Requirements on 802.3dm for automotive cameras

IEEE 802.3dm

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Gumersindo Veloso, BMW Group

Draft

For input collection and discussion

Supporters

- Kirsten Matheus (BMW Group)
- Hideki Goto (Toyota Motor Corporation)
- Dongok Kim (Hyundai Motor Company)
- Josetxo Villanueva (Ampere Software Technology)

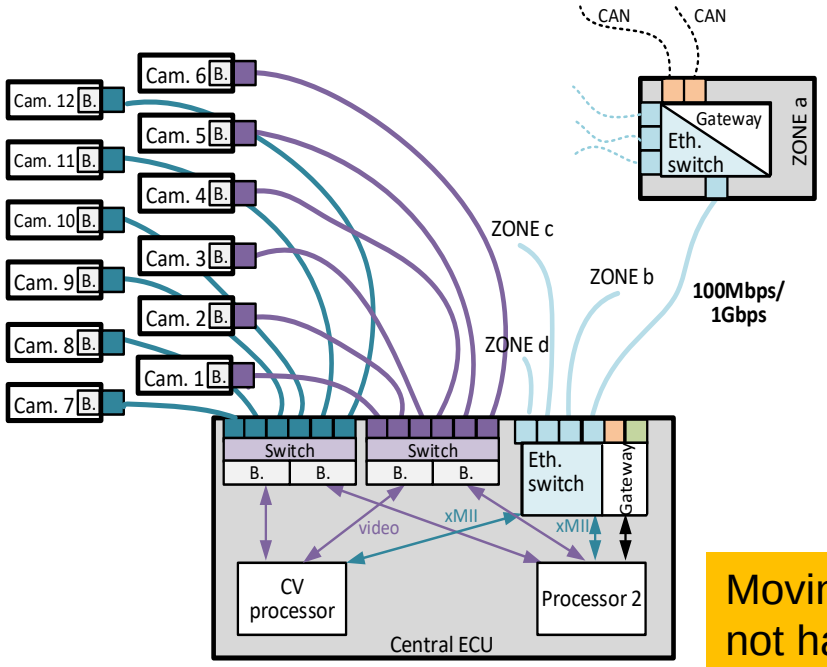
Motivation

- Different technical options are being presented for IEEE 802.3dm; all potentially valid.
- Only a comprehensive list of requirements and the consideration of both technical and deployment and use related aspects can help sort the proposals.
- It is thereby essential to include the specific needs of the target industry, including timelines and what they consider the best solution.
- This presentation contributes to determining what means “best” for the automotive industry.
- It presents input collected from individuals working for car manufacturers.

