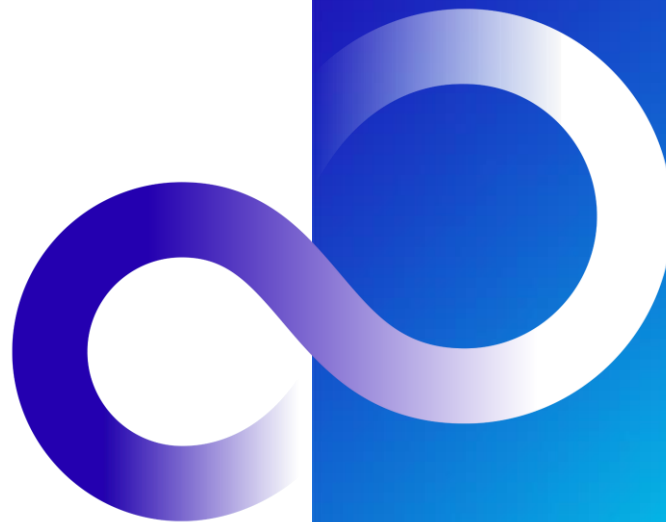
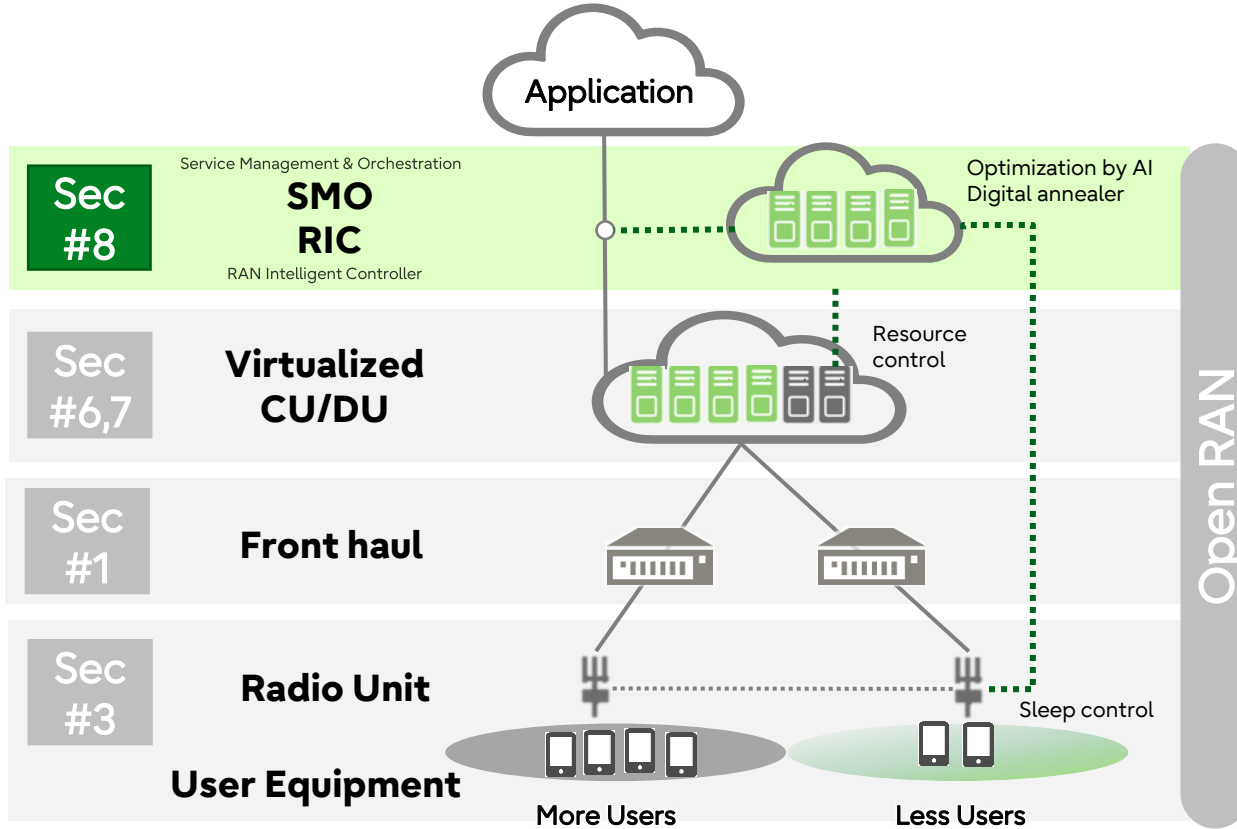


