An Intent-Based Management Framework for Software-Defined Vehicles in Intelligent Transportation Systems


Jaehoon (Paul) Jeong* and Yiwen (Chris) Shen
Sungkyunkwan University, South Korea
Email: {pauljeong, chrisshen}@skku.edu

July 23, 2024
Vancouver in Canada
Outline

• Background: Software-Defined Vehicles (SDV)
• Motivation
• Intent-Based Management (IBM) for SDV
  • SDV in ITS
  • An Example of an SDV Platform
  • Life Cycle of IBS for SDV in ITS
  • Intent-Based Management (IBM) for SDV
  • Interfaces in the IBM Framework for SDV
  • Applications of IBM for SDV
• Proof-of-Concept by Hackathon Project
• Next Steps
Background: Eclipse Software-Defined Vehicle (SDV)

- Continuous Integration and Deployment (CI/CD)

https://www.eclipse.org/org/workinggroups/sdv-charter.php
Background: AUTOSAR Platform

[AUTOSAR Classic Platform]
https://www.autosar.org/standards/classic-platform

[AUTOSAR Adaptive Platform]
https://www.autosar.org/standards/adaptive-platform
Background: SOAFEE Building Blocks

• The Scalable Open Architecture for Embedded Edge (SOAFEE)

https://www.soafee.io/
Motivation

• Intent-Based Networking (IBN) driven by
  • Complexity of networks,
  • Scale,
  • Cost and efficiency,
  • Dynamic environments, and
  • Security.

• Automotive industry also having a fundamental transformation:
  • Traditional distributed → Central/Zone architecture.
  • Ethernet-based IP backbone in-vehicle networks.
  • Managing applications and network functions in SDV become a challenge.

• Integrating IBN and SDV for a better management

Figure: Transition of Vehicular Architecture
SDV in ITS

• Shifting to SDVs is also a new paradigm in Intelligent Transportation Systems (ITS).

• The SDVs can interact with each other via Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications (e.g., Edge Servers) for safe driving and infotainment services.

• Figure 1 shows an architecture of vehicular networks for SDVs. They can communicate with Edge Servers and Vehicular Cloud by IP Road-Side Unit (IP-RSU), e.g., gNodeB in 5G [TS-23.501].
An Example of an SDV Platform

• Automotive Apps:
  • ADAS (Advanced Driving Assistant System),
  • LKA (Lane Keep Assistant),
  • AEB (Automatic Emergency Brake), etc.

• Network Functions
  • Routers
  • Switches
  • Hubs, etc.

Figure 2: A Vehicular Platform for SDV
Life Cycle of IBS for SDV in ITS

- Integrating IBN and SDV for a better management
- According to the Life Cycle of IBN [RFC9315], we show the Life Cycle of an Intent-Based System (IBS) for SDV management.
- Each space is further divided into two sections, Fulfillment and Assurance.
Intent-Based Management (IBM) for SDV

- Intent-Based System (IBS) is designed for SDV, as shown in Figure 6.

- Vehicular Cloud (VC) receives an **intent** from SDV User and translates it into a **high-level policy**.

- The Cloud Controller in VC sends the translated **high-level policy** to the SDV Controller in a target SDV.

- The SDV Controller converts the high-level policy into the **low-level policy** for SDV.

- Eventually, **Service Functions (SF)** are the selected entities for a particular service.

Figure 6: Intent-Based Management (IBM) Framework for SDV
Interfaces in the IBM Framework for SDV

- Interfaces between a pair of system components in the Vehicular Cloud and SDV:
  - Consumer-Facing Interface
  - Controller-Facing Interface
  - SF-Facing Interface
  - Registration Interface
  - Monitoring Interface
  - Analytics Interface
  - Analyzer-Facing Interface
  - VMS-Facing Interface
  - Database Interface

- The interfaces can be designed by YANG.

Figure 6: Intent-Based Management (IBM) Framework for SDV
Applications of IBM for SDV

• IBS for Applications in SDVs
  • SDV applications can include safe driver (e.g., AI driver) for an autonomous vehicle and navigator for a human driver.

• Examples:
  • An automotive company needs to upgrade and install new applications on a group of automobiles sold to customers, i.e., over-the-air (OTA) update.
  • An SDV Intent User in the automotive company can issue a request like “Please upgrade and install <application A> to the cars.”
Proof-of-Concept by Hackathon Project
ietf120-hackathon-interface-to-in-network-functions-i2inf/

- **SDV User**
  - Make an intent (e.g., SDV monitoring) and send it to Cloud Controller.

- **Service Function (e.g., Powertrain ECU)**
  - Perform the requested service (e.g., SDV monitoring data delivery)
  - Deliver Monitoring Data to Cloud Analyzer
Next Steps

• Polishing the Document
  • The authors will polish up the text with the comments from the OPSAWG in terms of both description and maturity.

• Enhancement of the Document
  • The authors will technically enhance the Sections through the IETF Hackathon Project.

• Adoption Call
  • If the OPSAWG think this draft to be a timely appropriate topic with interests, may I ask for Adoption Call for the development of this draft in the OPSAWG?