

# Maintenance and Enhancement of Intent-driven Closed-loop Autonomous Networks in R11

Requirements Subcommittee Review  
25<sup>th</sup> April, 2022

**REQ Owners:** Dong Wang (China Telecom), Keguang He (CMCC), Henry Yu (Huawei),  
Ahila Pandaram (Wipro), Kevin Tang (STL), Lei Shi (AsiaInfo)  
**Academic Supervisor:** Prof. Chungang Yang (Xidian University)

# Outline

**1**

**Overview of Intent-based Networking**

**2**

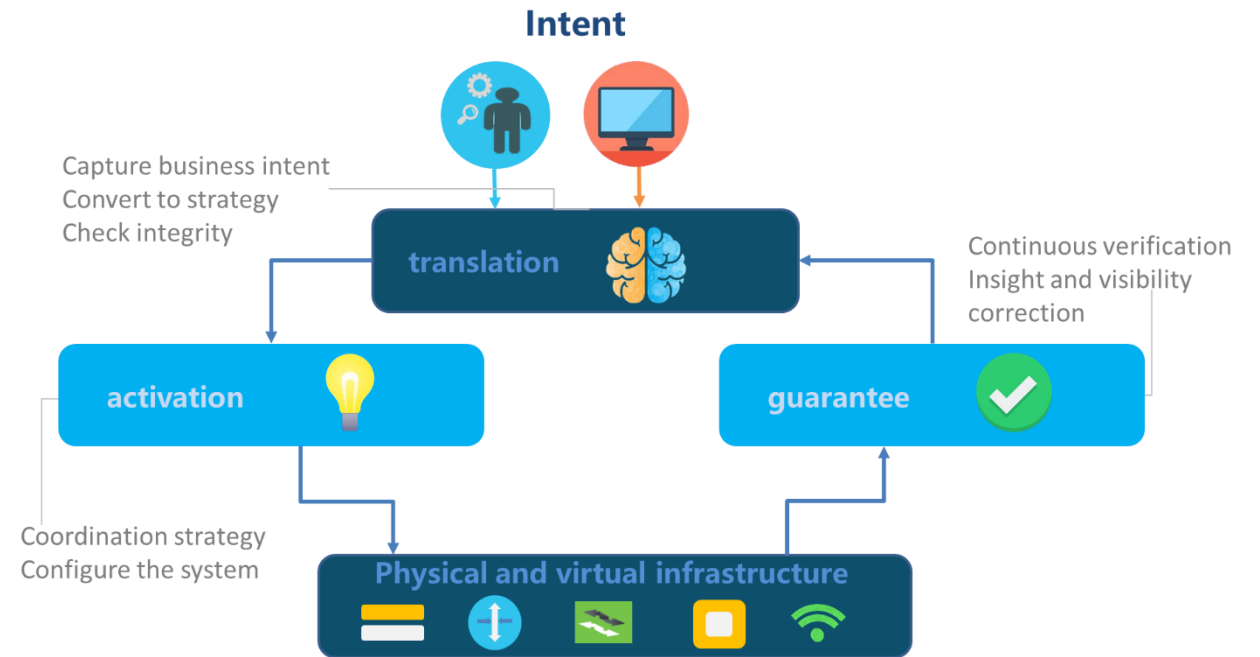
**Implementation of IBN from R8 (Honolulu) to R10 (Jakarta)**

**3**

**REQ of R11 Maintenance and Enhancement**

# Intent-based Networking (IBN)

- Intent-based networking (IBN) is a self-driving network that uses **decoupling network control logic** and **closed-loop orchestration techniques** to automate application intents.
- An IBN is an intelligent network, which can **automatically convert, verify, deploy, configure, and optimize** itself to achieve target network state according to the intent of the operators, and can **automatically solve abnormal events** to ensure the network reliability.



A high-level framework of Intent-based Networking

# Collaborations among Academics, SDOs and ONAP

Academics



- A Survey on Intent-Driven Networks
- A Brief Survey and Implementation on Refinement for Intent-Driven Networking

Academic exchanges

Open-source



Align with Multi-SDO

## Autonomous Networks Multi-SDO Initiative

Who we are

SDO	Group/Project	SDO	Role
3GPP	SA5	IETF	WG on AN
CCSA	TC7	ITU-T	FG-AN
ETSI	ENI, F5G, MEC, NFV, PDL, TC INT/AFI, ZSM	Linux Foundation*	ONAP
GSMA	Future Networks	NGMN	Automation
IEEE	Future Networks	TM Forum	AN Project

\*Open Source Community

SDOs



IETF/IRTF:

- Intent-Based Networking - Concepts and Definitions
- Intent Classification



ETSI ZSM/ENI:

- ZSM 011 Intent-driven autonomous networks; Generic aspects
- ENI 008 InTent Aware Network Autonomicity (ITANA)



TMF:

- IG1234 Intent Oriented Customer Engagement (IoCE) Guide
- IG1253 Intent in Autonomous Networks



3GPP SA5:

- TS 28.312 Intent driven management services for mobile networks
- TR 28.812 Study on scenarios for Intent driven management services for mobile networks



ITU-T:

- Scenarios and Requirements of Intent-Based Network for network evolution
- functional architecture of NGN evolution by adoption of Intent-Based Network



CCSA:

- 2015B58 Network Intelligent Capability Enhancement for SDN/NFV: Study of Key Technologies of Intent Network

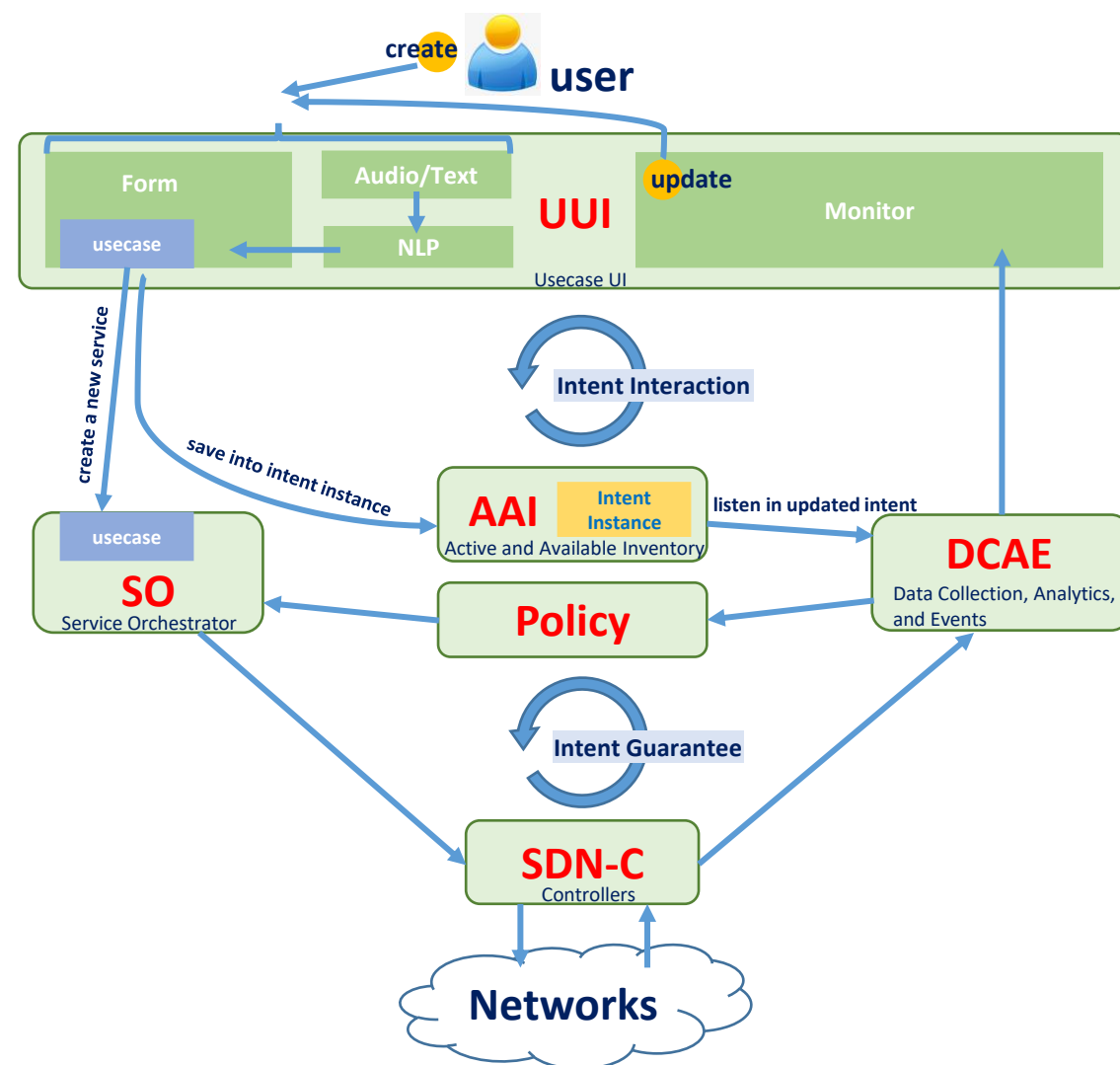
# Architecture of Intent-driven Closed-loop Autonomous Networks based on ONAP Projects

## Key Functions and Developments of Intent-based Networking in ONAP:

- ✓ **REQ-453/ONAPARC-641** Smart Operator Intent Translation in UUI based on IBN - R8 5G Slicing Support
- ✓ **REQ-861/ONAPARC-701** Smart Intent Guarantee based on IBN - R9 Intent Instance
- ✓ **REQ-1074/ONAPARC-729** Smart Intent Guarantee based on Closed-loop in R10
- ✓ **REQ-1075/ONAPARC-730** Network Services without Perception for Users based on IBN
- Maintenance and Enhancement of Intent-driven Closed-loop Autonomous Networks in R11

