O-RAN.WG2.Non-RT-RIC-ARCH-TS-v01.00

Technical Specification

O-RAN Working Group 2
Non-RT RIC Architecture

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Date	Revision	Author	Description
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2021.07.16	01.00	Intel, CMCC	Addressed editorial comments in the following document: *WG2-Non-RT-RIC-ARCH-TS-v01.00.02-review comments-RMI-JIO-INT-NOK.xlsx*

Contents

1 Introduction

1.1 Scope

This Technical Specification has been produced by the O-RAN Alliance.

The contents of the present document are subject to continuing work within O-RAN and may change following formal O-RAN approval. Should the O-RAN Alliance modify the contents of the present document, it will be re-released by O-RAN with an identifying change of release date and an increase in version number as follows:

Release xx.yy.zz

where:

xx the first two-digit value is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc. (the initial approved document shall have xx=01).

yy the second two-digit value is incremented when editorial only changes have been incorporated in the document.

zz the third two-digit value is included only in working versions of the document indicating incremental changes during the editing process; externally published documents never have this third two-digit value included.

The present document provides the technical specification for the Non-RT RIC (RAN Intelligent Controller) architecture. This document collects requirements on the Non-RT RIC framework, hosted applications, and services of the R1 interface. This document specifies Non-RT RIC framework functionalities and services exposed to the applications.

1.2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same* Release as the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] O-RAN.WG1.O-RAN-Architecture-Description, “O-RAN Working Group 1, O-RAN Architecture Description”.

[3] O-RAN.WG2.UCR, “O-RAN Working Group 2; Use Case and Requirements”.

[4] O-RAN.WG2.AIML, “O-RAN Working Group 2; AI/ML workflow and requirements”.

[5] O-RAN.WG2.A1GAP, “O-RAN Working Group 2; A1 interface: General Aspects and Principles”.

[6] O-RAN.WG2.Non-RT-RIC-ARCH-TR, “O-RAN Working Group 2; Non-RT RIC: Functional Architecture”.

[7] O-RAN.WG2.A1AP, "O-RAN Working Group 2; A1 interface: Application Protocol".

[8] O-RAN.WG2.A1TP, "O-RAN Working Group 2; A1 interface: Transport Protocol".

[9] O-RAN.WG2.A1TD, "O-RAN Working Group 2; A1 interface: Type Definition".

1.3 Definitions and Abbreviations

1.3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

Non-RT RIC (O-RAN Non-Real-Time RAN Intelligent Controller): a logical function within SMO that enables non-real-time control and optimization of RAN elements and resources, AI/ML workflow including model training and updates, and policy-based guidance of applications/features in Near-RT RIC.

Near-RT RIC (O-RAN Near-Real-Time RAN Intelligent Controller): a logical function that enables near-real-time control and optimization of RAN elements and resources via fine-grained (e.g. UE basis, Cell basis) data collection and actions over E2 interface.

Functions anchored inside the Non-RT RIC framework: Logical functions in the SMO framework that are part of the Non-RT RIC framework.
NOTE: The definition makes no assumption on the mandatory or optional qualifier of the function being anchored.

Functions anchored outside the Non-RT RIC framework: Logical functions in the SMO framework that are not part of the Non-RT RIC framework.
NOTE: The definition makes no assumption on the mandatory or optional qualifier of the function being anchored.

Non-anchored functions: Logical functions in the SMO framework that may or may not be part of the Non-RT RIC framework.
NOTE: The definition makes no assumption on the mandatory or optional qualifier of the function being non-anchored.

1.3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply.

AI	Artificial Intelligence
EI	Enrichment Information
ML	Machine Learning
Near-RT RIC	Near-real-time RAN Intelligent Controller
Non-RT RIC	Non-real-time RAN Intelligent Controller
RAN	Radio Access Network
SMO	Service Management and Orchestration

2 Overview

2.1 Non-RT RIC in O-RAN Overall Architecture

Non-Real Time RAN Intelligent Controller (Non-RT RIC) is the functionality internal to the Service Management and Orchestration (SMO) framework in O-RAN overall architecture, as shown in Figure 4.1-2 of [2].

- Non-RT RIC represents a subset of functionality of the SMO framework.
- Non-RT RIC supports intelligent RAN operation and optimization.
- Non-RT RIC logically terminates the A1 interface, and it provides policy-based guidance, enrichment information, and AI/ML model management [FFS] to the Near-RT RICs.
- Non-RT RIC can access other SMO framework functionalities, for example influencing what is carried across the O1 and O2 interface.

