Ministry of Science and ICT

IETF

I2ICF Side Meeting

IITP Institute of Information & Communications Technology Planning & Evaluation

A Use Case of Interface to In-Network Computing Functions (I2ICF) for Cooperative Intelligent Transportation Systems (C-ITS)

(draft-ahn-opsawg-i2icf-cits-00)

March 20, 2025
Bangkok in Thailand

Byoungman Robert An, Jaehoon Paul Jeong, and Seonghyun Alex Jang

Email : bman@keti.re.kr, pauljeong@skku.edu, jang.sh@keti.re.kr

KETI 한국전자기술연구원 Korea Electronics Technology Institute

성균관대학교 SUNG KYUN KWAN UNIVERSITY

TTA 한국정보통신기술협회 Telecommunications Technology Association

Motivation of This Draft

❖ draft-ahn-opsawg-i2icf-cits-00

- ○ This draft defines the use case of In-Network Computing Functions (I2ICF) for cooperative intelligent transportation systems.
  - doc link : https://datatracker.ietf.org/doc/draft-ahn-opsawg-i2icf-cits/
- ○ This draft specifies a structured **framework for orchestrating, managing, and monitoring** ICFs in C-ITS
  - For example, in the context of Vehicle-to-Everything (V2X) communications, efficient management of Vehicle-to-Vehicle (V2V) communications and their integration with C-ITS can greatly benefit from in-network computing.
  - By leveraging ICFs, it becomes possible to optimize real-time communication, streamline traffic management, and enhance data processing and security services at the network edge.

❖ Main contents of this draft

- ○ Framework components
- ○ Interfaces in the I2ICF
- ○ Use cases
- ○ Security consideration

I2ICF Framework and Interfaces

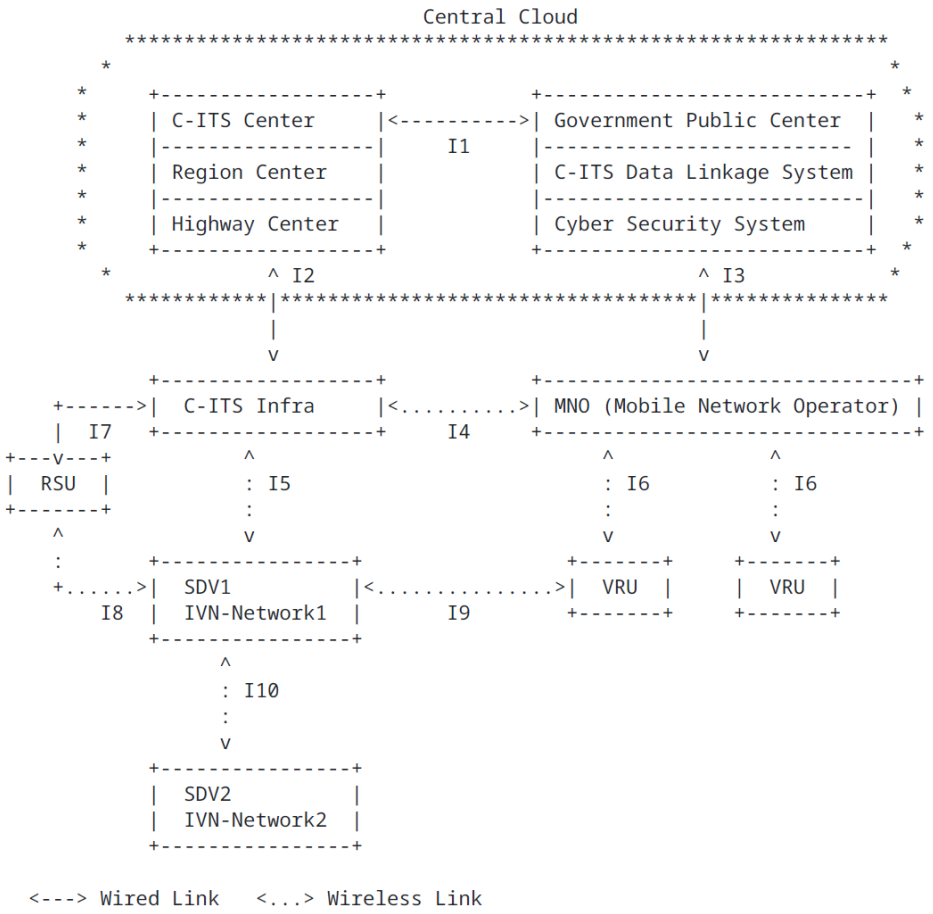
❖ Cooperative Intelligent Transportation Systems (C-ITS)

