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**AUTOMOTIVE
CONFERENCE 2024**
Korea

Development of Vehicle Platform Controller Application Software for Hybrid Vehicles using MATLAB and Simulink

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Contents

- Overview
- Development of Application Software
- Verification of Application Software
- Summary & Future plans

Overview

Transition to Software Defined Vehicle

- Providing new services and continuously updating vehicle performance through OTA (Over-The-Air)
- Equipped with high-load technology utilizing the cloud
- Providing various connectivity services

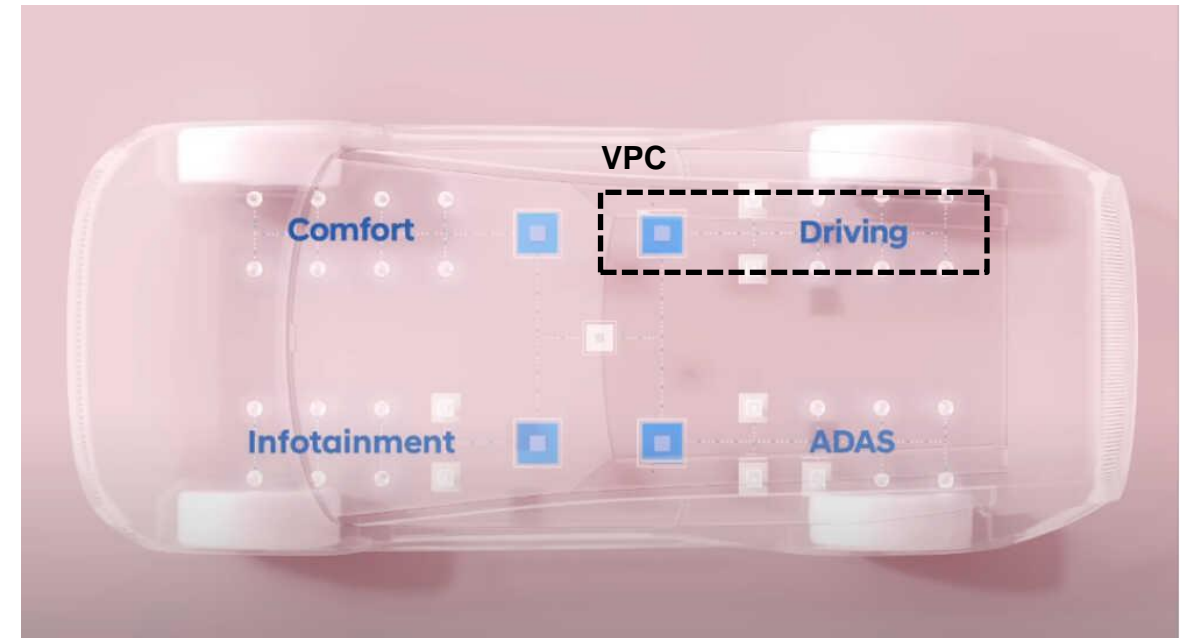


<https://www.hyundai.co.kr/search/searchDetail?searchContents=sdv>

Overview

VPC(Vehicle Platform Controller)

- Domain Centralized Architecture
- Reduction of SW development complexity through vehicle-level function integration
- Expanding Model-Based Development



<https://www.hyundai.co.kr/story/CONT000000000094656>

Overview

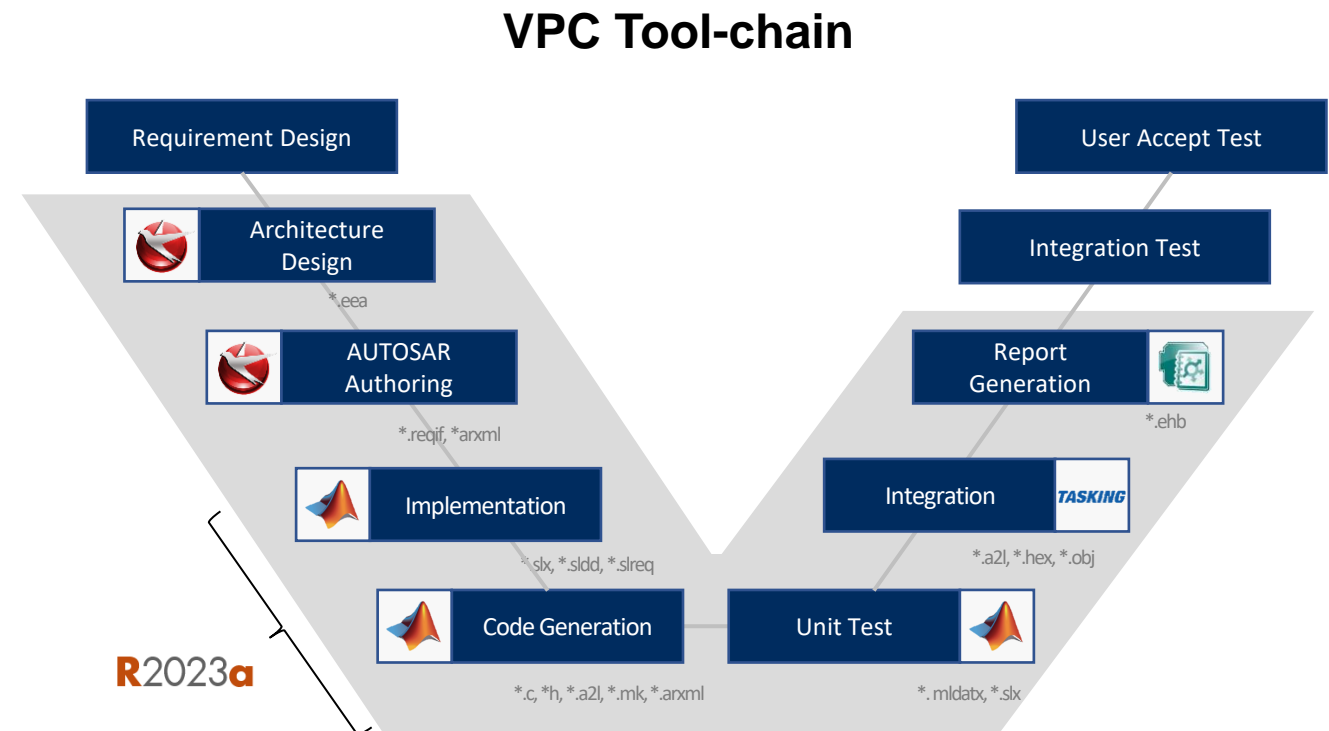
Major changes for VPC

- Integration of vehicle controllers
- AUTOSAR platform
- Feature based software architecture
- VPC LINK

Overview

Major changes for VPC

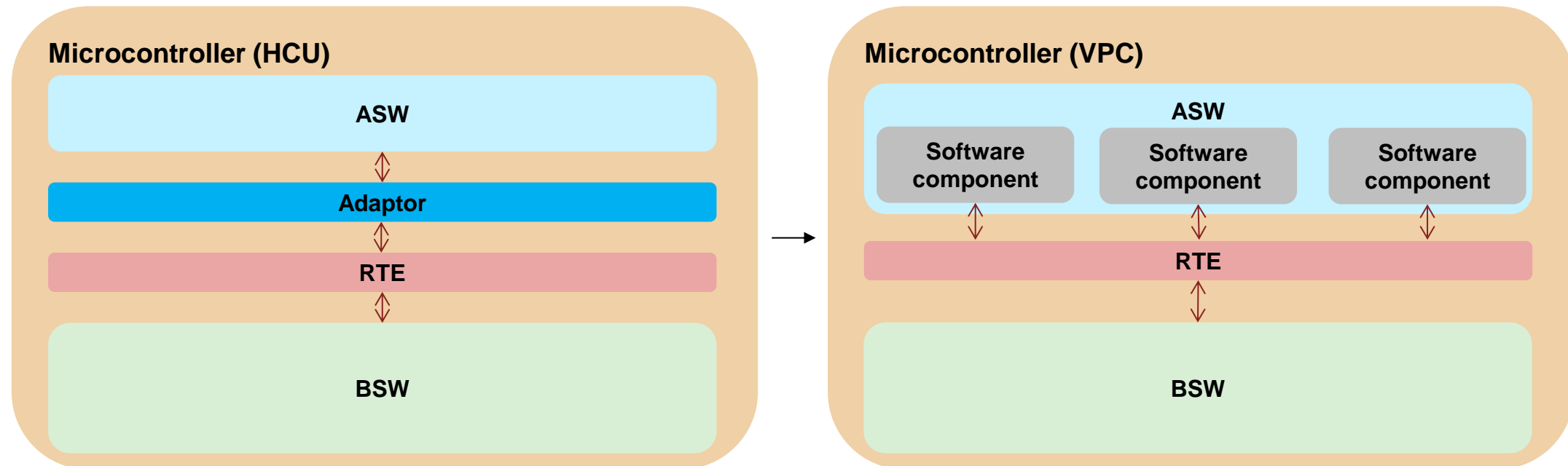
- Integration of vehicle controllers
 - Using Common tool-chain
 - MATLAB R2023a
 - Converting naming convention
 - Converting block properties



