

# Development of X Studio based on ASAM XIL for automation of MIL-SIL-HIL integration



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Association for Standardization of  
Automation and Measuring Systems

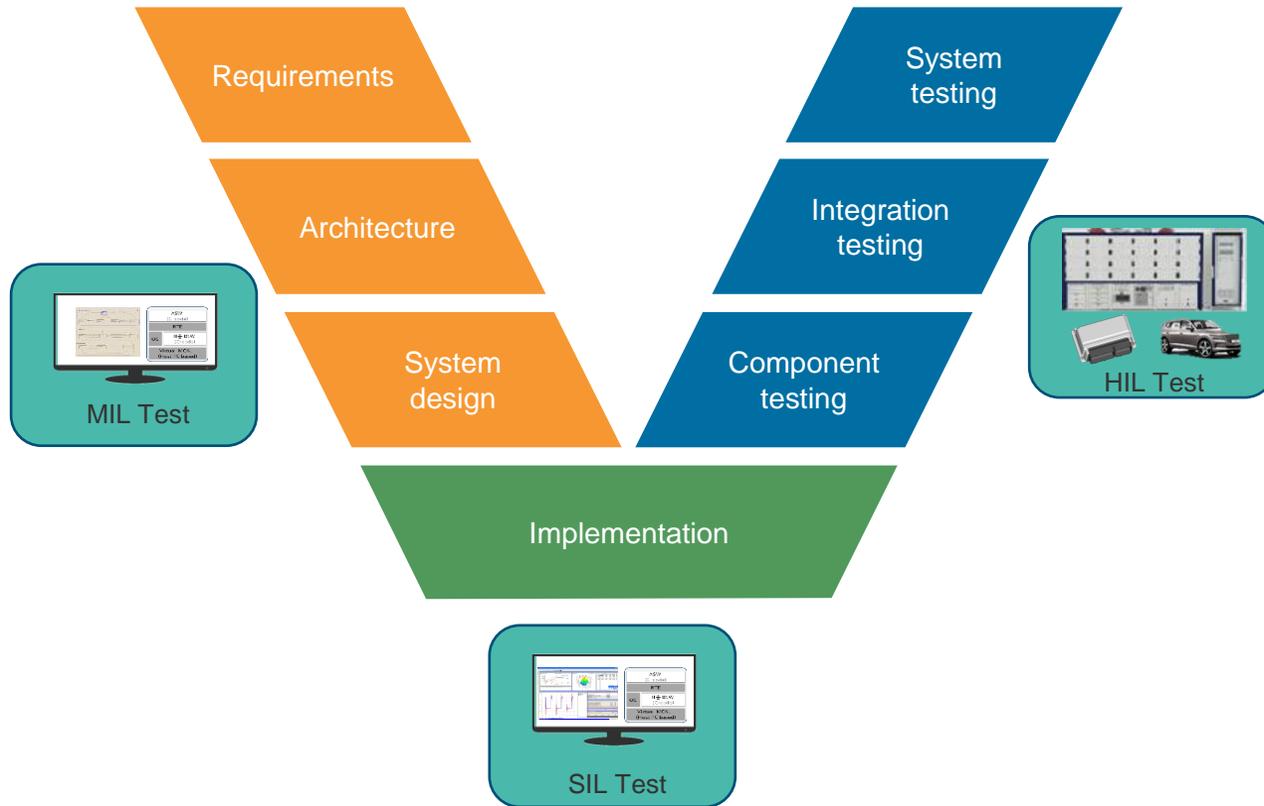
# Agenda

Development of X Studio based on ASAM XIL for automation of MIL-SIL-HIL integration

<b>1</b>	<b>Solutions to MIL-SIL-HIL</b>
<b>2</b>	<b>ASAM XIL Standard</b>
<b>3</b>	<b>X Studio : Test Automation Software</b>
<b>4</b>	<b>Conclusion</b>

# Solutions to MIL-SIL-HIL

Solutions to test MIL-SIL-HIL



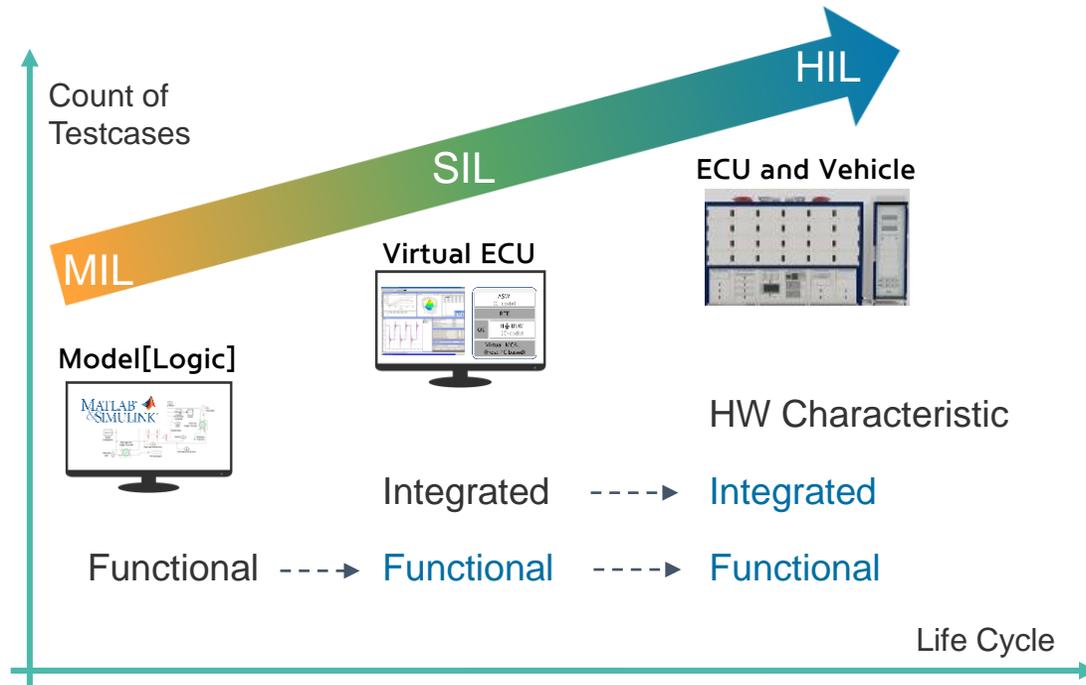
- Tested early and more
- Develop many testcase
- Training engineers
- Difficult to transfer know-how

