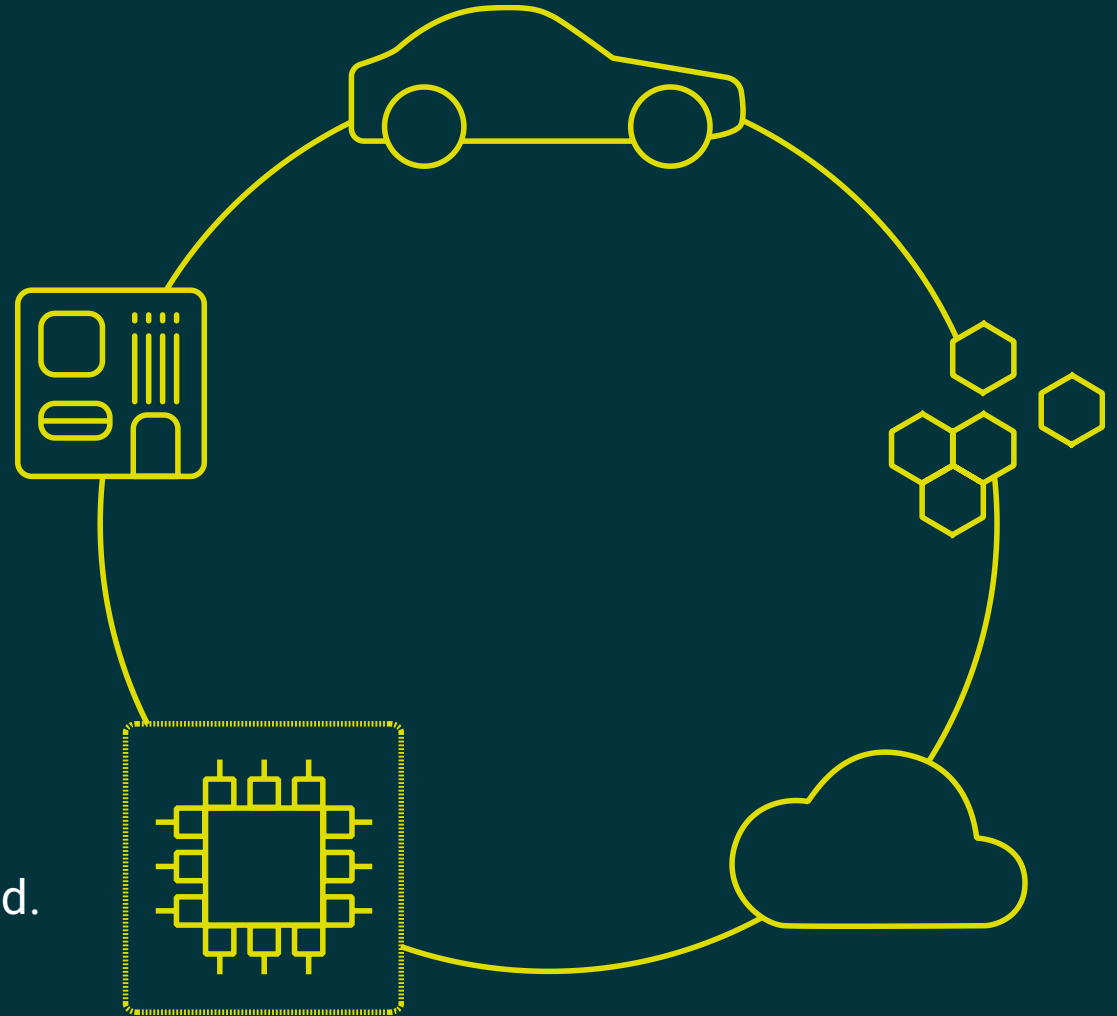




# Internet of Vehicles Platform

**Astemo**

Tasuku ISHIGOOKA  
Technology Development Division, Hitachi Astemo, Ltd.  
September 21, 2023



## Contents

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1. Company Introduction
2. Hitachi Astemo's Vision for Software-Defined Vehicle
3. Approach: Internet of Vehicles Platform
4. Conclusion

Hitachi Astemo was born in January 2021 from the merger of

Hitachi Automotive Systems, Keihin, Showa and Nissin Kogyo with the strengths and abilities to make significant contributions to safety, comfort, and environmentally sustainable technologies for mobility.

Hitachi Automotive Systems

**KEIHIN**

**SHOWA**

**NISSIN**

are integrated to be

# Hitachi Astemo



We will realize safe and comfortable mobility through technological innovation in CASE area



AD/ADAS



Powertrain Systems  
(Electric / Engine)



Chassis Systems



Motorcycle Systems



Connected



Software



Aftermarket



Power Products  
Industrial Equipment

## Advanced driver assistance ECU and high-definition map position unit adopted in Nissan's new model "SKYLINE"

**Tokyo, September 8, 2020** --- Hitachi Automotive Systems, Ltd. today announced that their advanced driver assistance ECU (Electronic Control Unit) and high-definition map position unit capable of automatic map updates via OTA (Over The Air)\*1 has been adopted in Nissan Motor Corporation's (hereinafter "Nissan") new model "SKYLINE", which went on sale in September 2019, for the first time.



Advanced driver assistance



High-definition map position unit

<https://www.hitachi.com/New/cnews/month/2020/09/200908.html>

## AD ECU and OTA Unit Adopted in New Model Legend -Capable of Over-the-Air (OTA) Vehicle Control Software Updating-

**Tokyo, April 26, 2021** --- An AD ECU\* capable of updating vehicle control software and an OTA Unit that receives and manages update data, both developed by Hitachi Astemo, Ltd. as "over-the-air (OTA) software update solutions", have been adopted by the new model Honda Legend, which is equipped with a traffic jam pilot function that achieves Automated Driving Level 3 and was released in March by Honda Motor Co., Ltd. (President and Representative Director: Toshihiro Mibe) The solutions have been realized with the technologies of the Hitachi Group as one-stop solutions that establish a platform from a data center (OTA Center) that sends software updates to the in-vehicle device system.

\* AD ECU: Autonomous Driving Electronic Control Unit



AD ECU and OTA Unit Adopted by New Model Legend

<https://www.hitachi.com/New/cnews/month/2021/04/210426.html>

## Contents

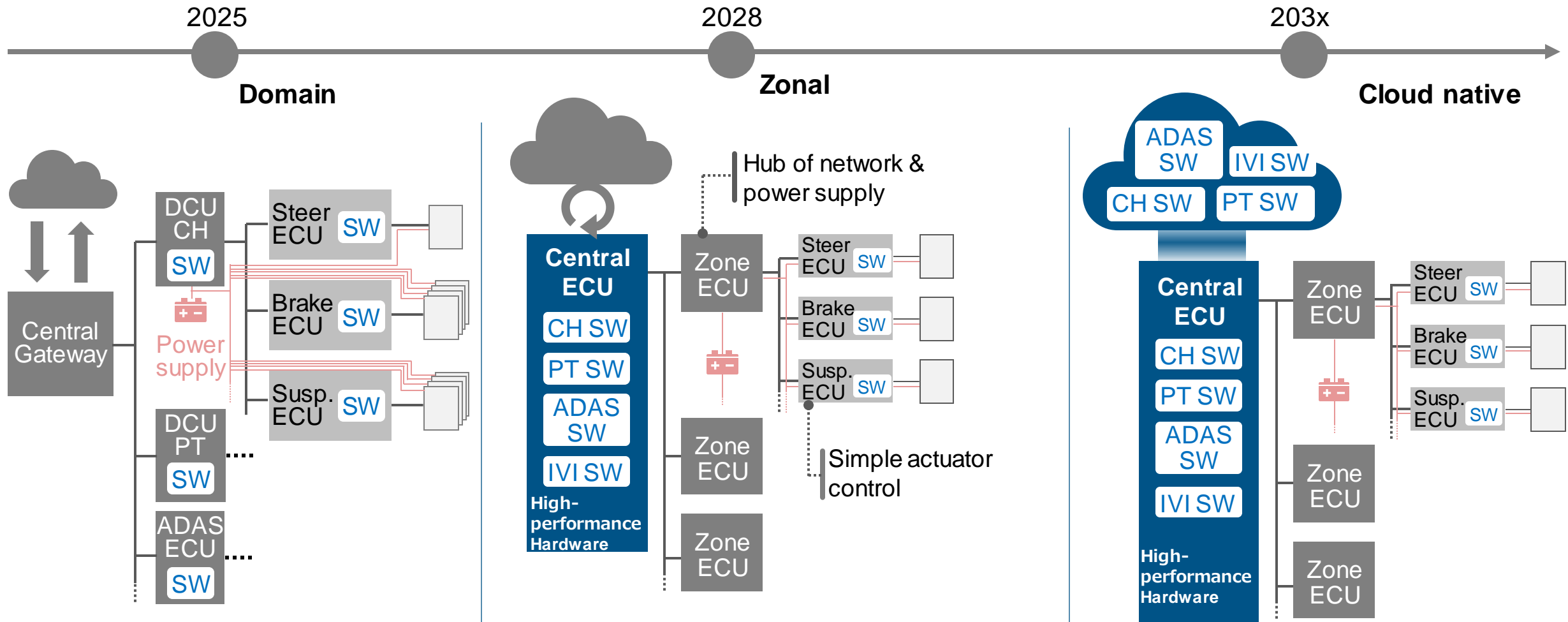
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1. Company Introduction
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# 2-1. Market Trend [Architecture]

