Activity report: 3VSG for proposed ASAM standard

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3V-SG

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ASAM Association for Standardization of Automation and Measuring Systems

Agenda

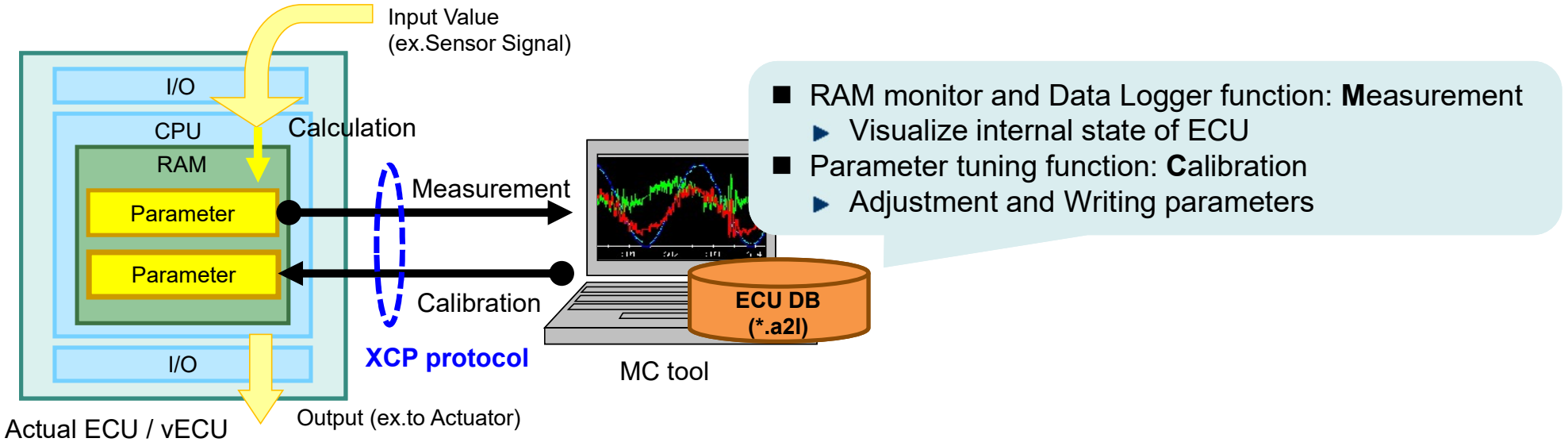
1	Background and Issue
2	Objective and Methodology
3	Use case and Requirements
4	Evaluation and Results
5	Conclusion

Background and Issue (1/2)

vECU and ASAM MCD-1 XCP

- ASAM XCP compliant MC tools are widely used for monitoring and calibration of ECUs.
- It is expected reducing cost of tool and reducing time for engineering training by applying MC tools to vECU as well as actual ECU.
- However, it is not clear if there are any restrictions and difference of usability because the assumption of ASAM XCP is actual ECU, not for vECU.

Actual ECU / vECU and MC(Measurement/Calibration) tool



Background and Issue (2/2)

3V-SG (Virtual Verification & Validation using vECU Study Group)

- 3V-SG (**V**irtual **V**erification and **V**alidation using vECU **S**tudy **G**roup) is a group of cross domain engineers and researchers from OEMs, suppliers, semiconductor, tool, and SI who work on development of ECUs using virtual verification methodologies.
- 3V-SG widely researches virtual verification methodologies in the development of automotive electronic systems.
- One of task forces in the 3V-SG works on development environment utilizing virtual ECUs in the cloud and XCP.
- The task force focus on the current challenges and limitations of applying XCP to software running on virtual ECUs in the cloud.

Participating organizations

- ETAS K.K.
- InterBuddy Inc.
- WITZ Co.,Ltd.
- Australian Semiconductor Technology Company
- GAIO TECHNOLOGY Co., Ltd.
- Zerosoft Assist Technology Co. Ltd.
- SYNKOM CO., Ltd.
- dSPACE Japan K.K.
- Tokyo Computer Service Co., Ltd.
- TOSHIBA Digital Solutions Corporation
- Toyota Technical Development Corporation
- NISSAN MOTOR Co. Ltd.
- Cadence Design Systems, Japan
- Nihon Synopsys G.K.
- Hitachi Industry & Control Solutions, Ltd.
- Bosch Corporation
- T2 Laboratory Co. Ltd.
- Mazda Motor Corporation
- MoDeCH Inc.
- Renesas Electronics Corporation
- Ryoden Corporation
- TechnoPro, Inc.
- ASAM Japan G.K.
- Hirano ResearchLab

(24 organizations)

