CFI Multi-Gig Automotive Ethernet PHY

Call for Interest at IEEE802.3 Working Group

San Antonio, TX, November 2016 Plenary Meeting

CFI Multi-Gig Automotive Ethernet PHY

CFI Panel Members

- **Chair & Presenter**
  - Steve Carlson (High Speed Design)
- **Supporters and Experts for the Q&A Session**
  - Helge Zinner (Continental)
  - Kirsten Matheus (BMW)
  - Natalie Wienckowski (General Motors)
  - Thomas Hogenmüller (Bosch)

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Supporters (max. 3 per company)

Automotive Industry Car Makers:

Dongok Kim (Hyundai)
Doug Olliver (Ford)
Hideki Goto (Toyota)
Jim Lawlis (Ford)
Jinhwa Yun (Hyundai)
John Leslie (JLR)
Josetxo Villanueva (Renault)
Juergen Herrle (Audi)
Kirsten Matheus (BMW)
Mike Potts (General Motors)
Natalie Wienckowski (General Motors)
Nishanth Ullas (JLR)
Olaf Krieger (Volkswagen)
Samuel Sigfridsson (Volvo Cars)
Stefan Buntz (Daimler)

Automotive Industry System Suppliers:

Chris Lupini (Delphi)
Christoph Arndt (Continental)
Craig Gunther (Harman International)
Daniel Hopf (Continental)
Haruka Honda (Denso)
Helge Zinner (Continental)
Larry Matola (Delphi)
Magnus Nigmann (Intedis)
Peter Fellmeth (Vector Informatik GmbH)
Thomas Hogenmüller (Bosch)
Thomas Müller (Rosenberger)
Wes Mir (Delphi)
Yoshifumi Kaku (Denso)

Automotive Industry Components & Tools:

Alexander Umnov (Corning Optical Communications)
Ali Angha (Spirent)
Bert Bergner (TE Connectivity)
Christian Boiger (b-plus)
Curtis Donahue (UNH-IOL)
Daniel Wiesmayer (DRÄXLMAIER Group)
David Bollati (C&S Group)
Eric DiBiaso (TE Connectivity)
Jim Nadoiny (Samtec)
Matthias Jaenecke (Yazaki)
Mike Gardner (Molex)
Naoshi Serizawa (Yazaki)
Phillip Brownlee (TDK)
Richard Melitz (Samtec)
Shigeru Kobayashi (TE Connectivity)
Triess Burkhard (ETAS)
Vimalli Raman (Yazaki Systems Technologies)

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Supporters (max. 3 per company)

Industrial and Communication Industries:

David Brandt (Rockwell Automation)
Dieter Schicketanz (Independent)
John D'Ambrosia (Huawei)
Jon Lewis (Dell EMC)
Karl Weber (Beckhoff Automation)
Ludwig Winkel (Siemens Ag)
Peter Jones (Cisco Systems)

Other Transportation (air, rail, water):

Dr. Alexandros Elefsiniotis (Airbus Group)
Matthias Fritsche (HARTING Electronics GmbH)

Semiconductor Industry:

Alexander Tan (Marvell)
Amir Bar-Niv (Aquantia)
Brett McClellan (Marvell)
Christopher Mash (Marvell)
Claude R. Gauthier, Ph.D. (OmniPHY)
Dale Amason (NXP)
George Zimmerman (CME Consulting & Aquantia)
Guenter Sporer (NXP)
Harald Zweck (Infineon)
Henry Muyshondt (Microchip)
Kamal Dalmia (Aquantia)
Mehmet Tazebay (Broadcom)
Mike Jones (Microchip)
Norbert Schuhmann (Fraunhofer IIS)
Yong Kim (Broadcom)

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CFI Objective

- To gauge the interest in starting a study group developing a

Multi-Gig Automotive Ethernet PHY

- 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

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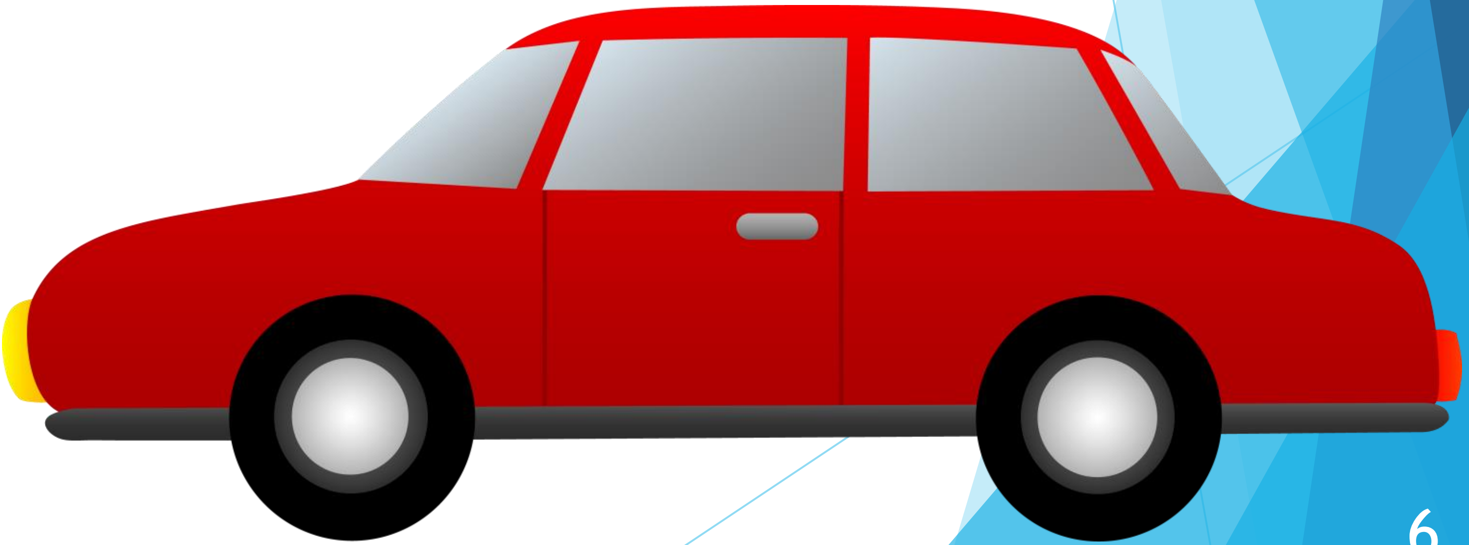
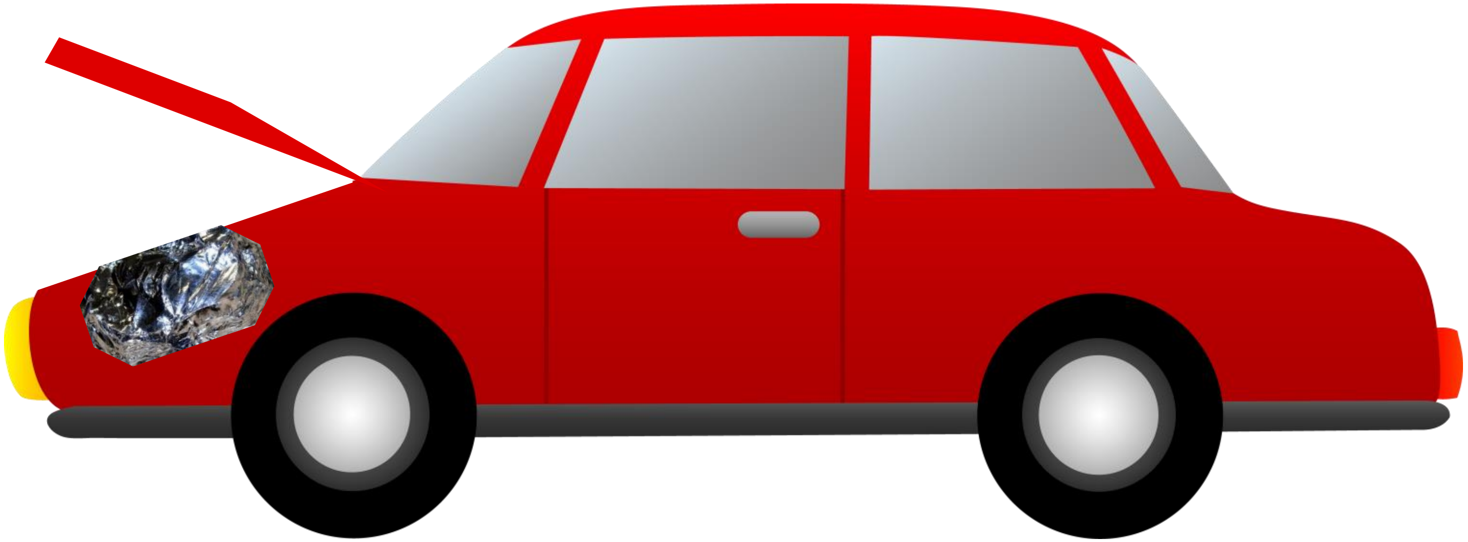
What powers the modern automobile?