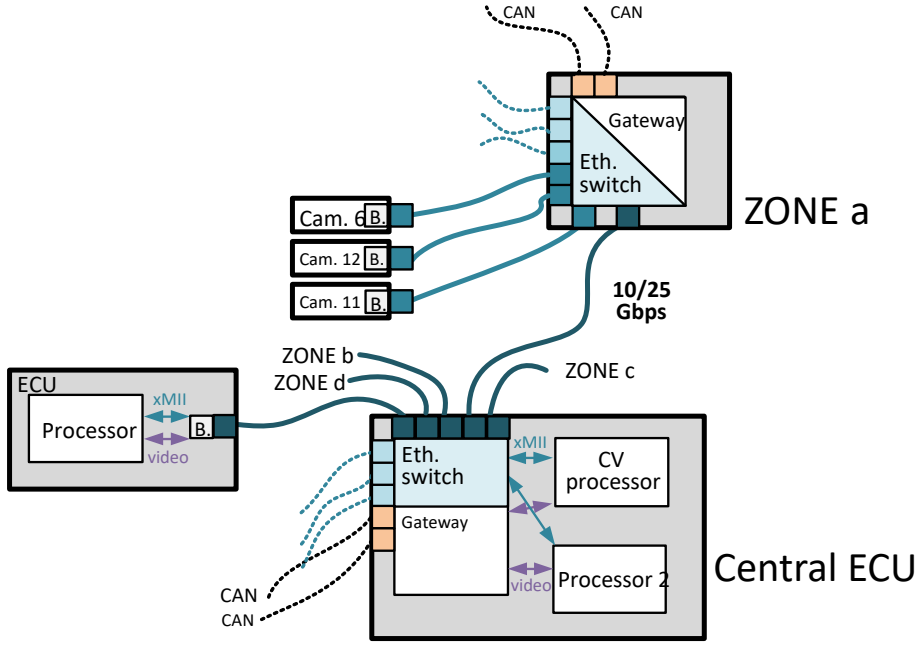
Introduction: Customer paradox

- An ever increasing number of cameras and a shift towards centralized video data processing, move the communication technology that connects those cameras more into focus.
- Resilience and innovation are evermore important (e.g. security, zonalization, integration, multi-sourcing, etc.).
- Standardization and common interfaces are here key enabling factors.
- BUT: Currently, distributed systems are still state of the art and most current demands could be satisfied by the existing point-to-point solutions.
  - Specially: Current solutions will remain for longer time in use for that reason.
- MEANS: For those searching for a standardized alternative, an easy transition is the main goal…while: being small, complexity- and power-efficient and supporting power-over capabilities…but that is not all.

Introduction: Customer paradox (1)



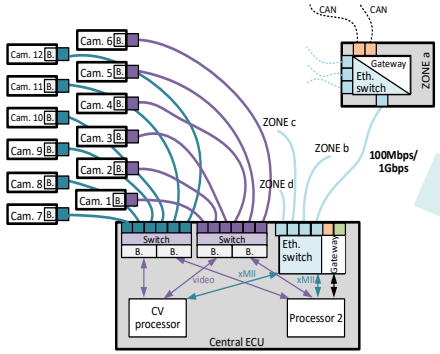
Moving from left to right does probably not happen in a single jump but rather in a risk-averse approach, hence in several small and flexible steps.



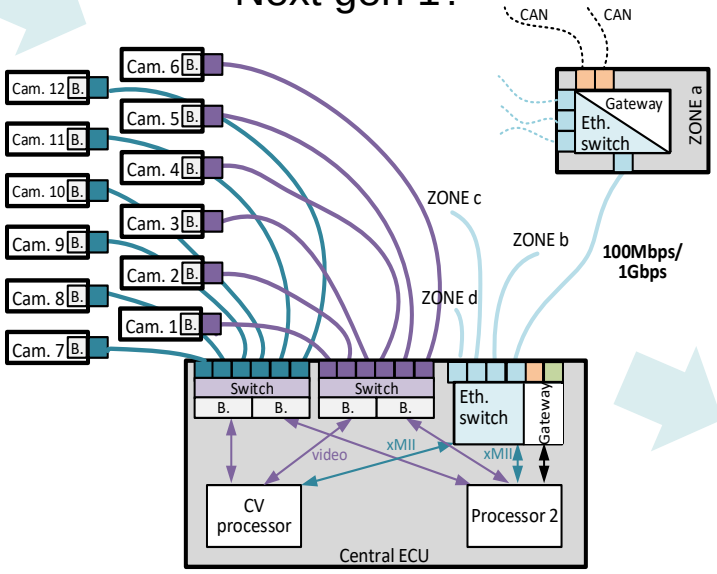
- Proprietary SerDes PHY
- SerDes DLL/switch
- Standard MG Ethernet capable PHY(s)
- Standard 10, 100, 1000 Mbps Ethernet
- Ethernet DLL/switch
- B. Protocol bridge

Let's see an example

Introduction: Customer paradox (2)



