

# ONE-PAIR ETHERNET IN THE AUTOMOTIVE INDUSTRY

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SPE TECHNOLOGY DAYS

**BMW  
GROUP**

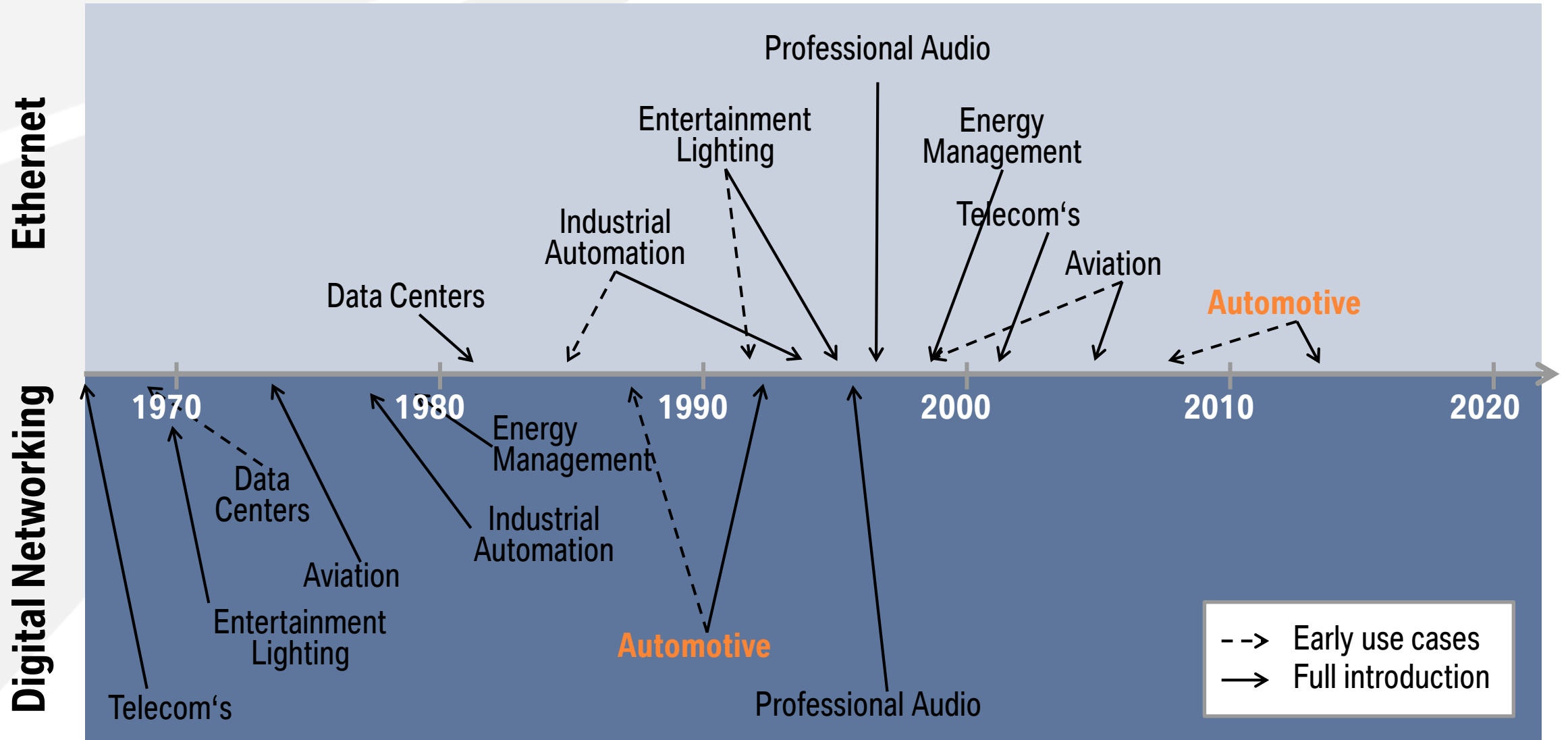
THE NEXT  
100 YEARS



# AGENDA

- How Ethernet came to the automotive industry
- Why one-pair Ethernet made the difference
- Which structural support was set up to make one-pair Ethernet successful
- Outlook to Ethernet in the automotive industry