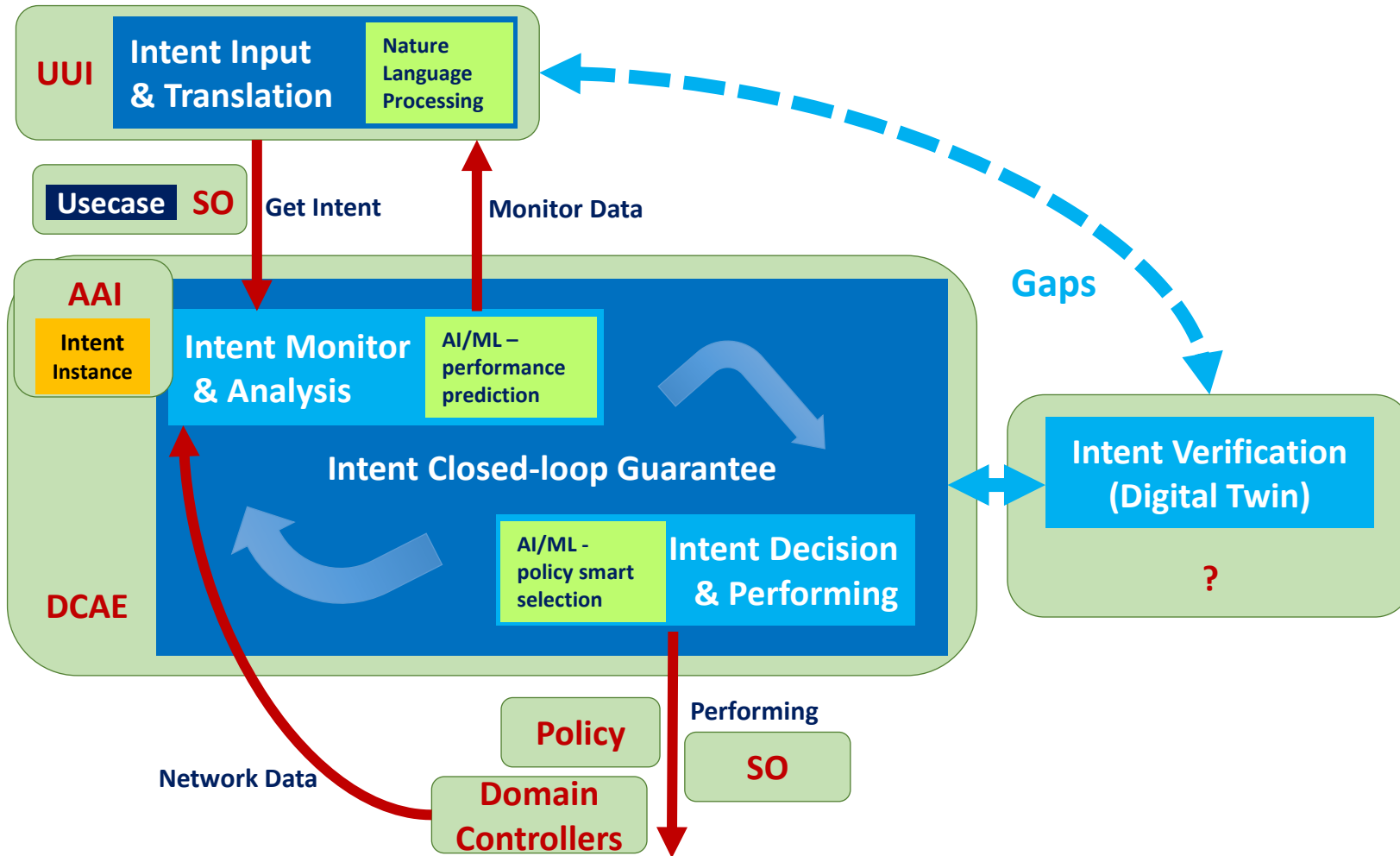
## Collaborations and Outputs with SDOs (ETSI ZSM / ITU-T):

- ✓ **ETSI ZSM PoC 003:** Automation of Intent-based cloud leased line service
- ✓ **ITU-T:** Scenarios and Requirements of Intent-Based Network for network evolution; functional architecture of NGN evolution by adoption of Intent-Based Network; signalling architecture of Intent-Based Network for network evolution



Architecture of Intent-driven Closed-loop Autonomous Networks

# Enable AI/ML for Intent-driven Autonomous Networks in ONAP



AI/ML Abilities for Intent-driven Autonomous Networks in ONAP

## Key Features

### AI/ML Algorithms

- Nature Language Processing
- STT (Speech to Text)
- Prediction
- Decision-making

### AI/ML Frameworks

- TensorFlow
- PyTorch

### AI/ML Platform

- ✓ Acumos AI



<https://www.acumos.org/>

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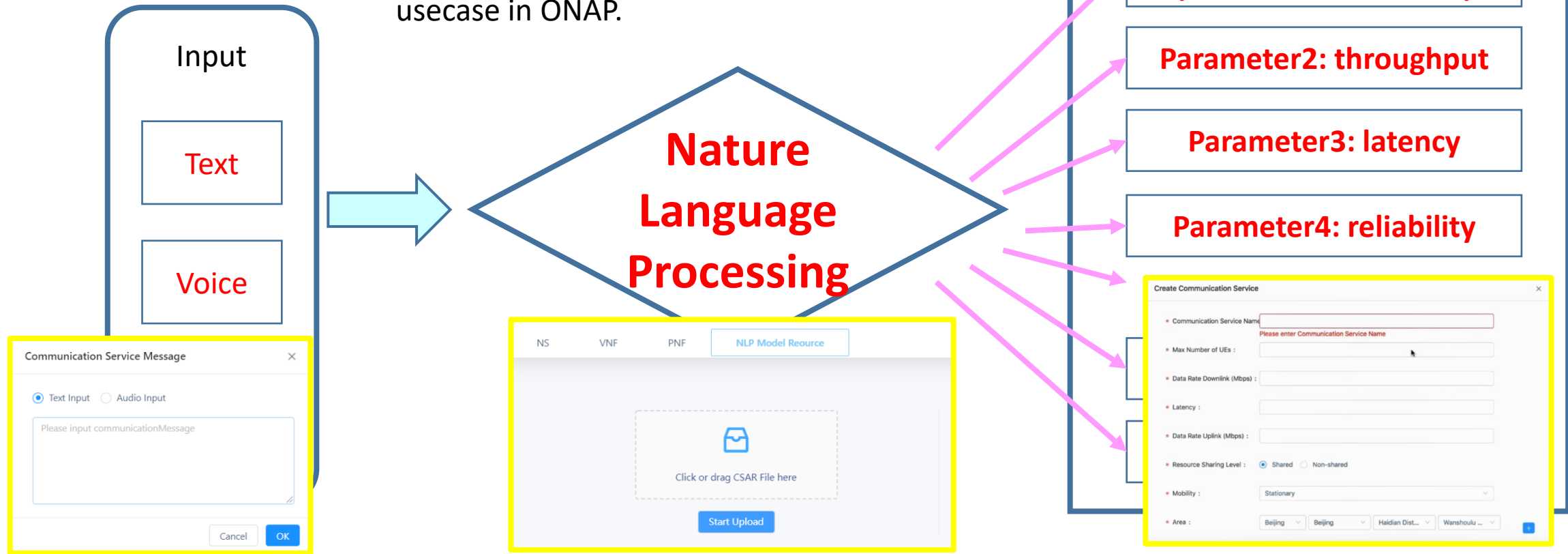
**3**

**REQ of R11 Maintenance and Enhancement**

# 2.1-1 Intent Translation in UUI for E2E Slicing (R8)

## UUI

Target of R8: translate from human inputs to slice parameters based on NLP in UUI, and then run the E2E slicing usecase in ONAP.





# 2.1-2 Screenshot of Smart Create for E2E Slicing (R8)

The screenshot displays the ONAP Smart Create interface for E2E Slicing. The interface is divided into three main sections:

- Sidebar (Left):** Contains navigation options: Home, Customer, Services (highlighted), Lifecycle Management, SOTN Eline, 5G Slicing Management (highlighted), Intent-based Services, Package Management, Network Topology, and Monitor.
- Main Panel (Right):** Shows the 'Communication Service' configuration page. It includes a 'Status' dropdown set to 'All', a 'Smart Create' button (highlighted), and a 'Create' button. Below these are columns for 'S-NSSAI', 'Status', 'Activate', and 'Terminate'.
- Dialog Box (Center):** A 'Communication Service Message' dialog box is open. It features two radio buttons: 'Text Input' (selected and highlighted) and 'Audio Input'. Below the radio buttons is a text input field with the placeholder text 'Please input communicationMessage'. At the bottom of the dialog are 'Cancel' and 'OK' buttons.

# 2.1-3 Screenshot of Smart Create for CCVPN (R9)

The screenshot displays the ONAP Smart Create interface for CCVPN (R9). The interface is divided into a sidebar menu on the left and a main content area on the right.

**Sidebar Menu:**

- Home
- Customer
- Services** (highlighted)
- Lifecycle Management
- SOTN Eline
- 5G Slicing Management
- Intent-based Services** (highlighted)
- Package Management
- Network Topology
- Monitor

**Main Content Area:**

The main content area features a navigation bar with the following items:

- Cloud Leased Line** (highlighted)
- Intention Library Management
- Intention Instance Management

Below the navigation bar, there are two buttons: **Smart Create** (highlighted) and **Create**.

