Capgemini engineering

RATIO: CAPGEMINI RIC FOR INTELLIGENT OPEN RAN OPERATIONS

This brochure describes the features of the Capgemini O-RAN-compliant RIC based on the O-RAN Software Community open-source software RIC and the xApp and rApp applications developed over the Capgemini RIC

Introduction

Capgemini has developed a set of software frameworks that enable communications service providers (CSPs), Network Equipment Providers (NEPs), OEMs to accelerate the development and launch of their products and solutions. The frameworks cover the entire end-to-end 5G Open Network ecosystem. As part of this effort, Capgemini developed RATIO, a highly scalable Open RAN Intelligent Controller (RIC) platform, based on hardened open-source components from the O-RAN Software Community.

RATIO includes a near-real-time (Near-RT) RIC, a non-real-time (Non-RT) RIC, and service management and orchestration (SMO). Capgemini is also developing xApps and rApps to leverage the capabilities of the O-RAN RIC platform to perform intelligent RAN operations. (See Figure 1.)

RATIO supports a fully disaggregated RIC architecture, which is fully aligned with the O-RAN Alliance specifications, and supports multi-vendor centralized units (CUs) and distributed units (DUs) through standard O-RAN interfaces RATIO helps avoid vendor lock-in and allows CSPs the flexibility to choose different vendors for CU/DU and xApps/rApps.

Capgemini Engineering xApps and rApps are O-RAN-compliant applications that can run on any RIC platform and are pre-integrated with the Capgemini Engineering RIC and 5G CU/DU nodes.

Figure 1: Capgemini RIC framework – components, context, and ecosystem
Source: Capgemini

Near-real-time RIC

The Capgemini near-RT RIC is a fully containerized microservices-based solution that can be deployed as Kubernetes or Docker containers. It is compliant with O-RAN architecture and specifications, which support multi-vendor xApps and interface with O-CU/O-DU through standard O-RAN interfaces. The entire near-RT RIC is based on a disaggregated architecture that enables flexibility in integration with any third-party O-RAN component. In addition, it supports high availability and fault tolerance with a horizontally scalable RIC cluster. (See Figures 2 and 3.)

The RIC platform has a rich user interface to support life cycle management, configuration, and monitoring for xApps and the RIC platform. The platform includes:

- Standardized E2 interface for communication between near-RT RIC and O-CU/O-DU

- Standardized A2 interface for communication between near-RT RIC and non-RT RIC

- Conflict management for conflict resolution of subscription and control procedures across xApps

- Secured E2, A1, and O1 interfaces for communication with E2 nodes, secure onboarding, and role-based access control (RBAC) for xApp access control

- Third-party xApps can be ported on the Capgemini near-RT RIC platform using xApp SDK, which abstracts the complexity of the underlying platform so that xApp application developers can focus on crucial business logic

- Integrated with the Capgemini NetAnticipate platform described below, which has support for multiple machine-learning (ML) models and can be leveraged by xApp developers

