Autonomous Operation in Beyond 5G Networks

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Rakuten Mobile, Inc.

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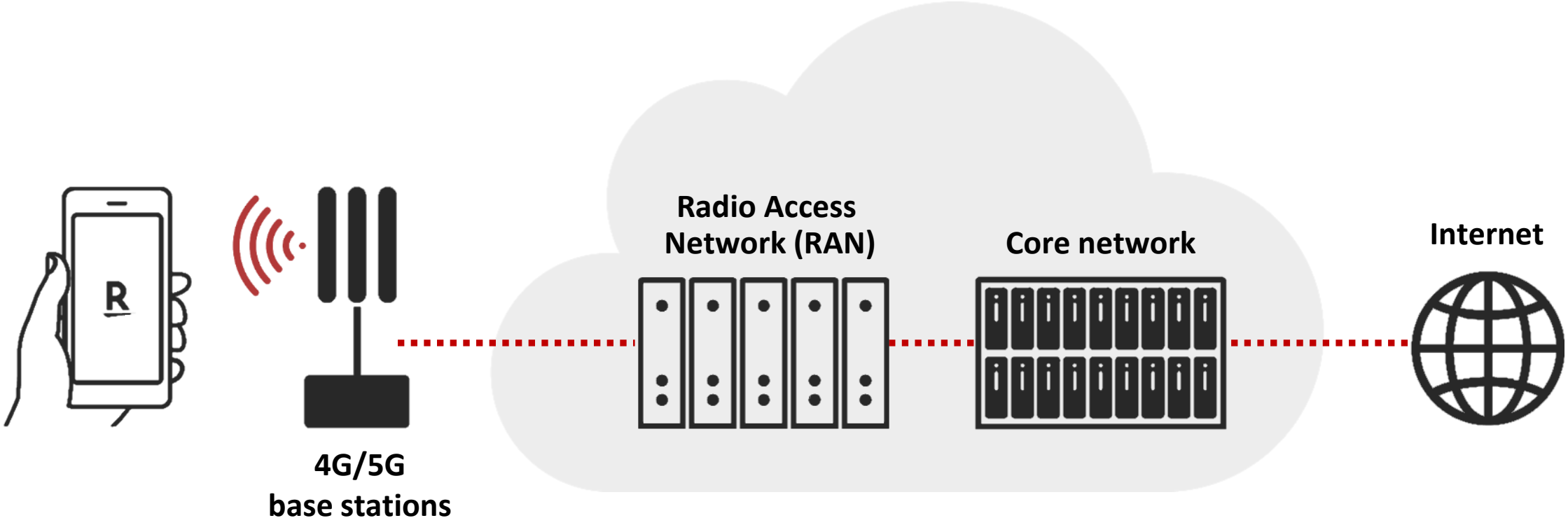
Rakuten Mobile

We are

End-to-End Fully Virtualized Cloud Native Mobile Network



Fully virtualized, cloud native

Introduction of Innovations for Telco Industry

Global
Open RAN Leadership

Highly Advanced
Edge Network

Efficient Operations
through Automation

Introduction of Innovations for Telco Industry

Global
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What is next?

Efficient Operations
through Automation

Introduction of Innovations for Telco Industry

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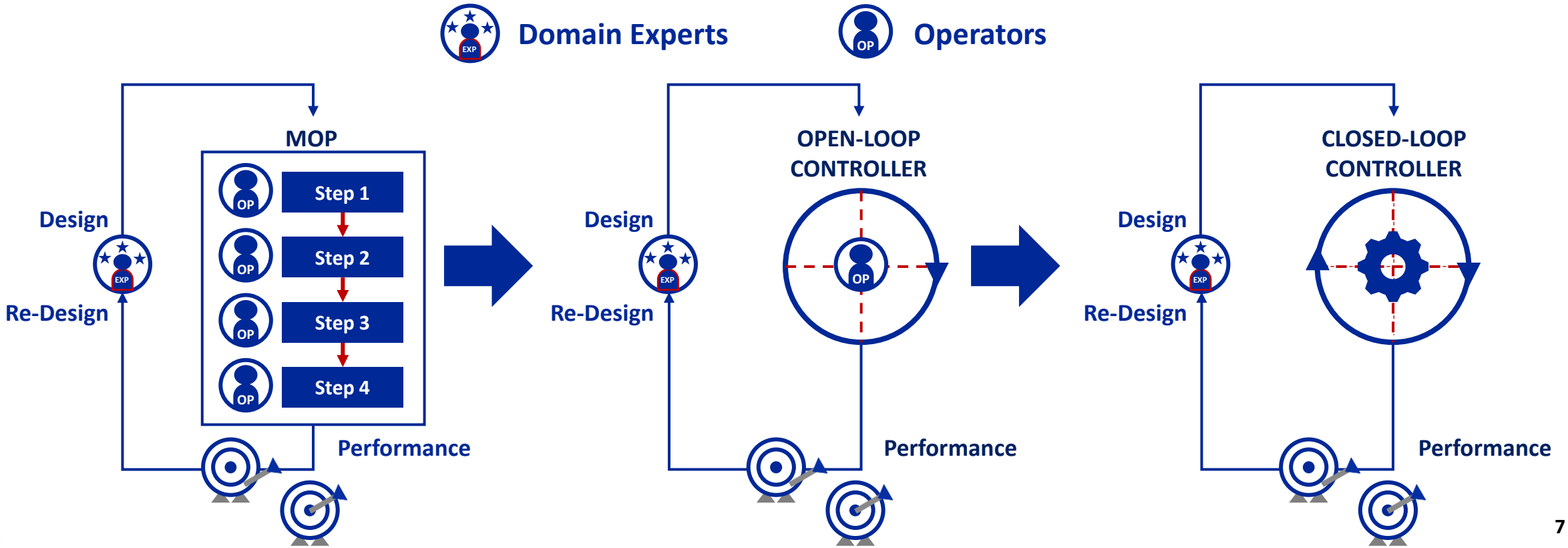
What is next?