- E/E Architecture is evolving from distributed to **centralized, accelerating HW/SW decoupling**
- **Evolving performance & functionality by software, achieving above on high-performance HW**

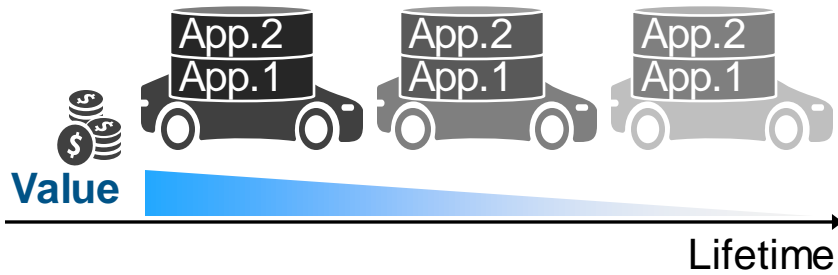


# 2-2. Market trend [Software-Defined Vehicle]

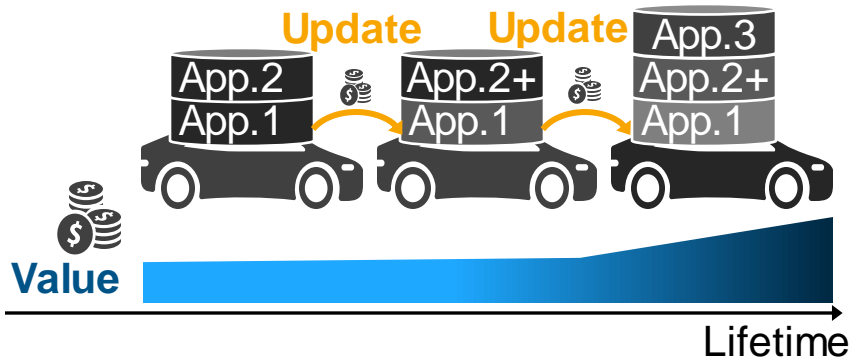
- As user needs diversify, the business model is **shifting to continuous improvement model**.
- Monozukuri is transforming to DevOps. Fast update for new value is important, **SW first SDV is key**.

## Change of automotive business

### Sell-out business

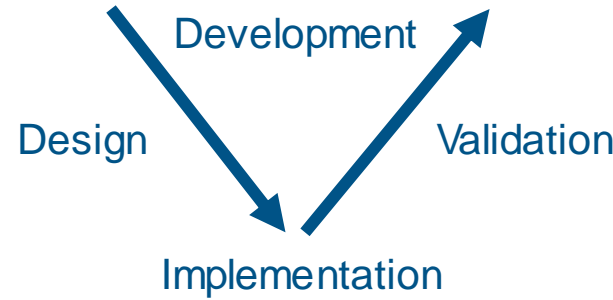


### Recurring business

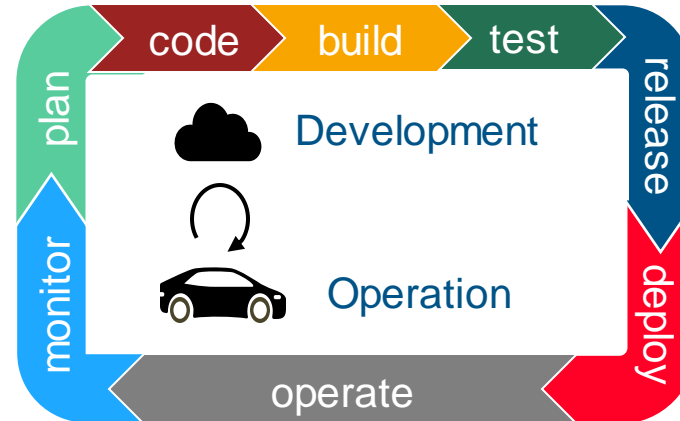


## Transformation of Monozukuri (Development Process)

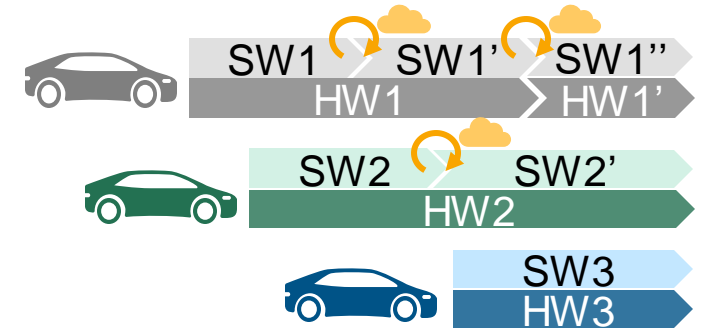
### V-process



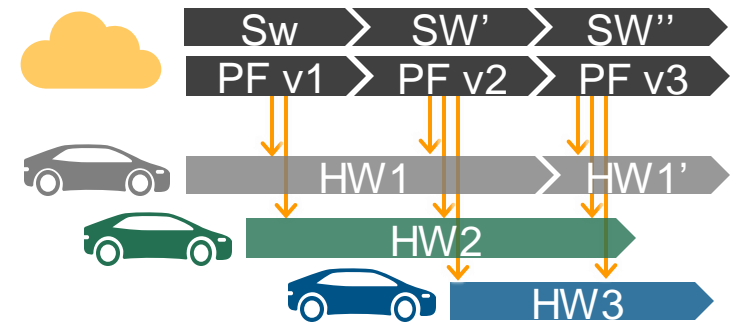
### DevOps



## Hardware-Defined Vehicle



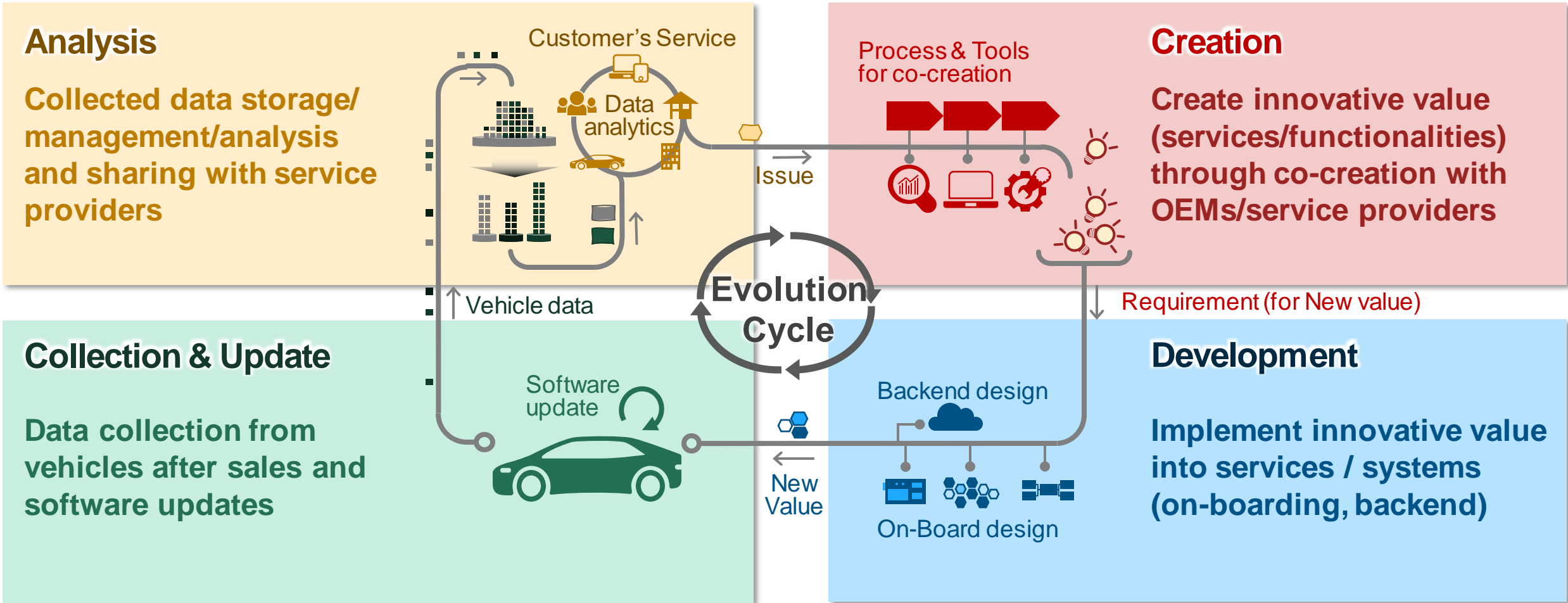
## Software-Defined Vehicle





# 2-3. Vision: Vehicle Evolution

- Defined the **essential functions as: Collection→Analysis→Creation→Development→Update.**
- For following the change of user needs, **a platform that can accelerate this cycle is necessary.**



