Considerations for PAR, CSD and Objectives

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Motivation.

In the September 27, 2023 ISAAC interim meeting ~23 people voted in favor of increasing the max. data rate in the PAR from 10 to 25 Gbps in the conducted straw poll (~1/3 of the meeting participants and ~1/2 of the people participating in the straw poll).

This presentation provides background information that

1. Questions the broad market potential of and need for a new 25 Gbps link for cameras and radars,
2. Questions the applicability of an asymmetric technology to the backbone,
3. Shows some of the technical complexity 25 Gbps would add to the project,
4. Emphasizes the need to align on the requirements and scope of the project in the SG before going to TF.

Content.

1. 25 Gbps links for cameras.
2. 25 Gbps links for radars.
3. 1 Gbps upstream use case for displays.
4. The 25 Gbps channel.
5. An inherently asymmetric technology for the backbone.

1. 25 Gbps links for cameras.
Bits per pixel.

https://www.ieee802.org/3/ISAAC/public/092723/ringle_ISAAC_01_092723.pdf listed the following three examples, the last of which referring to https://www.sony-semicon.com/en/news/2023/2023091201.html .*

8MP	x	60fps	x	16b	+	20% -	~9Gbps	<10 Gbps✓
12MP	x	30fps	x	24b	+	20% -	~10Gbps	
17MP	x	30fps	x	24b	+	20% -	~15Gbps – Estimated	

Resolution

Frame rate

Bits per pixel
?

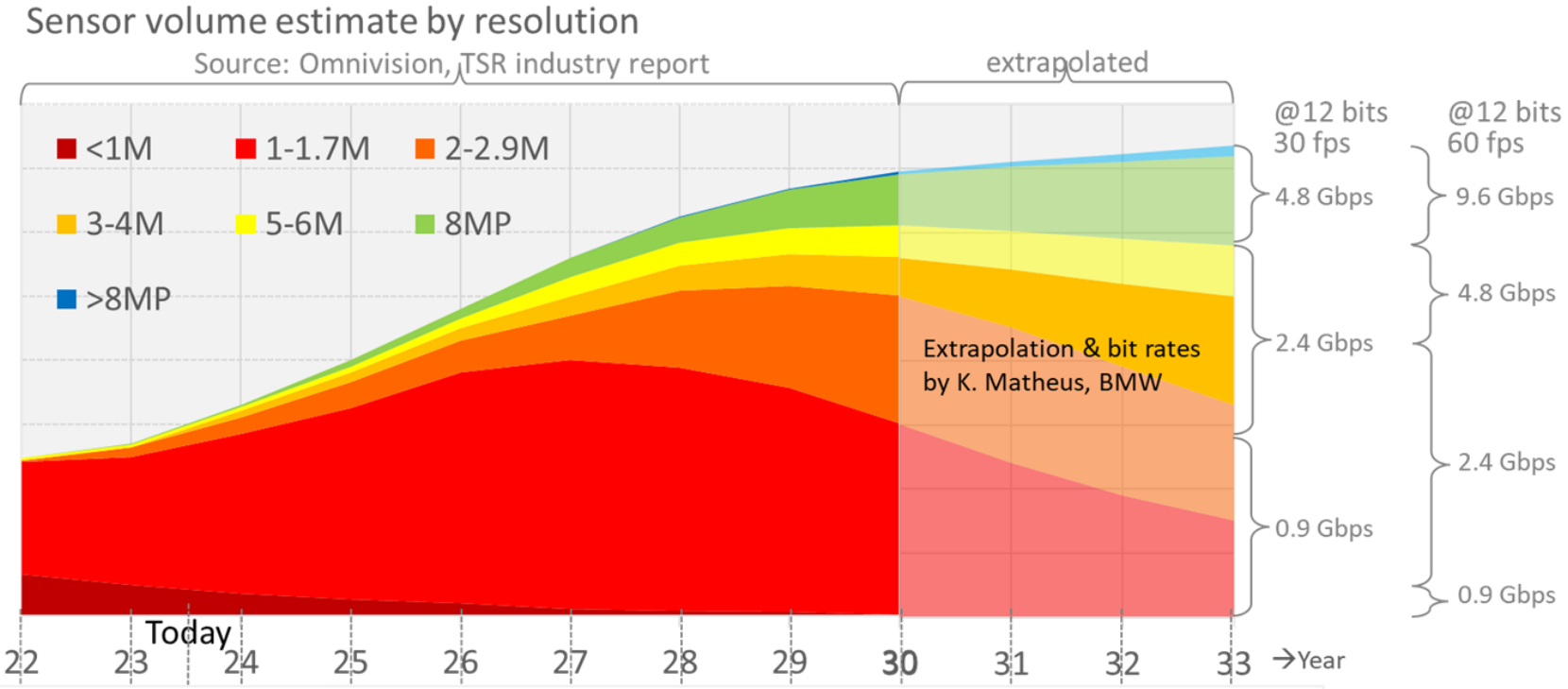
Overhead (blanking typically < 10%, package mismatch and protocol conversion)