MIL : Model in the Loop, SIL : Software in the Loop, HIL : Hardware in the Loop

# Solutions to MIL-SIL-HIL

## Best Test Strategy

- Integration of Test Automation SW



- Re-use Testcase
- Avoid Redundant Testing
- Evaluate Development Process
- Continuous Automation Test

ECU : Electronic Control Unit, HW : Hardware

# Agenda

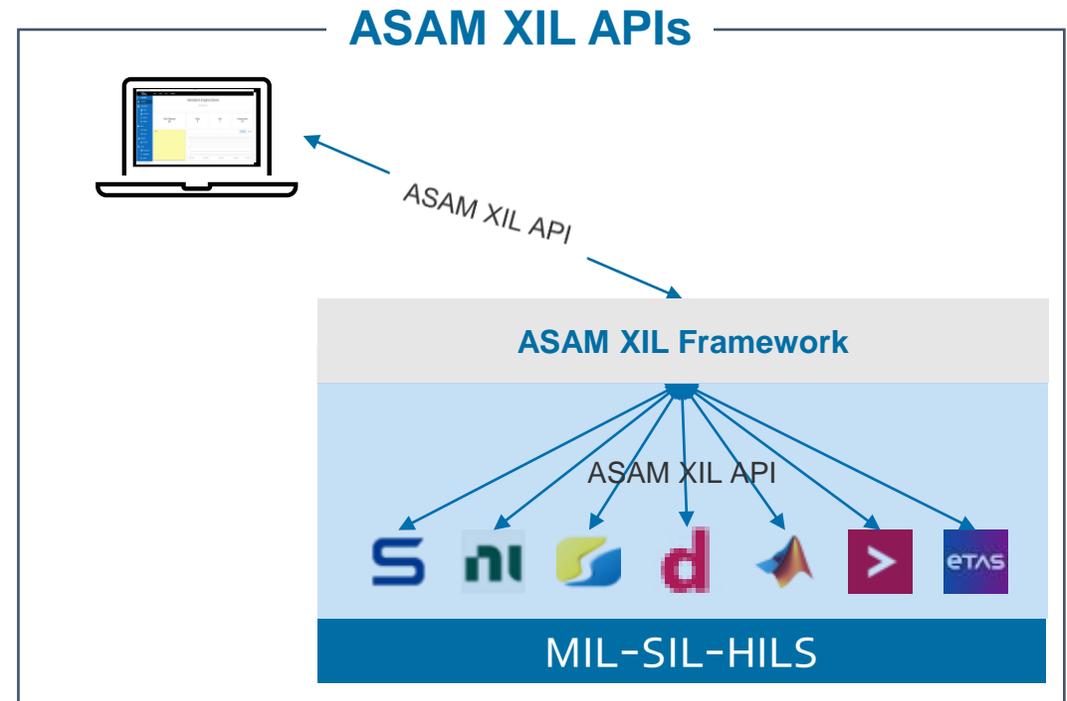
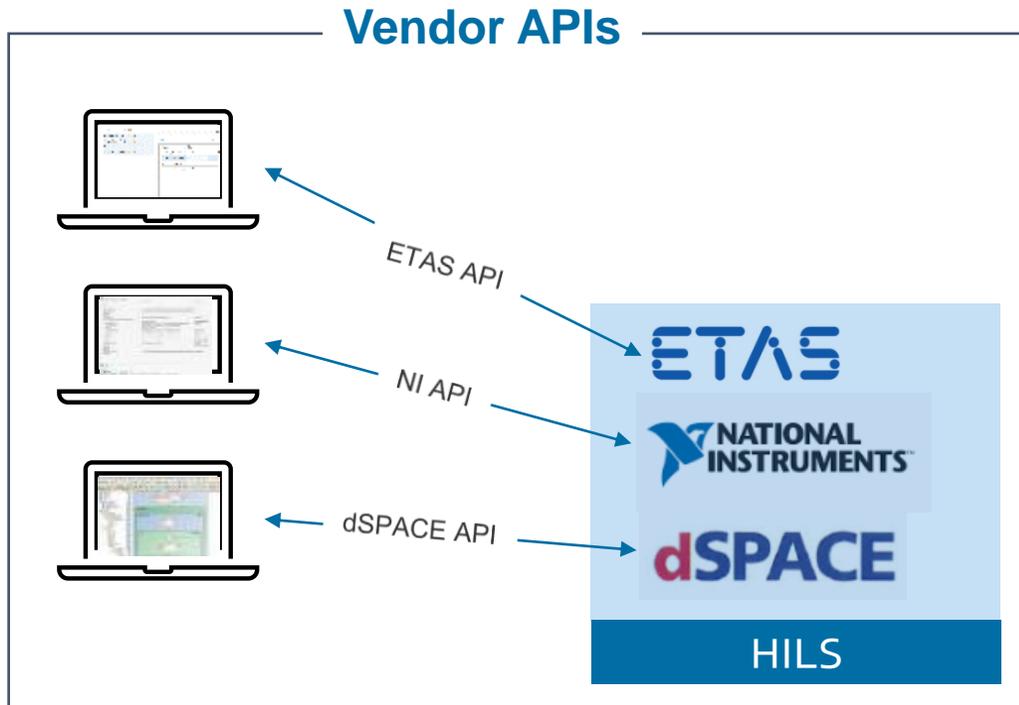
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# ASAM XIL Standard