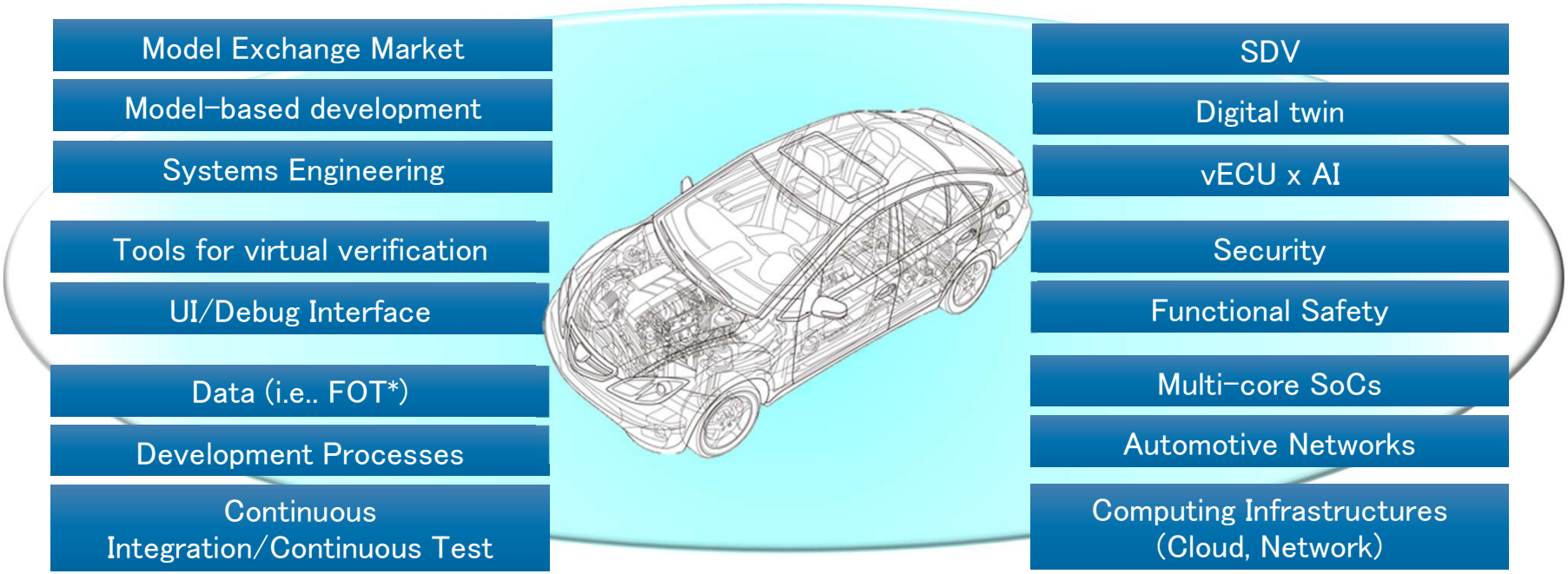
3V-SG

3 V-SG
https://www.3vsg.org

3V-SG

Area of interest

3V-SG widely researches virtual verification methodologies in the development of automotive electronic systems.



*) FOT: Field Operational Test

3V-SG

Activities

1. Investigation, verification, and verification of common technologies and standard technologies related to virtual verification methods.
2. Proposal and verification of new methods related to virtual verification methods, standardization proposals.
3. Dissemination and enlightenment of virtual verification.

3V-SG

Task Forces (TFs)

TF name	Description	TF reader (affiliation)
ASAM Collaboration TF	Study ASAM XCP applying to virtual ECUs through proof-of-concept. Examine if the standard is applicable as well as in physical environment, study merits, if there are any notices.	Akira Watanabe（Nissan）
FMI*1 Collaboration TF	Study the FMI standard and tools supporting the standard. Investigate how to utilize the standard.	Dai Araki (Toshiba)
4VAI-Prototyping	4V (Virtual Verification & Validation for Vehicle) Installation Artificial Intelligence Rapid Prototyping Task Force develops samples of deep learning applications using rapid prototyping systems and virtual ECUs.	Masanori Otake (Gaio Technology)

*1) FMI : Functional Mock-up interface

3V-SG

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*1) FMI : Functional Mock-up interface

Collaboration on ASAM XCP TF

Participating Organizations

In the Collaboration on ASAM XCP TF, following seven organizations are participated.

- ASAM Japan (observer)
- Australian Semiconductor Technology Company K.K.
- dSPACE Japan K.K.
- ETAS K.K.
- GAIO TECHNOLOGY Co., Ltd.
- Nihon Synopsys G.K.
- Nissan Motor Co., Ltd.

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Objective and Methodology

Since the XCP standard is based on the premise of physical ECUs, and applicability and constraints are not clear to apply to the vECUs. We like to understand limitations and issues in case of applying the current MC tools to the vECUs.

- **Objective**

  Identify limitations and issues of applying the current MC tools to the vECU.

- **Methodology**
  - Assume use cases which use vECUs to apply MC tool. And consider concerns and Issues to realize MC on virtual environment.
  - Chose functionalizes in MC tools to apply in the use cases.
  - Evaluate the functionalities using current MC tools to see if it is applicable and to understand the limitation.