Overview

Major changes for VPC

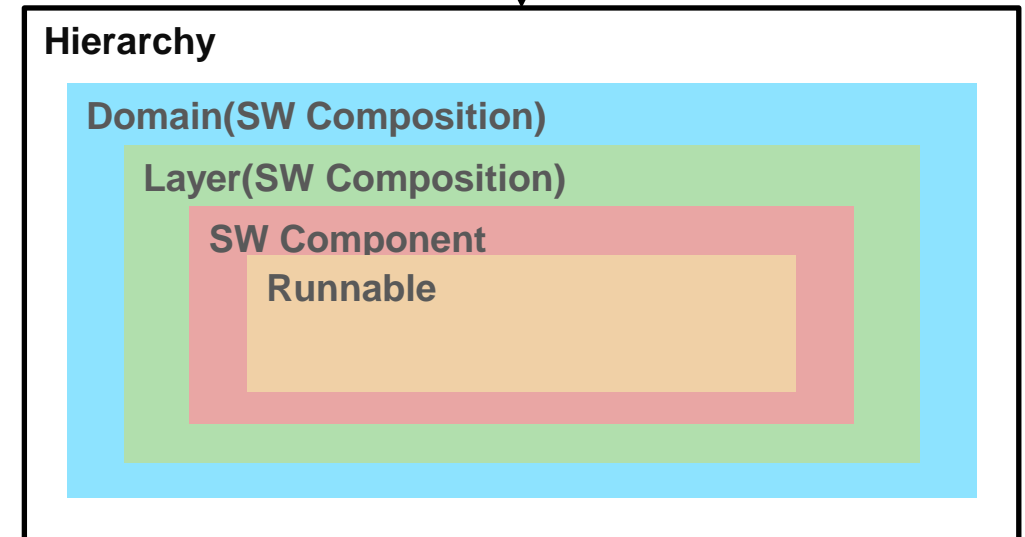
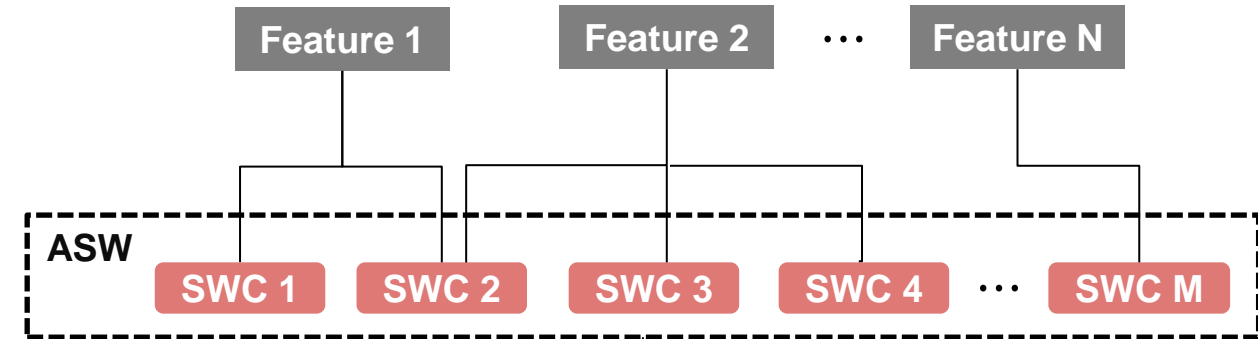
- AUTOSAR platform



Overview

Major changes for VPC

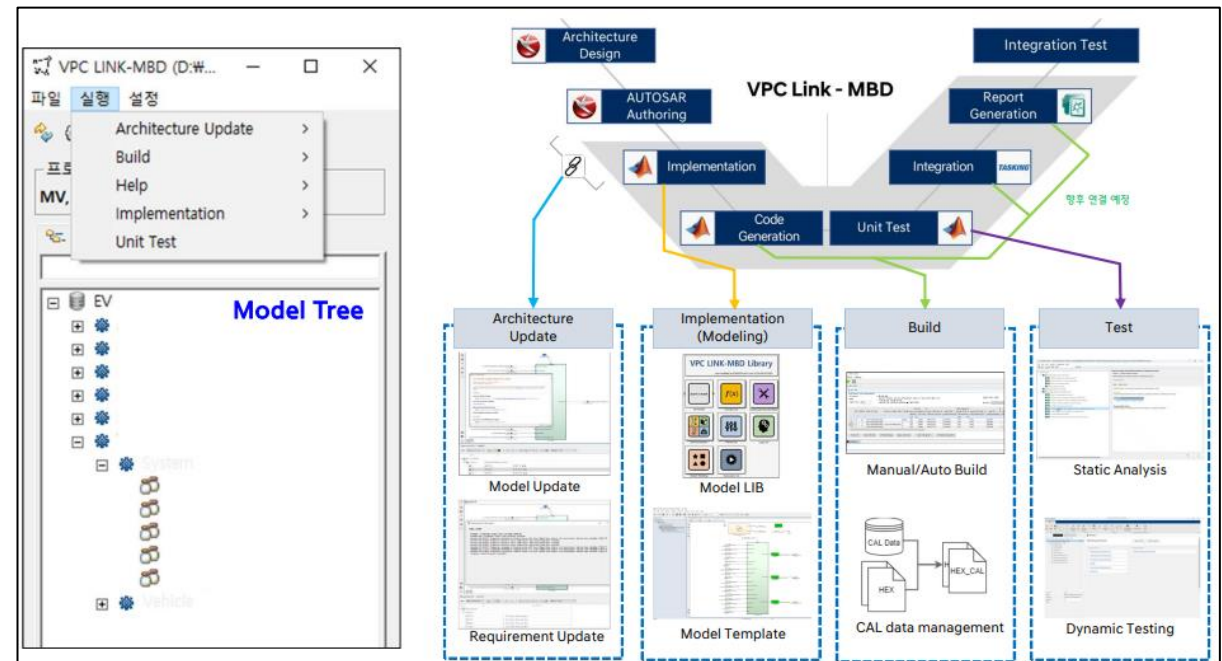
- Feature based software architecture
 - Classification of application software by feature
 - Software composition grouping
 - Domains are classified by functional purpose.
 - Domain is divided into layers as control target.