# FUJITSU advanced RAN control technology

MWC Barcelona 2023



# Fujitsu's end-to-end Open RAN solutions

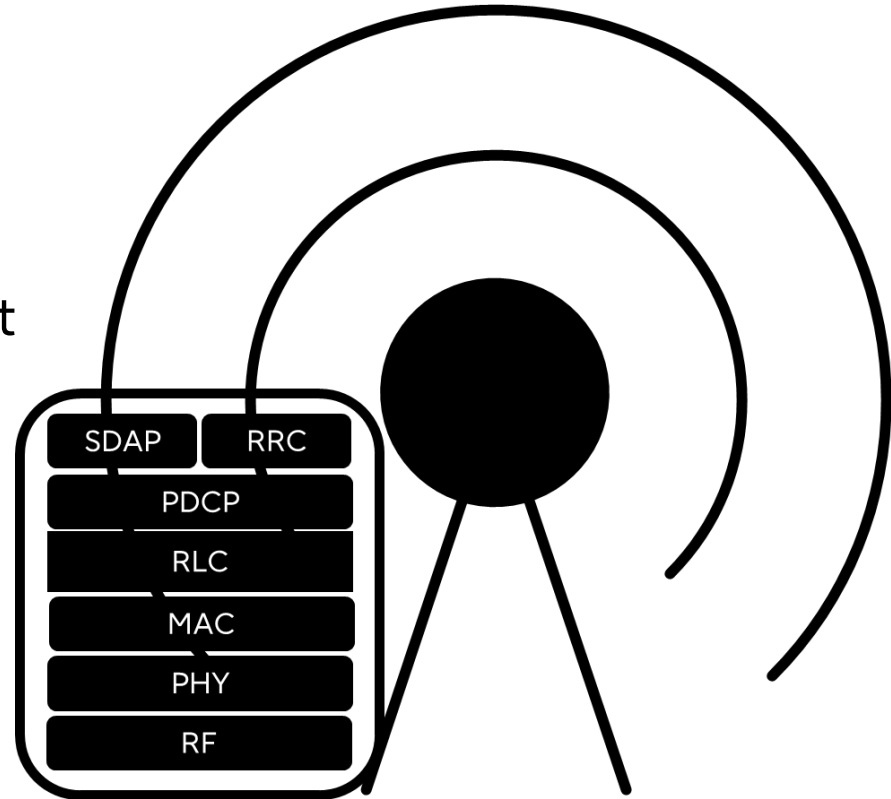


# Virtuora Service Management & Orchestration

MWC Barcelona 2023

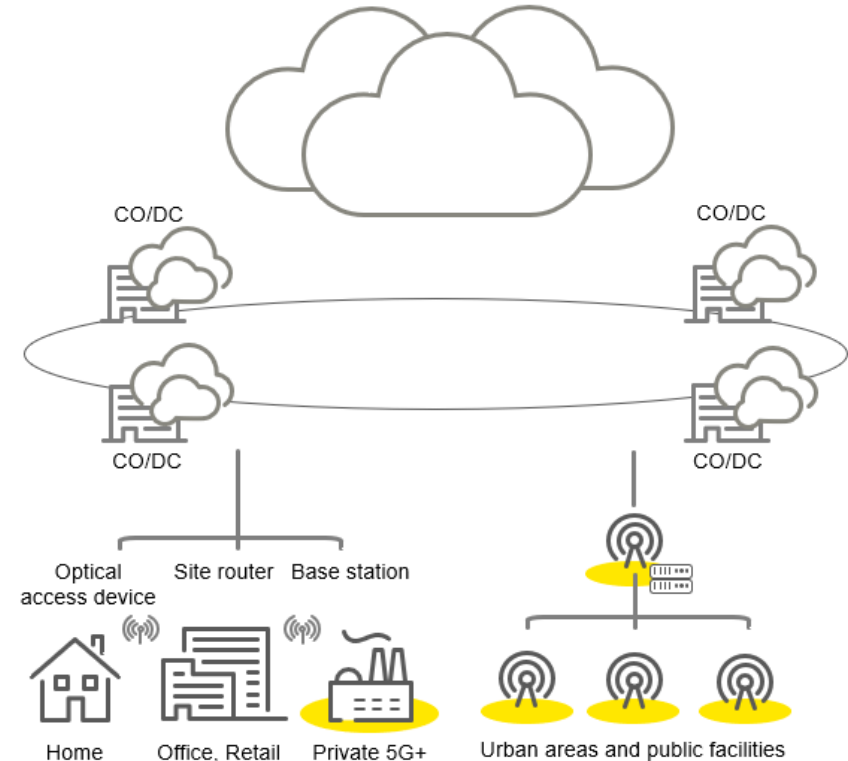
## Monolithic solutions

- Inefficient spectrum utilization
- Limited reconfigurability: equipment can't be fine-tuned for diverse deployments and traffic profiles
- Limited coordination among network nodes that prevents joint optimization and control



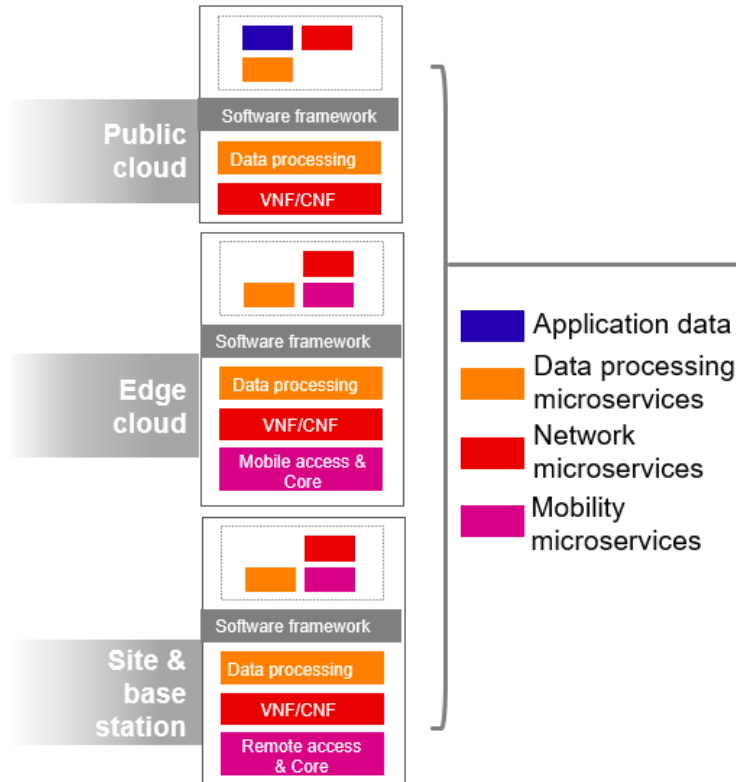
# O-RAN meets increasing 5G availability and elastic capacity needs

- Mobile networks need more macro-sites, in-building wireless, small cell installations, and radio access networks to **satisfy increasing demand**
- **Virtualized, open, and cloud-native technologies** can deliver differentiated services **at scale, faster and more economically** than their hardware counterparts