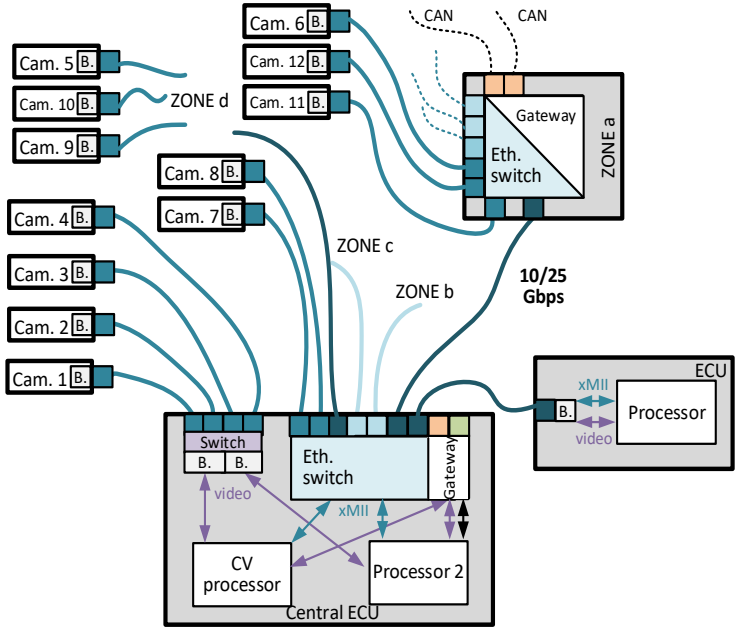
Next gen 1?



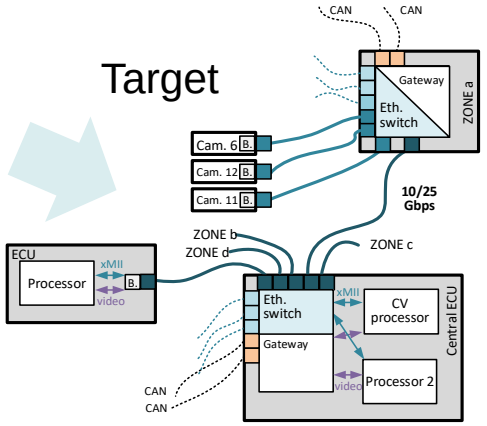
"from left to right" involves several steps!

The communication solution should not preclude or require specific architecture but allow for flexible deployment as needed!

Next gen 2?



Target



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One step forward, many questions

- First things that come in mind:
  - EMC performance
  - Channel selection (Coax versus STP)
  - Complexity
  - Synchronization
  - Impact of switches, added hops
  - Number and type of products
  - Security
  - Time to market
  - Ease of introduction (SerDes to Ethernet DLL, Ethernet to Ethernet)

EMC and channel (1)

- Proper EMC performance and signal integrity are hygiene factors.
  - Coax has lower loss per unit length than STP…
  - STP provides better immunity and better SNR than Coax…
  - Performance-wise both will work similar for certain cable lengths…
- Channel selection also has to focus on things, like:
  - Relative costs
    - Power-over solutions avoid separate power supply cables (and are common for today's camera implementations) and have to be supported.
    - Coax connections are advantageous in a relative cost comparison with STP cables and connectors.
  - Package and size
    - Coax, for example, provides the smallest interconnect for high speed data
    - Coax needs fewer connector pins, which overall reduces the connector layout space
    - This is particularly important when many cameras need to be connected to the same unit.

EMC and channel (2)

- We want Power-Over but…
- Power over losses are mainly driven by copper area and filtering losses
  - Coax gives benefits at DC resistance
  - High frequencies lead to easier filtering
- (Common mode choke) size matters
  - Necessary to separate DC (power) from video signal (AC).
  - Larger inductors lead to wasted space, more heat generation, dissipation needs, related costs.

Complexity

- Complexity of a solution is measured not only by the complexity of the duplexing/PHY design, but also by aspects like:
  - Number of parts, bridging of interfaces at imager and SoC. ,,,.
- Integrateability of serializer with imager is a must.
  - Reduces the number of parts, hence smaller PCB.
  - Reduces the overall power consumption.
  - This leads to less thermal dissipation needs, hence higher integrateability.
- Interfaces at imager and SoC.
  - Either Transceiver products are needed that must include a bridge to common interfaces (MIPI CSI-2, VESA eDP, SPI…)
  - Or the imager and SoCs products must support video processing via xMII. The latter is a larger change that adds complexity to the products and the complete endeavour.
  - Requiring additional/new products for an asymmetric Ethernet PHY is a general challenge for the project.