Overview

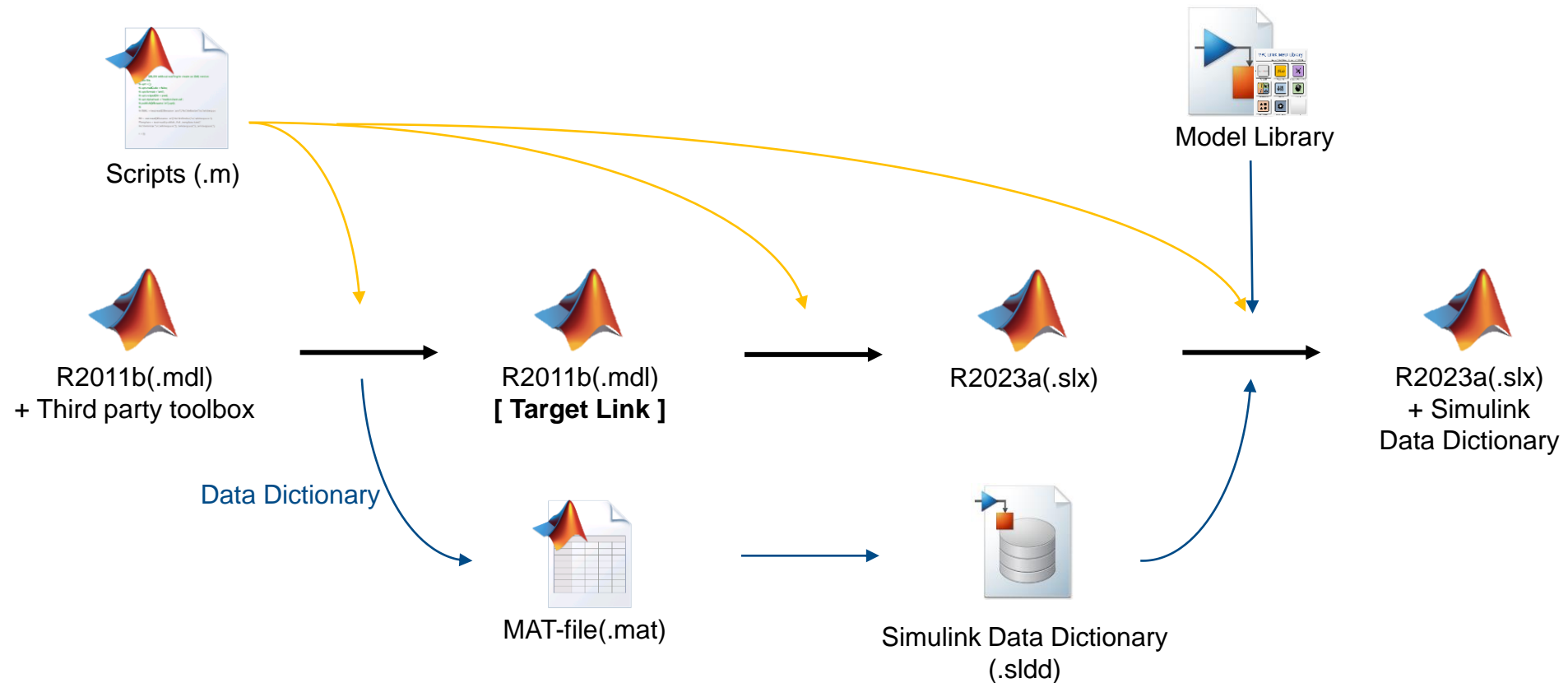
Major changes for VPC

- VPC LINK - MBD
 - Shorten SW development time
 - Seamless SW development environment
 - Functions
 - Architecture Update
 - Model Library & Template
 - Code gen. & Build
 - Test (Static & Dynamic)



Development of Application Software

Update MATLAB R2011b to R2023a



Development of Application Software

Update MATLAB R2011b to R2023a

- Change Simulink blocks

Gain block (Target Link)

Output | Gain | Logging & Autoscaling | Documentation

Production code options

Description:

Variable: Name: SS_SB Unit:

Class: default Address:

Type: Int16 Width: Uniform elements

Scaling: Element:

	Implemented	Calculated	Simulink
LSB: 2 ⁰ 0	32767	n.a.	n.a.
Offset: 0	-32768	n.a.	n.a.

Saturate

Saturate

Gain value

Gain: 1 Tolerance: 1 % Scalar

Use value of Data Dictionary variable

Production code options

Description:

Variable: Name: Unit:

Class: default Address:

Type: Width: Uniform elements

Scaling: Element:

Implemented of gain

LSB: 2⁰ Max:

Offset: Min:

Gain block (Embedded Coder)

Gain

Element-wise gain ($y = K.*u$) or matrix gain ($y = K*u$ or $y = u*K$).

Main | Signal Attributes | Parameter Attributes

Gain: 1

Multiplication: Element-wise(K.*u)

Main | Signal Attributes | Parameter Attributes

Output minimum: Output maximum:

Output data type: Inherit: Inherit via internal rule >>

Lock output data type setting against changes by the fixed-point tools

Integer rounding mode: Floor

Saturate on integer overflow

Main | Signal Attributes | Parameter Attributes

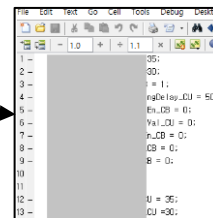
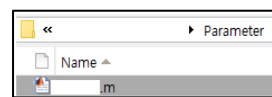
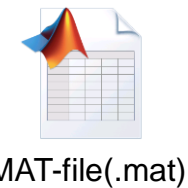
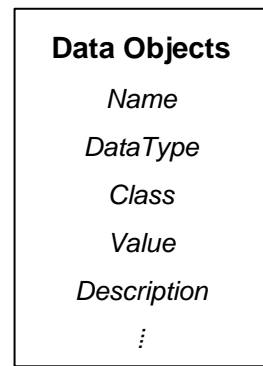
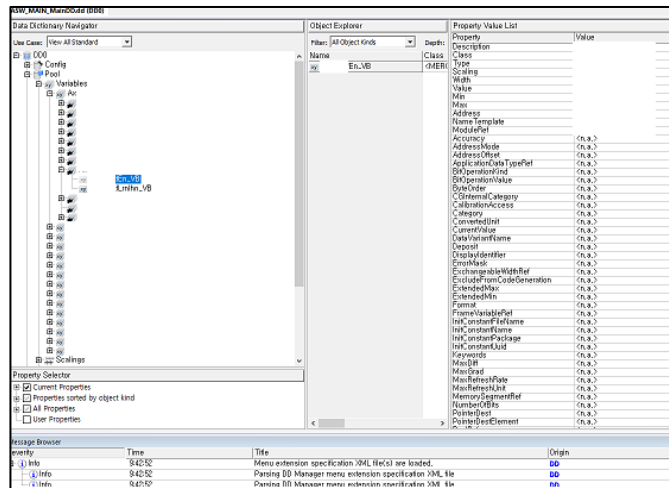
Parameter minimum: Parameter maximum:

Parameter data type: Inherit: Inherit from 'Gain' >>

Development of Application Software

Update MATLAB R2011b to R2023a

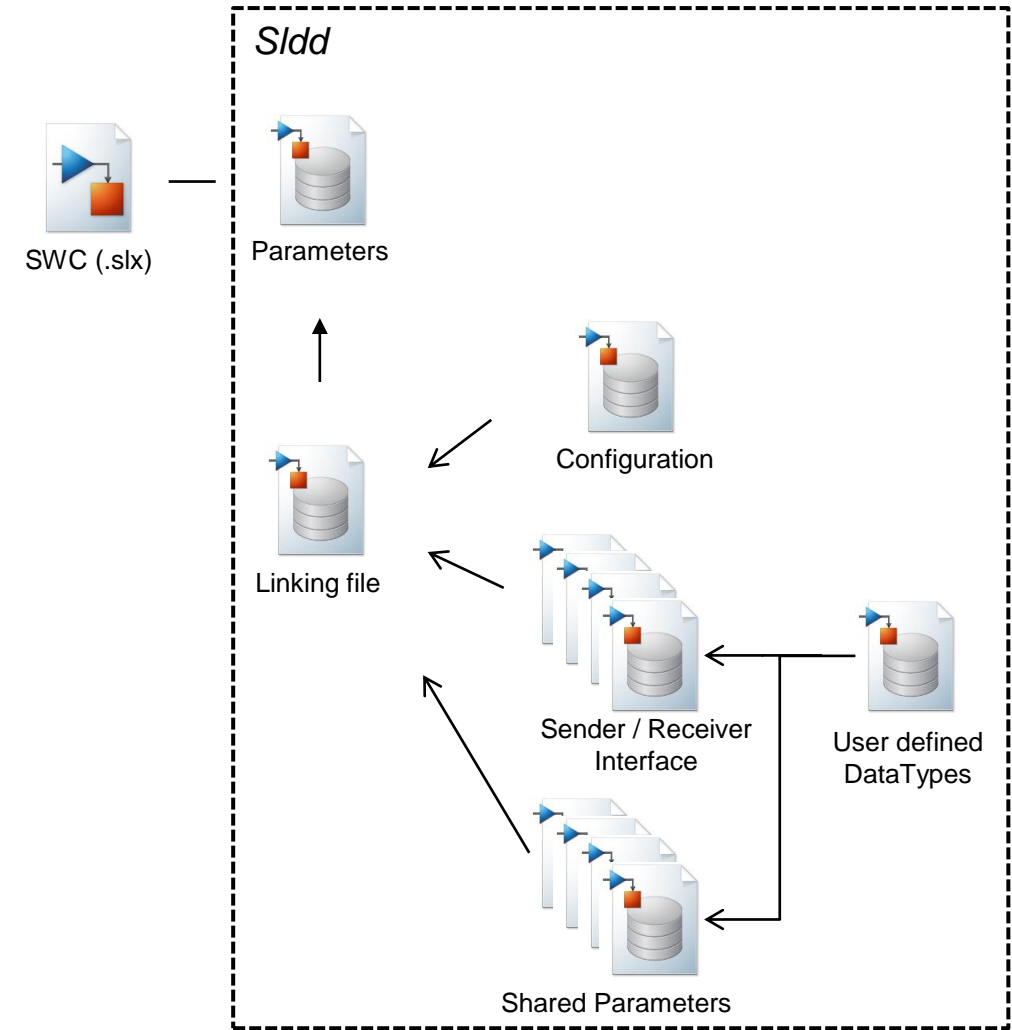
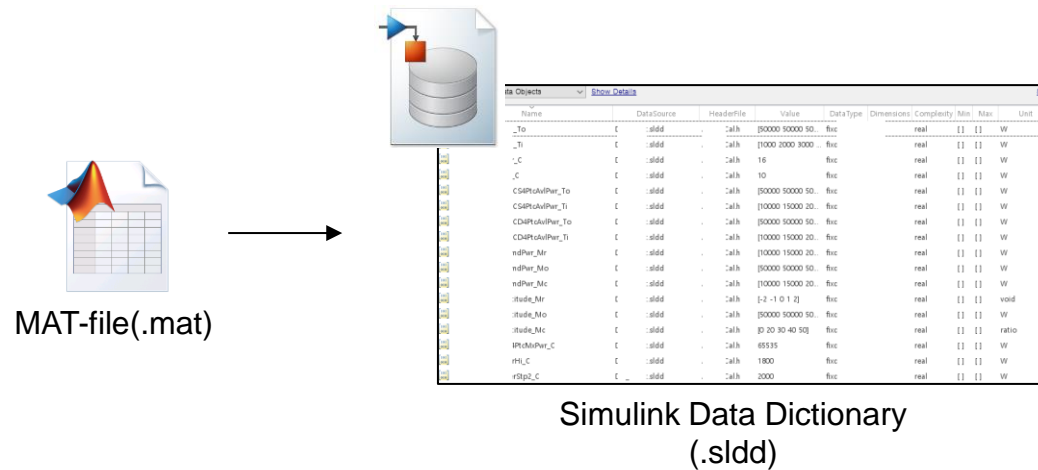
- Extract data dictionary to mat-file



Development of Application Software

Update MATLAB R2011b to R2023a

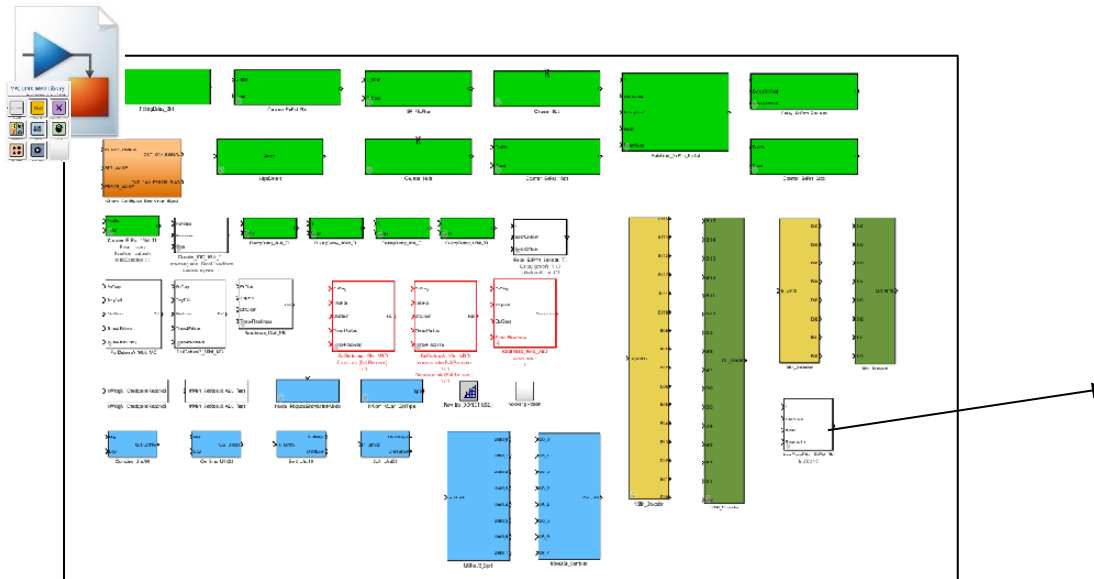
- Create Simulink Data Dictionary



Development of Application Software

Update MATLAB R2011b to R2023a

- Apply VPC model library



Mask

HMC Modeling Pattern / (mask)

Parameters

Output type : Int16

Output LSB [ex. 2⁻³] : 0.125

OK Cancel Help Apply

Code Browser Parameters & Dialog Code Constraints Icon

Search

Initialization & Callbacks

Initialization

Parameters

out_type

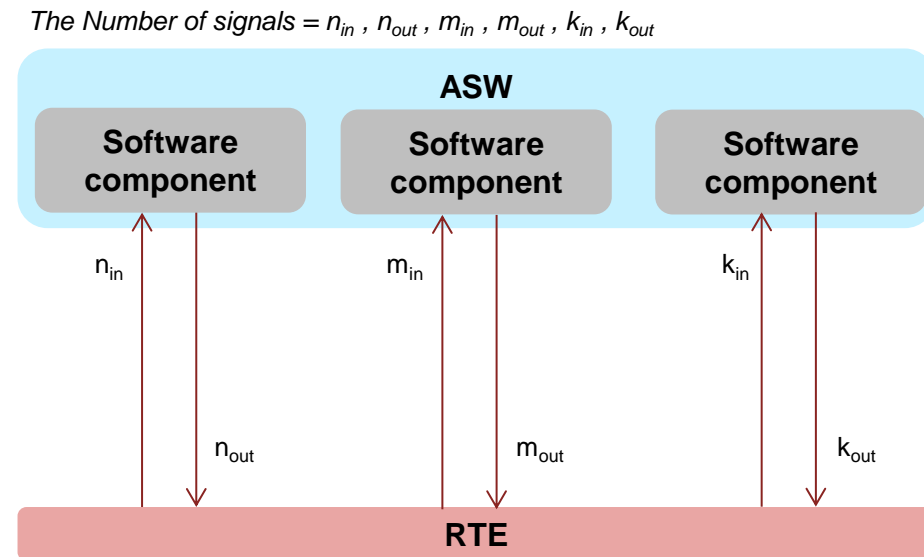
out_lsb

```
1 % Initialization code section
2 function initialization()
3
4 end
5
6 % Parameter callback section
7
8 % Callback for out_type
9 function out_type_callback()
10     _ChgParam;
11 end
12
13 % Callback for out_lsb
14 function out_lsb_callback()
15     _ChgParam;
16 end
```

