

1

O-RAN Work Group 10 (OAM for O-RAN)

O-RAN Information Model and Data Models Specification

2

3

4

1	Contents	
2		
3	Foreword.....	3
4	Modal verbs terminology	4
5	1. Scope	5
6	2. References	6
7	2.1 Normative references	6
8	2.2 Informative references	6
9	3. Definitions of term, symbols and abbreviations.....	8
10	3.1 Terms	8
11	3.2 Symbols	8
12	3.3 Abbreviations and acronyms.....	8
13	4. Overview and Philosophy	10
14	4.1 “Prosumer” relationship between O-RAN and Standards Development Organizations.....	10
15	4.2 Information and Data Models as a Modeling Continuum.....	11
16	4.3 Information and Data Modeling Co-Evolution.....	11
17	4.4 Model and Use Case Development (process)	12
18	4.5 O-RAN components reflected within O-RAN Information Model and Data Model(s).....	13
19	5. O-RAN Information Model.....	14
20	5.1 Modeling approach, Unified Modeling Language (UML).....	14
21	5.2 O-RAN Information Model Definitions	14
22	5.2.1 Imported and associated information entities	14
23	5.2.2 Class diagrams	14
24	5.2.3 Class definitions	17
25	5.2.4 Attribute definitions	25
26	5.3 Classes/components and interfaces that comprise the O-RAN Information Model and Data Models.....	31
27	6. O-RAN Data Models.....	33
28	6.1 Formal relationship (traceability) between O-RAN Data Models and the O-RAN Information Model.....	33
29	6.2 Usage of 3GPP Data Models	33
30	6.3 Usage of non-3GPP data models	35
31	6.4 YANG Conventions.....	39
32	6.4.1 General	39
33	6.4.2 Naming.....	39
34	6.4.3 Revision Statement.....	39
35	6.4.4 Indents	39
36	6.4.5 YANG Language Usage.....	40
37	6.4.6 Cross Working Group Co-ordination	40
38	6.4.7 Development of YANG Data Models compatible with O1.....	40
39	6.4.8 Augmentations of 3GPP YANG Data Models	40
40	Annex A (informative): Links to Data Models approved for use.....	42
41	Change History	43
42		

1 Foreword

- 2 This Technical Specification (TS) has been produced by WG10 of the O-RAN Alliance.

1 Modal verbs terminology

2 In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and
3 "**cannot**" are to be interpreted as described in clause 3.2 of the O-RAN Drafting Rules (Verbal forms for the expression
4 of provisions).

5 "**must**" and "**must not**" are **NOT** allowed in O-RAN deliverables except when used in direct citation.

6

7

1. Scope

The contents of the present document are subject to continuing work within O-RAN WG10 and may change following formal O-RAN approval. Should the O-RAN.org modify the contents of the present document, it will be re-released by O-RAN Alliance with an identifying change of release date and an increase in version number as follows:

Release x.y.z

where:

- x the first digit is incremented for all changes of substance, i.e., technical enhancements, corrections, updates, etc. (the initial approved document will have x=01).
- y the second digit is incremented when editorial only changes have been incorporated in the document.
- z the third digit included only in working versions of the document indicating incremental changes during the editing process.

This document is both a Specification and an Informational Report in that it specifies the Information Model and the Data Models that are foundational for O-RAN's model-driven architecture and for the functions carried out over O-RAN interfaces.

In addition, this document includes information about existing standards and industry work that serve as a basis for work items in O-RAN. There is a "prosumer" relationship evolving between O-RAN and 3GPP, as each makes its model available and provides model feedback to the other.

Lastly, this document describes the de facto methods and procedures with respect to a "modeling continuum" that aims to establish and evolve an O-RAN Information Model from which O-RAN Data Models may be generated manually or with a set of tools.

2. References

2.1 Normative references

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 Release 17

The following referenced documents are necessary for the application of the present document.

- [1] 3GPP TR 21.905: Vocabulary for 3GPP Specifications
- [2] 3GPP TS 28.622: Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)
- [3] RFC 8342: “Network Management Datastore Architecture (NMDA)”, IETF, March 2018
- [4] RFC 8407: “Guidelines for Authors and Reviewers of Documents Containing YANG Data Models”, IETF, October 2018
- [5] RFC 7950, “The YANG 1.1 Data Modeling Language”, IETF, August 2016
- [6] 3GPP TS 32.156: Telecommunication management; Fixed Mobile Convergence (FMC) Model repertoire, version 17.2.0, January 2023
- [7] 3GPP TS 32.160: Management and orchestration; Management service template, version 17.7.0, March 2023
- [8] O-RAN.WG10.O1-Interface.0-v10.00: “O-RAN Operations and Maintenance Interface Specification”, March 2023
- [9] OMG formal/2017-12-05: OMG® Unified Modeling Language® (OMG UML®), Version 2.5.1
- [10] O-RAN.WG3.O1-Interface-for-Near-RT-RIC.0-v01.00: “O1 Interface Specification for Near Real Time RAN Intelligent Controller”, November 2022
- [11] 3GPP TS 28.625: Telecommunication management; State Management Data Definition Integration Reference Point (IRP); Information Service (IS)
- [12] O-RAN.WG6.O2IMS-INTERFACE-v04.00: “O2ims Interface Specification”, March 2023
- [13] 3GPP TS 32.404: Technical Specification Group Services and System Aspects; Telecommunication management; Performance Management (PM); Performance measurements
- [14] ETSI GS NFV-IFA 027 V4.2.1, “Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Performance Measurements Specification”, May 2021
- [15] 3GPP TS 28.620: Telecommunication management; Fixed Mobile Convergence (FMC), Federated Network Information Model (FNIM), Umbrella Information Model (UIM), version 17.0.0, March 2022

2.2 Informative references

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 Release 17.