The main content area displays a table with the following columns:

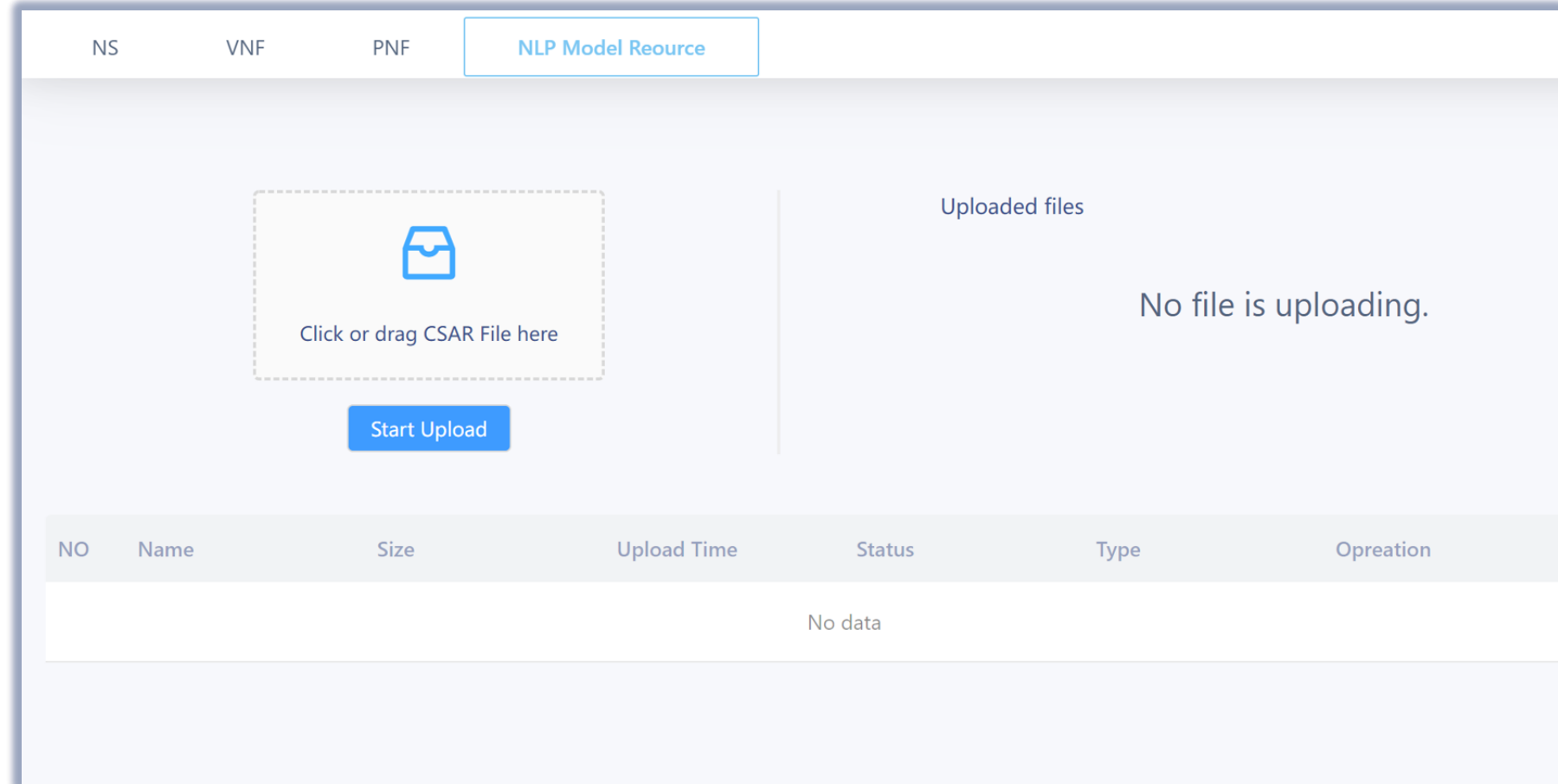
No	Communication Service Name	Intent Instance ID	Status	Operation button
No data				

# 2.1-4 NLP Model Management (R8-R9)

## Key Features

### NLP Model Management

- ❑ Upload model
- ❑ Delete model
- ❑ Active/Inactive model
- Select model for different usecases in same AI framework and microservice

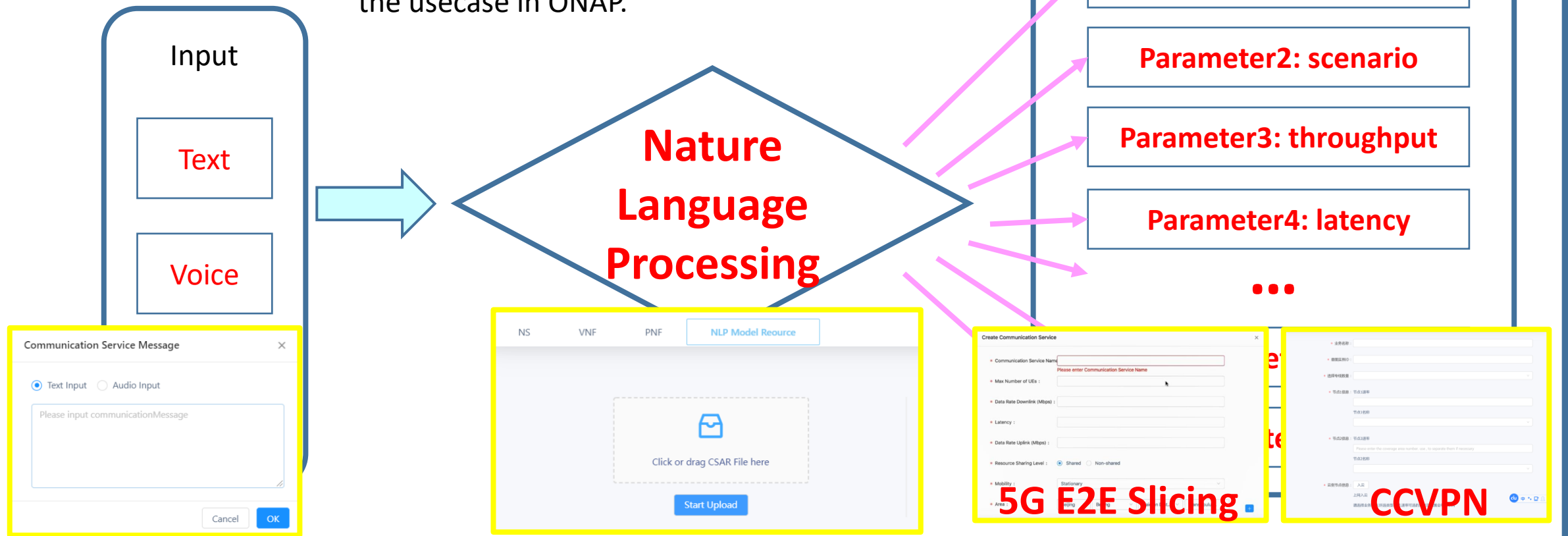


Screenshot of NLP Model Management

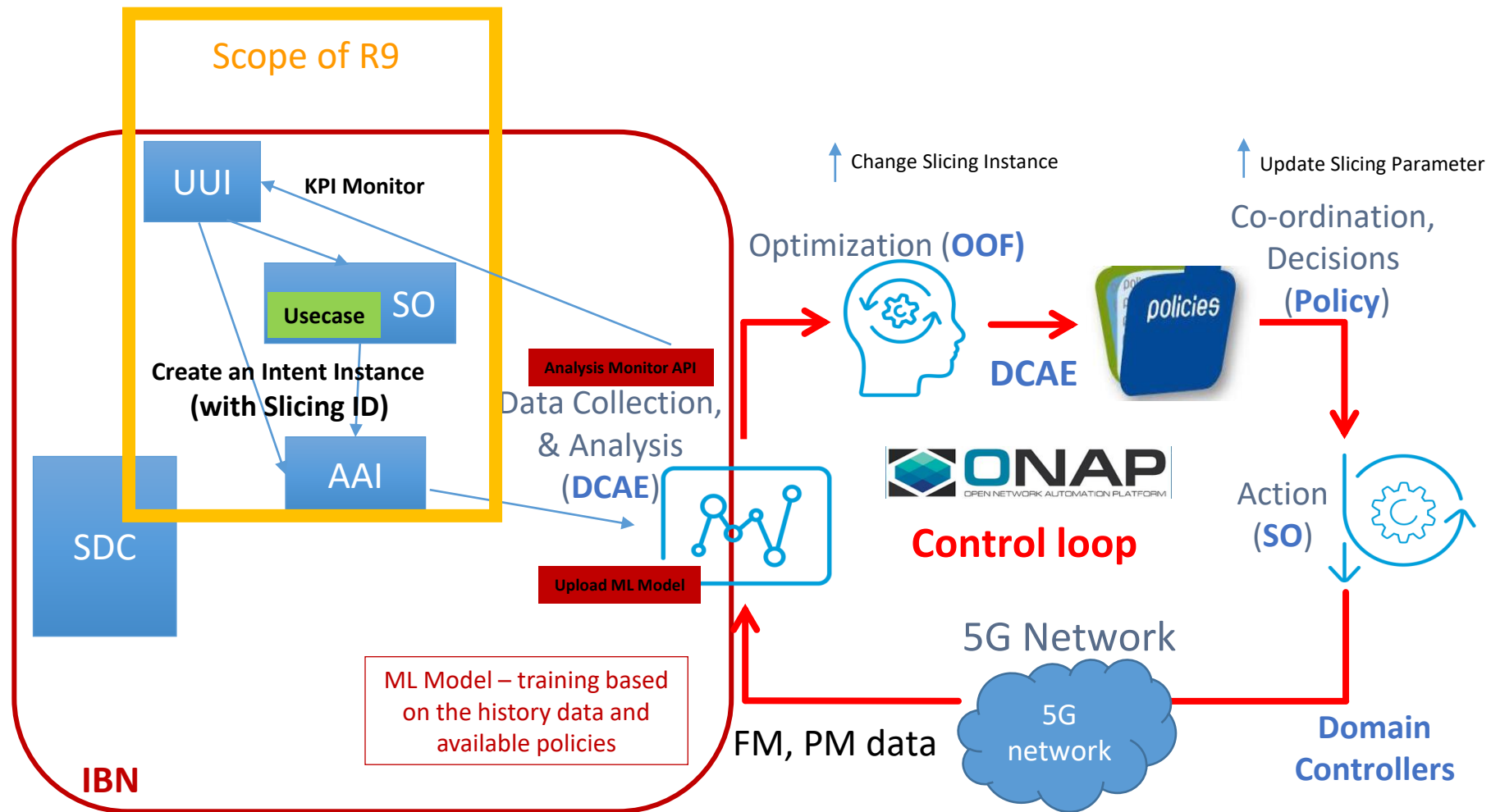
# 2.1-5 Network Services without Perception for Users (R10)

## UUI

Target: translate from human inputs to network parameters based on NLP in UUI, choose a suitable usecase and then run the usecase in ONAP.