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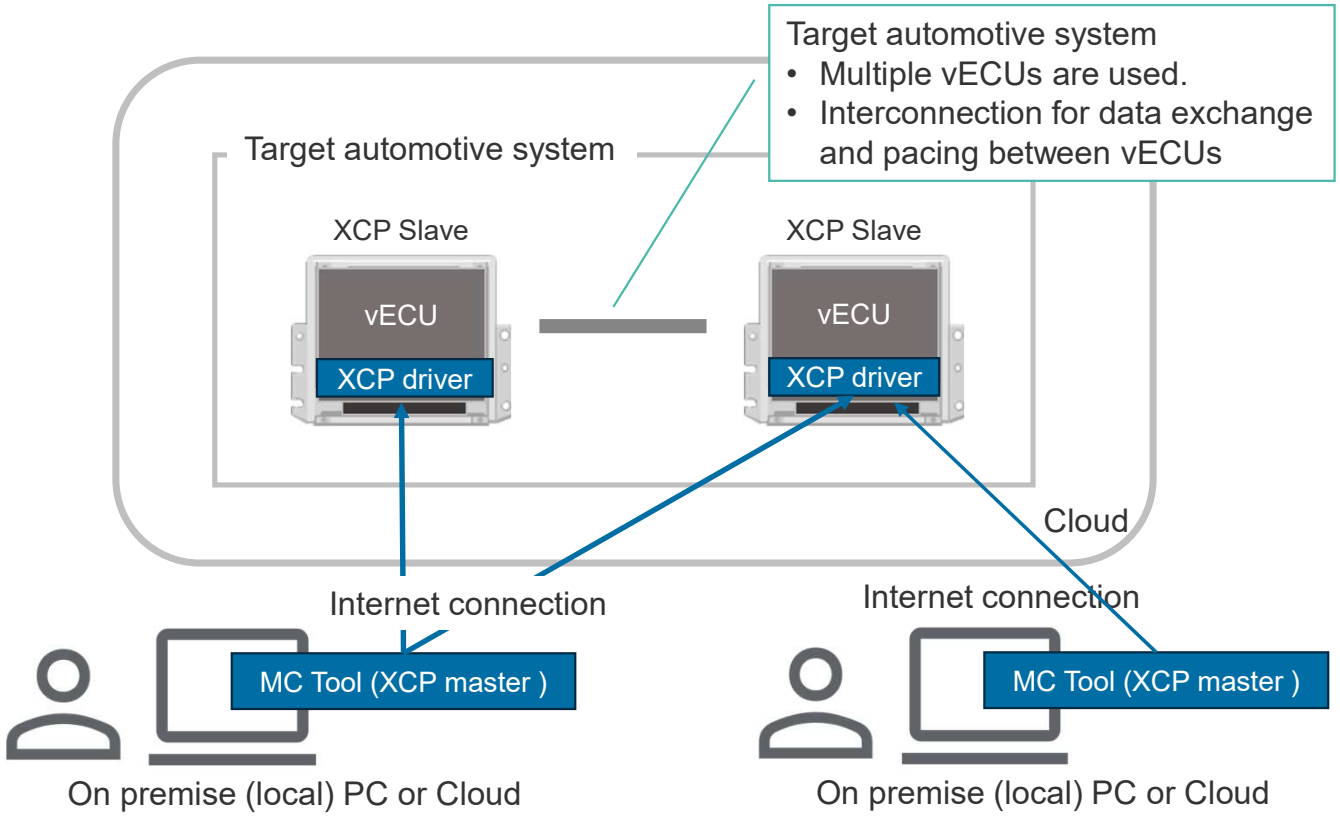
Use case

"Measurement and Calibration using XCP for virtual automotive systems in the Cloud"



- Target automotive system uses multiple vECUs.
- The target automotive system runs in Cloud.
- The vECUs have interconnection for data exchange and pacing between vECUs.
- The vECUs have XCP communication functionalities normally provided tools for vECUs.
- Engineers apply MC tool from on premise PC using internet connection.

Concerns and Issues to realize MC on virtual environment

On virtual environments, there are different concerns and issues such as the followings.

No	Item	Description
1	Startup sequence	If startup sequence is different among vECUs, there is a concern that synchronous measurement is not possible. (e.g. MC tool should be start first, or simulator started first...) Startup sequence of vECU should be flexible and not depend on the specific order.
2	Restriction by security mechanism on execution environment	Due to security mechanism on PC which MC tool or vECU is set on, not possible to change configuration of network and firewall. For this MC tool PC and vECU PC cannot be connected.
3	Multi-master connection in cloud environment	ASAM MCD-1 XCP does not allow multi-master topology. On cloud environment there is a possibility that multiple masters connect to a vECU. Ex. During a user is monitoring or calibrating a vECU on cloud, another user may connect to the same vECU.
4	Seed & Key support	vECU. Is it possible to support Seed & Key mechanism to vECU? (or already supported?)
5	Disconnection control between MC tool and vECU	A mechanism to forcibly disconnect XCP communication is needed. (ex. In the case that no one notices that keep MC tool connecting to vECU)
6	MC tool on cloud	Restrictions on MC tool: Is it possible to use MC tool on cloud? What kind of restriction will be? (ex. Any restriction of license)
7		Multiuser access to MC tool: If MC tool is put on cloud, there is a case multi users will use at the same time. The number of user will be limited?
8		Location of A2L file: If MC tool is put on cloud, where should A2L file be put? (Cloud server where MC tool is installed, or user's local PC?)
9	Timeout setting in A2L	For vECU the timeout value for command-response defined in A2L is different from real ECU.
10	HW virtualization of ECUs	With HW virtualization technologies such as hypervisor, the ECUs in the car have been virtualized. How should XCP be applied in the integrated ECU (1 SoC multiple OS) environment?