CFI Multi-Gig Automotive Ethernet PHY

What powers the modern automobile?

Silicon!



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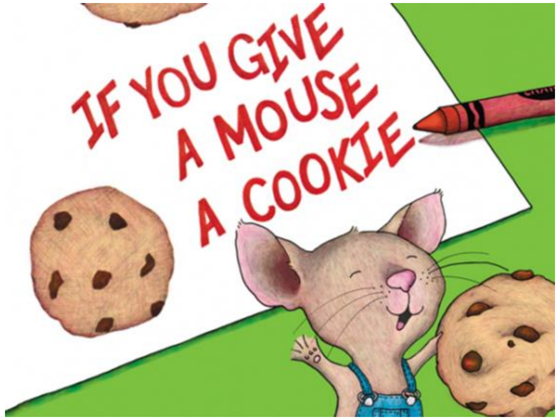

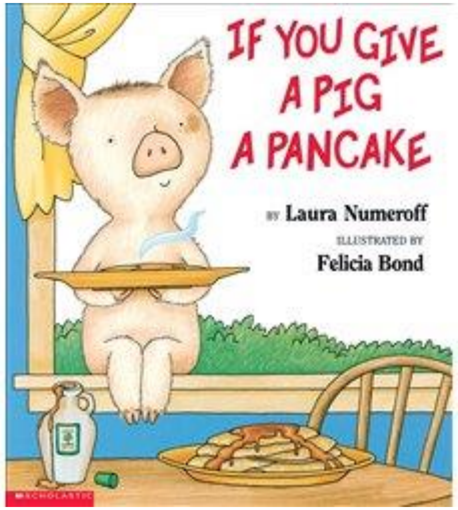

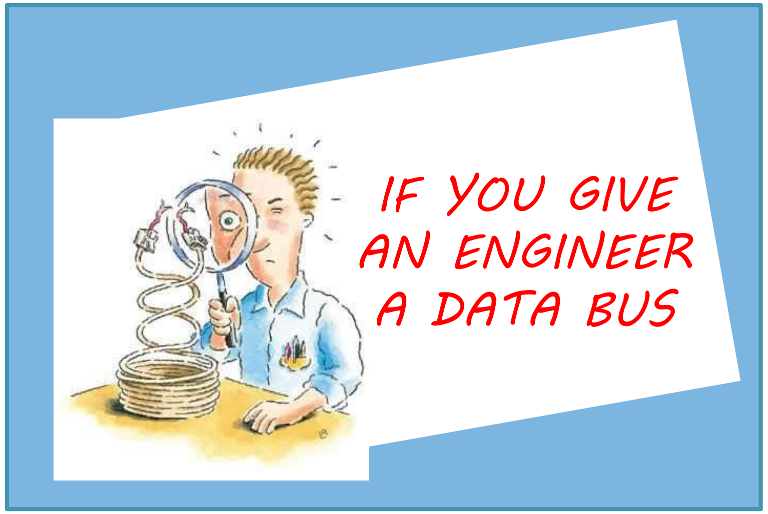

He's going to ask for a glass of milk.

She'll ask for a bottle of syrup.

He'll ask for more bandwidth and faster speeds.

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Agenda

- Target Markets
- Why Multi-Gig
- How Many Multi-Gig
- Use Cases
- Why Now?
- Automotive Market Potential
- Summary
- Q&A
- Straw Polls

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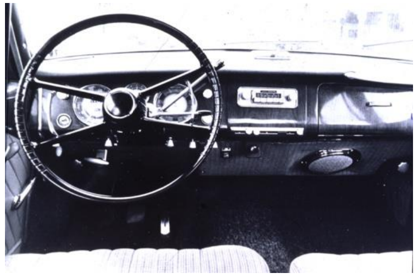
Innovation in Automotive Technology is both Hardware & Software



- Electronic Injection
- Check engine control
- Cruise control
- Central locking
- …

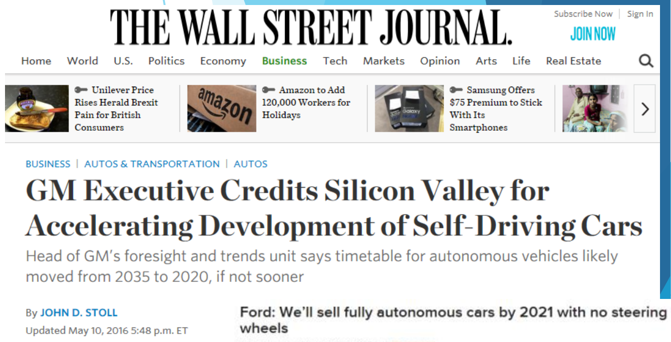
- Gearbox control
- Climate control
- ASC Anti Slip Control
- ABS Anti -lock Brake Sys.
- Telephone
- Seat heating control
- Automatic mirrors

- Navigation system
- CD-changer
- Active Cruise Control
- Airbags
- Dynamic Stability Control
- Roll stabilization
- Xenon lighting
- Vehicle Assist
- Voice input
- Emergency call

- ACC Stop&Go
- Lane departure warning
- Blind spot warning
- Traffic sign recognition
- Night vision
- Active headlight system
- Parking automation
- Efficient dynamics
- Hybrid engines
- Internet access
- Telematics
- Online Services
- Bluetooth integration
- Local Hazard Warning
- Personalization
- SW Update
- Smart Phone Apps

1970 1980 1990 > 2010

http://www.driverless-future.com/?page_id=384



Adapted from material provided by BMW

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Typical networks used in cars today include:

- CAN (Controller Area Network) - since 1981
  - Low-speed serial data bus: 1 – 1000 Kbps
  - Shared medium with CSMA/CR (Collision Resolution)
  - Dominant control bus in all automotive domains
  - Standardized in ISO 11898; Multi-vendor support
- FlexRay (consortium of automotive companies) - since 2005
  - 10 Mb/s serial data bus (single or dual channel)
  - Shared medium with TDMA
  - Control bus for high dynamic applications, chassis control, but also designed for future “X-by-Wire” applications
  - Standardized in ISO 10681; Multi-vendor support

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- MOST (Media Oriented Systems Transport) - since 2001
  - Shared ring topology: 25 Mb/s (POF), 50 Mb/s (Cu), 150 Mb/s (POF)
  - Bus system for control and streaming Infotainment data
  - Proprietary solution

- Ethernet (100Mb/s) - since 2008
  - Mainly diagnostics and firmware upgrades during vehicle servicing (typically not used while the car is operating due to EMC limits)
  - Standardized in ISO 13400-3:2011 Road Vehicles – Diagnostic communication over Internet Protocol (DoIP) – Part 3: Wired vehicle interface based on IEEE 802.3
  - 100BASE-T1 – since 2013

- LVDS - since 2002
  - Point-to-point high-speed links (1-4 Gb/s) for cameras and displays
  - Multi-vendor support but typically incompatible with each other

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Target Markets

- **Automotive networking**
  - The dominant driving market for this CFI
  - Increasing bandwidth and interconnecting requirements for in-vehicle control systems
  - Large market volume (i. e., port count)
  - This presentation will focus on this segment