**5G and beyond end-to-end service delivery**

# Networks need intelligent management & orchestration

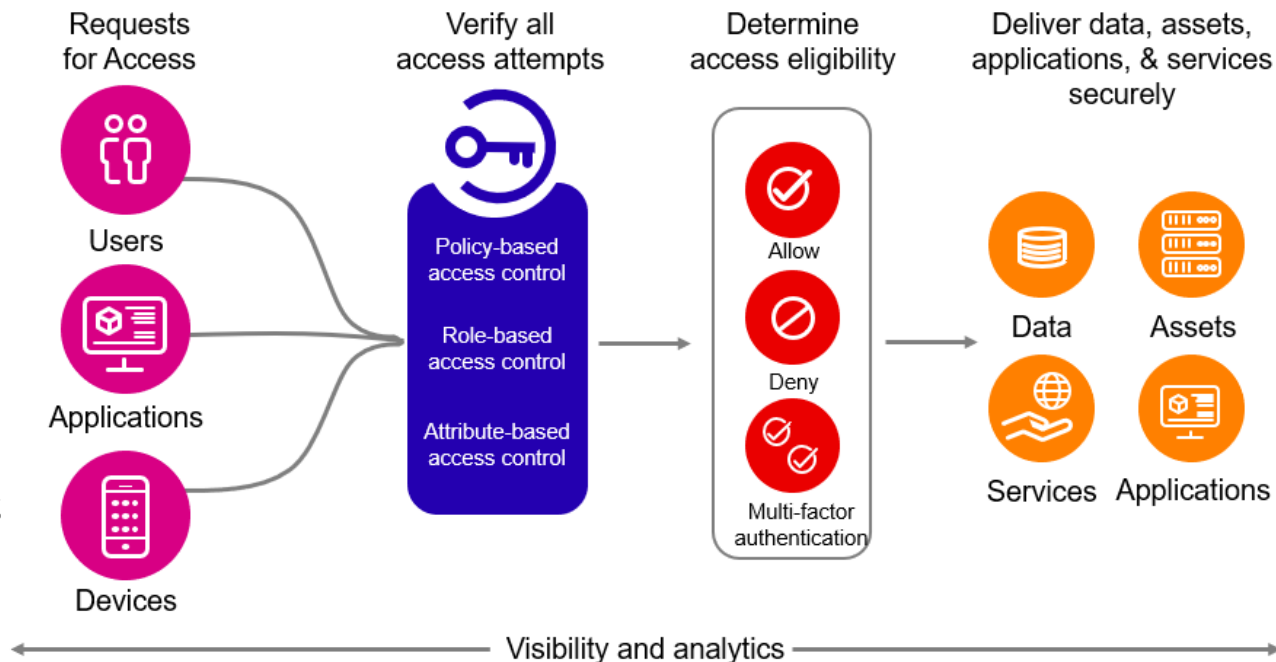


*5G and Beyond: Intelligent management & orchestration*

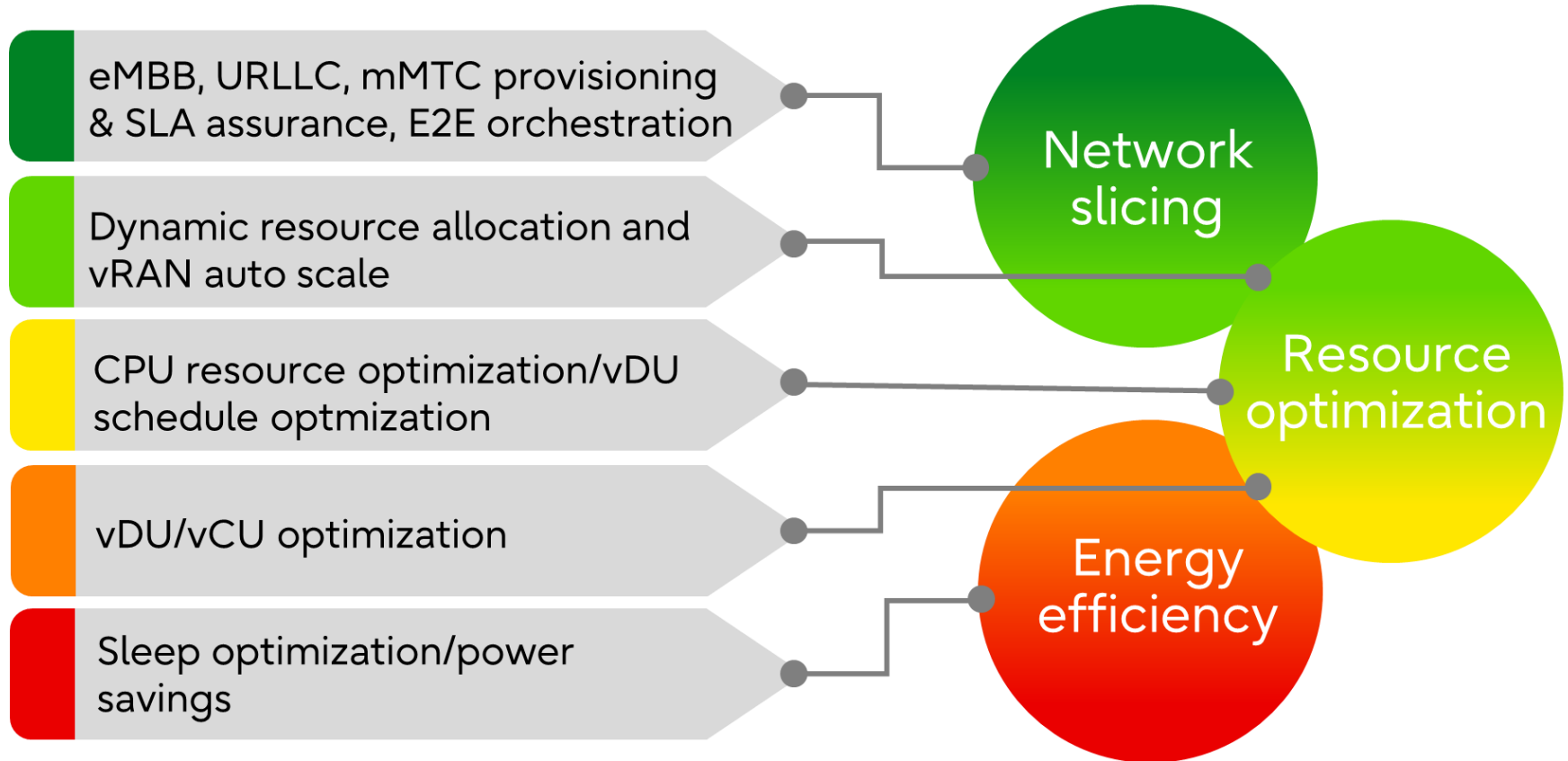
- **Effective E2E RAN service delivery needs sophisticated software to orchestrate and manage multi-vendor physical, virtual, and cloud deployments**
- **Transform with O-RAN**
  - Data-driven optimization, & automation
  - Increased resiliency & reconfigurability
  - Close-loop control with Open APIs
- **Combine disaggregated, distributed, and multi-vendor ecosystems with intelligent service management and orchestration**
  - Discover
  - Coordinate
  - Optimize
  - Manage energy efficiencies

# Networks need O-RAN Zero Trust architecture

- Leverage network segmentation
- Prevent lateral movement
- Provide threat prevention
- Simplify user-access with more granular control