2.2 Non-RT RIC Composition

Non-RT RIC is comprised of:

- Non-RT RIC Framework – Functionality internal to the SMO Framework that:
  - Logically terminates the A1 interface to the Near-RT RIC.
  - Exposes set of R1 services to Non-RT RIC Applications (rApps).
- Non-RT RIC Applications (rApps) – Applications that leverage the functionalities available in the Non-RT RIC Framework / SMO Framework to provide value added services related to RAN operation and optimization. The scope of rApps includes, but is not limited to, radio resource management, data analytics, and providing enrichment information.

3 Requirements

3.1 Requirements for the Non-RT RIC Framework

[REQ-NRTFWK-FUN1]	The Non-RT RIC framework shall support functionality to register services along with their service producers in the Non-RT RIC and SMO.

[REQ-NRTFWK-FUN2]	The Non-RT RIC framework shall support functionality to allow service consumers to discover services.

[REQ-NRTFWK-FUN3]	The Non-RT RIC framework shall support functionality to allow service consumers to subscribe/unsubscribe notifications about newly registered/updated/deregistered services.

[REQ-NRTFWK-FUN4]	The Non-RT RIC framework shall support functionality to notify subscribed service consumers about newly registered/updated/deregistered services.

[REQ-NRTFWK-FUN5]	The Non-RT RIC framework shall support functionality to authenticate service consumers.

[REQ-NRTFWK-FUN6]	The Non-RT RIC framework shall support functionality to authorize service consumers to access services.

[REQ-NRTFWK-FUN7]	The Non-RT RIC framework shall support functionality to send messages to and receive messages from the Near-RT RIC via the A1 interface.

[REQ-NRTFWK-FUN8]	The Non-RT RIC framework shall support functionality to allow data consumers (including rApps) to register data types they consume, if such functionality is not supported in the SMO framework.

[REQ-NRTFWK-FUN9]	The Non-RT RIC framework shall support functionality to allow data producers (including rApps) to register data types they produce, if such functionality is not supported in the SMO framework.

[REQ-NRTFWK-FUN10]	The Non-RT RIC framework shall support functionality to allow data consumers (including rApps) to subscribe/request registered data types, if such functionality is not supported in the SMO framework.

[REQ-NRTFWK-FUN11]	The Non-RT RIC framework shall support functionality to train AI/ML models, if such functionality is not supported in the SMO framework.

[REQ-NRTFWK-FUN12]	The Non-RT RIC framework shall support functionality to allow service consumers to store and retrieve trained AI/ML models, if such functionality is not supported in the SMO framework

[REQ-NRTFWK-FUN13]	The Non-RT RIC framework shall support functionality to monitor the performance for deployed AI/ML models in runtime, if such functionality is not supported in the SMO framework

[REQ-NRTFWK-FUN14]	The Non-RT RIC framework may support functionality to collect external enrichment information from external enrichment information sources.

[REQ-NRTFWK-FUN15]	The Non-RT RIC framework may support functionality to retrieve trained ML models (and metadata) from external AI/ML service providers.

[REQ-NRTFWK-FUN16]	The Non-RT RIC framework may support functionality to allow external sources to inject RAN intents, suspend/resume/check rApps, and configure/check/initiate/suspend/resume/terminate AI/ML training processes.

3.2 Requirements for rApps

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3.3 Requirements for R1

O-RAN.WG2.UCR [3] specifies R1 interface functional requirements.

4 Non-RT RIC Architecture

The following figure depicts the reference architecture of the Non-RT RIC as part of the SMO framework.