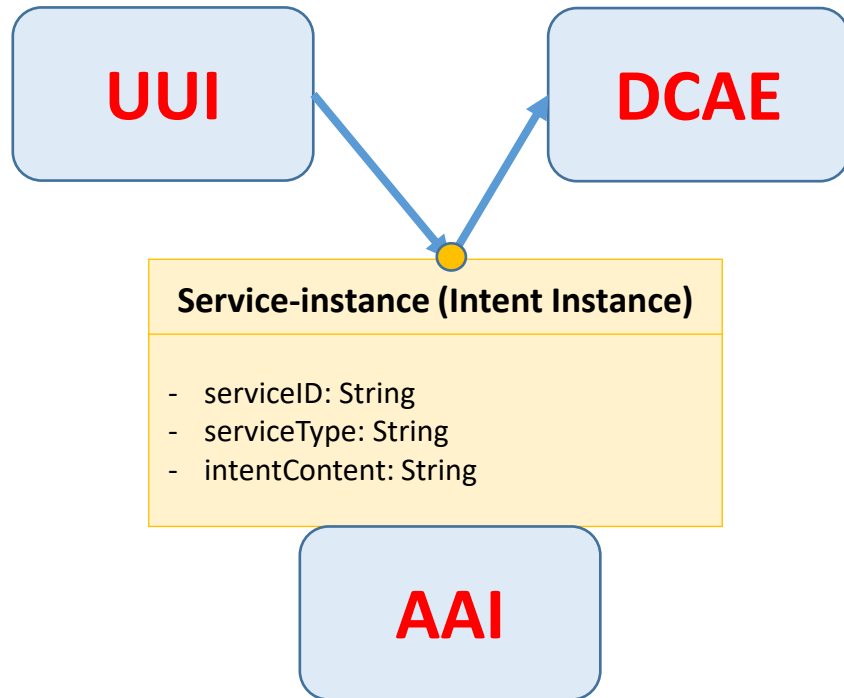


# 2.2-1 Intent-driven E2E Slicing Closed-loop (R9-R10)



## 2.2-2 Intent Instance in AAI (R9)

Functions: Intent Instance is created to save the users' **real-time intent** (network parameters) and connected service ID (CCVPN service ID / E2E Slicing CSI ID) in AAI.

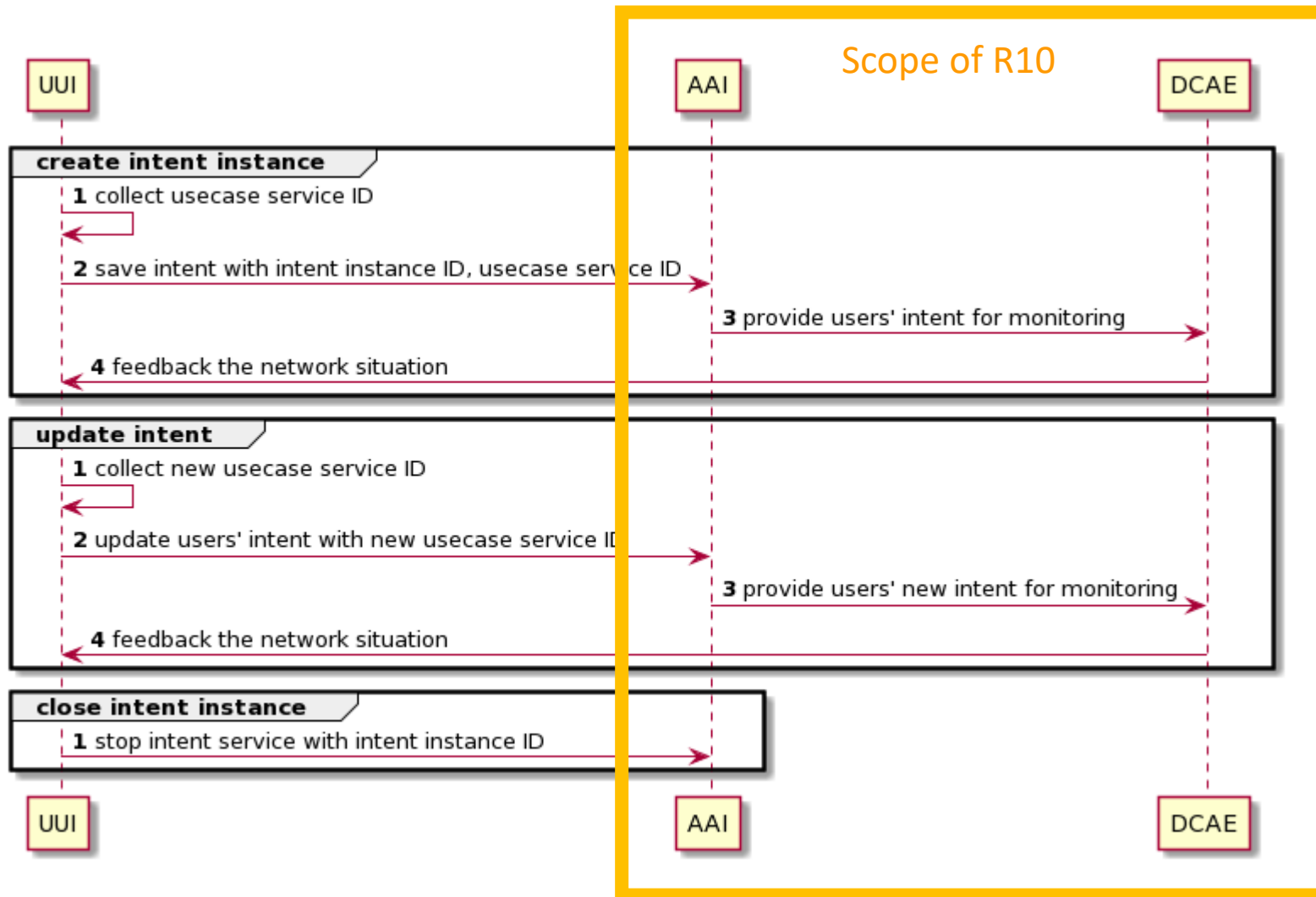


serviceType: 'CCVPN', 'E2ESlicing'

### Intent Instance Applied in AAI:

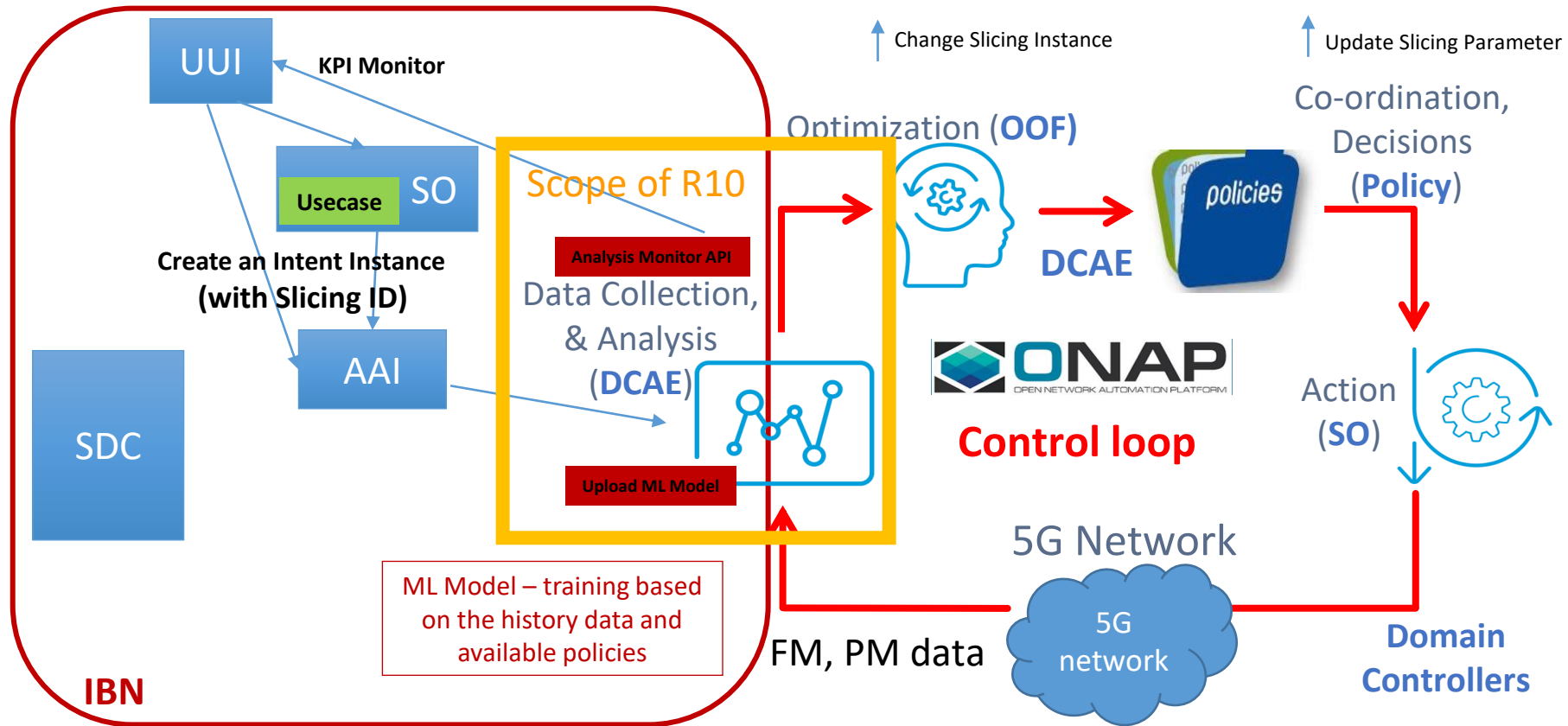
1. Intent Instance is created to save the users' real-time intent in Active and Available Inventory. The other records related to the intents are not real-time, which are saved in the independent database in UUI, and will be saved in CPS in further releases.
2. The target of Intent-based Networking is to develop to support multiple usecase services, so it is not a sub-node of any usecase in AAI. And the IBN will be expect to provide network services without perception for users. Multiple usecase services could be changed by IBN instead of the users.
3. DCAE keeps calling the intent from AAI for monitoring.

