An Intent-Based Management Framework for Software-Defined Vehicles in Intelligent Transportation Systems
(draft-jeong-opsawg-intent-based-sdv-framework-00)

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Main Ideas of the Draft (1/2)

- **Objectives**
  - This draft proposes a **Framework and Interfaces of Intent-Based Network Management** for **Unified Configuration and Monitoring Interfaces** of Networks, Security, and Applications in **Software-Defined Vehicles (SDVs)**.

- **IBN Testbed**
  - **5G Testbed for Intent-Based SDV Management Framework** with Free5GC, Kubernetes, OMNeT++, SUMO, and Matlab Simulink for AUTOSAR.

- **Plan for Implementation**
  - We will design and implement the IBN Testbed through **IETF Hackathon Project** this year (i.e., IETF-120 and IETF-121).

- **Design Choice**
  - We will design the interfaces of the SDV management framework with **YANG** and **NETCONF/RESTCONF** through the experience in the I2NSF WG work.
Main Ideas of the Draft (2/2)

- **Encountered Problems and Lessons**
  - The design and implementation of Intent Translation Engine (e.g., Intent Translator) is challenging with two different-level YANG data models.
  - We will use our experience of I2NSF Security Policy Translator:
    - I-D: [draft-yang-i2nsf-security-policy-translation-16](#)

- **Positioning regarding IBN Propositions in Other SDOs**
  - Focus on South-bound Interfaces for an SDV’s in-vehicle network for Other SDOs (e.g., CAMARA, TM Forum, and GSMA).

- **Remaining Challenges and Problems**
  - Intent Translation Engine with LLM (Large-scale Language Model).

- **Next Steps**
  - We will set up an SDV Framework Testbed and make an Intent Translator.
Introduction

- Software-Defined Vehicle (SDV)

Related Work: AUTOSAR

[Source] [https://velog.io/@kiw0224/Autosar-Base-Software-BSW](https://velog.io/@kiw0224/Autosar-Base-Software-BSW)
Related Work: COVESA (Connected Vehicle Systems Alliance)

[Source] https://covesa.github.io/vehicle_signal_specification/introduction/overview/
Related Work: Eclipse SDV

[Source] https://sdv.eclipse.org/
Vehicular Networks for Software-Defined Vehicles

Vehicular Cloud

Traffic Control Center

IP RSU-1

IP RSU-2

Edge Server-1

Edge Server-2

V2I Link

V2I Link

V2V Link

SDV-1

SDV-2
Intent-Based Management Framework for SDVs

- **Unified Configuration Interfaces** for Networks, Security, and Applications
  - IPv6 Network Prefixes
  - Default Gateways
  - DNS Servers
  - Network Security Policies
  - SDV Applications (e.g., Navigator and Autonomous Driver)

- **Unified Monitoring Interfaces**
  - ECUs in SDVs
  - Network Functions
Components
- Member Modules in Vehicular Cloud or SDV

Interfaces
- Communication Messages for two components
- Protocols: REST API, NETCONF, and RESTCONF
- Documents: XML and YAML

Intent-Based Management
- Intent Translator in Cloud
- Policy Translator in SDV
- Closed-Loop Control
Intent Translator is a key function for Intent-Based Network Management.
This draft proposes an **Intent-Based Management Framework** for Networks, Security, and Applications in SDVs.

- It can support **Mobile Object Network Management (MONM)** including SDVs, UAV (Unmanned Aerial Vehicle), and UAM (Urban Air Mobility).

This framework is designed for **Intelligent Interaction** between a vehicular cloud and SDVs with an intent-driven management.

As next steps, we will design and implement of components & interfaces for **Intent-Based SDV management** in 5G networks by simulation and emulation.
Intent Translation Engine for Intent-Based Networking  
(draft-pedro-ite-01)

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Interaction Overview of Intent Translation Engine

Mgmt Mech: Mechanisms supported by the CMS to implement policies.