Expert statements: a) “Mostly 12bit is ADC resolution giving 72db numerical dynamic range. Mostly 120db is requested, so 20bpp should be quantized and compressed to 12bit. Frame rate of 60fps is challenging for imagers as shorter exposure time might lead to lead to less dynamic range …” b) “The trend is 12bpp or 16bpp.”

17MP x 30fps x 12b x 20% = 7.34 Gbps < 10 Gbps✓

* On Sept. 29 the presentation uploaded was not the same one as the one shown during the meeting on Sept. 27.

1. 25 Gbps links for cameras. Market of high resolution imagers.



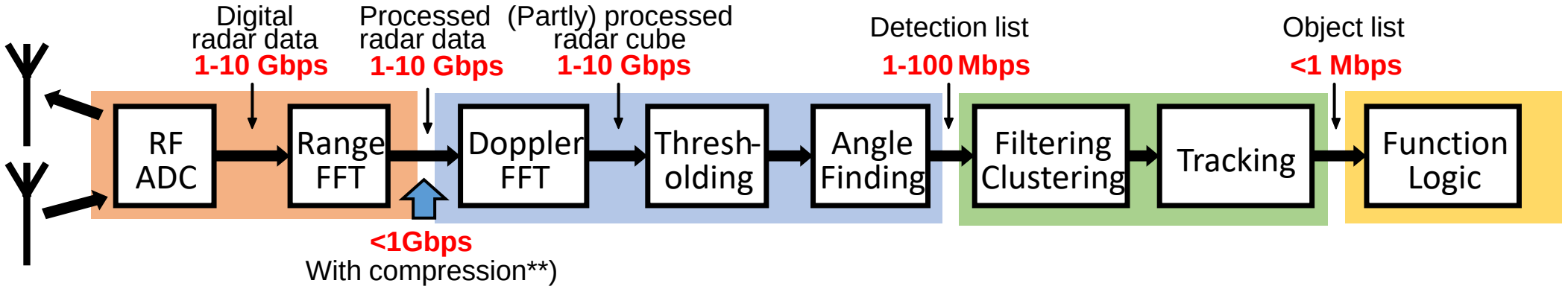
Source: https://www.ieee802.org/3/cfi/0723_1/CFI_01_0723.pdf
CFI slides had 81 supporters.

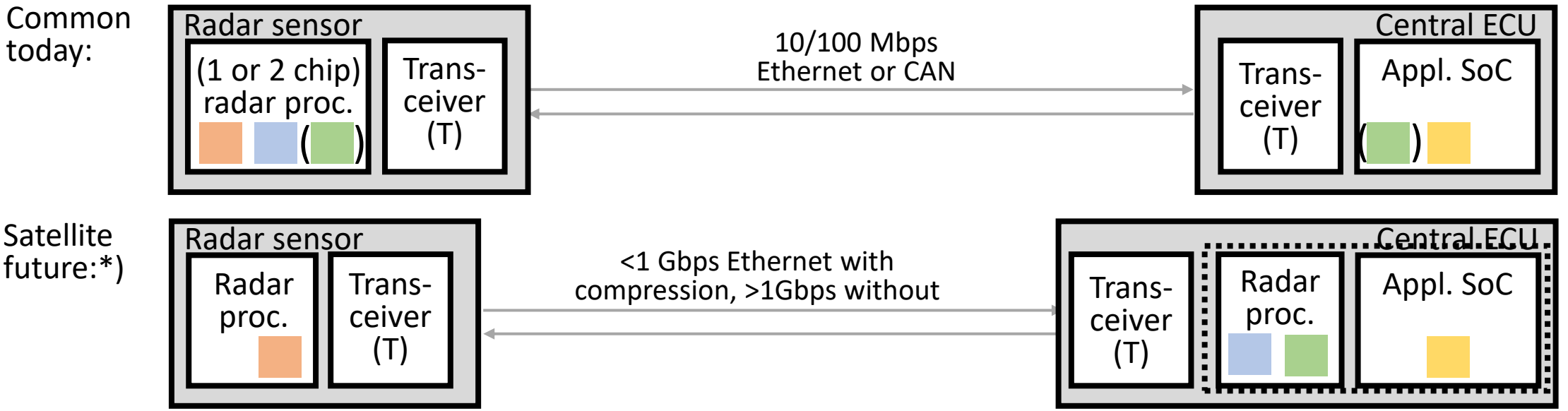
Expert feedback:

a) “Very low share for some extraordinary front looking cameras expected. Reason is cost and missing computing power of AI computer vision SoCs.”

b) “The market share data looks good. But the share of 3-4MPix will higher and the 2-2.9MPix lower. The market share for such camera links which run >10Gbps will be very low.”

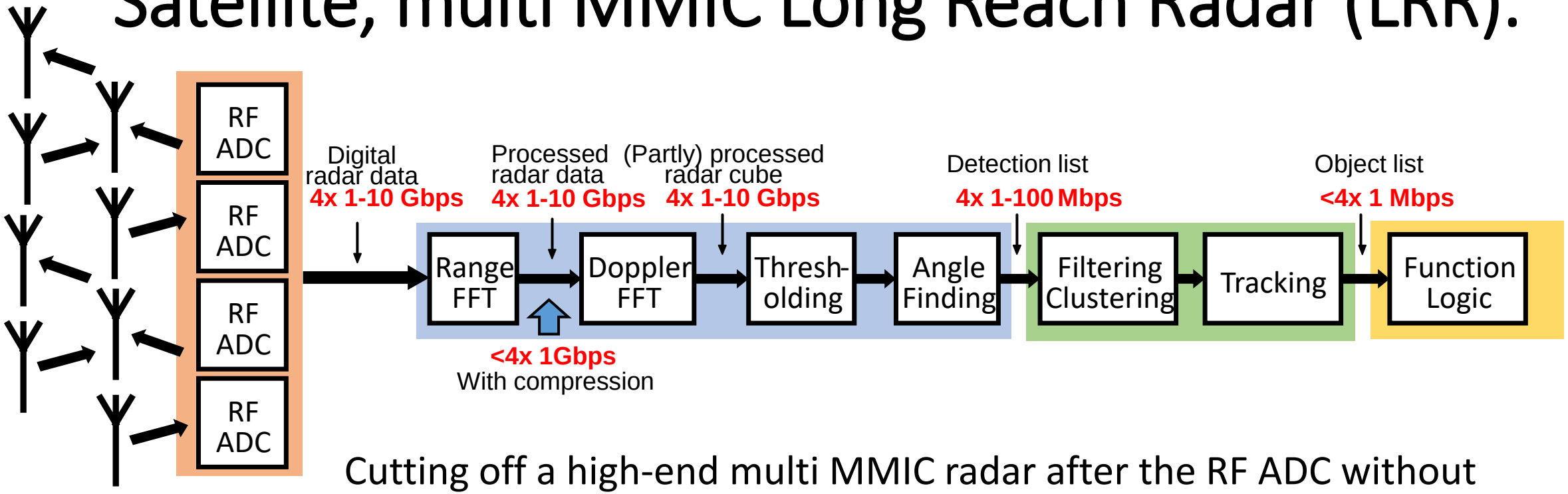
2. 25 Gbps links for radars.
Basic concept of satellite radars.





*) Cut off after RF ADC also possible. The main difference is that cutting off after the range FFT allows to filter and compress.
**) See also results from IWPC workshop on "new architectures for radars" with 80 participants from 35 companies May 31, June 1, 2023