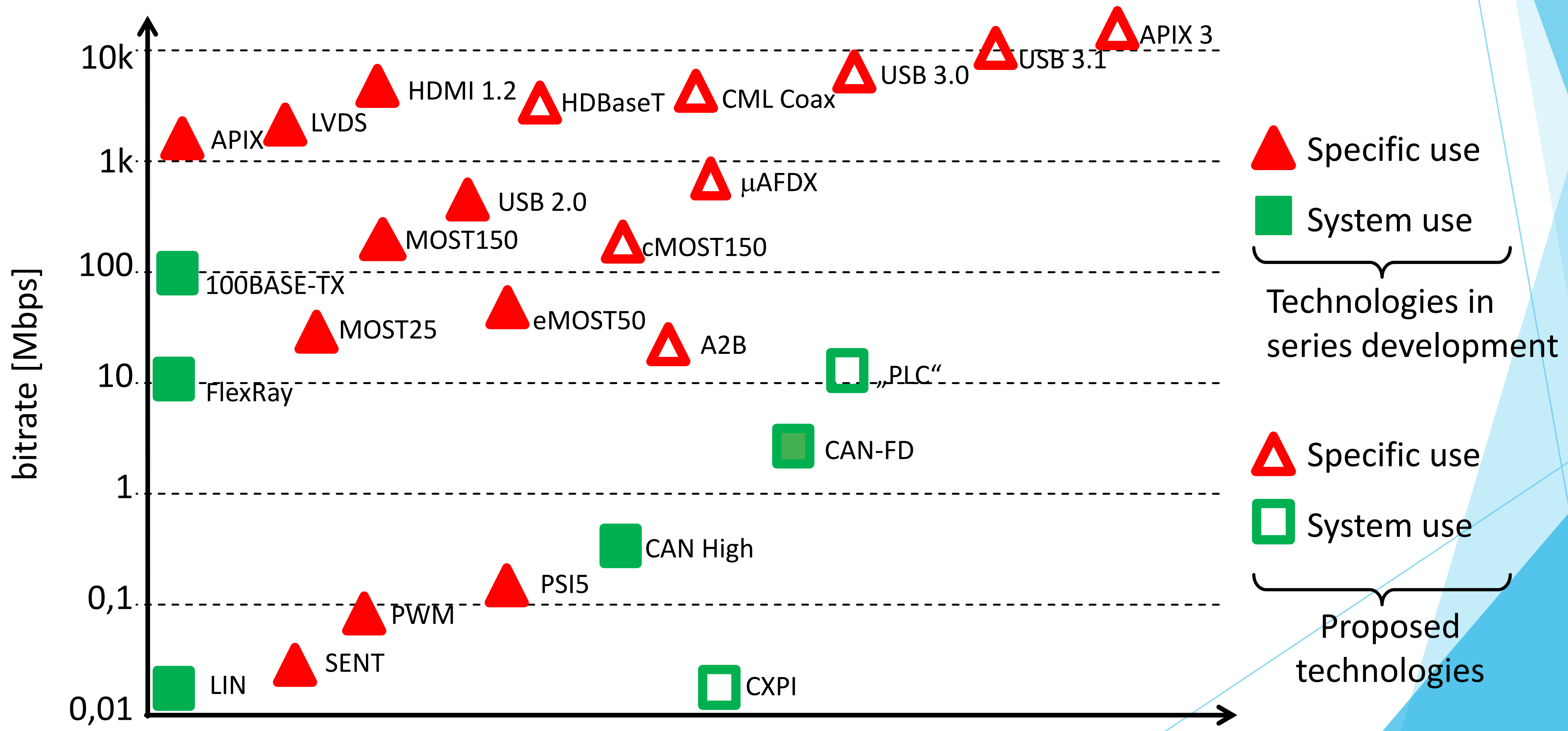
A Multi-Gigabit PHY could be leveraged across other segments including:

- **Avionics networking**
  - The need for weight savings for the cabling infrastructure is even more dominant than in the automotive industry

CFI Multi-Gig Automotive Ethernet PHY

Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

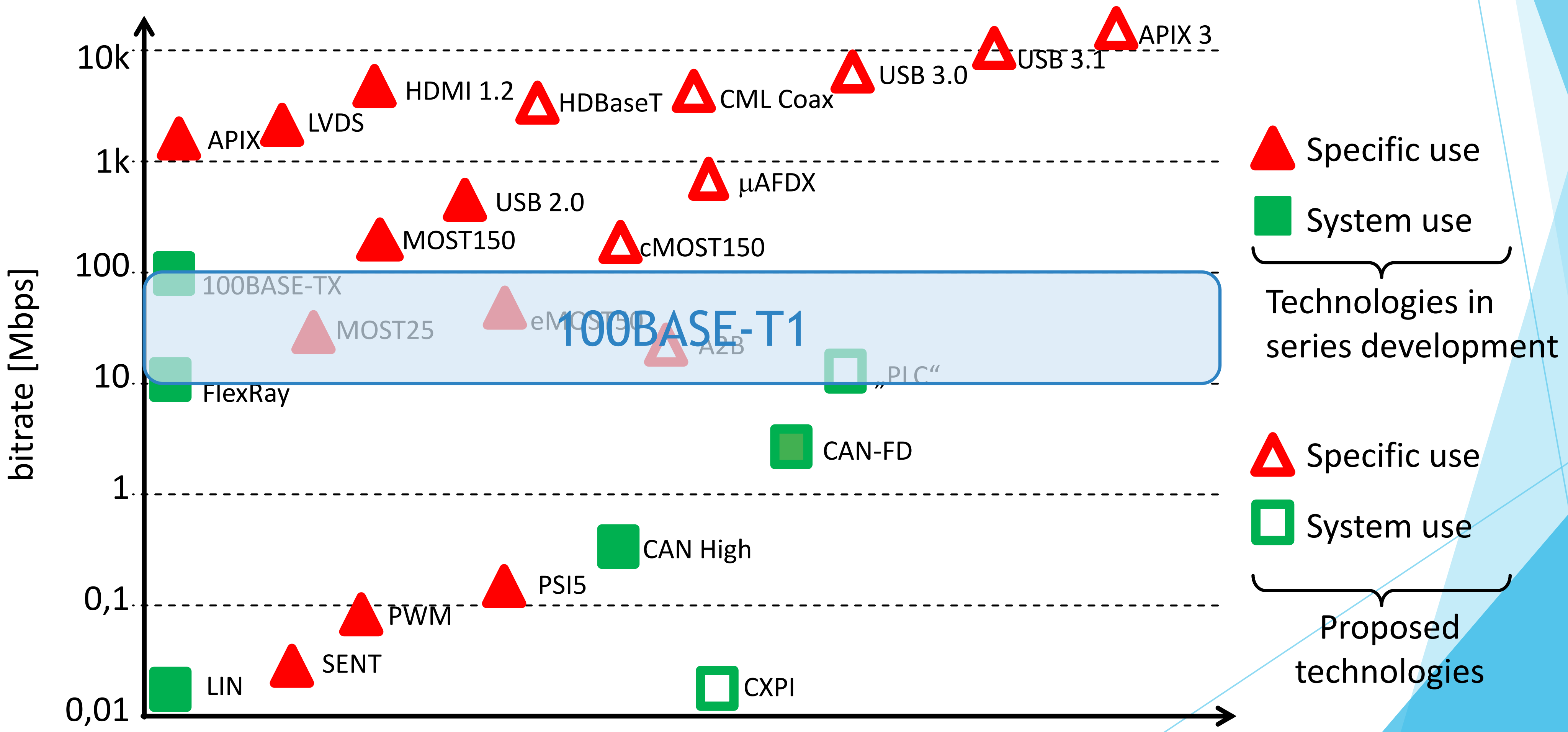
There are many standard communication links for system usage below 10 Mbps



