

# IETF-121 I2INF Side Meeting



## Interface to In-Network Functions (I2INF): Problem Statement

([draft-jeong-opsawg-izinf-problem-statement-02](#))

November 6, 2024

Dublin in Ireland

Jaehoon Paul Jeong, Yiwen Shen, Yoseop Ahn, Younghan Kim,  
Elias P. Duarte Jr., Kehan Yao

Email: {pauljeong, chrisshen, ahnjs124}@skku.edu, younghak@ssu.ac.kr,  
elias@inf.ufpr.br, yaokehan@chinamobile.com



# Interface to In-Network Functions (I2INF)

- ❑ **Interface to In-Network Functions (I2INF)**
  - ▣ I2INF aims at making a standard framework and its interfaces for In-Network Functions like Programmable Network Devices (PNDs).
    - ▣ [draft-jeong-opsawg-i2inf-problem-statement-02](#)
  - ▣ I2INF will work on the standardization of **Interface YANG Data Models (DMs)**:
    - ▣ In-Network Function (INF) Capability
    - ▣ Registration Interface, Consumer-Facing Interface, NSF-Facing Interface, and Monitoring Interface



# Interface to In-Network Functions (I2INF)

- ❑ **Goal:** Standardization of I2INF for Computing in the Network (COIN)
  - ▣ Interface to In-Network Functions (I2INF): **Problem Statement**
    - ▣ <https://datatracker.ietf.org/doc/draft-jeong-opsawg-izinf-problem-statement/>
  - ▣ A **Framework** for the Interface to In-Network Functions (I2INF)
    - ▣ <https://datatracker.ietf.org/doc/draft-jeong-opsawg-izinf-framework/>
  - ▣ **Use Cases** of Interfaces of In-Network Functions in Data Center Networking
    - ▣ <https://datatracker.ietf.org/doc/draft-ywj-opsawg-izinf-data-center-networking/>



