Automotive Imager and 25Gbps

IEEE 802.3

ISAAC Study Group

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Conrad Zerna

Aviva Links Inc.

Background

- Clarify the existing eco system of asymmetrical data communication for Automotive cameras
  - Incumbents
  - Standards

- Automotive cameras

- Automotive imagers

- On PAR/Objectives

Incumbent Technologies

- SerDes are advertised with line rates
- Available payload data rates are lower

Technology (year)	Line rate [Gbps]	Payload data rate [Gbps]	Comment
FPD-Link II (2006)	1.5	ca. 1.35	
GMSL1 (2008)	3.125	ca. 2.2	
FPD-Link III (2010)	2 - 4.16	up to ca. 3.75	
GMSL2 (2018)	6.0	ca. 4.2	Supports up to 1.5Gbps line rate upstream
GMSL3 (2021)	12.0	ca. 8.4 - 9.0	
FPD-Link IV (2022)	7.55	ca. 6.5	Also ca. 13.0 Gbps payload on short 5m length

(line rates are public information, payload data rates are educated estimations)

SerDes Standards

- Automotive SerDes Alliance (ASA) "Motion Link"
  - Speed Grades marketing numbers use line rates (as incumbent SerDes technologies do)
  - Payload data rates are lower (deducing physical layer, data link layer and security overheads)
  - Camera use case motivates Speed Grades (SG) 1-3, with SG 4 to scale
  - Speed Grade 5 was specifically added for a display use case: 4k uncompressed 24bpp 60fps video
  - Higher speeds up to 64Gbps for advanced use cases are enabled through link aggregation

Speed Grade	Line rate [Gbps]	Payload rate [Gbps]
1	2	1.8
2	4	3.6
3	8	6.5
4	12	9.7
5	16	13

https://auto-serdes.org/wp-content/uploads/2022/08/201013_FraunhoferIIS_AutomotiveSerDes_ASApart.pdf

- A-PHY
  - Supports similar payload data rates (on same line rates) on single cable
  - Higher speeds up to 32Gbps are also only through link aggregation / parallel cables (Dual-downlink configuration)
 - 48 Gbps is a roadmap number, without any details of how it will be realized

  https://www.mipi.org/specifications/a-phy

Automotive Camera Applications

- **Volume camera market**
  - 2MP, 3MP, 5MP sensors
  - Parking cameras, lane assist
  - Built into tight spaces
  - Very cost sensitive
    - Enclosure size and quality
      … maximum (thermal) power dissipation inside the module
    - Less space, fewer components give an edge
      … attractiveness of integrated solutions
    - Single coax connector for everything
  - May become volume: 8 MP
    - ADAS forward looking cameras

https://www.electronicsdatasheets.com/manufacturers/texas-instruments/reference-designs/TIDA-050036

- **NOT a volume product: Stereo cam**
  - Very different cost structure and requirements
  - Much larger enclosure, higher thermal power

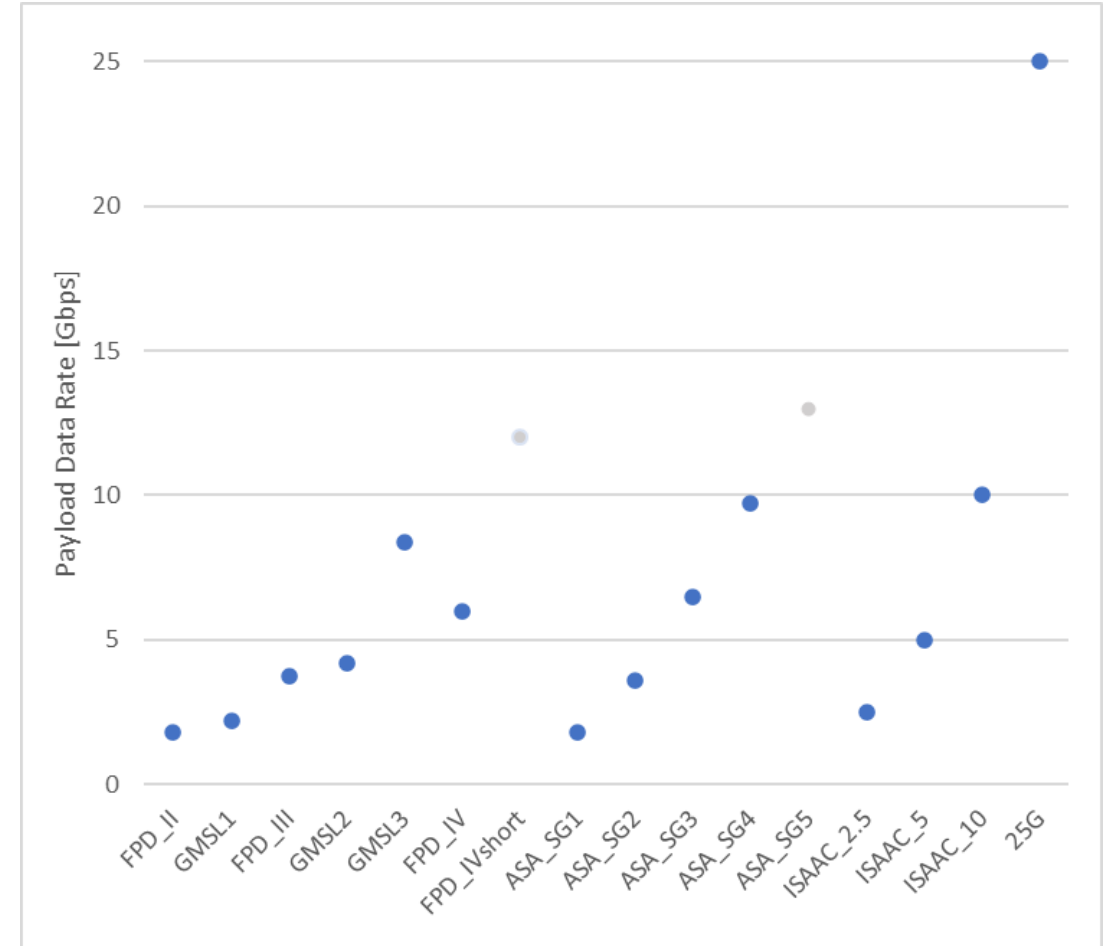https://www.caplinq.com/passive-components/sensors/automotive-camera-module/
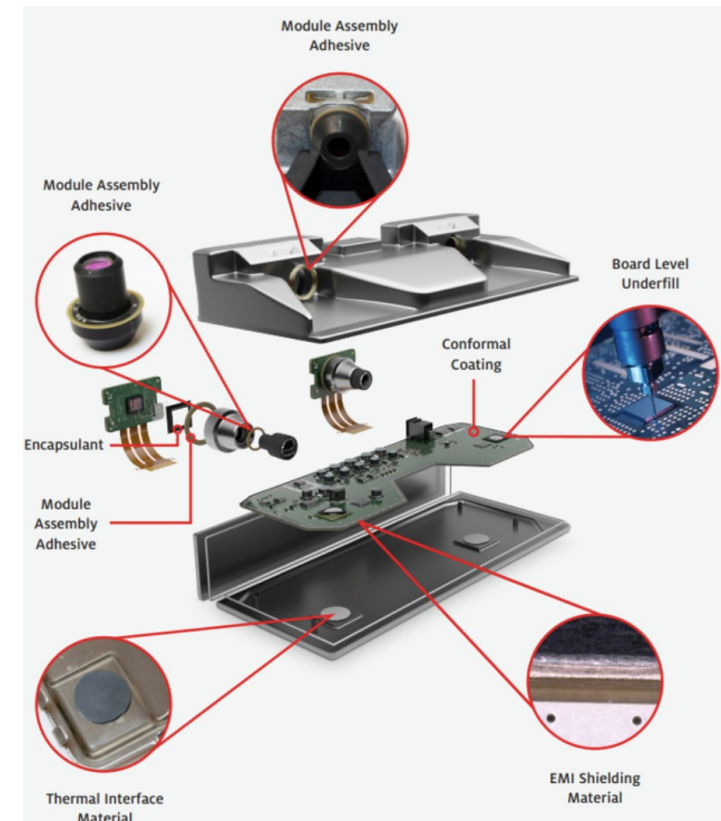
Automotive Imagers

- Automotive imager are different developments and follow different economics
- They are NOT cell phone imagers (or DSLR imagers)

- Automotive imagers
  - Always larger pixels sizes (compared to cell phones) … more pixels have to size up imager and optics
  - Have to work in more extreme light conditions and under higher temperature swings
    - TDP and heat distribution (hot spots) are directly related to image quality ... if imager conversion circuitry, encoders and/or data com interfaces produce more heat for more pixels or more data rate, they kill off any improvement in the application
    - Optics have to take almost the same temperature swing and are small (because if small spaces, and cost)
  - Automotive cameras are not sold directly to end users
    - No mindless megapixel race ... more pixels are built in and/or bit depth is increased ONLY IF it leads to an effective improvement in displayed image quality or machine vision result
    - Car end customer does not care (or even know), about the Mpxls built in (there is no technophile marketing here)
- Automotive Imager numbers will remain with highest volumes on lowest resolutions
  - 8 MP will take a smaller share than 5MP occupies
  - 12 MP might at some point be deployed, and it will take a smaller share than 8 MP
    - Same goes for 17MP (one press release so far), and this is a high-end specialty for sensor fusion, not a volume application)

On PAR/Objectives

- Payload data rate of 25G is not motivated by any Automotive volume application, nor will it be in any foreseeable future

- Technologies for higher data rates to address special applications already exist, a cost optimization exercise is not necessary

- Including 25G just opens a "can of worms"
  - Different channels requirements
  - Different technical feasibility
  - Different economics

→ Leave 25G for a separate project (to be separately motivated) or just stick with 802.3cy

Thank You!