

Introduction to Intent Based Networking: Concepts and Applications

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Telecom O&M API Evolution

Upper layer application/system

1st Gen

2nd Gen

3rd Gen

Atomic interfaces

- Frequent command interaction

Upper layer : Functional integrator
Lower layer : Functional actor

Scenario API

- Transaction based interaction
- Abundant notifications

Upper layer : Service orchestrator
Lower layer : Transaction Executor

Intent API

- Intent based interaction

Upper layer : Intent owner
Lower layer : Intent handler

Unchanged requirements for O&M interfaces



Compatibility

(Easy to extend)



Simplification

(Improve efficiency)



Completion

(Cover all requirements)

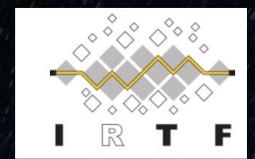


Decoupling

(Independent of network implementation)

- Intent describes the business objective of operators as well as the expectations of customers and users. In this respect, intent establishes machine-readable knowledge about goals, targets, requirements, and constraints.
- Intent defines what an autonomous network is expected to achieve, but it leaves the details of how a network is designed and operated to the internal operations of the network platform.

Key Information from NMRG / IRTF



The NMRG is chaired by **Laurent Ciavaglia** and **Jérôme François**

- ✓ The Internet Research Task Force (IRTF) focuses on longer term research issues related to the Internet while the parallel organization, the Internet Engineering Task Force (IETF), focuses on the shorter term issues of engineering and standards making.
- ✓ The Network Management Research Group (NMRG) provides a forum for researchers to explore new technologies for the management of the Internet.
- ✓ In particular, the NMRG will work on solutions for problems that are not yet considered well understood enough for engineering work within the IETF.

NMRG Topics

Intent based Networking (IBN)

Artificial Intelligence in Network management (AI-NM)

Self-Driving / Managing Networks (SD/MN)

Current NMRG Documents / Internet Drafts

In IRSG poll:

Intent-Based Networking – Intent Classification ()**

<https://datatracker.ietf.org/doc/draft-irtf-nmr-ibn-intent-classification/>

In IRSG review:

Intent-Based Networking – Concepts and Definitions

<https://datatracker.ietf.org/doc/draft-irtf-nmr-ibn-concepts-definitions/>

Recently adopted RG document:

Digital Twin Network: Concepts and Reference Architecture

<https://datatracker.ietf.org/doc/draft-irtf-nmr-network-digital-twin-arch/>

Candidate RG Document:

Network measurement intent – one of IBN use cases

<https://datatracker.ietf.org/doc/draft-yang-nmr-network-measurement-intent/>

() Huawei Ireland Research Center is active in this group and we have 2 editors in the Intent Classification Draft**

Intent-Based Networking – Concepts and Definitions



Authors: Alexander Clemm, Laurent Ciavaglia, Lisando Graville and Jeff Tantsura

NMRG Internet Draft:

Intent-Based Networking - Concepts and Definitions

<https://datatracker.ietf.org/doc/draft-irtf-nmrg-ibn-concepts-definitions/>

1. Defines the intent and other core concepts
2. Provides the overview of functionality
3. Clarified the difference with Service and Policy

INTENT provides:

1. **Data Abstraction** from network, devices and controllers APIs, configurations and status
2. **Functional Abstraction** from how the network is managed/controlled by controllers and managers

PRINCIPLES:

The following principles allow a System to be characterized as an intent-driven:

1. **Single Source of Truth (SSoT)** and Single Version/View of Truth (SVoT) expected vs actual, set of validated intent expressions
2. **One-touch but not one-shot**, may include interactive and iterative communication with the user
3. **Autonomy and Supervision.**
4. **Learning, Reasoning and knowledge** representation and management. Transfer of reasoning/rationality from the human (domain knowledge) to the system.
5. **Capabilities Exposure.**
6. **Abstraction.**

INTENT A set of operational goals that a network should meet and outcomes that a network is supposed to deliver, defined in a declarative manner without specifying how to achieve or implement them

Intent-Based Management The concept of performing management based on the concept of intent

IBA: Intent-Based Analytics Analytics that are defined and derived from users' intent and used to validate the intended state.