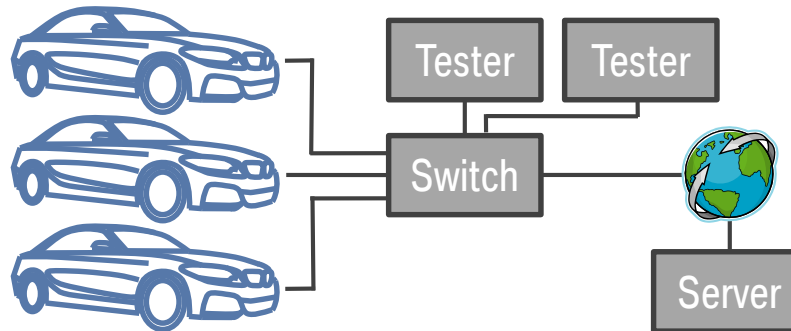
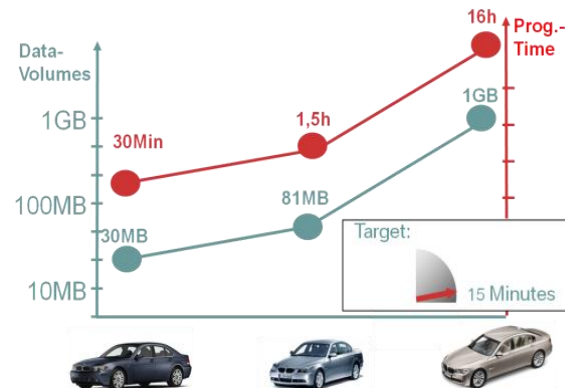
# THE CAR INDUSTRY JOINED THE ETHERNET COMMUNITY RELATIVELY LATE.



# IT STARTED WITH THE NEED FOR HIGHER DATA RATES FOR SOP 2008.

## 1. Reduction of flash time to 15 minutes anywhere in the world:

- Existing CAN would have required 16 h.
- Unshielded 100BASE-TX when stationary.



## 2. 20Mbps data rate for exchange of map data between HU and RSE:

- Existing MOST 25 ring capacity was used up and would not in any case not have supported 20Mbps packet data.
- Use of 100BASE-TX shielded.



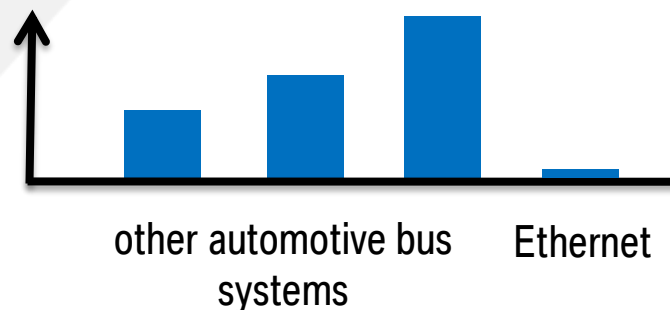


# UNFORTUNATELY, THE USED 100BASE-TX WAS NOT COST EFFICIENT.

## Lessons learned with 100BASE-TX

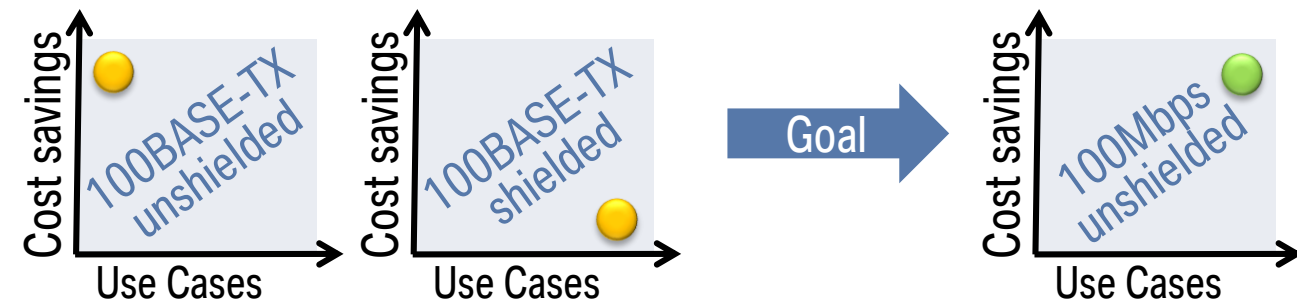
- Very good immunity results.
- Ethernet comparatively easy to implement.
- Emissions too high for runtime applications.
- Shielded cabling not cost competitive.