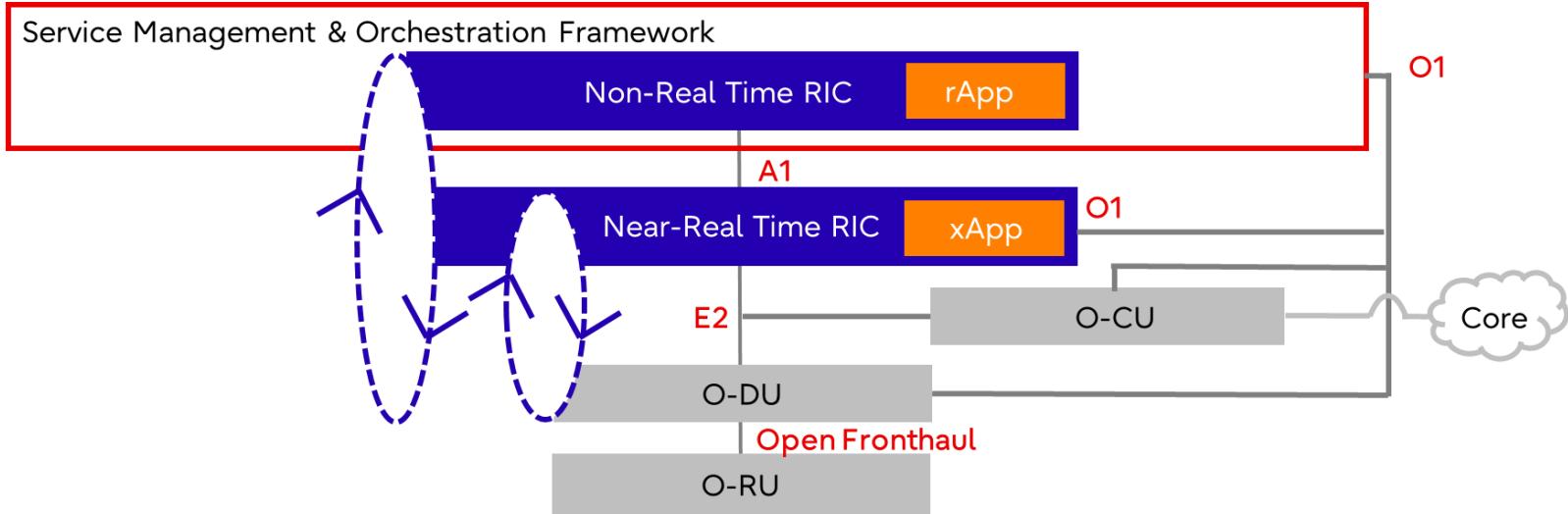


# Service management and orchestration use cases





# Virtuora SMO intelligent control



Easily configure multi-vendor systems with open and standard interfaces

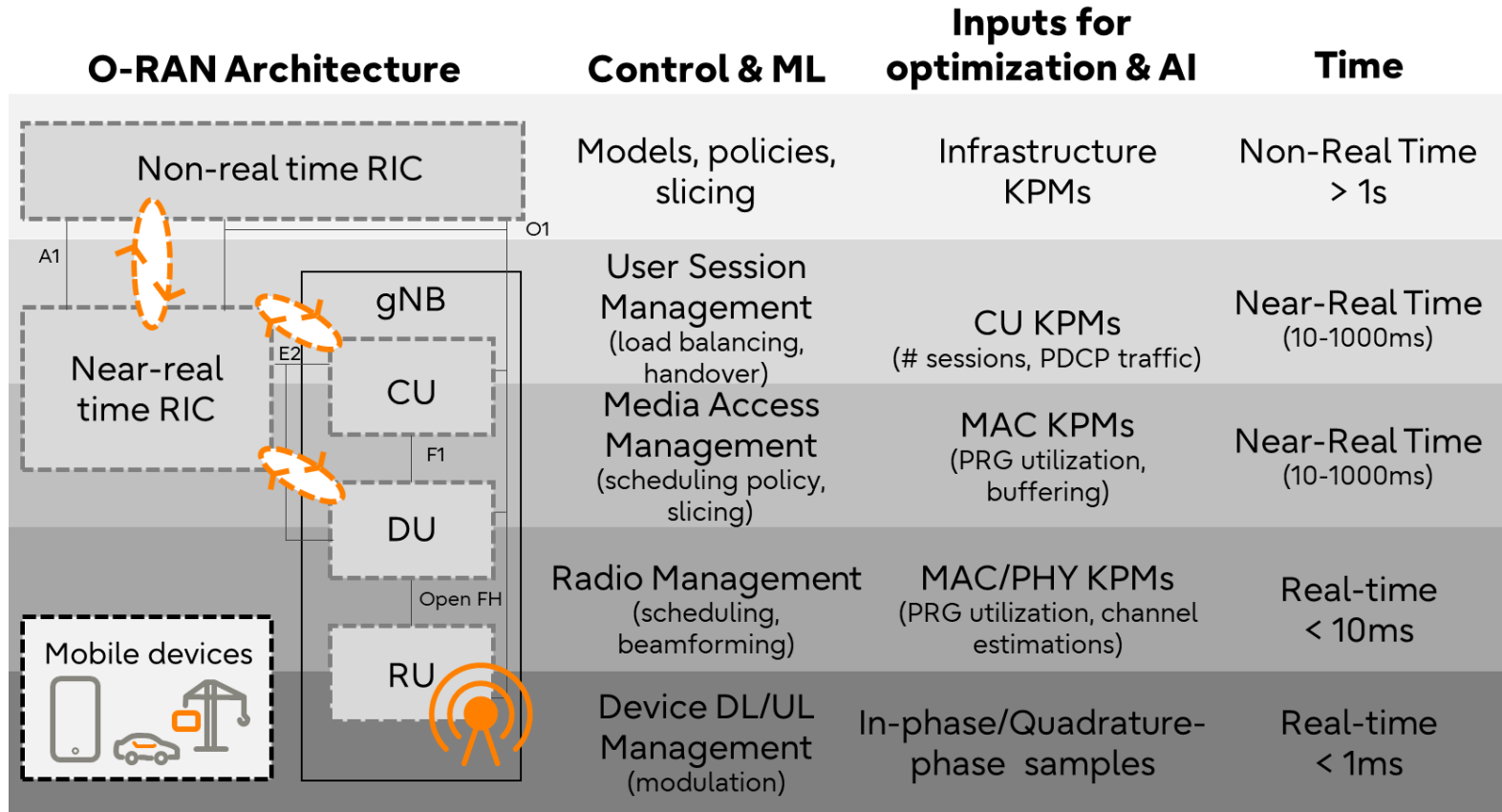


Optimize RAN resources and automate network operations with RAN Intelligent Control