Separate Test Automation and XIL

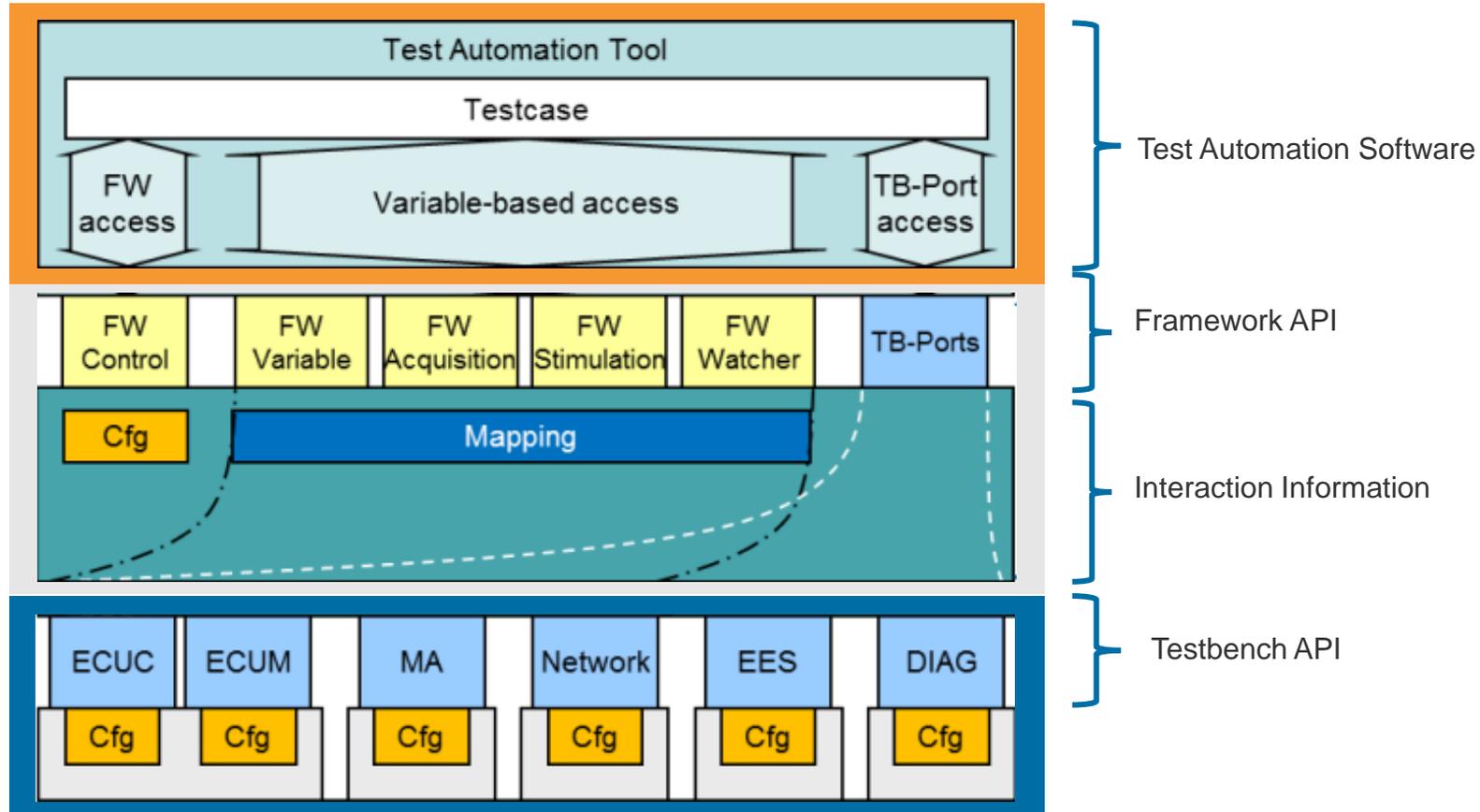
- ASAM XIL Framework



XIL : MIL/SIL/HIL, API : Application Programming Interface

# ASAM XIL Standard

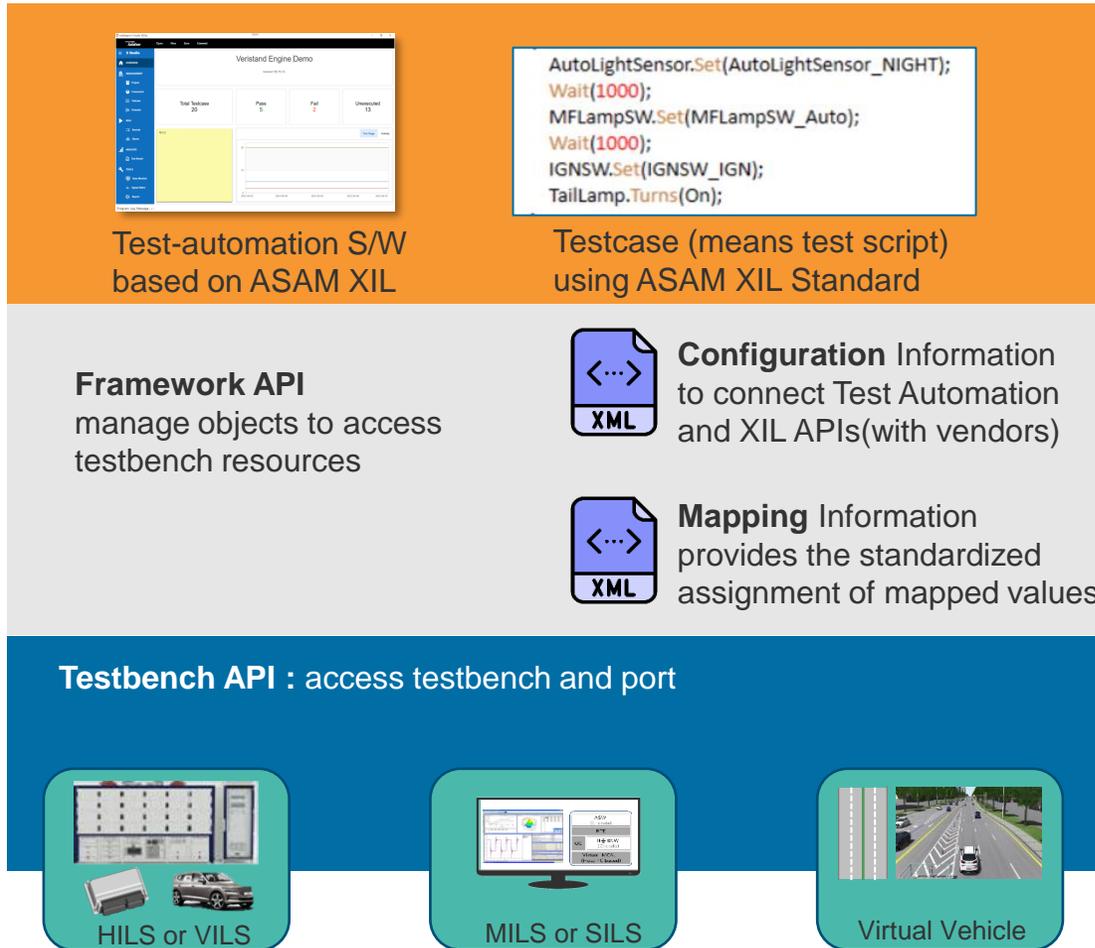
Layer of ASAM XIL



FW : Framework, TB : Testbench, ECUC : ECU Calibration, ECUM : ECU Measurement, MA : Model Access, EES : Electric Error Simulation, DIAG : Diagnostic

# ASAM XIL Standard

Detail function of ASAM XIL