CFI Multi-Gig Automotive Ethernet PHY

Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

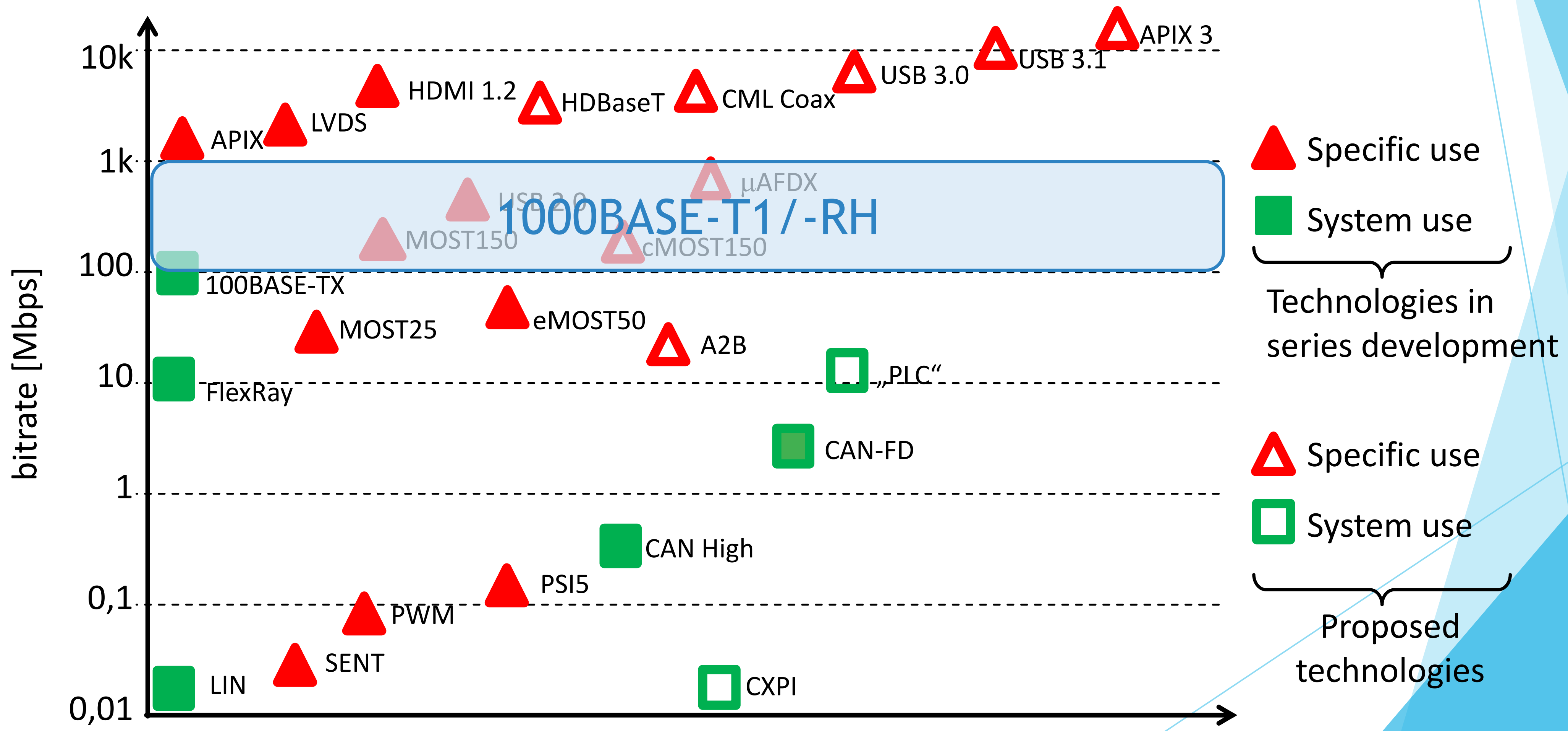
There are few standard communication links for system usage between 10 Mbps and 100 Mbps



CFI Multi-Gig Automotive Ethernet PHY

Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

There are no standard communication links for system usage between 100 Mbps and 1000 Mbps



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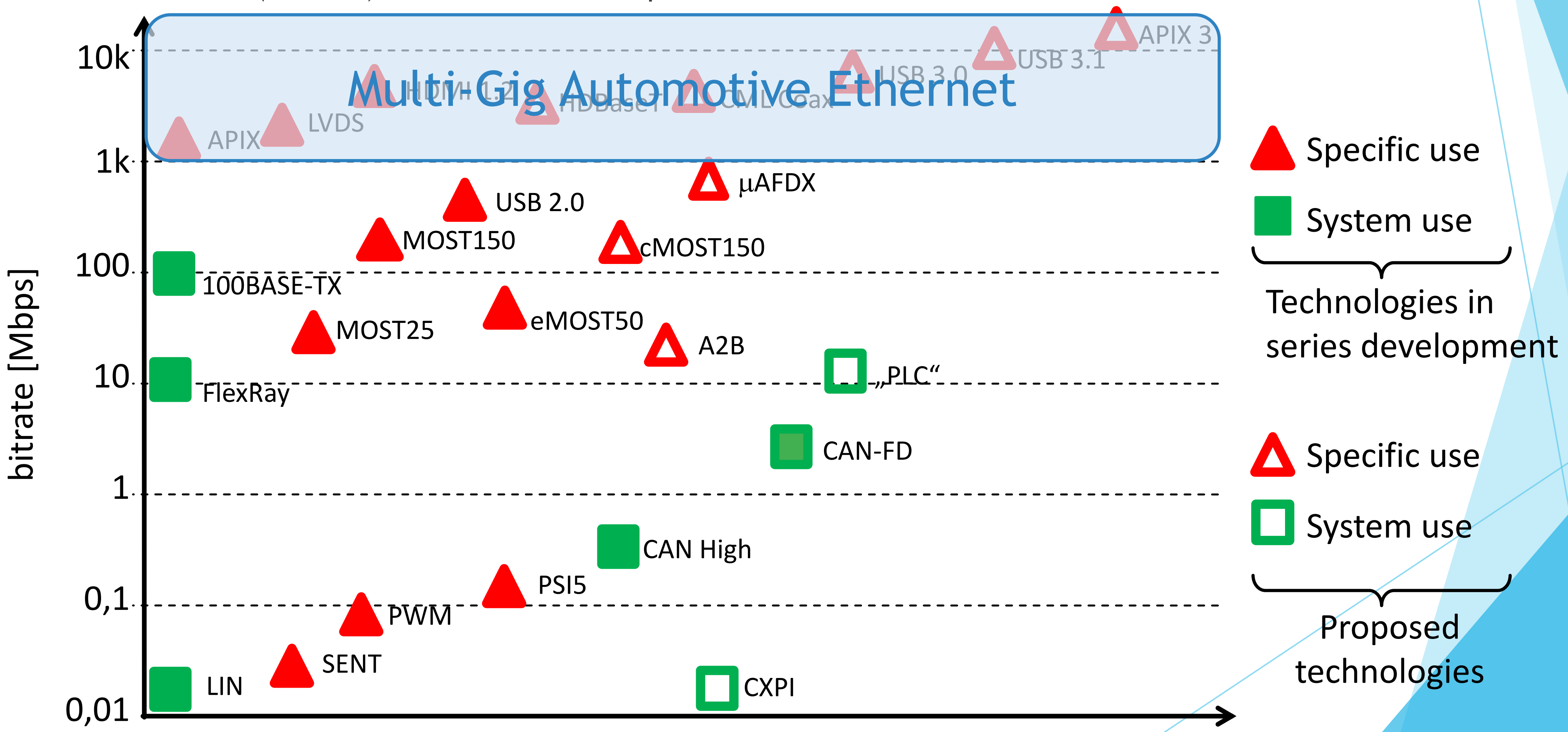
Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

There are no standard communication links for system usage above 1000 Mbps

There are many proprietary communication links above 1000 Mbps

A standard link (or links) is needed for this space



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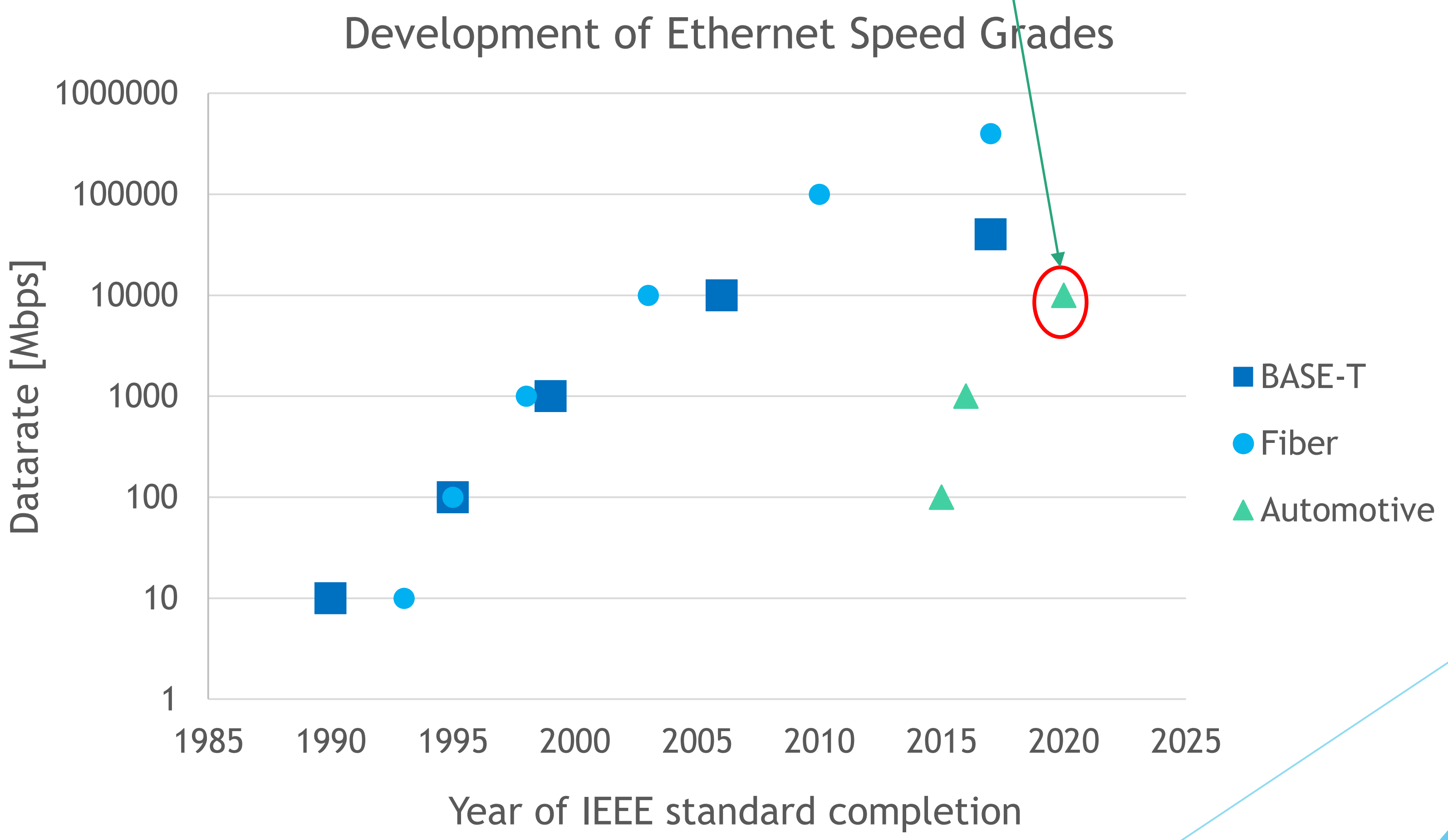
Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