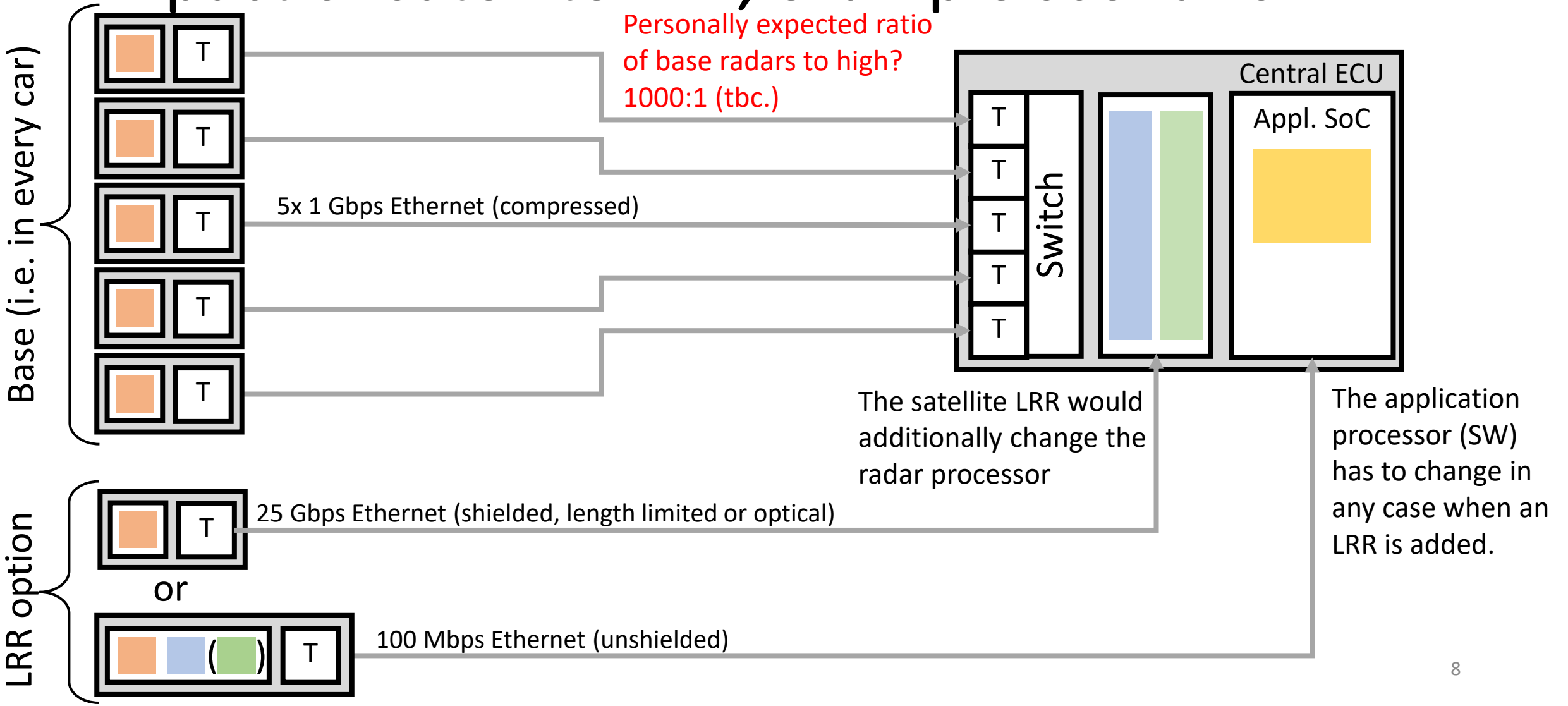
2. 25 Gbps links for radars.
Satellite, multi MMIC Long Reach Radar (LRR).



Cutting off a high-end multi MMIC radar after the RF ADC without compression, the communication link likely needs more than 10 Gbps. But,

1. Why not compress and cut off after the range FFT?
2. Why not use 802.3cy/cz? After all, no incumbents for satellite radars.
3. Does this type of radar have a relevant market share?
4. Why do a satellite architecture for this radar?