Development of Application Software

AUTOSAR Blockset

- Sender/Receiver Ports
 - The more RTE calls there are, the higher the CPU load
 - To reduce the number of RTE calls, the In/Out signals between SWCs are create as structures

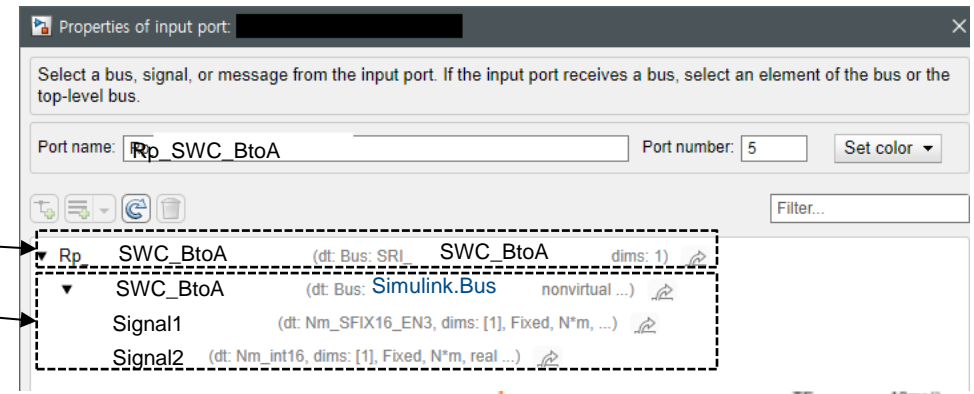


Development of Application Software

AUTOSAR Blockset

- Sender/Receiver Ports

AUTOSAR	Simulink
Sender / Receiver ports	In/Out Bus element
Port	Port Name : SWC B to A
Data Element	Name : SWC B to A (Datatype : Simulink.Bus)



Development of Application Software

AUTOSAR Blockset

- Sender/Receiver Ports

AUTOSAR	Simulink
Sender / Receiver ports	In/Out Bus element
Port	Port Name : SWC B to A
Data Element	Name : SWC B to A (Datatype : Simulink.Bus)

Simulink.Bus:

Launch Type Editor

Design Code Generation

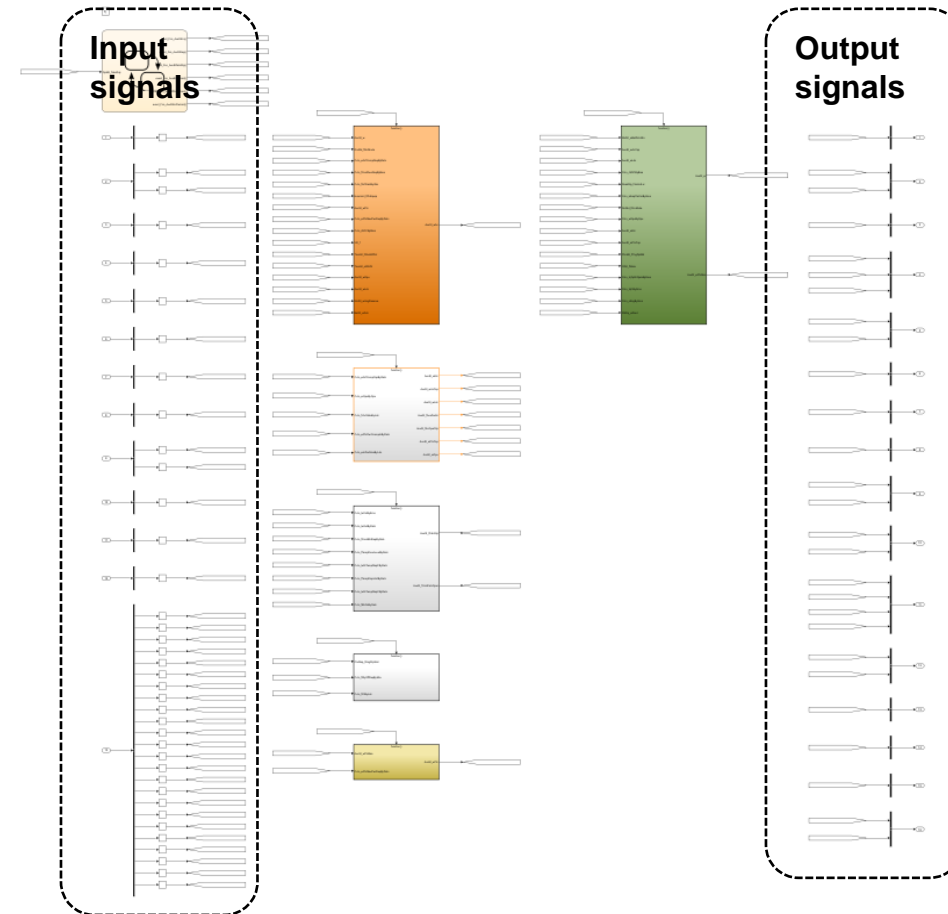
Bus elements

am	DataType	Complexity	Dimensions	Min	Max	DimensionsMode	Unit
P...	boolean	real	1	0	0	Fixed	void
P...	Nm_int16	real	1	0	0	Fixed	N*m
P...	boolean	real	1	0	0	Fixed	void

Signal

Development of Application Software

AUTOSAR Blockset



Development of Application Software

AUTOSAR Blockset

- Code Mappings

AUTOSAR Dictionary:

- AUTOSAR
 - AtomicComponents
 - ReceiverPorts
 - SenderPorts
 - SenderReceiverPorts
 - ModeReceiverPorts
 - ModeSenderPorts
 - ClientPorts
 - ServerPorts
 - NvReceiverPorts
 - NvSenderPorts
 - NvSenderReceiverPorts
 - ParameterReceiverPorts
 - TriggerReceiverPorts
 - IRV

Name	symbol	canBelv
RE_ _10ms	RE_ 10ms	false
RE_ _Init	RE_ _Init	false

Code Mappings – Component Interface

Functions | Inports | Outports | Parameters | Data Stores | Signals/States | Data Transfers | Function Callers

Source	DataAccessMode	Port	Element
Rp	ImplicitReceive	Rp_E	E
Rp	ImplicitReceive	Rp_M	M
Rp	ImplicitReceive	Rp_L	L

Code Mappings – Component Interface

Functions | Inports | Outports | Parameters | Data Stores | Signals/States | Data Transfers | Function Callers

Source	DataAccessMode	Port	Element
Pp	ImplicitSend	Pp_A	A
Pp	ImplicitSend	Pp_A	A
Pp	ImplicitSend	Pp_A	A