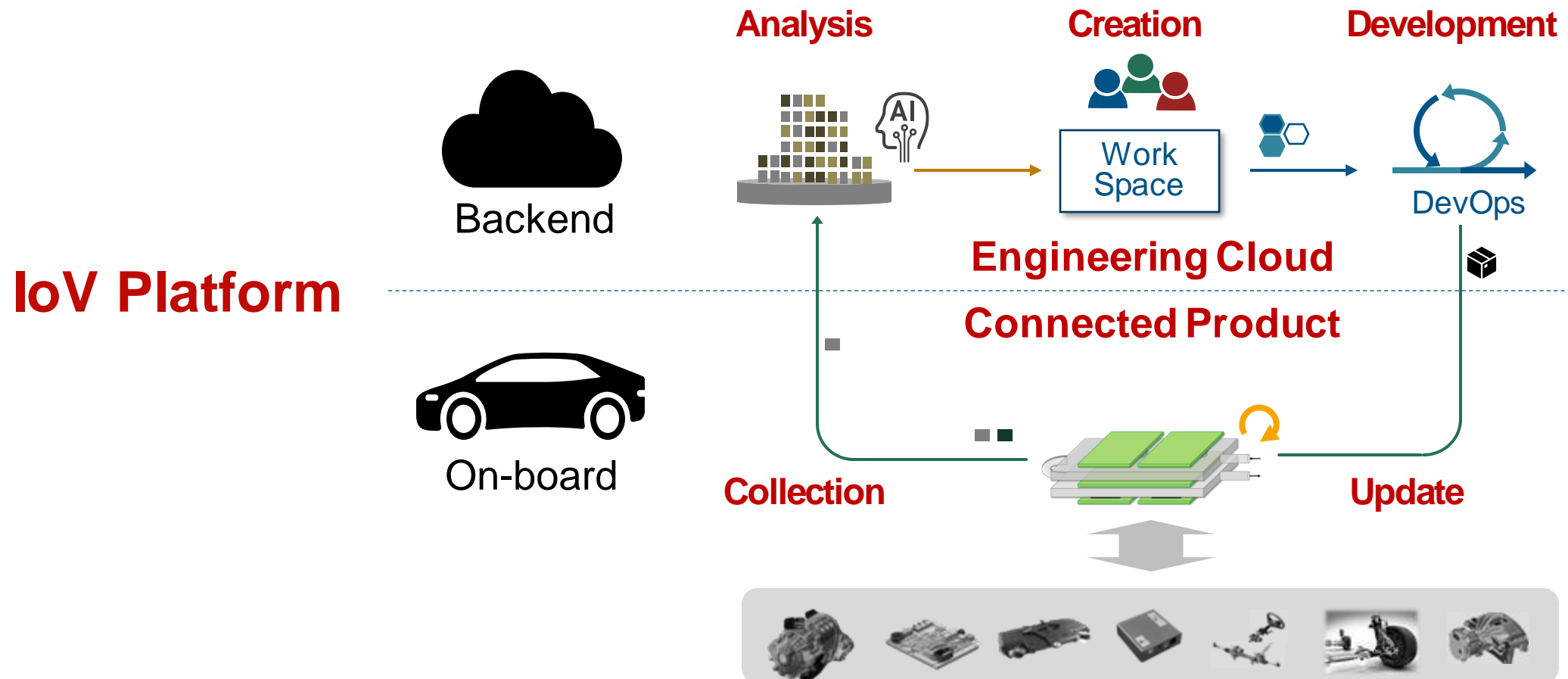
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- 3. Approach: Internet of Vehicles Platform**
4. Conclusion

# 3-1. Approach: IoV (Internet of Vehicles) Platform

- Platform to realize the cycles (collection, analysis, creation, development, update) for vehicle evolution through on-board and backend collaboration
- IoV platform will enable the continuous evolution of vehicles and a growing cycle to drive higher profits for OEMs and Astemo.



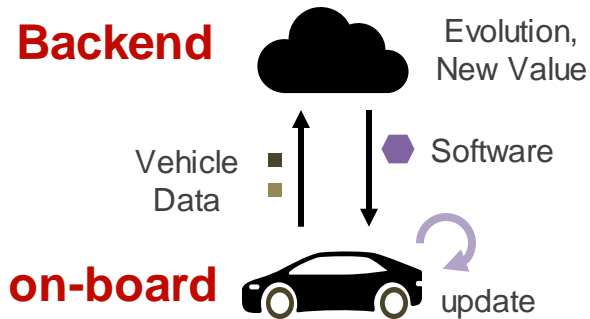
# 3-2. IoV Platform Concept

- IoV Platform is provided as a **reference platform and customizable** by OEM & service provider demand.
- Enable co-creation of new product & service and **acceleration from PoV & PoC to mass production.**

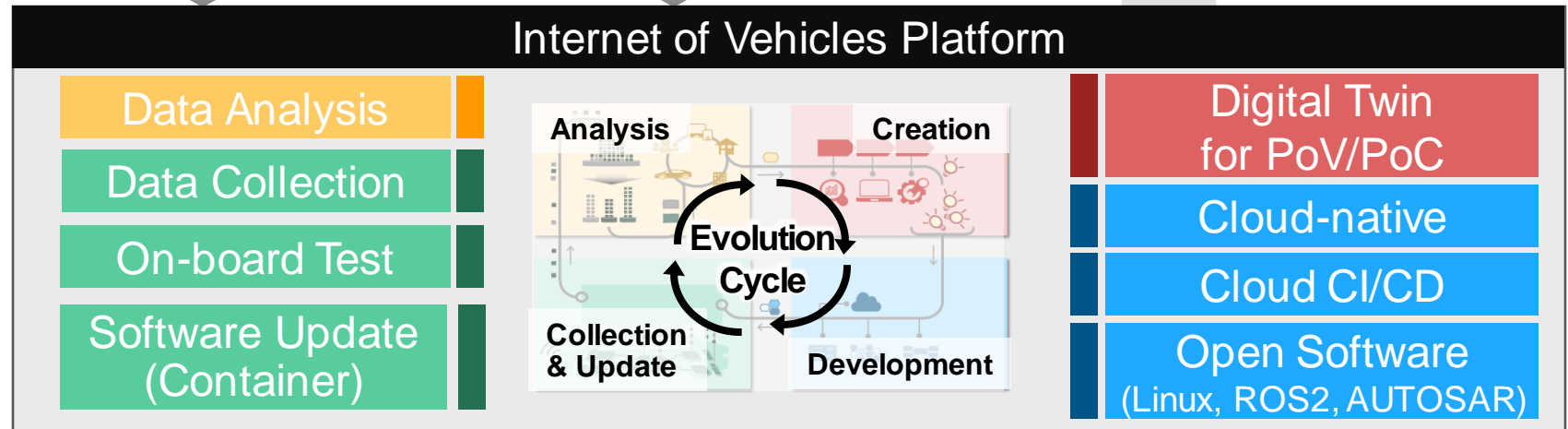
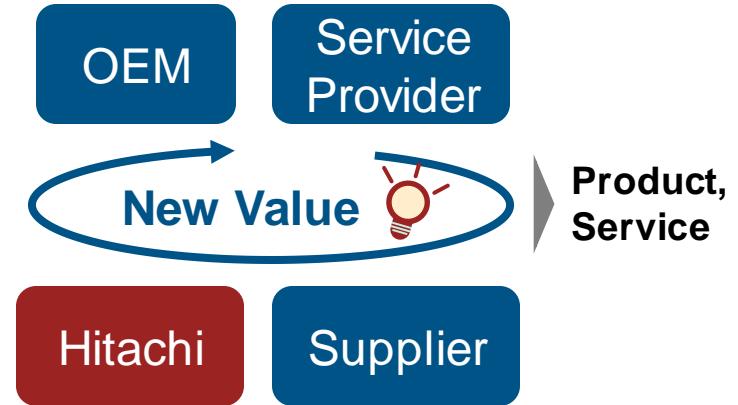
## Features

- 1 On-board x Backend**  
Astemo OT x Hitachi IT
- 2 Zero-Day Start**  
Reference Platform & Customization
- 3 Software First Dev.**  
Digital Engineering
- 4 Life Cycle Support**  
PoV/PoC – Mass Production – Next
- 5 Open Platform**  
Community, Data Business Support