Efficient Operations through Automation

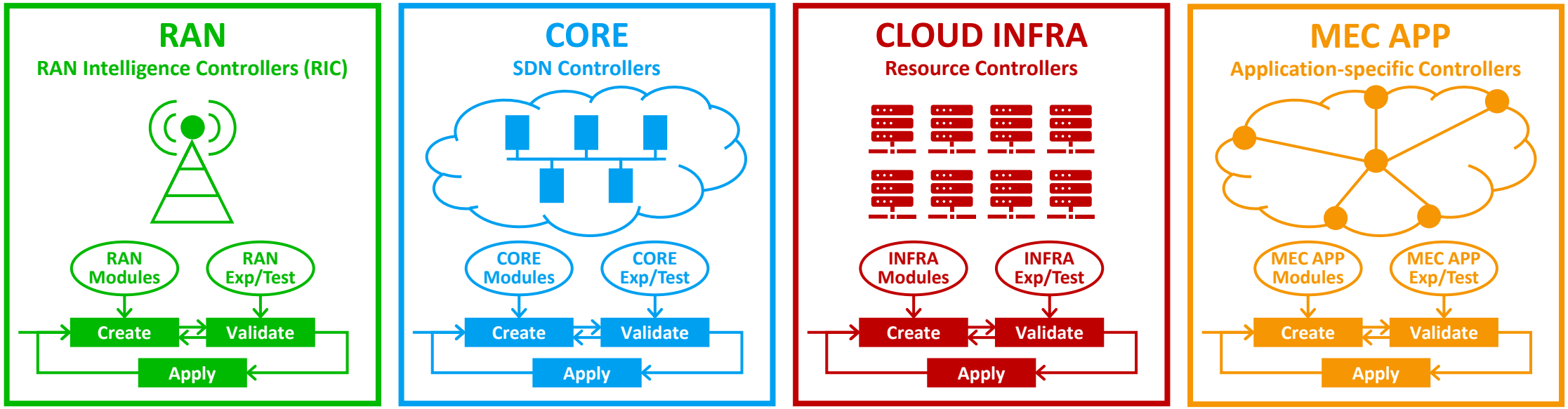
Autonomous Networks

Background: Closed-loop Controllers in Telco

- Operational tasks of (5G) networks have been automated at various levels: From **MOP** to **Open-loop controllers** to **Closed-Loop controllers (CLCs)**.
- **Focus in 5G:** Reducing human intervention for **operation of CLCs**.
- **Our vision for B5G:** Reducing human intervention for **design of CLCs** is crucial.



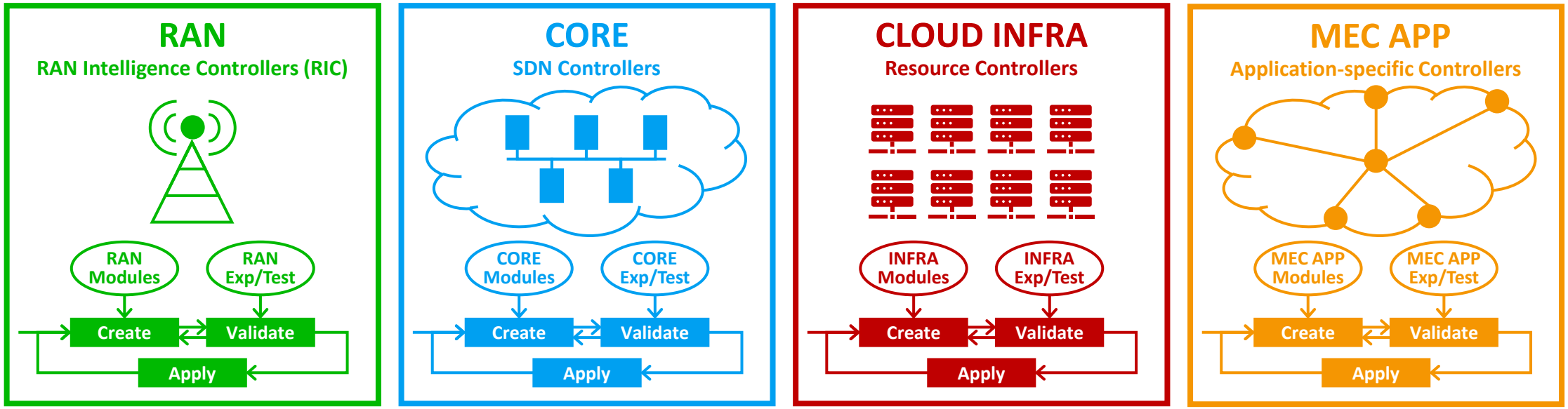
Background: Challenge toward Autonomous Network based on CLCs