- ○ I2ICF Framework for C-ITS and MNO* networking

  * Mobile Network Operator (MNO)

- ○ **Framework Components**
  - Central Cloud
  - C-ITS Center
  - Region Center
  - Highway Center
  - Government Public Center
  - C-ITS Data Linkage System
  - Cyber Security System
  - C-ITS Infra
  - RSU
  - SDV1, SDV2
  - IVN-Network1, IVN-Network2
  - VRU
  - MNO

I2ICF Framework and Interfaces



I2ICF Framework and Interfaces

❖ Framework Components

Components	Description
Central Cloud	A system that comprehensively **controls the entire C-ITS environment**. It manages information from various C-ITS centers, including regional centers and highway centers, and facilitates and oversees the connection between C-ITS data from the Government Public Center and end users.
C-ITS Center	The C-ITS Center is a comprehensive term that encompasses both the Region Center and the Highway Center. It serves as the **central hub for managing and coordinating intelligent transportation systems** across various environments, including urban regions and highways.
Region Center	The Region Center refers to local centers established at key locations. These regional centers are **connected to Road-Side Units (RSU) and function as one of the C-ITS Centers**.
Highway Center	The Highway Center operates similarly to the Region Center but is managed separately due to the unique characteristics of highways, which span **multiple regions rather than being confined to a single city**.

I2ICF Framework and Interfaces

❖ Framework Components

Components	Description
Government Public Center	The Government Public Center is **a C-ITS information provision system managed by the government**. Due to the nature of road traffic infrastructure, it is challenging for **private companies to manage this data effectively**, and concerns over **reliability** make it difficult for users to utilize privately managed data.
C-ITS Data Linkage System	The C-ITS Data Linkage System is a platform designed to **provide C-ITS data to external users**. By offering data through methods such as Open APIs, this system connects C-ITS infrastructure information with users, enabling seamless access to real-time traffic and transportation data.
Cyber Security System	The Cyber Security System is responsible for **managing the security of communications** between Software-Defined Vehicles (SDV), Vulnerable Road Users (VRU), RSU, Mobile Network Operators (MNO), and C-ITS infrastructure.
C-ITS Infra	The C-ITS Infrastructure is a system designed to **collect and provide various types of information**, including traffic signal data, roadside environment information, VRU data, and RSU data.

I2ICF Framework and Interfaces

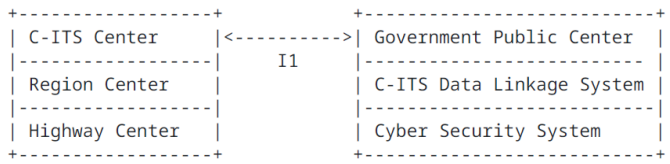
❖ Framework Components

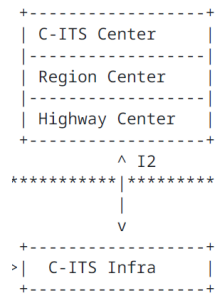
Components	Description
RSU	The RSU is a device that **connects the C-ITS Infrastructure with SDVs**. Through the RSU, SDVs can transmit and receive data between vehicles via V2V and between vehicles and infrastructure via V2I.
SDV1, SDV2	An SDV (Software-Defined Vehicle) consists of two main communication interfaces (External Communication Interface : Enables communication with external systems such as RSUs (Roadside Units), other vehicles (V2V), and infrastructure (V2I/V2N), supporting seamless interaction within the C-ITS ecosystem, and Internal Vehicle Network (IVN) Interface)
IVN-Network1, 2	These networks are part of the In-Vehicle Network (IVN), which facilitates communication within the vehicle.
VRU	A VRU refers to users who can communicate either with an MNO or directly with SDVs.
MNO	An MNO is a **service provider that owns and manages wireless communication infrastructure**, including network towers, core networks, and data centers.