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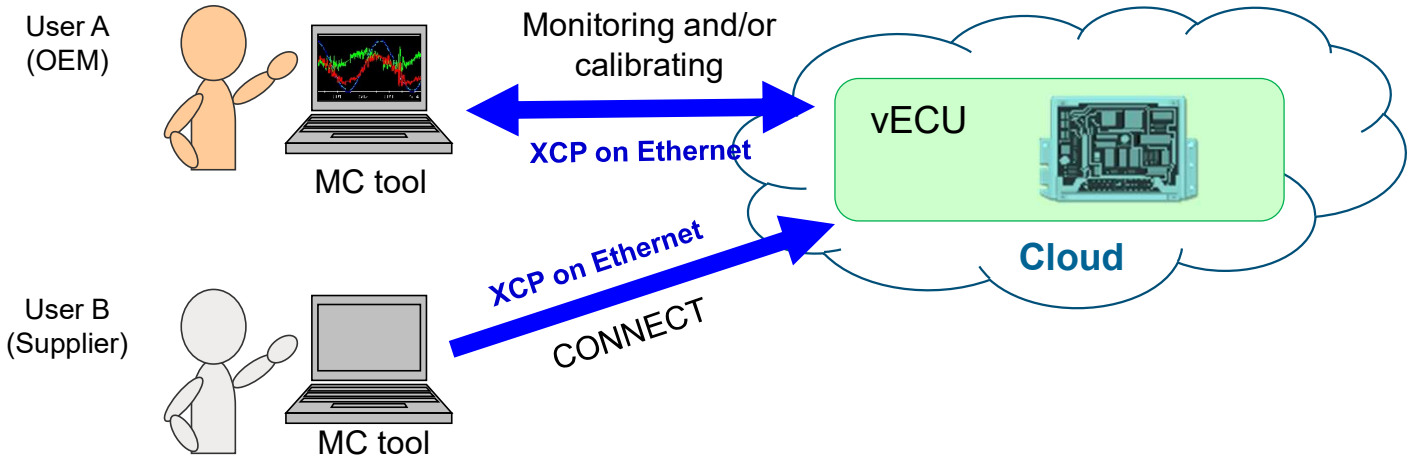
Concern about multi-master connection in cloud environment

Ex. During user A (OEM) is monitoring and/or calibrating of vECU, user B (supplier) connects.



From ASAM Office;

- MCD-1 XCP does **not define a behavioral specification of multi-master connection**.
- When multiple masters send CONNECT command with the same IP address and port, slave (vECU) cannot identify the user for each commands.
- Slave will respond to CONNECT commands even if multiple times. However, measurement may stop by command sequence error dependent on what command will be sent from users.
- Need to implement exclusive control mechanism to vECU.

Anyway, we will plan to include this case to verification scenario, and study to give feedback to ASAM if there is use case multi-master connection is necessary

ex. There might be a case that OEM user would like to share with supplier in real time the transition of variables associated with calibration.

Selected requirements for MC tool as a single master connection

Basic requirements to realize MC on virtual environment are selected from the assumed use case in the previous slide, and they are evaluated.

No.	Title	# of vECU models (Single or multiple)	Description
1	Sampling period	Single	Measurements can be made with respect to the model execution time and sampling period.
2	Parameter update		The parameters within the model can be updated from the MC tool.
3	Same sampling period	Multiple	In case multiple models have the same sampling periods, the period of each model can be measured.
4	Different sampling period		In case multiple models have different sampling periods, the period of each model can be measured.
5	Different execution time		In case the execution times of multiple models are different, measurements can be taken until all models have finished executing.
6	Use of individual IP addresses		Each model's XCP driver can be assigned a different IP address and measured.

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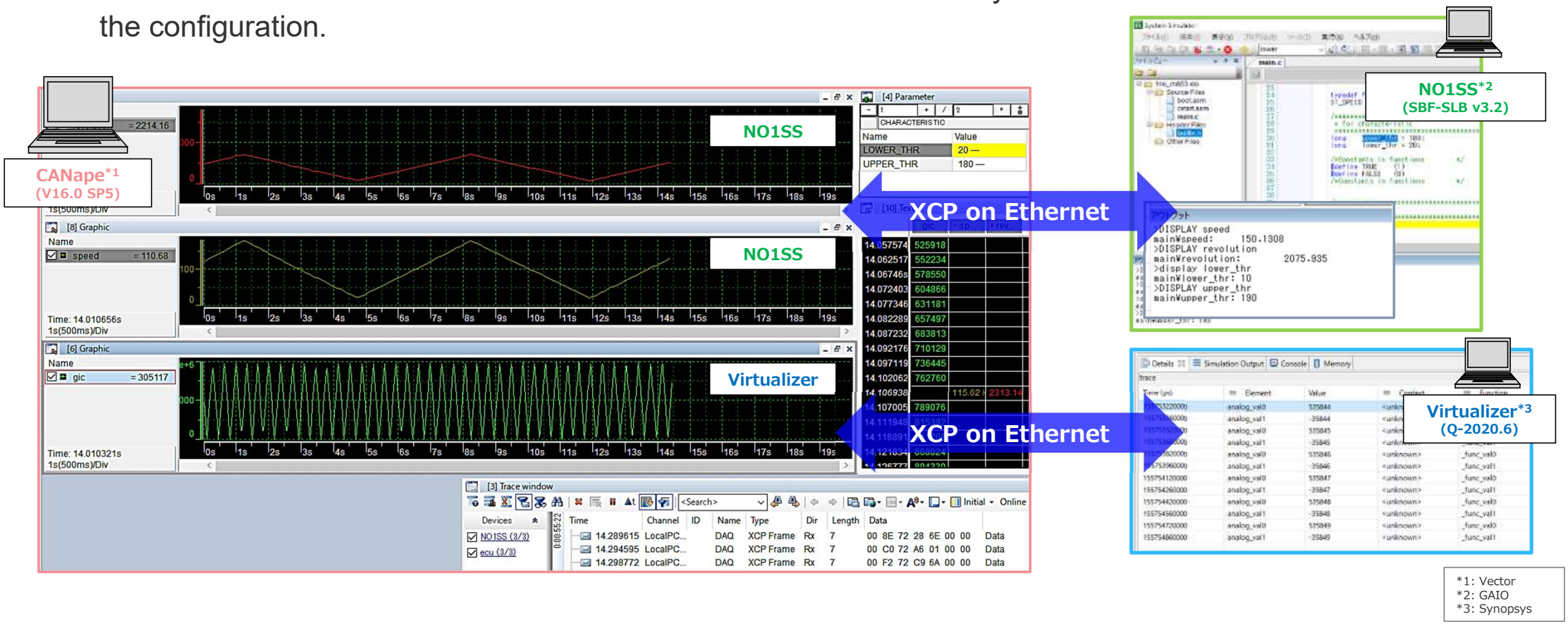
Trial status –SPILS*