Use rApps and xApps to analyze information and create and execute control policies

# Real-time intelligent control with machine learning and artificial intelligence

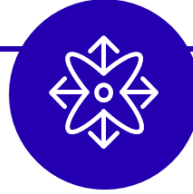


# The Virtuora SMO Offering



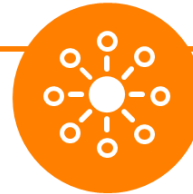
## Orchestration & Management Framework

- Cloud-native architecture
- Service and slice design and orchestration
- Cloud deployment and orchestration
- Operations tools
- FCAPS+
- SBIs/NBIs



## RAN Intelligent Control

- Multi-domain
- Policy enforcement
- Authentication & authorization
- ML models & slicing
- AI & ML Workflow
- Scheduling & closed loop control



## rApps & xApps

- QoS/QoE
- Traffic steering
- Beamforming
- Load balancing/ handover
- UE anomalies
- Power savings
- SDK kit
- NWDAF (core)

Data storage & movement

**Data Management**

Exposure & protection

- Fujitsu RIC rApp/xApp offers significant opportunities to monetize wireless access networks by improving quality of service, reducing costs through automated network operations, and increasing energy efficiency.



## Spectrum & QoE Optimization

- *Interference Management*
- *Transmit Power Optimization*
- *Beam Pattern Optimization*
  - *Dynamic Spectrum Sharing*
- *mMIMO BF Control*
  
- HO Optimization(MRO)
- Mobility Load Balancing(MLB)
- Mobility Load Balancing(MLB) + Traffic Steering
  - RAN Slice SLA Assurance
- **QoE Optimization** ★



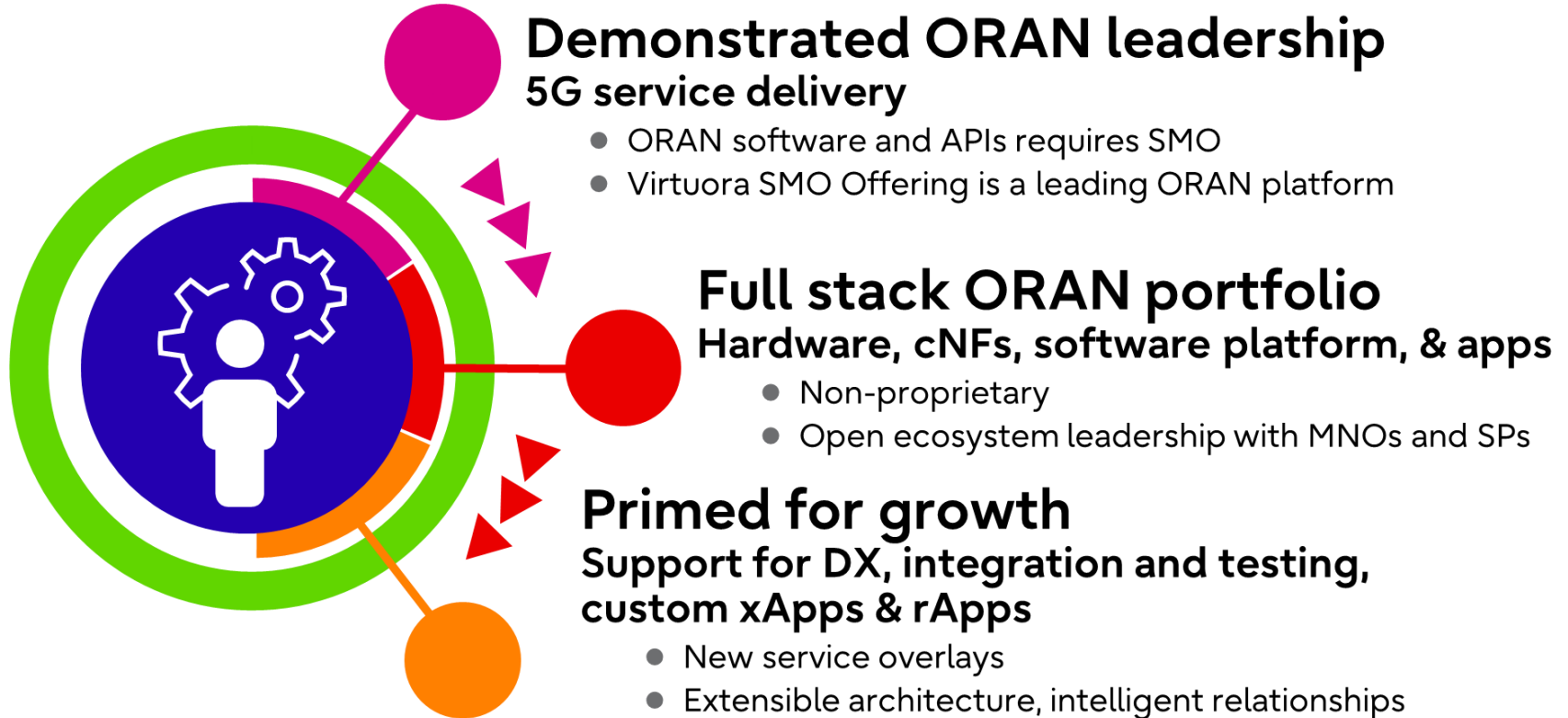
## Operation Automation & Optimization

- PCI Design
- RSI,RACH Design
- **Tilte Angle Optimization** ★  
(Disaster Recovery)
  
- Canary Release
- vRAN Autoscaling
- Cell outage Anomaly Detector / Smart Diagnosis