IBN: Intent-Based Network

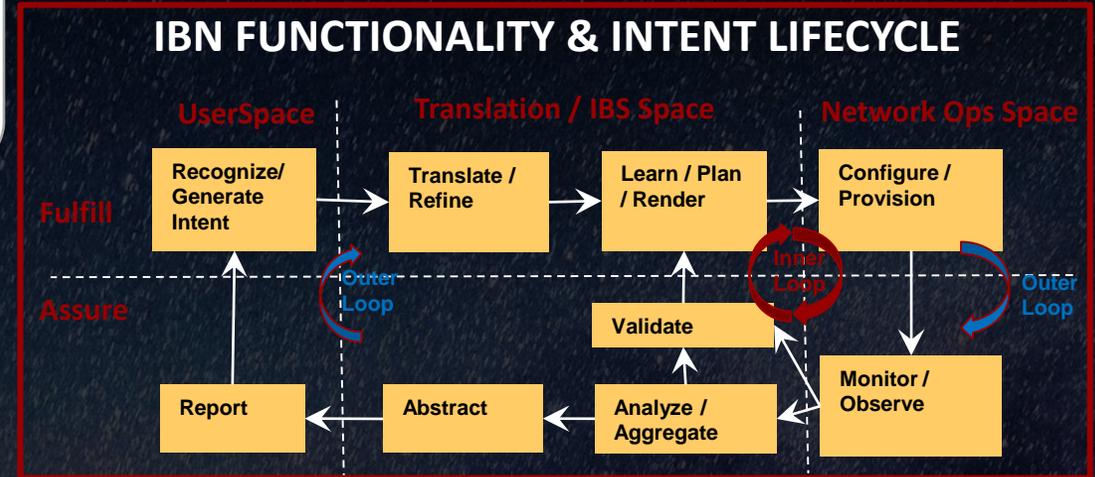
A network that can be managed using intents

IBS: Intent-Based System

A system that supports management functions that can be guided using intent

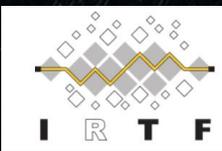
SSoT: Single Source of Truth

A functional block in an IBN system that normalizes users' intent and serves as the single source of data for the lower layers.



		Service	Policy
Intent	Similar	<p>Provide higher layers of abstraction</p> <p>Service models are often also complemented with mappings that capture dependencies between service and device or network configurations.</p>	<p>Provide the higher level of abstraction.</p> <p>Policy systems capture dynamic aspects of the system under management through the specification of rules that allow defining various triggers for specific courses of actions.</p>
	Different	<p>Service model does not define the desired outcome that would be automatically maintained by the system.</p>	<p>Unlike intent, the definition of those rules (and courses of actions) still needs to be articulated by users. Since the intent is unknown, conflict resolution within or between policies requires interactions with a user or some kind of logic that resides outside of PBM.</p>

Intent-Based Networking – Intent Classification



Authors:
 Chen Li, Olga Havel, Adriana Olariu,
 Pedro Martinez-Julia, Jéferson Nobre, Diego Lopez

Internet Draft:

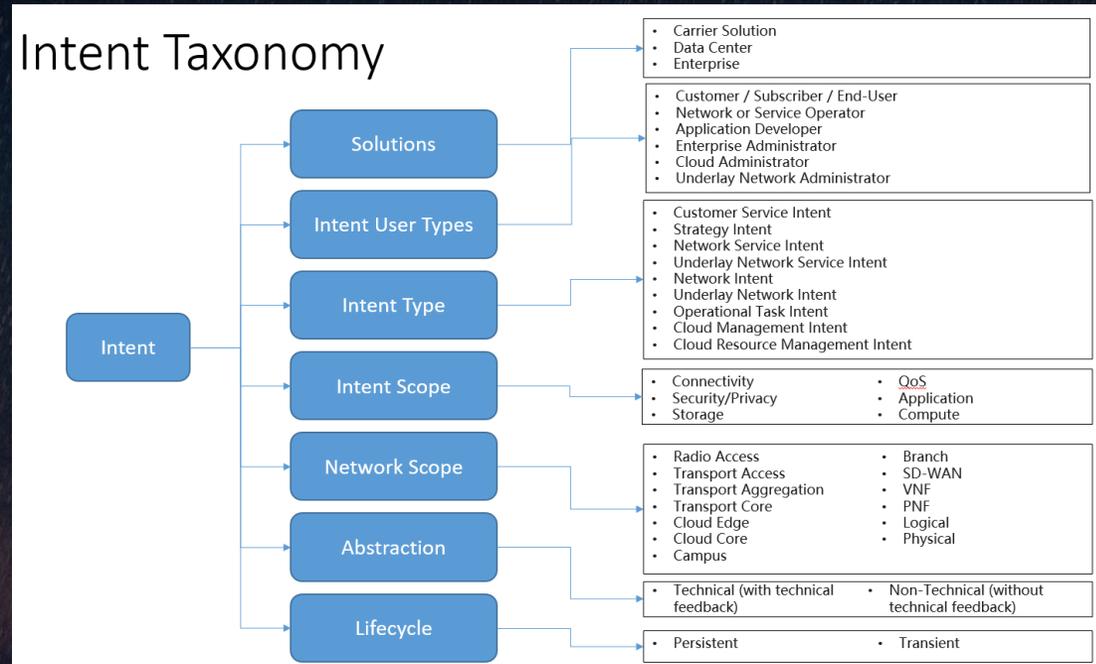
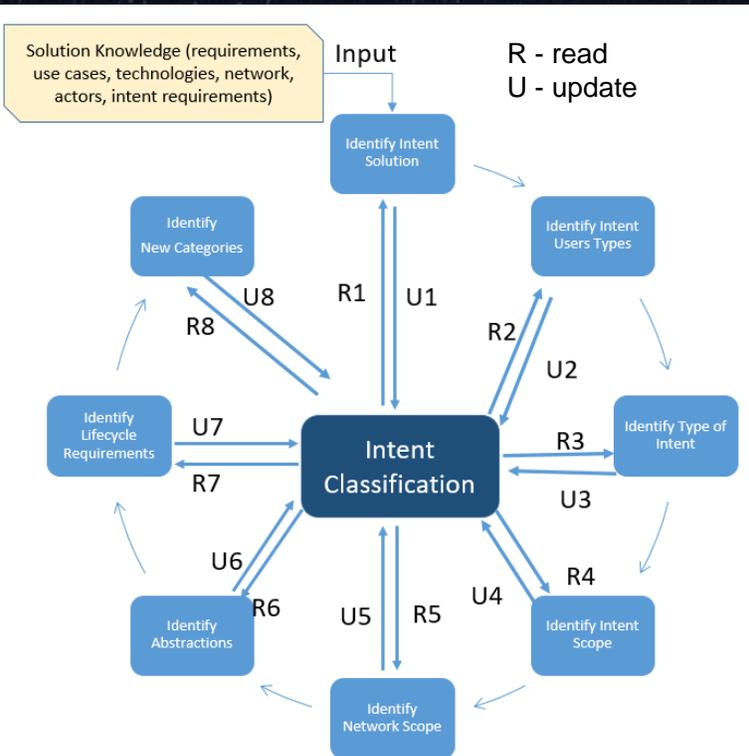
Intent-Based Networking – Intent Classification <https://datatracker.ietf.org/doc/draft-irtf-nmrg-ibn-intent-classification/>

- Focused on intent classification on various dimensions, such as solutions, intent users and intent types
- Proposes methodology for classifying intents
- Presents initial taxonomy and Intent Classification Tables for different Solutions and Users

Each step (1-8): Review existing classification and use/add/remove

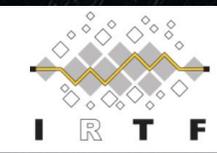
Shows aggregated taxonomy for all 3 solutions, classification tables show per solution/user (next slide)

- The goal of this document is to bring clarity to what an intent represents for different stakeholders, by means of classification on various dimensions



- This classification would ensure a common understanding across all participants and it can be used to identify the scope and priorities of individual projects, PoCs, research or open-source projects.
- This is achieved by proposing initial taxonomy and the methodology used for generating it. This methodology can be used to update the tables by adding or removing different solutions, users or intent types in order to cater for future scenarios, applications or domains

Intent-Based Networking – Intent Classification



3 Classification tables have been initially proposed, through 3 iterations, one per solution. In the future, as new scenarios, applications, and domains are emerging, new classification tables can be identified, following the proposed methodology.

Intent User	Intent Type	Intent Scope				NF Scope				Network Scope				ABS		L-C			
		C1	C2	C3	C4	C1	C2	C3	C4	C1	C2	C3	C4	C5	C6	C1	C2	C1	C2
Customer / Sub-scriber	Customer Service Intent																		
	Strategy Intent																		
Network Operator	Network Service Intent	X	X	X										X	X	X	X		
	Network Intent																		
	Operational Task Intent																		
	Strategy Intent																		
Service Operator	Customer Service Intent	Y	Y	Y										Y	Y	Y	Y		
	Network Service Intent																		
	Op Task Intent																		
	Strategy Intent																		
App Developer	Customer Intent																		
	Network Service Intent																		
	Network Intent																		
	Op Task Intent																		
	Strategy Intent																		

Carrier Solution

DC Solution

Intent User	Intent Type	Intent Scope						DCN Res	DCN Net	ABS	L-C		
		C1	C2	C3	C4	C5	C6	C1	C2	C1	C2	C1	C2
Customer /Tenants	Customer Service Intent												
	Strategy Intent												
Cloud Admin	Cloud Management Intent	X	X					X	X	X	X		
	Cloud Resource Management Intent												
	Operational Task Intent												
	Strategy Intent												
Underlay Network Admin	Underlay Network Intent												
	Underlay Network Resource Intent												
	Operational Task Intent												
	Strategy Intent												
App Developer	Cloud Management Intent												
	Cloud Resource Management Intent												
	Underlay Network Intent												
	Underlay Network Resource Intent												
	Operational Task Intent												

Enterprise Solution

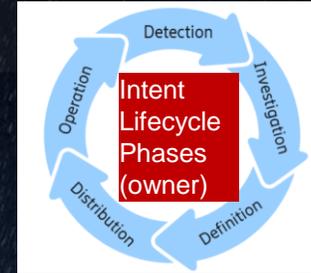
Intent User	Intent Type	Intent Scope				Net	ABS	L-C
		C1	C2	C3	C4	C1	C2	C3
End-User	Customer Service Intent							
	Strategy Intent							
Enterprise Administrator	Network Service Intent							
	Network Intent							
Application Developer	Operational Task Intent							
	Strategy Intent							
	End-User Intent							
Application Developer	Network Service Intent							
	Network Intent							
	Operational Task Intent							
Application Developer	Strategy Intent							

This methodology and taxonomy proposal has been successfully applied in an academic environment by Barbara Martini, Walter Cerroni, Molka Gharbaoui, Davide Borsatti for defining the scope of their research project and PoC “A multi-level approach to IBN” .
X-Slice Intent, Y- Service chain intent

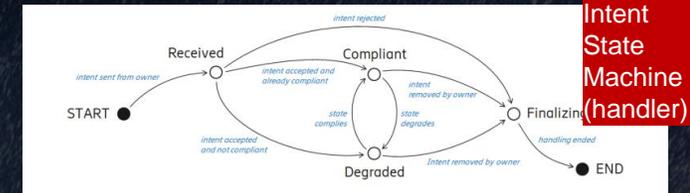
TM Forum – Intent in Autonomous Networks

TMF IG1253

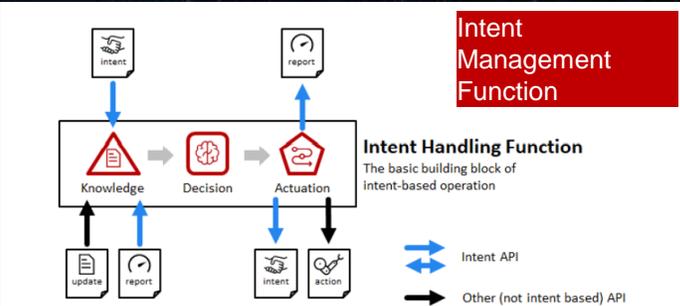
- Defines intent-driven operation according to the work in the Autonomous Networks Project. Definition of intent as well as the role of intent in autonomous operations
- Set of documents:
 - IG1253: Intent in Autonomous Networks
 - IG1253A: Intent Common Model
 - IG1253B: Intent Extension Models
 - IG1253C: Intent API and Lifecycle Management
 - IG1253D: Intent Handling Capacity Management
 - IG1253E: Use Cases and examples (future)