The following referenced documents are not necessary for the application of the present document, but they assist the user with regard to a particular subject area.

- [i.1] O-RAN-WG4.MP.0-v12.00: “O-RAN Alliance Working Group 4 Management Plane Specification”, March 2023
- [i.2] RFC 6241, “Network Configuration Protocol (NETCONF)”, IETF, June 2011

- 1 [i.3] “Modeling, Use Case and Architecture Process,” B. Cheung et al, May 2019, ONAP
- 2 [i.4] O-RAN.WG2.A1AP-v04.00: “O-RAN Working Group 2 (Non-RT RIC and A1 interface WG) A1
- 3 interface: Application Protocol”, November 2022
- 4 [i.5] O-RAN.WG3.E2GAP-v03.01: “O-RAN Working Group 3 Near-Real-time RAN Intelligent Controller
- 5 Architecture & E2 General Aspects and Principles”, March 2023
- 6 [i.6] O-RAN-WG5.O-CU-O1.0-v05.00: “O1 Interface specification for O-CU-UP and O-CU-CP”, March 2023
- 7 [i.7] O-RAN.WG5.O-DU-O1.0-v07.00: “O1 Interface specification for O-DU”, March 2023
- 8 [i.8] 3GPP TS 28.623: Telecommunication management; Generic Network Resource Model (NRM) Integration
- 9 Reference Point (IRP); Solution Set (SS) definitions
- 10 [i.9] 3GPP TS 36.423: Technical Specification Group Radio Access Network; Evolved Universal Terrestrial
- 11 Radio Access Network (E-UTRAN); X2 application protocol (X2AP)
- 12 [i.10] 3GPP TS 38.460: Technical Specification Group Radio Access Network; NG-RAN; E1 general aspects and
- 13 principles
- 14 [i.11] 3GPP TS 38.470: Technical Specification Group Radio Access Network; NG-RAN; F1 general aspects and
- 15 principles
- 16 [i.12] 802.1X-2020, “IEEE Standard for Local and Metropolitan Area Networks--Port-Based Network Access
- 17 Control”, IEEE, 2020-02-28
- 18 [i.13] RFC 5717: “Partial Lock Remote Procedure Call (RPC) for NETCONF”, IETF, December 2009
- 19 [i.14] RFC 6022: “YANG Module for NETCONF Monitoring”, IETF, October 2010
- 20 [i.15] RFC 6243: “With-defaults Capability for NETCONF”, IETF, June 2011
- 21 [i.16] RFC 6470: “Network Configuration Protocol (NETCONF) Base Notifications”, IETF, February 2012
- 22 [i.17] RFC 6643: “Translation of Structure of Management Information Version 2 (SMIV2) MIB Modules to
- 23 YANG Modules”, IETF, July 2012
- 24 [i.18] RFC 6991: “Common YANG Data Types”, IETF, July 2013
- 25 [i.19] RFC 7224: “IANA Interface Type YANG Module”, IETF, May 2014
- 26 [i.20] RFC 7317: “A YANG Data Model for System Management”, IETF, August 2014
- 27 [i.21] RFC 7758: “Time Capability in NETCONF”, IETF, February 2016
- 28 [i.22] RFC 7952: “Defining and Using Metadata with YANG”, IETF, August 2016
- 29 [i.23] RFC 8072: “YANG Patch Media Type”, IETF, February 2017
- 30 [i.24] RFC 8341: “Network Configuration Access Control Model”, IETF, March 2018
- 31 [i.26] RFC 8343: “A YANG Data Model for Interface Management”, IETF, March 2018
- 32 [i.27] RFC 8344: “A YANG Data Model for IP Management”, IETF, March 2018
- 33 [i.28] RFC 8348: “A YANG Data Model for Hardware Management”, IETF, March 2018
- 34 [i.30] RFC 8525: “YANG Library”, IETF, March 2019
- 35 [i.31] RFC 8526: “NETCONF Extensions to Support the Network Management Datastore Architecture”, IETF,
- 36 March 2019
- 37 [i.32] RFC 8528: “YANG Schema Mount”, IETF, March 2019
- 38 [i.33] RFC 8575: “YANG Data Model for the Precision Time Protocol (PTP)”, IETF, May 2019
- 39 [i.34] RFC 8632: “A YANG Data Model for Alarm Management”, IETF, September 2019
- 40 [i.35] RFC 8641: “Subscription to YANG Notifications for Datastore Updates”, IETF, September 2019
- 41 [i.36] draft-ietf-netconf-crypto-types: “YANG Data Types and Groupings for Cryptography”, IETF
- 42 [i.37] 3GPP TS 28.541: Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage
- 43 3
- 44

3. Definitions of term, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 0 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 0.

Information Model: a representation of concepts and the relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse. Typically, an Information Model specifies relations between kinds of things, but may also include relations with individual things. It can provide sharable, stable, and organized structure of information requirements or knowledge for the domain context.

Data Model: an abstract model that organizes elements of data and standardizes how they relate to one another and to the properties of real-world entities. The term data model may refer to two distinct but closely related concepts: (1) an abstract formalization of the objects and relationships found in a particular application domain; (2) the set of concepts used in defining such formalizations - for example concepts such as entities, attributes, relations, or tables.

Logical Data Model: a data model of a specific problem domain expressed independently of a particular database management product or storage technology (physical data model) but in terms of data structures such as relational tables and columns, object-oriented classes, or XML tag

Data Dictionary: a centralized repository of information about data such as meaning, relationships to other data, origin, usage, and format

Component Physical Data Models: a representation of a data design as implemented, or intended to be implemented, in a database management system for each component. In the lifecycle of a project, it typically derives from a logical data model and will include the database artifacts required to create relationships between tables or to achieve performance goals, such as indexes, constraint definitions, linking tables, partitioned tables or clusters

3.2 Symbols

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

3.3 Abbreviations and acronyms

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 0 and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 0.