This follows the typical Ethernet PHY development schedule.



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Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

- **Multi-Gig Data Transmission Links in Automotive Today**
  - LVDS / CML
  - APIX
  - USB
  - HDMI
- **Drawbacks of these links**
  - Point-to-point with no automatic relay systems
  - Additional processing power to retransmit
  - Difficult to coordinate timing
  - Proprietary solutions that make adding / changing devices difficult
  - High cable cost (shielding and application specific cables and connectors)

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Why Multi-Gig in Addition to 1000BASE-T1/-RH and 100BASE-T1?

- **Use Cases**
  - Sharing camera data
  - 4K and 8K shared display data
  - Connectivity: LTE 4G/5G, transport of 802.11ac
  - Connecting 1000BASE-T1/-RH switches
  - Diagnosis (port mirroring of multiple 1000BASE-T1/-RH links)
- **Scalability within a network**
  - 100BASE-T1 may be sufficient for collision warning
  - 1000BASE-T1/-RH may be sufficient for collision avoidance
  - xGig (Multi-Gig) required for advanced driver assistance
  - Switch with 100M/1000M/xGig capability

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How many Multi-Gig

- Automotive applications are very cost sensitive
  - There is always a need for more (speed and/or bandwidth)
  - Long cycle times require ability to upgrade without complete redesign, backward compatibility
  - Don’t want to pay for more than required
  - Prefer designs that allow components to be added on an “as needed” basis

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Use Cases

- **Cameras**
  - 4K Cameras at 60 fps – 6 to 8 Gbps
  - Short propagation delay (< 20 ms) doesn’t allow for compression
- **Data Sharing**
  - Aggregation of multiple 1 Gbps links requires xGbps links
- **Displays**
  - 4K/8K displays will start appearing in vehicles
- **Data Recorder**
  - Significant amount of raw data may need to be saved to reconstruct incidents

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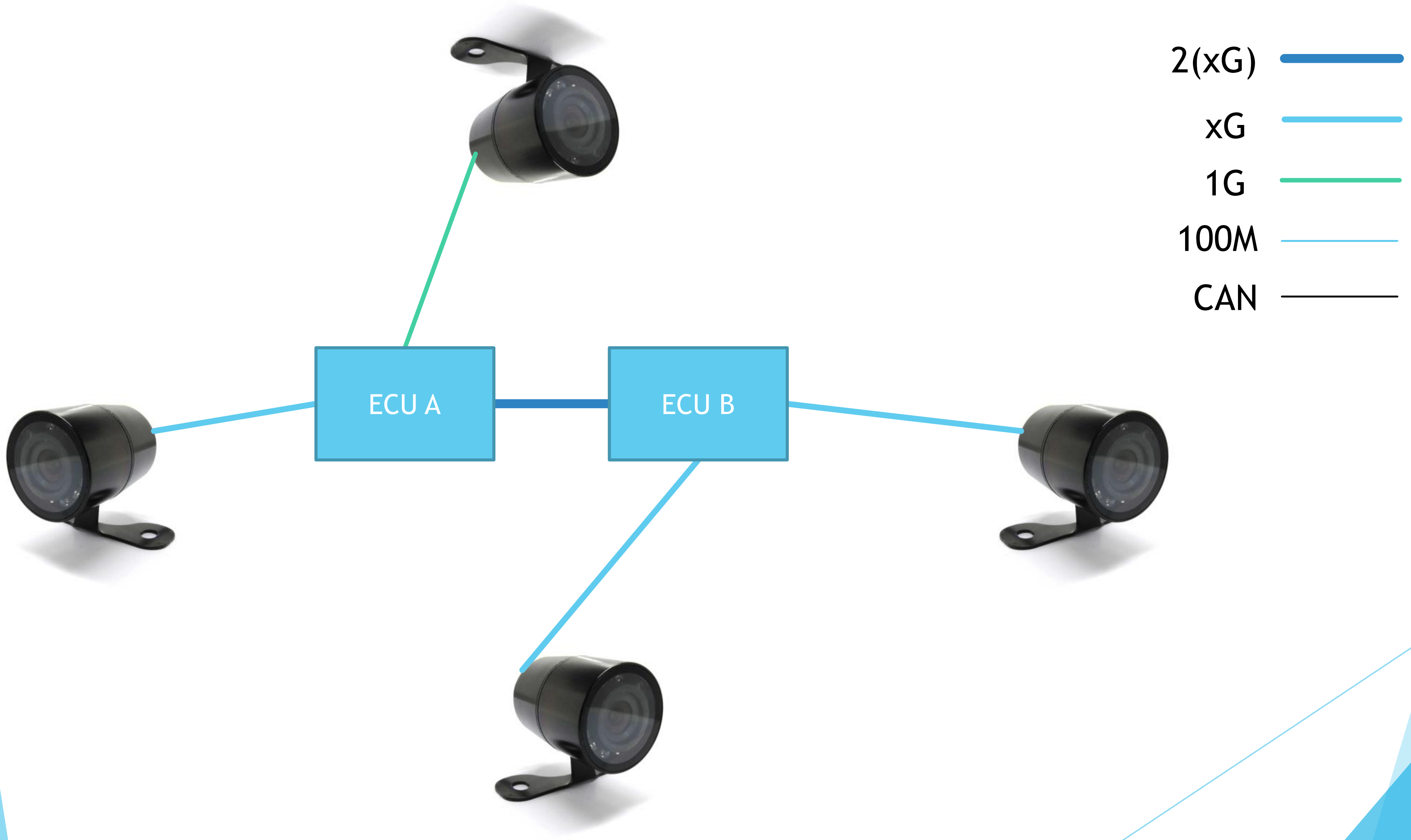
- Sharing Camera Data