Code Mappings – Component Interface

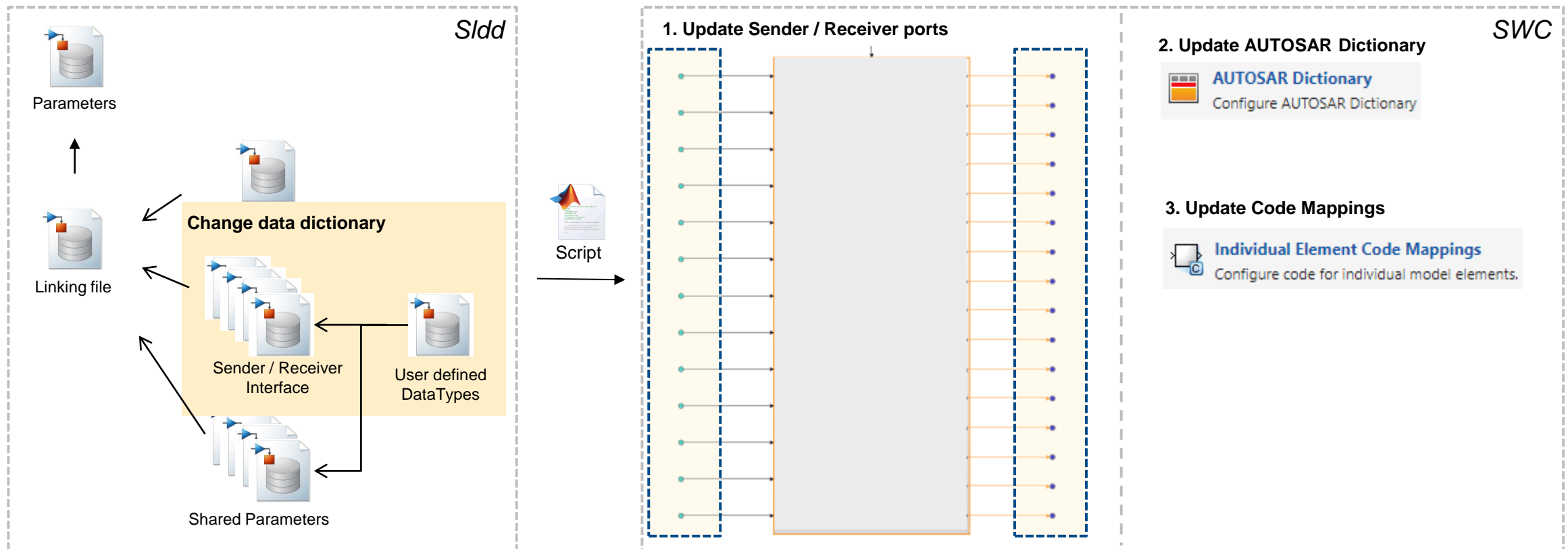
Functions | Inports | Outports | Parameters | Data Stores | Signals/States | Data Transfers | Function Callers

Source	Element
Exported Function:TE_AuxSt_10ms	RE_AuxSt_10ms
Initialize	RE_AuxSt_Init

Development of Application Software

AUTOSAR Blockset

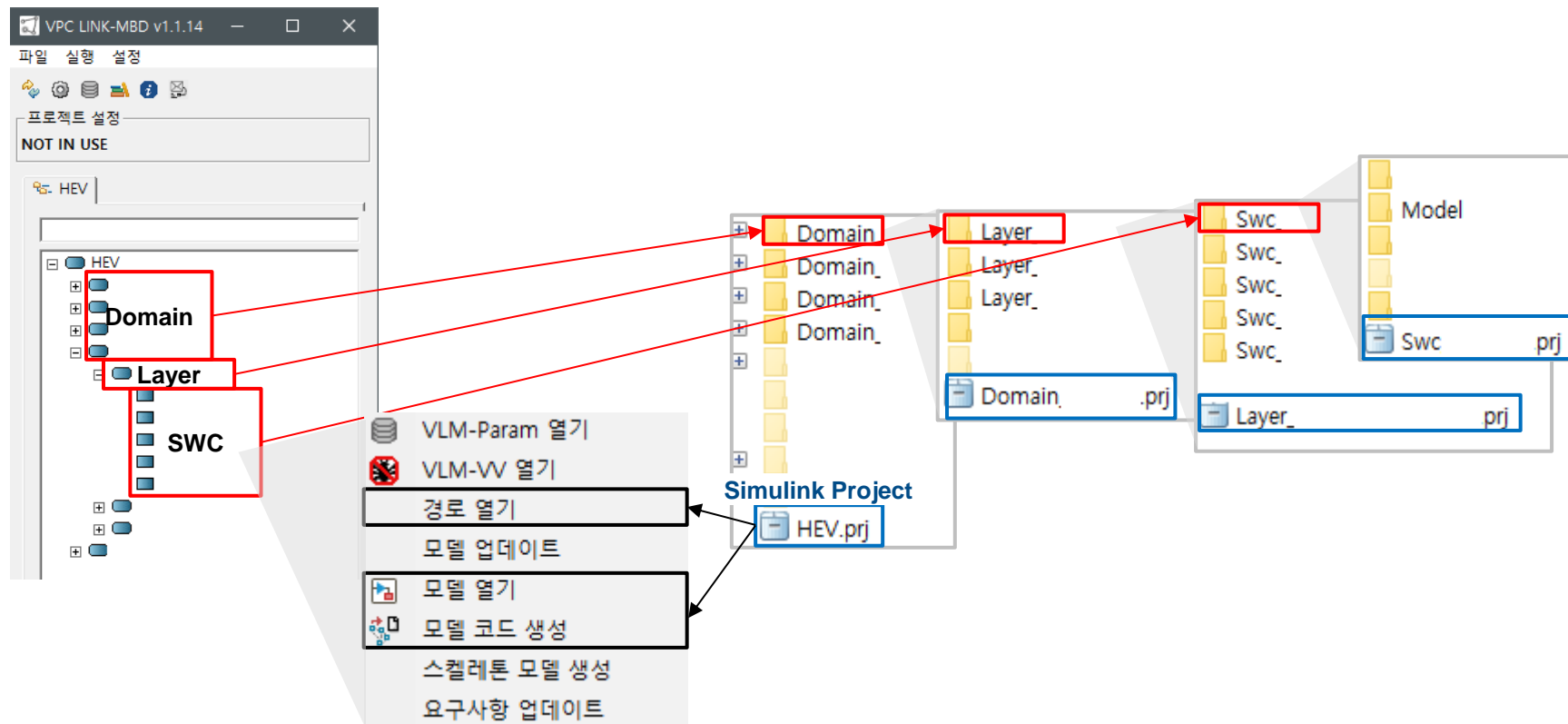
- Automation script for AUTOSAR Interface