3GPP	3 rd Generation Partnership Project
API	Application Programming Interface
CR	Change Requests
EMS	Element Management System
FCAPS	Fault, Configuration, Accounting, Performance, Security
IOC	Information Object Class
LS	Liaison Statement
MA	Managed Application
MANO	Management and Orchestration

1	ME	Managed Element
2	MF	Managed Function
3	MnS	Management Service
4	MO	Managed Object
5	MOC	Managed Object Class
6	MOI	Managed Object Instance
7	NAT	Network Address Translation
8	Near-RT RIC	O-RAN near real time RAN Intelligent Controller
9	NMS	Network Management System
10	Non-RT RIC	O-RAN non real time RAN Intelligent Controller
11	NRM	Network Resource Model
12	O-CU-CP	O-RAN Central Unit – Control Plane.
13	O-CU-UP	O-RAN Central Unit – User Plane
14	O-DU	O-RAN Distributed Unit
15	OMG	Object Management Group
16	O-RAN	Open Radio Access Network
17	O-RU	O-RAN Radio Unit
18	ONAP	Open Network Automation Platform
19	PNF	Physical Network Function
20	RAN	Radio Access Network
21	RRH	Remote Radio Head
22	SDO	Standards Development Organization
23	SMO	Service Management and Orchestration (layer)
24	TR	Technical Report
25	TS	Technical Specification
26	UML	Unified Modeling Language
27	SA5	Services & System Aspects Working Group 5 Telecom Management
28	VNF	Virtualized Network Function

4. Overview and Philosophy

4.1 “Prosumer” relationship between O-RAN and Standards Development Organizations

The O-RAN Alliance complements the work of other Standards Development Organizations (SDO): 3GPP, IETF, and IANA are among the primary sources for Management specifications for O-RAN components.

3GPP has published:

- its Generic Network Resource Model (NRM), including:
 - a Stage 2 NRM Information Model, in 3GPP TS 28.622 0;
 - corresponding Stage 3 Solution Sets, one of which consists of YANG Data Models, in 3GPP TS 28.623 0;
- its 5G Network Resource Model (NRM), including the Stage 2 NR NRM Information Model and corresponding Stage 3 Solution Sets, one of which consists of YANG Data Models, in 3GPP TS 28.541 **Error! Reference source not found.**;
- “Management and Orchestration APIs”, including YANG data models from both NRMs, in a publicly available git repository

O-RAN Information Model, Data Models, and modeling processes should complement the work of other SDOs, not conflict or compete.

When 3GPP makes updates to their specification, they are incorporated into the O-RAN OAM Interface Specification 0. This, in turn, drives the updates that are to be made to both the Information Model and Data Models within O-RAN.

4.2 Information and Data Models as a Modeling Continuum

Within O-RAN, the de facto methods and procedures with respect to the early stage of an O-RAN “modeling continuum” aim to evolve **one common and coherent Information Model** for providing O-RAN extensions to the existing 4G/5G IMs such as the 3GPP NRMs, from which O-RAN Data Models may be generated.

Information and Data Models as a Modeling Continuum

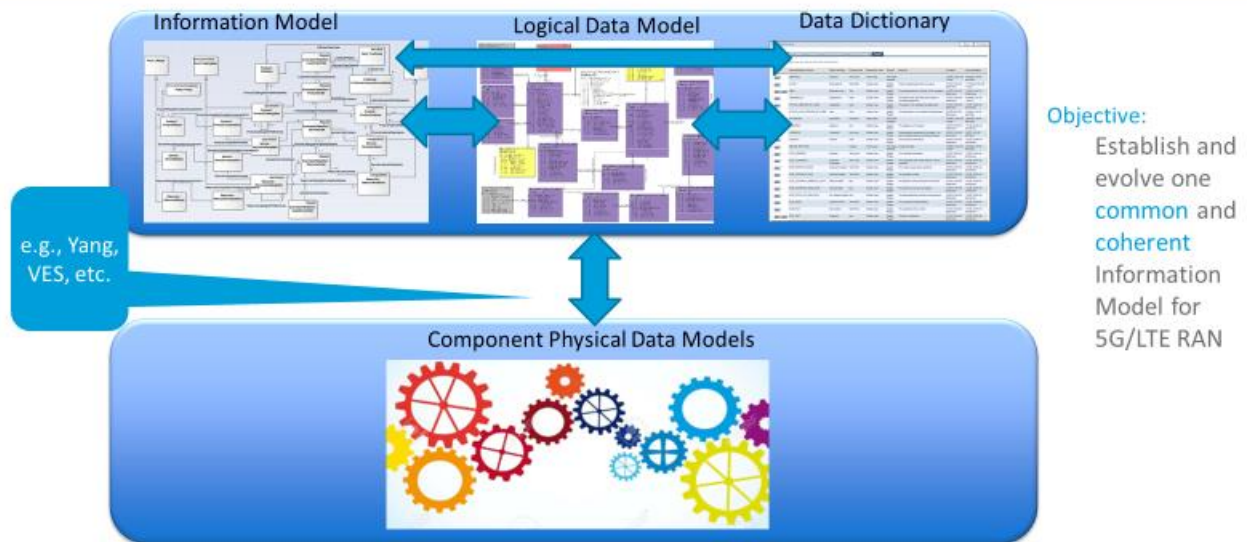


Figure 4.2-1 Information and Data Models as a Modeling Continuum (conceptual)

4.3 Information and Data Modeling Co-Evolution

The “Modeling Continuum” depicted as Figure 4.2-1 is purely conceptual and is intended to provide a framework for Information and Data Modeling Co-evolution.