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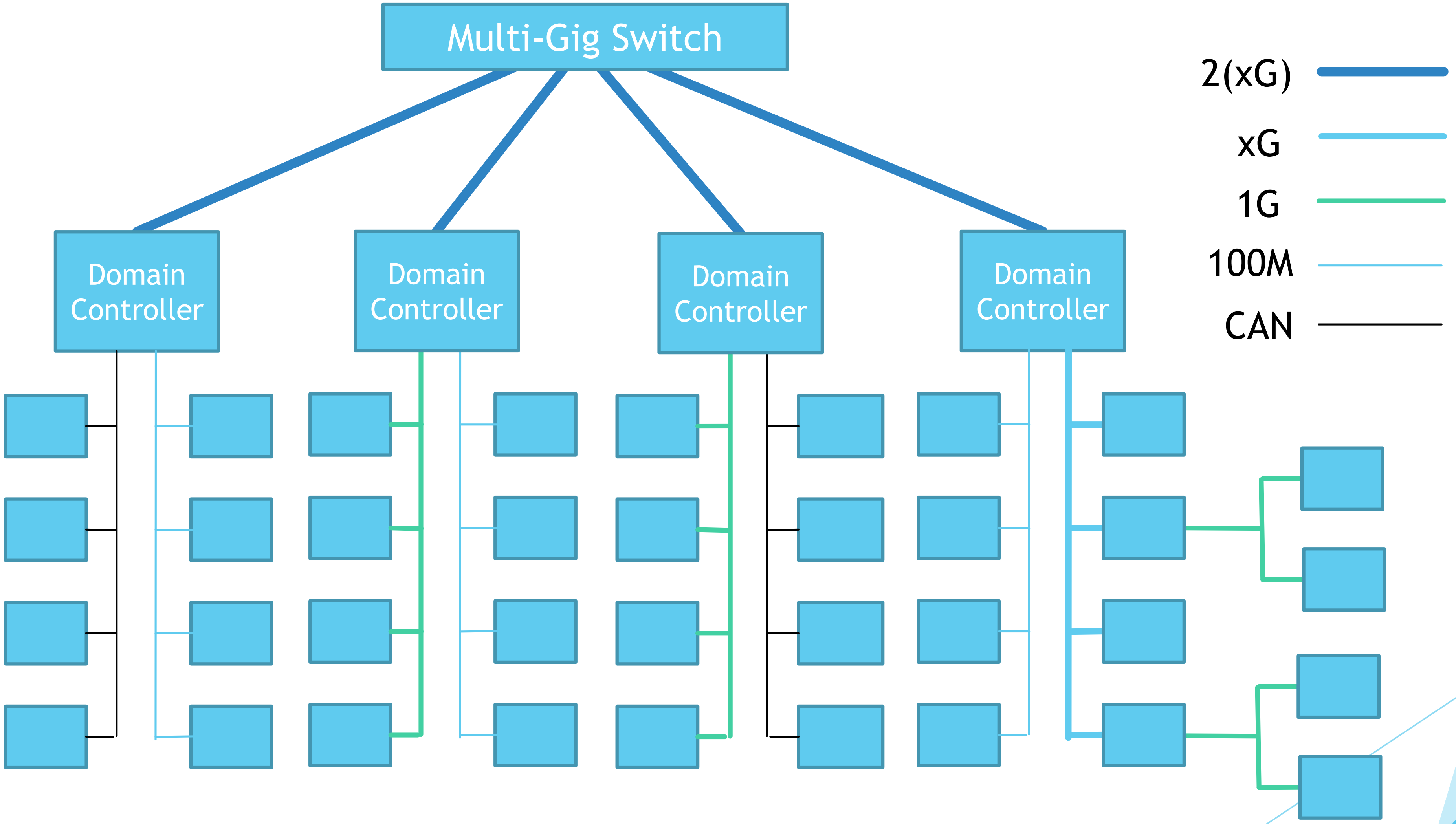
- Data Sharing



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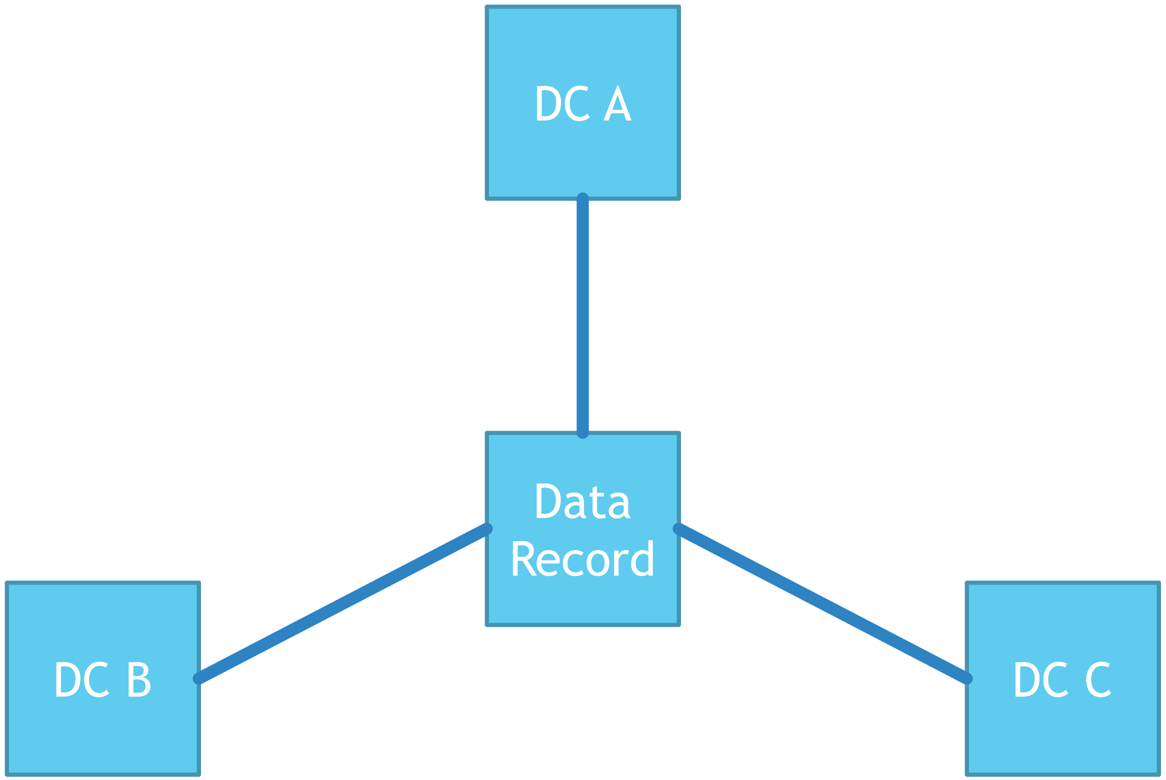
- Data Recorder



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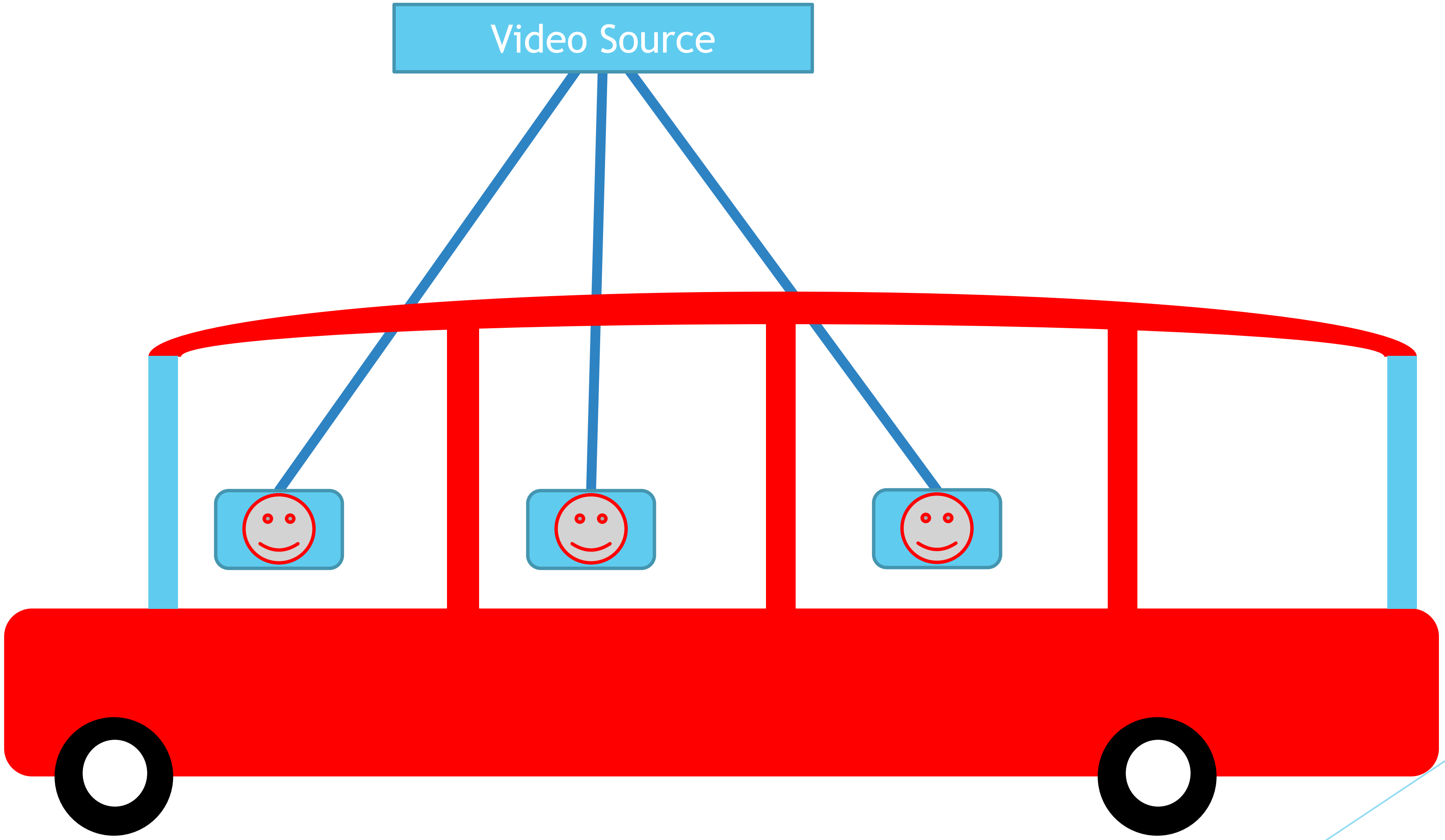
- Displays