Res: Resources; VNF: Virtual Net Functions.
Design of Intent Translation Engine

- **Implementation guide:**
  - An abstract algorithm that allows an ITE to obtain a set of network service definitions and the composition of management mechanisms that implements the required policies from a set of inputs.
  - The inputs are:
    (a) The intent provided by the tenant or some external agent.
    (b) A set of management mechanisms – retrieved from some management system available.
    (c) A set of VNFs and network resources – retrieved from some VIM.
  - The abstract algorithm helps obtaining validated network service definitions and management mechanism compositions which are valid for the available instantiation infrastructure.
Next Steps

- We will make one-step more for Intent Translation Engine in terms of the mapping of RDF Ontology and YANG data models for Network APIs and Cloud APIs.

- We will consider the Closed-Loop Control for Intent Assurance and Optimization by Monitoring, Analysis, and Reconfiguration.

- We will work for an IETF Hackathon Project for Intent Translation Engine in the IETF 120.
Thanks and Any Questions?
Appendix A for draft-jeong-opsawg-intent-based-sdv-framework-oo
Interworking of In-Vehicle Network and Edge Network

Configuration for Network and Security Functions in In-Vehicle Network and Edge Network

Vehicle-1 (Mobile Network-1)
- Host₁
- IP-OBU₁
- Host₂
- Router₁
- 2001:db8:10:1::/64
- 2001:db8:10:2::/64

EN-1 (Fixed Network-1)
- IP-RSU₁
- Host₃
- Router₂
- Server₁
- Serverₙ
- 2001:db8:1:1::/64
- 2001:db8:20:1::/64
- 2001:db8:20:2::/64

Vehicular Cloud

- 2001:db8:1:1::/64
Interworking of Two In-Vehicle Networks

Configuration for Network and Security Functions in In-Vehicle Networks

Vehicle-1 (Mobile Network-1)  Vehicle-2 (Mobile Network-2)
Appendix B for draft-pedro-ite-01
Required Specifications (1/4)

- **Interface for interaction between tenants and the ITE:**
  - TF1: Schema—RDF ontology and YANG model—that must be used to format intents introduced in the ITE.
  - TI1: Schema—RDF ontology and YANG model—that must be used by a tenant or other external entity to format and transmit an intent to the ITE.
  - TF2: Schema—RDF ontology and YANG model—that must be used to format declarations of intent semantics—namely, the set of concepts, relations, and ontologies that can be present in an intent.
  - TI2: Schema—RDF ontology and YANG model—that must be used by an ITE to publish—via NETCONF and others—the intent semantics it supports. Particularly, the set of concepts, relations, and ontologies that can be used by tenants to define input intents.
  - Minimum set of semantics that must be supported by any ITE.
Required Specifications (2/4)

- **Transmission of information about management mechanisms:**
  - MF1: Schema—RDF ontology and YANG model—that must be used by a management system to format declarations of management mechanisms and by an ITE to format their compositions.
  - MI1: Schema—RDF ontology and YANG model—that must be used by a management system to publish—via NETCONF and others—the management mechanisms it provides for being composed to implement policies and network services.
  - Minimum set of management mechanisms that must be provided by a management system for proper intent support.
Required Specifications (3/4)

- **Transmission of information about infrastructure resources and VNFs:**
  - VF1: Schema—RDF ontology and YANG model—that must be used to format declarations of network resources and virtual network functions (VNFs).
  - VI1: Schema—RDF ontology and YANG model—that must be used by a VIM to publish—via NETCONF and others—the network resources and virtual network functions (VNFs) it provides.
  - VF2: Schema—RDF ontology and YANG model—that must be used to format NSDs.
  - Minimum set of network resources and VNFs that must be provided by a VIM for proper intent support.
Transmission of information about intents and resources and VNFs:

- EF1: Schema—RDF ontology and YANG model—that must be used to format declarations of network intents, network resources, and virtual network functions (VNFs).

- EI1: Schema—RDF ontology and YANG model—that must be used by an ITE to allow external agents to provide network intents and retrieve information about available resources and virtual network functions (VNFs).