## Energy Efficiency

- **RU Sleep based on traffic prediction** ★
  
- vCU/vDU Sleep based on traffic prediction



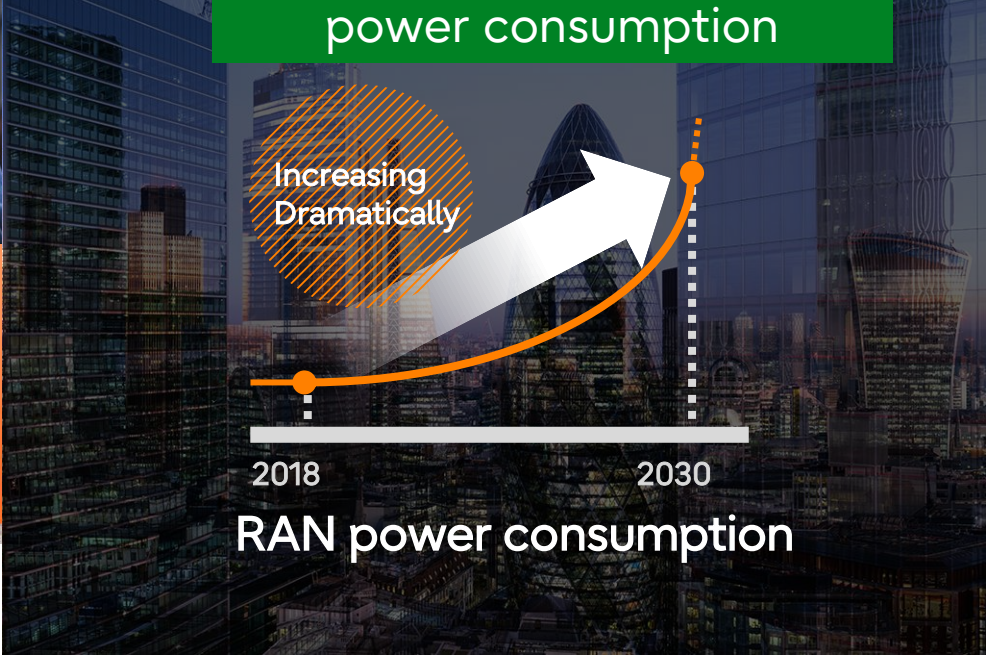
# SMO/rApp Power Savings Solution Demo.

# Can we achieve both communication quality and power savings?



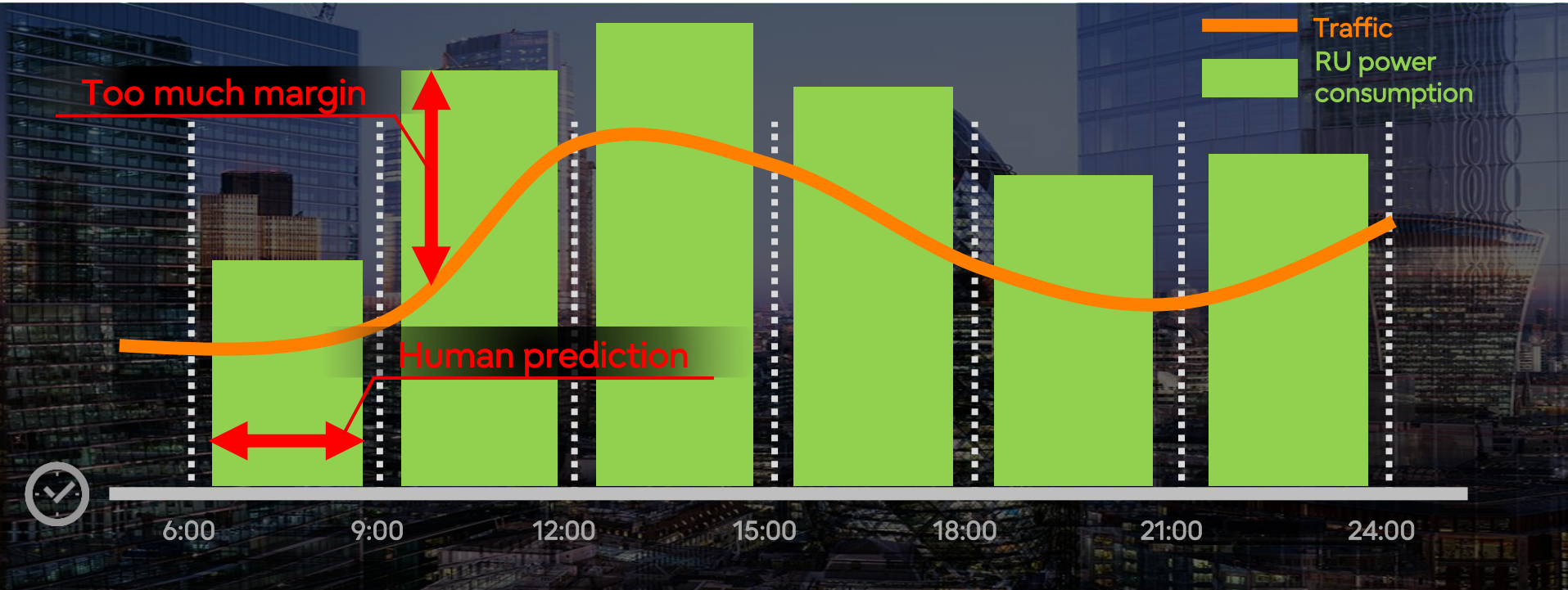
Maintaining communication quality

Increasing network power consumption



Both power savings for large-scale networks and maintaining communication quality must be compatible.