- How to Connect
  - Access Key (VendorName/ProductName/ProductVersion)
  - Using ASAM XIL Interface
  - XML Configuration / Mapping
  - Port Configuration for Testbench
  - One or more Connection

XML : eXtensible Markup Language

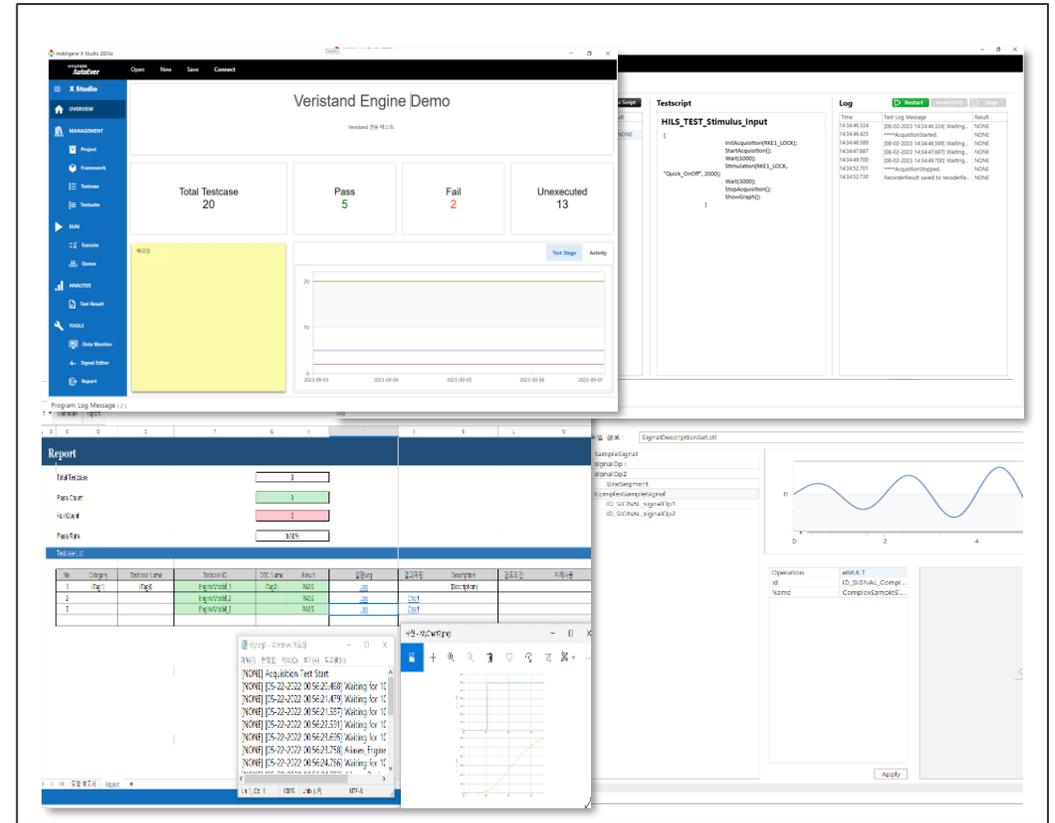
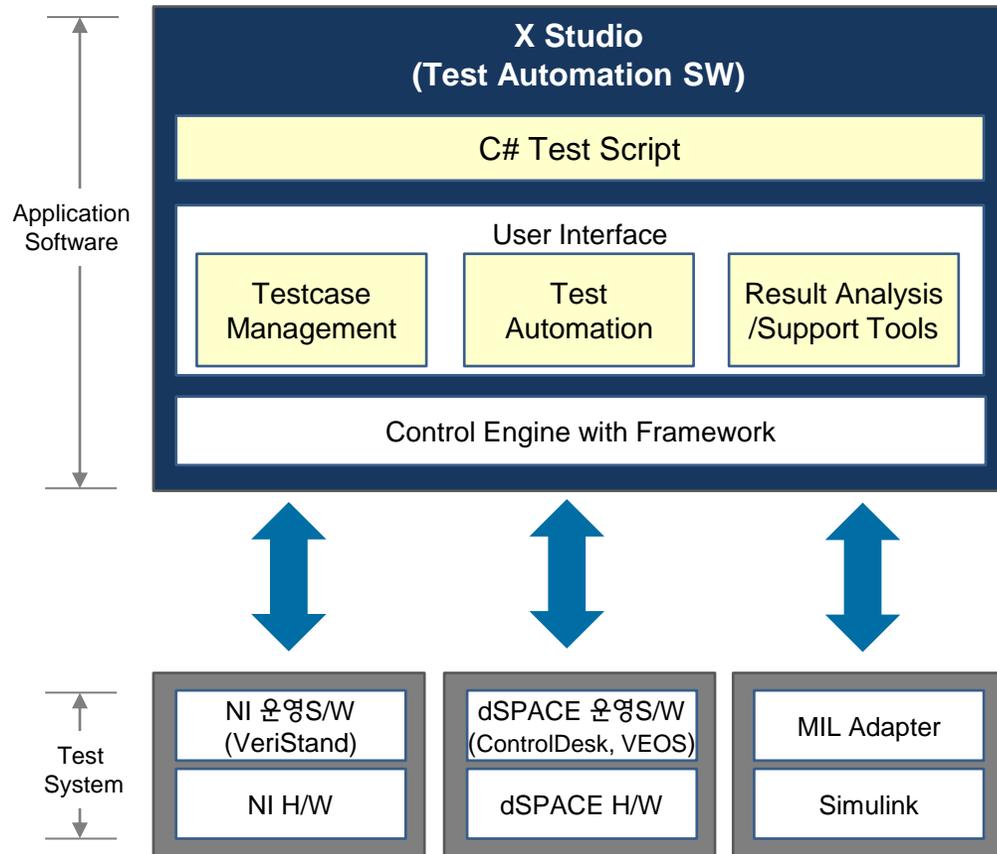
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# X Studio : Test Automation Software

