The Future of Ethernet in AUTOSAR

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Overview

- Ethernet in AUTOSAR 4.0 – The first steps
- Ethernet in AUTOSAR 4.1 – In-vehicle Ethernet communication
- Ethernet in AUTOSAR 4.2.1 – Enhancements and extensions
- Ethernet in AUTOSAR 4.x – There is more
Ethernet in AUTOSAR 4.0 – The first steps

- AUTOSAR 3.x
  - No support for Ethernet at all

- AUTOSAR 4.0
  - First AUTOSAR version supporting Ethernet
    - Challenge to include Ethernet into the existing AUTOSAR architecture because of the different communication scheme
      - TCP/IP protocol stack (e.g. data streaming with TCP)
      - Socket-oriented vs. AUTOSAR PDU-based communication

![AUTOSAR Diagram]
Use-case: Vehicle diagnostics
  - Diagnostics over Internet Protocol (DoIP)

Diagram:
- External Test Equipment
- In-vehicle Test Equipment
- Ethernet
- Switch
- DoIP Gateway
- CAN
- LIN
- FlexRay
- DoIP Node
- ECU

The Future of Ethernet in AUTOSAR
Use-case: Signal- and PDU-based communication
- Like CAN, LIN and FlexRay communication
- Transmit and receive multiple PDUs on one Socket to save resources
  - Transmission of multiple PDUs in one UDP packet is not possible
- Add small header in the Socket Adaptor to differentiate between PDUs
  - Header contains PDU ID and length

Use-case: XCP on Ethernet

Use-case: UDP network management
Ethernet in AUTOSAR 4.1 – In-vehicle Ethernet communication

- Major update of the Ethernet stack
  - Signal- and PDU-based communication according to AUTOSAR 4.0 did not meet all needs for vehicle-internal Ethernet networks
  - Extension of the Ethernet stack
    - Virtual LAN (VLAN) support
    - New Tcplp module
    - Split of SoAd and DoIP, new DoIP module
    - Extension of SoAd capabilities e.g. with respect to PDU multiplexing
    - New Service Discovery (Sd) module
  - Major update of the System Template
Use-case: Service-oriented communication
- Introduction of Services which can be a combination of …
  - … Events (notifications) and …
  - … Methods (remote procedure calls)
- Announce availability and location of Services
- Publish/Subscribe model for Events
- More dynamic approach of communication
  - Activation and deactivation of communication paths during runtime
  - Individual communication between two endpoints, usage of unicast instead of multi- or broadcast
  - Service content is statically defined (database)
- Save bandwidth and computing resources
- Relocation of Services without adapting the clients
  - Improved variant handling

- SOME/IP is not specified
  - Has to be realized in application or by a Complex Driver
Use-case: PDU multiplexing
- Transmit multiple PDUs in one Ethernet frame (UDP packet)
  - Multiple CAN, LIN and FlexRay PDUs (gateway to existing networks)
  - Multiple Events or Method calls for Service-oriented communication
- Different frame triggering conditions

Use-case: Partial networking with UDP network management
- Similar to partial networking on CAN
Further extension of the Ethernet stack
- New Ethernet Switch Driver (EthSwt) module
- Wakeup based on Ethernet communication
- Extension of the Tcplp module
  - Support of IPv6 for in-vehicle communication
  - DHCPv4/v6 server
- New Ethernet Time Synchronization (EthTSyn) module
- Improvements for Service-oriented communication (SoAd)
- New SOME/IP transformer
Use-case: SOME/IP – Scalable Service-Oriented Middleware over IP

- Serialization of structured data
  - Defines the on-the-wire format
- Is/Can be used for Service-oriented communication in combination with Service Discovery
  - Transmission of notifications
  - Remote procedure calls
- It is planned to use SOME/IP-SD also for dAUTOSAR
  - Existing solutions like CORBA are not designed for automotive use cases
Use-case: Ethernet switch configuration

- Automotive Ethernet switches offer different configuration possibilities
  - VLAN
  - Forwarding tables
  - Queuing mechanisms
- New software stack fits to all known Ethernet switch architectures
- Special DHCPv4/v6 server comes along with the possibility of switch configuration
  - Assign IP addresses to vehicle internal ECUs
  - Assign an IP address based on the switch port the ECU is connected to
Use-case: Global time synchronization

- Having the same understanding of the current time in a complete vehicle
  - Intra-network time synchronization e.g. within an Ethernet network
  - Inter-network time synchronization e.g. between CAN, FlexRay and Ethernet networks
- Synchronized Time-Base Manager (StbM) is the central module
  - Provider modules for each network technology, e.g. EthTSyn
  - For Ethernet networks gPTP (referring IEEE802.1AS) is used as time synchronization protocol

Use-case: Wakeup based on Ethernet communication

- The AUTOSAR software stack is prepared to support wakeup based on Ethernet communication
- First wakeable transceivers are expected soon
Ethernet in AUTOSAR 4.x – There is more

- Use-case: Transmission of media contents in time critical environments
  - Audio/Video Bridging (AVB)
    - Generalized Precision Time Protocol (gPTP – already implemented in EthTSyn)
    - Stream Reservation Protocol (SRP) – for automotive applications?
    - Forwarding and Queuing in Time Sensitive Systems (FQTSS)
    - Audio/Video Transport Protocol (AVTP) according to IEEE1722(a)

- Time Sensitive Networking (TSN)
  - Extension to AVB
  - Ethernet as backbone
Ethernet in AUTOSAR 4.x – There is more

- Use-case: Intelligent charging of electric and hybrid vehicles
  - Smart Charge Communication according to ISO 15118 and DIN 70121
    - AC and DC charging (DIN 70121 only supports DC charging)
    - Plug and Charge and External Identification Means (DIN 70121 only supports External Identification Means)
    - Transport Layer Security (TLS) for encryption of the TCP data stream

V2G
V2GTP, SCC, EXI, XML Security

SoAd

Tls

TcpIp
Ethernet in AUTOSAR 4.x – There is more

- Use-case: Vehicle remote access
  - E.g. check vehicle fill level via smartphone app or remote diagnostics
  - Usage of standard Internet mechanisms like DNS and HTTP

- Use-case: Car2X communication (only EU protocols shown)
  - Car2X comes along with a dedicated protocol stack
    - GeoNetworking
    - Basic Transport Protocol (BTP)
    - Cooperative Awareness Message (CAM) and Decentralized Environmental Notification Message (DENM)
    - Global Navigation Satellite System (GNSS)

- Use-case: Ethernet testability
  - Ensure protocol conformance of the TCP/IP stack
  - Standardized testing protocol
  - Ethernet Testability Interface (ETI)
Thank you for your attention!

Questions?