Additional Link Segment Delay Considerations

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Scott Muma, Steve Gorshe

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Supporters

- Mehmet Tazebay – Broadcom
- Kirsten Matheus – BMW
- Claude Gauthier – NXP
- Kamal Dalmia – NXP
- Ramanjit Ahuja – onsemi

Introduction

This presentation continues the discussion on defining a Maximum Link Delay specification for 802.3dm.

- ❑ Review and breakdown of data on link segment delays, reach and market estimates.
- ❑ Proposal for link delay based on available data and expected automotive operating conditions

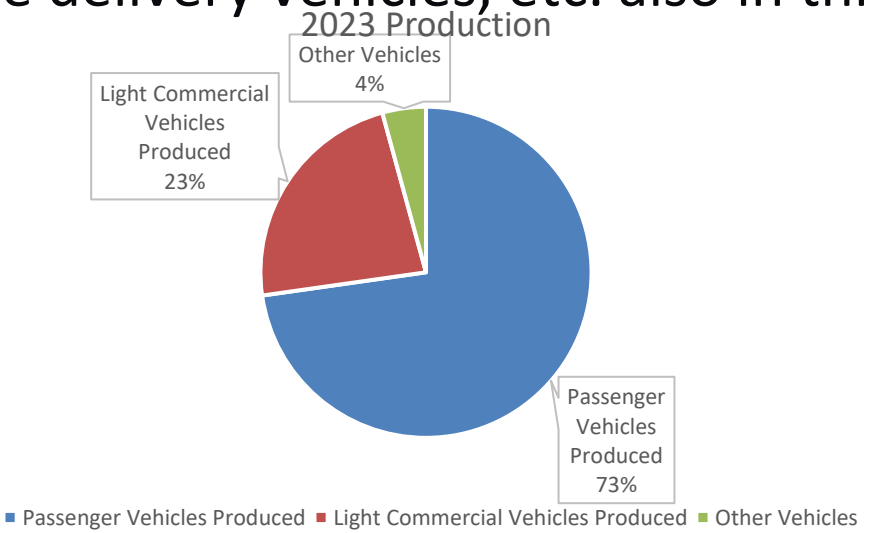
- ❑ Previous presentations to reference:
  - ❑ https://www.ieee802.org/3/dm/public/0925/Houck_Cordaro_Chimento_3dm_01a_0925.pdf
  - ❑ https://www.ieee802.org/3/dm/public/092525/houck_etal_3dm_01a_250925.pdf
  - ❑ https://www.ieee802.org/3/dm/public/0925/Gauthier_Wang_3dm_01c_091525.pdf
  - ❑ https://www.ieee802.org/3/dm/public/0525/gorshe_3dm_01_2505.pdf

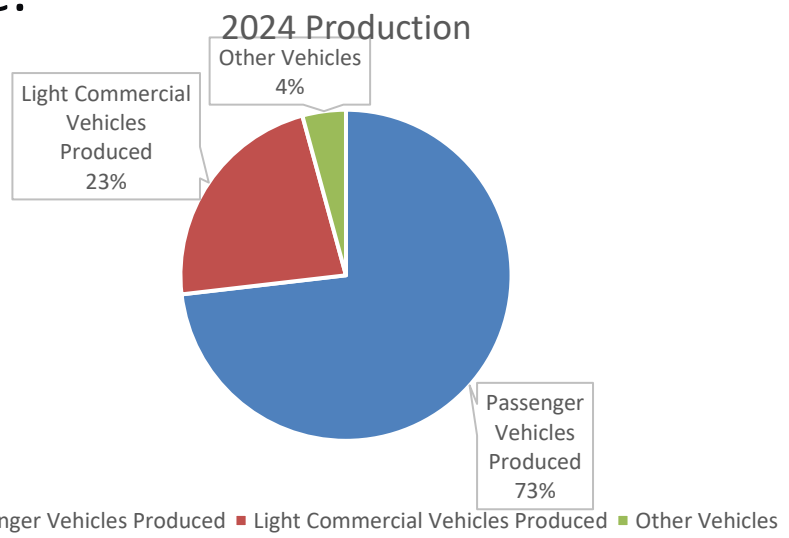
Available Market Information

- https://www.ieee802.org/3/dm/public/092525/houck_etal_3dm_01a_250925.pdf presented Motor vehicle market data and a past request for cables up to 40m reach and labelled previous statements that cables up to 15m are adequate for the majority of use cases as “misleading”. However, it was not clear:
  - how many of the ~26.4M commercial vehicles sold per year could benefit from cables up to 40m in length
  - if cables >15m in length would be a large percentage of the total links required.
- Commercial vehicles present a diverse set of characteristics, and can be further broken down into Light Commercial Vehicles, Busses, Heavy Trucks, and so on with different physical characteristics. Within each vehicle a diversity of link lengths will be used.
- This breakdown is provided by the same organization (OICA) cited in the presentation above.

