1000BASE-T1 from Standard to Series Production
Enabling Next Generation Scalable Architecture

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Agenda

• Next generation scalable network architecture
• The need for 1Gbit/s Ethernet
• Initial investigation
• Building the eco-system
• Qualification
• Summary
What do you expect from a smart vehicle?

- Additional features
- Support cross domain functions
- Increased application diversity for different vehicle configuration and different models
- Individualization – different features and setups on vehicles with the same hardware
- Personalization – available features and setups are linked to an individual driver account
- Upgradability – new functionality can be installed over time
• Centralization of vehicle functionality in a few powerful ECUs called ICAS (In Car Application Server)

• Connecting sensors and actuators using powerful network technology such as Ethernet and CAN-FD to the central ECU

• Consolidation of many different functionalities in powerful ECUs using virtualization
Centralization of Functionality

Benefits:
- Complexity of centralized implementation is lower compared to distributed functionalities
- No functional dependencies between sensor/actuator ECUs
- Separation of sensor/actuator and advanced vehicle functionalities increases flexibility for adding new features (feature update)

New requirements:
- High performance microprocessors
- Powerful OS
  Linux + Adaptive AUTOSAR
- High speed networking

CAN, CAN-FD and Lin Networks are not shown in this picture
Security and Virtualization

- Network with different security zones realized by VLANs
- Secure routing to communicate between security domains using Packet filter

Exposed Network e.g. LTE, WiFi, OBD

Internal Network secured for non critical vehicle applications

Internal Network highly secured e.g. for safety relevant application
Impact on Network Bandwidth

- The new E/E architecture is an enabler for a large number of new functionalities
- Most of the new functions are implemented in the ICAS ECUs
- Features like WiFi and LTE connectivity increases the bandwidth as well as Ethernet-based camera systems and other ADAS Sensors

On some links there is a bandwidth >> 100Mbit/s needed

Solution: Investigate 1000BASE-T1 for these links
Qualifying 1000BASE-T1 for use at VW

• Necessary steps:
  • Discussion with IC vendor who already had experience with 1000BASE-T1
  • Validating vendor component level test results
  • Performing VW technology system level tests
  • Decide to use 1000BASE-T1 as the technology meets the requirements
  • Update all necessary test systems including in car logging to 1000BASE-T1
1000BASE-T1 Compliance Testing

- IEEE 802.3bp compliance testing available from UNH
- 1000BASE-T1 PMA suite available and validated
- Technology validated using customer development board

- PCS & PHY Control test suite requires additional development
- In process now
1000BASE-T1 Robustness Testing

- Internal validation of link-up performed across range of factors

IEEE 802.3bp interoperability testing available from C&S
- Test suite available and devices currently going through testing
1000BASE-T1 Eco System

- Eco-system is well established with 3rd party’s products available
- Oscilloscope vendors completed integration of 1000BASE-T1 compliance testing
Tools

• 1000BASE-T1 media converters available
  • Intrepid Control Systems
  • Technica Engineering
  • X2E

• 1000BASE-T1 SFP modules available
  • Technica Engineering
Tools

• 1000BASE-T1 options available for protocol analyzers
  • Keysight / IXIA
  • Spirent SmartBits

• Other 3rd party products available covering taps/spy’s, analyzers, simulators, data loggers, switches, etc for protocol analysis
  • Telemotive, Vector and others
  • More coming soon!
Vehicle Level EMC Testing

- EMC tests were performed with engineering samples in 2017 and final silicon in 2018
- In vehicle tests followed device level and system level testing
- Early vehicle tests were performed with test ECUs (without functionality) in a similar vehicle with final harness components
Testing / Qualification Results

• During the development numerous tests were performed by the semiconductor vendor and VW
  • Conformance tests
  • Robustness tests
  • EMC tests
  • System level EMC tests
• Wide eco-system of tools and test equipment are available to support development of ECUs with 1000BASE-T1

1000BASE-T1 has been proven to be a robust technology that fulfills VW’s automotive requirements
Summary

• The new scalable E/E architecture enables new applications, additional functionality and adaptability

• New architecture requires > 100Mbit/s Ethernet

• 1000BASE-T1 has been tested / validated

• 1000BASE-T1 has been proven to be a robust technology that fulfills VW’s automotive requirements

• Solves bandwidth bottlenecks in current and next generation architectures
Thank you very much for your attention

Concept Car  VW I.D.  Volkswagen AG

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