number of failure tickets in the gateway project until 2008



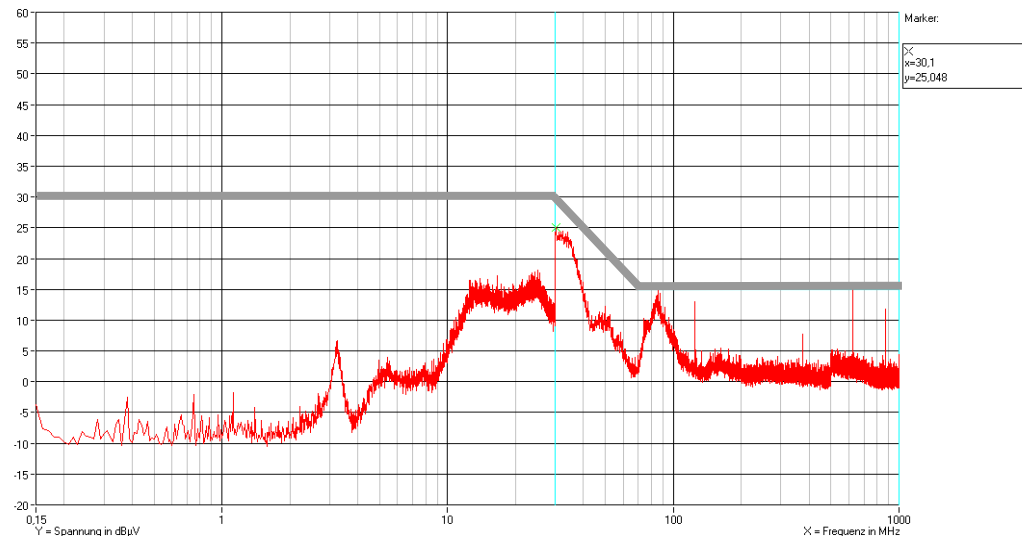
## Search for a solution always usable with UTP

- Extended investigation of all components on source of EMC emission (filters, ferrite beads,...).
- No solution found (at the time).



# THE BREAKTHROUGH CAME 2008 WITH THE „DISCOVERY“ OF BROADR-REACH (NOW 100BASE-T1), WHICH NEEDED ONE PAIR OF UTP CABLES ONLY.

- Ask for support of main players in the Ethernet industry!
- Only Broadcom responded positively.
- First ever emissions measurement performed with BroadR-Reach in the automotive industry by BMW in January 2008

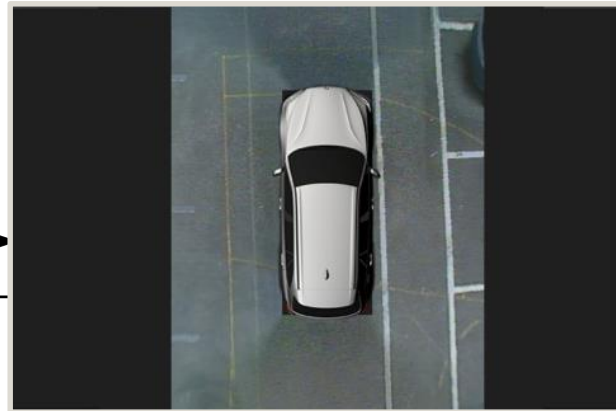
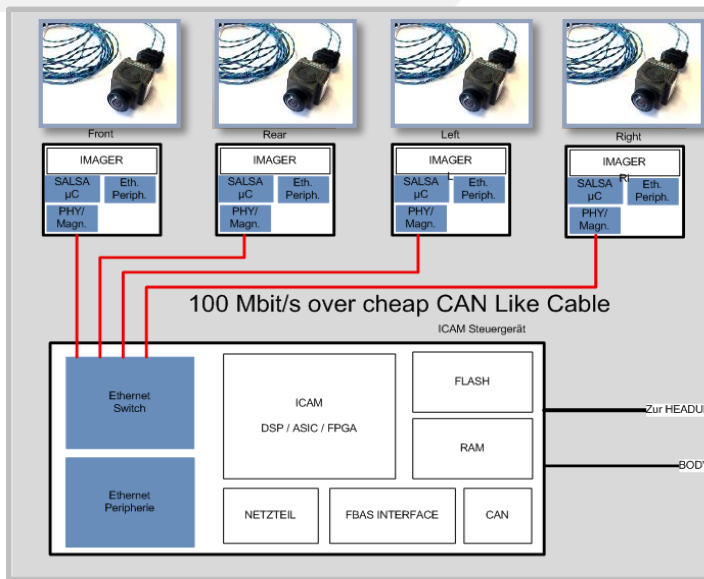


- Promising result, decision to follow this lead

# IN 2013 BROADR-REACH (TODAY 100BASE-T1) USING UTSP CABLES WENT INTO SERIES PRODUCTION AT BMW. ONE-PAIR MADE ALL THE DIFFERENCE.

## BMW first used UTSP Ethernet to connect the cameras to the surround-view system.

- Relevant technological challenges, e.g. EMC, package, video en- and decoding, tools.
- Risk minimized introduction with peripherals in a customer option.
- Significant cost advantages (cheaper harness) over the previously used SerDes (LDVS).



Presented at the 3<sup>rd</sup> Ethernet&IP@Automotive Technology Day

# SINCE THEN, THE NUMBER OF ADOPTERS AND THE NUMBER OF PHY SPEED GRADES HAS GROWN IN THE AUTOMOTIVE INDUSTRY.

→ Not only has Ethernet become an essential part of the existing and future BMW EE-architecture, all major car manufacturers have introduced 100Mbps Ethernet or have taken the decision to introduce Ethernet into their EE-architecture.



