Ethernet in CANape

An overview on Use Cases, Features and the network-based HW access concept
The big picture – Use of in-vehicle Ethernet is ever increasing

- Higher internal bandwidth required
- Increasing communication between in-vehicle and offboard systems
- Ethernet & IP as unifying technologies to connect on- and offboard systems
- Switched Ethernet networks connecting ECU domains & zones in-vehicle
- Powerful measurement access into Automotive Eth networks required!
And what about the (in-vehicle) measurement system itself?

- Many USB ports required
- Cable length / mechanical stability issue **in-vehicle** connectors/connection
- Extra wiring for time sync required
- Use Ethernet to simplify measurement infrastructure!
Introduction

Using Ethernet in the measurement system

- Interface integrated & configurable switches
- Less cabling, longer cables possible & more robust for in-vehicle use
- Use of PTP time sync on Ethernet – also for external (reference) sensors
The two basic use cases for in-vehicle Ethernet measurement

**Overview Use Cases**

**Passive observation**
- Just monitor everything “as is”
- Do not influence frame level, link level and PHY state
- **Tool is “unknown” to ECU**

**Active communication**
- Directly connect to ECU or become part of the network (...and then “just listen”)
- Up to: Actively trigger ECU to send out desired information
- **Tool is (more or less) “known” to ECU**
The two basic use cases for in-vehicle Ethernet measurement

- Passive observation
- Active communication

- Do not influence frame level, link level and PHY state
- Ethernet = (switched) Point-to-Point connection → No stub lines like e.g. in CAN → Re-wire connection!

In all **passive observation** type applications in **ECU networks** as default a **TAP** should be used for measurement.
The two basic use cases for in-vehicle Ethernet measurement

- Directly connect to ECU or become part of the network
- Ethernet = (switched) Point-to-Point connection → Connect via existing switch – or introduce one!

! Only for desired & required measurement traffic – No interference by PC’s (regular) network traffic!

In active communication type applications as default a SWITCH should be used for measurement.
Overview Use Cases

Features in CANape for Ethernet measurement

**Passive observation**

- Raw Ethernet packets
- AUTOSAR PDUs (FIBEX & ARXML)
- AUTOSAR SOME/IP (ARXML)
- Custom Protocols - via project based extensions

**Active communication**

- XCPonEthernet Measurement and Calibration
- DoIP - Diagnostics
- Active SOME/IP
- DLT

Tool observes via TAP

Tool becomes **active participant** in the switched SUT network:
- Has a MAC on the interface
- Has an IP Address in the SUT network
Ethernet HW configuration for measurement & calibration

Network-based access – some terminology...

Network
Port (virtual)
Segment
Port (physical)

Keep it simple - Configuring virtual ports NOT required for CANape use cases!

TIP: Use meaningful names!
Network based access – Configure & use a simple TAP

- Drag a **Link** segment into network pane → Creates a new network & the link segment
- Rename the network to something **meaningful** → This name will be shown later in the tool
- Drag the **two Physical Ports** - on which you will connect your ECUs later - into the link segment → Link segment will change and become a **TAP**
- Rename the Ports used in the TAP
- Rename the TAP itself
- Basic configuration done!
- Now you can connect the network in CANape & **passively observe** the traffic!
CANape Features for Ethernet

Ethernet Monitor for raw frames – the most basic monitor

- Measure & log **raw** Ethernet frames
  - Display raw Eth frame **payload** in Trace window
  - For offline analysis/re-interpretation (database added after logging took place)
  - (Bus)Logging in **frame oriented** formats
    - MDF > 4.0
    - BLF
    - PCAP/PCAPNG
CANape Features for Ethernet

Ethernet monitor for raw frames – Configuration from scratch

1.) Create new **ETH network** in CANape

2.) Map to **network defined in Vector HW interface**

3.) Create new **Device** on network

4.) Keep database unassigned

⇒ “Raw Eth monitor” type device

**TIP:** Use same name for network as in HW interface – to avoid confusion!
CANape Features for Ethernet

The inside of Eth frames – PDU and SOME/IP monitoring

- Adding a database to Ethernet monitor enables frame decoding
  - PDUs for AUTOSAR Classic
    - FIBEX
    - ARXML
  - SOME/IP for AUTOSAR Adaptive
    - ARXML

- Mapping of PDU content, SOME/IP fields and events to CANape signals
  - Usable in all CANape analysis windows
  - Offline decoding in Trace
Ethernet HW configuration for Measurement & Calibration

Network based access – Configure & use a SWITCH

- Drag a **Switch** segment into network pane → Creates a new network & the switch segment
- Rename the network to something **meaningful**

- Drag the **Physical Ports** - on which you will connect your ECUs later – into the switch segment
- Rename the Ports used in the switch
- Rename the switch itself – use a meaningful name
- HW configuration done!
- Now set CANape’s IP address in the network – and start **active communication** with the network e.g. via Active SOME/IP or XCPonEthernet!
Active SOME/IP Communication for AUTOSAR Adaptive

- **Active** SOME/IP communication for AUTOSAR **Adaptive**
  - Scalable service-oriented middleware over IP
  - Based on ARXML
    - Assigned to network – for active service discovery
    - Contains all Services
  - Works like diagnostic service based measurement and calibration
- To use a service, a client must subscribe to services on the server
- Server sends measurement signals only to subscribed clients
- Multiple instances of services are possible

**(Additional) Configuration of active device**
- Provide IP address for CANape in the ECU/SUT network
The network represents the „logical bracket“ for all measurement needs in an ECU Ethernet network.