- Modules that can be hosted on any infrastructure of choice (public/private cloud and on-premises)
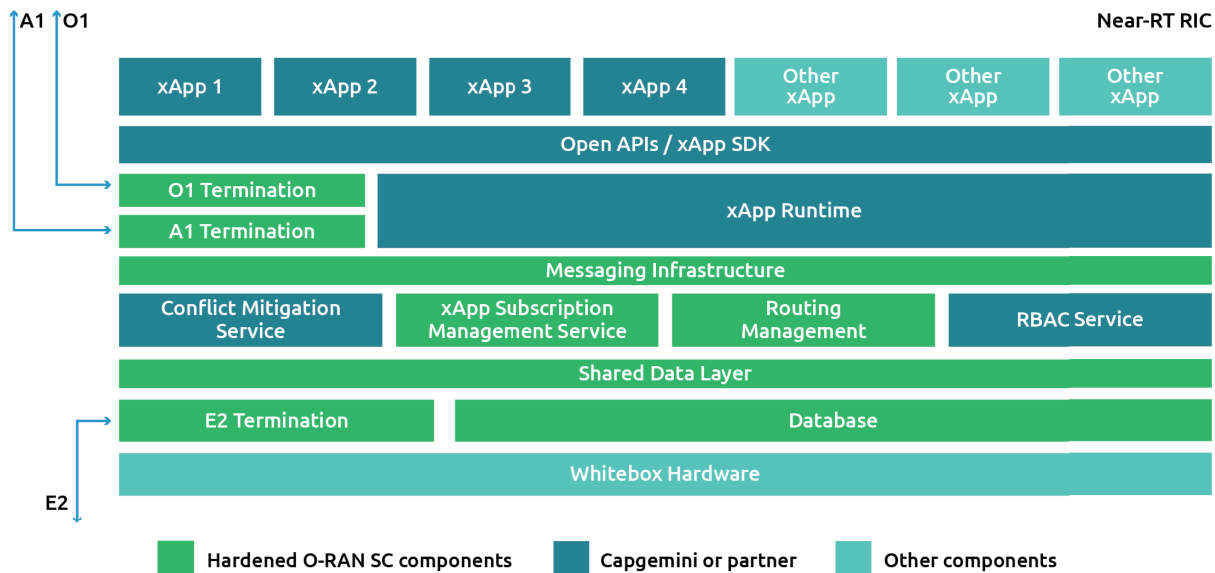
Figure 2: Capgemini near-RT RIC framework – components, context, and ecosystem
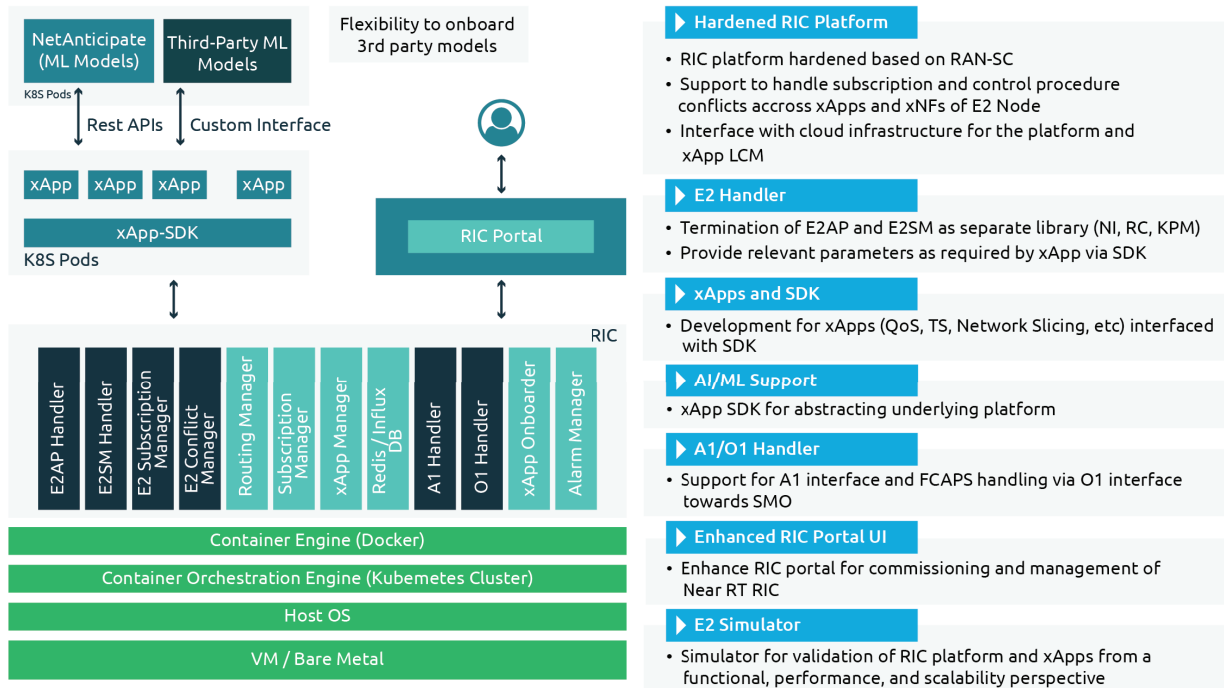Source: Capgemini

Figure 3: Capgemini near-real-time RIC realized as a set of logical modules
Source: Capgemini