→ Various automotive suitable Ethernet

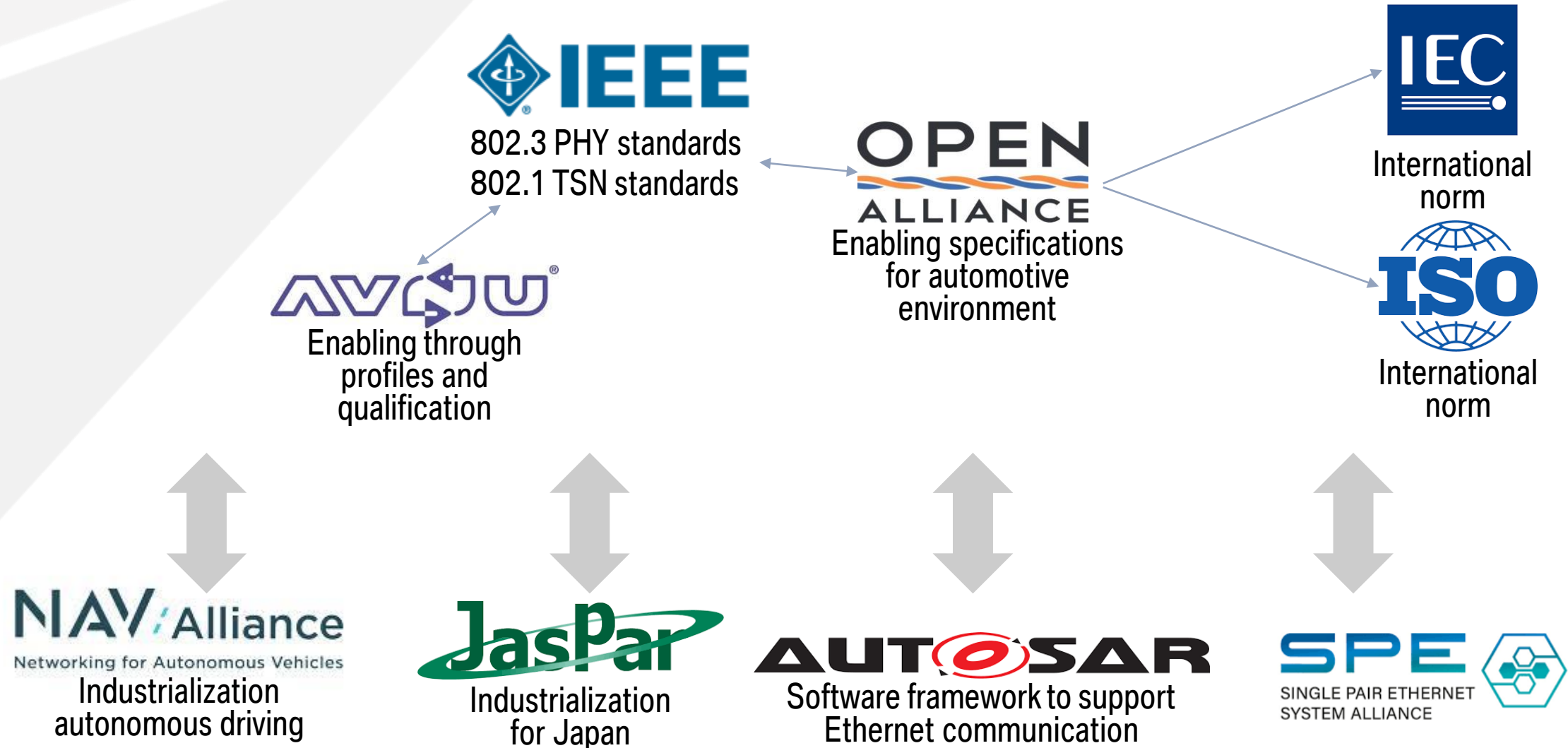
| Name                     | Channel                   | Standard   | Automotive SOP |
|--------------------------|---------------------------|------------|----------------|
| BroadR-Reach/ 100BASE-T1 | UTSP P2P                  | Completed  | 2013           |
| 1000BASE-T1              | Jacketed UTSP or STSP P2P | Completed  | 2019           |
| 1000BASE-RH              | POF P2P                   | Completed  | 2019           |
| 10BASE-T1S               | UTSP P2P or multidrop     | Completed  | ~2024          |
| 2.5,5,10GBASE-T1         | STSP (Coax in discussion) | Completed  | ~2025          |
| >10G (→ 100Gbps)         | Tbd.                      | Task Force | 2027+          |
| >1G optical (→ 100Gbps)  | Tbd.                      | Task Force | ?              |

UTSP => unshielded twisted single pair  
STSP => shielded twisted single pair  
POF => plastic/ polymer optical fiber  
P2P => point-to-point between switches

