Reduced Twisted Pair Gigabit Ethernet PHY

Call for Interest

IEEE 802.3 Ethernet Working Group

CFI Panel Members

- **Chair & presenter:**
  - Steve Carlson – High Speed Design, Inc.

- **Supporters and experts for the Question & Answer session:**
  - Dr. Kirsten Matheus – BMW, Auto manufacturer
  - Thomas Hogenmüller – Bosch, Auto Tier 1 supplier
  - Dr. Thilo Streichert – Daimler, Auto manufacturer
  - Don Pannell – Marvell, Ethernet PHY & Switch Chip Supplier
  - Dr. Ali Abaye – Broadcom, Ethernet PHY & Switch Chip Supplier

Supporters – Page 1

Ali Abaye – Broadcom
Thananya Baldwin - Ixia
Karl Barker – Jaguar Land Rover
Hugh Barrass – Cisco
Mike Bennett – LBNL
Robert Boatright – Harman
Brad Booth – Dell
Mark Bugg – Molex
Steve Carlson – High Speed Design
David Chalupsky – Intel
Joseph Chou – Realtek
Mabud Choudhury – CommScope
John D'Ambrosia – Dell
Dan Dove – APM
Dave Dwelley – Linear Technology
Magnus Eek – Volvo
Daniel Feldman – Microsemi
Kenneth Furge – XS Embedded
Thomas Gallner – Continental
Mike Gardner – Molex
Doarte Goncalves – PSA (Peugeot)
Bob Grow – Intel
Sudhakar Gundubogula – Marvell
Craig Gunther – Harman
Marek Hajduczenia – ZTE
Adam Healey – LSI
Chris Healy – IMSCO (aeronautics)
Jeff Heath – Linear Technology
Mike Hill – Goodrich (aeronautics)
Rob Hoeben – NXP
Thomas Hogenmüller – Bosch
Tony Jeffree – Chair IEEE 802.1
Markus Jochim – GM
Mike Jones – Micrel
Max Kicherer – BMW
Yong Kim – Broadcom
Scott Kipp – Brocade
Oliver Kleineberg – Hirschmann
Olaf Krieger – Volkswagen
Ged Lancaster – Jaguar Land Rover

Supporters – Page 2

Wayne Larsen – CommScope
Andreas Leibold – Harman Becker
Helmut Leier – Daimler
John Leslie – Jaguar Land Rover
Ludwig Leurs – Bosch Rexroth
Kent Lusted – Intel
Val Maguire – Siemon/TR42
Dr. Kirsten Matheus – BMW
Authur Marris – Cadence
Chris Mash – Marvell
Brett McClellan – Marvell
Richard Mei – CommScope
Kent Melin – Volvo
Venkatesh Nagapudi – APM
Paul Nikolich – YAS Broadband Ventures
Dave Olsen – Harman
Massimo Osella – GM
Don Pannell – Marvell
Jerry Peper – Ixia
Wiren Perera – Micrel
René Queck – Porsche
Mehrnoush Rahmani – Siemens (trains)
Adee Ran – Intel
Jamal Riani – Marvell
Burkhard Rieke – Porsche
Juergen Roeder – Continental
Samuel Sigfridsson – Volvo
Irene Signorino – Microsemi
Kevin Stanton – Intel
Nancy Supinsky – Focus (automotive)
Thilo Streichert – Daimler
Katsuhisa Tawa – Sumitomo Electric
Geoff Thompson - GraCaSI S.A.
Nathan Tracy – TE Connectivity
Paul Vanderlaan – Nexans
Pedro Reviriego Vasallo – Nebrija Univ.
Ludwig Winkel – Siemens (industrial)
George Zimmerman – CME Consulting
Helge Zinner – Continental

CFI Objective

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

  Reduced Twisted Pair Gigabit Ethernet PHY

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

Agenda

- **Target Markets**
- **History of Automotive Networking**
- **Automotive Market Potential**
- **Automotive Ethernet Challenges**
- **CFI Proposal**
- **Q&A**
- **Straw Polls**