- **Closed-loop controllers** (**CLCs**) are key to autotomous networks in (Beyond) 5G.
- However, CLCs tend to live in silos across domains in such a complex network, making only domain experts capable to develop and operate CLCs.

- **Question:** Can a unified framework be built for reliable development of CLCs with little human intervention toward realization of autonomous networks?

Background: Challenge toward Autonomous Network based on CLCs



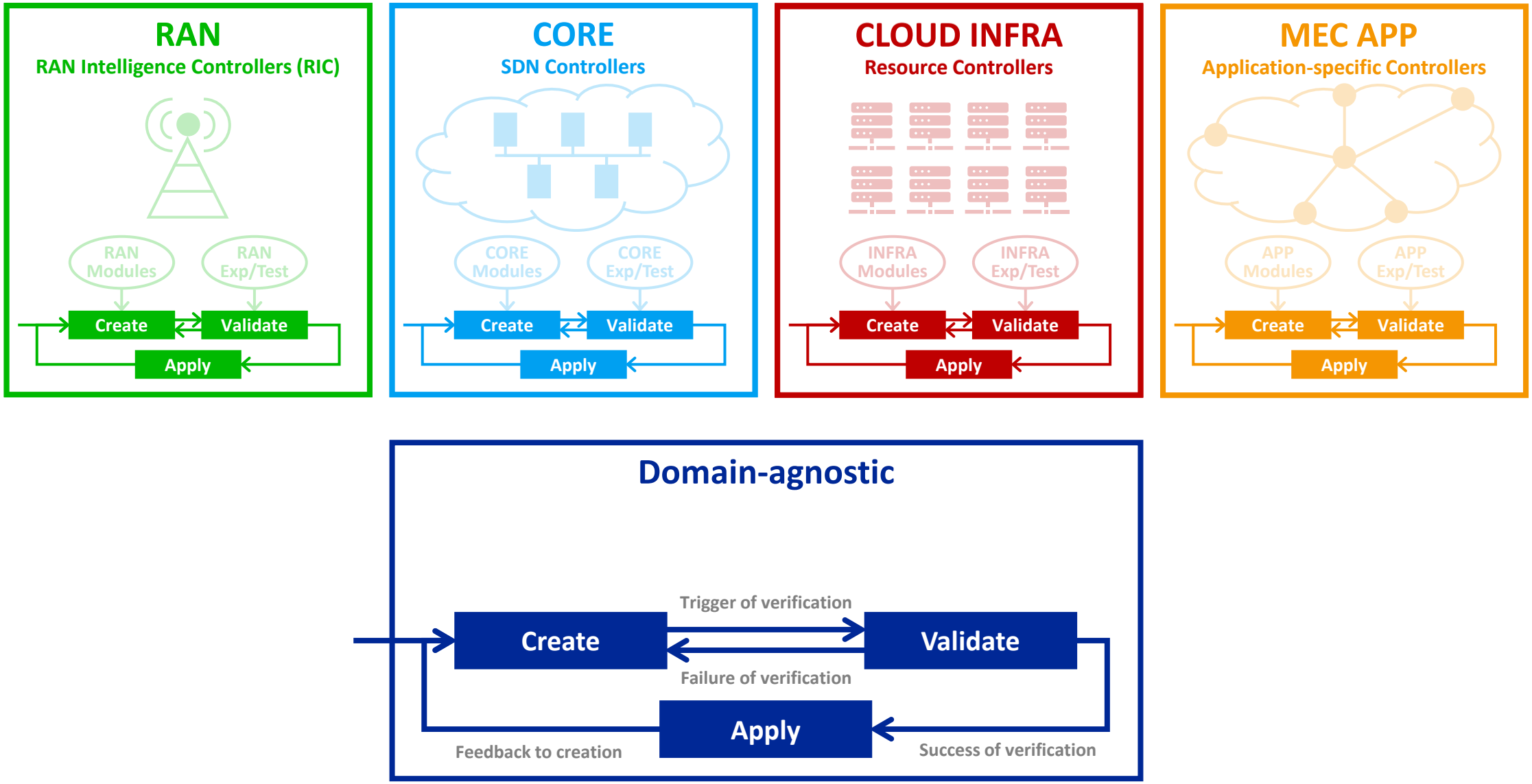
Observation:

- ❑ **Create/Validate/Apply** are domain-agnostic concepts in development of CLCs.
- ❑ Domain-specific knowledge can be represented as **Modules** + **Experiments**.