Development of Application Software

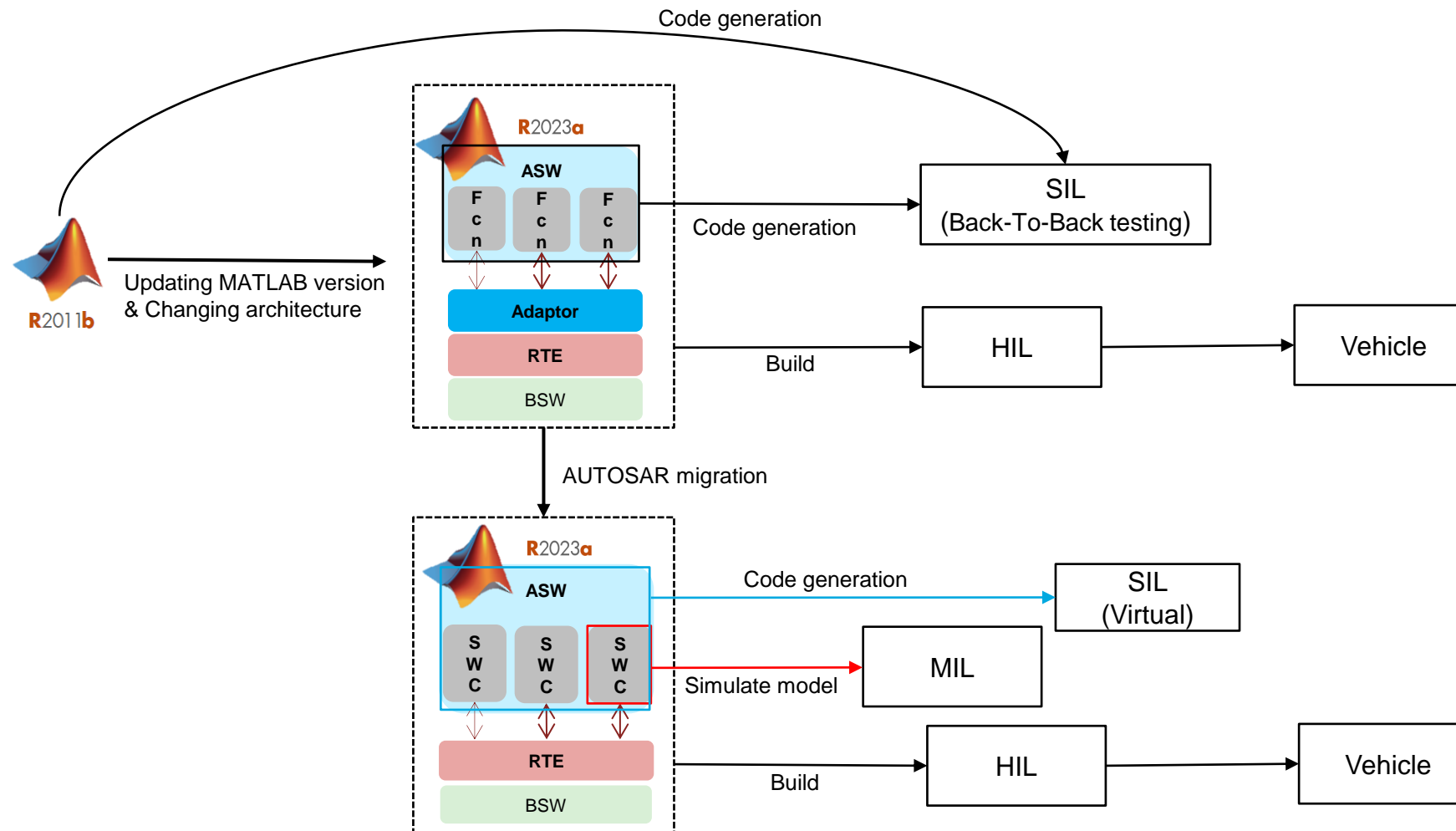
VPC LINK - MBD

- Creating a Simulink Project for linking VPC LINK



Verification of Application Software

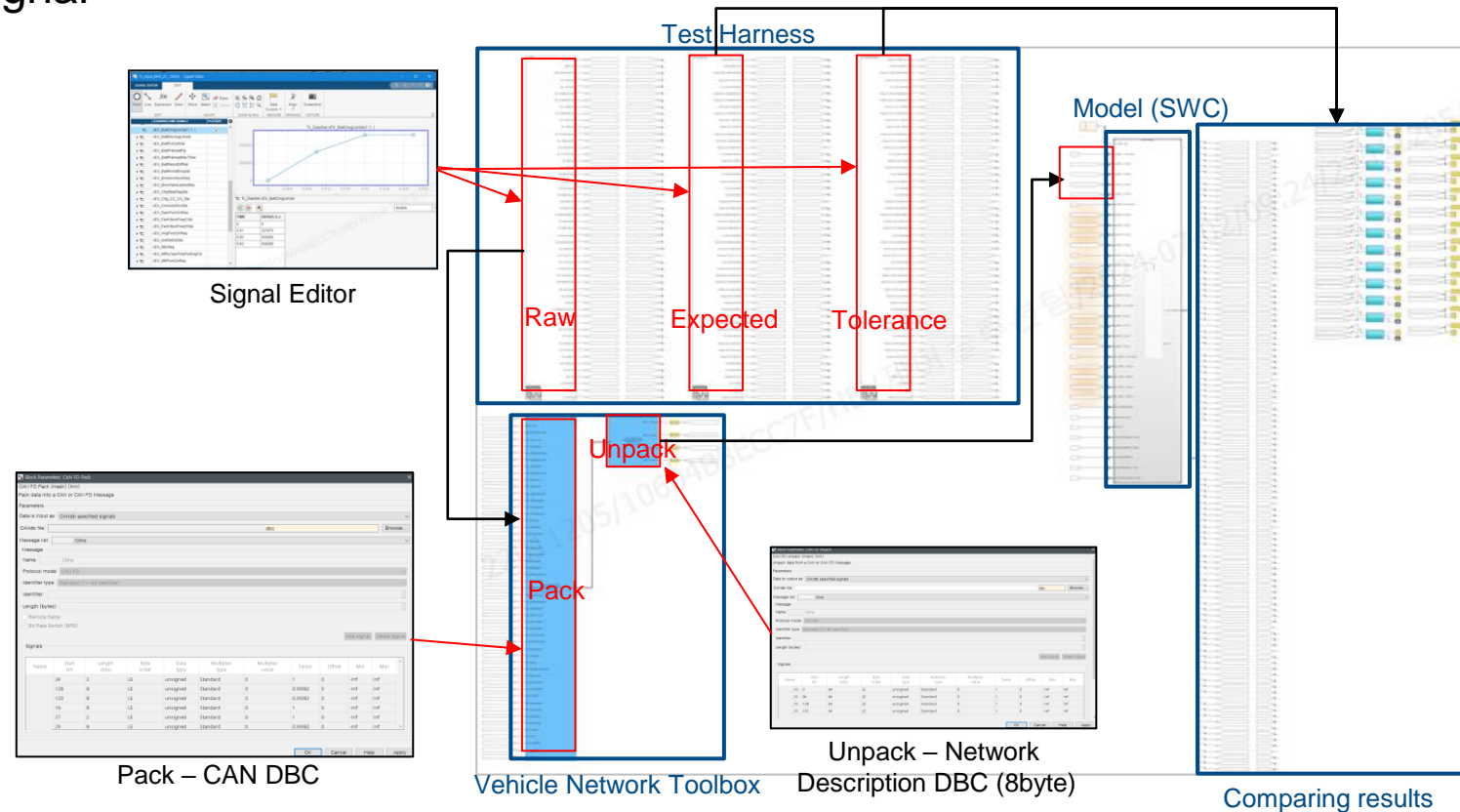
Verification Process



Verification of Application Software

Model In the Loop (MIL)

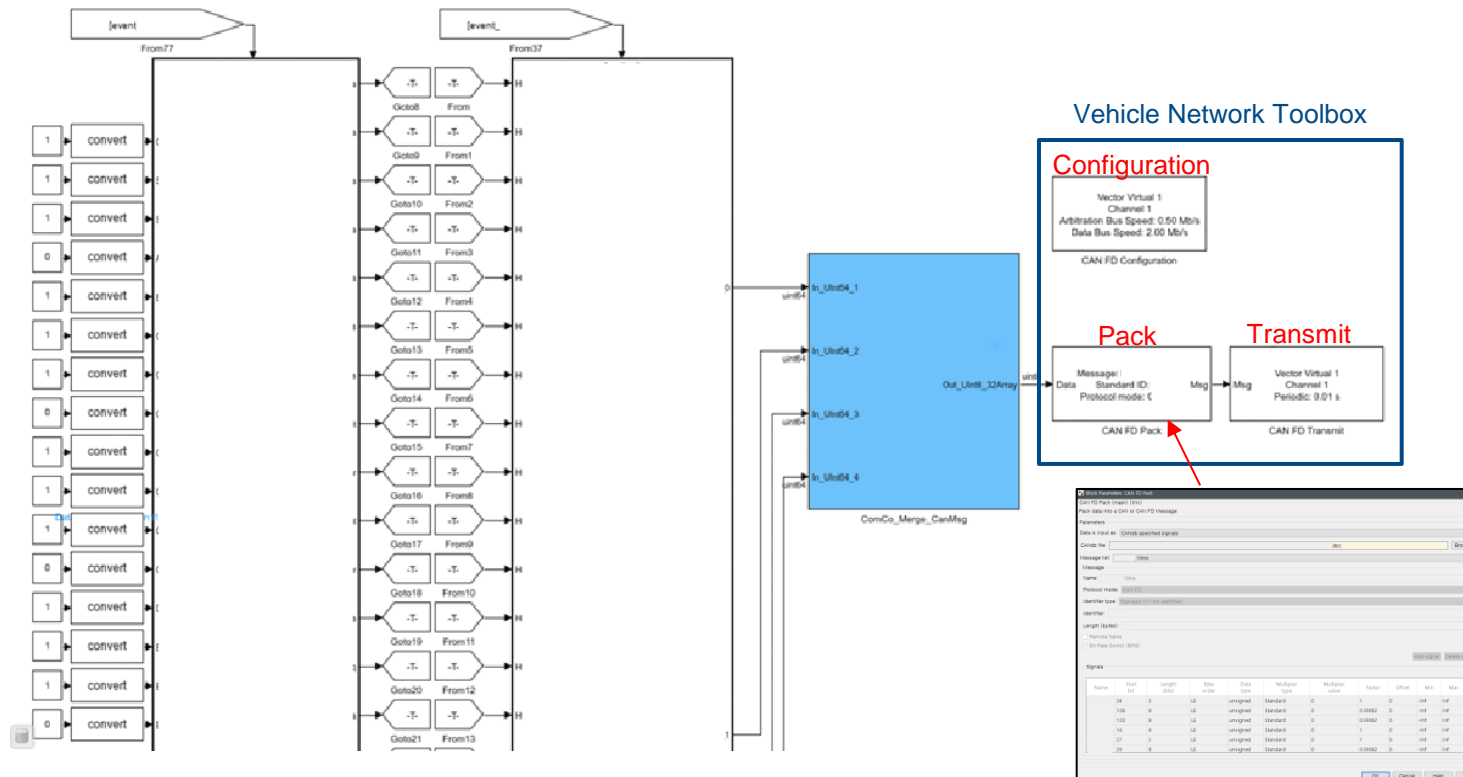
- CAN Input signal



Verification of Application Software

Model In the Loop (MIL)