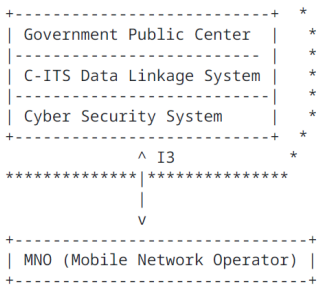
I2ICF Framework and Interfaces

I2ICF Interfaces

Interface 1	This is the registration interface between the ITS Center and the Government Public Center. It facilitates the **exchange of C-ITS infrastructure data**, such as traffic information and real-time road conditions, ensuring the Government Public Center can provide accurate and trustworthy data to external users.
Interface 2	This interface connects the C-ITS Center with the C-ITS Infra. It is **responsible for distributing infrastructure data**, such as traffic signal information, road environment data, and RSU status, from the C-ITS Center to the C-ITS Infra for real-time processing and delivery to connected vehicles.
Interface 3	This is the data exchange interface between the Government Public Center and the MNO (Mobile Network Operator). It **enables the secure transmission of C-ITS data to MNOs**, allowing mobile networks to deliver critical traffic and safety information to VRUs and vehicles.



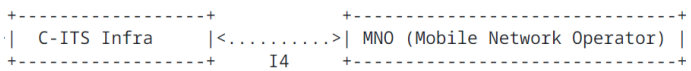


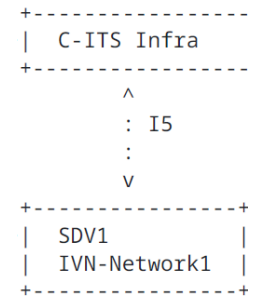


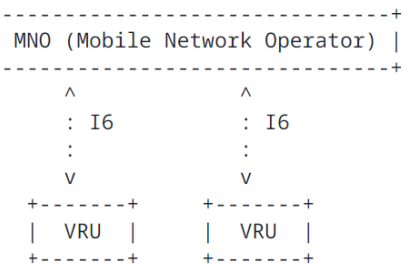
I2ICF Framework and Interfaces

I2ICF Interfaces

Interface 4	This interface connects the C-ITS Infra with the MNO. It **supports the sharing of network resources and real-time communication** between infrastructure components and mobile networks.
Interface 5	This is the communication interface between the C-ITS Infra and SDVs. It **enables bidirectional data exchange, allowing SDVs to receive real-time infrastructure information** (e.g., traffic signals, road hazards) and transmit vehicle status data back to the infrastructure.
Interface 6	This interface connects the MNO with both VRUs and SDVs. It is used to **deliver real-time safety messages**, navigation updates, and other critical data. It also allows VRUs and SDVs to send status or emergency signals back to the network.



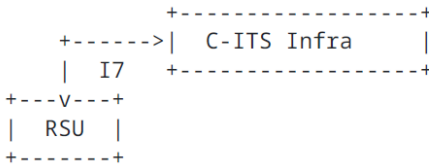


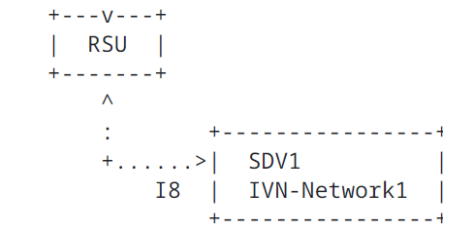


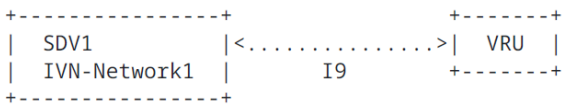
I2ICF Framework and Interfaces

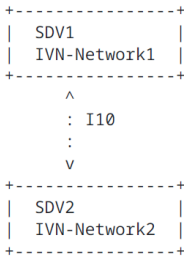
I2ICF Interfaces

Interface 7	This is the management interface between the RSU and the C-ITS Infra. It **facilitates the configuration, monitoring, and management of RSUs** to ensure stable communication between roadside infrastructure and vehicles.
Interface 8	This interface supports V2I communication between SDVs through the RSU. It **allows SDVs to exchange critical information** such as speed, direction, and emergency signals, enabling collision avoidance and cooperative driving.
Interface 9	This is the communication interface between SDVs and VRUs. It **ensures that vulnerable road users receive immediate safety notifications** from nearby vehicles and infrastructure.
Interface 10	This is the external and internal communication interface between multiple SDVs It **enables secure and efficient communication** within the vehicle's zonal architecture, facilitating seamless data exchange between various internal systems and supporting autonomous driving functions.