Diagram text

NetAnticipate (ML Models) **Third-Party ML Models**
K8S Pods

Flexibility to onboard 3rd party models

Rest APIs   Custom Interface

xApp   xApp   xApp   xApp
xApp-SDK
K8S Pods

RIC Portal

RIC

E2AP Handler | E2SM Handler | E2 Subscription Manager | E2 Conflict Manager | Routing Manager | Subscription Manager | xApp Manager | Redis / Influx DB | A1 Handler | O1 Handler | xApp Onboarder | Alarm Manager

Container Engine (Docker)
Container Orchestration Engine (Kubemetes Cluster)
Host OS
VM / Bare Metal

Hardened RIC Platform
- RIC platform hardened based on RAN-SC
- Support to handle subscription and control procedure conflicts accross xApps and xNFs of E2 Node
- Interface with cloud infrastructure for the platform and xApp LCM

E2 Handler
- Termination of E2AP and E2SM as separate library (NI, RC, KPM)
- Provide relevant parameters as required by xApp via SDK

xApps and SDK
- Development for xApps (QoS, TS, Network Slicing, etc) interfaced with SDK

AI/ML Support
- xApp SDK for abstracting underlying platform

A1/O1 Handler
- Support for A1 interface and FCAPS handling via O1 interface towards SMO

Enhanced RIC Portal UI
- Enhance RIC portal for commissioning and management of Near RT RIC

E2 Simulator
- Simulator for validation of RIC platform and xApps from a functional, performance, and scalability perspective

Non-real-time RIC

The Capgemini non-RT RIC is a fully containerized microservices-based solution that can be deployed as Kubernetes or Docker containers. It is compliant with the O-RAN architecture and specifications, which support multivendor rApps (RAN Automation Applications) working in synchronization with the multi-vendor near-RT RIC through standard O-RAN interfaces. The entire non-RT RIC is realized as a set of logical modules that enables flexibility in integration with any third-party O-RAN component. It is a fault-tolerant solution with horizontally scalable components to ensure high availability.

The non-RT RIC has a rich UI interface that supports operations on the non-RT RIC, including rApp life cycle management, AI/ML model training, monitoring, and KPIs. The platform includes:

- A rich A1 interface with support of APIs for A1-P (policy management service), A1-ML (ML model management service), and A1-EI (enrichment information service)

- A rich developer experience with an R1 interface and rApp service exposure function. The R1 interface (i.e., Open APIs for rApps) provides an interface between rApps and the non-RT RIC platform, which exposes the comprehensive non-RT RIC platform services to rApps for creating differentiated services

- Third-party rApps can be ported on the Capgemini non-RT RIC platform using rApp SDK, which makes it easy to develop xApps by exposing simplified APIs

- Secured A1 and O1 interfaces for communication with near-RT RIC and SMO

- Integration with the Capgemini NetAnticipate platform an award-winning flexible self-learning data science platform to manage the life cycle of ML models