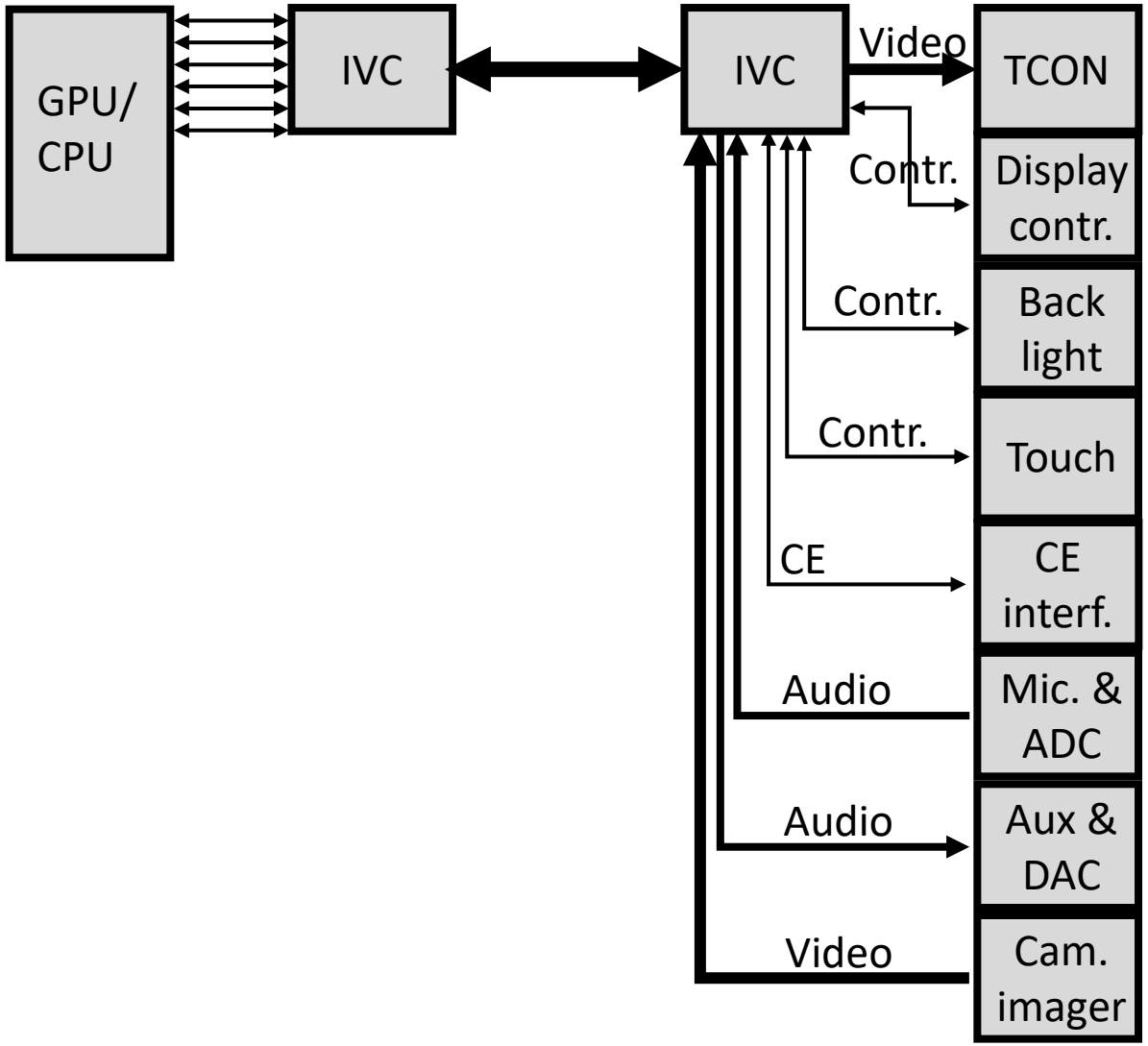
2. 25 Gbps links for radars.
Impact of satellite LRR, example scenario



2. 25 Gbps links for radars. Cameras fight a legacy, radars do not.

	Displays	Radars	Lidars	Cameras
Market size	Large (but smaller than for cameras, growth limited)	Large (outlook a little smaller than for cameras)	Very small (but growing)	Large and growing fast
Market maturity for sat. arch.	Established (but also many standalone)	New, in discussion	Various architectures proposed	Legacy is established and common
Location	Typically inside car	Typically facing outside	Facing outside	Majority facing outside
Size of housing	Large	As small as possible	Medium	As small as possible, smaller than radar
Power over	Not a requirement	In discussion	Not a requirement	A requirement
Perception	Human vision	Machine vision	Machine vision	Human and machine
Data compression	Visually lossless	Depends on architecture, in discussion	Depends on architecture	Not desired because of latency
Safety	QM, some ASIL A/B	ASIL B	ASIL B	ASIL B, QM exception
Security	Some DRM	Authentication	Authentication	Authentication
Data rate	>> 10Gbps expected	<10 Gbps expected	Depends on arch. (~10Gbps possible)	<10 Gbps expected

3. 1 Gbps upstream use case for displays. Block diagram.