# Motivation of this Draft



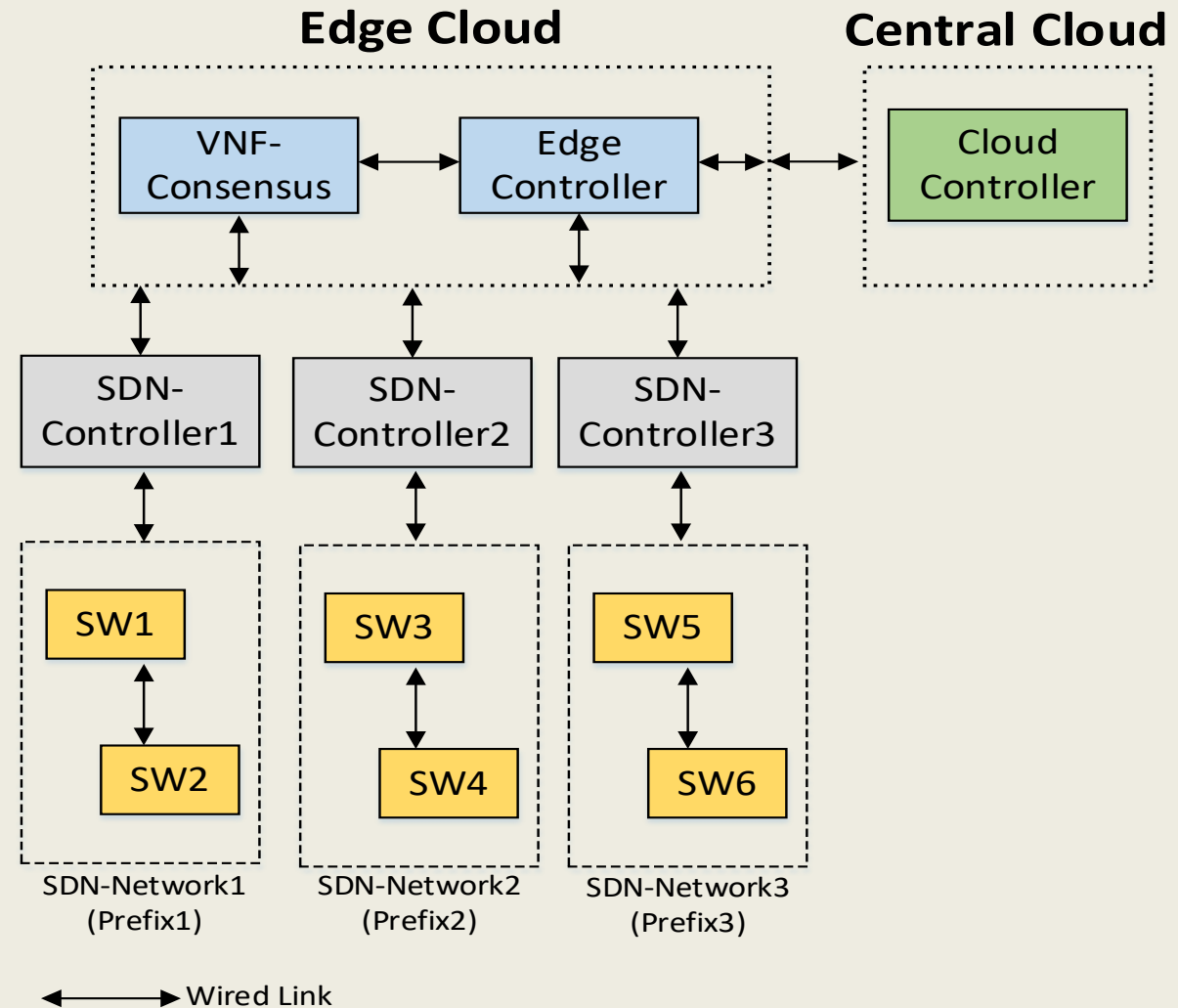
- ❑ **draft-jeong-opsawg-izinf-problem-statement-02**
  - ▣ This draft defines the [In-Network Computing Functions and Problems for Interface to In-Network Functions \(I2INF\)](#) for In-Network Functions (INFs).
  - ▣ This draft investigates the need for a standard framework with the interfaces for INFs, in terms of applications with the need to run AI in the network and interoperability among multi-vendor INFs.
    - ▣ AI can, for instance, enable the creation of dynamic, adaptable network/security policies, which are particularly important in the cloud-edge-core-continuum.
    - ▣ AI can learn from telemetry data collected from multiple networks and reach conclusions that can be applied globally or to individual networks.

# I2INF Framework for INF Management:

(e.g., VNF-Consensus, Failure Detector, and Reliable Broadcast)

- This framework shows a **VNF-Consensus Architecture in an Edge Cloud** for I2INF framework to synchronize the SDN Controllers for flow table information in the same Edge Cloud.