## Overview



[Application User Interface]

# X Studio : Test Automation Software

## Features

- **ASAM XIL**
  - Support of ASAM XIL standard for Independent Vendors
  - Same evaluation results between one and another MIL-SIL-HIL
- **C# Script**
  - Testcase can be developed using C# language
  - Test script using module without complex code
  - Easy to standardize testcase, such as evaluation library
- **Easy to Use**
  - Support tools for test configuration
  - Commercial development tools can be applied when developing and managing test cases.
- **Extensibility**
  - Provide control library such as Simulink, INCA, CarMaker(unsupported ASAM XIL)
  - High extensibility for 3rd party SW with C# Script support

# X Studio : Test Automation Software

How to develop testcase : C# Script

- Automation
  - Convert testcase to test-script
  - Implement Evaluation Module to Library
  - Use C# functions (as necessary)
- Managing (Recommendation)
  - Managing Test Project with VS Code
  - Collaboration with Git

1. AutoLightSensor Set Night
2. Wait 1000ms
3. MFLampSW Set Auto
4. Wait 1000ms
5. IGNSW Set IGN
6. Tailamp Turns On

```
Control_ExteriorTailLamp_by_Tail  
{  
    AutoLightSensor.Set(AutoLightSensor_NIGHT);  
    Wait(1000);  
    MFLampSW.Set(MFLampSW_Auto);  
    Wait(1000);  
    IGNSW.Set(IGNSW_IGN);  
    TailLamp.Turns(On);  
}
```

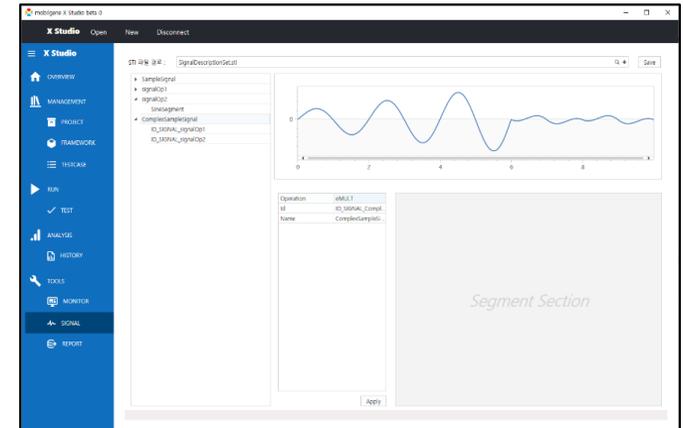
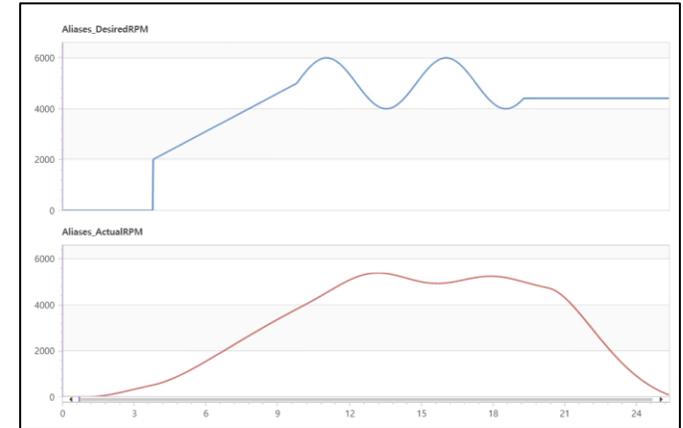


```
public static XStudioResult Set(this IBoolVariable variable, IBoolQuantity quantity)  
{  
    variable.Write(quantity);  
    var result = new XStudioResult()  
    {  
        Time = DateTime.Now,  
        Message = variable.AbstractIdentifier + ".Set(" + quantity.Value + ")",  
        ResultType = XStudioResultType.DONE  
    };  
    logger.LogResult(result);  
    return result;  
}
```

