

# RATIO: CAPGEMINI O-RAN RIC FRAMEWORK POWERED BY AI/ML

RATIO is Capgemini's O-RAN Intelligent Controller (RIC) framework that includes Near-Real-Time (Near-RT) RIC, Non-RT RIC, Service Management and Orchestration (SMO), and a machine-learning (ML) platform called Netanticipate.

RATIO is a highly scalable platform based on hardened open-source components from O-RAN SC and supports a fully disaggregated RIC architecture. RATIO is fully aligned with the O-RAN Alliance specification and supports multi-vendor centralized units (CU) and distributed units (DU) through standard O-RAN interfaces. RATIO helps avoid vendor locking and allows operators to choose different vendors for CU/DU and xApps/rApps.

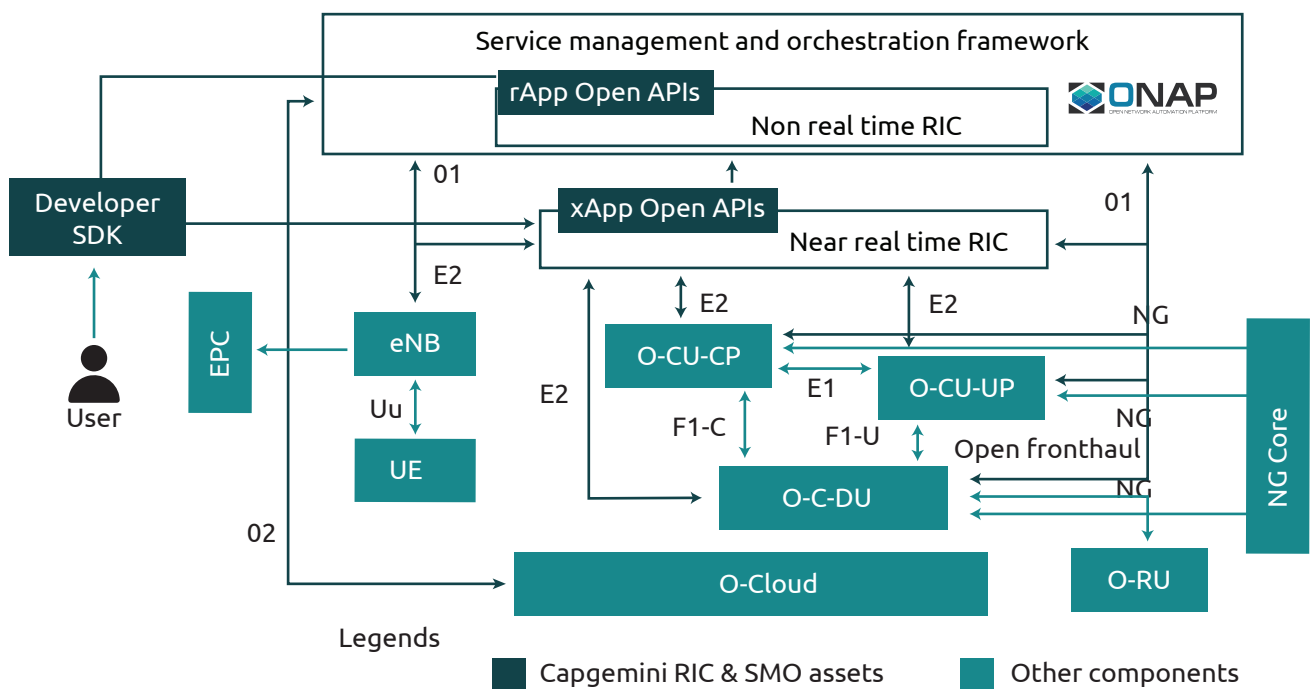


Figure 1 – Key components of Capgemini RATIO

## Near-RT RIC features:

1. An architecture that supports multi-vendor xApps to manage multi-vendor CU/DU through standard O-RAN interfaces
2. Third-party xApps that can be ported on the Capgemini Near RT RIC platform using xApp SDK, which abstracts the complexity of the underlying platform
3. Conflict management for conflict resolution of subscription and control procedures across xApps
4. Secured interfaces for E2, A1, and O1 interfaces for communication with E2 nodes, secure onboarding, and role-based access control (RBAC) xApp access
5. xApp SDK and open APIs that abstract out the complexity of underlying RIC platform services so that xApp application developers can focus on key business logic
6. Support for high availability and fault tolerance with a horizontally scalable RIC cluster
7. A modular microservices-based architecture that can be deployed as Kubernetes or Docker containers
8. Modules that can be hosted on any infrastructure of choice (Public/Private Cloud, On-Prem)

## Capgemini's SMO features:

1. A lightweight ONAP-based platform
2. Support for FCAPS/O1
  - a. O1/VES and O1/SDNR interface for FCAPS support
  - b. Standard VES collector used for rare events like FM and CM
  - c. High-velocity VES collector (HV VES) used for real-time event streaming for PM
3. Supported O1 interface procedures
  - a. Provisioning Management - Create, Read, Modify, Delete and Notify Managed Object
  - b. Fault Management - Supervision and Notification
  - c. Performance Assurance - File, Streaming
  - d. Trace - Call, Stream, Radio Link Failure (RLF)
  - e. File Management - Ready Notification, Transfer, Download
  - f. PNF - Startup Plug-n-Play, Registration, Software Management
  - g. Software Package - Download, Activation Pre-Check, Activate
4. O2/Orchestration
  - a. Orchestration services of infrastructure and xNF