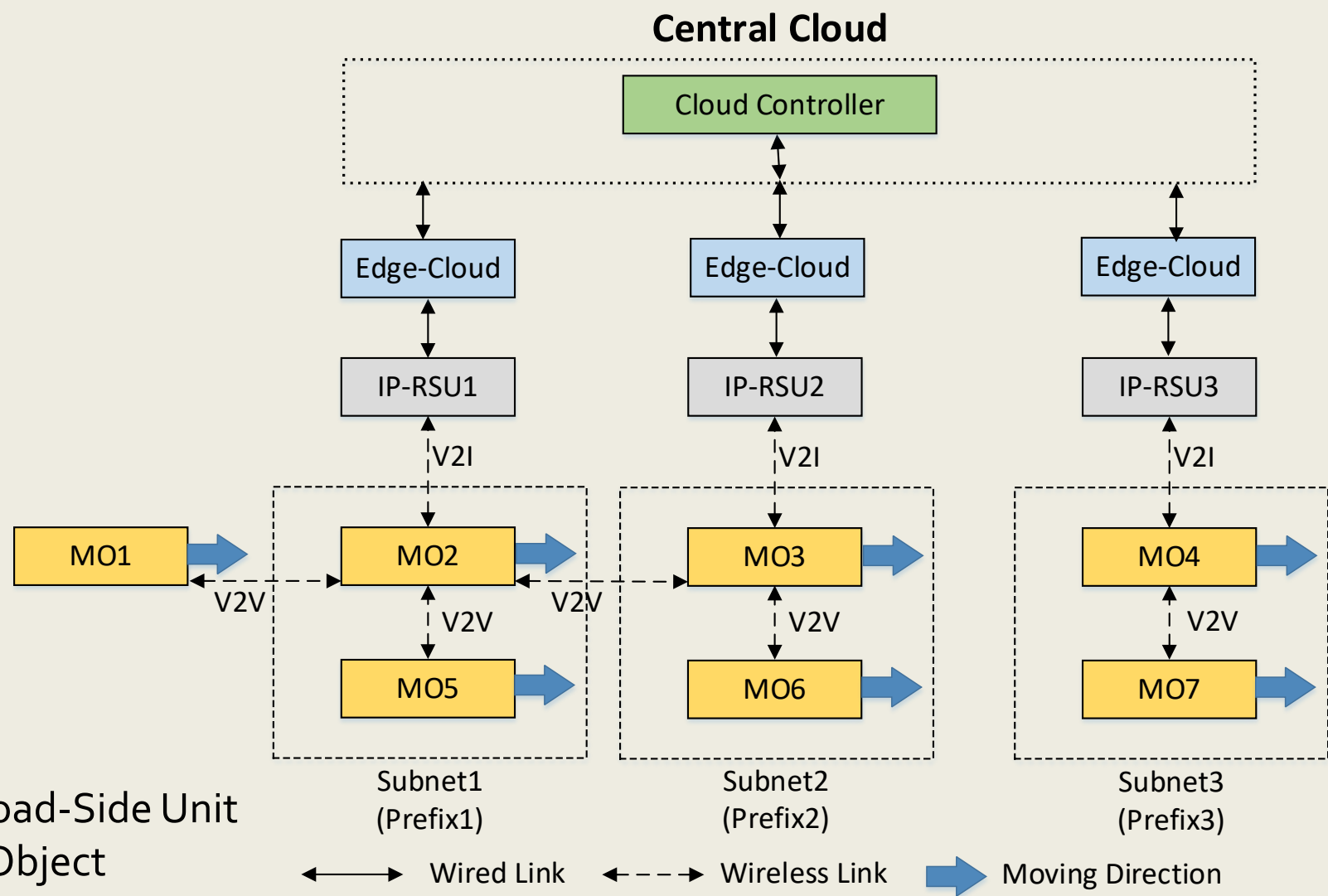
**VNF:** Virtual Network Function  
**SW:** Switch





# I2INF Framework for INF Management

(e.g., Mobile Objects (MOs) like Software-Defined Vehicles)



**IP-RSU:** IP Road-Side Unit  
**MO:** Mobile Object



# In-Network Computing Functions (1/4)

- ❑ **The State of the Art in Computing in Network (COIN)**
  - ▣ **In-Network Computing Functions (INCF)** are proposed by COINRG with Network Softwarization (e.g., NFV and SDN).
- ❑ **Services in COIN**
  - ▣ **Providing New COIN Experiences**
    - ▣ Mobile application offloading and Extended Reality (XR) and immersive media.
  - ▣ **Supporting New COIN Systems**
    - ▣ In-Network Control, Time-Sensitive Application, Large Volume Applications, and Industrial Safety.



# In-Network Computing Functions (2/4)

## ❑ Services in COIN (Con't)

### ▣ Improving Existing COIN Capabilities

- ▣ Content Delivery Networks (CDN), Compute-Fabric-as-a-Service (CFaaS), and Virtual Networks Programming (e.g., P4 programs and OpenFlow rules).

### ▣ Enabling New COIN Capabilities

- ▣ Distributed AI Training among distributed endpoints for large-scale problems.





# In-Network Computing Functions (3/4)

## ❑ Services in NFV-COIN

### ▣ NFV Failure Detection

- ▣ It gets monitoring data from SDN Switches via SDN Controller and detects the failure of communication links.