# Difficulty in achieving both power savings and communication quality

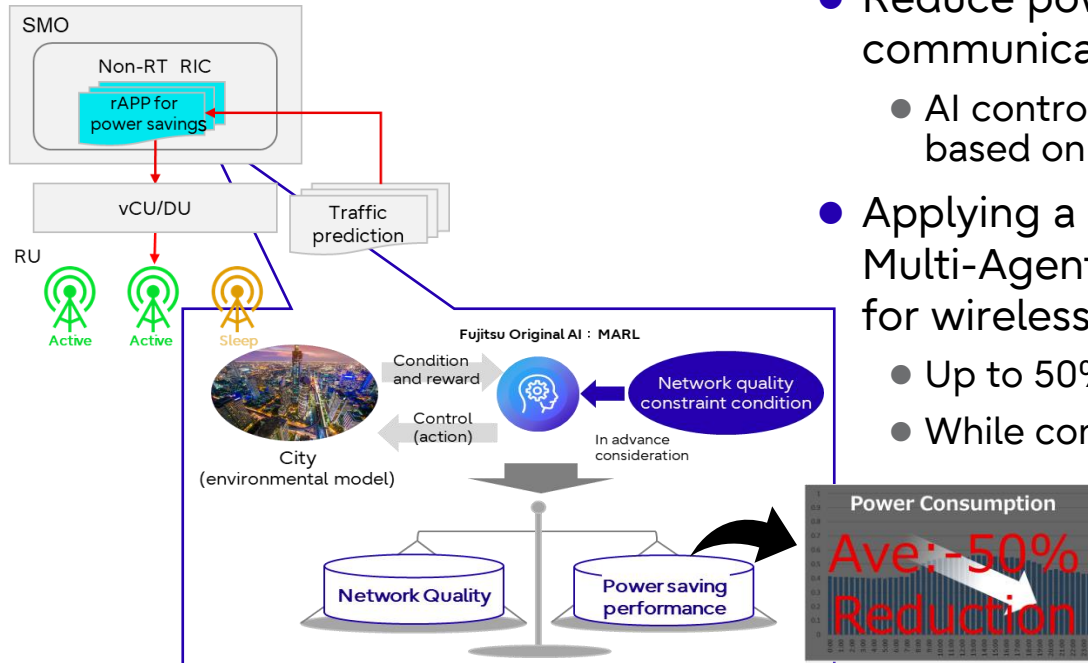


Intelligent power control is essential for both power savings and communication quality



# Overview of power savings application

This application solves the problems of complexity and power savings due to the diversified communication services.



- Reduce power consumption while maintaining communication quality.
  - AI control (RU sleep) lot of wireless base stations based on traffic and time.
- Applying a new method, performance assured Multi-Agent Reinforcement Learning\* (MARL) for wireless base station operations.
  - Up to 50% RU power reduction.
  - While considering system load factor constraint.

\* patent pending

# Value for our customers

Fujitsu's original AI technology achieves both communication quality and power savings.

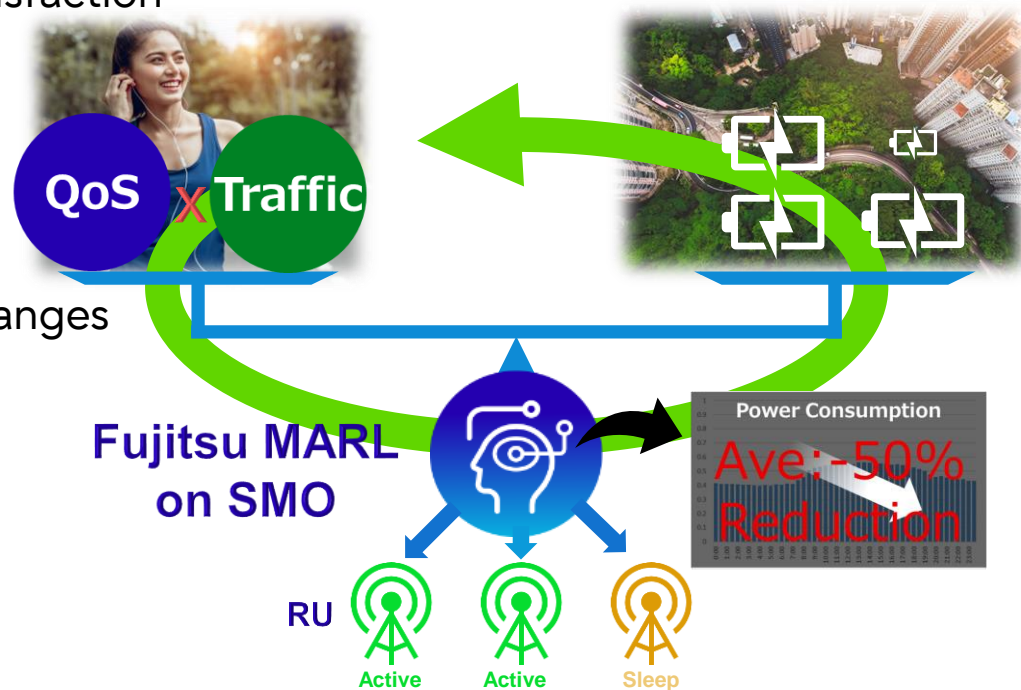
- power savings without losing user satisfaction

- **Solve customers problem**

- ✓ Achieving power-saving networks
- ✓ Achieving communication quality
- ✓ Adaptable to every moment's traffic changes

- **Fujitsu's provided value**

We realize a sustainable network environment that is safe, secure, and power savings.



# Towards quality of experience (QoE)

Step  
**1**

Automate Network  
Operation by AI

Step  
**2**

Network Optimization  
Based on Individual QoE



Achieve both required QoS  
and cost efficiency by AI



Maximize user satisfaction through QoE  
based on human cognitive models

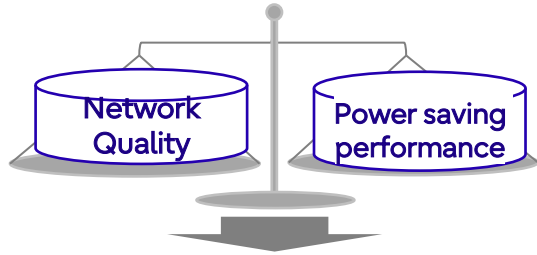
# Appendix

## Fujitsu original AI:MARL

To improve performance while meeting constraint criteria

Challenge 1

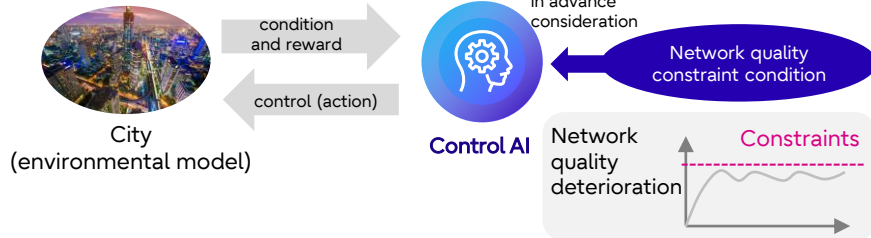
Usually, it is necessary to decide which parameter should be emphasized, and trial and error are required in each learning process.



solution

Performance assurance of KPIs such as Network quality and power saving

Reduce the amount of time spent adjusting and validating KPIs by considering them in advance with constraints



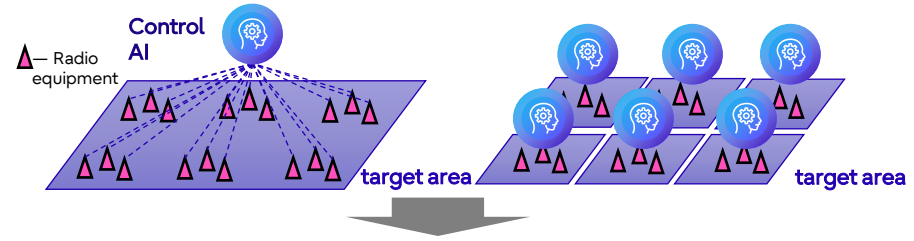
To apply larger systems

Challenge 2

Centralized management of a wide area has an issue in processing a large amount of data in real time.