- Intent Owner manages intent lifecycle
- Intent Handler receives and intent object and operates the domain it is responsible for

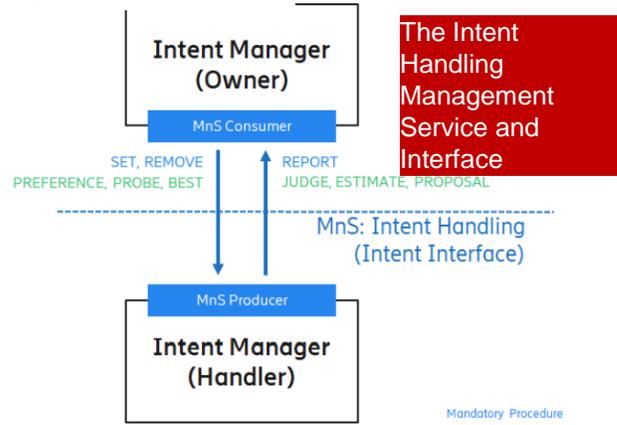


Intent State Machine (handler)

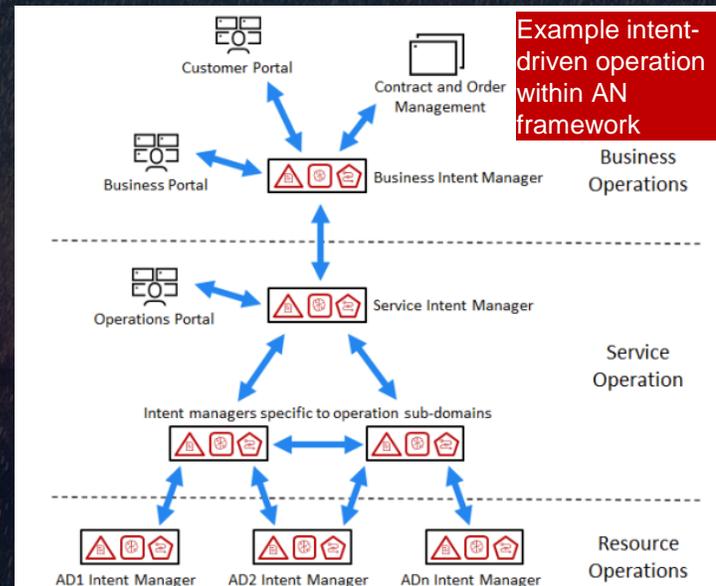


Intent Management Function

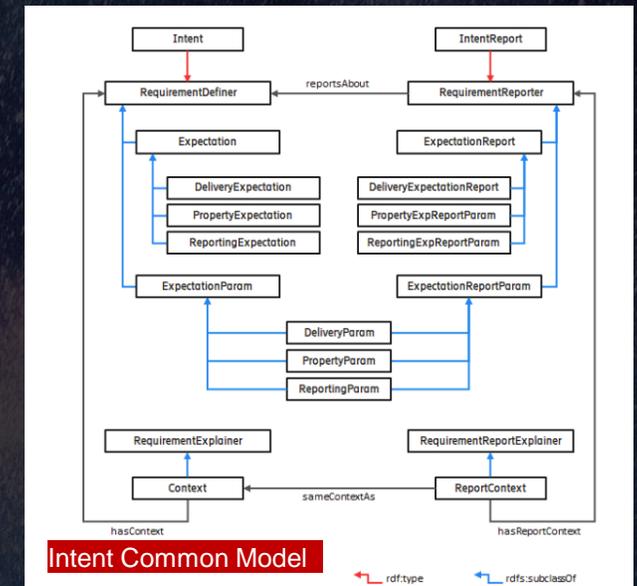
Intent Handling Function
The basic building block of intent-based operation