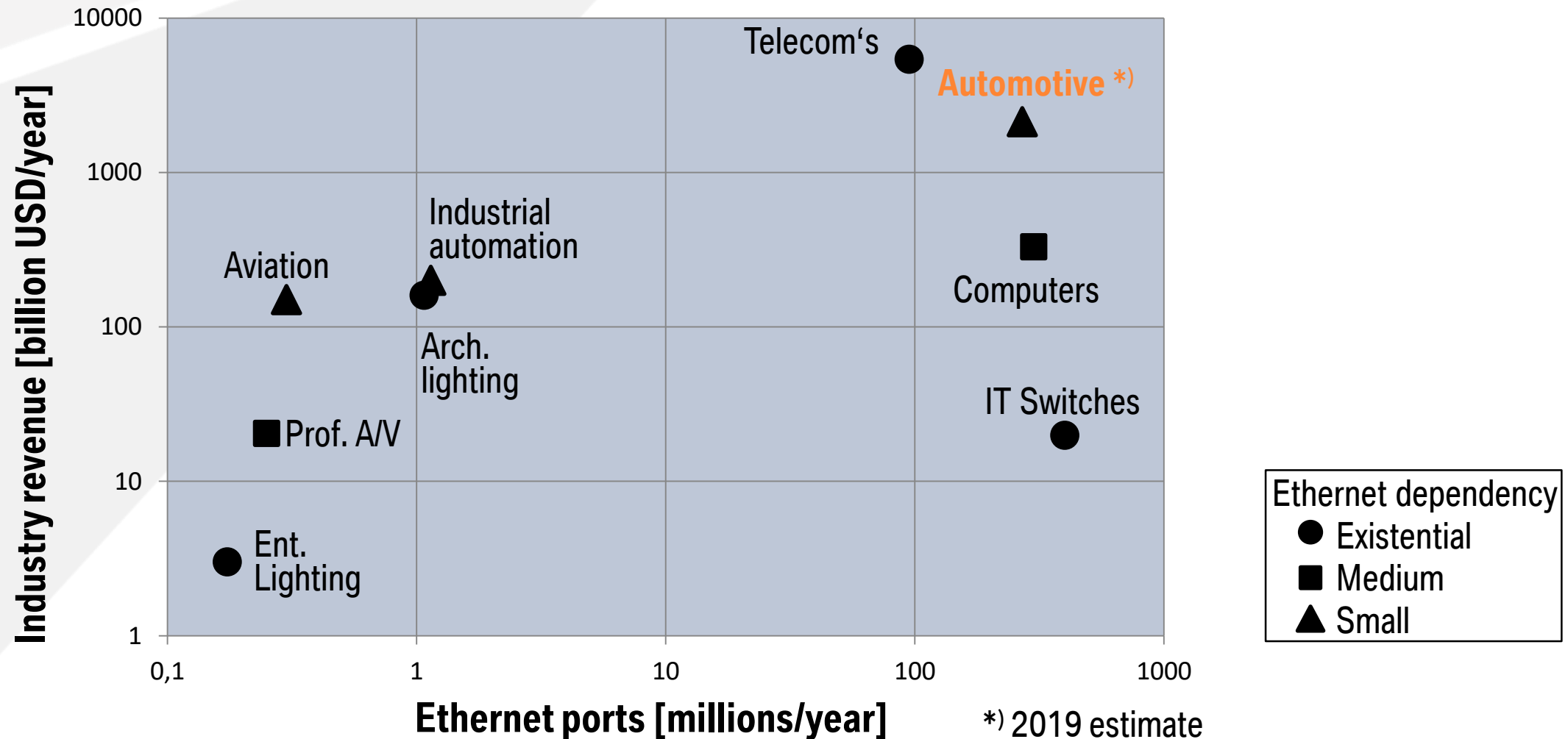
Not all have gone public!



SINCE THEN, A LARGE ECO-SYSTEM IS WORKING WITH THE AUTOMOTIVE SUITABLE, SINGLE PAIR ETHERNET VERSIONS.



# THE AUTOMOTIVE INDUSTRY HAS MARKET POWER TO JUSTIFY THE INVESTMENTS AND EFFORT.



# ALL GOOD?

# THE EFFECTS OF DIGITIZATION CHALLENGE THE AUTOMOTIVE INDUSTRY.

The car manufacturers are facing a time in which they need to continue to strive in ever fiercer competition while having to embrace the changes induced by a digitized world.

With digitization, data and software are the new currency.



This can change everything. From the way we build cars to the products and services we offer.