Target Markets

Potential Markets

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

A Reduced Twisted Pair Gigabit Ethernet PHY could be leveraged across other segments including:

- **Industrial networking**
  - Re-use of current installed cable infrastructure with increased bandwidth
    - Factories
    - Trains
- **Avionics networking**
  - The need for weight savings for the cabling infrastructure is even more dominant than in the automotive industry

History of Automotive Networking

Innovation in Automotive Technology is both Hardware & Software

- **Increasing number of applications**
  - Increasing complexity over time
  - Higher bandwidth requirements
  - Need reliable networks

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

Adapted from material provided by BMW

Current Automotive Network Solutions

- **The previous slide showed the increasing complexity of features being added to cars**
- **Each of these ‘features’ takes one or more MCU’s (microcontroller units)**
- **A typical mid-range car may have ~50 MCU’s and a high end car may have up to ~140 MCU’s**
- **These MCU’s need to be connected somehow – thus the creation of automotive networking**
- **Early networks were low speed & are still useful today for simple applications**
- **More sophisticated applications required improved network solutions**

Current Automotive Network Solutions

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

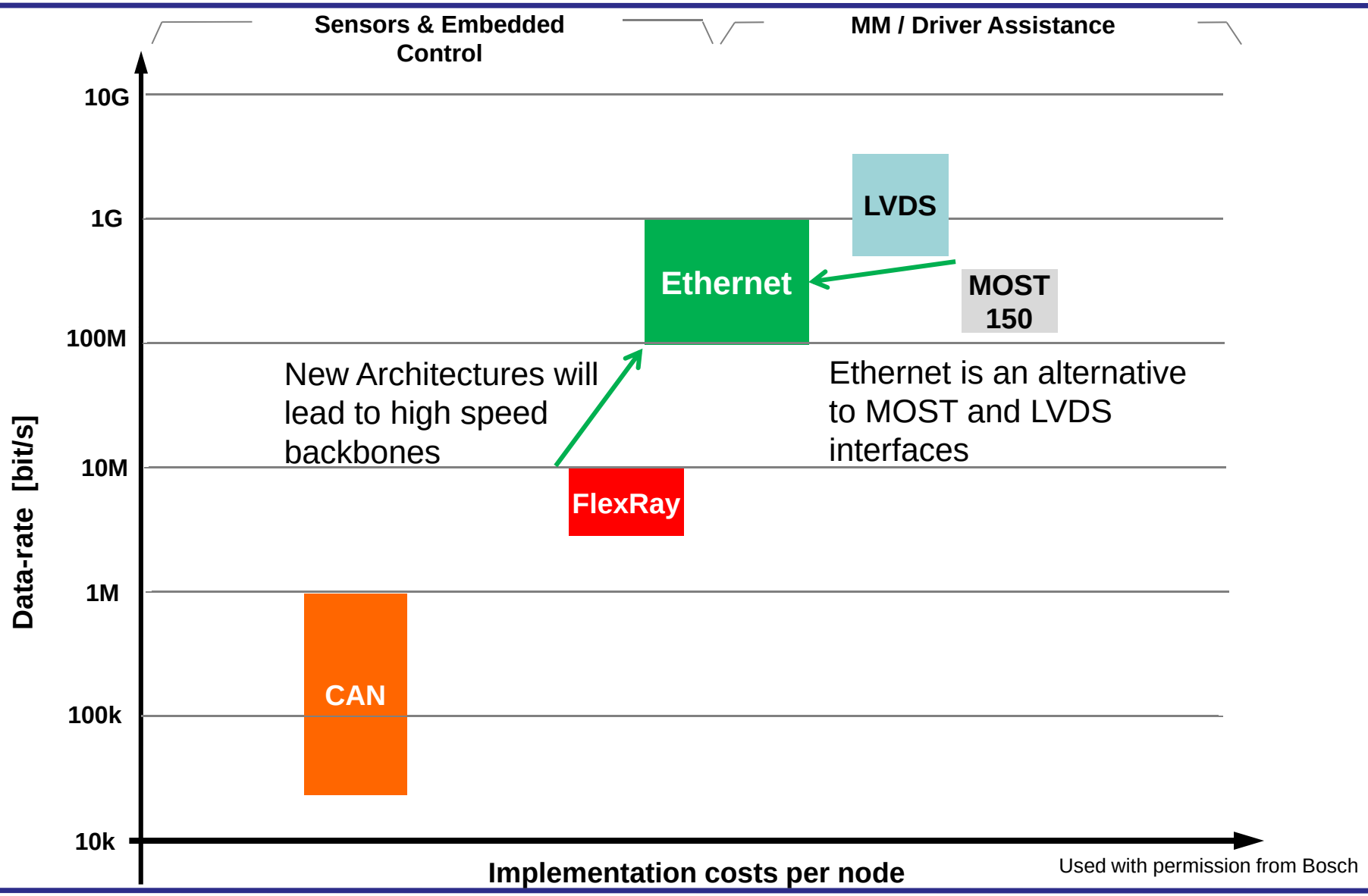
Current Automotive Network Solutions

- **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

- **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

Overview of Automotive Comm Systems



Typical Wiring Harness in a Car

Used with permission from Molex

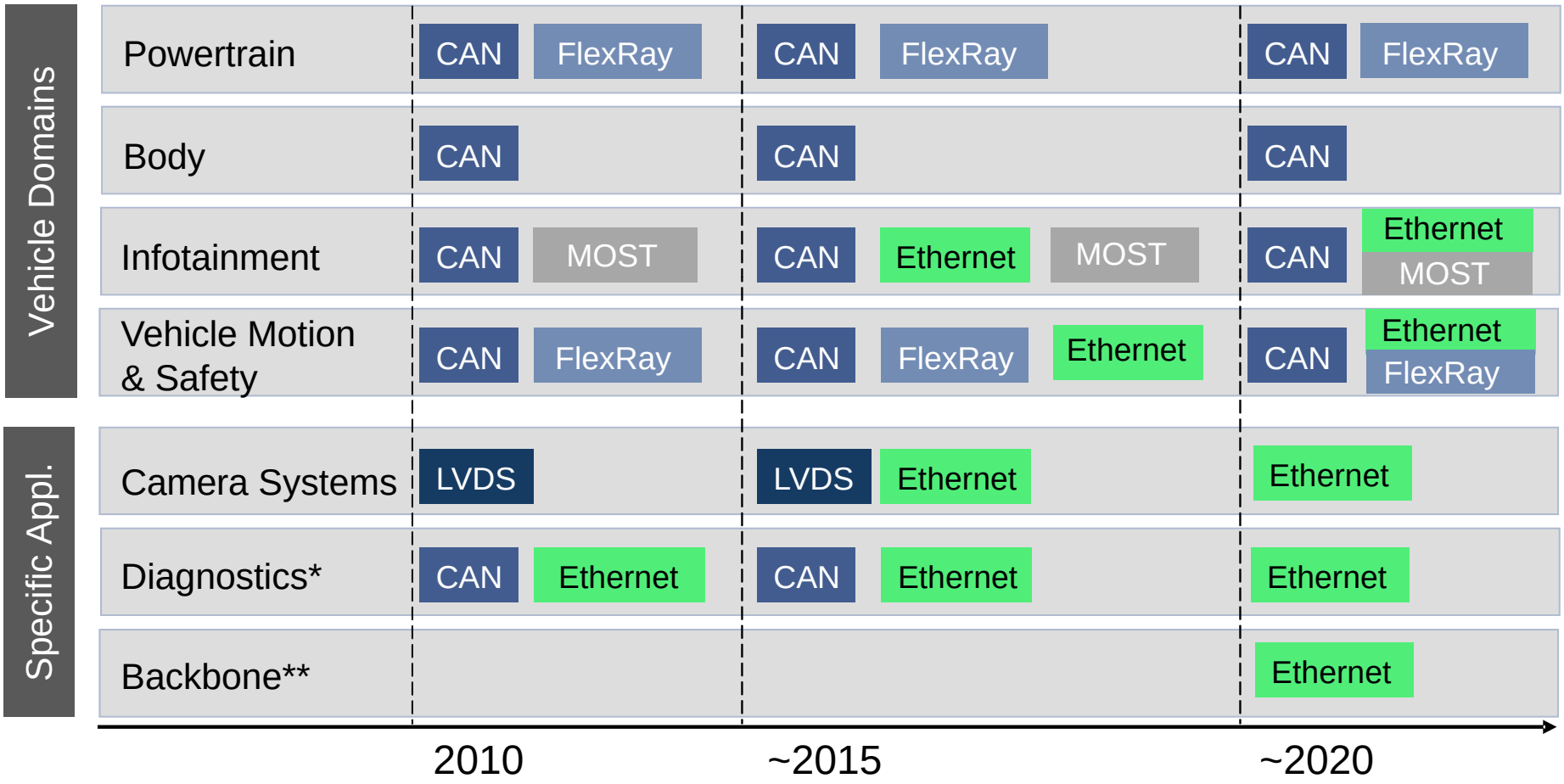
Cabling is the 3rd highest cost component in a car
- Engine (1st)
- Chassis (2nd)