# X Studio : Test Automation Software

How to develop testcase : Acquisition, Stimulation

- Acquisition
  - Timing critical test
  - Complex signal : Count, Period, Duty
  - Record raw data
- Stimulation
  - Avoid input delay
  - Continuous signal input
  - Edit signal (by STI file)
    - Segment : Const, Ramp, Sine, Pulse, Noise...
    - Operation : Add or Multiple Segment or Signal



STI file : extension of Signal Description File

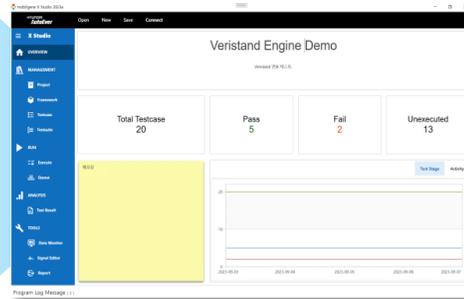
# X Studio : Test Automation Software

Support Software

ASAM XIL compliance SW

-  VeriStand
-  VECTOR CANoe
-  ETAS LABCAR  
COSYM
-  dSPACE ControlDesk  
Veos

ASAM  
XIL



Non-ASAM XIL compliance SW

TCP/IP  
.Net  
Python

-  IPG CarMaker
-  VIREV
-  MathWorks MATLAB  
Simulink
-  Android Studio
-  Tektronix Oscilloscope

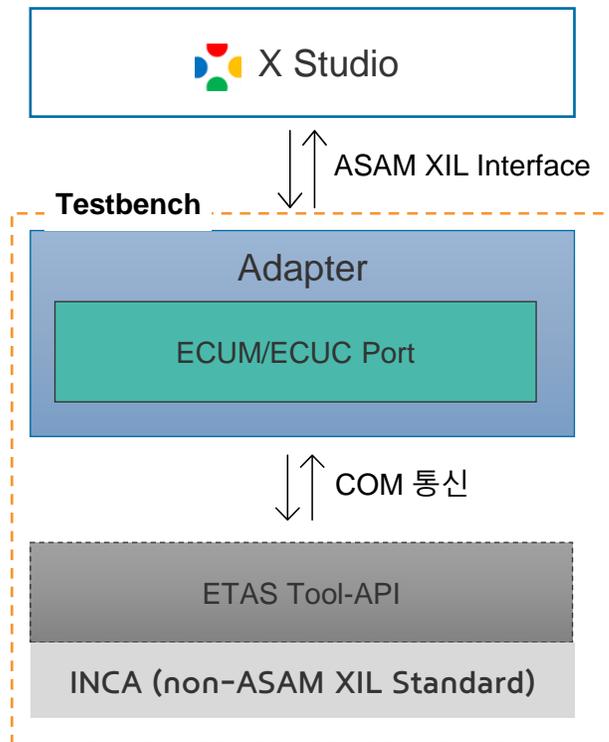
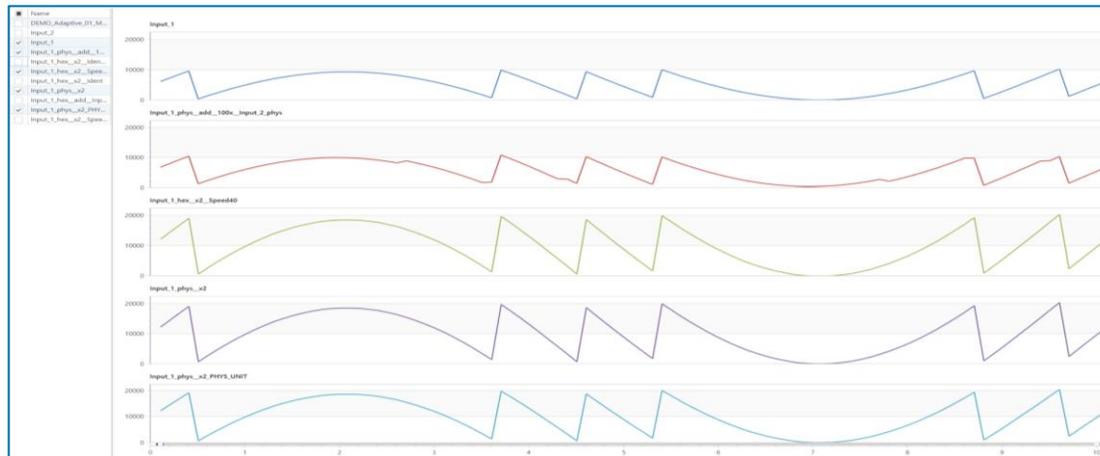
Test Script Developing/managing Tool (Recommended)



# X Studio : Test Automation Software

Support Incompatible interface

- Incompatible Interface
  - Adapter : allow objects with incompatible interfaces to collaborate.
    - control / config / read-write data / acquisition / stimulation
  - INCA control using ETAS Tool-API
  - COM library, Python, TCP/IP is developed



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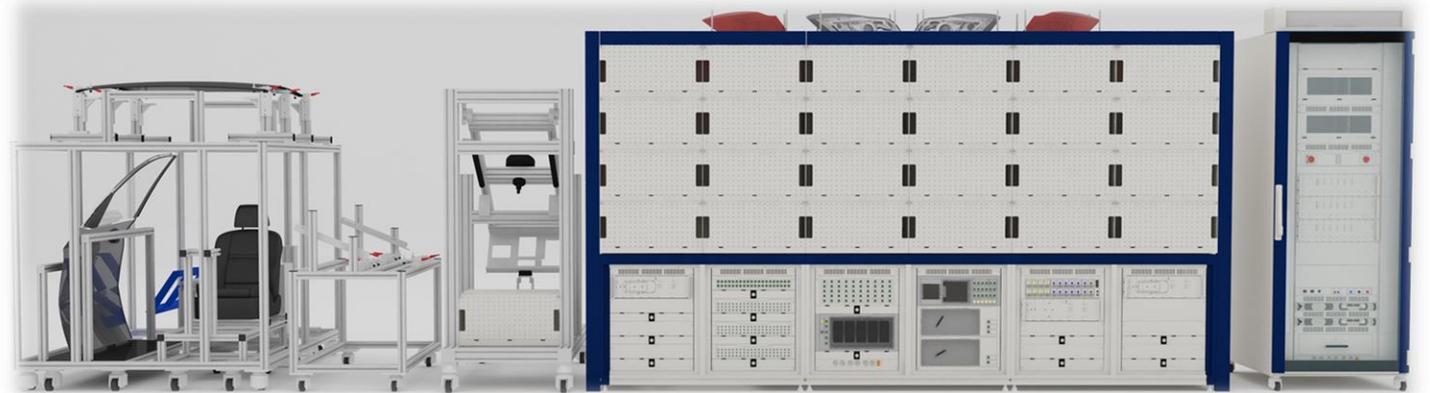
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# Conclusion

