One OEM’s Serial Data, Diagnostic, and Cybersecurity Component Validation Strategy

Vector Congress 2019
INTRODUCTION

Rachael Ayotte

Advanced Development and Validation
GM Serial Data, Diagnostic, and Cybersecurity Test Automation Team Members

- Amit Pai
- Anup Dhote
- Ashish Khanduri
- Deepak Raj Velpula
- Lavanya Kodali
- Priya Jaiswal
- Rachael Ayotte
- Surya Narayana Chinnabuchi
Purpose

- Develop tools and methods to support validation of GM’s Serial Data, Diagnostic, and Cybersecurity requirements
- Develop test automation to improve efficiencies for Component Level testing of GM’s Serial Data, Diagnostic, and Cybersecurity requirements
- Provide Support to Tier 1 suppliers and GM validation
Scope

- CAN and Ethernet
  - Wake-up, Steady State, Shutdown
  - Specific to GM
  - Fault injection
- Diagnostics
  - UDS
  - Infrastructure
  - Bootloader
- Message Authentication
- Black box testing
- Single component
Process Overview

REQUIREMENTS

VALIDATION PROCEDURES

Input 1

Input 2

Input 3

Step 1

Step 2

Step 3

Repeat per...

Step 4

End

TESTING

REVIEW

PASS

FAIL
GM and Supplier have a Kick-Off meeting to discuss Serial Data/Diagnostic/Cybersecurity testing expectations and timing

- GM-defined automation is strongly recommended
- Supplier executes Serial Data/Diagnostic/Cybersecurity tests on a single ECU
- Supplier submits test results to GM
- GM reviews test results, provides feedback, and audits as needed
Process Overview

Requirements

Validation Procedures

Testing

Review

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Challenges

- Large supplier base and multiple users
- Various understanding of the requirements
- Various understanding of tools
- Testing is time consuming
- Review is time consuming
- Requirements change
Process Overview

**Requirements**

**Validation Procedures**

**testing**

**Review**

SOLUTION: automate on/for the CANoe platform:

GB CAN Tester, MAC CAN Tester, RBS, DiVa, ARXML Viewer, INI Generator, Ethernet Tester
“GB CAN TESTER” OVERVIEW

Ashish Khanduri

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Need of Serial Communication Validation

Tool environment must be capable of set-up for following tests:

- High bus loads for fault injection
- Network Management
  - Network Management frame (NMF) validation
  - Partial Network Activation and Deactivations scenarios
- Rest of the Bus Simulation (RBS)
- Network supervision
  - Partial Network supervision
  - Loss of Communication
- Bus Off requirements
- Diagnostic
  - CAN/CAN FD ISO 15765-2 Transport Layer
  - DIDs, RIDs and DTCs
GB CAN Tester on Vector CANoe Platform

Designed GB CAN Tester which uses the Vector CANoe platform for developing automation and for the test environment.
Why CANoe ???

CANoe has all the features to automate GM serial communication test specifications

- High Bus Load for fault injection
  - Millisecond and microsecond timers which allow simulation of any busload on CAN bus

- Network Management
  - Single-shot feature for transmitting CAN message (negates the retry transmission at the hardware level) for complete control of message transmit

- Rest of the Bus Simulation
  - Vector IL Dll simulates transmission of other ECUs

- Network Supervision
  - Control to enable and disable transmission of messages in Rest of the Bus Simulation using Vector IL Dll

- Bus Off
  - Capable of disturbing messages to create Bus Off

- Diagnostic
  - Generic Diagnostic framework that provides APIs to allow diagnostic automation irrespective of transport protocol selected
Challenges

GB CAN Tester runs on one instance of CANoe and RBS runs on a second instance of CANoe

- CHALLENGE: How to interact GB CAN Tester with RBS?
- CHALLENGE: Critical timing controlled in RBS through GB CAN Tester needed for Supervision testing

GB CAN Tester is a generic tool for all the ECUs; released as a default configuration (fixed number of CAN and Ethernet networks, baud rate, no ODX)

- CHALLENGE: Some GB CAN Tester users do not have CANoe experience so they struggle to configure CANoe and it requires a lot of support
Solution: COM Object