# 2.2-3 Workflow of Intent Management (R9-R10)



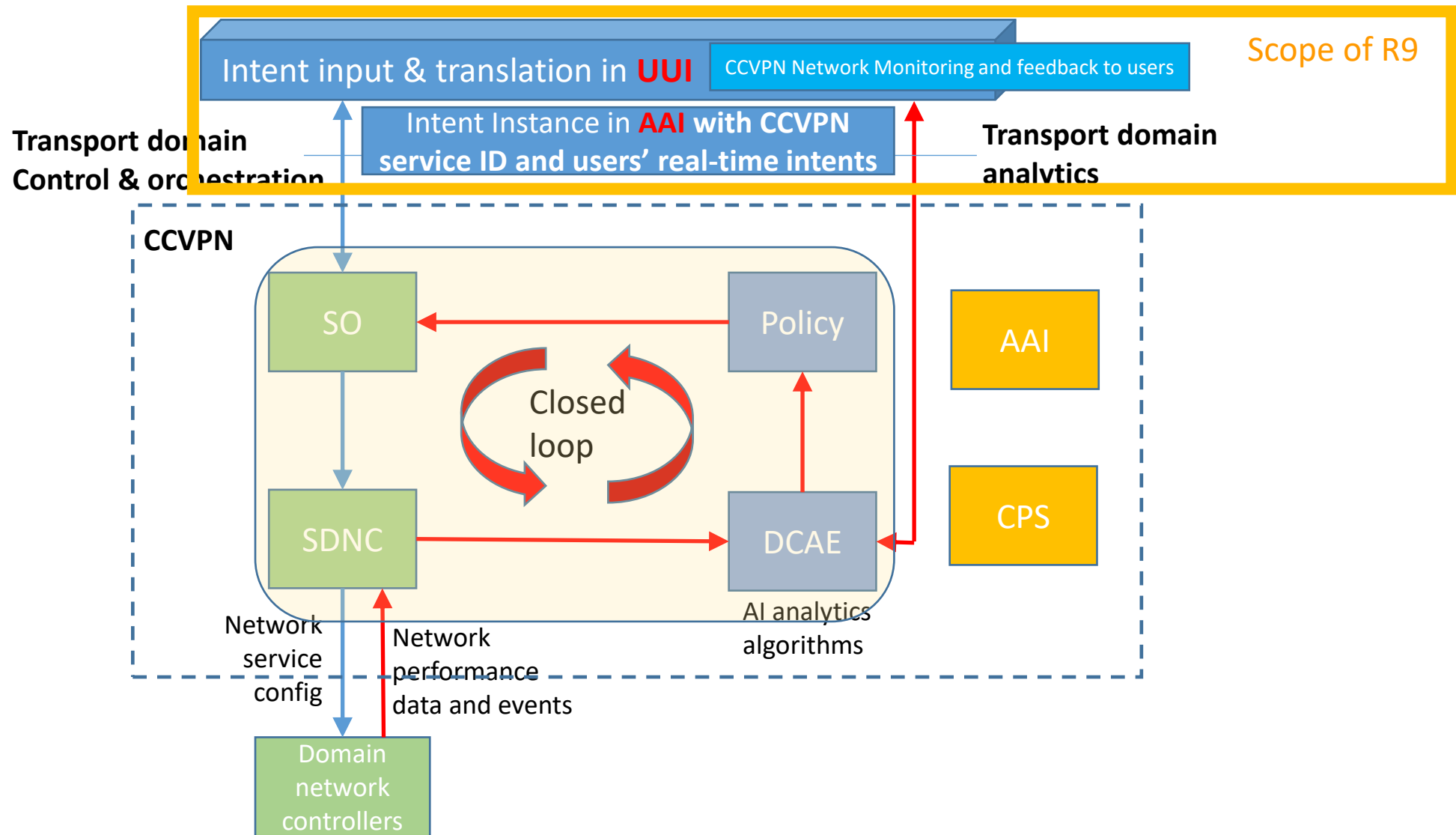
\*1. A usecase service ID includes the service instance ID of CCVPN or CSI ID of E2E Slicing, which is collected in UUI after creating a new service.

# 2.2-4 Smart Intent Guarantee by Closed-loop (R10)

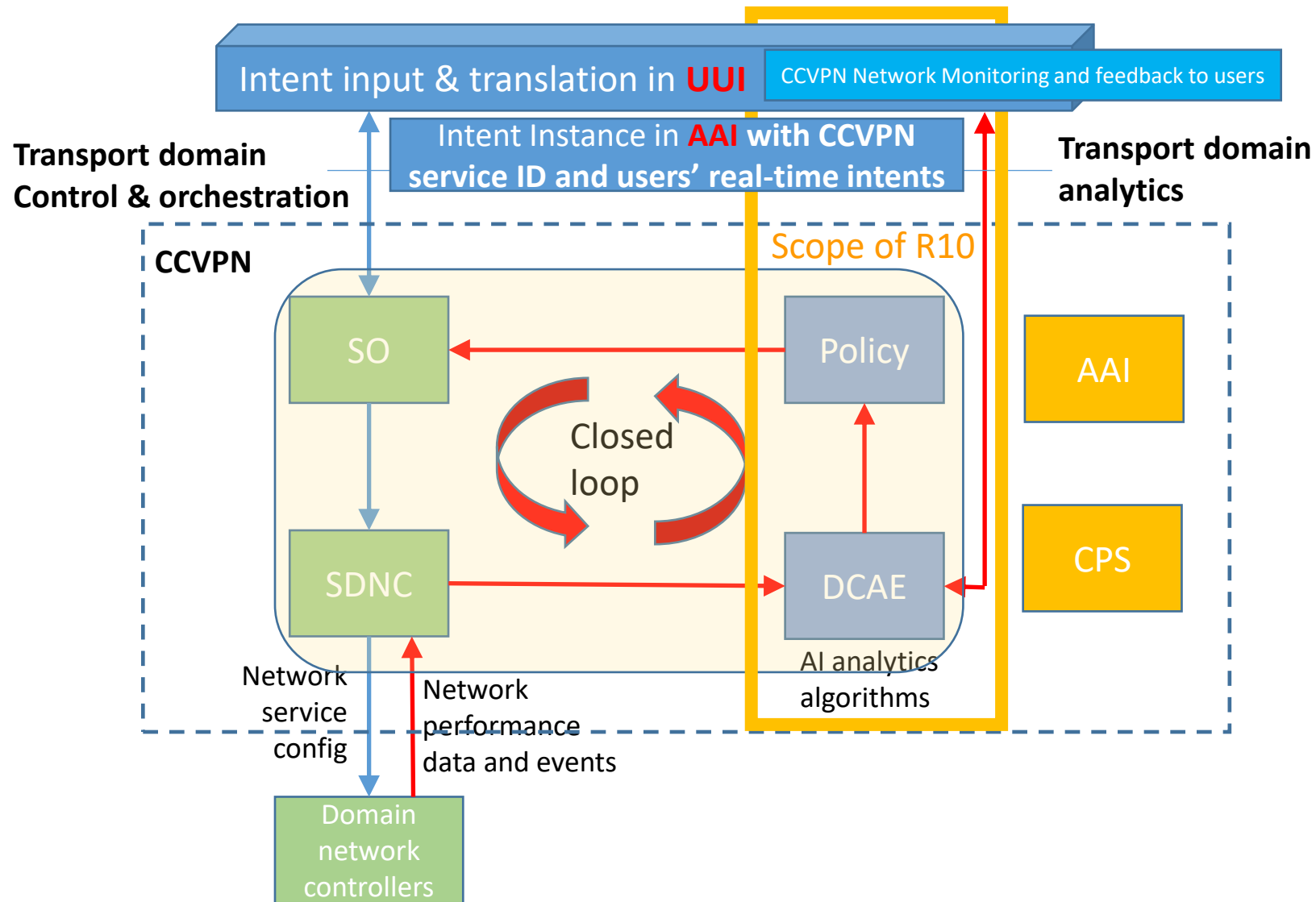




# 2.3-1 Intent-driving CCVPN Closed-loop (R9 - Intent Instance)



## 2.3-2 Intent-driving CCVPN Closed-loop (R10 - Intent Guarantee)



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**REQ of R11 Maintenance and Enhancement**

# 3. Scope of R11: Maintenance and Enhancement

- ❑ Maintain the documentation of Intent-driving Autonomous Networks
- ❑ Maintain the support of CCVPN usecase for ETSI ZSM PoC demo
- Enhance NLP platform and model
- Enhance the support of E2E Slicing usecase
- Scene-based end-to-end test and demo: Smart Energy Industry

