10G+ Automotive Ethernet Electrical PHYs

Call for Interest Consensus Meeting
IEEE802.3 Working Group
March 12, 2019
Vancouver, BC
CFI Panel Members

Chair & Presenter

• Steve Carlson (High Speed Design)

Supporters and Experts for the Q&A Session

• Christopher Mash (Marvell)
• Christoph Wechsler (Audi)
• Helge Zinner (Continental)
• Olaf Grau (Bosch)
• Natalie Wienckowski (GM)
Supporters

**OEM affiliated**
Olaf Krieger – Volkswagen
Samuel Sigfridsson – Volvo Cars
Jose Villanueva – Renault
Kirsten Matheus – BMW
Jinhwa Jun – Hyundai Motor Company
Syreeta Bath – Jaguar Land Rover
Hideki Goto – Toyota
Yong Kim – NIO
Mike Potts – GM
Keld Lange – Porsche
Sanaz Mortazavi - Volkswagen
Dongok Kim – Hyundai Motor Company
Jim Lawlis – Ford Motor Company
Haysam Kadry – Ford Motor Company

**System affiliated**
Daniel Hopf – Continental
Sven Hildebrandt – Harman
Thomas Hogenmueller – Bosch
Thomas Mueller – Rosenberger
Chris DiMinico – Panduit
Tamir Reshef – Semtech
Georg Janker – Ruetz System Solutions
Eric DiBiaso – TE Connectivity
Bert Bergner – TE Connectivity
Mike Gardner – Molex
Harsh Patel – Molex

**Others**
Chunhui (Allan) Zhu - Futurewei Technologies, Inc.
Jon Lewis – Dell/EMC
John D’Ambrosia - Futurewei Technologies, Inc.
Marek Hajduczenia - Charter

**Semiconductor affiliated**
Albert Kuo – Realtek
Kinny Chen – Realtek
Amir Bar-Niv – Aquantia
Conrad Zerna – IIS Fraunhofer
Kamal Dalmia – Dryv.io
Guy Hutchison – Dryv.io
Sujan Pandey – NXP
Hamid Salehi – Marvell
Brett McClellan – Marvell
Peter Wu – Marvell
Ramin Shirani – Ethernovia
Hossein Sedarat – Ethernovia
William Lo - Axonne
Tom Souvignier – Broadcom
Mehmet Tazebay – Broadcom
Ramin Farjad - Aquantia
Mike Tu - Broadcom
Gerrit Den Besten – NXP
Alex Tan – NXP
Claude Gauthier – NXP
Mike Jones – Microchip
Mark Bohm – Microchip
David Chalupsky - Intel
CFI Objective

To gauge interest in starting a study group developing

10G+ Automotive Ethernet Electrical PHYs

This Meeting will NOT:
- Fully explore the problem
- Choose any one solution
- Debate strengths and weaknesses of solutions
- Create a PAR or 5 Criteria
- Create a standard or specification

Anyone in the room may speak / vote
Respect … give it, get it
Agenda

- Automotive Networking Evolution
- Why 10G+ is needed
- Market Potential
- Why Now?
- Q&A
- Straw Polls
Automotive Networking Evolution

1991
- CAN (Controller Area Network) (500K - 2M)
- Low-speed serial data bus (<1K)

2001
- MOST (Media Oriented Systems Transport)
  - Shared ring topology: 25M (POF), 50M (Cu), 150M (POF, Coax)
- LVDS (Low-voltage differential signaling) / SerDes (Serializer / De-serializer)
  - Point-to-point links (1-12G) for cameras and displays

2005
- FlexRay (consortium of automotive companies)
  - 10M serial data bus (single or dual channel)

2008
- Ethernet
  - 10M, 100M, 1G, 2.5/5/10G, & 10G+
Automotive Electrical PHYs in IEEE802.3

• 802.3bp - 1000BASE-T1
• 802.3bw - 100BASE-T1
  • CFI 3/2014, Standard 10/2015
• 802.3cg - 10BASE-T1S / (10BASE-T1L)
  • CFI 7/2016, Standard 2019 (est)
• 802.3ch - 2.5/5/10G BASE-T1
  • CFI 11/2016, Standard 2020 (est)
# Trends in Automotive Ethernet

<table>
<thead>
<tr>
<th>Year</th>
<th>1 port</th>
<th>&lt;10 ports</th>
<th>10-50 ports</th>
<th>&gt;100 ports*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>OBD</td>
<td>100BASE-TX</td>
<td>100BASE-T1</td>
<td>2.5/5/10G BASE-T1</td>
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<tr>
<td>2013</td>
<td>Low Res Cameras</td>
<td>10BASE-T1</td>
<td>1000BASE-T1</td>
<td>10G+</td>
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<tr>
<td>2017</td>
<td>Connected Car, IVI, TCU, Gateway</td>
<td>1000BASE-T1</td>
<td>2.5/5/10G BASE-T1</td>
<td></td>
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<tr>
<td>2019</td>
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<td>2021</td>
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<td>2024</td>
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<td>2025</td>
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<tr>
<td>2026+</td>
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*Average Ethernet ports per vehicle
Transition from domain to zonal architectures will require 10G+ links between the zonal ECUs.
Zonal Overview