## Vision: Updatable Vehicle

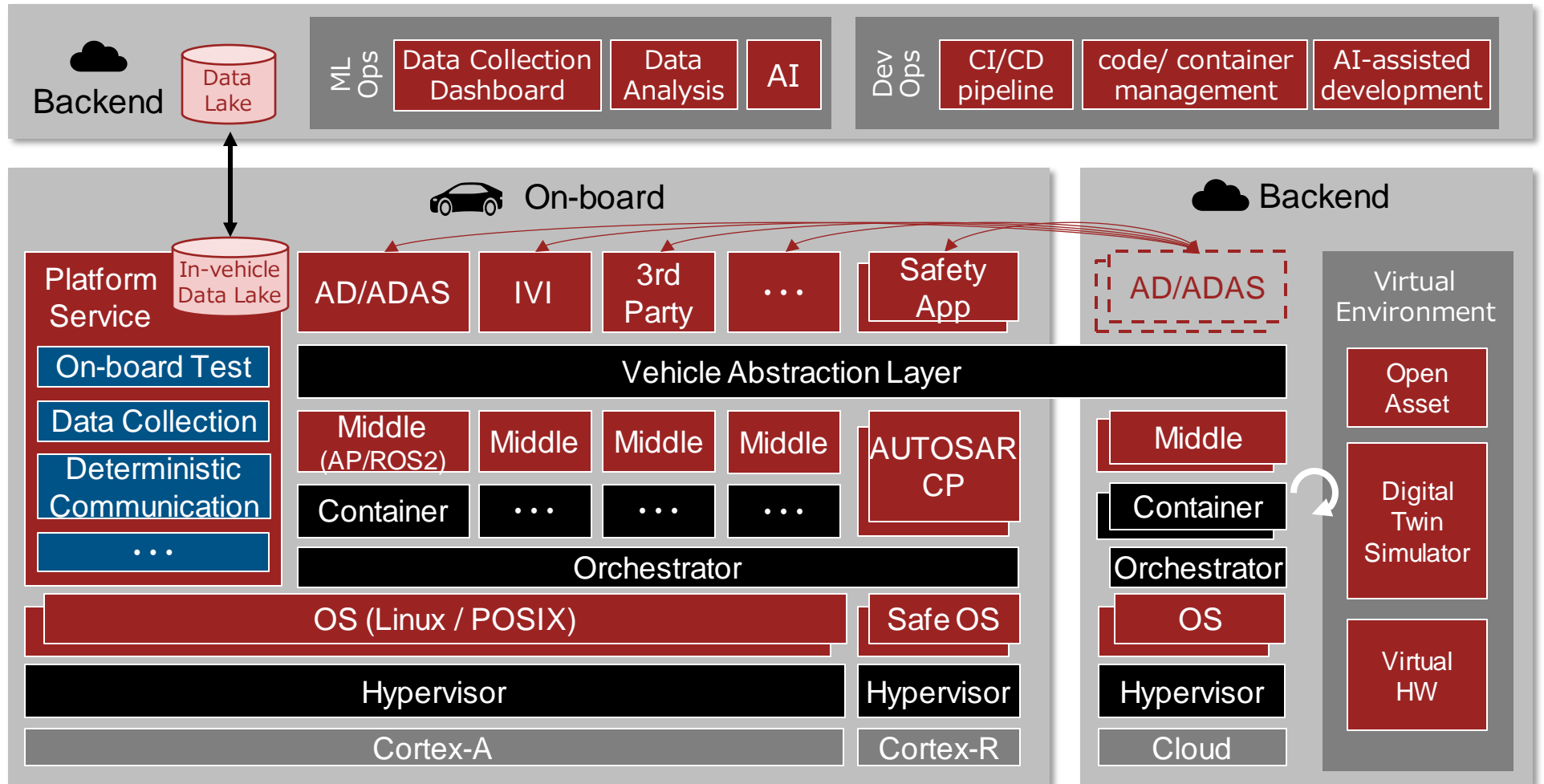
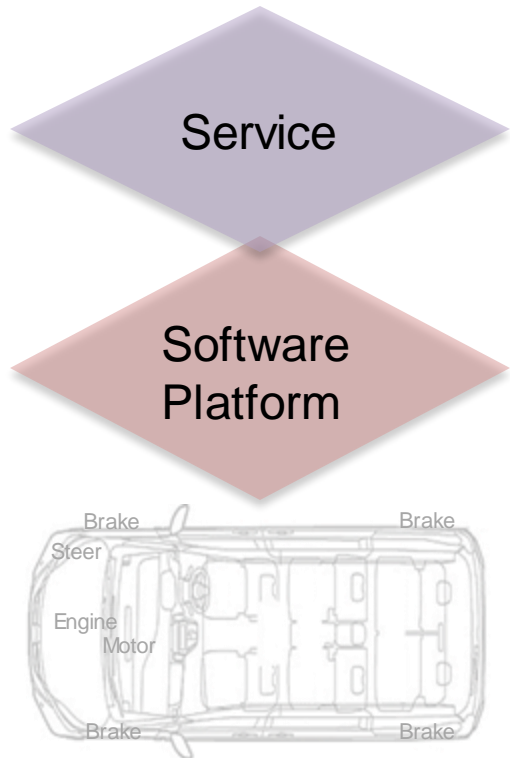


## Co-creation



# 3-3. IoV Platform: Software Architecture

- **Cloud-native** Software Architecture for SDV to realize Updatable Vehicle
- IoV PF is referring to **SOAFEE / Eclipse SDV** and provides **platform services as extension**.

