Ethernet Alliance
Technology Exploration Forum 2013
"The Future of Ethernet"

Fast, Simple, Reliable and Cheap: Ethernet in the Vehicle

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What is Vehicular Ethernet?

- Automotive networking
  - Cars, light trucks, SUVs
  - Increasing bandwidth requirements
  - Large market volume (i.e., port count)
- Trains, buses, and heavy trucks
- Avionics networking
  - The need for weight savings for the cabling infrastructure is even more dominant than in the automotive industry

Innovation in Automotive Technology is both Hardware & Software

Increasing number of applications

- Increasing complexity over time
- Higher bandwidth requirements
- Need reliable network

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 DataCom 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 DataCom 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 DataCom 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

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!

IEEE 802.3 Solutions

- IEEE P802.3bp 1GbE over 1 twisted-wire pair
  - Full Duplex
  - GMII Interface
  - 15 meter reach over the automotive link segment
  - Severe EMC environment
- IEEE Power over Data Lines (PoDL) Study Group
  - Will be IEEE P802.3bu
  - Injects power over the IEEE P802.3bp 1-pair link
  - Provides voltage and current at non-Clause 33 levels
  - Provide wake-up functionality
  - Interoperable, robust and ubiquitous

IEEE 802.3 Solutions

- IEEE P802.3bp 1GbE over 1 twisted-wire pair
  - Similar complexity to current 1000BASE-T DSP PHYs
    - 10GBASE-T does 2.5 Gb/s over each pair
    - 15 meter reach makes things much simpler, e.g. 10mW for echo cancelling instead of 3W for 10GBASE-T
    - This is classic 802.3 Ethernet---reuse the technology you have
- IEEE Power over Data Lines (PoDL) Study Group
  - 802.3 power experts will reuse knowledge and experience to serve this new market
  - Leverage experience in PoE silicon processes
  - No additional wiring required
- **IEEE P802.3bp and P802.3bu are the "killer app!"**
  - **Will enable wide range of new in-car applications, both intracar and intercar**