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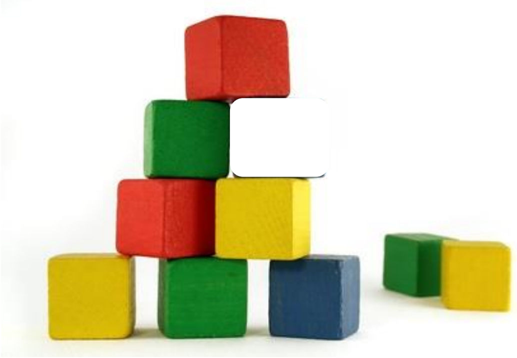
IEEE 802 Automotive Ethernet Eco-System

- IEEE 802.3 for Diagnostics and Flashing
  - S 100BASE-TX
- IEEE 802.3 for In-vehicle communication
  - S 802.3bp 1000BASE-T1 / RTPGE
  - S 802.3br Interspersing Express
  - P 802.3bu PoDL
  - P 802.3bv Gigabit over Plastic Optical Fiber (GEPoF)
  - S 802.3bw 100BASE-T1 / 1TPCE
  - SG 10 Mbps for Automotive
  - C Multi-GE for Automotive
- IEEE 802.1 Data Link Layer
  - S Audio Video Bridging
    802.1BA, 802.1AS, 802.1Qat, 802.1Qav
  - P Time Sensitive Networking
    802.1AS-Rev, 802.1CB, 802.1Qcc, 802.1Qci,
    802.1Qbu, 802.1Qbv, 802.1Qca, 802.1Qcr, 802.1Qch
  - P Security – 802.1AEcg



Something is missing!

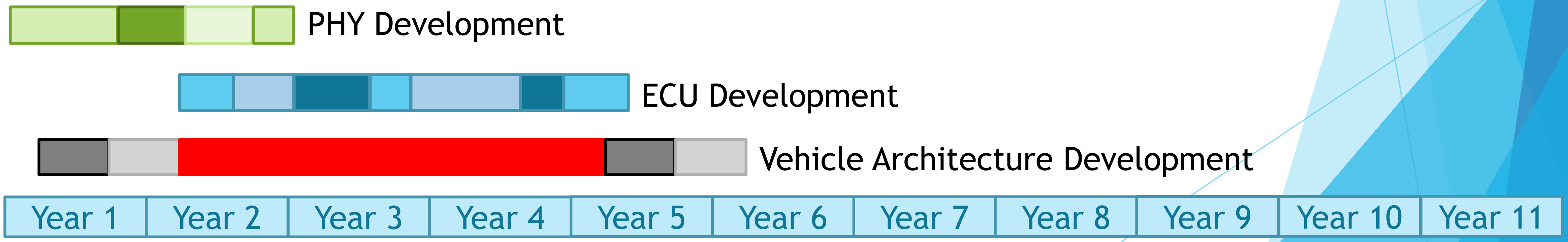
C = CFI; SG = study group; P = Project; S = Standard

CFI Multi-Gig Automotive Ethernet PHY

Why Now?

Total Automotive Ethernet PHY Development from Concept to Production

- Vehicle Architecture Development takes about 1 year and is done every 4 to 6 years.
- ECU Development takes about 3.5 years from RFQ to SOP.
- ECU Development starts after Vehicle Architecture Development.
- PHY Development takes about 2 years from the time all requirements are known and silicon is available for qualification.
- PHY samples must be available before end of Vehicle Architecture Development in order to be considered for the Architecture.



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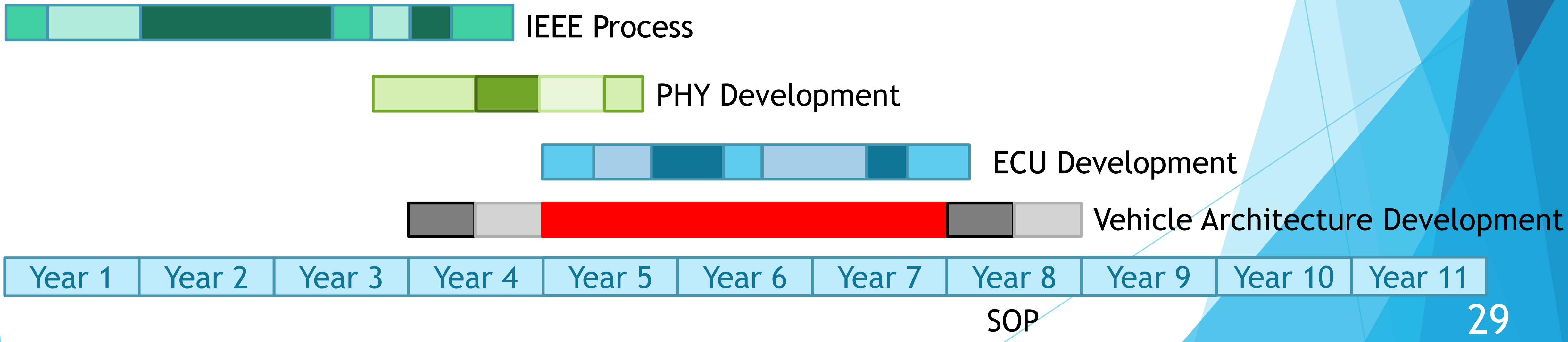
Why Now?

Total Automotive Ethernet PHY Development from Concept to Production

- The IEEE Process takes about 4 years.
- PHY sample development can start about 3 years into this process.
- If this lines up with the Vehicle Architecture Development, SOP is 8 years after the start of the IEEE Process.



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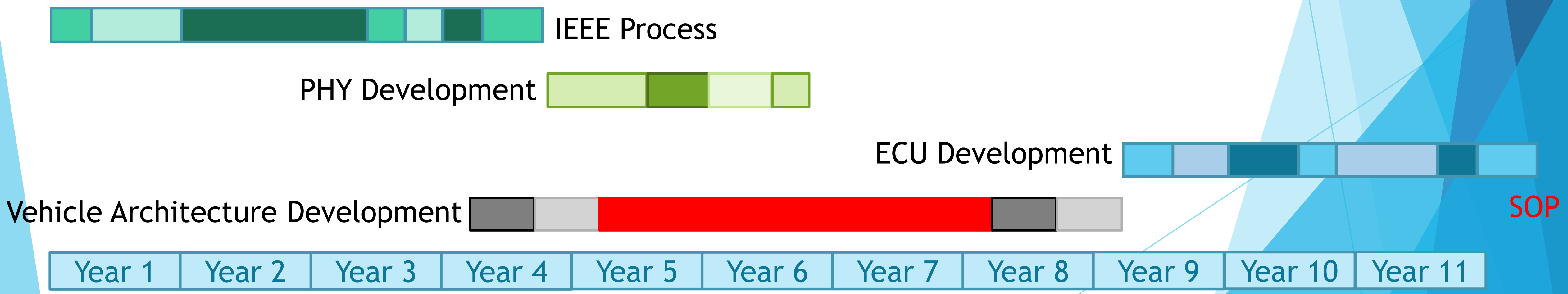
Why Now?

Total Automotive Ethernet PHY Development from Concept to Production

- PHY Development may not start until the IEEE Process completes.
- If this lines does not line up with the Vehicle Architecture Development, SOP may be 11 (or more) years after the start of the IEEE Process.