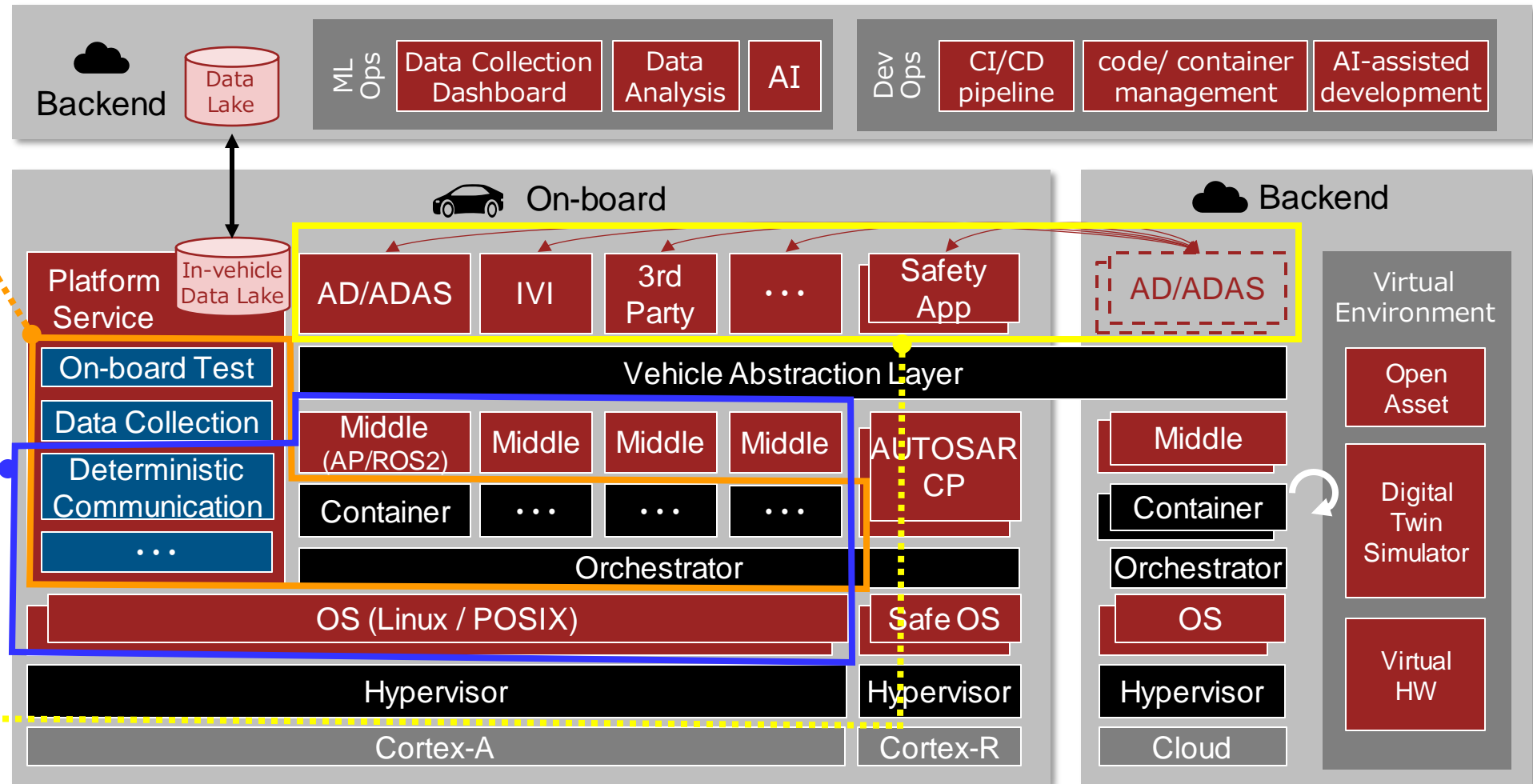


# 3-4. IoV Platform: Use-Case

1. On-board Testing

2. Seamless Deploy with Determinism

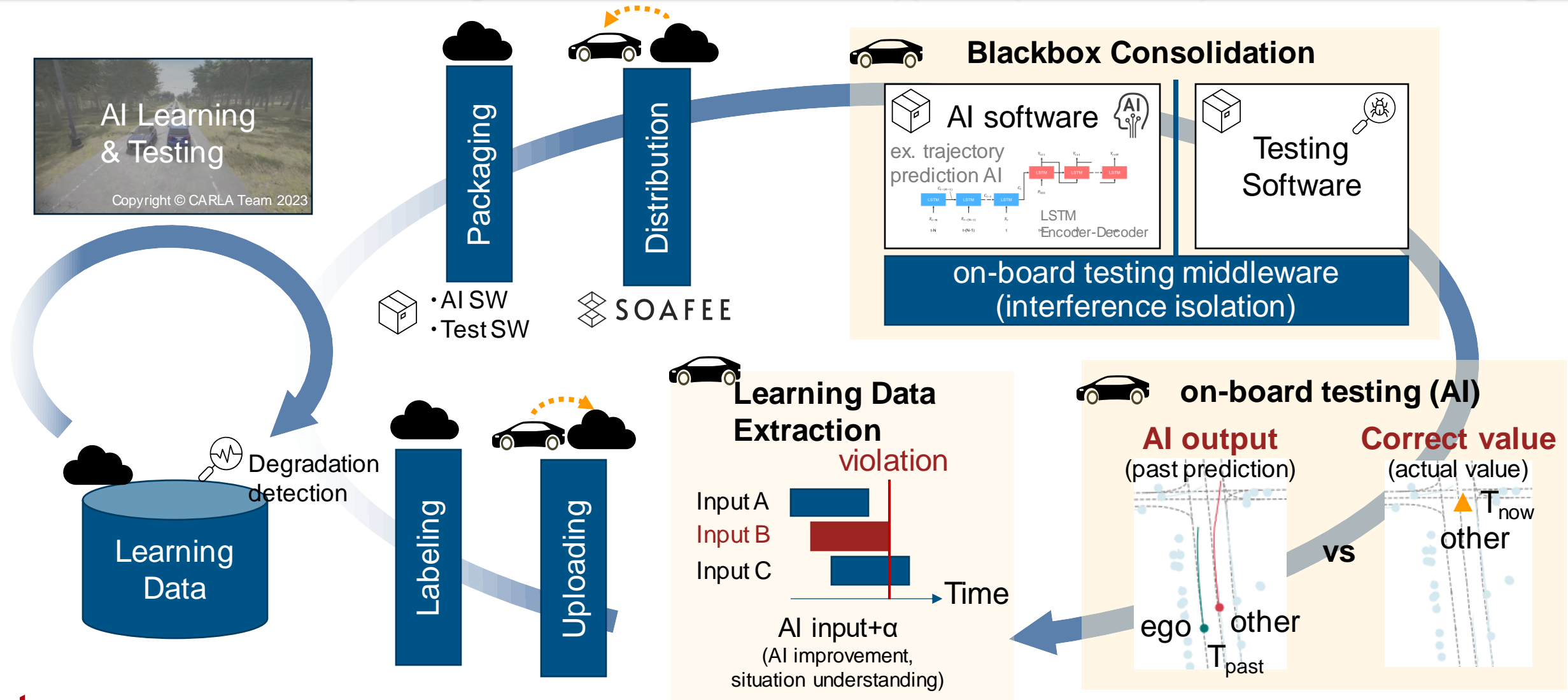
3. ECU Function Offload





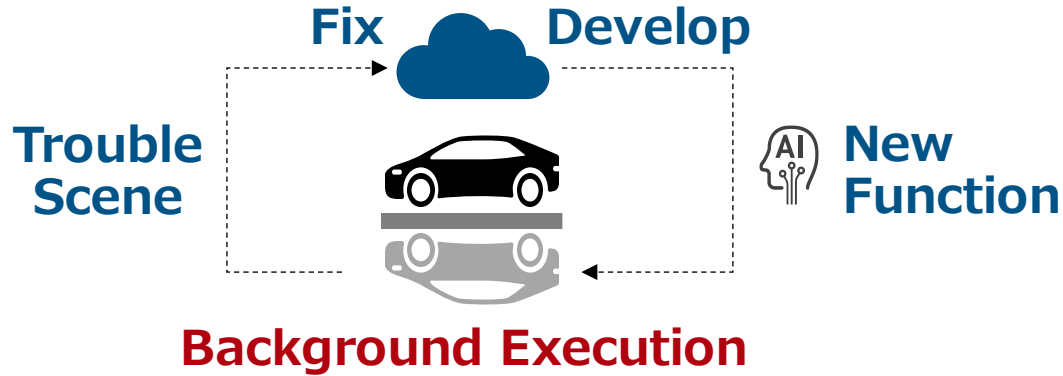
# 3-5. IoV Platform: Overview of MLOps

■ After AI is well tested in backend, it's distributed by container. On-board testing MW enables that testing software can test AI by utilizing sensor value. If AI error happen, input data is uploaded for re-learning.

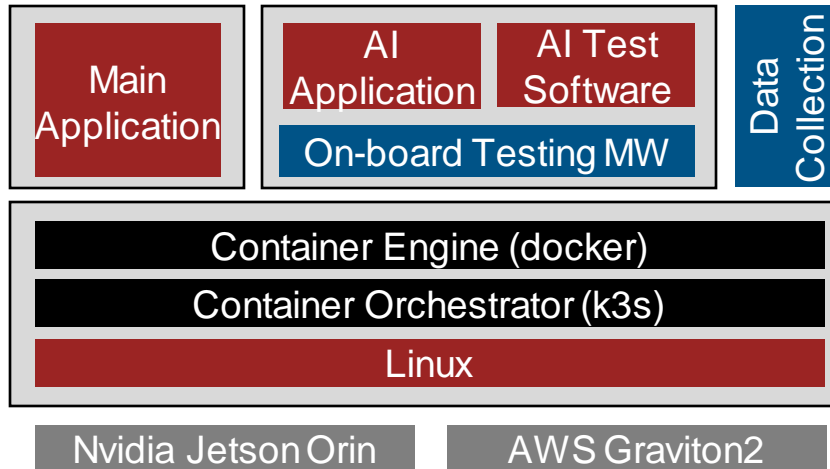
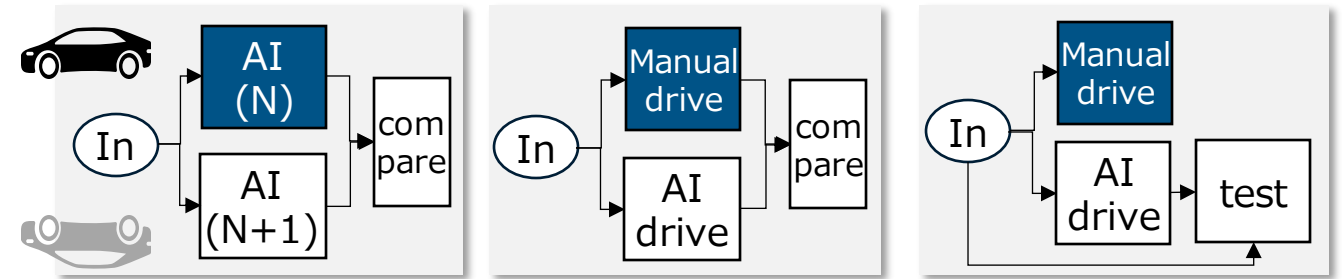


# 3-6. On-board Testing: Overview

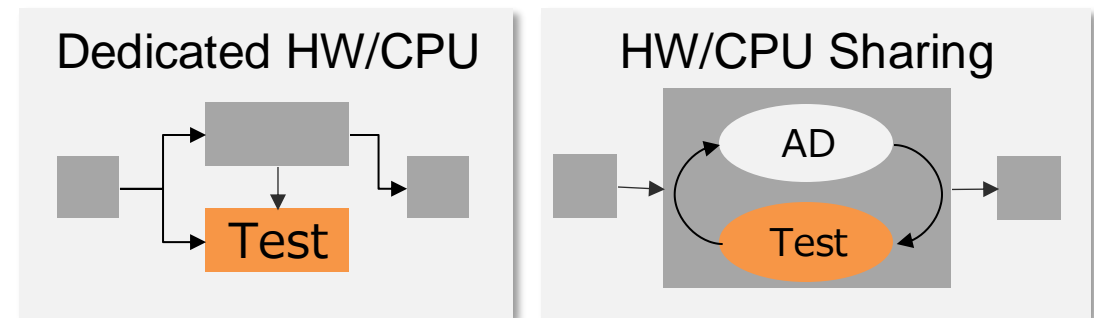
- On-board testing middleware enables to **test new functions in user's vehicle**.
- On-board testing technologies can accelerate software development.