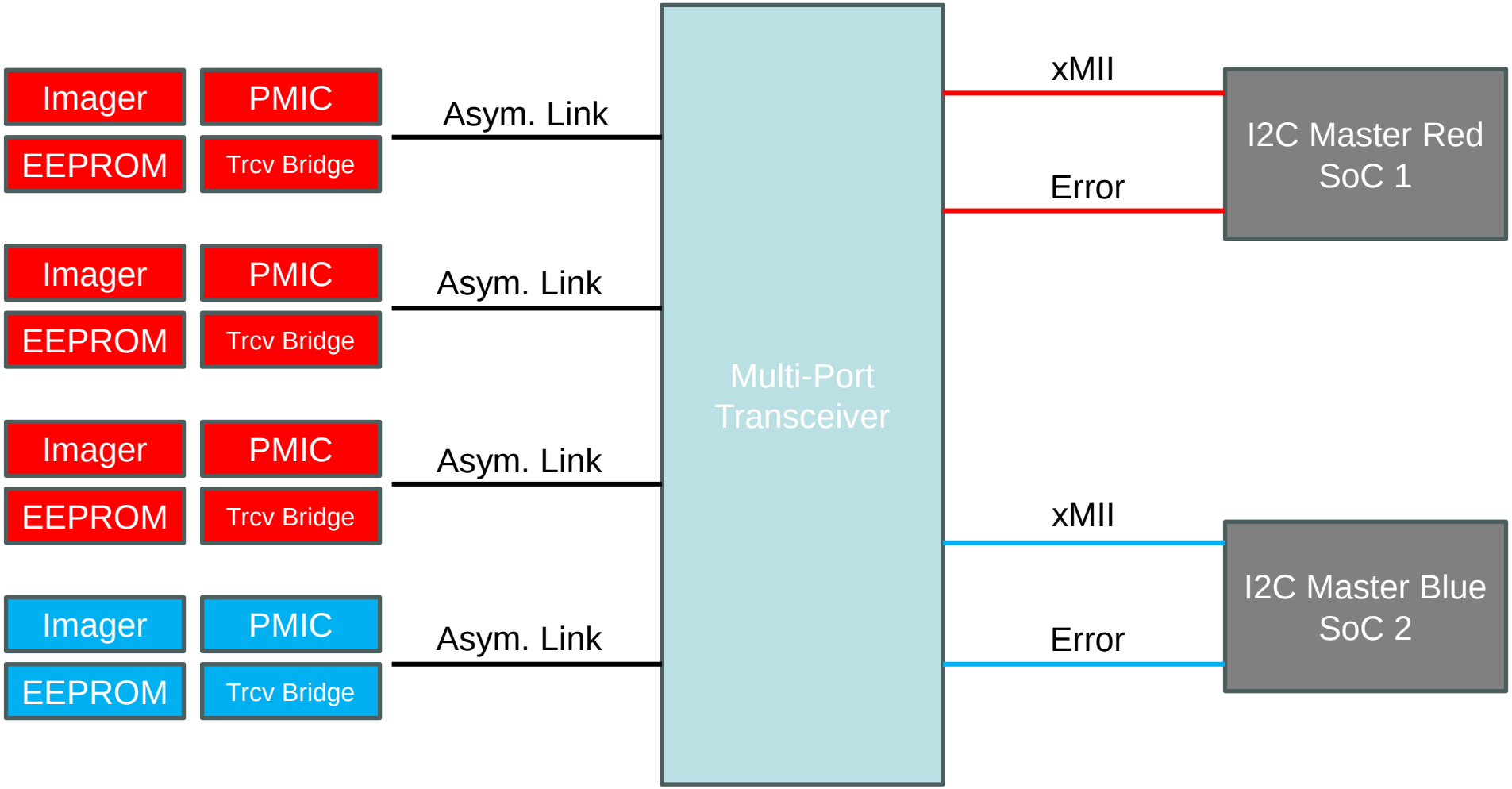
Synchronization

- Camera synchronization is ever-more important in autonomous driving and specially under zonalization.
- It is important to be able to synchronize multiple cameras attached to the same switch/Ethernet subsystem.
- Reference clock and frame reference signals have to be available.
- Error mitigation mechanisms that lead to varying data rates (such as link adaptation) affect the synchronization and should be avoided.