*) Software Processor- In the Loop Simulation

- SPILS : MC tool x 1 vs. Microcontroller model x 2
  It is confirmed that MC tool can measure both models simultaneously with the configuration.

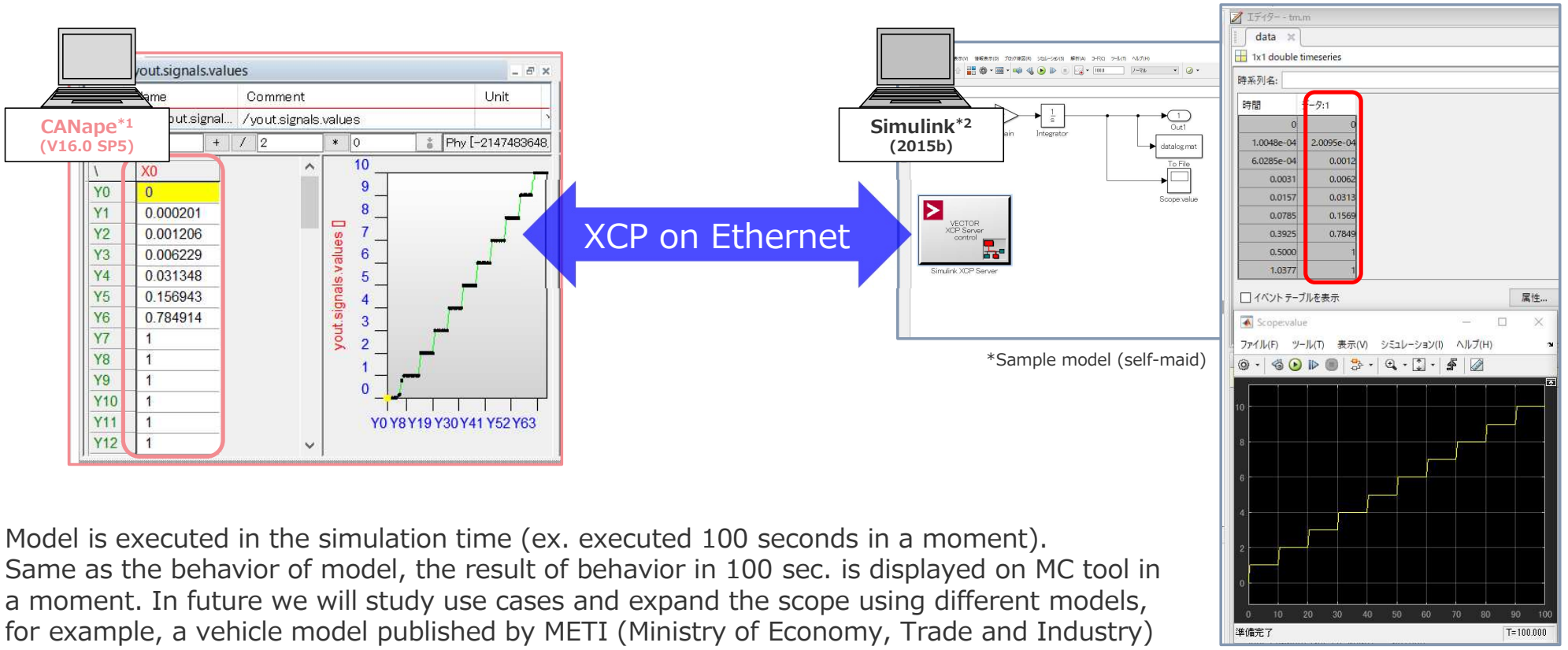


*1: Vector
*2: GAIO
*3: Synopsys

Trial status -MILS

- MILS : It is confirmed that MC tool can read/write the values of Simulink model.