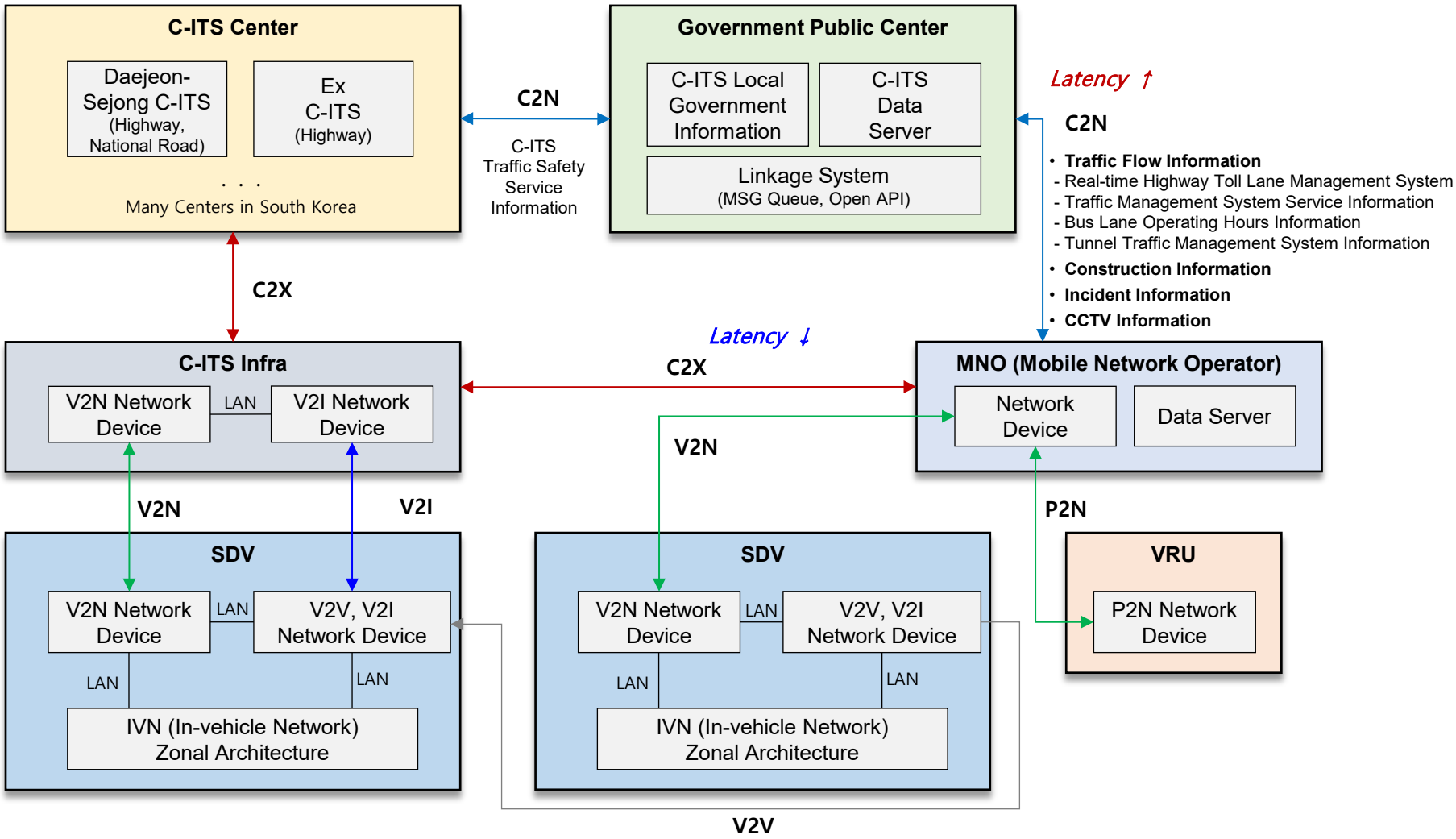




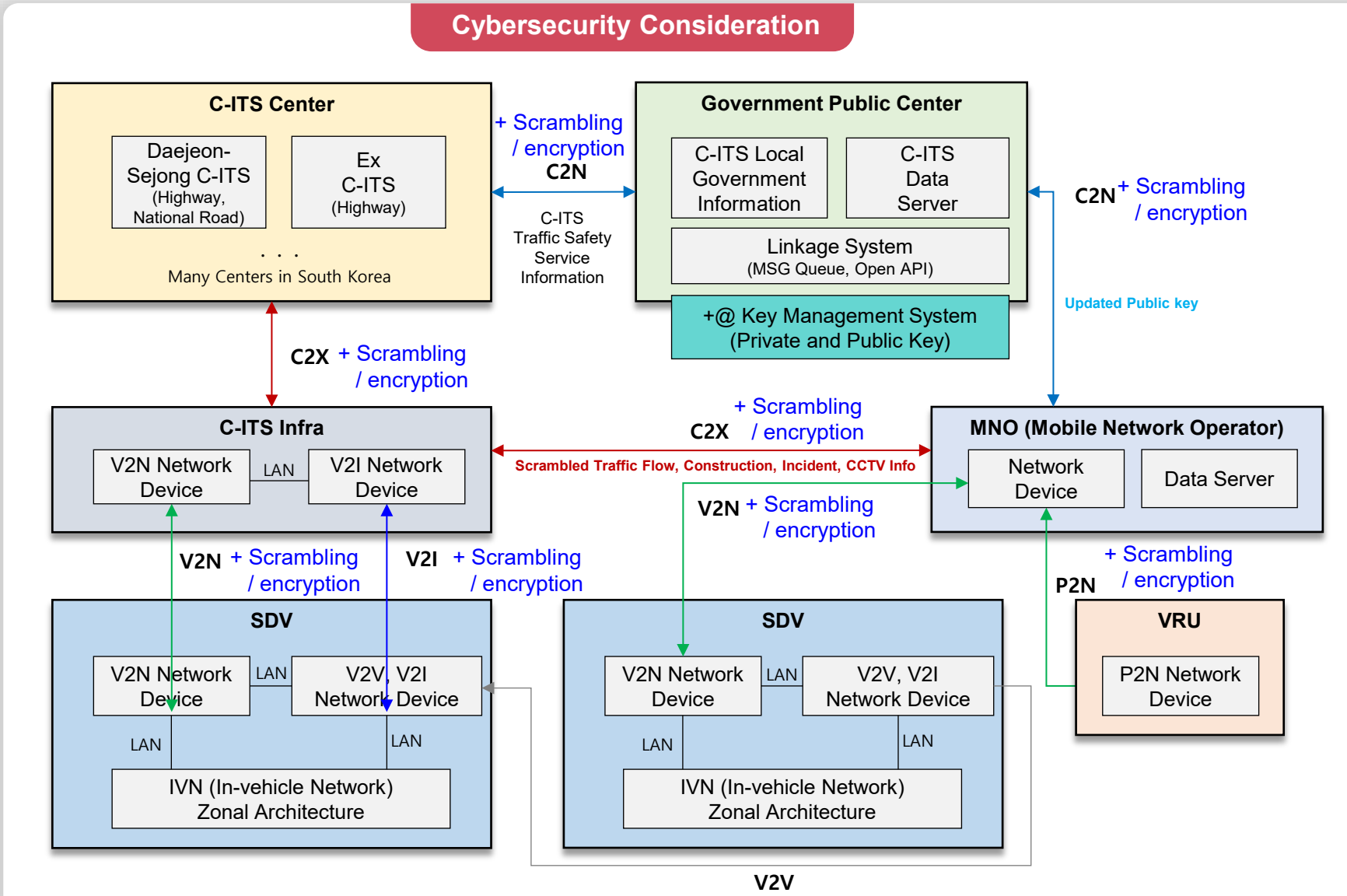


Use Cases of I2ICF for C-ITS

Data Processing, Streamline Traffic Management



Use Cases of I2ICF for Security C-ITS



Summary and Next Steps

❖ Summary

- ○ This document introduces **a structured framework** for their registration, configuration, management, and monitoring.
- ○ It evaluates extended **use cases**, including V2X communication, wherein ICFs facilitate the efficient orchestration of V2V networks, **seamless integration with C-ITS, and interoperability with MNOs**.
- ○ This document underscores the pivotal role of ICFs in **strengthening cybersecurity** measures for both private and public data within such interconnected ecosystems.

❖ Next Steps

- ○ This draft will be enhanced to accommodate use cases for I2ICF as follows:
  - A Use Case of C-ITS Networking
  - A Use Case of Real-Time Data Processing for SDV
  - A Use Case of E2E Communication for Cooperative Driving
  - A Use Case of Enhanced Cybersecurity for C-ITS and MNO Integration
  - A Use Case of Edge Computing for Latency-Sensitive Applications

Unframed Perspective

"틀에서 벗어난 시각으로 미래를 이끌어 간다"

KETI Korea Electronics Technology Institute

This work was supported by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea Ministry of Science and ICT (MSIT) (No. 2022-0-00199, 5G-NR-V2X performance verification for connected Autonomous Driving).
This work was in part supported by Institute of Information & Communications Technology Planning & Evaluation (IITP) grant funded by the Korea Ministry of Science and ICT (MSIT) (No. RS-2024-00398199 and RS-2022-II221015).