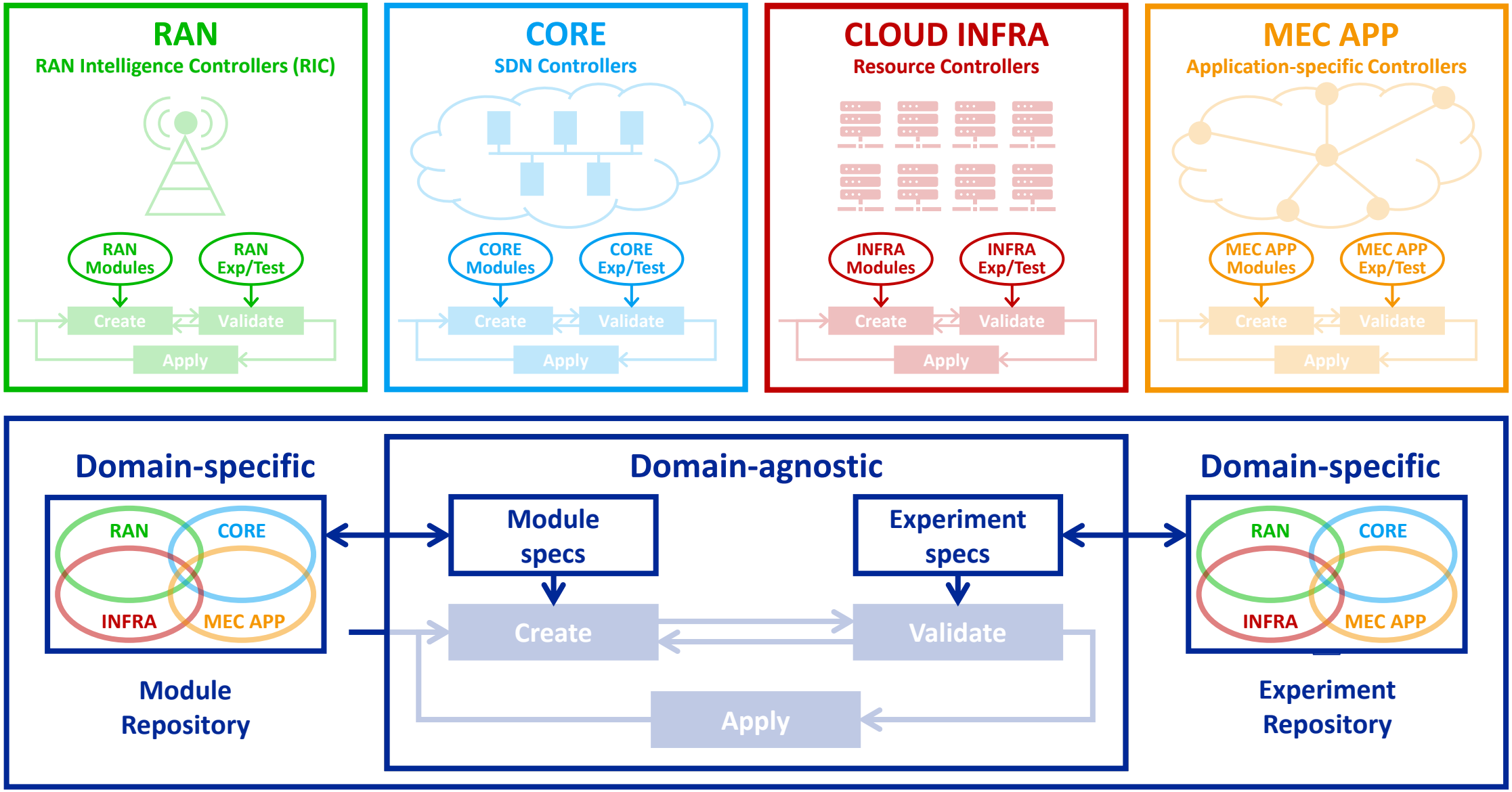
Hypothesis:

- ❑ Controllers can be continuously (re)designed without human/expert intervention in a combination of **Create/Validate/Apply** and **Modules/Experiments.**