# 3.1 Documentation

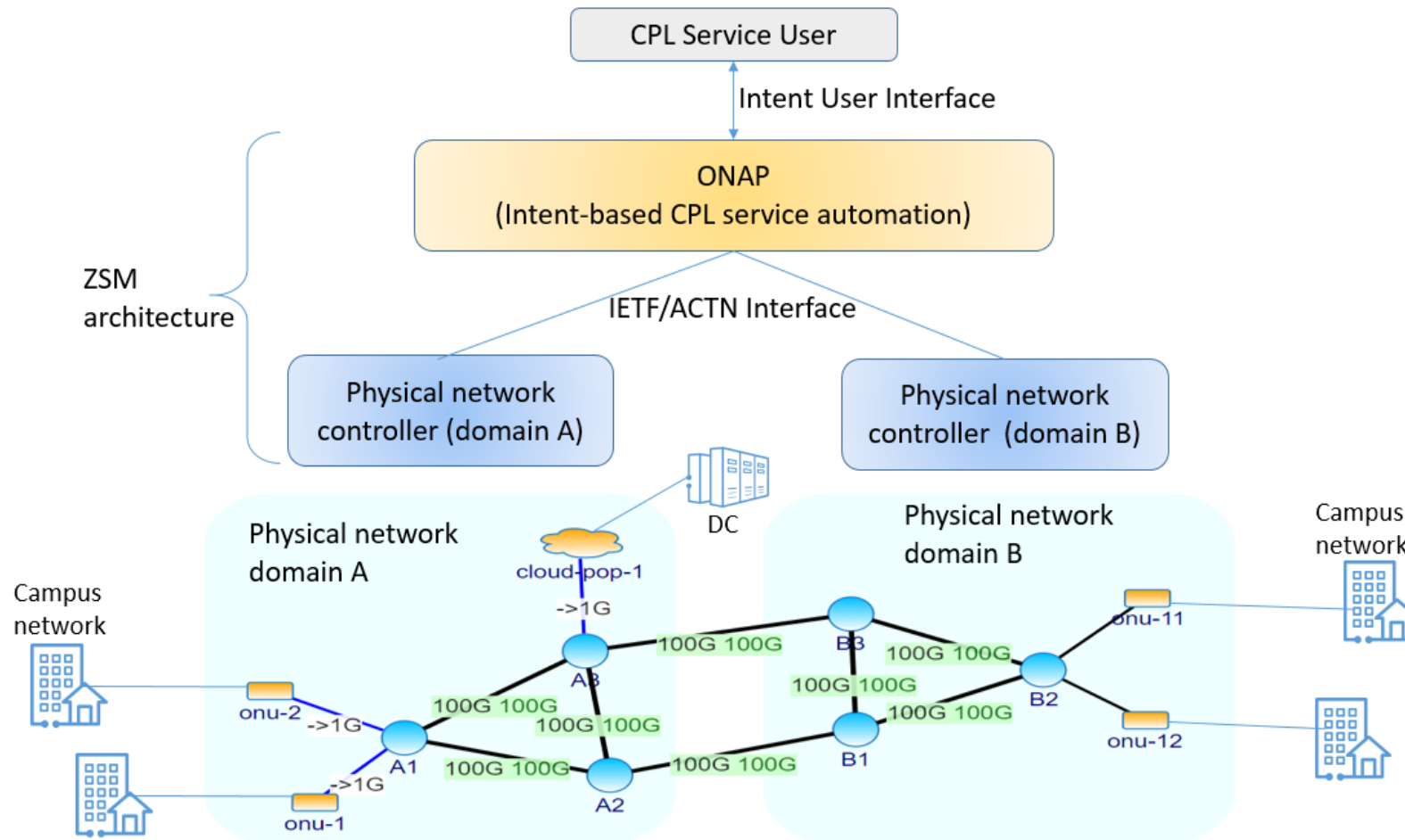
Maintain and update the documentation of full functions for user and developer guides in wiki and docs.

## Contents

### Intent-driven Closed-loop Autonomous Networks

- i. Overview
- ii. Vision & Architecture
- iii. Projects Impact
- iv. Workflow
- v. Usecases Support
- vi. AI/ML Model
- vii. Example Scene

## 3.2 Support the demo: Automation of Intent-based cloud leased line service



ETSI ZSM PoC 003: Automation of Intent-based cloud leased line service

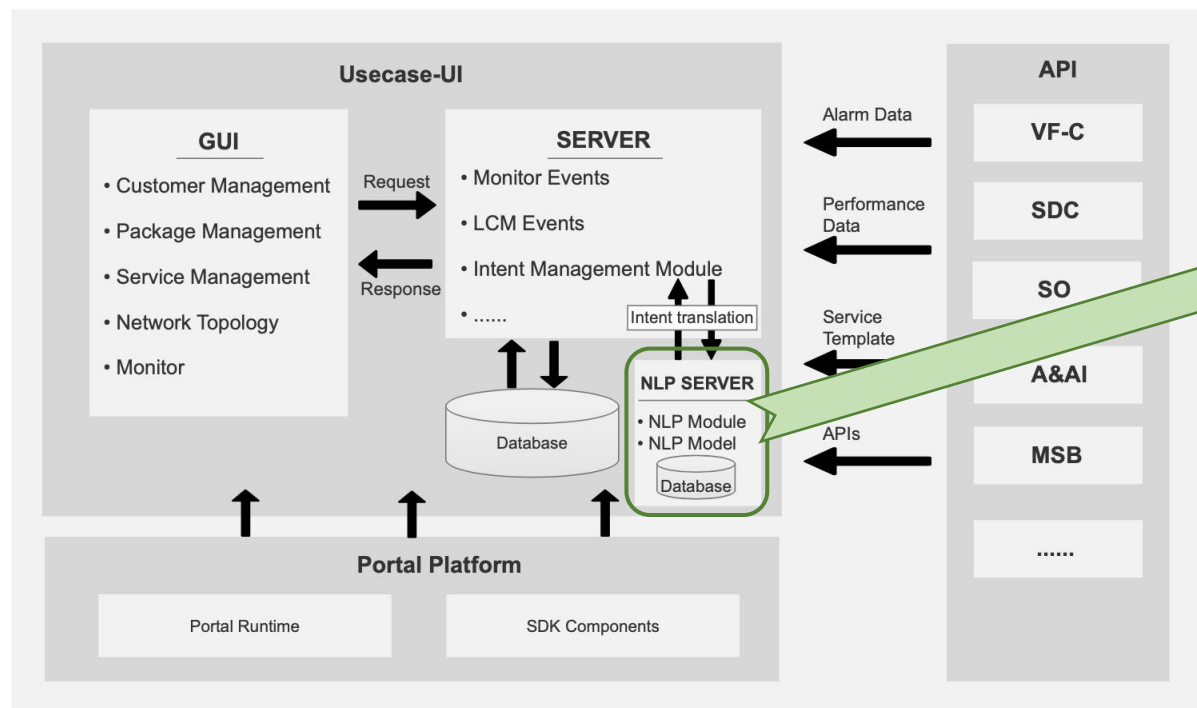
Milestone	Date
PoC project start	Jan 2022
<b>Demo 1:</b> Automated CLL service creation, modification and deletion (simulated hardware)	May 2022 (ZSM#19 tbc)
<b>Demo 2:</b> Closed-loop operations for CLL service assurance (simulated hardware)	May 2022 (ZSM#19 tbc)
<b>Interim report:</b> Contribution on lessons learned from Demo 1 & 2, and how to improve Demo 3	July 2022
<b>Demo 3:</b> CLL service automation and closed-loop operations with real hardware and real data traffic	Nov 2022
<b>Final report:</b> Contribution on lessons learned from the PoC	Dec 2022
PoC project end	Dec 2022

## ZSM PoC#3 Team Members

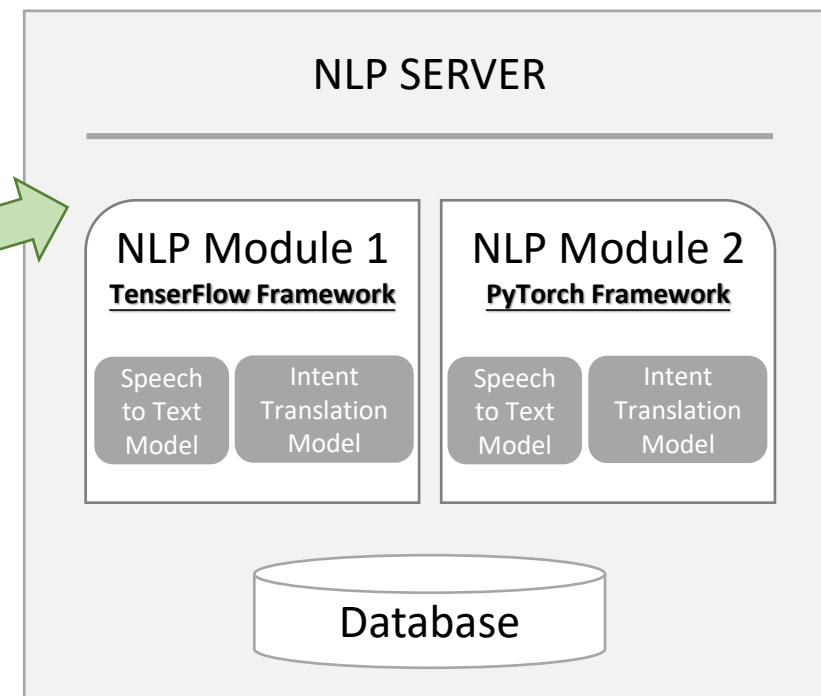


# 3.3 Enhancement of NLP platform and model in UII

- **Task 1:** Add PyTorch framework to support more models (TensorFlow framework has been added since Honolulu Release).
- **Task 2:** Improve the accuracy rate of intent translation with multiple models.
- **Task 3:** Enhance the function of STT (speech to text).



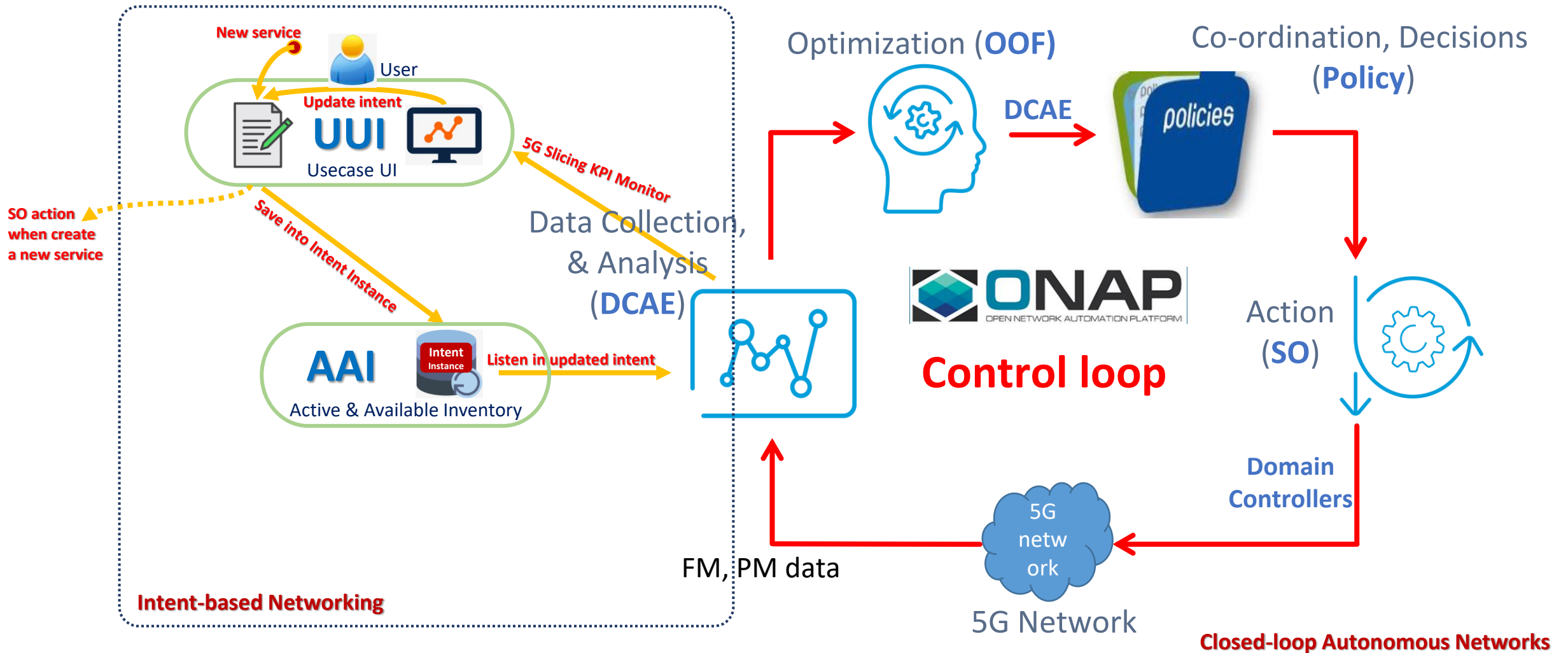
Components of UII since Honolulu Release