Here is an example of the process to be adapted to, and adopted by, O-RAN:

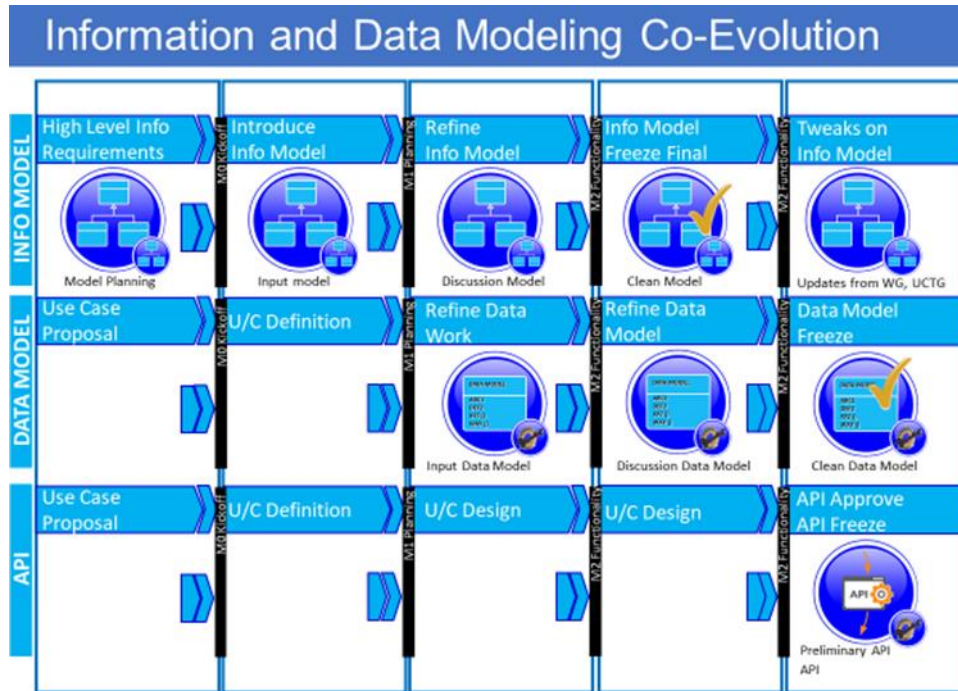


Figure 4.3-1 Information and Data Modeling Co-Evolution Error! Reference source not found.

4.4 Model and Use Case Development (process)

There is evolving process within O-RAN to guide and inform Information Model and Data Model(s) development based on prioritized use cases.

Here is example of the process to be adapted to, and adopted by, O-RAN.

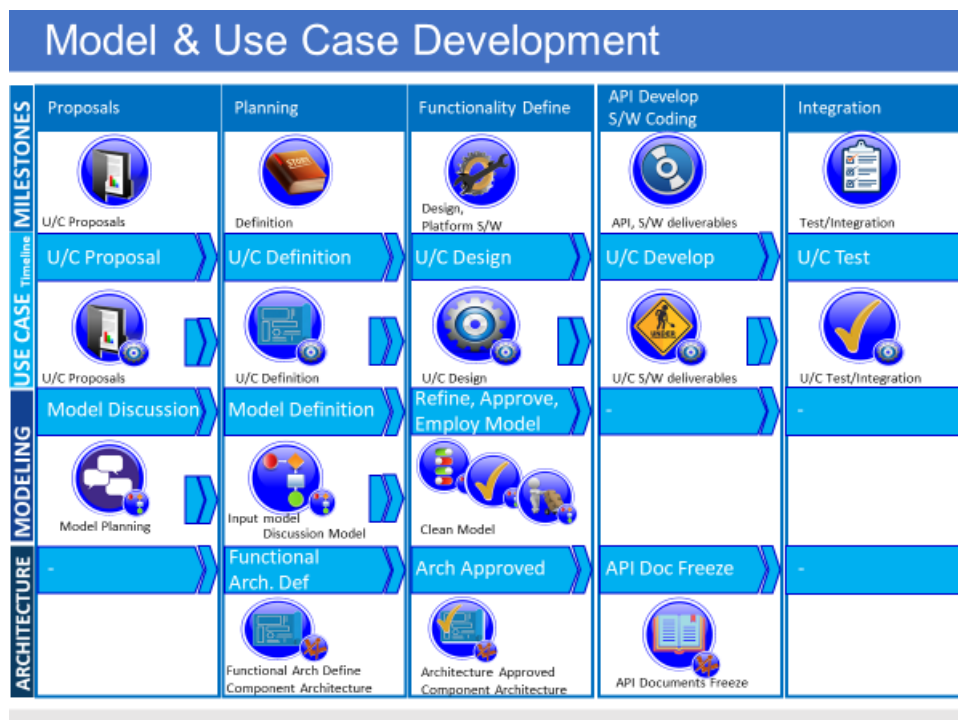


Figure 4.4-1 Model and Use Case Development (process) Error! Reference source not found.

4.5 O-RAN components reflected within O-RAN Information Model and Data Model(s)

The work to evolve the following O-RAN components will both follow and provide feedback on the OAM Information Model and Data Models of 3GPP:

- Near-RT-RIC
- O-CU-UP
- O-CU-CP
- O-DU
- O-RU
- O-eNB

5. O-RAN Information Model

5.1 Modeling approach, Unified Modeling Language (UML)

Modeling is the designing of software applications before coding. Modeling is an essential part of software projects.

Models raise the level of abstraction by hiding or masking details, bringing out the “big picture,” or by focusing on different aspects of a prototype.

The Information Model within O-RAN uses the Unified Modeling Language™ (UML®) version 2.5.1 0 from the Object Management Group (OMG).

O-RAN Information Model follows methodology documented 3GPP TS 32.160 [7] Clause 5.2.