## Development of Test System (MIL-SIL-HIL)

- Testing in HILS (NI Veristand, Vector CANoe, ETAS LABCAR, etc)
  - Integrated Body Domain Simulator (BDC)
  - Automation Simulator in Vehicle (IBU/ICU/ACU)
  - Chassis ECU Test HILS (MDPS / ESC)
  - Compact HILS (BDC)
- Testing in MILS (MathWorks Simulink)
  - Control logic consistency test
- Testing in SILS (in develop)
  - Virtual ECU and Environment

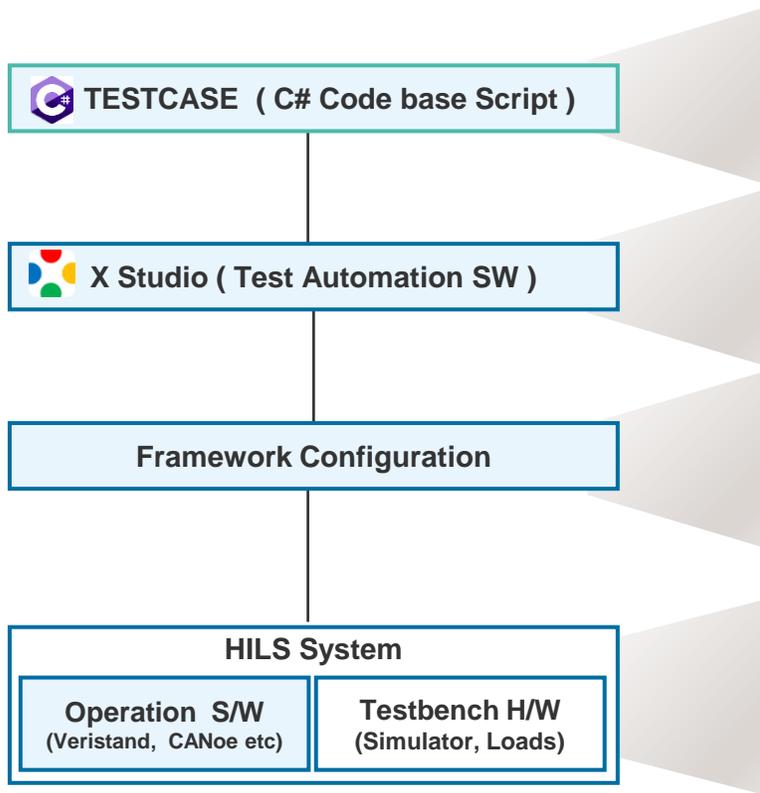


BDC : Body Domain Control unit, IBU : Integrated Body control Unit, ICU : Integrated Central control Unit , ACU : Airbag Control Unit, MDPS : Motor Driven Power Steering, ESC : Electronic Stability Control

# Conclusion

## Details of HILS

- Tasks of Development



- Development test script and modules
- **Convert existing testcase to test script**
- Development convert tool

- Install automation software & Support **response to customer's requirement**
- Development additional functions

- Configuration test environment
- **Mapping framework and testbenches**

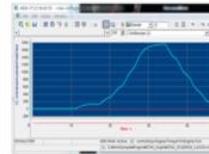
- Design functions of HILS
- Wiring & Connecting
- Configuration Operation S/W
- Acceptance Test

- 1) 엔진 시동
- 2) 엔진 가속/감속 : AccelPedal.Set()
- 3) 시동 3초 이내 RPM 1500 초과 확인

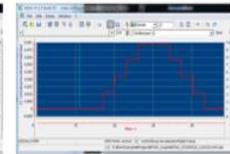
```
InitAcquisition (EngineRPM, AccelPedal);
StartAcquisition();

for(int i=0; i < 5; i++) {
    AccelPedal.Set(0.02 * i);
    Wait(3000); }

EngineRPM.WaitFor(value=>(value>1500), 3000);
StopAcquisition();
```



[엔진 RPM 데이터]



[가속 페달 데이터]

- 1) Send(Message) : Send Request Message
- 2) Read() : Read Response Message

```
Diag.Send(0x19,0x02,0x08);
Wait(500);
var data = Diag.Read();
string response = "";
foreach (var item in data)
{
    response+= item.ToString("X2") + " ";
}
logger.LogInformation(response);
```

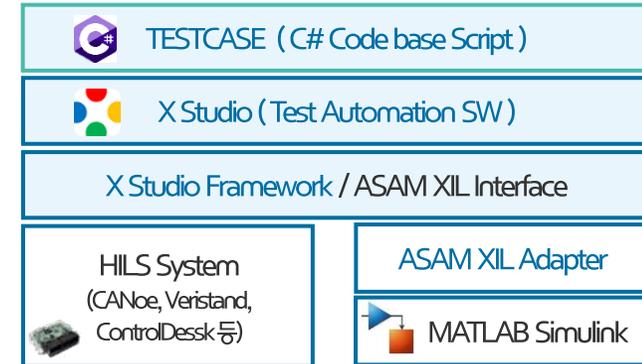
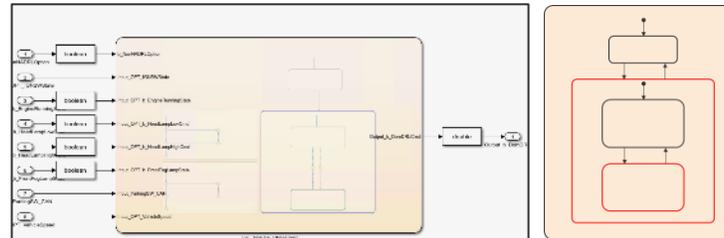
결과 값