- Easily **combine passive and active use cases** – just add more & different segments.
- **No change** in tool configuration for existing devices required - as the same network still represents SUT topology.

Combining passive & active MC use cases – in one network.
Some devices deliver data via their own protocols
- Without using standardized automotive protocols
- Referring to – and re-using – application software internal data structures (often: transmitted in UDP frames)

→ But: How to bring such data into the measurement tool?

Solution: CANape Protocol Decoder
- Plugin in CANape
  - (Vector) Customizable decoder DLL – decodes signals and objects, based on the user specific protocol specification
  - Uses A2L to describe signal and object definitions
- Supports UDP and TCP

Implementation of user-specific Protocol Decoders can be offered as projects by Vector.
Existing Ethernet hardware interfaces upgraded with new network-based access mode

**VN5610A**

*2 channel* Ethernet interface with
- IEEE 100BASE-T1 (Automotive Ethernet)
- IEEE 100BASE-TX/1000BASE-T

**VN5640**

*16 channel* Ethernet interface

Option **100Base-T1**
- 12 channels IEEE 100BASE-T1
- 4 channels with IEEE 100BASE-TX/1000BASE-T physical layer (standard Ethernet)

Option **1000Base-T1**
- 6 channels 100BASE-T1/1000BASE-T1
- 6 channels only 100BASE-T1
- 4 channels with IEEE 100BASE-TX/1000BASE-T physical layer (standard Ethernet)

In network-based access mode
- Up to 6*2 channels for TAPs or 12 channels for switch
- 4 ports for uplink and infrastructure switch / cascading (later firmware release)
**New Interface generation – recently released hardware**

<table>
<thead>
<tr>
<th>Device</th>
<th>VN5620 Standard Tool I/F</th>
<th>Device</th>
<th>VN5430 Cascading I/F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Host Connection</strong></td>
<td>2 x 100BASE-TX/1000BASE-T</td>
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<td>2 x 100BASE-TX/1000BASE-T</td>
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<tr>
<td></td>
<td>1 x USB3.1Gen1</td>
<td></td>
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<tr>
<td><strong>User Interfaces</strong></td>
<td>4 x 100/1000BASE-T1 fixed</td>
<td><strong>User Interfaces</strong></td>
<td>6 x 100/1000BASE-T1 fixed</td>
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<tr>
<td></td>
<td>2 x CAN FD</td>
<td></td>
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<tr>
<td><strong>Powering</strong></td>
<td>USB / External Power</td>
<td><strong>Powering</strong></td>
<td>External Power</td>
</tr>
<tr>
<td><strong>IO</strong></td>
<td>1xIO-Channel</td>
<td><strong>IO</strong></td>
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<tr>
<td><strong>Device category</strong></td>
<td>Office</td>
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New Hardware Interface generation VN5240

- VN5240 provides
  - 6 TAPs
  - 10GBASE-T for uplink data
  - Prepared for Multi-Gig Automotive Ethernet
- Maximum cascading of 4 modules connected to the VP64xx*
- Form factor of VN5240 is tailored to integrate with custom designed VP64xx*

<table>
<thead>
<tr>
<th>Device</th>
<th>VN5240* Measurement I/F</th>
</tr>
</thead>
</table>
| Host Connection | 2 x 100BASE-TX/1000BASE-T  
                | 2 x 10GBASE-T                           |
| User Interfaces | 12 x 100/1000BASE-T1 (Module)            |
| Powering        | External Power                           |

*Coming up in Q4 2020
Logging Hardware - for high bandwidth Ethernet logging setups

VP6400

- Up to 500MByte/s write rate
- Up to 4 TByte storage capacity
- Numerous Eth interfaces – also 10GbE for fast uplinks
- GPS referenced PTP master clock
- Extended temperature range – for in-vehicle use

VP7400

- Up to 1 Gbyte/s write rate
- Up to 32 TByte storage capacity

VP64xx Example setup with 12 x Auto-Eth TAPs

⇒ CANape + VP64/74 + Eth Interfaces = In-vehicle Eth logging solution
Summary

- CANape allows measurement and analysis of & with many Automotive Ethernet protocols and also custom protocols – all in one tool
- Easy & fast measurement setup into SUT network - via network-based access
  - Application centric network definition & usage – also using multiple networks
- Only measure & log required data
  - Measurement of only RXed frames in CANape
  - Filtering in hardware possible - to reduce traffic at source
- Software features complemented by powerful logging hardware – for smart in-vehicle Ethernet logging
Additional resources

- CANape XCP on Ethernet Demo → "<DemoDir>\Examples\XCPDemoOnETH"
- Application Note "AN-IND-1-023_EthernetVN_Family_From_Firmware_Version_11.1" (Webpage)
- VN5000 Ethernet Hardware Manual
- Vector Virtual Week “From Lone Fighter to Team Player” (in English) (https://www.youtube.com/watch?v=mIsnWlvGzdQ)
- 차량용 Ethernet을 위한 벡터 네트워크 인터페이스 (https://www.youtube.com/watch?v=RfxmpW4iQZM&t=640s)
For more information about Vector and our products please visit

www.vector.com

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New Hardware Interface generation

- New Ethernet Interface devices:
  - Flexibility due to new Interface Software
    - Optimized support for high bandwidths
    - Filter out unwanted data in hardware - to save logging bandwidth
  - Various amount of 100BASE-T1/1000BASE-T1 ports
  - Channel extension by cascading in later software release
  - Optimized support for a wide range of application areas (Analysis, Simulation, Logging, HiL, ...)

Ethernet Interface Hardware – for lab and in-vehicle use