### ▣ Virtual Network Function (VNF) Consensus

- ▣ It performs the synchronization of the control planes of multiple SDN Controllers (e.g., flow table sharing).

### ▣ NFV Reliable Broadcast

- ▣ It performs reliable and in-order delivery of broadcasted data packets with a VNF-Sequencer.



# In-Network Computing Functions (4/4)

## ❑ In-Network Computing Functions

### ▣ Observation 1

- ▣ Functionalities of each service need to be decomposed into Application Functions (AFs) and Network Functions (NFs).

### ▣ Observation 2

- ▣ The management and configuration of those AFs and NFs is a functionality that must be provided by a service coordinator in the context of COIN-based network services.

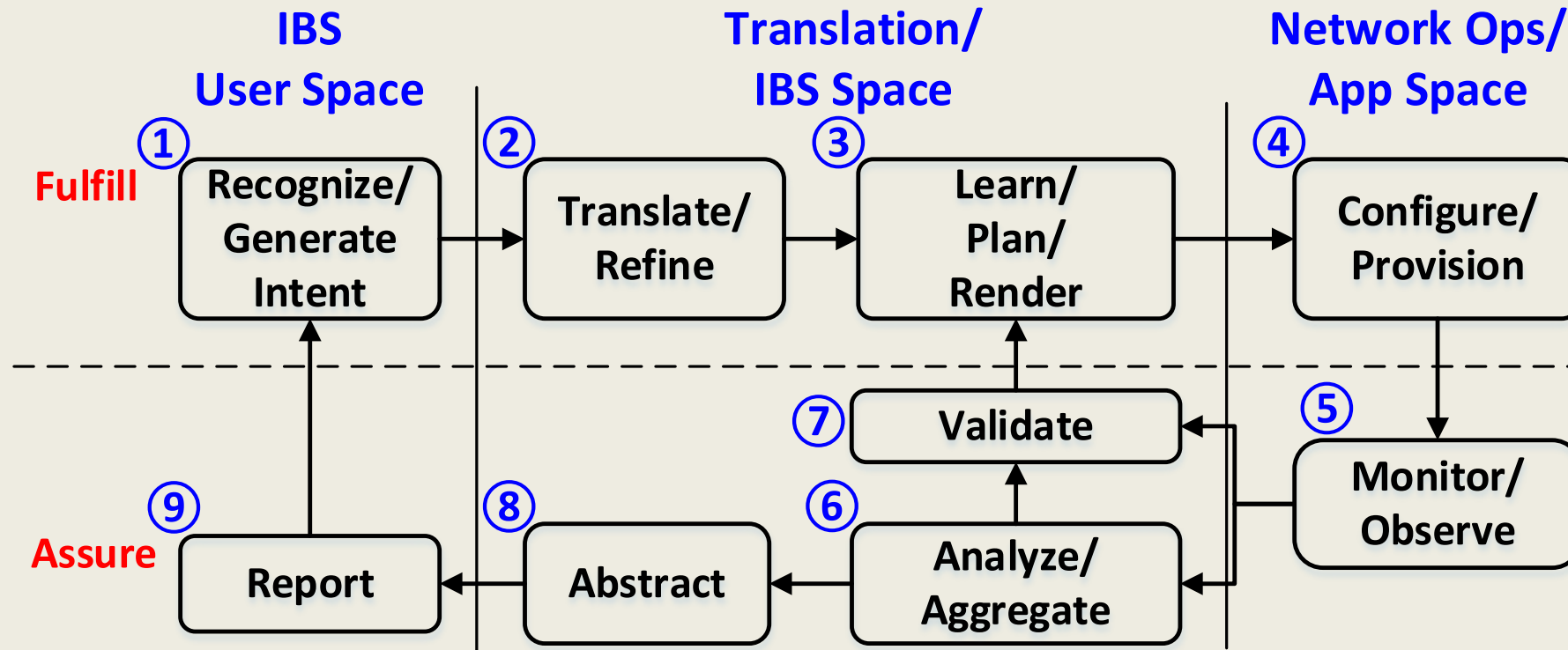
### ▣ Observation 3

- ▣ There is currently no framework or interfaces defined as standards specifying the life cycle of COIN-based services.