5.2 O-RAN Information Model Definitions

5.2.1 Imported and associated information entities

5.2.1.1 Imported information entities and local labels

Label reference	Local label
3GPP TS 28.622 [2], IOC, Top	Top
3GPP TS 28.622 [2], IOC, ManagedFunction	ManagedFunction
3GPP TS 28.625 [11], Archetype, StateManagementEntity	StateManagementEntity

5.2.1.2 Associated information entities and local labels

Label reference	Local label
TS 28.622 [2], IOC, ManagedElement	ManagedElement
WG3.O1-Interface-for-Near-RT-RIC [10], IOC, NearRTRICFunction	NearRTRICFunction
WG6.O2-Infrastructure Management Specification [12], IOC, ResourceType	OcloudResourceType

5.2.2 Class diagrams

5.2.2.1 Relationships

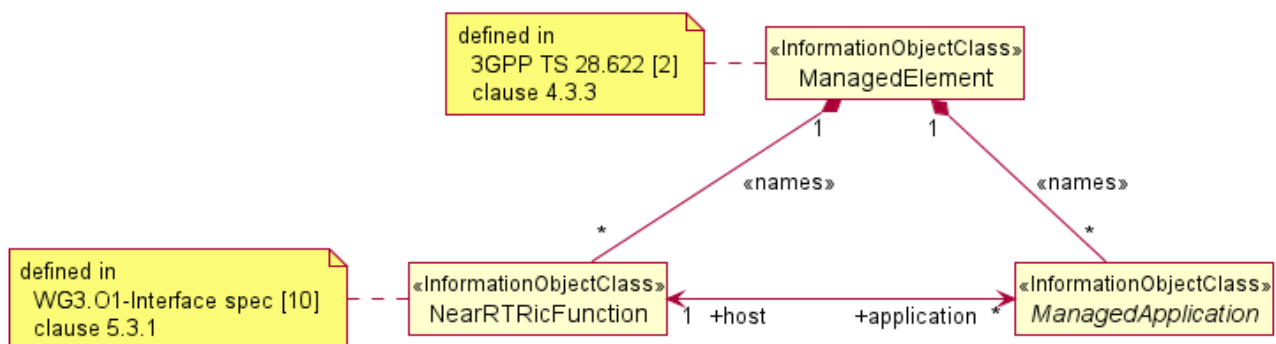


Figure 5.2.2.1-1: ManagedApplication containment

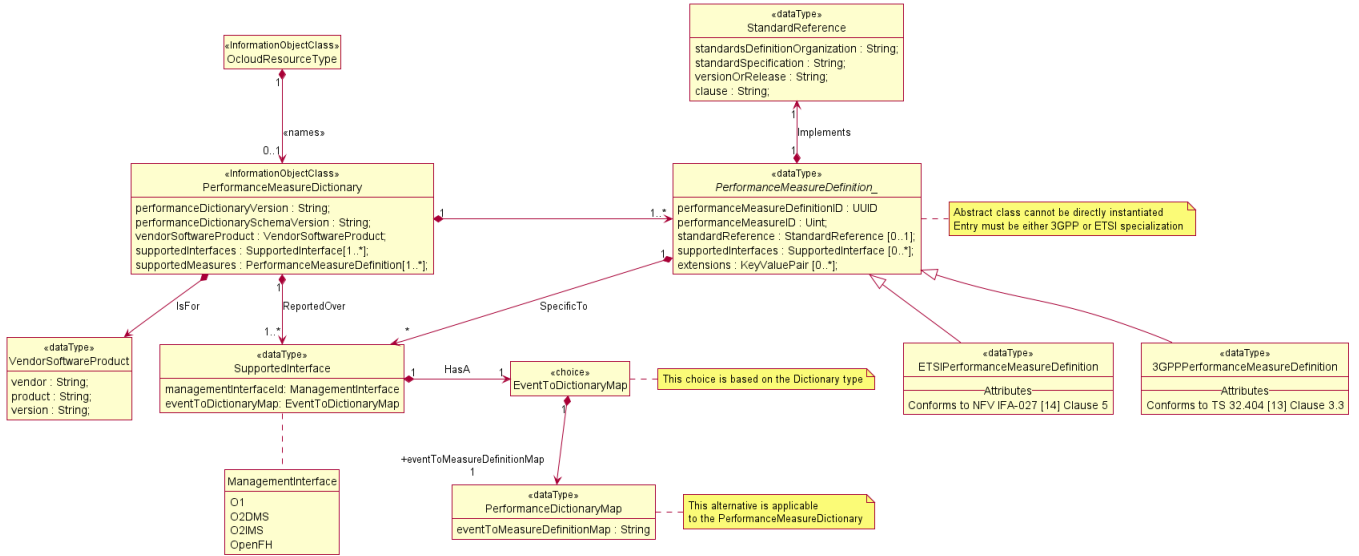


Figure 5.2.2.1-2 Performance Dictionary Relationships

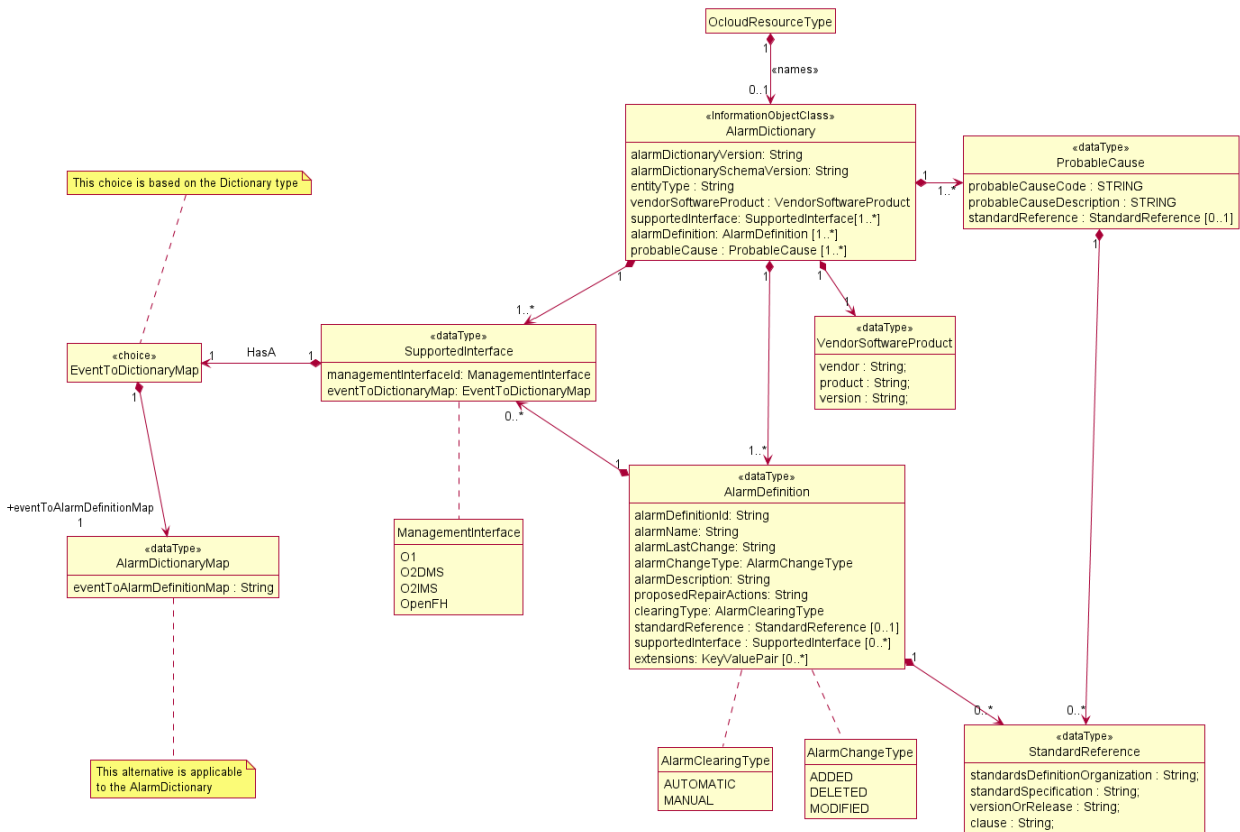


Figure 5.2.2.1-3 Alarm Dictionary Relationships

5.2.2.2 Inheritance

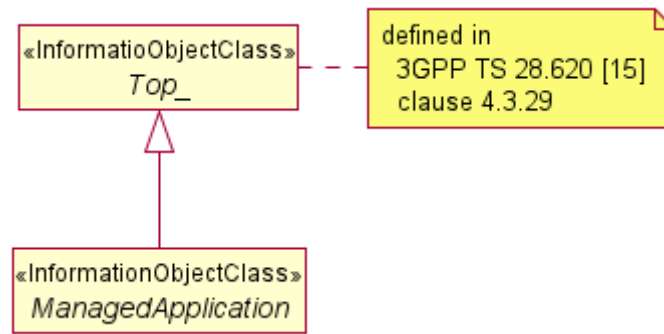


Figure 5.2.2.2-1: ManagedApplication inheritance

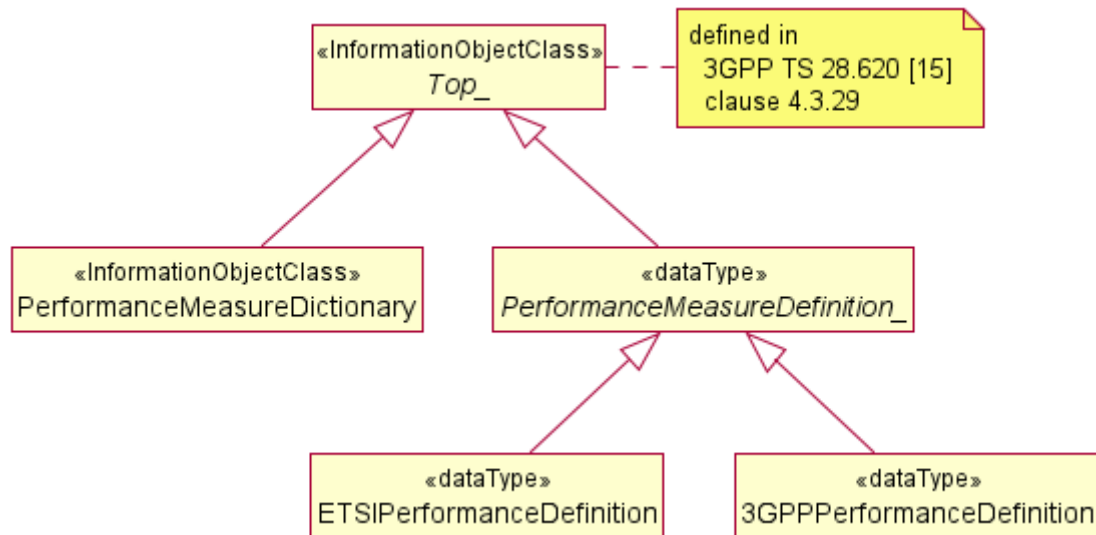


Figure 5.2.2.2-2 PerformancemeasureDictionary inheritance

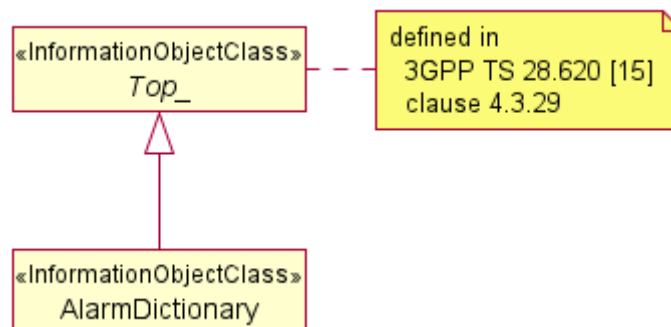


Figure 5.2.2.2-3 Alarm Dictionary inheritance

5.2.3 Class definitions

5.2.3.1 ManagedApplication <<IOC>>

5.2.3.1.1 Definition

This Information Object Class (IOC) is provided for sub-classing only. It provides attribute(s) that are common to application IOCs.