Challenge 3

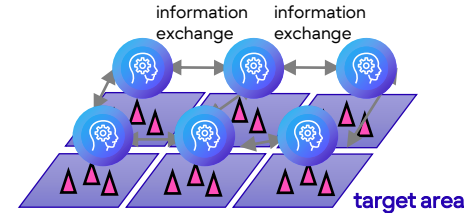
The simple distributed processing method is the local optimization is the, but not the global optimization.



solution

Coordinated distributed control by multiple AIs

Distributed control of multiple agents considering each other's actions enables both real-time processing and global optimization

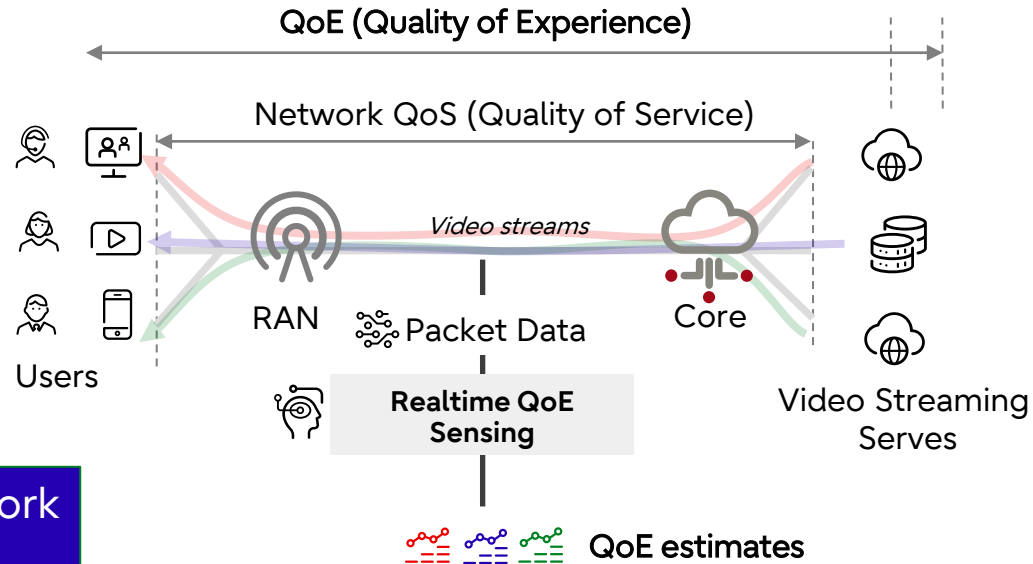


# Appendix

## QoE Estimation

## FUJITSU AI Technology Realtime QoE Sensing (RQS) enables to estimate QoE from each video streams in 5G network

- QoE is a measure of a user's experiences with a service
  - more advanced target metric than QoS
- RQS can estimate each QoE
  - at high accuracy (>80%)
  - in real time (<1s)
  - from encrypted video streams

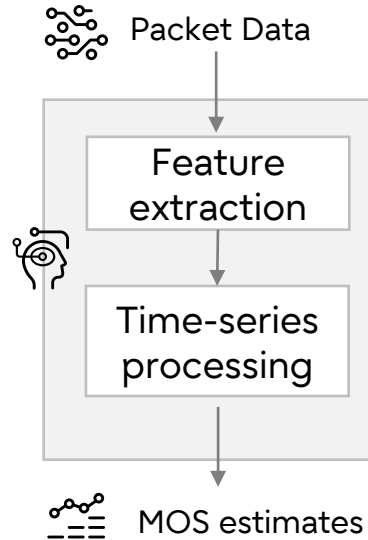


A MNO can provide fine-grained network control based on an individual QoE

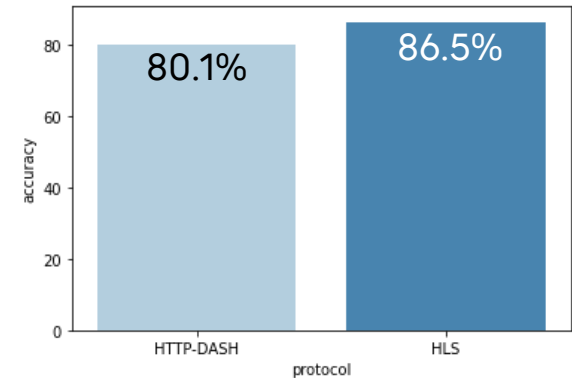
RQS estimates a **viewer's QoE** from encrypted packet stream

## ● RQS AI

- Handles extracted features from encrypted packet stream as time-series data so that it can estimate behavior of video streaming protocols
- Outputs an estimate of **Mean Opinion Score (MOS)** which is one of the measures of QoE, every second.



## Estimation Accuracy Result



shows Top-level performance



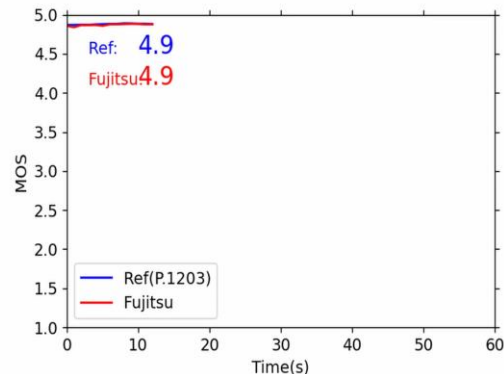
## QoE Estimation Example

Video Playback



(c) copyright 2008, Blender Foundation / www.bigbuckbunny.org

Estimated MOS



Well suits reference in real-time

## Application examples of QoE Estimates

### Network Slice Management

Maintain adaptive slice selection to guarantee sufficient QoE level for each user's needs



### Root Cause Analysis of QoE degradations

Analyze root cause of QoE degradation and identify hidden failures of network instances



Thank you



AI/ML  
White paper



MWC 2023 in  
Barcelona microsite