# Intent-Based Networking (IBN)

- ❑ **Intent-Based System (IBS)** can be based on **RFC 9315** (Intent-Based Networking - Concepts and Definitions).



**The Life Cycle of IBS for Intent Management**



# Problem Statement (1/5)



- ❑ **The goal of an Intent-Based System (IBS)**
  - ❑ To enforce the service corresponding to a user's intent with an appropriate application in a target network in terms of functionality and quality.
- ❑ **Enforcement Procedure of an Intent**
  - ❑ ① **Intent Translation**
    - ❑ An intent needs to be translated into either a network policy and an application policy by an intent translator.



# Problem Statement (2/5)



## ❑ Enforcement Procedure of an Intent (Con't)

### ❑ ② Delivery of Network and Application Policies

- ❑ The network policy and application policy needs to be delivered to a network controller and an application controller.

### ❑ ③ Network Policy Translation

- ❑ The network controller translates the network policy into the network rules for network entities (i.e., NFs).

### ❑ ④ Application Policy Translation

- ❑ The application controller translates the application policy into the application rules for application entities (i.e., AFs).



# Problem Statement (3/5)



- ❑ **Data Models for INF Capability and Registration Interface (RI)**
  - ❑ The **Capability Data Model** for INFs (i.e., NFs and AFs) are required to describe the INF capabilities for usage.
  - ❑ A **Registration Interface** is required for a vendor to register the INF Capability to an INF Controller.
  - ❑ **YANG Data Models for INF Capabilities and Registration Interface** should be specified to make a registration message for the Vendor's Management System (VMS).



# Problem Statement (4/5)

## ❑ Data Model for Consumer-Facing Interface (CFI)

- ❑ An IBS user needs an interface to deliver its intent to an IBS Controller (e.g., Cloud Controller).
- ❑ The IBS Controller translates the intent into a network policy and an application policy with an intent translator.
- ❑ It dispatches the policies to appropriate destinations (e.g., NF Controller and AF Controller) with a dispatcher.
- ❑ This interface is called a Customer-Facing Interface (CFI) for the IBS User.
- ❑ **A YANG Data Model for the Customer-Facing Interface** should be specified.



# Problem Statement (5/5)

- ❑ **Data Model for Service Function-Facing Interface (SFI)**
  - ❑ Both an NF Controller and an AF Controller need an **SF-Facing Interface** to deliver the network and application rules to the appropriate NFs and Afs, respectively.
- ❑ **Data Models for Monitoring Interface (MI) and Analytics Interface (AI)**
  - ❑ **Monitoring Interface** collects monitoring data from either an NF or an AF to a Data Collector.
  - ❑ **Analytics Interface** delivers analysis results to either an NF Controller or an AF Controller.





# Planning for WG Scope



## ❑ WG Phase 1

- ❑ I2INF Problem Statement and Use Cases
- ❑ I2INF Framework
- ❑ A YANG Data Model for INF Capability
- ❑ A YANG Data Model for Registration Interface

## ❑ WG Phase 2 (Re-charter)

- ❑ YANG Data Models of Consumer-Facing Interface, Controller-Facing Interface, SF-Facing Interface, Monitoring Interface, and Analytics Interface



# Next Steps

- ❑ This draft will include use cases for I2INF as follows:
  - ❑ A Use Case of I2INF for Data Center Networking
    - ❑ <https://datatracker.ietf.org/doc/draft-ywj-opsawg-i2inf-data-center-networking/>
  - ❑ A Use Case of I2INF for Edge Cloud
  - ❑ A Use Case of I2INF for Mobile Object
- ❑ I2INF Group will prepare a Non-WG-Forming BoF in the IETF 122 in Bangkok in March, 2025.
- ❑ I2INF Group will prepare IETF-122 Hackathon Project to clarify (i) the I2INF Problem Statement & Use Cases and (ii) the I2INF Framework.