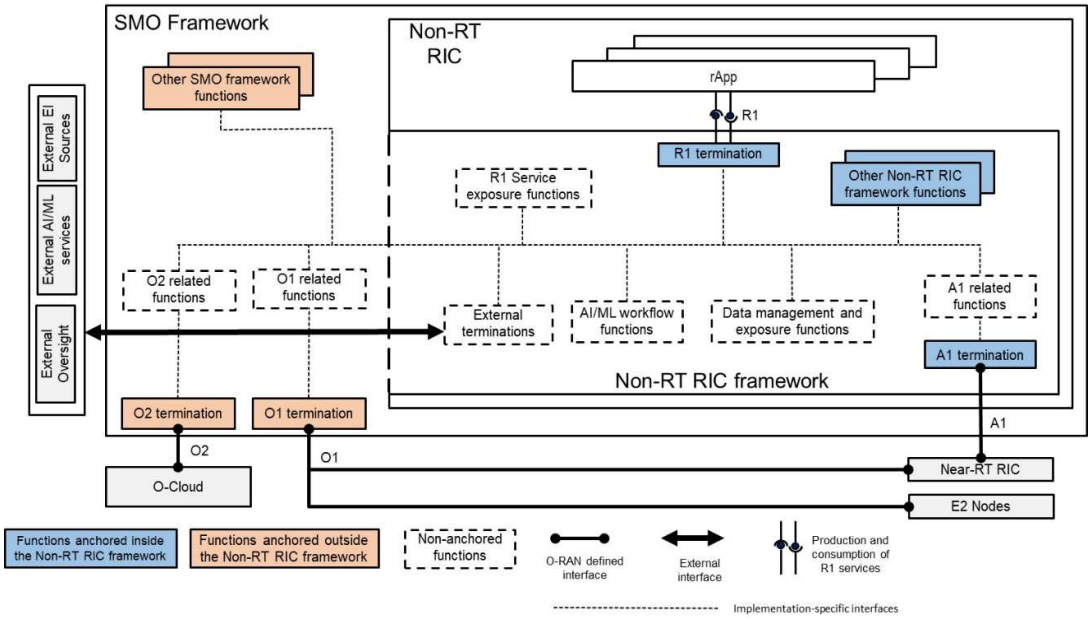

Figure 4-1: Non-RT RIC Reference Architecture

There are three categories of logical functions in Non-RT RIC framework and SMO framework:

- Functions anchored inside the Non-RT RIC framework, which are indicated in solid blue box in Figure 4-1.
- Functions anchored outside the Non-RT RIC framework, which are indicated in solid orange box in Figure 4-1.
- Non-anchored functions, which are indicated in dashed line box in Figure 4-1.

The categories are defined in Clause 1.3.1.

The decomposition of logical functions is not mandatory, and it is up to vendor's implementation.

NOTE: There might be other SMO framework functions or other Non-RT RIC framework functions which may provide additional services over the R1 interface or provide EI for A1 enrichment information services. It is FFS.

NOTE: Other SMO framework functions may be defined by other O-RAN WGs and the potential impacts on Non-RT RIC architecture is FFS.

NOTE: Whether the A1-related functions are anchored functions or not is FFS.

The R1 services are a collection of services produced by logical functions in the Non-RT RIC framework / SMO framework or by rApps.

R1 Service exposure functions include (not limited to): Authorization, Authentication, Registration, Discovery, and Communication support.

The R1 termination enables the Non-RT RIC framework and rApps to exchange messages to access the R1 services via the R1 interface.

The implementation-specific interfaces, which are indicated by the dashed line in Figure 4-1, allow the logical functions in Non-RT RIC framework/SMO framework to communicate with each other by means outside the scope of the present document.

5 R1 Service Definitions

5.1 General Description

A service is a set of capabilities related to each other, offered by a service producer to service consumer(s) for consumption. The capabilities within a service typically have a common purpose and can be inter-dependent. In order to improve re-usability, the mutual coupling across any two services is usually avoided or minimized. Services are produced by service producers and consumed by service consumers through service endpoints (typically APIs). The interoperability of service producers and service consumers is ensured by support of the related service endpoints, but it does not depend on the decomposition of logical functions. Being a service producer and/or a service consumer is a role of an rApp or of a logical function in the SMO or the Non-RT RIC framework (see Clause 0).

The set of R1 services which can be accessed via the R1 interface includes (but is not limited to):

- Exposure services, which include service registration and service discovery services, authentication services, authorization services and communication support services. The exposure services support extensibility of the set of R1 services.
- Data management and exposure services, which deliver data created or collected by data producers to data consumers according to their needs.
- A1-related services, which provide access to functionality related to A1.
- AI/ML workflow services, which provide access to AI and ML workflow.
- O1-related services, which provide access to functionality related to O1.
- O2-related services, which provide access to functionality related to O2.

NOTE: A part of the services listed above may be used on other O-RAN-defined interfaces as well.

5.2 General Principles

Void

5.3 Data management and exposure services

Data management and exposure services provided by the SMO/Non-RT RIC framework enable

- Data registration
- Data discovery
- Data subscription
- Data request
- Data collection from data producers to the SMO/Non-RT RIC framework
- Data delivery from SMO/Non-RT RIC framework to data consumers
- Access to optional data processing in the SMO/Non-RT RIC framework.

Data producers (e.g., rApps) communicate information about the data types that they produce in data registration. Data producers can communicate constraints related to the authorization of the data consumers to discover registered data types and access produced data. Data producers communicate information about how the data is collected by the SMO/Non-RT RIC framework (e.g., collection periodicity, event-trigger conditions, push or pull, etc.)

Data consumers (e.g., rApps) communicate information about the data types that they want to discover. Data consumers subscribe/request data from the SMO/Non-RT RIC framework for consumption with specific data type, periodicity, and delivery (or reporting) method, scope, etc. The delivery (or reporting) method contains information about how the subscribed/requested data is delivered from the SMO/Non-RT RIC framework (e.g., delivery periodicity, event-trigger conditions, push or pull, etc.)