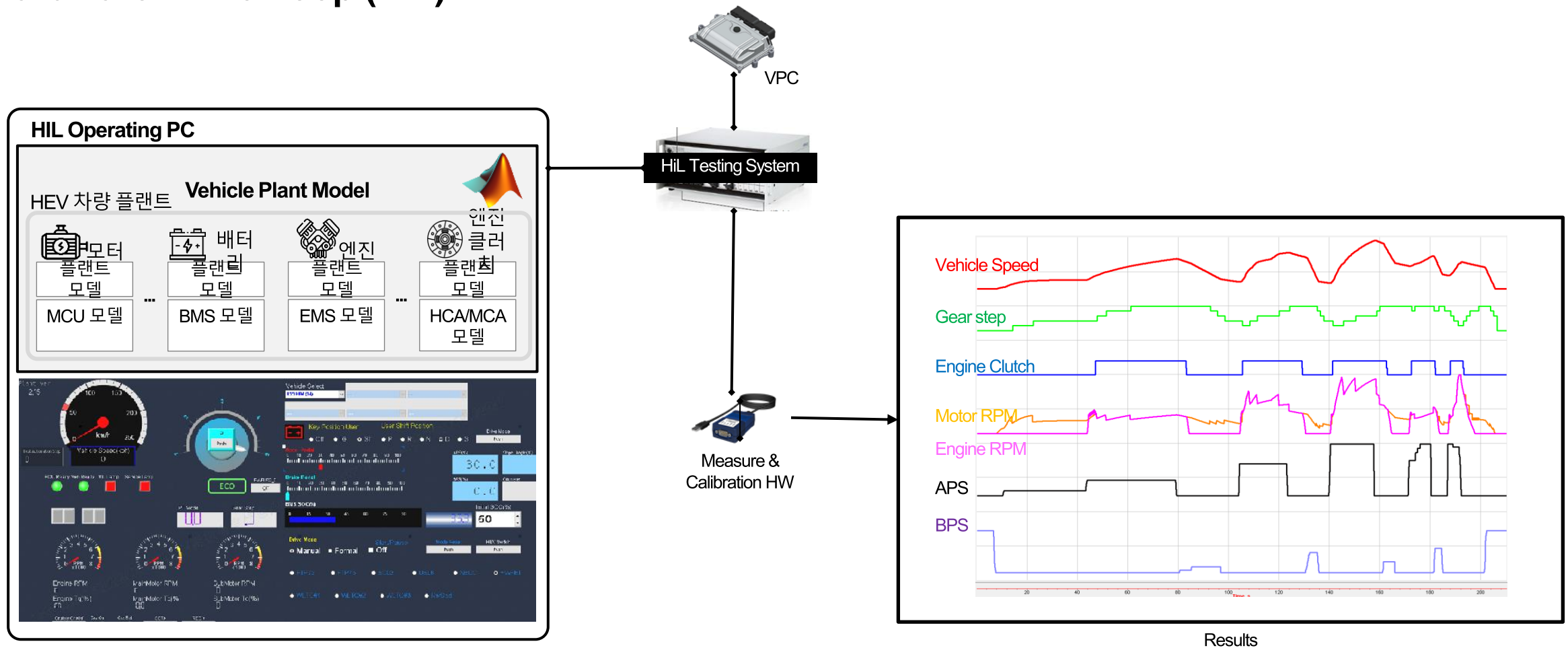
- CAN Output signal



Pack - CAN DBC

Verification of Application Software

Hardware in the Loop (HiL)



Summary & Future plans

Summary

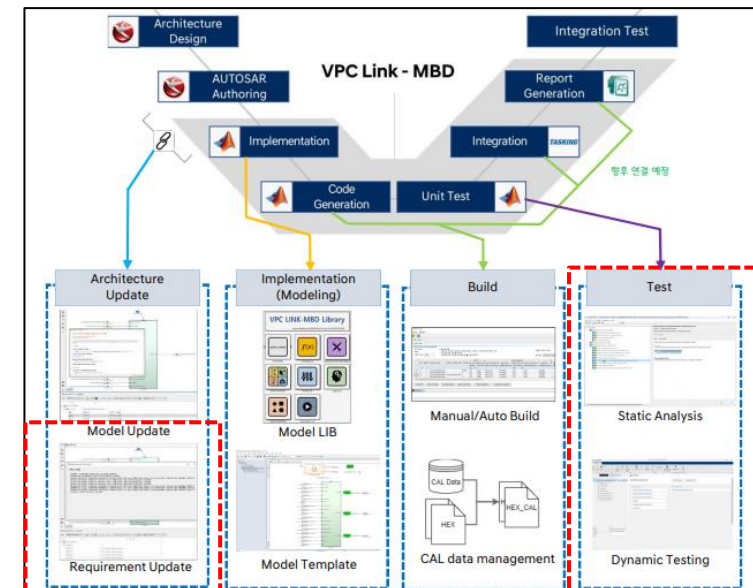
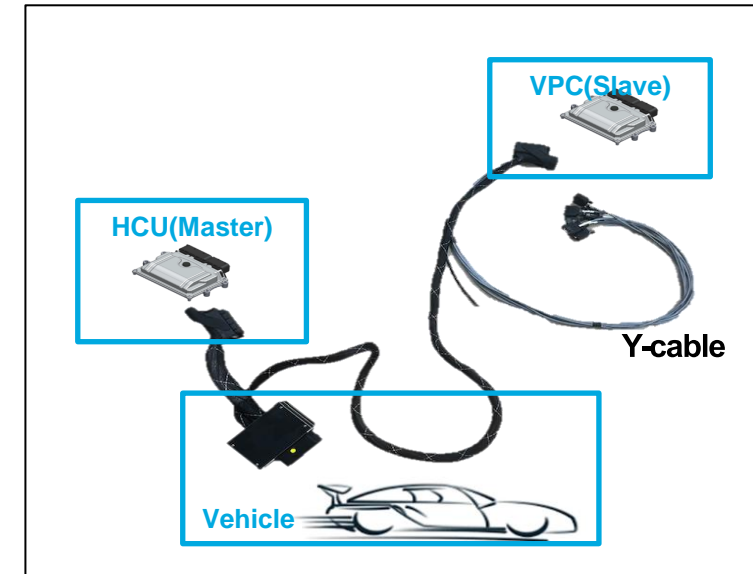
- Project goal is development of Vehicle Platform Controller(VPC)
- Updated MATLAB from 2011b to 2023a to use the tool-chain for VPC development.
- Using AUTOSAR Blockset for applying AUTOSAR platform to ASW
- Test harness and Vehicle network toolbox are used to verify CAN Interface
- Perform VPC SW verification using HILS

Summary & Future plans

Future plans

- Vehicle Test using y-cable
 - Drive the vehicle using HCU controller as the master controller
 - Use the VPC controller as a slave to perform only calculations within the controller
 - ASW verification by comparing the output of controllers connected to Master and Slave

- Applying Simulink Requirement Toolbox and Simulink Test using VPC LINK - MBD



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Thank you



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