*1: Vector
*2: MathWorks



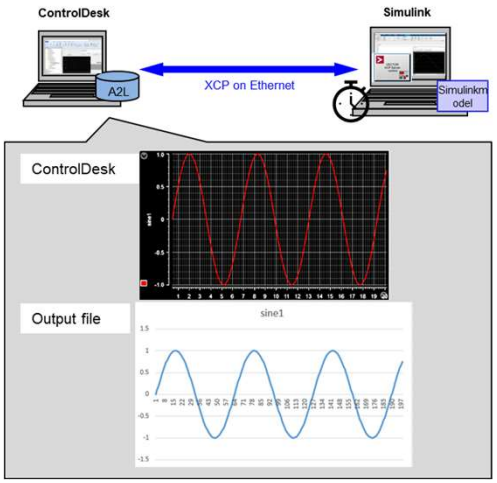
*Sample model (self-maid)

Model is executed in the simulation time (ex. executed 100 seconds in a moment).
Same as the behavior of model, the result of behavior in 100 sec. is displayed on MC tool in a moment. In future we will study use cases and expand the scope using different models, for example, a vehicle model published by METI (Ministry of Economy, Trade and Industry)

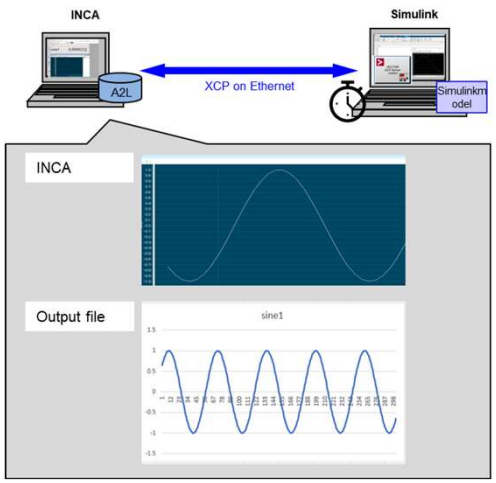
Req No.1 Sampling period
Req No.2 Parameter update

- **Evaluation setup :** Connect the PC with the MC tool and the PC with the Simulink model one-to-one using XCP on Ethernet.
- **Evaluation :**
  - Req No.1 : Measure output of Simulink model in XCP slave. Its measurement and update parameter is measured and For single XCP slave.
  - Req No.2 : Update data in the Simulink model in XCP slave.
  - Evaluate two cases which use 3 different MC tools.
- **Result :** Confirmed that Requirement No.1 and No.2 can be fulfilled.

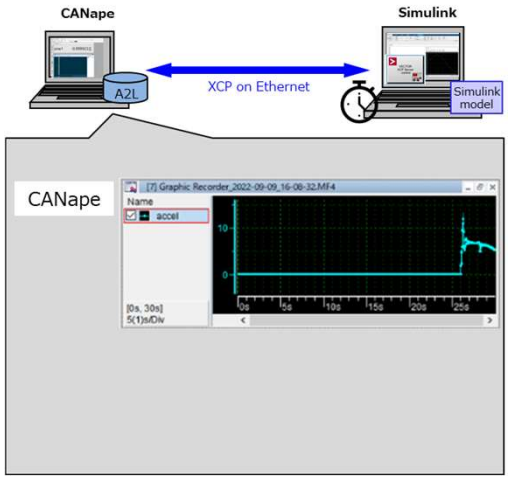
1. ControlDesk*1 + Simulink*2 XCP Server



2. INCA*3 + Simulink*2 XCP Server



3. CANape*4 + Simulink*2 XCP Server

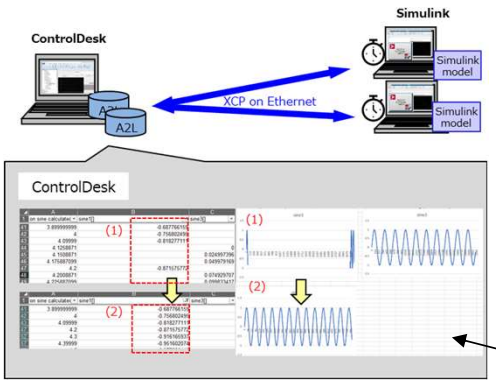


*1) dSPACE ControlDesk (6.0)
*2) MathWorks Simulink (Ver10.2 MC Add on 16.0.0)
*3) ETAS INCA (7.2.1)
*4) CANape (V16.0 SP5)

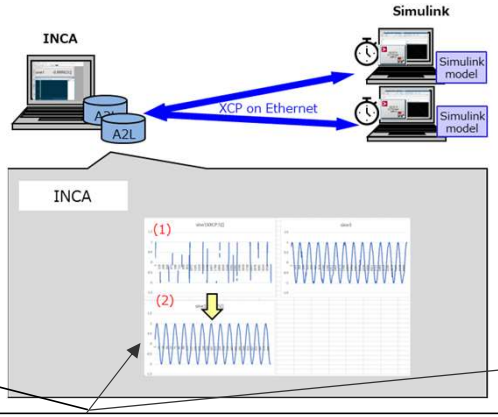
Req No.3 Same sample period
Req No.4 Different sample period
Req No.5 Different execution time

- **Evaluation Setup :** Connect the PC with the MC tool and two PCs with the Simulink model using XCP on Ethernet.
- **Evaluation :**
  - Req No.3 & No.4 : Measure output of Simulink models in two XCP slaves which use the same or different sampling period.
  - Req No.5 : Measure output of Simulink models in two XCP slaves which have different execution time.
  - Evaluate 3 cases. Each cases use different MC tool.
- **Result :**
  - Req No.3 & Req No.4 : In both cases models' outputs are measured but the time stamp is used from the one of the models.
  - Req No.5 : Measurement ends when one of the models stops running in one MC tool.