This IOC represents a deployed instance of software application that may be independently tested and separately deployed from the hosting entity (e.g. NearRTRICFunction). The hosting NearRTRICFunction can mediate the management services for the ManagedApplication. A NearRTRICFunction can host zero or more ManagedApplication.

5.2.3.1.2 Attributes

The ManagedApplication IOC includes attributes inherited from Top IOC (defined in 3GPP TS 28.622 [2], clause 4.3.29), attributes operationalState, usageState, administrativeState imported from StateManagementEntity Archetype (defined in 3GPP TS 28.625 [11], clause 4.3.1) and the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
applicationVersion	M	T	F	F	T
applicationName	M	T	T	F	T
Attribute related to role					
hostDN	M	T	F	T	T

5.2.3.1.3 Attribute constraints

None

5.2.3.1.4 Notifications

There are no notifications defined.

5.2.3.1.5 State diagram

None

5.2.3.2 PerformanceMeasureDictionary

5.2.3.2.1 Definition

Resource Types in the O-Cloud provide the SMO a dictionary of performance measures available by Resources of the Resource Type. The O-Cloud Deployment Management Services also report performance of workloads deployed into the cloud. The DMS Performance follows ETSI-NFV specification IFA027 [14]. The performance dictionary should be structured to allow resource vendors to specify their unique performance measures while also supporting performance measures which are defined by a standard.

5.2.3.2.2 Attributes

The PerformanceMeasureDictionary includes attributes inherited from Top IOC (defined in 3GPP TS 28.622 [2], clause 4.3.29) and the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
performanceDictionaryVersion	M	T	F	T	F
performanceDictionarySchemaVersion	M	T	F	T	F
vendorSoftwareProduct	M	T	F	T	F
supportedInterfaces	M	T	F	T	F
supportedMeasures	M	T	F	T	F

5.2.3.2.3 Attribute constraints

None

5.2.3.2.4 Notifications

This class does not support any notification.

5.2.3.2.5 State diagram

None

5.2.3.3 PerformanceMeasureDefinition_ <<dataType>>

5.2.3.3.1 Definition

The PerformanceMeasureDefinition is an abstract class which requires specialization to be implemented. Typically Network functions follow 3GPP definitions and cloud functions follow ETSI. This abstract class defines the O-RAN attributes common to both variants of a performance measurement definition.

5.2.3.3.2 Attributes

The PerformanceMeasureDefinition is an abstract class that can only be implemented via a concrete class that is specialized. It inherits attributes from Top IOC (defined in 3GPP TS 28.622 [2], clause 4.3.29) and extends it with the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
performanceMeasureDefinitionId	M	T	F	T	F
performanceMeasureId	M	T	F	T	F
standardReference	M	T	F	T	F
supportedInterfaces	M	T	F	T	F
extensions	M	T	F	T	F

5.2.3.3.3 Attribute constraints

None

5.2.3.3.4 Notifications

This class does not support any notification.

5.2.3.3.5 State diagram

None

5.2.3.4 ETSIPerformanceMeasureDefinition <<dataType>>

5.2.3.4.1 Definition

The ETSIPerformanceMeasureDefinition is an extension of the PerformanceMeasureDefinition_ abstract class. It provides the extended attributes specific to an ETSI based performance measurement definition.

1 5.2.3.4.2 Attributes

2 The ETSIPerformanceMeasureDefinition is a specialized class of the PerformanceMeasureDefinition_ class which
3 inherits attributes from. It extends the class with the attributed defined in ETSI NFV IFA027 [14] clause 5.

4 5.2.3.4.3 Attribute constraints

5 None

6 5.2.3.4.4 Notifications

7 This class does not support any notification.

8 5.2.3.4.5 State diagram

9 5.2.3.5 3GPPPerformanceMeasureDefinition <<data Type>>

10 5.2.3.5.1 Definition

11 The 3GPPPerformanceMeasureDefinition is an extension of the PerformanceMeasureDefinition_ abstract class. It
12 provides the extended attributes specific to an 3GPP based performance measurement definition.

13 5.2.3.5.2 Attributes

14 The 3GPPPerformanceMeasureDefinition is a specialized class of the PerformanceMeasureDefinition_ class which
15 inherits attributes from. It extends the class with fields defined in 3GPP TS 32.404 [13] clause 3.3.

16 5.2.3.5.3 Attribute constraints

17 None

18 5.2.3.5.4 Notifications

19 This class does not support any notification.

20 5.2.3.5.5 State diagram

21 None.

22 5.2.3.6 StandardReference <<data Type>>

23 5.2.3.6.1 Definition

24 Some definitions are provided by a Standards body. There should be possibility to reference standardized definitions
25 such that the specified standard can be read for additional information.