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!

Estimated Ethernet Adoption Timeline

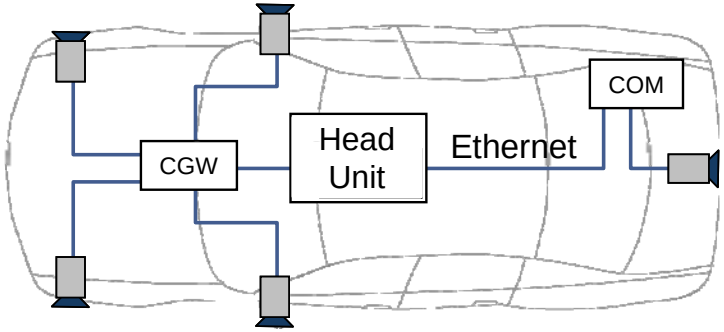


* via Gateway ** with introduction of domain control units

Used with permission from Bosch

Use Cases for Ethernet and IP Communication

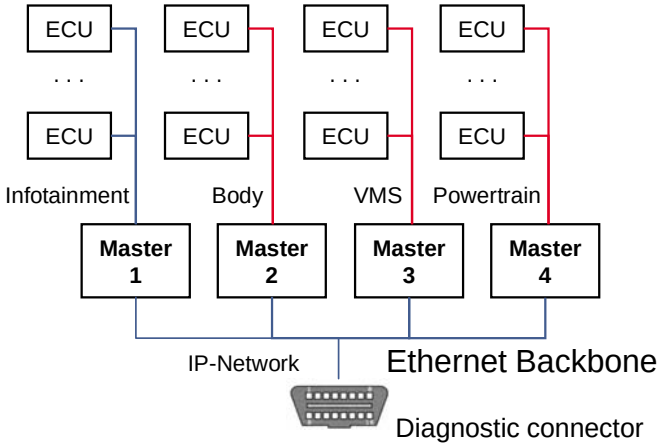
- **Driver Assist Cameras**
  - Cameras on bumpers and mirrors
  - GbE link saves need for compression
  - Reducing latency increases safety
  - Compression artifacts make obstacle detection harder/less reliable



CGW = Camera Gateway

Driver Assist System (start of production: 2013)

- **Ethernet Backbone**
  - Many regions of the car linked together via Ethernet
  - Allows 'data' from one region to be re-used elsewhere in the car
  - GPS navigation can be overlaid on camera data
  - Enables separate CAN bus domains to communicate with each other



Backbone (start of production: ~2020)

Used with permission from Bosch

Summary - Why Ethernet in Automotive?