Very high bandwidth (10G+)
Full duplex traffic
> 6 links per car
Mixed data type
Redundant systems
Zonal effects on ECUs

Locally distributed processing resources

Communication only between systems (ECUs)

Cross domain distributed processing resources

Communication between systems via Ethernet Switches

Central integration of processing resources

Consolidation of processing resources requires 10G+ bandwidth

Consolidation of processing will require 10G+ links
Zonal effects on ECUs

Central integration of processing resources

Cross domain distributed processing resources

Locally distributed processing resources

µC

Switch

Communication only between systems (ECUs)

Communication between systems via Ethernet Switches

Consolidation of processing resources requires 10G+ bandwidth

µC

Consolidation of processing will require 10G+ links
Zonal effects on other Ethernet speeds

10G+ enables Zonal architectures ➔ more overall Ethernet links will be required (10Mbit/s - 10Gbit/s)

- 2.5/5/10G BASE-T1
- 1000BASE-T1
- 100BASE-T1
- 10BASE-T1S
Zonal / Central Architecture Introduction

- OEMs who have publicly announced investigation into Zonal / Central architecture:
  - Audi
  - General Motors
  - Jaguar Land Rover
  - Toyota
  - Volkswagen
  - Volvo Cars

- Additional OEMs expected to publicly announce this year
Driverless cars are the future of Automotive

Source: Audi AG
Data Drives Autonomous Cars

Autonomous Vehicles

UTILIZE AVG
~4 TERABYTES
PER AVERAGE DAY

Source: Mashable January, 2017
Autonomous Driving systems incorporate camera’s that transmit uncompressed data requiring 10G+ bandwidth. Additional sensor (Lidar, radar, etc.) aggregation requires 10G+ bandwidth.
Redundant processing units needed to enable autonomous cars will require 10G+ connections
'Live Software Migration' supporting the transfer of processes across compute nodes or ECUs will require low latency 10G+ connections.
‘Black Box’ in the car will require significant bandwidth/capacity to store raw sensor data
~100 Million 10G+ ports by 2030

Source: McKinsey's "Automotive revolution – perspective towards 2030" study, 2016 and internal estimates
Why Now?

Car OEM test vehicles already using enterprise class Ethernet devices supporting 25 Gb/s & 50 Gb/s

OEMs require automotive variants before mass production for model year 2025
Timeline

Expected timeline to complete specification

- $t_0$ – Idea for CFI
- $t_1$ – SG approved. Start to work on PAR, CSD, objectives
- $t_2$ – PAR approved. Start TF meetings and select technology components
- $t_3$ – D1.0 complete. Refine specification
- $t_4$ – D2.0 complete. WG ballot begins
- $t_5$ – D3.0 complete. SA ballot
- $t_6$ – SA complete
- $t_7$ – Specification complete

Year A Year B Year C Year D

Year A Year B Year C Year D

$t_0$ $t_1$ $t_2$ $t_3$ $t_4$ $t_5$ $t_6$ $t_7$
Why IEEE?

It’s Ethernet --- it belongs in IEEE 802.3

• IEEE 802.3 is recognized as the international standard for Ethernet
  • Responsible for Ethernet physical layers

• The automotive industry wants the same level of international recognition for 10G+
  Automotive Electrical Ethernet PHYs as exists for the rest of IEEE 802.3
Q & A
Straw Polls
Straw Polls

120 - Number of people in the room

73 - Individuals who would attend and contribute to a 10G+ Automotive Ethernet Electrical PHYs Study Group

44 - My organization would support participation in the 10G+ Automotive Ethernet Electrical PHYs Study Group in IEEE 802.3
Straw Polls

Request that IEEE 802.3 WG form a study group to develop a PAR and CSD for a:

**10G+ Automotive Ethernet Electrical PHYs**

<table>
<thead>
<tr>
<th>People in the Room</th>
<th>802.3 Voters Only</th>
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<tbody>
<tr>
<td>Y: 104</td>
<td>Y: 61</td>
</tr>
<tr>
<td>N: 0</td>
<td>N: 0</td>
</tr>
<tr>
<td>A: 20</td>
<td>A: 13</td>
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Backup
Wiring Harness – from RTPGE CFI

Cabling is the 3rd highest cost component in a car
Engine (1st)
Chassis (2nd)

Harnesses are built ONE at a time with 50% of cost in labor

Cabling is the 3rd heaviest component in a car
Chassis (1st)
Engine (2nd)

Reducing cable weight has a direct impact on fuel economy!