## Use case (Example: AI)

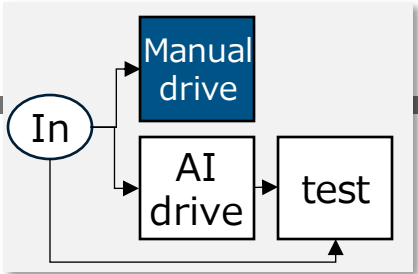


## Architecture



**SOAFEE** powered by **aws**

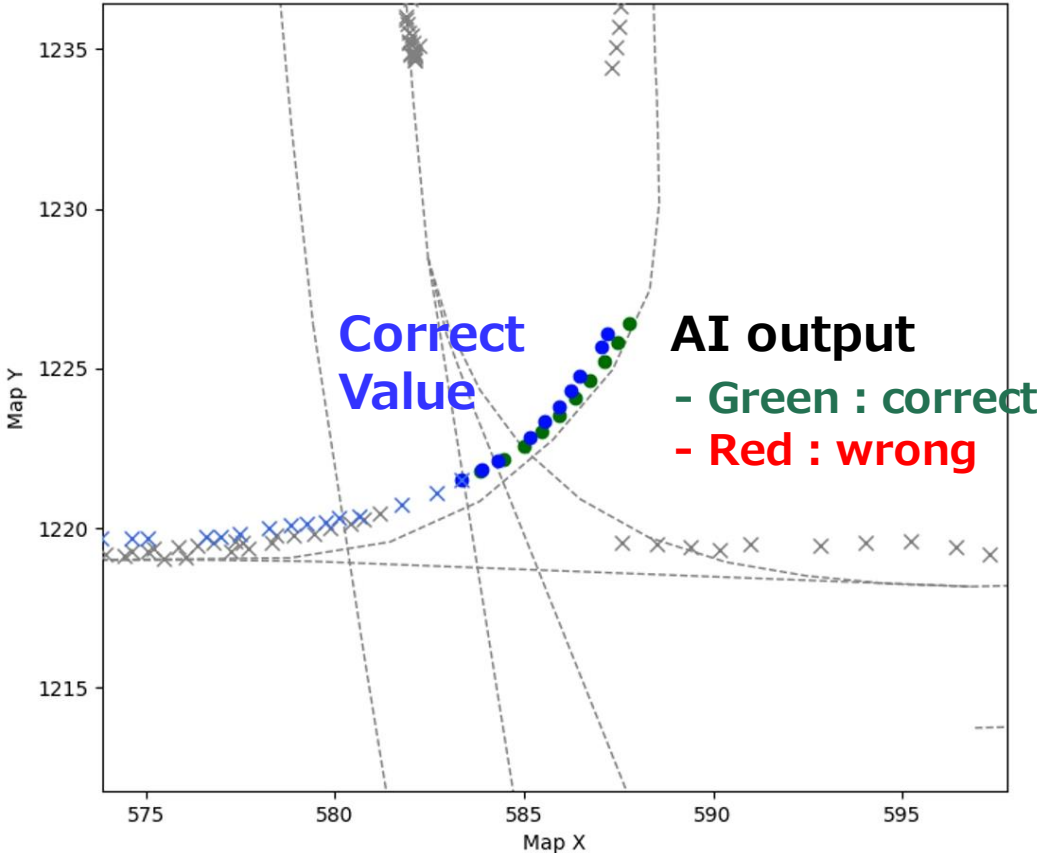
# 3-7. On-board Testing: Example



Before Update

Ex. Trajectory Prediction AI

After Update

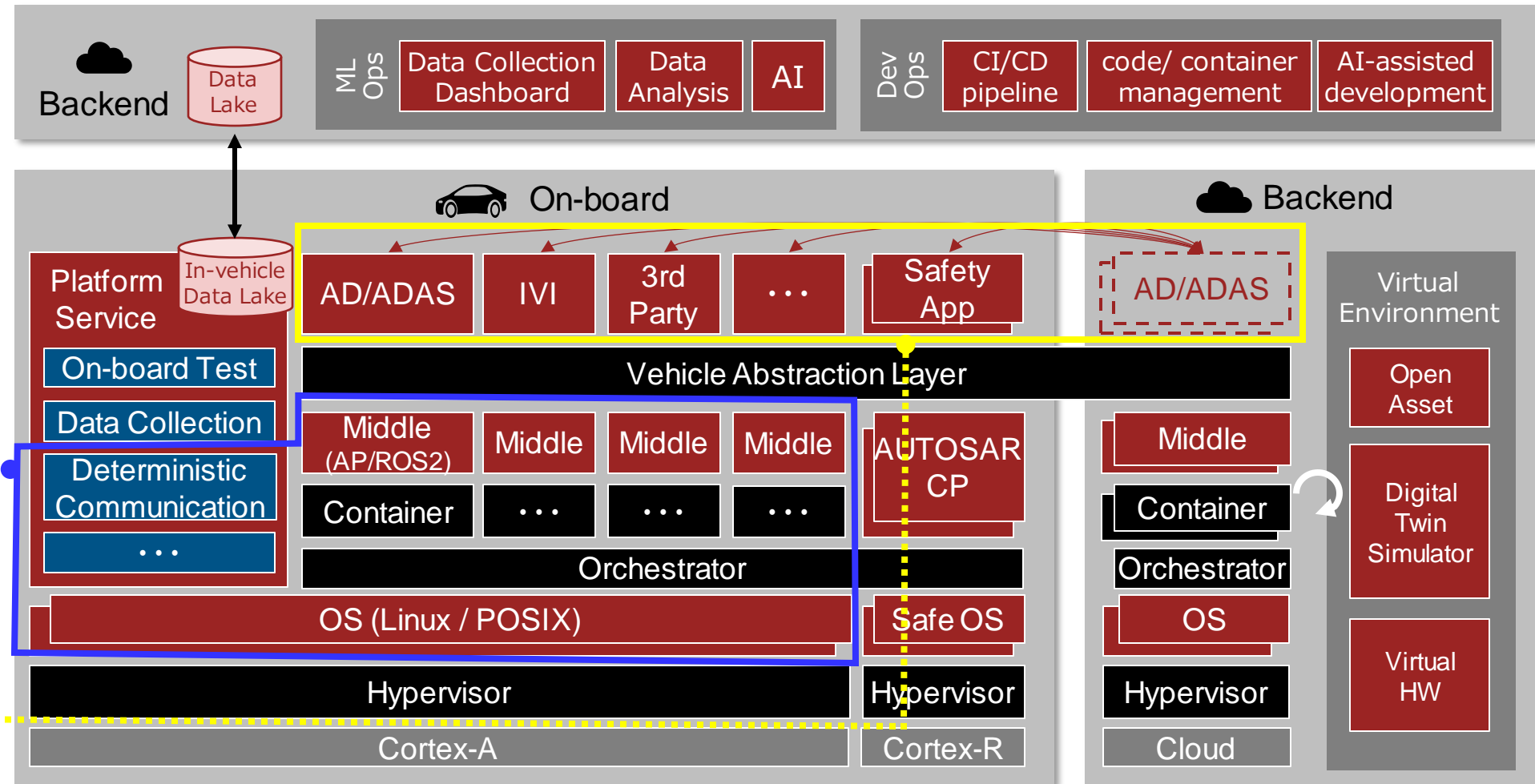


# 3-8. IoV Platform: Use-Case

1. On-board Testing

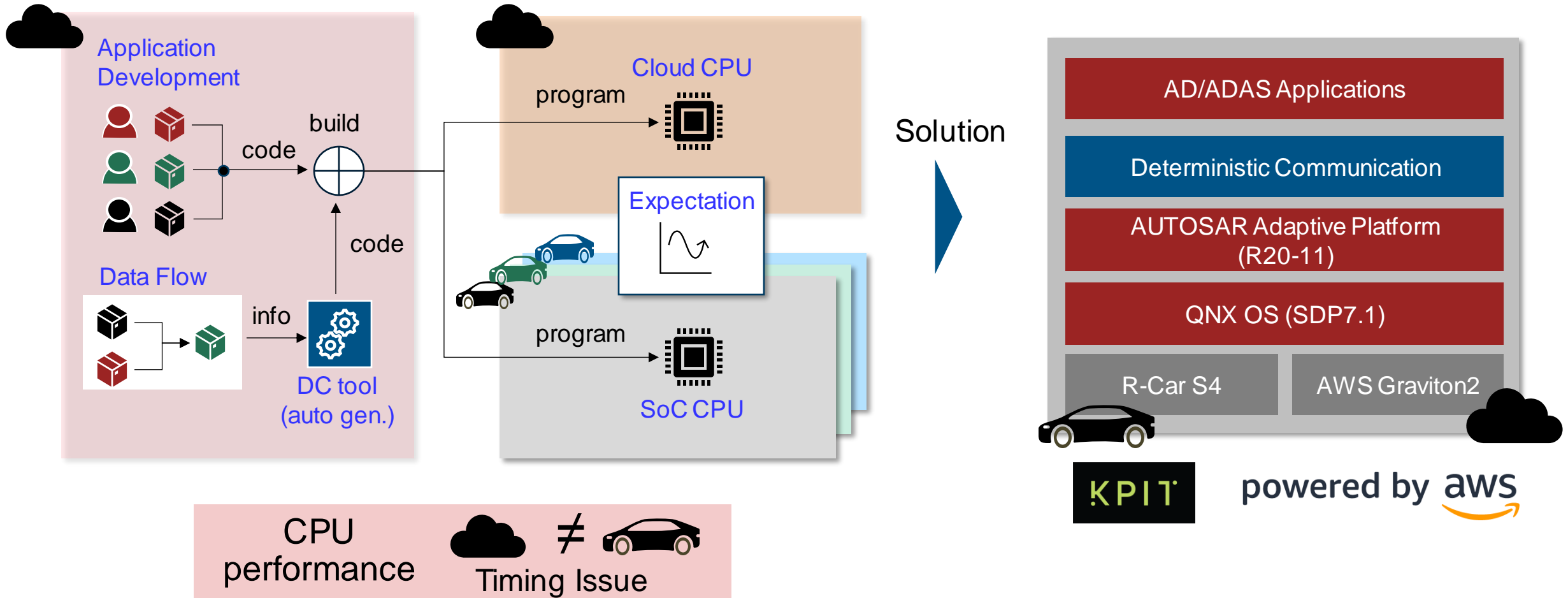
2. Seamless Deploy with Determinism

3. ECU Function Offload



# 3-9. Seamless Deploy with Determinism: Overview

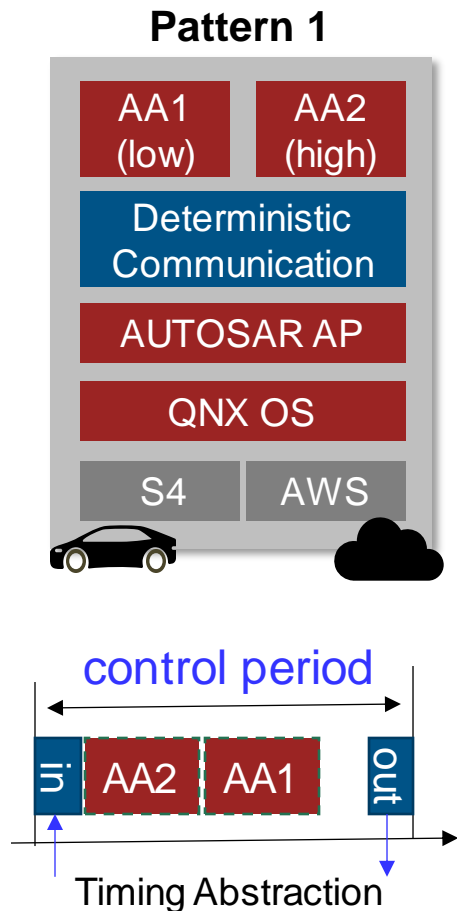
- In cloud-native development, various users develop and test in cloud. After test, software is deployed.
- There is **timing issue between on-board and backend**. We propose **Deterministic Comm** as a solution.