- CANoe supports COM Object which allows control of CANoe through programming language

- COM Object allows automated configuration of GB CAN Tester as per the user given input in the INI Generator
Unlike CAN Diagnostics, support for Diagnostic/ISO TP configuration through ODX for Ethernet SoAd is not available

- **CHALLENGE:** Need the ability to configure Ethernet settings
- **SOLUTION:** Automated by updating .cfg/.tse file using text editor

**NOTE:** Update .cfg/.tse file only if you know exactly what to update; it can corrupt configuration if not done properly.
User provides all (green) inputs then selects “Configure & Launch”

GB CAN Tester user does not need deep CANoe knowledge to run tests
Execution

Launches two instances of CANoe

1. RBS
2. GB CAN Tester
All the settings (adding network, arxml file, odx file, Tester IDs, IP, Port, Vector hardware mapping, baud rate) are configured automatically.
Ashish Khanduri

MESSAGE AUTHENTICATION
OVERVIEW

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Rest of the Bus Simulation

- ECU (real)
- Diagnostics
  - Simulate Secure messages
  - Verify Secure messages
- RBS (IL simulation)
  - CAPL wrapper
- Windows MAC dll
Transmit Authenticated Messages from RBS

- Simulate ECU MAC RX
- Secure message
- Build the MAC from payload
- Transmit secure message with updated MAC
- Trigger MAC dll when a message is about to transmit
Receive & Verify Authenticated Messages from RBS

1. Receive secure message from ECU
2. Extract MAC signals
3. Verify MAC using dll
4. Update verification summary
5. Trigger MAC dll to verify secure messages
6. Receive secure message on bus
ECUs can reside on multiple buses

**CHALLENGE:** Possibility of calling MAC Dll at same time and causing a CANoe error

- **SOLUTION:** Simultaneously simulate and verify secure messages over multiple networks including CAN and Ethernet using multiple instances of the Dll
Amit Pai

ARXML READER & INPUT FILE GENERATOR (UTILITY)

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Data Extraction Needs

- Generic testing
- Based on ECU
  - ARXML
  - ODX
  - Bus type
  - Baud rates
  - Ethernet port
  - IP address
- Based on user input
  - Hardware mapping
  - ECU subset
Enabler to Other Automation

SOLUTION: One Dll that can extract the required information and generate a generic file that can be used in the toolchain.
CHALLENGE: AUTOSAR Explorer does not display all required information from the ARXML database file for our testing needs

SOLUTION: Use the Dll and add a GUI to display data as needed for Serial Data testing
**ARXML Modification for RBS**

- **CHALLENGE**: ARXML data must be modified for RBS
  - **SOLUTION**: Use the Dll to update certain properties so that simulated message transmission matches that of a real ECU
Data Flow Overview

Input
- Diagnostic file (ODX/PDX)
- ECU Specific ARXML
- MAC file

Utility
- Diagnostic File Reader
- DLL

Tool
- INI Generator for GB CAN Tester
- RBS Convertor
- ARXML Viewer
- INI Generator for MAC CAN Tester

Output
- .ini file Used in GB CAN Tester
- ARXML for RBS
- .ini file Used in MAC CAN Tester
CHALLENGE: Certainty that you are extracting all data irrespective of PREEvision version and protocol support
   ○ SOLUTION: Deep understanding of ARXML schema and content

CHALLENGE: ARXML files are large; it takes time to read and map all the information so that it can be used in test tools.
   ○ SOLUTION: Changed from series solution to multi-threading solution for processing data
AUTOMOTIVE ETHERNET
SERIAL DATA VALIDATION

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Automotive Ethernet Validation

- Validate support of GM defined requirements for:
  - Ethernet Communication
  - AVTP (Audio Video Transport protocol)
  - GM propriety Ethernet Application layer Protocols
  - Diagnostic Over Ethernet Testing using DoIP and DoSoAd
  - 100BaseT1, 1000BaseT1, 100BaseTX Ethernet bus support