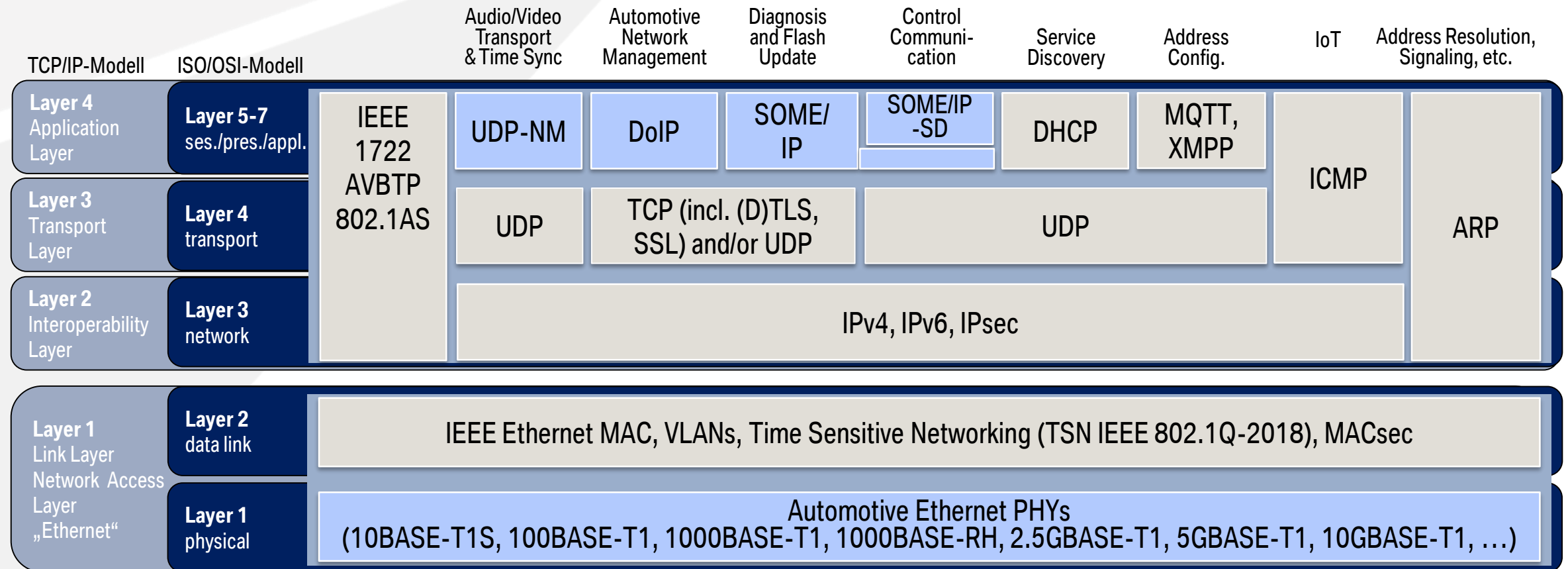


It results in new requirements on the infrastructure inside the car: the EE-architecture and also the in-vehicle network.





