Automotive Ethernet,
Holistic Approach for a Next-generation
In-vehicle Networking Standard

AMAA 2012

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Content

- Introducing NXP Semiconductors
- Why Automotive Ethernet?
- Domain Architectures Today and Tomorrow
- Standards for Automotive Ethernet
- Evolution towards Automotive Ethernet
- BroadR-Reach Ethernet Solution
- EMC Fast Ethernet vs. BroadR Reach
- Conclusion
Introducing NXP Semiconductors

NXP Semiconductors provides High Performance Mixed Signal and Standard Product solutions that leverage its leading RF, Analog, Power Management, Interface, Security and Digital Processing expertise

- **Headquarters**: Eindhoven, The Netherlands
- **Employee base:**
  - approximately 25,000 employees
  - in more than 25 countries
  - R&D in Europe, US, and Asia
  - Manufacturing in Asia and Europe: 85% out of own production
- **Net sales**: $4.2 B in 2011, over 60% in Asia Pacific
- **Customers**: Leading OEMs worldwide
NXP – Automotive Product Portfolio

Established leadership positions

In-vehicle networking
- CAN / LIN
- FlexRay
- System Basis chips #1

Car access & Immobilizers #1

Car entertainment
- Radio/Audio DSP
- Tuner
- Audio Amplifiers #1

Magnetic Sensors #3
- Speed (ABS, engine)
- Angular (steering, throttle)

Small Signal Discretes #1
- Diodes & Transistors

Automotive Logic #1

Driving growth

2011 and beyond

Connected Mobility
- Car entertainment
  - Multi Standard Digital Radio
  - Digital 1-Chip Radio
- Car access
  - Passive Keyless Entry / Go
  - Connected Key: 2-way, NFC

Telematics and Car ITS
- e-Call & Eco routing
- Car-2-x communications

CO2 reduction
- Sensors for Brushless DC motors
- IVN
  - Partial Networking
  - Ethernet
  - Isolated CAN
- Lighting & Instrumentation
  - LED Driver IC
  - LED Backlighting
- Battery Management
  - Realtime Clocks for Hybrid Drive

Standard MOSFET Interface Products
- LCD Drivers, LED Controllers, UARTs & Bridges, I/O Expanders, GPIOs, RTCs, PCI express PHY, Cap Touch

Steffen Müller - Automotive Ethernet, Holistic Approach for a Next-generation In-vehicle Networking Standard
Automotive Transceivers reach 3 Billion

11 years to the 1\textsuperscript{st} billion...

11 quarters to the 2\textsuperscript{nd} billion...

11 quarters to the 3\textsuperscript{rd} billion....

... to the 4\textsuperscript{th} billion in 2012

Milestone in September 2010 → 3 billion transceivers shipped
Every newly produced car has 8 NXP transceivers on board
Why Automotive Ethernet?

- Communication and bandwidth requirements increase more and more with more complex car applications, e.g. enhanced safety, entertainment
- Car networks like LIN, CAN, FlexRay are not specified to cover increasing demands for bandwidth and scalability
- Network solutions for higher bandwidth are available but expensive
- End users expect in the car same level of data availability as at home
- Future networking technology shall re-use as much as possible from non-automotive while taking automotive-specific requirements into account

Today, car network architectures are of a heterogeneous and historically grown nature
Domain Architecture, Today and in Future (1)
Domain Architecture, Today and in Future (2)

- Ethernet is good for **backbone bus** systems to connect application domains and **sub-networks** that require higher bandwidth.

- Switched Ethernet networks rely on **point-to-point comm.** and bandwidth is more efficiently used than in broadcast systems (CAN, FlexRay).

- Ethernet is a **paradigm shift in design of next-generation car networks** to
  - Connect different application domain networks
  - Transport different kinds of data (control data, streaming, etc.)
  - Fulfil stringent robustness demands (Temp, EMC) across network protocols.
Evolution towards Automotive Ethernet (1)

- One Pair EtherNet OPEN Alliance; over 50 partners, formed for physical layer
- Standardisation for components, tests based on Broadcom’s BroadR-Reach tech.
- Gather requirements for future networks “Reduced Pair Gigabit”
- AUTOSAR addresses Automotive Ethernet in their software layer stack
Evolution towards Automotive Ethernet (2)

- Driver Assistance Systems include several cameras to allow surround view
- High-resolution cameras require high bandwidth (for uncompressed data) transfers
- Backbone architecture is hierarchically organized with domain controllers
- Different data communication classes coexist on the same network
- IP based routing concept eases addressing and allows scalability
BroadR-Reach Ethernet Solution

100Base-TX (Fast Ethernet)
- MII
- 4B/5B
- MLT-3
- PMD

Per twisted pair 100Mbit/s, 125MBAud, uni-directional
- Transmit
- Receive

1000Base-T (Gigabit Ethernet)
- GMII
- 8B/1B
- PAM-5
- PMD

Per twisted pair 250Mbit/s, 125MBAud, bi-directional
- Transmit & Receive

Automotive Ethernet

BroadR-Reach
- MII
- PCS
- PAM-3
- PMD

Per twisted pair 100Mbit/s, 66.6MBAud, bi-directional
- Transmit & Receive
EMC Fast Ethernet vs. BroadR Reach
Summary

- CAN and FlexRay remain for body and safety-critical communication
- **Increasing bandwidth** needed for driver assistance and infotainment
- Network topologies will change from **decentralised domain-specific architectures** to **hierarchical architectures** that need backbone
- Ethernet provides **scalability and flexibility** for next-generation networks
- New **automotive optimised components** required (Ethernet switches, PHY), promising steps taken with BroadR-Reach technology
- Further studies needed to validate the secure coexistence of different data communication classes on the same Ethernet network
- OPEN Alliance and AUTOSAR are driving further standardisation on the hardware and software levels