHz
- However, because of EMC and PoDL considerations, a “sweet spot” between 2MHz and 30MHz for PSD is recommended
- Input requested:
  - Feedback from PHY and cable manufacturers on feasibility and suitable frequency range
  - Investigation on impact on relaxation of harness requirements
  - Final definition of the channel model

Channel adaptation from 100BASE-T1 to 10SPE@15m

$$IL = \begin{cases} 1dB & \text{for } 0.3 \text{ to } < 1MHz \\ 1+1.6x(f-1)/9dB & \text{for } 1 \text{ to } <10MHz \\ 2.6+2.3x(f-10)/23dB & \text{for } 10 \text{ to } <33MHz \\ 4.9+2.3x(f-33)/33dB & \text{for } 33 \text{ to } 66MHz \end{cases}$$

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