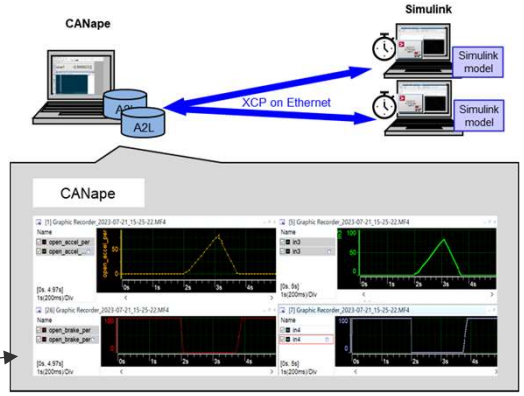
1. ControlDesk*1 + Simulink*2 XCP Server



2. INCA*3 + Simulink*2 XCP Server



3. CANape*4 + Simulink*2 XCP Server



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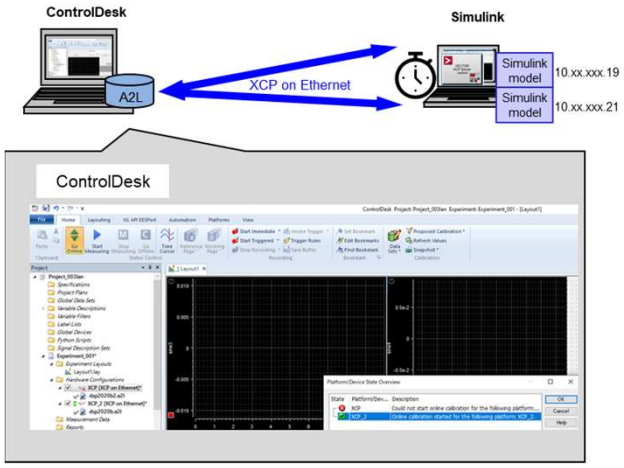
*3) ETAS INCA (7.2.1)
*4) CANape (V16.0 SP5)

- The measurement data itself is recorded, but the timestamp is incorrect.
- measurement ends when one of the models stops running in one MC tool.

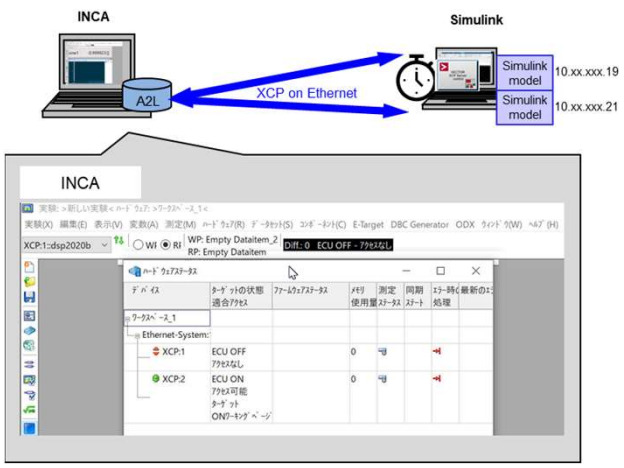
Req No.6 Use of individual IP addresses

- **Evaluation setup :** Connect the PC with the MC tool and the PC with the Simulink model one-to-one. Start instances of the two models, assign different IP addresses to each model, and run those models on a single PC..
- **Evaluation :**
  - Req No.6 : Check if MC tool can connect to the two Simulink model in XCP slave.
  - Evaluate 3 cases which use different MC tools.
- **Result :** Only one of the models can be connected to the MC tool, and it is not possible to access both models simultaneously.

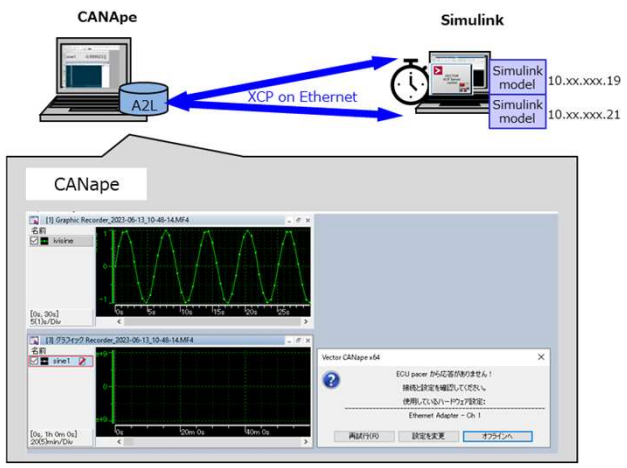
ControlDesk*1 + Simulink*2 XCP Server



INCA*3 + Simulink*2 XCP Server



CANape*4 + Simulink*2 XCP Server



*1) dSPACE ControlDesk (6.0)
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*3) ETAS INCA (7.2.1)
*4) CANape (V16.0 SP5)

Result summary

No.	Title	# of vECU models	SPILS	MILS			Remarks
			CANape	ControlDesk	INCA	CANape	
1	Sampling period	Single	✓	✓	✓	✓	
2	Parameter update		✓	✓	✓	✓	
3	Same sampling period	Multiple	✓	NG	NG	NG	Output of models' output are measured but the time stamp is used from the one of the models.
4	Different sampling period		✓	NG	NG	NG	Same as above.
5	Different execution time		TBE	✓	✓	NG	Measurement ends when one of the models stops running in one MC tool.
6	Use of individual IP addresses		TBE	NG	NG	NG	Only one of the models can be connected to the MC tool, and it is not possible to access both models simultaneously.