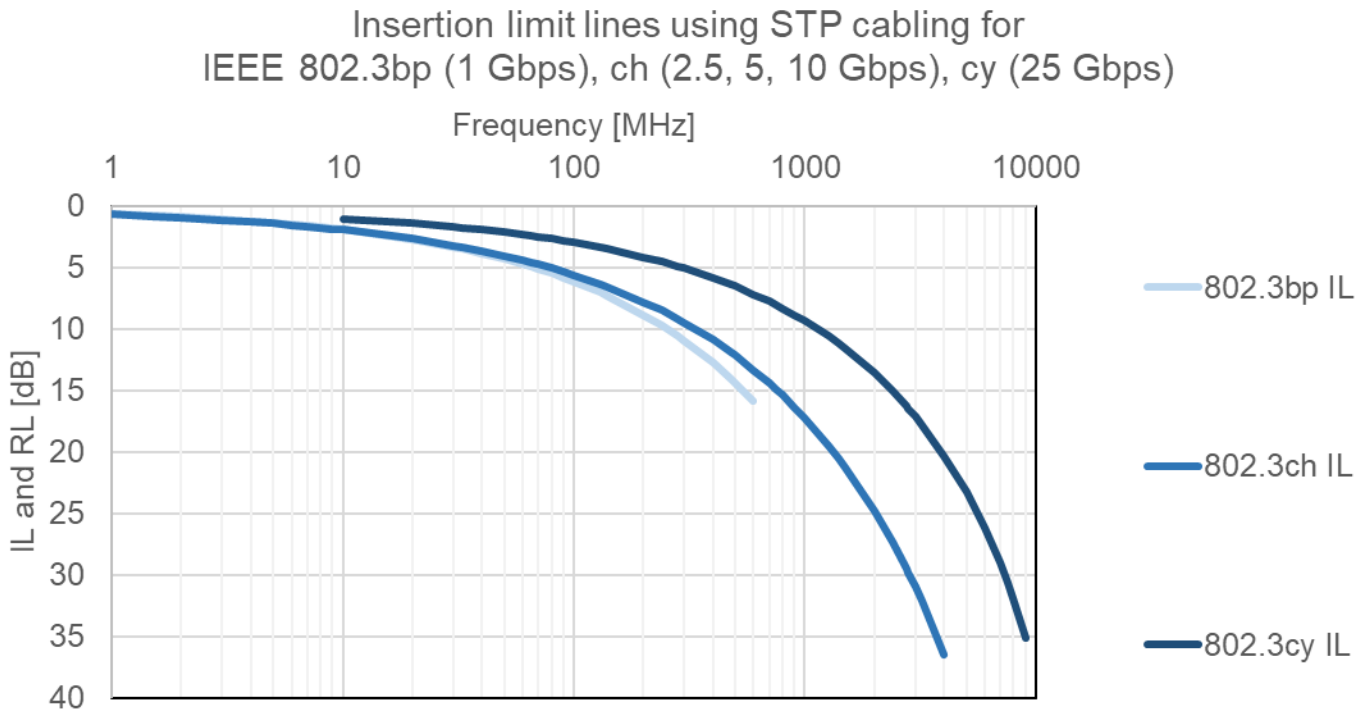


Use case: Video conferencing.

Example products with > 100Mbps upstream

- 2x 187.5 Mbps upstream https://inova-semiconductors.de/inap562taq-592taq.html
- 1x 187.5 Mbps upstream https://www.analog.com/en/products/max96717r.html#product-overview

4. The 25 Gbps channel. Comparison of IL of bp, ch, cy.



Significantly changed limit line from 802.3ch to cy.

4. The 25 Gbps channel. Electrical or optical?

Question to the audience asked at the 2022 AEC in Munich: Starting from which data rate on do you think optical Ethernet is advantageous over electrical Ethernet for automotive IVN (choose one):