# AUTOMOTIVE ETHERNET PROVIDES THE RIGHT INFRASTRUCTURE TO EMBRACE THE CHANGES.

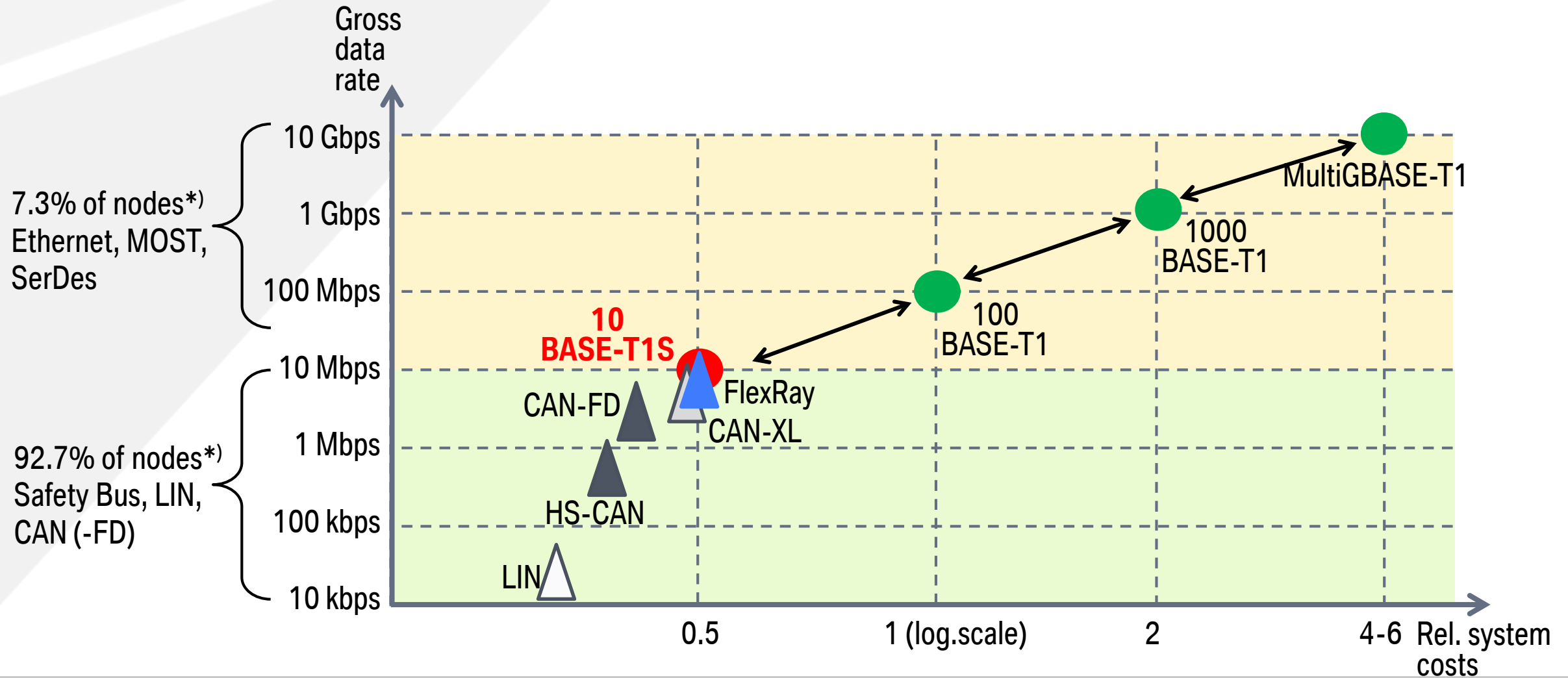


IT Standard

Automotive

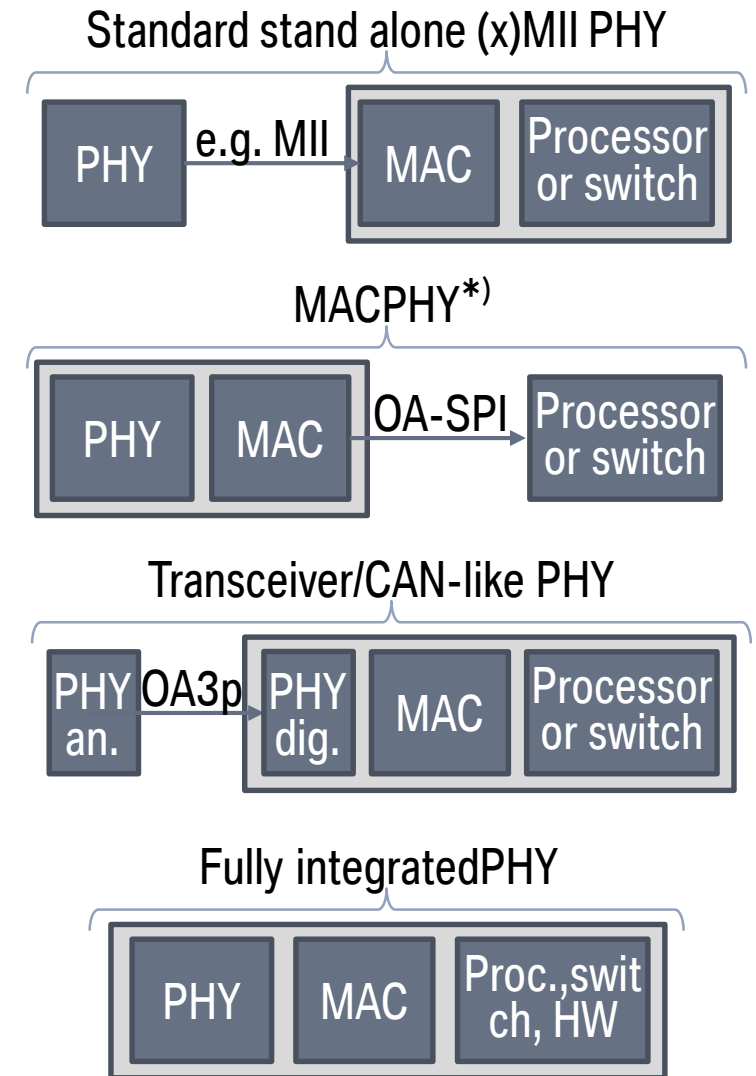
Automotive Ethernet allows for one ubiquitous network that is flexible, scales, supports different timing requirements, and inherently provides the communication paradigms for a modern in-vehicle architecture (service orientation, security).

# 10BASE-T1S IS PARTICULARLY IMPORTANT FOR EXTENDING THE ETHERNET UNIVERSE AS >90% OF IVN COMMUNICATION IS BELOW 10MBPS.



# 10BASE-T1S CONNECTIVITY COMES IN A NUMBER OF DIFFERENT PRODUCTS.

1. PHY uses the standard MII interface to connect between PHY and switch or processor. This results in a 32 pin package for 10BASE-T1S PHY because of 19 pins for MII+MDIO. Connects to all existing switches that support the full MAC standard with CSMA/CD.
2. The PHY can be integrated with the MAC. This ensures the CSMA/CD function and reduced the number of pins. The OPEN Alliance defined the respective SPI interface. Allows for a 16 pin package. Connects to all processors or switches with SPI interface.
3. The analogue part of the PHY can be split from the digital part with a 3-pin interface. Allows for 8-pin packages. Pinning proposal exist. Requires the availability of processors and switches with the digital interface.
4. The PHY can be fully integrated with the processor or switch, or be part of an ASIC.