Enhancement of NLP microservice in UII



# 3.4 Intent-driving E2E Slicing usecase



# E2E Network Slicing Meeting (Apr 12, 2022)

## Discussion on joint work proposal (IBN, CCVPN and NS)

- Introduction of ML prediction MS
- Introduction of workflow and API of intent interaction
- Introduction of Intent-driven Closed-loop Autonomous Networks in R11
- Intent-driven E2E Network Slicing proposal with key tasks:
  - Integration of ML prediction MS with DCAE (IBN and network slicing teams)
  - Enhancement to intent creation and workflow to support E2E Network Slicing based on UII, AAI and DCAE (IBN team)
  - Enhancement to the closed-loop and the ML prediction MS for 5G KPI monitoring to support IBN (NS team)

<https://wiki.onap.org/display/DW/E2E+Network+Slicing+Meeting+Notes+for+Apr+12%2C+2022>

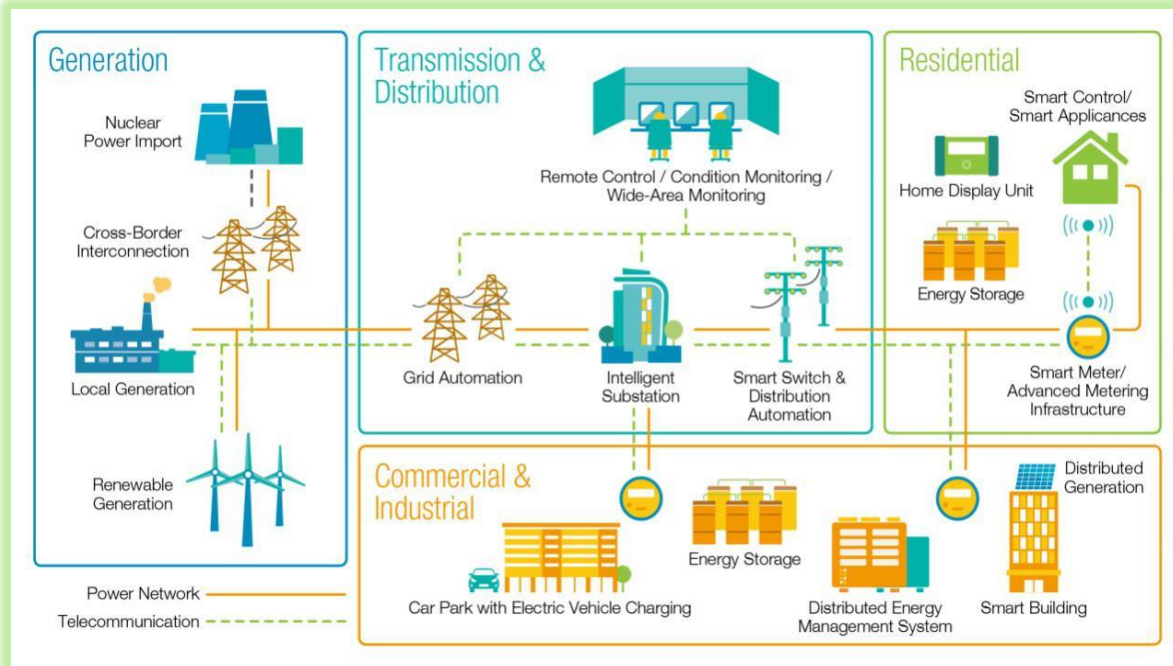
# 3.5 Application Scene: Smart Energy

An application scene, **Smart Energy**, is chosen for the end-to-end test and demo of intent-driven on-demand services based on fixed and mobile networks:

- ✓ Fixed Networks - CCVPN (Cloud leased line)
- ✓ Mobile Networks - 5G E2E Slicing

## A Vision of Smart Energy

Ref. 3GPP TR 22.867 Study on 5G Smart Energy and Infrastructure



## Network Performance KPIs of Smart Energy and Infrastructure

Table 7.2-3 Clock Synchronization Service Performance Requirements

Use case	User-specific clock synchronicity accuracy level [65]	Number of devices in one Communication group for clock synchronisation	Clock synchronicity requirement	Service area	5GS synchronicity budget requirement
5.3 Distributed Feeder Automation	-	54/km <sup>2</sup> (note 1) 78/km <sup>2</sup> (note 2)	-	several km <sup>2</sup>	<10 μs

Table 7.2-2 KPI Table of Aperiodic Communication Services

Use case	Experience ed data rate	availability	Transfer Interval: target value	Message size	Service area	Allowed End-to-End latency	Max density	liability	Storage node density # /km <sup>2</sup> (note 2)
5.1 Distributed Energy Storage - monitoring	UL: > 16 Mbit/s (urban), 640 Mbit/s (rural) DL: > 100 kbit/s (note 1)	DL: >99.90 %	UL: 10 ms	UL: 50 x 16 kbyte	-	DL:<10 ms UL:<10 ms	>10 /km <sup>2</sup> (urban), >100 /km <sup>2</sup> (rural) (storage node density, note 2)	>99.90%	>[x]*100
5.1 Distributed Energy - Storage Data collection	UL: > 128 kbit/s (urban), 10.4 Mbit/s (rural) DL: > 100 kbit/s (note 1)	DL: >99.90 %	UL: 1000 ms	UL: 50 x 26 kbyte DL: >100 kbyte	-	DL:<10 ms UL:<1000 ms	>10 /km <sup>2</sup> (urban), >[100 /km <sup>2</sup> (rural) (storage node density, note 2)	99%	-
5.2 advanced metering	UL:<2 Mbit/s DL:<1 Mbit/s	>99.99%	-	-	-	General information data collection: <3000 ms (note 3)	<10000/km <sup>2</sup> (connection density, note 4)	-	-
5.3 Distributed Feeder Automation	2 Mbit/s to 10 Mbit/s	99.999%	Normal: 1s; Fault: 2ms	-	-	<10 ms (see note 6)- Latency jitter <50 μs (note 5)	54/km <sup>2</sup> (see note 7) 78/km <sup>2</sup> (connection density, note 8)	-	-
5.5 Distribution Automation (DA), centralized architecture	9.6-100 kbit/s	99.999%	-	-	-	100 ms – 2 s	100/km <sup>2</sup> concentrated rural, 10/km <sup>2</sup> semi-urban	-	-

## 3.5 Application Scene: Smart Energy

An application scene, **Smart Energy**, is chosen for the end-to-end test and demo of intent-driven on-demand services based on fixed and mobile networks:

- ✓ Fixed Networks - CCVPN (Cloud leased line)
- ✓ Mobile Networks - 5G E2E Slicing

A story is provided for end-to-end test and demo:

An energy company opened a Cloud leased line (fixed network) and a 5G leased line (mobile network) to support its business. The cloud leased line could provide high bandwidth and high reliability. And the 5G leased line provides high mobility. For user's intent-driven on-demand services in future networks, if the user want to start a new service (like virtual meeting), he just need to say 'I need the service for virtual meeting', and the intent-based networking could prefer to choose the CCVPN (Cloud leased line) for his service with high bandwidth and high reliability. If the user is moving, a high reliability and suitable bandwidth 5G slicing is chosen for the service. Moreover, the closed-loop autonomous networks provides closed-loop intent guarantee by keeping monitoring the network and updating the policies.

In order to support the above story, dataset and business survey are required for ML training and business analysis:

- a. A dataset of users' service intents is required for training NLP model to support intent translation function.
- b. Business survey and analysis is used to configure pre-defined Cloud leased line templates and 5G Slicing templates for a specialized industry (like smart energy).

This sub-REQ focuses on the solution of the above story.

# REQ-XXXX: Maintenance and Enhancement of Intent-driven Closed-loop Autonomous Networks in R11

Intent-based networking is applied to support the smart interaction between users (customers/operators) and networks. Based on the closed-loop automation of ONAP, the proposal of **Intent-driven Closed-loop Autonomous Networks** is proposed for the smart operation of networks. In R11, the proposal enhances the functions of intent interaction and intent guarantee for CCVPN and E2E Slicing usecases.

**Key Contacts** - Dong Wang (China Telecom), Keguang He(CMCC), Henry Yu (Huawei), Ahila Pandaram (Wipro), Kevin Tang (STL)

**Executive Summary** - Intent-based networking (IBN) is a self-driving network that uses decoupling network control logic and closed-loop orchestration techniques to automate application intents. An IBN is an intelligent network, which can automatically convert, verify, deploy, configure, and optimize itself to achieve target network state according to the intent of the operators, and can automatically solve abnormal events to ensure the network reliability. In R11, the proposal enhances the functions of intent interaction and intent guarantee for CCVPN and E2E Slicing usecases.

**Business Impact** - It is a challenging problem for networks to satisfy users' intents in real time. The REQ intent-based networking provides intent interaction and guarantee functions for users.