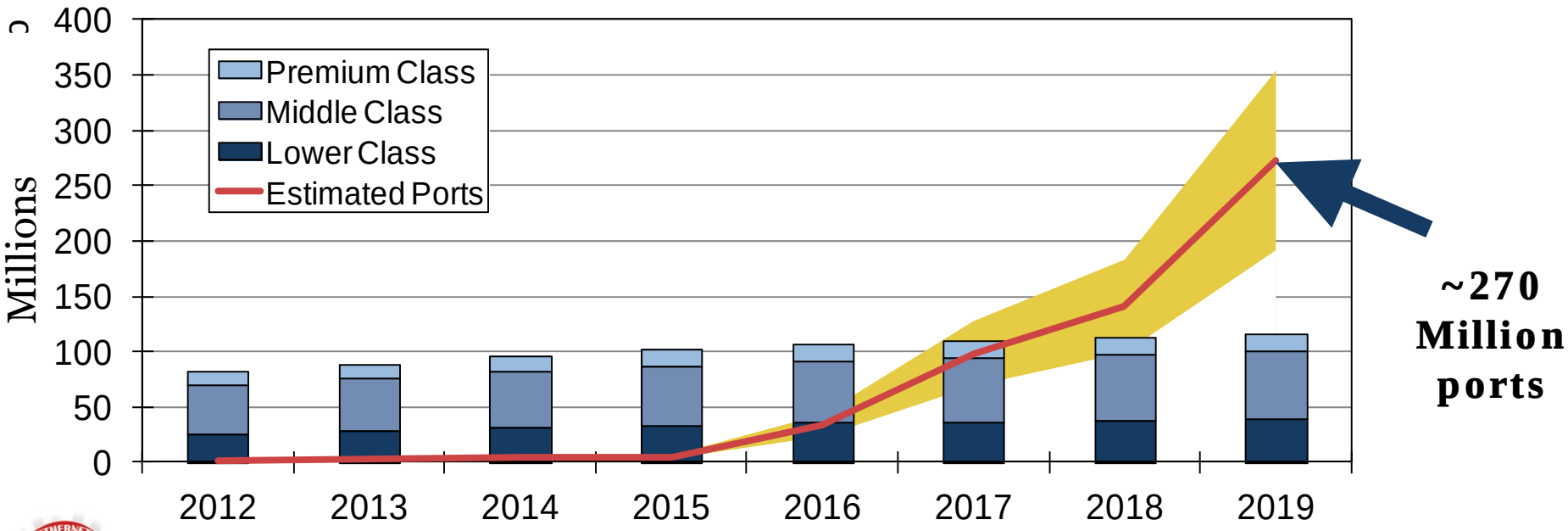
Market Potential – Ethernet Ports

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 in March of 2012---latest estimates double these numbers



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

Our panel - Moderator

Abhi Dugar leads IDC's worldwide research, strategic analysis, advisory services and client relationships for semiconductors, embedded system solutions, and associated software in the Cloud, Mobile and Security infrastructure markets. Before joining IDC in 2010, he worked closely with leading automotive system vendors and OEMs in Europe, Asia and US to develop and launch the automotive infotainment business for Maxim Integrated Products. Prior to that he led the marketing and product strategy for video encoding/decoding products at ESS Technology where he positioned the company's portfolio into the first video products integrated into automobiles by major OEMs worldwide. Mr. Dugar is the Founder and first Chair of the IEEE Consumer Electronics Society's Silicon Valley/Bay Area Chapter. He is based in IDC's San Mateo, California office

Our panel

Dave Dwelley received his BSEE/CS degree from UC Berkeley in 1986 and has worked for Linear Technology as an analog chip designer and then as a manager for 25 years. He was a member of the original IEEE P802.3af (PoE) task force starting in 2000 and was a founding member of the P802.3at (PoE+) group starting in 2004. He now serves as chair of the IEEE 802.3 Power over Data Lines Study Group and participates in the P802.3bp Reduced Twisted Pair Gigabit group. Dave holds 16 patents and spends his free time raising two teenagers and thinking about rebuilding the collection of old cars gathering dust in his garage.

Our panel

Rick Kreifeldt
Vice President, Research and Innovation
Corporate Technology Group
HARMAN International

Chairman/President – AVnu Alliance

Rick has 20 years experience in R&D at HARMAN and is currently responsible for company-wide advanced research. Previous to his current role in centralized R&D for HARMAN, he was head of Automotive Research, led the HARMAN Professional HiQnet networking initiative and before that was Director of Engineering for the dbx Professional brand and prior to that a DSP engineer developing audio signal processing algorithms for Harman. Rick has served as the Chairman and President of the AVnu Alliance since it was founded in 2009.

Rick holds fourteen patents in the areas of DSP algorithms, networking protocols and system design. A National Merit Scholar, Rick graduated Cum Laude from Utah State University with a BSEE. While conducting graduate studies at Utah State, he was involved in several significant DSP research projects, including time at the Los Alamos National Lab Theoretical Division.

Our panel

Steven B. Carlson is the President of High Speed Design, Inc., a Portland, Oregon-based consulting company. Mr. Carlson has over 39 years' experience in embedded control systems and networking for the entertainment and energy management industries. He currently serves as the Chair of the IEEE P802.3bp Reduced Twisted Pair Gigabit Ethernet Task Force and is the Executive Secretary of the IEEE 802.3 Ethernet Working Group. Mr. Carlson served as the Chair of IEEE 802.3af-2003 DTE Power via MDI project, usually referred to as "Power over Ethernet," the IEEE 802.3bf - 2011 Time Sync Task Force and was a founder of the Professional Light and Sound Association's Technical Standards Program, ANSI E1-Entertainment Technology.

Thank you!