# THE TRUE ADVANTAGES OF ETHERNET ARE NOT IN THE PHYSICAL LAYER BUT IN THE CHANGES IT ALLOWS FOR MODERN EE-ARCHITECTURES.

- Support of a service-based architecture with service-oriented communication (SOME/IP\*)
- Replacement gateways / different organization of traffic (unambiguous addressing scheme, barrier-free network independent of speed, self learning switches)
- Standardized, state-of-the-art security (not only SecOC)
- HW-/SW-separation over layer 2 (allows for scalability and flexibility)
- (Galvanic separated (48V or HV-applications, Power over DataLine, avoids ground-shift-problems) )

\*Scalable service-Oriented MiddlewarE over IP (SOME/IP)



## SUMMARY AND OUTLOOK.

- The car industry has driven and embraced SPE (we like to call it „Automotive Ethernet“).
- A large number of industry players invested in the industrialization of SPE in a number of organizations.
- A first most important hurdle is/was enabling the physical layer (EMC, wiring harness, semiconductors, ....), also in the automotive industry.
- However, Ethernet is more than just a new physical layer.
- The true chance of Ethernet is its universe that supports and allows for new approaches in the EE-architecture and communication paradigms.
- Here, the automotive industry is still at its beginning.

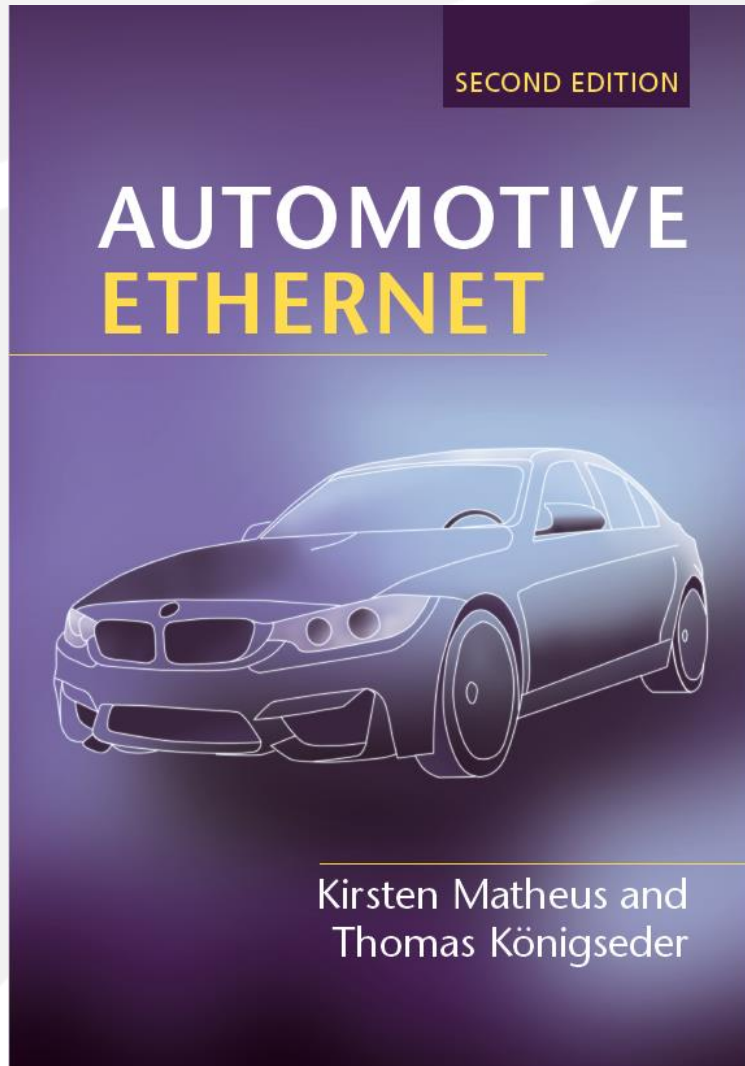
# THANK YOU FOR YOUR ATTENTION



Dr. Kirsten Matheus



## MORE INFORMATION ON AUTOMOTIVE ETHERNET CAN BE FOUND IN:



New content includes:

- Detailed explanations of how the 100BASE-T1 PHY and 1000 BASE-T1 PHY technologies actually work.
- A step-by-step description of how the 1000BASE-T1 channel was derived.
- A summary of the content and uses of the new TSN standards.
- A framework for security in Automotive Ethernet.
- Discussion of the interrelation between power supply and Automotive Ethernet communication.