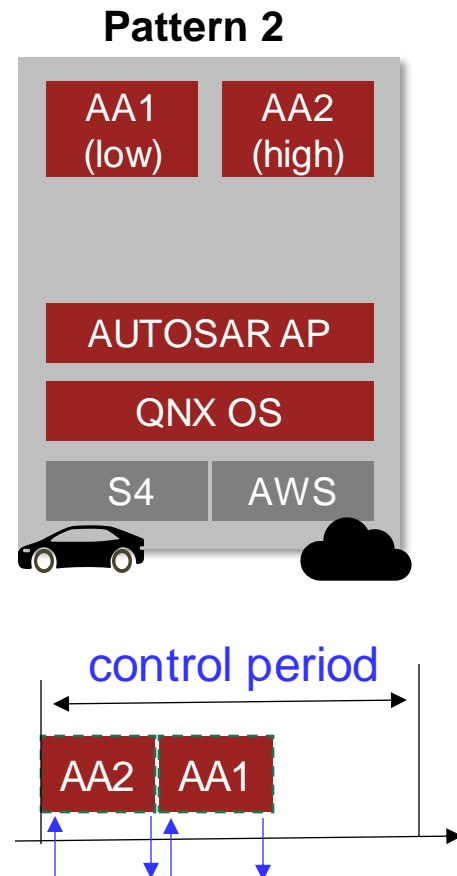
# 3-10. Seamless Deploy with Determinism: Prototype

- Developed and Evaluated a prototype. **Confirmed deterministic comm realize timing gap reduction.**
- Expect the technology contributes to **efficient software development** with seamless deploy.

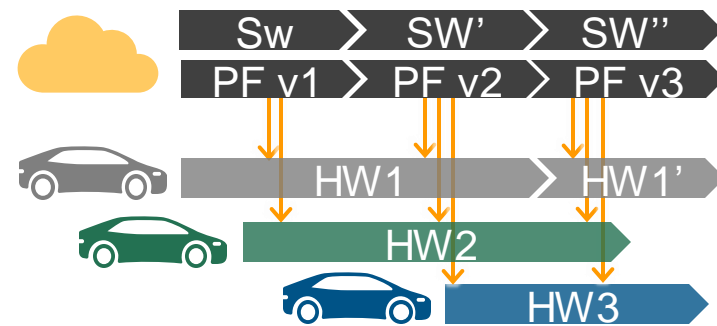
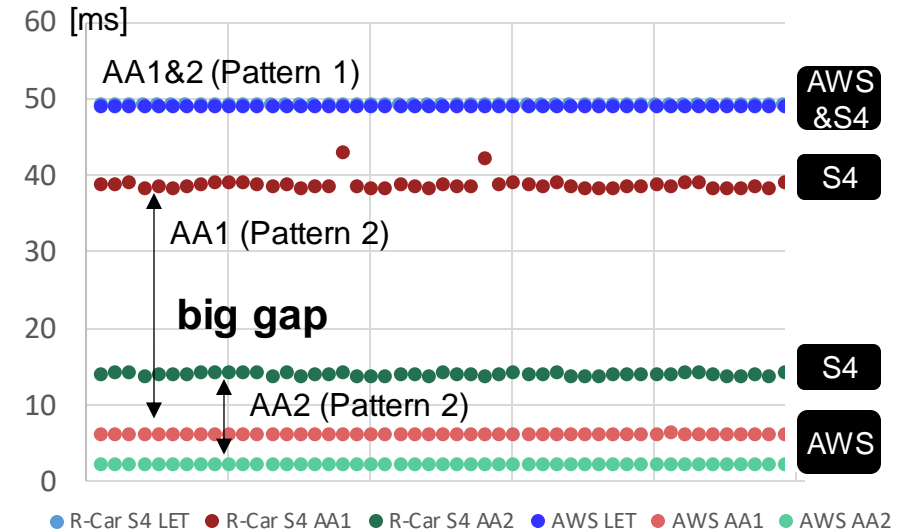
## Evaluation Setup



AA: Adaptive Application



## Results (output timing)



Will publish latency reduction method in 2023 JSAE Annual Congress (Autumn)