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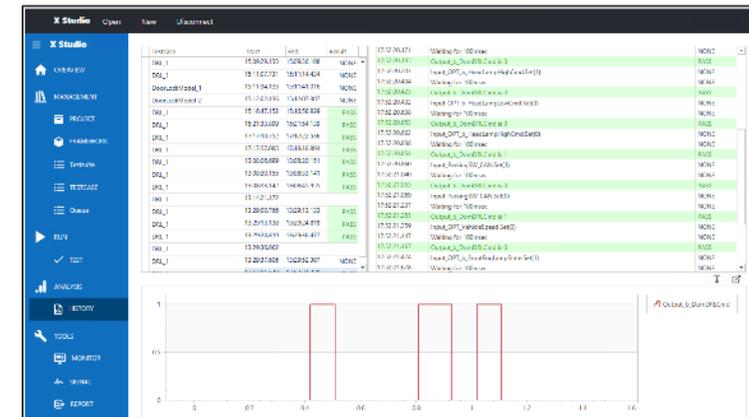
# Conclusion

## Details of MILS

- Simulation in MATLAB Simulink
  - Test Automation in model
  - Re-use Testcase in SIL or HIL
  - Support port : MAPort (Acquisition, Stimulation)
- Functions
  - Stimulation Signal data to Simulink input
  - Simulink output to Acquisition Recorder Data
  - Testcase convert to Simulink input
  - Reduced wait delay



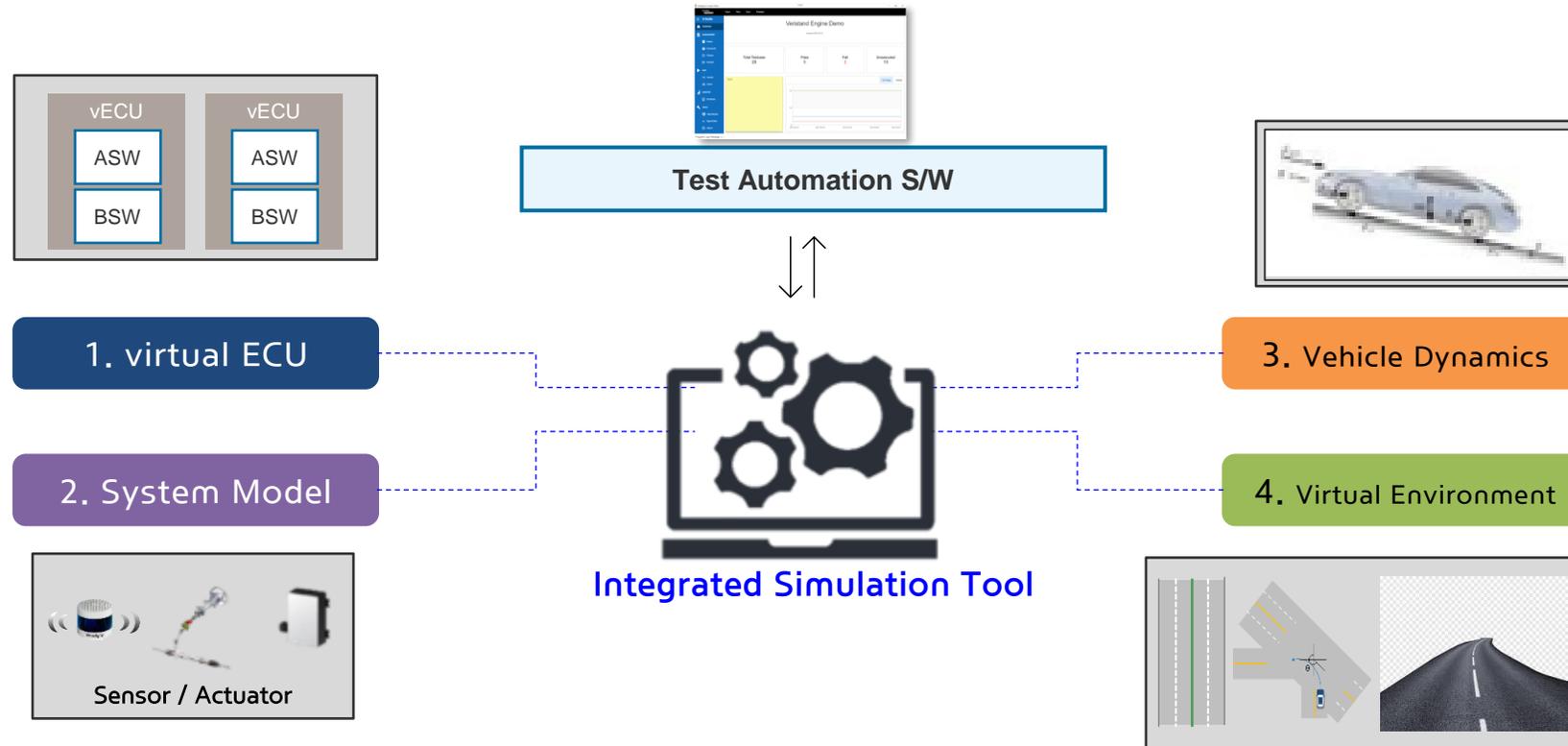
< MIL/HIL Layer >



# Conclusion

## Details of SILS

- Interface with Integrated Simulation Tool
  - Test Automation in virtual platform



# Thank you for your attention!



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