- **New high bandwidth applications will be introduced**
  - Camera based systems like “Top View”, obstacle warnings, etc.
  - Current communication links are based on higher-cost LVDS
  - Infotainment is based on proprietary technology
  - New driver assistance systems are based on sensor “fusion” of several domains
- **Paradigm shift from decentralized domain-specific communication to centralized backbone architectures**
  - Greater flexibility, scalability and innovation (reuse of hardware and software; synergies)
  - Lower complexity, weight and cost (parts and labor)
  - Increased demand on bandwidth and need for lower latency
- **Automotive systems require guaranteed bandwidth & latency**
  - Ethernet can now support these features based on IEEE 802.1 AVB & IEEE 1722 standards (current and ongoing work)

Application growth will come with the introduction of Ethernet

Automotive
Market Potential

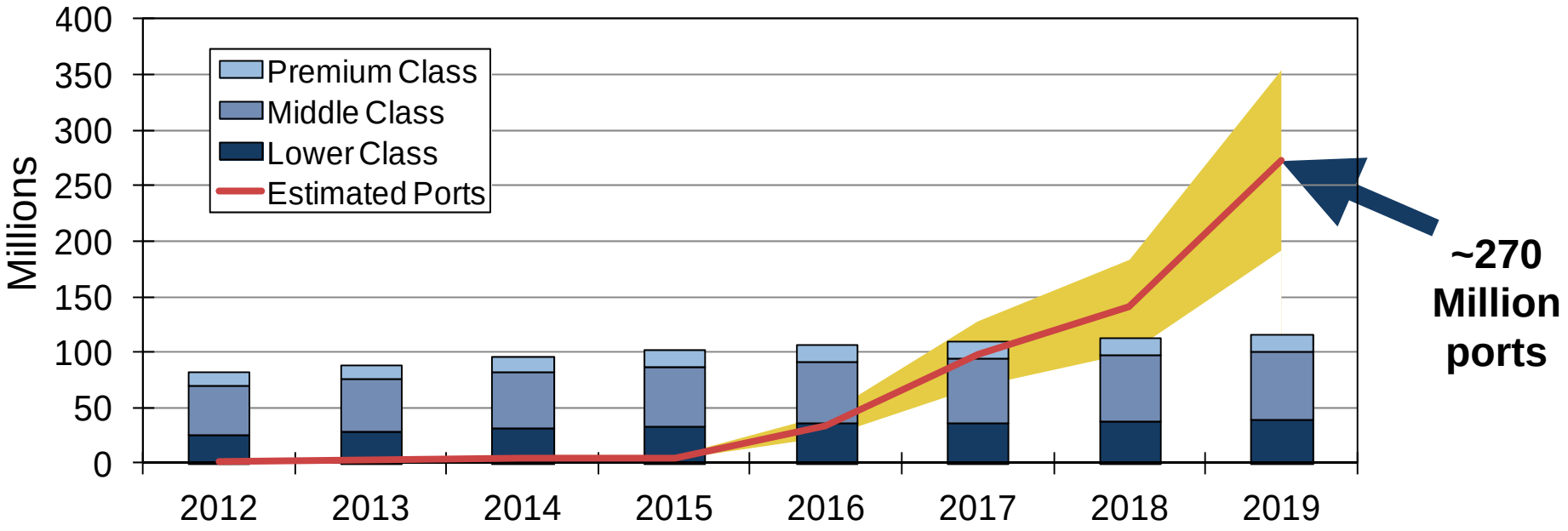
Market Potential – Ethernet Ports

Introduction

- Premium class OEMs (volume OEMs will follow → due to life safety improvement goals)
- Chart data includes cars, SUVs, light trucks, but not commercial vehicles