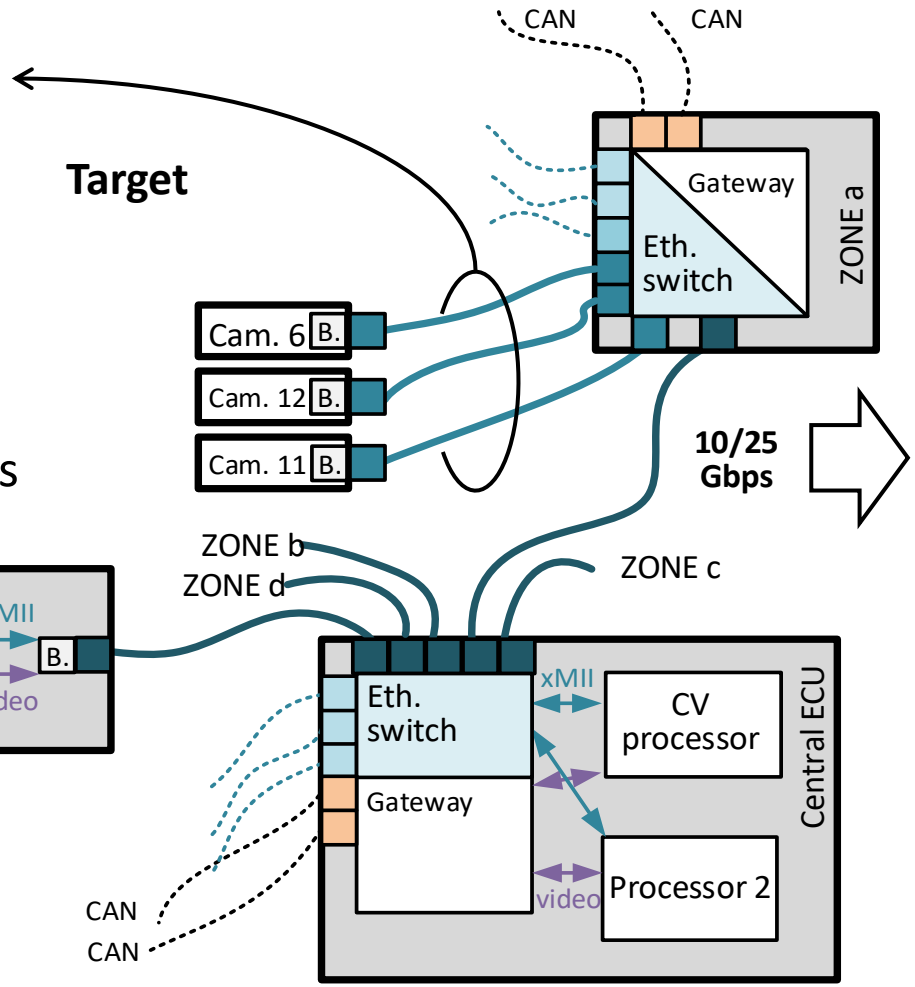
10 Gbps 17%, 25 Gbps 36%
i.e. more than 50% of the audience thought optical communication advantageous over electrical for 25 Gbps.

5. An inherently asymmetric technology for the backbone. Assumptions for ISAAC.

ISAAC

Requires an efficient camera end-point connectivity that allows for

- (As) painless (as possible) migration from SerDes to Ethernet.
- Cost and processing efficiency similar to what the car industry is used to today.



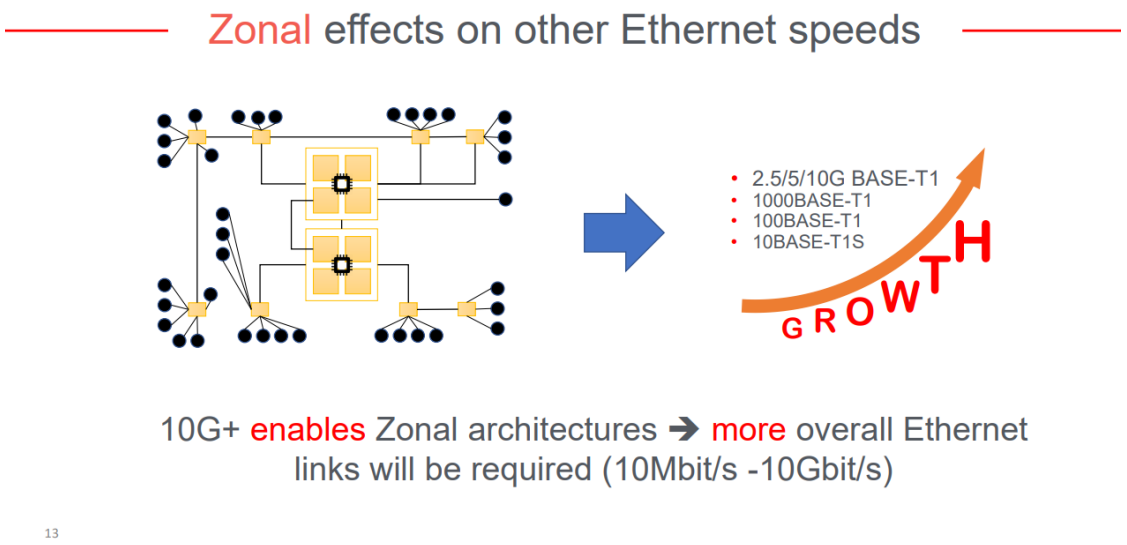
Requires a high speed Ethernet back-bone between zones.