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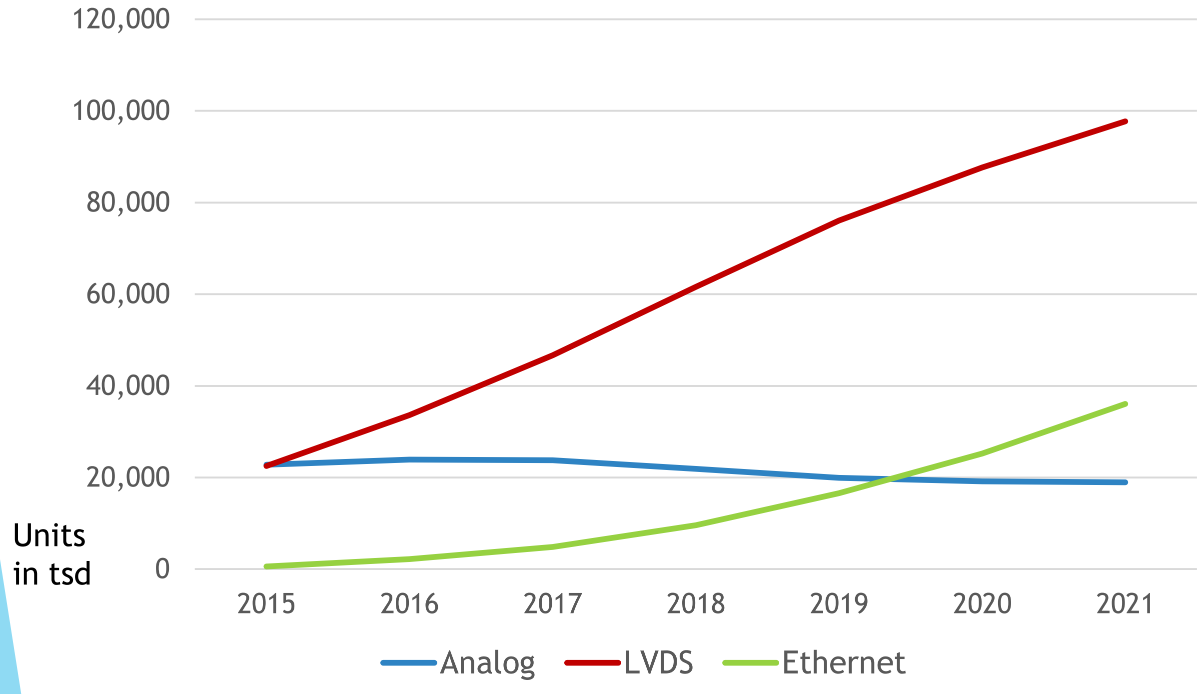
Automotive Market Potential

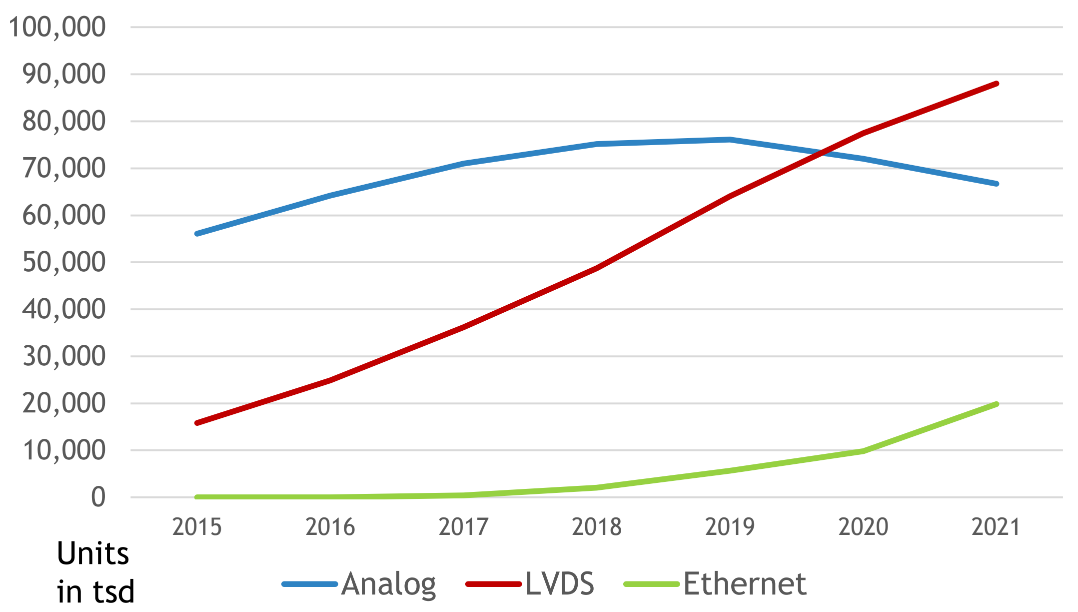
Camera Connectivity Forecast

(Distance Warning, Parking, Blindspot, Nightvision,...)



Display Connectivity Forecast

(Headunit, Seperate, HUD,...)



Data provided by STRATEGY ANALYTICS

CFI Multi-Gig Automotive Ethernet PHY

- Forecast from 100 BASE-T1 CFI

Forecast from 2014 CFI for 1TPCE

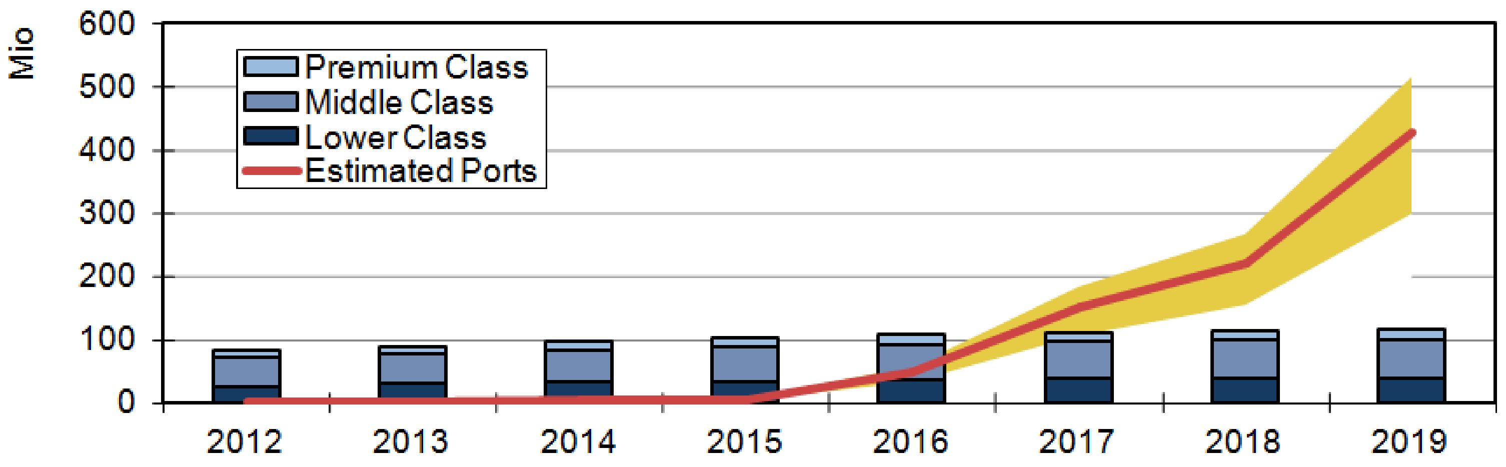
- For RTPGE CFI we forecasted 270 million Ethernet ports by 2019/20
- We were wrong, sorry!
- We now assume about 400 million ports

Some numbers

- In 2019 the automotive industry will produce 117 million vehicles
- Up to 35 ports (20 avg.) in premium class vehicles and 20 (8 avg.) in medium class vehicles that have Ethernet

Ethernet increases creativity for new applications

- Ethernet provides an infrastructure for automotive innovations



Why Now and Why in IEEE 802.3?

- **The automotive industry is requesting it**

- **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 a Multi-Gig Automotive Ethernet PHY as exists for the rest of IEEE 802.3

- **The effort should start now to meet the automotive industry adoption timeline**

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Q&A

Straw Polls

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_90_ Number of people in the room

_50_ Individuals who would attend and contribute to a **Multi-Gig Automotive Ethernet PHY Study Group**

_38_ Companies that support the formation of a **Multi-Gig Automotive Ethernet PHY Study Group**

CFI Multi-Gig Automotive Ethernet PHY

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

Multi-Gig Automotive Ethernet PHY

People in the Room	Dot 3 Voters Only
Y: __85___	Y: __47___
N: __0___	N: __0___
A: __7___	A: __2___

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Thank You!