Forecast

- Up to 35 ports (20 avg.) in premium class vehicles and 20 (8 avg.) in medium class vehicles that have Ethernet
- Chart data was compiled by Bosch



Automotive Ethernet Challenges

Automotive Ethernet Challenges

- **Harsh Environmental Conditions**
  - Operating temperatures:
    - Body & cabin: -40°C to 85°C
    - Chassis & powertrain: -40°C to 125°C or even 150°C
  - Mechanical accelerations:
    - Body & cabin: up to 4 G
  - Dirt, water, salt, dust, ice, snow, mud, oil, grease, transmission fluid, brake fluid, engine coolant, hydraulic fluid, fuel, etc. (i.e., this is not a data center)
- **Automotive EMC requirements are stringent!**
  - Tighter requirements than Class A/Class B EMI specs for consumer products
  - Automotive EMC test specs exist, e.g., CISPR25 & ISO11452-2 & -4
  - Cost and weight constraints - unshielded twisted pair cabling only
- **Very low standby power requirements**
  - Standby power needs << 100 uA
  - Wake up time < 100-500 ms, support of typical automotive wakeup/sleep/diagnosis mechanism

“Need for Speed” in a car

- **100 Mb/s links will not meet future bandwidth needs**
  - Otherwise, driver assist camera video needs to be compressed
  - Desire multiple compressed 720p infotainment video streams
  - Enhanced navigation
  - Tuner module – data from satellite antenna (Internet, TV, etc.) gets uncompressed & digitized at the antenna eliminating costly antenna cables from the roof to the head unit
    - Could dump raw digitized radio data on the backbone for all ECU’s that may need it
- **What about next generation needs?**
  - Uncompressed video for driver assist (200 - 800 Mb/s)
  - Multiple compressed 1080p streams (3-4 streams)
  - Single backbone for reduction of multiple different networks
  - Lower latency
  - …and needs yet unimagined!
- **Future requirements are driving the bandwidth to > 100Mbps**

This CFI is not requesting changes to the MAC - only a new PHY

- **Therefore the next highest existing speed is 1000Mb/s**
  - Many CPUs, SOCs or other devices are available that support IEEE 802.3 standard Gigabit Ethernet MACs that can run at 10 Mb/s, 100 Mb/s or 1000 Mb/s – a standardized interface to the micro controllers

- **Any PHY speed that is >100Mb/s and <1000Mb/s requires modifications to the MAC**
  - This includes CPUs, bridges and other devices with Ethernet MACs
  - Non-standard speeds cannot use **existing** MACs or devices

High Level Summary

- **Ethernet is being deployed in vehicles at an ever-increasing rate**
- **The automotive industry estimates the number of worldwide Ethernet ports in vehicles at ~270 million ports/year ~2019**
- **Ethernet is poised to become the network backbone in vehicles over the next decade**
- **A new Gigabit Ethernet PHY that meets these qualifications is needed**
  - Operates on fewer than 4-pairs of UTP cabling
  - Operates over the channel model developed in conjunction with the automotive/industrial networking industries
  - Meets automotive EMC & susceptibility requirements
  - Meets automotive environmental requirements

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 Reduced Twisted Pair Gigabit Ethernet PHY as exists for the rest of IEEE 802.3

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

Reduced Twisted Pair Gigabit Ethernet PHY

Q&A

15 minutes

Straw Polls

Straw Polls

_103_ Number of people in the room

__65_ Individuals who would attend and contribute to a
Reduced Twisted Pair Gigabit Ethernet PHY Study Group

__42_ Companies that support the formation of a
Reduced Twisted Pair Gigabit Ethernet PHY Study Group

Straw Polls

- Request that IEEE 802.3 WG form a study group to develop a PAR and 5 Criteria for a:

Reduced Twisted Pair Gigabit Ethernet PHY

People in the Room	Dot 3 Voters Only
Y: __86__	Y:__49__
N: ___0__	N:___0__
A: __15__	A:___8__

Thank you!