Our Autonomous Network Framework



Our Autonomous Network Framework



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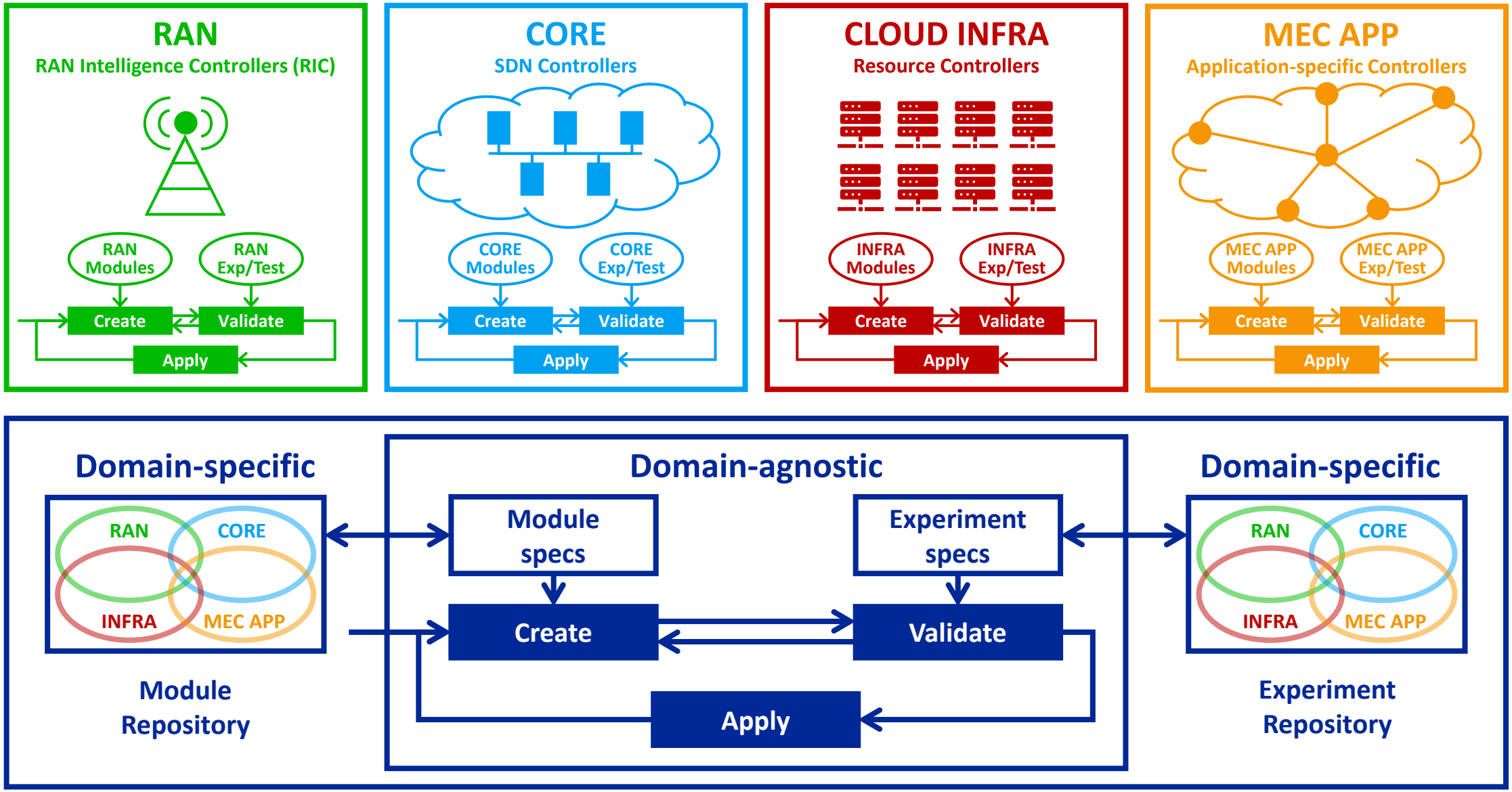


Our Target

- **Further automation in development cycle of closed-loop controllers** in a unified AN framework based on three domain-agnostic concepts:
  - **Create** (via **Exploratory Evolution**)
  - **Validate** (via **Realtime Responsive Experimentation**)
  - **Apply** (via **Dynamic Adaptation**)
- **Our strategy**:
  - **Standardization (ITU-T FG-AN)**
  - **Academic collaborations**
  - **Government-funded research: B5G (focused in my talk)**

NICT B5G Fund

Research Grant

NICT **Beyond 5G Grant**

Period: **October 2021-March 2025**

Research Theme : **Coordinated Autonomous Networks & AI/ML use cases**

Research Consortium

NAGOYA UNIVERSITY

Robots Meta Portal

OKI

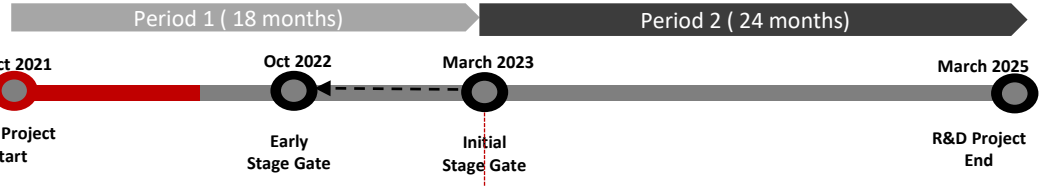
Leader

Two-way CDN

Media Server

Rakuten Mobile

Autonomous Network Prototype



Consortium's Key Deliverable

By 2025 , End to End Demonstration of coordination between the Autonomous Network prototype OKI's CDN and Nagoya University's Robot

