Highlights

- OPEN Alliance TC11 scope and goals
- Requirements to switch semiconductor
- Test specifications
- Test system
- Future outlook

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First insights to compliance verification of Automotive Ethernet Switches based on OPEN TC11

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OPEN TC11?
OPEN Alliance TC11

SCOPE AND GOALS

• Started in January 2016
• Align and identifying a minimum set of common switch features of automotive applications
  • Non-availability of certain functions could be irrelevant for one OEM, while it is essential for others
• Defining requirements out of this minimum set
• Definition of an automotive switch conformance test specification
OPEN Alliance TC11

**REASONS**

• A minimum set of switch features required
  • To cover all network characteristics of each OEM
  • Generate economies of scale without limiting to a specific network architecture

• Compliance testing of switch semiconductor product
  • Helpful already in the creation phase creating a common understanding of requirements of the automotive industry
  • Guarantees a certain required functionality
  • Reduce effort and costs when changing a key switch semiconductor
Requirements
• Requirement specification released on **September 28, 2016**
• **86** requirements defined in **9** different areas
Requirements to switch semiconductor

**GEN-005**
“The Ethernet Switch shall operate as store and forward switch”

**FILT-007**
“The Ethernet Switch shall support filtering on L2 fields.”

**QOS-004**
“The Ethernet Switch shall support strict priority scheduling for each egress port.”

**TIME-002**
“The Ethernet Switch shall support time synchronization on all ports.”

**VLAN-001**
“The Ethernet Switch shall support VLAN handling according to IEEE 802.1Q.”

**ADDR-004**
“It shall be possible to read and write entries to the address table(s) by the host processor.”
Test Specification
Test Specification

OVERVIEW

• Defined **166** test cases overall
• Categories aligned with requirement specification
  • GEN, ADDR, VLAN, QOS, TIME, FILT, DIAG, INTF, CONF
• Covered **95%** of the initial TC11 requirements
• Only **4** uncovered requirements, because:
  • Already covered in others test specifications (3)
  • Not testable due to vague specification (1)
Test Specification

CONTENT

General (GEN, 23 test cases)
- Startup performance
- Queue/Frame buffer size
- Port Mirroring

Address Resolution (ADDR, 17)
- Tagged/untagged Frames
- Aging time
- Read/write address table

Virtual LAN (VLAN, 75)
- Handling according to IEEE 802.1Q
- Freely configure VLAN IDs
- Overwrite VLAN IDs at ingress port

Time Synchronization (TIME, 4)
- PTP 1-step-clk
- PTP 2-step-clk

Quality of Service (QOS, 12)
- Priority based QoS
- Support of WRR and CBS
- Overwrite priority

Configuration (CONF, 5)
- Reconfiguration without interruption
- Starting in „dont forward“ mode

Filtering (FILT, 17)
- Filtering based in L2/L3 information
- Rate limitation

Diagnostics (DIAG, 11)
- MIB counter support (RFC 2819)
- Port_Based_Counters

Interfaces (INTF, 2)
- Configuration via SPI
- AUTO-MDI-X for 100BASE-TX
Test Specification

- Test tool is connected to Device Under Test via host board (Ixia hardware used)
- Various test topologies are simulated for testing different scenarios from VLAN, ARP, TSN, FILT, etc.
- Test execution fully automated
- Same DUT that was used for PHY interoperability testing (OPEN TC1 IOPT)
Experience & Outlook
Experience

- Extensive upper layer interface (Upper Tester) required
  - Configuration of switch features/parameters
- Vendor specific implementation
- Comparison between functionality required for IOPT and TC11
  - IOPT requires about a dozen driver functions
    - GetLinkStatus, GetSQI, GetCableDiagnostic, etc.
  - TC11 requires about a hundred driver functions / service primitives
    - CreateVLAN, DeleteVLAN, SetPVID, etc.
Experience

**TEST IMPLEMENTER**

- Requires Hardware Capability
- Availability of a singleton implementation
- Absence of standard method of accessing Device data
## Development Status

### Test System

<table>
<thead>
<tr>
<th>Test Scope</th>
<th>Test Cases</th>
<th>ADDR</th>
<th>VLAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADDR</td>
<td>17</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>VLAN</td>
<td>75</td>
<td>100%</td>
<td>80%</td>
</tr>
</tbody>
</table>

### Test Scopes
- GEN (23)
- ADDR (17)
- VLAN (75)
- TIME (4)
- QOS (12)
- CONF (5)
- FILT (17)
- DIAG (11)
- INTF (2)
• Implementation of the remaining Test Suites is expected to be finished by November 2018
Targeted publish date of TC11 Test Specification

October 2018

We are ready to test

Now
Outlook

FUTURE TOPICS

• Security testing, especially in security-critical applications and systems an awareness for security must be created

• 802.11AE MAC Security (MACSec) standard offers MAC-level encryption and message authentication for Ethernet using 802.1x for secure key exchange.
Questions?