SMO/Non-RT RIC framework collects data produced by data producers. SMO/Non-RT RIC framework delivers data to data consumers for consumption. SMO/Non-RT RIC framework can optionally store collected data. SMO/Non-RT RIC framework can optionally process collected and/or stored data (e.g., quantization, normalization, labelling, correlation, etc.)

6 Non-RT RIC Function Definitions

6.1 General Descriptions

In the Non-RT RIC architecture in Clause 0, R1 services are provided by a collection of logical functions in Non-RT RIC framework/SMO framework or rApps. These logical functions, as defined in Clause 0, include (but are not limited to):

- R1 service exposure functions include (not limited to): Authorization, Authentication, Registration, Discovery, and Communication support.
    - The service registration and discovery functions produce the following services:
        - Services registration: It allows to register services. It also stores and maintains data about the service.
        - Services deregistration: It allows deregister services and delete the related data.

- Service discovery: It supports service discovery for a service consumer to find a required service based on its selection criteria.
- Service notification: Based on the subscription, it notifies its service consumers about the newly registered/updated/deregistered services.
- Communication support: It enables service consumers and producers to interact with each other

More detailed description of related R1 services are in Clause 5.

The R1 service exposure functions can also allow to register and discover SMO services via service registration and discovery services that are produced by the service registration and discovery functions. Examples of service producers include: AI/ML workflow service producer, A1-related service producer, etc. Examples of service consumers are rApps. It is noted that rApps can also be service producers and logical functions can also be service consumers.

A service producer or an entity acting on its behalf can send a service registration request to the service registration and discovery function to register services. A service consumer can either send a service discovery request to the service registration and discovery function to discover the required services and the endpoints on which they can consume, or send a service request directly if it receives a service notification with the related information on the service and on the endpoints on which it can consumed.

- The authentication and authorisation functions produce the following services and support the following functionalities:
  - Authentication: It allows the authentication of a service producer and/or a service consumer.
  - Authorisation: includes services to provide authorisation to service consumer that allow it to access particular services, and mechanisms to enforce authorization.

More detailed description of the related R1 services are in Clause 5.

- R1 termination: It enables the Non-RT RIC framework and rApps to exchange messages to access the R1 services via the R1 interface.
- Data management and exposure functions

NOTE: Data management and exposure functions will be defined in further releases of the present document.

- A1 related functions

NOTE: A1 related functions will be defined in further releases of the present document.

- A1 termination

NOTE: A1 termination will be defined in further releases of the present document.

- AI/ML workflow functions

NOTE: AI/ML workflow functions will be defined in further releases of the present document.

- O1 termination

NOTE: O1 termination will be defined in further releases of the present document.

- O1-related functions

NOTE: O1-related functions will be defined in further releases of the present document.

- O2 termination

NOTE: O2 termination will be defined in further releases of the present document.

- O2-related functions

NOTE: O2-related functions will be defined in further releases of the present document.

- External terminations

NOTE: O2 termination will be defined in further releases of the present document.

7 External Interfaces

7.1 A1 Interface

O-RAN.WG2.A1GAP [5] specifies A1 interface general aspects and principles.

O-RAN.WG2.A1AP [7] specifies A1 interface application protocols.

O-RAN.WG2.A1TP [8] specifies A1 interface transport protocols.

O-RAN.WG2.A1TD [9] specifies data model and data types used in the A1 interface.

7.2 Other Interfaces

NOTE: Other external interfaces include external EI interface, external AI/ML interface, interface for external oversight, which are out of scope of the present specification.

8 Procedures

Void

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By execution hereof, no form of any partnership, joint venture or other special relationship is created between Adopter, or O-RAN Alliance or its Members, Contributors or Academic Contributors. Except as expressly set forth in this Agreement, no party is authorized to make any commitment on behalf of Adopter, or O-RAN Alliance or its Members, Contributors or Academic Contributors.

In the event that any provision of this Agreement conflicts with governing law or if any provision is held to be null, void or otherwise ineffective or invalid by a court of competent jurisdiction, (i) such provisions will be deemed stricken from the contract, and (ii) the remaining terms, provisions, covenants and restrictions of this Agreement will remain in full force and effect.

Any failure by a party or third party beneficiary to insist upon or enforce performance by another party of any of the provisions of this Agreement or to exercise any rights or remedies under this Agreement or otherwise by law shall not be construed as a waiver or relinquishment to any extent of the other parties' or third party beneficiary's right to assert or rely upon any such provision, right or remedy in that or any other instance; rather the same shall be and remain in full force and effect.