The Intent Handling Management Service and Interface

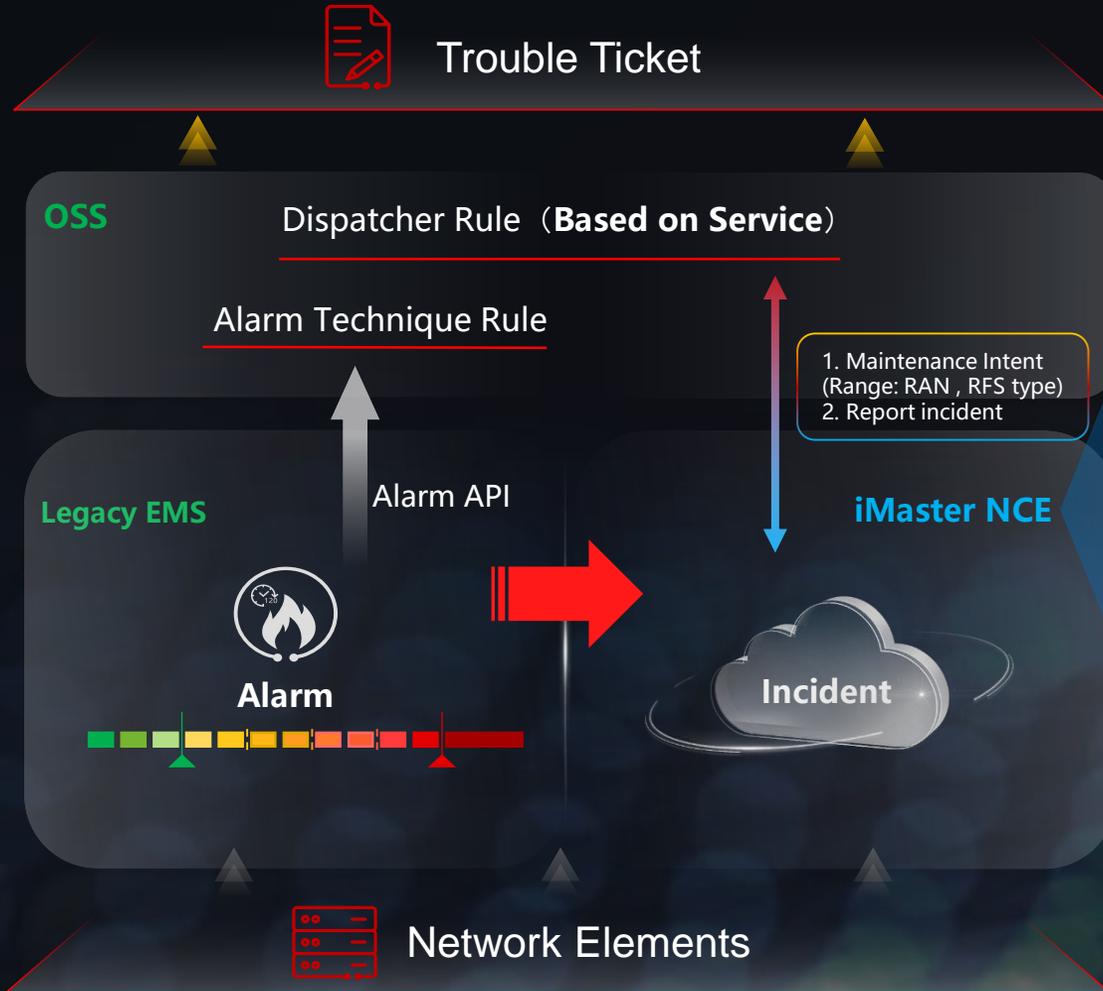


Example intent-driven operation within AN framework



Intent Common Model

UC1: Intent-driven Network for Incident Management



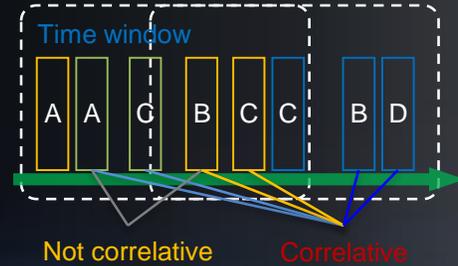
AI algorithms to identify based on E-FPG (Frequent Pattern Mining)