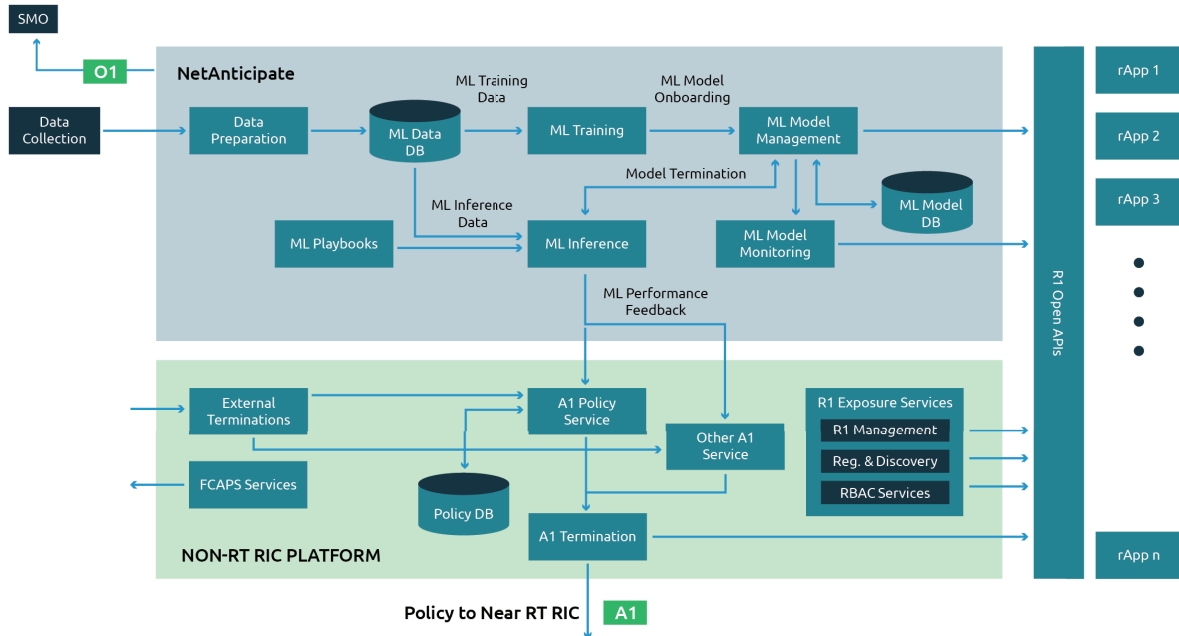- Modules that can be hosted on any infrastructure of choice (public/private cloud and on-premises)

Figure 4: Features of the Capgemini non-RT RIC solution
Source: Capgemini

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The NetAnticipate machine-learning platform

The award-winning NetAnticipate platform is a self-learning data science platform that easily manages the life cycle of ML models and O-RAN applications in a distributed environment. The platform enables automated model training and the publishing of models in a catalog for easy searching and deployment in a production environment. Playbooks provide the automation workflows by packaging ML models with the associated business logic. (See Figures 4 and 5.)

Here are the salient features:

- MLOps to build a comprehensive ML pipeline for continuous operation and self-learning of ML models through feedback loops

- 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
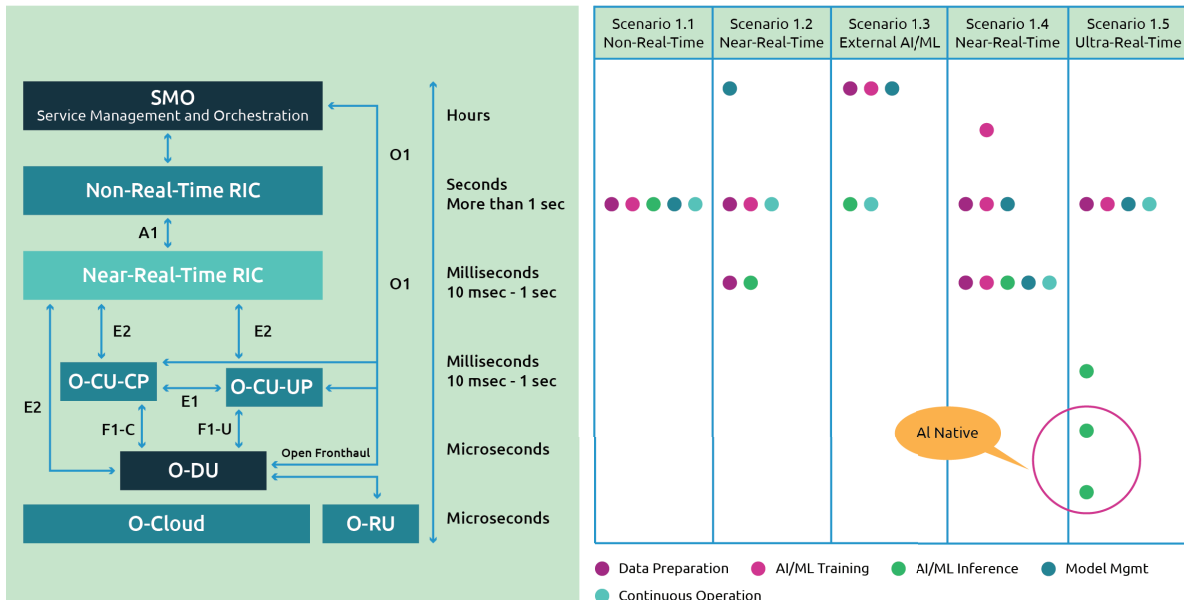
Figure 5: non-RT RIC architecture and AI/ML use cases in O-RAN
Source: Capgemini

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

Capgemini has developed multiple xApps and rApps that are aligned with the O-RAN Alliance specifications.
The xApp & rApp architecture allows them to be integrated with any third-party RIC platform. Here are the few use-cases implemented by Capgemini.