**Satisfy period requirement for any HW and SW**

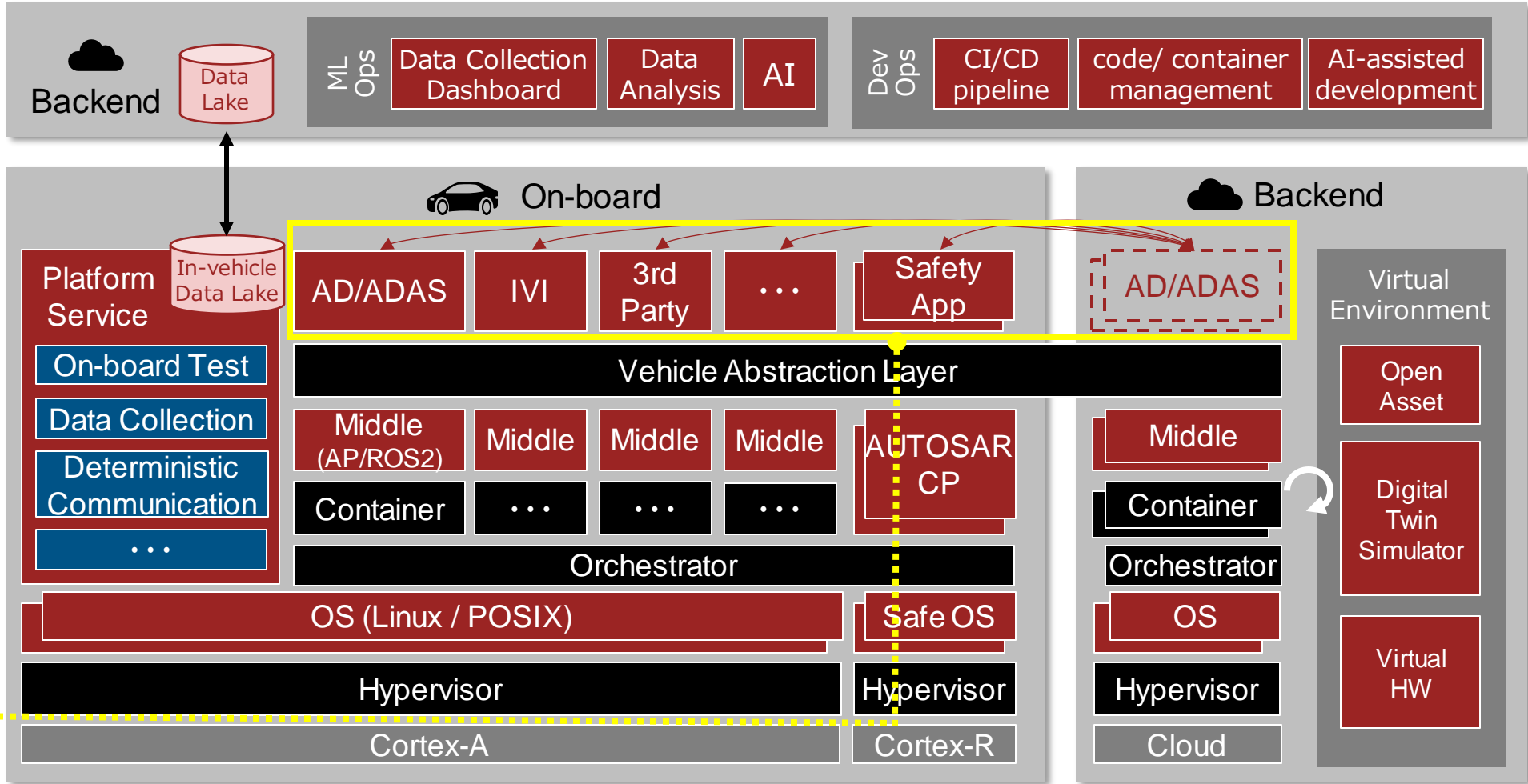


# 3-11. IoV Platform: Use-Case

1. On-board Testing

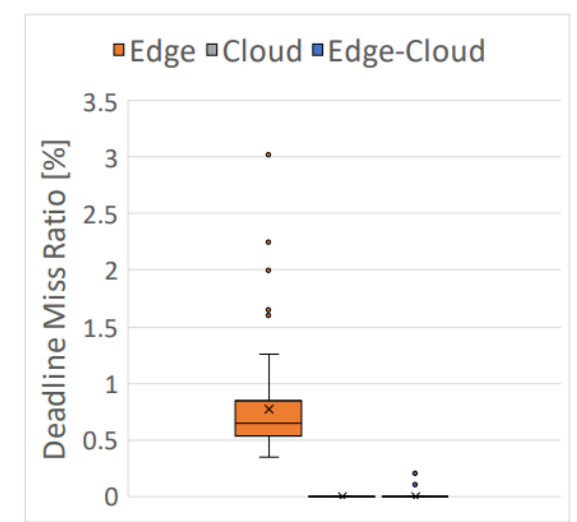
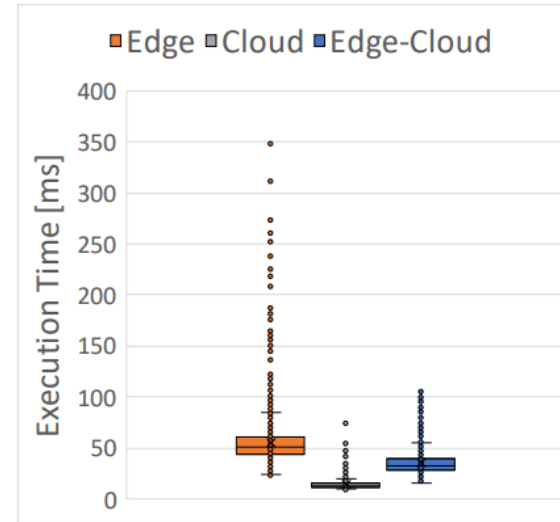
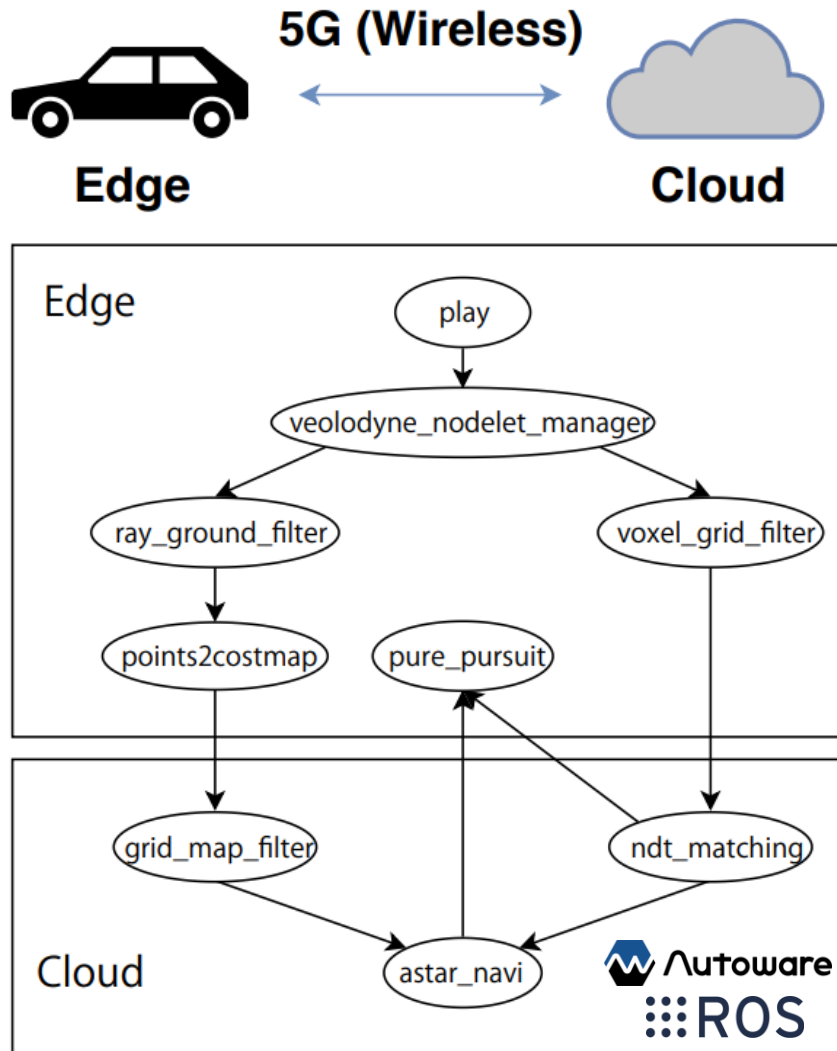
2. Seamless Deploy with Determinism

3. ECU Function Offload



# 3-12. ECU Function Offload: Overview

■ We investigated edge-cloud computing architecture using ECU function offload based on Autoware/ROS.



**Faster and more stable**

## An Edge-Cloud Computing Model for Autonomous Vehicles

Yu Sasaki<sup>1</sup>, Tomoya Sato<sup>1</sup>, Hiroyuki Chishiro<sup>1</sup>,  
Tasuku Ishigooka<sup>2</sup>, Satoshi Otsuka<sup>2</sup>, Kentaro Yoshimura<sup>2</sup>, and Shinpei Kato<sup>1,3</sup>

*Abstract*— Edge-cloud computing for autonomous driving has been a challenge due to the lack of fast and reliable networks to handle a large amount of data and the traffic cost. The recent development of 5th Generation (5G) mobile network allows us

Another distributed model, CVN, is a model where multiple vehicles create a wireless link network, called Vehicular Ad hoc Networks (VANETs) [5], through which vehicles share data and computational resources. Although CVN has

11th IROS Workshop on Planning, Perception, Navigation for Intelligent Vehicle (PPNIV 2019)

# 3-13. ECU Function Offload: Prototype

Collaborative  
with



**HITACHI**  
Inspire the Next



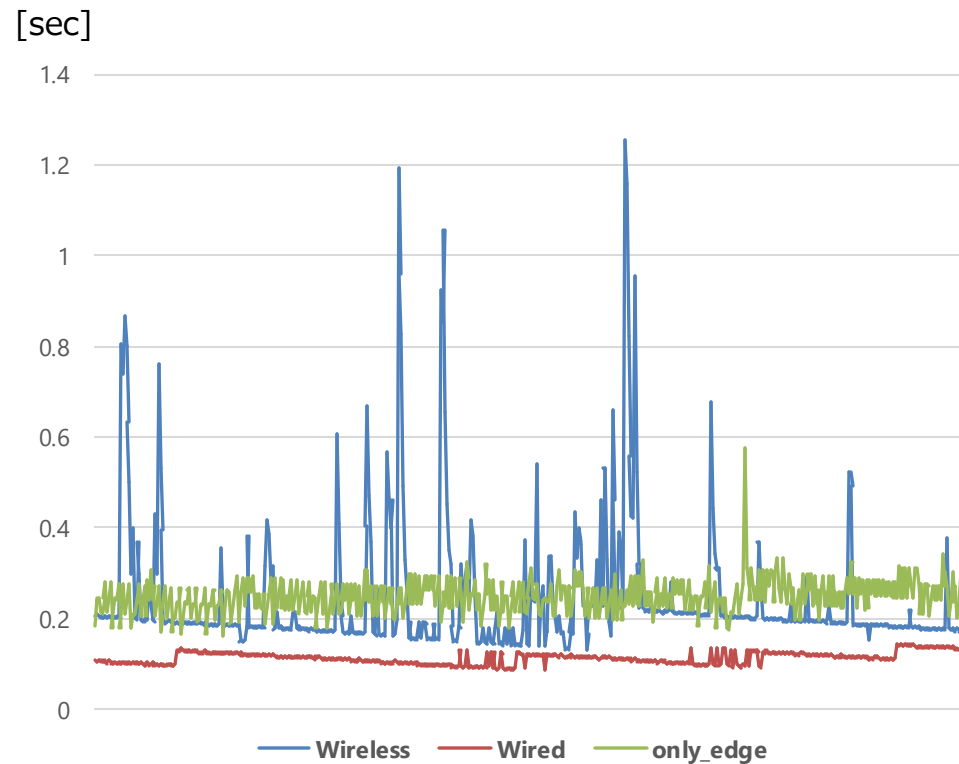
 AutoWare  ROS

@ Hitachi Research Laboratory

# 3-14. ECU Function Offload: Lessons Learned and Next

- Under the stable communication situation, edge-cloud computing is effective way for load balancing.
- For unstable wireless communication, we proposed a safety architecture and a method to improve real-time performance. We will enhance this know-how and will try ECU function offload in cloud or MEC.

MEC: Multi-access Edge Computing

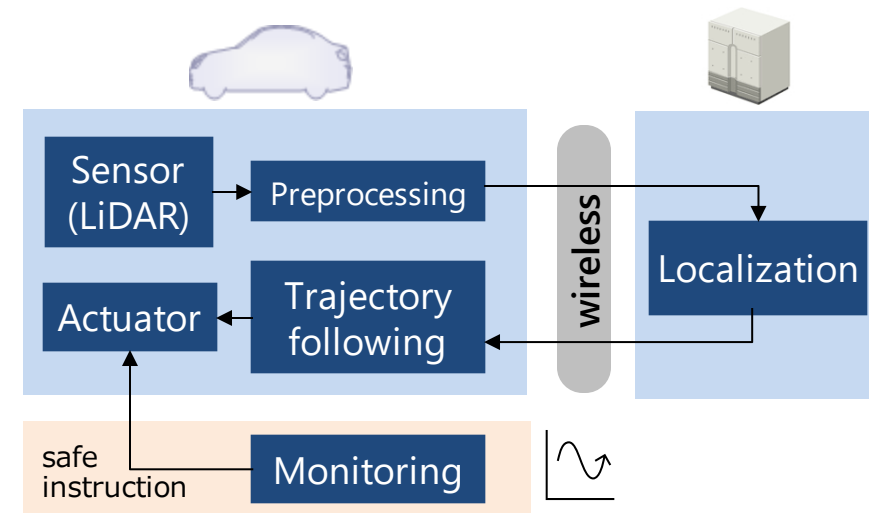


## A middleware protocol for time-critical wireless communication of large data samples

Jonas Peeck\*, Mischa Möstl\*, Tasuku Ishigooka†, Rolf Ernst\*  
\*TU Braunschweig, Institute of Computer and Network Engineering, Braunschweig, Germany  
{peeck|moestl|ernst}@ida.ing.tu-bs.de  
†Hitachi Ltd., Research & Development Group, Ibaraki, Japan  
tasuku.ishigoka.kc@hitachi.com



- 42nd IEEE Real-Time Systems Symposium (RTSS 2021)
- IEEE Transactions on Vehicular Technology (VT 2023)



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We introduced “Hitachi Astemo’s Vision for Software-Defined Vehicle” and “Internet of Vehicles(IoV) Platform”.

- IoV Platform Concept
- Use-case
  - ✓ On-board testing
  - ✓ Seamless Deploy with Determinism
  - ✓ ECU function offload

We welcome further SOAFEE collaboration partner.



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Inspire the Next 