- IEEE 802.3ch, cy, and cz offer automotive suitable solutions using STP or optical cables for SOPs 2026+. ✓

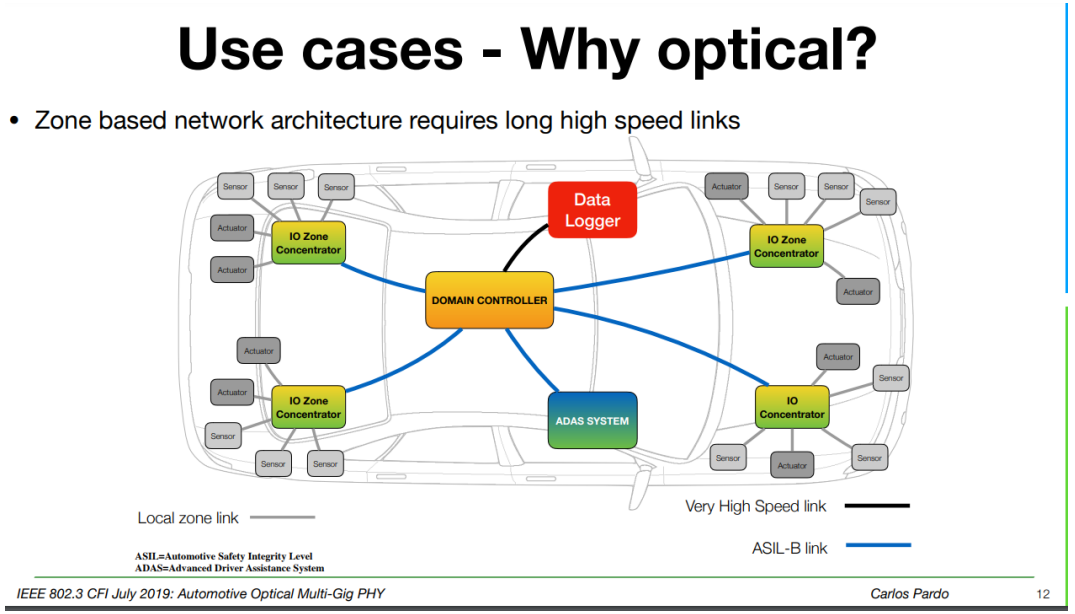
See also: https://www.ieee802.org/3/ISAAC/public/082823/20230825_Matheus_GoingZonal_verA.pdf

5. An inherently asymmetric technology for the backbone. Purpose of 802.3cy and cz.

https://www.ieee802.org/3/cfi/0319_1/CFI_01_0319.pdf



https://www.ieee802.org/3/cfi/0719_1/CFI_01_0719.pdf



Both cy and cz support 25 Gbps, cz even 50 Gbps bi-directional Ethernet.
What has gone wrong in their development, if it is now discussed to use yet a different technology for the Ethernet backbone? No incumbents to unseat.

5. An inherently asymmetric technology for the backbone. Aggregation links (vs end node).

>10Gbps „just“ for aggregating camera data.

- Aggregation link only carries video and camera related control data.
- Aggregation link might be inherently asymmetric, with careful design.
- Solutions outside IEEE 802.3 exist.

>10Gbps for aggregating camera data in zones.

- Backbone carries other traffic as well, including time critical control data (brakes, steering, …).
- Asymmetry adds additional challenges to QoS/TSN on backbone, as does EEE.*)
- Large difference between end-node and backbone link.

*) See also Max Turner „Combining TSN and Half-Duplex High Speed Links in Zonal Controllers”, AEC 2023

Summary and conclusion.

- In the September 27, 2023 ISAAC interim meeting, ~23 people voted in favor of increasing the max. data rate in the PAR from 10 to 25 Gbps.
- This presentation provided data that
  - Questions the broad market potential of such a 25 Gbps link for cameras and radars,
  - Questions the applicability of an asymmetric technology to the backbone,
  - Shows some of the technical complexity such a data rate would add,
  - Emphasizes the need to align the requirements and scope before going to TF.
- Removing the upper limit data rate from the PAR, will provide ground for a TF that works against moving targets (it has been emphasized many times, that objectives can be easily changed).
- The SG must align to a clear scope in the PAR.