✓ : Requirement is satisfied.
TBE : To be evaluate.
NG : Requirement is not satisfied.

Result Summary (continue)

- MILS :
  - XCP slave is consists of Simulink model and XCP driver.
  - The measurement and update is made for a single XCP slave.
  - For multiple XCP slave, time stamp for XCP slave data is incorrect. And in case one of the model finished XCP stop measuring.
- SPILS :
  - SPILS tools are used in XCP slave.
  - The measurement and update is made for a single XCP slave.
  - For multiple XCP slave, the measurement and update is made as expected.

- Current XCP standard is not sufficient to apply to vECU, and it is difficult to apply current MC tools to vECU which complies with the standard.

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In conclusion

- In response to the advancement of S/W, it is expected that XCP can also be applied to vECU as well as actual ECU.
- Software-Defined Vehicles (SDVs) that require frequent software updates, the development of software using vECUs within the cloud will be necessary.
- And in the era of SDV, support for SoCs with multiple operating systems is required.
- The XCP is also used for AUTOSAR application development, and it would be required to support development using virtual environments.
- Further, support for the virtual environut would be useful for the digital-twins which target both physical ECUs and vECUs.

- Towards solving the issues, it is expected initiatives including solution providers, tool vendors, suppliers, OEMs as they are cross-boundary issues of them.
- Studying has also begun in 3V-SG. It is anticipated that development of the technologies for XCP are achieved through collaboration.
- We should establish it as the XCP standard for the SDV era.
- ASAM, would you have any plan?

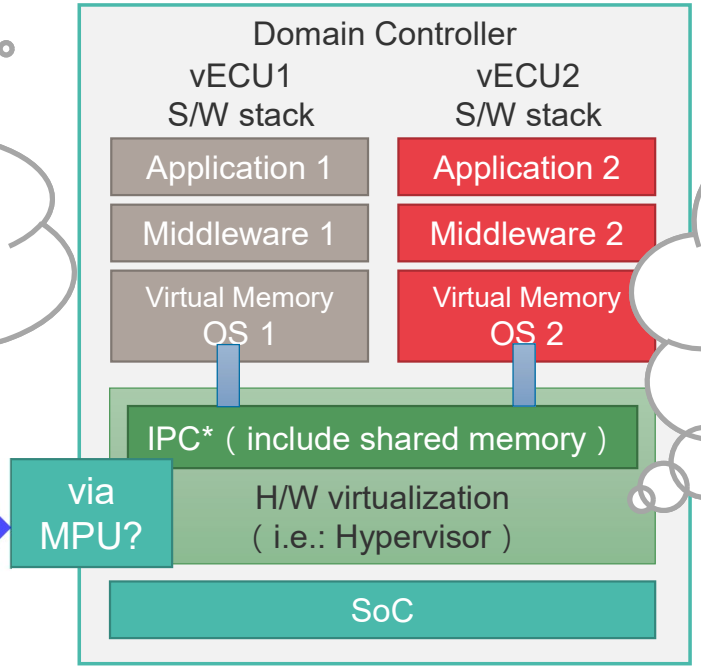
ASAM XCP for Integrated ECU on 1 SoC

Monitor Calibration for Integrate ECU using vECU

Emulator of 1 SoC multiple OSs

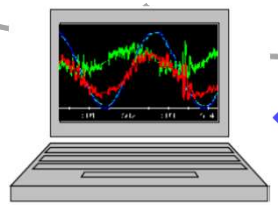
1. Assume emulator which runs multiple OSs in single SoC are available.

A SoC which implements integrated ECUs and monitor-calibration for the SoC



MCD-1 XCP

2. I/F between MC tool and ECU/emulators;
   - Conventional framework using memory addresses will be suitable? (Applying XCP to a generic OS that has **dynamic memory allocation** is the challenge)
   - CAN, Ethernet or any other transport layer?



MC tool

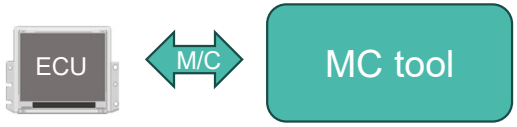
MCD-2 MC (ASAP2/A2L)

3. How to create A2L DB file?
   - It is needed as much as number of VMs? Hypervisor also needs DB file?
   - How to describe in the case of generic OS that has dynamic memory allocation.

*) IPC : Inter Process Communication

XCP for SDV and Digital twin era

- Current：Measurement/Calibration of a real ECU.



- Apply MC tools for Measurement/Calibration of SDV and digital-twin.

M/C : measurement and calibration