## Netanticipate ML Framework features include:

1. Award-winning, self-learning data science platform that easily manages the life cycle of ML models and O-RAN applications in a distributed environment. NetAnticipate5G enables automated model training, publishing models in a catalog for easy searching and deployment in a production environment. Playbooks provide the automation workflows by packaging ML models together with the associated business logic
2. MLOps to build a comprehensive ML pipeline for continuous operation and self-learning of ML models through feedback loops
3. Support for various AI/ML deployment scenarios, including:
  - a. Training at SMO/Non-RT RIC and inference in Non-RT RIC
  - b. Training at SMO/Non-RT RIC and inference in Near-RT RIC
  - c. Training at SMO/Non-RT RIC and Inference in O-CU O-DU

## Non-RT RIC features:

1. Well-defined, standardized interfaces that enable an open, interoperable ecosystem in full support of and complementary to standards promoted by 3GPP and other industry standards organizations
2. A rich A1 interface with support of Open APIs for A1-P (Policy Management Service), A1-ML (ML Model Management Service), and A1-EI (Enrichment Information Service)
3. High performance and scalable Open API gateway between rApps and Non-RT RIC that exposes the Non-RT RIC framework capabilities to rApps
4. A rich developer experience with an R1 interface and rApp Service Exposure Function. The R1 interface (Open APIs for rApps) provides an interface between rApps and the Non-RT RIC framework. This exposes the comprehensive Non-RT RIC framework and SMO services to rApps for creating differentiated services
5. Container and container orchestration primitives such as Docker and Kubernetes to provide a horizontally scalable solution that can be hosted on the infrastructure of choice (Public/Private Cloud, On-Prem)
6. A1 that can be transported over IPv6 (IETF RFC 8200) and/or IPv4 (IETF RFC 791). TCP v1.3 (IETF RFC 8446 and higher) is supported as the transport protocol for the A1 interface as required by HTTP (IETF RFC 7230). Both non-RT RIC and near-RT RIC may act as HTTP clients and HTTP servers. As a result, Non-RT RIC and Near-RT RIC may establish a TCP connection for bidirectional communication
7. Support for TLS (IETF RFC 2246) to provide security protection at the transport layer

## Capgemini O-RAN use-case portfolio – xApps and rApps

Capgemini is developing multiple xApps and rApps, which are aligned with the O-RAN Alliance specifications. The xApp architecture allows them to be integrated with any third-party RIC platform. Here are three use cases that are being developed:

