Platforms and Architectures: Automotive Use Cases

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2 possible directions

1) Use TTEthernet as a flexible high-speed bus for a separate domain and application, examples:
- Driver Assistance Systems
- Multimedia
- By-Wire

2) Use TTEthernet as a central, unifying network, examples:
- Domain architecture with TTEthernet as backbone network
- Optimized “Front-Rear” architecture with TTEthernet as backbone network

Possibility: start with (1) and migrate to (2)
Use Cases – General Directions

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Driver Assistance

Providing improved sensor data fusion
- RADAR, LIDAR; IR-, 3D cameras; Front-, rear- and side-cameras
- Transmission of raw signals → higher quality data fusion

Benefits of TTEthernet
- Achieving highest quality of sensor data by synchronization with minimum delay and jitter
- Replacing LVDS or CVBS and corresponding control bus, e.g. LIN or CAN
- Cost savings using cheaper cables
- Maximum bandwidth utilization

- Automatic distance control
- Lane change warning
- Lane departure warning
- Parking assistant
- Side view
- Top view
- Night-vision
- Pedestrian safety
- Traffic sign recognition
Interoperability and connectivity with consumer mainstream

- Navigation, infotainment, extensive audio and video entertainment
- Shorter time-to-market
- Technology updates and refresh (e.g. CAR2x, Internet-Applications)

Benefits of TTEthernet

- Guaranteed data rates for audio and video
- Integration of driver assistance systems and infotainment into the same network
Integration of fail-operational systems
• E.g. Brake-by-wire (for electric vehicles)

Benefits of TTEthernet
• Fault-tolerant and fail-operational network
• TTEthernet is the only solution to address a broad variety of Real-Time and Safety related Applications
• Certified safety
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Encapsulated ECUs (with distributed functionality)
- Price/Performance-optimized architecture

Domain Controller
- Main controllers with integrated functionality
- Smart satellites for actuator control

Due to the increase of optional equipment

From presentation by Mr. Frickenstein (BMW)
Advances in Automotive Electrics in Ludwigsburg
**Benefits of TTEthernet**

- Integration of all domain traffic classes in one network
- Integration of different safety criticality classes (partitioning)
- Switch network allows easily to scale
Inter Domain Communication

**TTEthernet =**

- Ethernet + Clock Synch. + Time-Triggered Communication + Rate Constrained Communication + Safety

- IEEE 802.3
- established
- dominant
- Standard

- IEEE 1588
- coordination
- distributed control

- SAE AS6802
- real-time control (chassis, engine, active&passive safety systems)
- determinism

- ARINC 664, AVB
- audio/video streaming
- sensor fusion

- ISO26262 ASIL D
- IEC 61508 SIL 4
- „By-wire“

Integration of **all data flows** in one single network

- 100% compatible with Ethernet standard IEEE 802.3
- Scales from low to high speed (10 Mbit/s, 100 Mbit/s, 1 Gbit/s, …)
- Scales from simple to safe and high-availability systems
TTEthernet supports mapping of functional domain structure to cost optimized front-rear structure.
**Front Rear Architecture: Basic Idea**

Comparison wire harness | front ↔ rear / cockpit ↔ boot
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Class of cars | Upgrade options | With communication system [n] | Without communication system | today [n] | new [n] | Δn | Δkg | today [n] | new [n] | Δn | Δkg |
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
Premium class SOP 2004 | Min | 162 | 145 | 8 | 137 | 5,5 | 71,5 € – 118,3 € |
| Max | 318 | 235 | 8 | 227 | 9,1 |
Middle class SOP 2007 | Min | 108 | 8 | 100 | 3,6 | 46,8 € – 76,7 € |
| Max | 174 | 8 | 166 | 5,9 |

n…number of cables, \( \Delta kg = \Delta n \times L \), L…average cable length, A…cable cross-section
Benefits of TTEthernet

- Less cabling → weight and cost reduction
- Less connectors → Reliability
- Improved reliability by redundant network paths, function distribution and redundant sensors
Step 1: Today’s Ethernet use cases
- Driver Assistance
- Multimedia
- Diagnosis (DoIP)
- Software based end systems (MAC)
- 1 TTEthernet switch chip / car

Step 2: Domain Architecture
- Integration of all domain communication over TTEthernet
- Powertrain, chassis, body, multimedia, driver assistance, diagnosis, ...
- > 5 TTEthernet based end systems (MAC)
- 2 TTEthernet switch chip / car