- Black box testing
- One real device under test with simulated ECUs
- Provide both Rest of the bus Simulation and automated testing
- Testing Ethernet is also part of the Serial Data, Diagnostic, and MAC Review Processes
Challenges of Ethernet

**CHALLENGE:** Multiple GM Proprietary databases need tool support

- **SOLUTION:** Vector has provided a special CANoe Add-on to support GM propriety Ethernet Protocols:
  - Basic support of protocols
  - APIs to access protocol data
  - Decodes raw data displayed in engineering units

**CHALLENGE:** Rest of the bus configurations required for both AUTOSAR-based PDU and GM Proprietary protocols

- **SOLUTION AUTOSAR-based PDU RBS:** Generate the entire simulated network using the Vector Wizard
- **SOLUTION GM Proprietary protocol RBS:** Use the CANoe Add-on to generate nodes then write functionality in CAPL as needed
AUTOSAR-based PDU RBS
GM Proprietary Protocol RBS
GM Proprietary Protocol Tester

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**CHALLENGE:** More CANoe settings are required for Ethernet compared to CAN (MAC, IP, Port, VLAN ID, VLAN Priority, Message IDs)

- **SOLUTION:** TCP/IP settings of simulated nodes are managed by the CANoe DLL when the simulated network is created. GM provides simulations with correct default settings per ECU.

- **SOLUTION:** GM is also doing a project with Vector to implement Ethernet Comm Params in the ODX file, that CANoe will be able to use.
**CHALLENGE:** We need to test AVB CRF, Stream ID, and Rate. GM supports IEEE1722-D6 which specifies a different Clock Reference Stream sub-type than the released IEEE1722-2016 release. CANoe supports IEEE1722-2016.

- **SOLUTION:** Vector released a specific AVB_IL Dll to support the IEEE1722-D6 implementation that GM can utilize for test automation implementation
DIAGNOSTIC TESTING

Rachael Ayotte & Deepak Raj Velpula

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Diagnostic Scope

- UDS
  - CANoe.DiVA
  - Extensions for GM
  - Our own scripting

- Secure Unlock

- Infrastructure
  - Automated with GB CAN Tester and RBS

- Bootloader
  - No automation
16 UDS Services supported in Application (excluding OBD Services)

Testing includes Positive Flow, Negative Flow, No Response, and specific Functionality

- Standard DiVa
  - 12 Services automated for Positive Flow testing
  - Negative Flow tests generated for responses that DiVa can know how to induce - incorrect Length, Session, Security, Out of Range
  - No Response test generated for invalid Functionally Addressed requests

- GM Extensions
  - 12 Services automated for specific functionality
CHALLENGE: While DiVa is an off-the-shelf tool, there are specific configurations needed for proper testing

- SOLUTION: Provide support from GM in the way of personnel, training, and training material

CHALLENGE: Testing relies on the ODX file which continues to be updated and is not easily understood

- SOLUTION: Continue to work toward perfect ODX files and include ODX review as part of the DiVa training

CHALLENGE: Functionality is making it more difficult to extract the UDS testing

- Still working on a solution
$2A and $2C Test Solution

CHALLENGE: No Extensions for $2A and $2C testing
  ○ SOLUTION: Use CAPL to automate

CHALLENGE: Need to dynamically update test patterns based on any ODX file
  ○ SOLUTION: Create an input file containing the required diagnostic data that can be accessed by CAPL code

CHALLENGE: The $2A and $2C testing should look like an extension of DiVa
  ○ SOLUTION: Vector provided instructions to integrate tests such that the CAPL coded test steps will execute in series to the DiVa test steps
Secure Unlock

CHALLENGE: Dynamic Seed & Key implementation that requires access to a GM Server

SOLUTION: Vector supported GM by creating dlls that can be included in the CANoe Diagnostic ISO/TP setting to unlock an ECU provisioned as:

- Production ECU (access GM Server)
- Development ECU (CANoe simulates the Server)
CHALLENGE: Need the ability to quickly and easily change Tester ID, target address type, CAN/Ethernet, and send diagnostic requests that are not allowed as per the ODX file

○ SOLUTION: Create our own diagnostic panel in GB CAN Tester that utilizes Vector’s generic Diagnostic framework