Spatiotemporal Correlation Pattern Mining@AI

Training State

Massive network maintenance data

Expert experience revision



AI

Fault Pattern Database

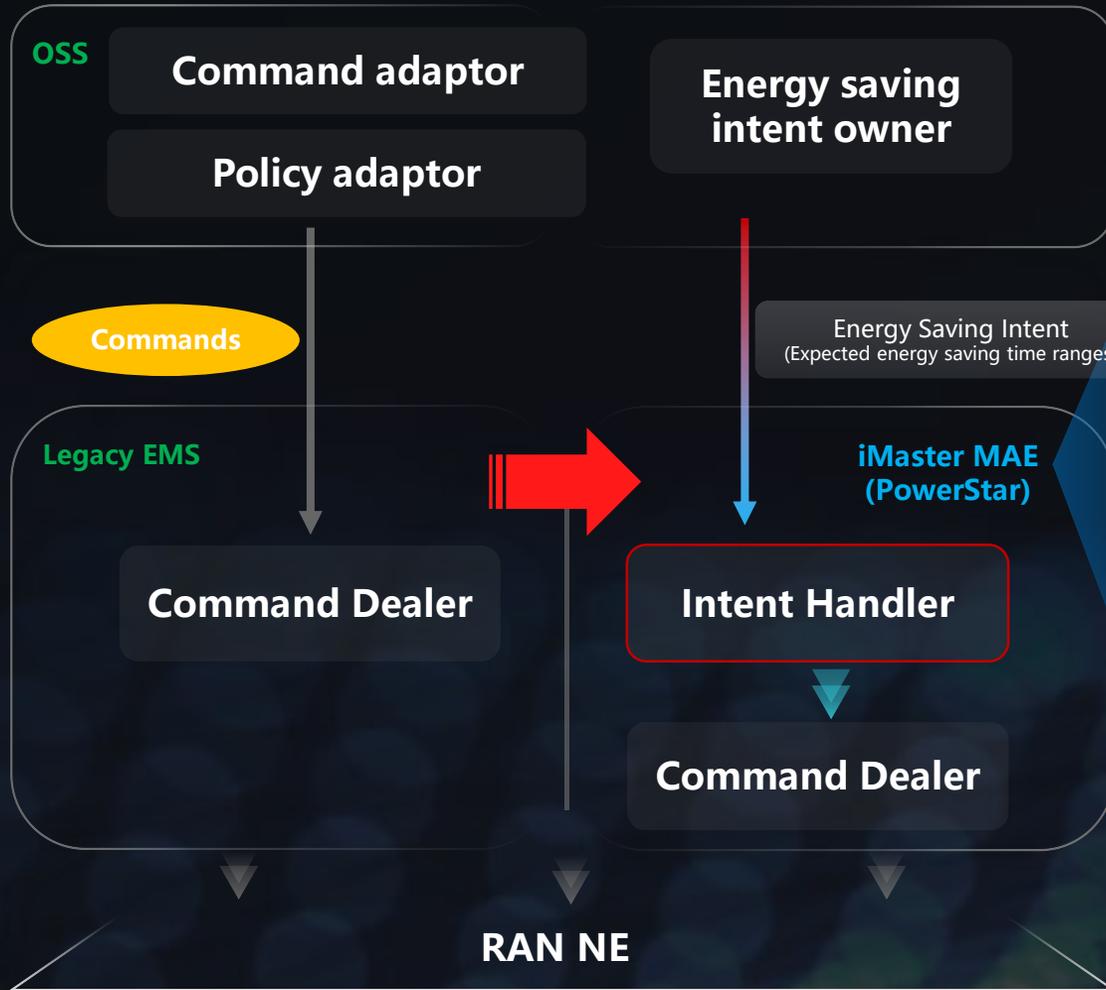
Inference State

Alarms on the live network

Fault matching

**Online fault pattern database rectification*

UC2: Intent-driven Network for 5G Energy Saving



1 Accurate prediction

BBU

RRU

Base station ID	1	2
Energy saving period	8	6
Energy saved (kWh)	0.10	0.13

Estimating sleep durations and energy saving benefits based on traffic models

2 Efficient deployment

- Data configuration engineering
- Parameters/traffic statistics



- ✓ Strategy recommendation
- ✓ Parameter design
- ✓ Generate scripts

Parameters designed using the MBB platform-based PowerStar app

3 Stable KPIs

+Δ Energy saving proportion



-Δ Energy saving proportion

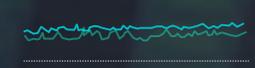
Stabilizing KPIs through optimization strategies and online iterative adjustment

4 Visible effects

Energy consumption trend

Energy consumption distribution

KPI monitoring



Real-time visualized operation of energy saving benefits and KPIs

Thank you

Q&A

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