**Business Markets** - This REQ provides a novel solution of Intent-driven Closed-loop Autonomous Networks with two closed-loops, intent interaction closed-loop and intent guarantee closed-loop. And intent instance is used to manage users' real-time intents.

**Funding/Financial Impacts** - Intent-based networking simplifies interaction and network configuration to save OPEX cost. It also provides the services to satisfy users' real-time intents, so as to increase the income of operators with few investments.

**Organization Mgmt, Sales Strategies** - *There is no additional organizational management or sales strategies for this requirement outside of a service providers "normal" ONAP deployment and its attendant organizational resources from a service provider.*

# Projects Impact

Project	Impact	Notes
UUI	<ul style="list-style-type: none"><li>● Enhance the functions in NLP microservice;</li><li>● Enhance the STT and Intent Translation models;</li><li>● Support the intent management for E2E Slicing usecase.</li></ul>	
AAI	n/a	re-use the Intent Instance node
DCAE	<ul style="list-style-type: none"><li>● Integrate the ML MS for Closed-loop (PoC of E2E Slicing in R10);</li><li>● Add the function of listening in updated intent for E2E Slicing.</li></ul>	re-use the <b>AAI-EVENT</b>
Doc	<ul style="list-style-type: none"><li>● Maintain the documentation.</li></ul>	



**ONAP**

OPEN NETWORK AUTOMATION PLATFORM

**Thanks!**

# Influences

**Intent Based Networking. A major step towards autonomous networks, for operator and enterprise use cases.**

**ONAP Marketing Priorities 2021**



**ONAP**  
Open Network Automation Platform

About Architecture Software Resources Community Verification News

Software

### Latest Release

The ninth release of ONAP, Istanbul, broadens and deepens ONAP's position in the industry as the comprehensive platform for orchestration, management, and automation of network and edge computing services for network operators, cloud providers, and enterprises.

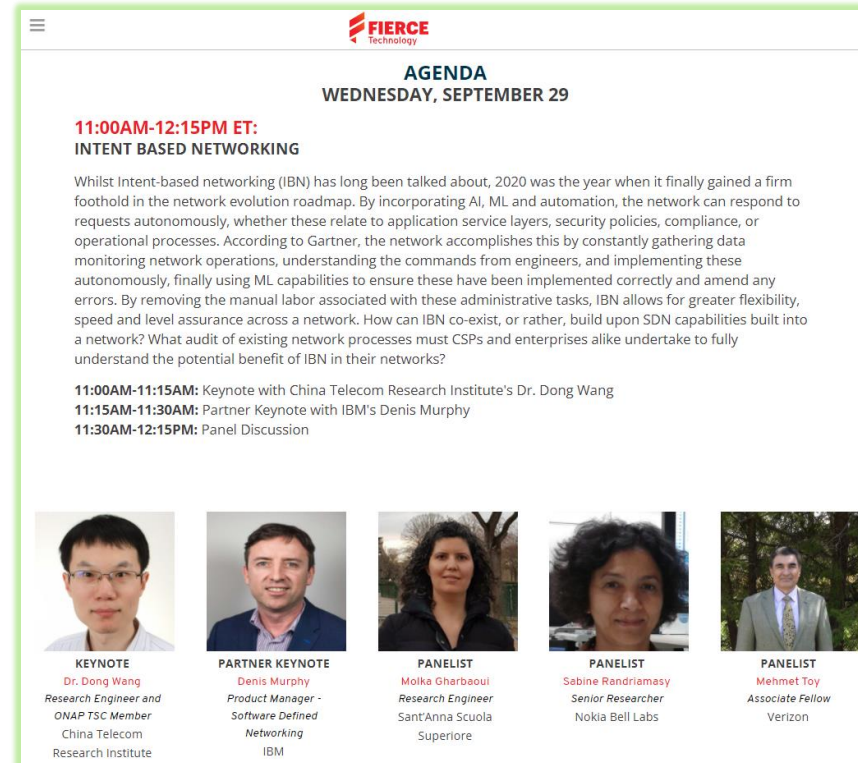
"I am excited to announce the general availability of the ONAP Istanbul release", said Catherine Lefevre, ONAP TSC Chair. "We continued to enhance our Blueprints (GG, CCVPN) while expanding our intent based networking capabilities. We are paving the way for CNF orchestration and Enterprise/Vertical markets through the work performed by our task forces. We maintained a strong focus on increasing scalability, reliability and security for production readiness deployments, as well as improving our delivery agility by concentrating on a single release candidate milestone while still meeting all the release criteria in a timely manner".

[Get the Code](#) | [Read the Docs](#) | [See Release Notes](#) | [Get the Architecture Overview](#) | [See the Wiki](#)

### Release Highlights

- Intent based networking (IBN) simplifies interaction and network configuration by Control-Loop and Smart AI.
- Alignment with O-RAN Strategy to enable new RAN use cases
- Continued Cloud Native evolution with a rich feature set for CNF orchestration capabilities
- Next level of functionality for 5G use cases including Network Slicing, Performance management, SON, and CCVPN
- A second generation of control loop automation architecture
- New Network Function lifecycle management features based on real-life use cases
- New functionality for complex network configuration management
- Flexibility in resource onboarding with choice of modeling including SDC AID, ETSI SOL001
- Software quality and security improvements based on deployment experience
- Cloud native deployment support for all DCAE Services via helm (in addition to Cloudify/Blueprints)

**ONAP Istanbul - Release Highlights**



**FIERCE**  
Technology

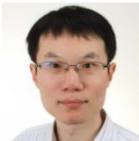




### AGENDA

WEDNESDAY, SEPTEMBER 29

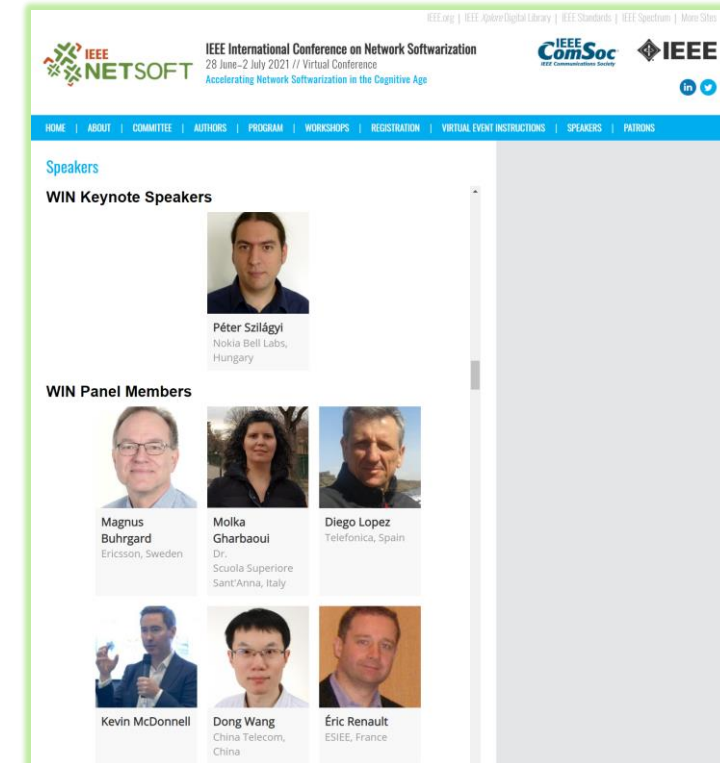
**11:00AM-12:15PM ET:**  
**INTENT BASED NETWORKING**

Whilst Intent-based networking (IBN) has long been talked about, 2020 was the year when it finally gained a firm foothold in the network evolution roadmap. By incorporating AI, ML and automation, the network can respond to requests autonomously, whether these relate to application service layers, security policies, compliance, or operational processes. According to Gartner, the network accomplishes this by constantly gathering data monitoring network operations, understanding the commands from engineers, and implementing these autonomously, finally using ML capabilities to ensure these have been implemented correctly and amend any errors. By removing the manual labor associated with these administrative tasks, IBN allows for greater flexibility, speed and level assurance across a network. How can IBN co-exist, or rather, build upon SDN capabilities built into a network? What audit of existing network processes must CSPs and enterprises alike undertake to fully understand the potential benefit of IBN in their networks?

**11:00AM-11:15AM:** Keynote with China Telecom Research Institute's Dr. Dong Wang  
**11:15AM-11:30AM:** Partner Keynote with IBM's Denis Murphy  
**11:30AM-12:15PM:** Panel Discussion

 <p><b>KEYNOTE</b> Dr. Dong Wang Research Engineer and ONAP TSC Member China Telecom Research Institute</p>	 <p><b>PARTNER KEYNOTE</b> Denis Murphy Product Manager - Software Defined Networking IBM</p>	 <p><b>PANELIST</b> Molka Gharbaoui Research Engineer Sant'Anna Scuola Superiore</p>	 <p><b>PANELIST</b> Sabine Randriamasy Senior Researcher Nokia Bell Labs</p>	 <p><b>PANELIST</b> Mehmet Toy Associate Fellow Verizon</p>
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**Fierce Wireless Presents: Network Automation Week**  
<https://www.fiercedigitaltechevents.com/fiercedigitaltechevent/network-automation-week>



IEEE.org | IEEE Author Digital Library | IEEE Standards | IEEE Spectrum | More Sites


**IEEE NETSOFT**  
IEEE International Conference on Network Softwarization  
28 June-2 July 2021 // Virtual Conference  
Accelerating Network Softwarization in the Cognitive Age

IEEE ComSoc | IEEE





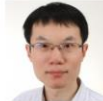

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### Speakers

#### WIN Keynote Speakers

  
Péter Szilágyi  
Nokia Bell Labs,  
Hungary

#### WIN Panel Members

 Magnus Buhrgard Ericsson, Sweden	 Molka Gharbaoui Dr. Scuola Superiore Sant'Anna, Italy	 Diego Lopez Telefonica, Spain
 Kevin McDonnell	 Dong Wang China Telecom, China	 Eric Renault ESIEE, France

**International Workshop on Intent-Based Networking (WIN'2021)**  
In conjunction with IEEE Netsoft 2021  
<http://www.adda-association.org/win-2021/Program.html>