Quality of Service (QoS)

- Ensuring the RAN user-plane serves the guaranteed bit rate (GBR) QoS flows with satisfactory performance by keeping track of the RF resource that is already being used by the admitted QoS flows and evaluating admission control for incoming GBR QoS flow requests

- Support based on the latest E2AP and E2SM specifications

- Decision logic to decide whether to reject the new flow request or release some existing flows that are a lower priority in order to admit the new flow

- The xApp-based design allows flexible QoS metric selection as well as algorithm evolution on resource prediction and evaluation, as it is now decoupled from the sophisticated RAN software

- Integrated with the Capgemini RIC platform as well as with third-party RIC platforms

Traffic steering

- Using intelligent trigger conditions and application logic, the xApp and rApp steers the UEs to the right serving cell to ensure per-use SLAs and QoS requirements are met and in turn improve overall network performance

- The logic is performed on UE or a group of UE cells, and support is based on the latest E2AP and E2SM specifications

- Support for traffic steering is based on measurements and KPIs from O-CU/O-DU

- Handover triggers using E2SM-RC include intra-CU/inter-DU and inter-CU related scenarios

- ML models are used to make predictions based on the KPIs and help in traffic steering decisions made by xApp

- Integrated with the Capgemini RIC platform and with third-party RIC platforms

RAN slice assurance

- xApp and rApp ensure RAN slice KPI assurance using AI-based triggers and KPIs received from O-RAN components

- Near-RT RIC shall obtain the SLA objectives as A1 policies from the non-RT RIC and provide guidance or control to the E2 nodes to achieve SLA assurance enforcement at O-CU/O-DU

- Slice-level metrics collected from O-CU/O-DU are used in xApp, and AI-based inference is also made using the trained models

- The xApp(s) shall control the E2 nodes in adjusting PRB allocation levels per slice based on which MAC schedulers are expected to handle the PRB allocation per slice

- Near-RT RIC shall support and interface with SMO requests for the creation, activation, modification, de-activation, and termination of RAN slices

- Slice assurance done per UE or group of UEs is based on the pre-standard version of E2SM specifications and then is migrated to approved specifications when available

Along with the xApps and rApps mentioned above, Capgemini has a rich ecosystem of partner xApps and rApps that can be used along with the Capgemini RIC to realize various O-RAN use cases. These include SON use cases, MU-MIMO, energy-saving, and other potential xApps and rApps. Capgemini is also helping customers in developing and building rApp/xApp use-cases based on their requirements.

Why Capgemini?

Capgemini has a rich set of software frameworks and product engineering services across many communication technologies, including RAN, transport, core networks, and edge computing. Our software frameworks enable our clients to leverage standard software and components that accelerate the development of connected solutions and reduce development time in the range of 30% to 60%.

Capgemini has more than 125 licensable frameworks that deliver unique value propositions. Our strategy is aligned with the O-RAN Alliance vision of open, intelligent, virtualized, and fully interoperable RAN. The Capgemini RATIO RIC platform is a step toward realizing that vision.

About Capgemini Engineering

Capgemini Engineering combines, under one brand, a unique set of strengths from across the Capgemini Group: the world leading engineering and R&D services of Altran – acquired by Capgemini in 2020 – and Capgemini's digital manufacturing expertise. With broad industry knowledge and cutting-edge technologies in digital and software, Capgemini Engineering supports the convergence of the physical and digital worlds. Combined with the capabilities of the rest of the Group, it helps clients to accelerate their journey towards Intelligent Industry. Capgemini Engineering has more than 52,000 engineer and scientist team members in over 30 countries across sectors including aeronautics, automotive, railways, communications, energy, life sciences, semiconductors, software & internet, space & defense, and consumer products.

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