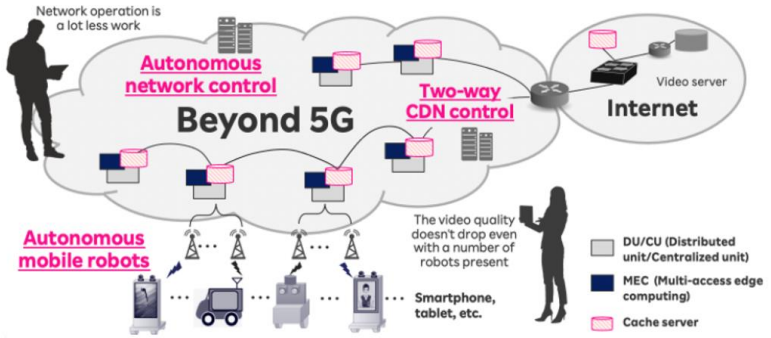
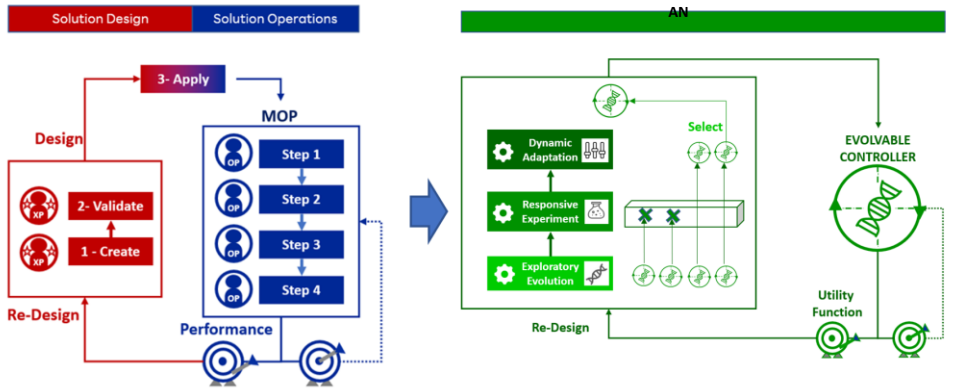


Diagram of the aims of R&D into coordinated type autonomous networks

Rakuten Mobile's Key Deliverable

Autonomous Network Research Prototype following the ITU-T FG-AN architecture applied to CDN use case



Consortium Research Target

Rakuten

Rakuten is designing the **Autonomous Network framework** for cloud-native mobile architectures that can autonomously adapt to changing traffic patterns and diverse service requirements to provide low-latency CDN experience

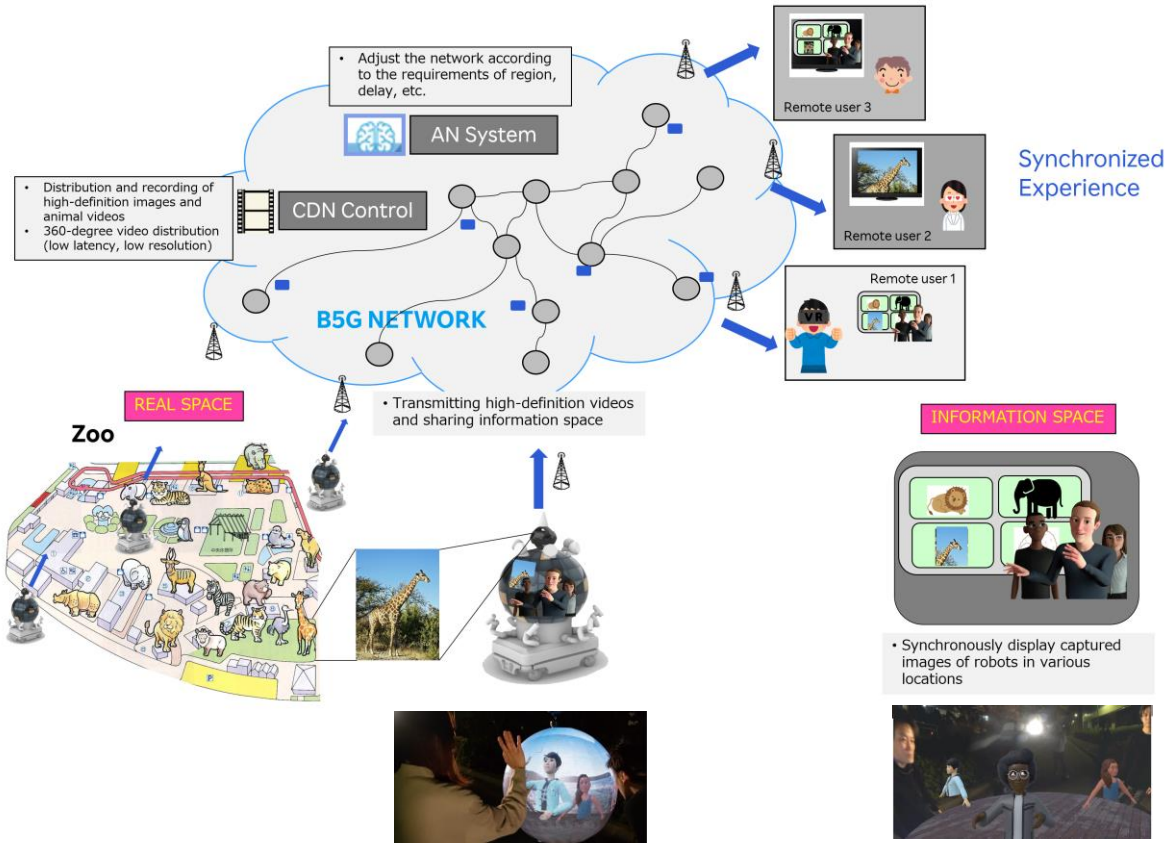
OKI

OKI is designing **two-way CDN controller** for sending and receiving **synchronized high-definition video** to and from autonomous mobile robots and XR devices over the autonomous network

NAGOYA UNIVERSITY

Nagoya University is designing **Autonomous Mobile Robots (AMR)** with modules necessary for autonomous movements and service modules for realizing real sharing experience between people in real space and the Metaverse

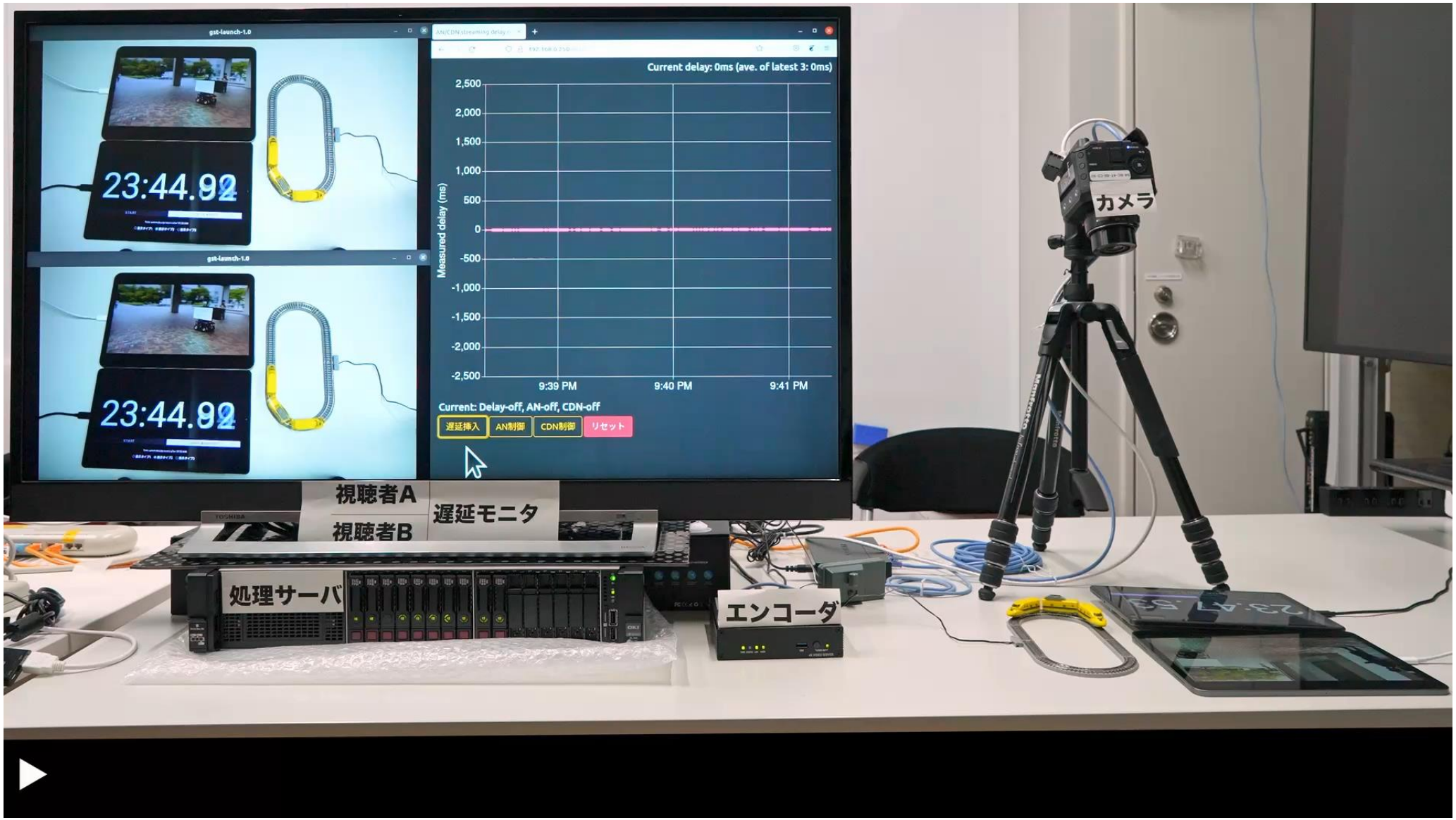
Consortium's Key Common Demo



Create a **shared & synchronized experience** through high-quality video and metaverses between people in the real space and the information space.

Dynamically adapt to circumstances to maintain the best possible experience

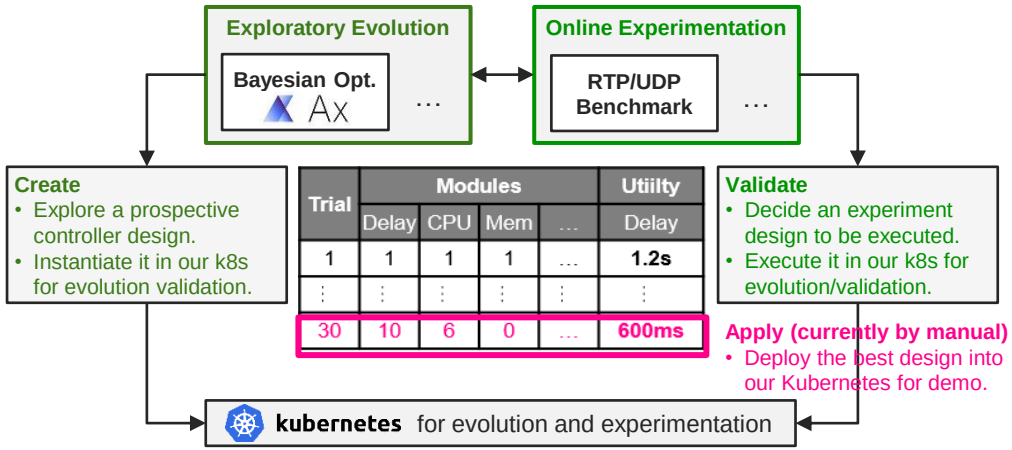
Stage Gate demo



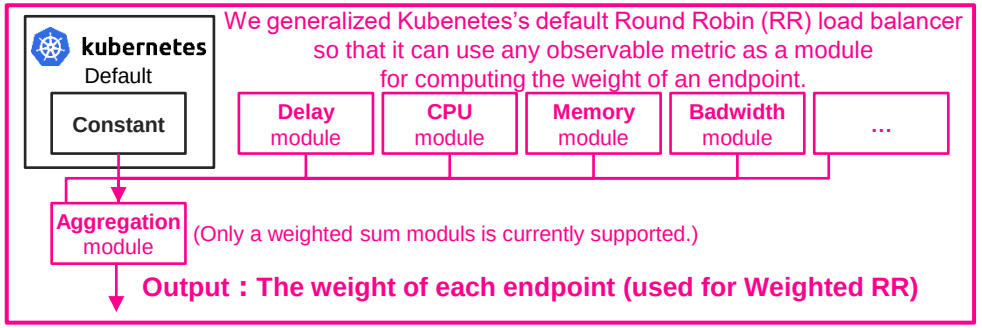
Overview of R&D Achievement

Autonomous composition of Kubernetes load balancer specialized for latency reduction based on our AN concepts

Our autonomous network PoC in October



Our own metrics-aware Kubernetes load balancer



Our dashboard for Autonomy Engine

- Explored controller designs and their evaluation results,
- Weights (delay, CPU idle, memory, bandwdith),
- Time series variation of metrics observed, etc.

Goal: Develop the *Exploratory Evolution* subsystem and *Online Experimentation* subsystem of our AN concepts and evaluate their capability under use case scenarios for autonomous operation of a container orchestrator.

Result: Developed PoC of the Evolution and Experimentation subsystems and conducted an experiment of autonomous creation of Kubernetes load balancer specialized for delay reduction.

Example execution of our Autonomy Engine

Conclusion

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Rakuten Mobile

RMI Research Target

Main Deliverable

Autonomous Network Research Prototype composed of :

- 1 a- Exploratory Evolution subsystem (Create)
- 1 b – Real-time Responsive Experimentation subsystem (Validate)
- 1 c – Dynamic Adaptation subsystem (Apply)
- 1d – End to End Demo including OKI's CDN and Nagoya's Robot

Key Principles

Autonomous Network Research Prototype will :

- Follow ITU-T architecture
- Produce results relevant to RMI deployment and Symworld products
- Build to address use cases relevant to RMI and RS' customers
- Build by outsourcing dev team (fully B5G budget)
- Build a platform to experiment and accelerate research

RMI's Key Deliverable