Available Market Information

- Most light commercial vehicles can be covered by 15m cables as these are cargo vans and other vehicles < 3.5tons gross vehicle weight rating (GVWR).
  - A very long LCV example is the extended length Mercedes-Benz Sprinter with an OVERALL length of 7.37m (290”) https://www.mbvans.com/en/sprinter/cargo-van See Cargo Van 3500XD for example.
  - Even doubling that is less than 15m, and vehicles that increase in length do not typically increase proportionally in height, width, and number of corners. Doubling length is not always a useful rule of thumb.
- Light commercial vehicles can also include some vans and pickup trucks (up to 3.5 tons GVWR), and these vehicles are in the 4m-6m range. Large rental moving trucks have 7m box cargo length, so perhaps 8m total length. Many moving trucks/cube vans, appliance delivery vehicles, etc. also in this range.





Available Market Information

- In 2023 and 2024 of the approximately 93M total motor vehicles produced each year the breakdown can be approximated as Passenger+LCV = 88Million / Other = 5Million
  - 93M total motor vehicles produced in 2023 and 2024
    - https://oica.net/wp-content/uploads/2025/10/By-country-region-2024.pdf
  - 21M Light Commercial Vehicles produced in 2023 and 2024
    - https://oica.net/wp-content/uploads/2025/10/Light-Commercial-Vehicles-2024.pdf
  - 67M Passenger Cars produced in 2023 and 2024 approximately 67M Passenger Cars were produced
    - https://oica.net/wp-content/uploads/2025/10/Passenger-Cars-2024.pdf
  - RV's, agricultural equipment, etc. not included since they do not follow the same reporting.
- Remainder <5M vehicles such as heavy trucks and about 300k busses per year, which is around 5%.
- The need for >15m cables is driven by ~5% of total vehicles, however the total number of cables is even more relevant. Based on expected camera use cases it seems unlikely that >15m cables make up more than 1% of these motor vehicle use cases.
- If non-automotive markets are to be considered, it would be secondary or on an all-things-equal basis since the project scope is specifically "**optimized for automotive end-node camera links**" (refer to PAR)

MICROCHIP

Cable Data

- Page 5 of https://www.ieee802.org/3/dm/public/0925/Houck_Cordaro_Chimento_3dm_01a_0925.pdf points to a previous Madrid presentation which points to 0.8dB/m for CX44c from https://ieee802.org/3/dm/public/adhoc/062625/Koeppendoerfer_3dm_coax_performanve_01_06262025.pdf however, that presentation measured just 2 samples of a cable and was about aging solely due to temperature. 0.8dB/m is not mentioned. 0.8dB/m is about 15% lower than the ISO limit line at room temperature. Other aging effects also need to be considered.
- Page 5 then uses 5ns/m for delay. Is this delay for the same CX44c cable? Cables with lower insertion loss often have lower propagation delay, so if lower insertion loss can be arbitrarily chosen, then can also choose lower propagation delay cable (4.26ns/m).
- It would be more useful to reference a specific datasheet/cable that is known to exist than to use single-measurement parameters from multiple different presentations that may not belong to the same cable or may not be possible under the necessary operating conditions in production volumes when aging and other effects are considered.

Cable Data

- Page 6 of https://www.ieee802.org/3/dm/public/0925/Houck_Cordaro_Chimento_3dm_01a_0925.pdf discusses CX031 cable from https://www.ieee802.org/3/dm/public/adhoc/082125/mueller_3dm_01a_08_21_25.pdf as a reference which reported insertion loss measured at room temperature on a single sample of a cable assembly. 0.8dB/m is used here too, but it's not clear why this is also correct for this cable, or if this from the CX44c cable estimation. Instead of pointing to a single presentation which didn't seem to provide an insertion loss specification it would be more robust to use agreed ISO cable specifications or point to published datasheet specifications for cables that provide the desired better performance.
- The data may or may not be correct, but it's derived from presentations which did not seem to be intending to provide new insertion loss specifications or to pair delays with certain losses. Is it reasonable for 802.3dm to treat it as data?
- Given that cable insertion loss is sensitive to temperature an end system might choose an operating temperature that is much lower than the expected automotive temperature ranges that 802.3dm will be optimized for. This is true for all other 802.3 specifications but other clauses don't seem to have specified delay for the lowest possible operating temperature, they are specified for the worst-case: delay at maximum loss/temperature.
- If multiple operating temperature ranges need to be supported then that needs to be properly defined and considered.

Summary

- Propose a Maximum link delay specification of 90ns.
  - Maximum propagation delay of 90ns allows for up to 20m cables using lower-loss cables with lower propagation delays (Vf=0.78) and >15m for higher-loss cables with higher propagation delays (Vf=0.66).
  - This would result in loss-limited link lengths based on ISO cable limits and automotive temperature ranges.
- >95% of production motor vehicles use cases are fully covered with cable assembly mechanical lengths of up to 15m. Even higher percentage of links are covered. Data is required to explain where large numbers of >15m mechanical length links would be needed.
- Previous presentations imply the potential for lower insertion loss at lower temperatures, but considering this in the Maximum link delay would be inconsistent with previous 802.3 specifications.
  - Is there a need for multiple operating temperature ranges?

Questions?