More on camera communication (1)

- Dual I²C controller support (more product related, informative).
  - On-the-fly PHY output enabling and disabling without interfering on the other PHY.
  - Certain systems require to select output to different SoC.
  - Report back of errors through dedicated pins at multiport transceiver.
  - Merging of EEPROM and PMIC IRQ signals to individual serializer GPIs with transceiver Multiplexer IRQ signal.
- Link-lock within 100ms after power-up.
  - Can be ensured with one P2P link. Start-up in complex scenarios with multiple hops and switches still needs to be verified.

More on camera communication (2)



Network complexity

- An Ethernet network relies on switches, which:
  - Mix different traffic types.
  - Might be cascaded between Talker and Listener.
- These are legitimate scenarios for switches but introduce unnecessary sources for:
  - Delays
  - Bandwidth limitations (on egress port)
  - Configuration complexity
  - Additional costs
- A reason why currently camera connections are point-to-point based and moving away from this requires strong arguments.
  - Good reason why 802.3dm focuses on the last hop to camera.
  - The added value of Ethernet networking is not obvious to sell.

Security

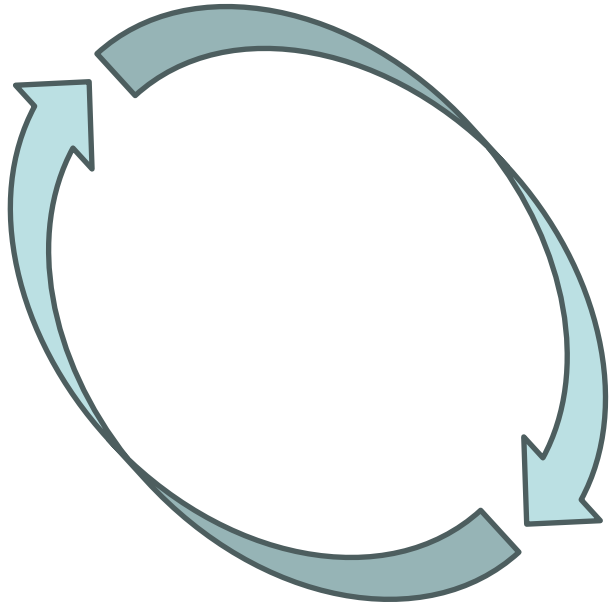
- Link layer security: Security between Nodes on a single link.
  - Either Authentication or Authentication and Encryption.
  - AES-GMAC-128 default minimum.
  - Given by MACsec independent of PHY layer selected.
- Number of used protocols is critical.
  - More open flanks and more complexity.

Market impacts

- Time to market.
  - Automotive OEMs are driven by ever shorter development cycles, quick and predictable availability of technologies is key.
- New solutions need to fix inside existing eco-systems.
  - Test specifications available?
  - Industrialization?
  - Tools?
- New solutions ideally contribute to reduce the amount of products needed.
  - Can the same transceiver serve DS and US?
  - Do we need additional, different PHYs in Switches?
- We should not forget: SDV and autonomous driving will have a great impact on coming E/E architectures.
  - 802.3dm should be an enabler and not an obstacle.

Quick overview on requirements

Criteria
Connector Size
Power-Over components size
Integrability (Serializer, Imager…)
Transition SerDes – Ethernet DLL
Synchronization
Security
(De)serializer pining mux
Link-lock/Link-up
Time-To-Market
Market availability
No. of products
Eco system



A comprehensive variety of requirements need to be fulfilled and also questions be answered.

Summary and conclusion

- Power-over-coax, low power consumption, and integrateability are key technical requirements to be met (EMC robustness being a prerequisite).
- Swift availability, sensible overall number of technologies, low relative system costs and smooth transition are the additional aspects to consider.
- Many technical approaches can meet the technical requirements, with different pros and cons, many based on individual preferences.
- But **when** this will happen and at which **price (complexity vs. value)**, are the key differentiations.
- As well how flexible a transition from SerDes to Ethernet DLL can be done.
- A deep evaluation of all this factors is needed in order to find an 802.3dm solution that can compete with established technologies.
- Only a solution that matches expectations is a good solution.

Thank You!