26 5.2.3.6.2 Attributes

27 The StandardReference contains attributes used to identify where in a standard the definition is provided.

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
standardDefinitionOrganization	M	T	F	T	F
standardSpecification	M	T	F	T	F
versionOrRelease	M	T	F	T	F
clause	M	T	F	T	F

28 5.2.3.6.3 Attribute constraints

29 None

1 5.2.3.6.4 Notifications

2 This class does not support any notification.

3 5.2.3.6.5 State diagram

4 None.

5 5.2.3.7 SupportedInterface <<dataType>>

6 5.2.3.7.1 Definition

7 Provides mapping between fields of particular MOI to management interface over which it can be reported.

8 5.2.3.7.2 Attributes

9 The SupportedInterface contains attributes used to identify which interface field(s) are used to match the mapping.

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
managementInterfaceId	M	T	F	T	F
eventToDictionaryMap	M	T	F	T	F

10 5.2.3.7.3 Attribute constraints

11 None

12 5.2.3.7.4 Notifications

13 This class does not support any notification.

14 5.2.3.7.5 State diagram

15 None.

16 5.2.3.8 EventToDictionaryMap <<choice>>

17 5.2.3.8.1 Definition

18 The EventToDictionaryMap is a choice where the the fields used to map performance and/or fault data from the
19 network to there corresponding dictionaries maybe different based on the containing dictionary type. Therefore two
20 alternatives are supported one for alarms and one for performance measures.

21 5.2.3.8.2 Attributes

22 As a choice stereotype the class has no intrinsic attributes. Instead, the attributes of the class are described in the
23 alternative class type definitions.

24 5.2.3.8.3 Attribute constraints

25 None

26 5.2.3.8.4 Notifications

27 This class does not support any notification.

28 5.2.3.8.5 State diagram

29 None.

5.2.3.9 PerformanceDictionaryMap <<dataType>>

5.2.3.9.1 Definition

The PerformanceDictionaryMap provide the attributes required to map a performance measure in a performance report to its corresponding PerformanceMeasureDefinition entry in an PerformanceMeasureDictionary. Performance measures for a given software product are reported over an interface. A map is required to identify the measurement report attribute which correlates to the performanceMeasureDefinitionId within the dictionary for a given interface. The PerformanceDictionaryMap provides the ability to identify the attribute name within a performance report which will contain the value to use as the performanceMeasureDefinitionId in a PerformanceMeasureDictionary.

5.2.3.9.2 Attributes

The PerformanceDictionaryMap contains attributes used to identify which interface field(s) are used to match the performanceMeasureDefinitionId of a PerformanceMeasureDefinition_ in the PerformanceMeasureDictionary.

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
eventToMeasureDefinitionMap	M	T	F	T	F

5.2.3.9.3 Attribute constraints

None

5.2.3.9.4 Notifications

This class does not support any notification.

5.2.3.9.5 State diagram

None.

5.2.3.10 VendorSoftwareProduct <<dataType>>

5.2.3.10.1 Definition

The VendorSoftwareProduct defines the attributes required to identify vendor, product and its version which is supported.

5.2.3.10.2 Attributes

The VendorSoftwareProduct defines the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
vendor	M	T	F	T	F
product	M	T	F	T	F
version	M	T	F	T	F

5.2.3.10.3 Attribute constraints

None

5.2.3.10.4 Notifications

This class does not support any notification.

5.2.3.10.5 State diagram

None.

1

5.2.3.11 AlarmDictionary

5.2.3.11.1 Definition

There is more information about an alarm than is included in a notification about an alarm occurrence. The Alarm Dictionary provides that data to the SMO such that the extended data may be used to assist in alarm event processing. These could include repair actions which guide a user of the SMO of what to do when the alarm occurs. If the alarm is based on a standard, this could also include the standard-defined descriptions/discussion about the alarm condition.

Along with Network Functions, O-Cloud resources or deployments can generate an alarm notification which are sent to subscribed consumers. It is expected that the SMO is the primary consumer of these events which may need the ability to correlate them when there is a single root cause for alarms from multiple sources. The dictionary definition provides extensibility where such end-to-end type of signatures may be described.

Not all alarms definitions are standardized and therefore the alarm dictionary should be structured to allow a resource and/or application vendors to specify their unique alarms while also supporting alarms which are defined by a standard.

14

5.2.3.11.2 Attributes

The AlarmDictionary includes attributes inherited from Top_ [2] and the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
alarmDictionaryVersion	M	T	F	T	F
alarmDictionarySchemaVersion	M	T	F	T	F
entityType	M	T	F	T	F
vendorSoftwareProduct	M	T	F	T	F
supportedInterfaces	M	T	F	T	F
alarmDefinitions	M	T	F	T	F
probableCauses	M	T	F	T	F

5.2.3.11.3 Attribute constraints

None

5.2.3.11.4 Notifications

This class does not support any notification.

5.2.3.11.5 State diagram

None

5.2.3.12 AlarmDictionaryMap <<dataType>>

5.2.3.12.1 Definition

The AlarmDictionaryMap provides the attributes required to map an alarm event record to its corresponding AlarmDefinition entry in an AlarmDictionary. Alarm event records for a given software product are reported over an interface. A map is required to identify the AlarmEvent attribute which correlates to the alarmDefinitionId within the dictionary for a given interface. The AlarmDictionaryMap provides the ability to identify the attribute name within an Alarm event rRecord which will contain the value to use as the alarmDefinitionId in a AlarmDictionary.

5.2.3.12.2 Attributes

The AlarmDictionaryMap contains attributes used to identify which interface field(s) are used to match the alarmDefinitionId of a AlarmDefinition in the AlarmDictionary.

32

1

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
eventToAlarmDefinitionMap	M	T	F	T	F

2 5.2.3.12.3 Attribute constraints

3 None

4 5.2.3.12.4 Notifications

5 This class does not support any notification.

6 5.2.3.12.5 State diagram

7 None.

8 5.2.3.13 AlarmDefinition <<data Type>>

9 5.2.3.13.1 Definition

10 TheAlarmDefinition is a definition which includes additional data about an alarm which is static and does not need to
11 be transmitted in the actual Alarm event notification. The data is used by the consumer for alarm planning, automation,
12 troubleshooting or to enrich the infrastructure alarm event notification when received.

13 5.2.3.13.2 Attributes

14 The AlarmDefinition inherits attributes from Top_ [2] and extends it with the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifyable
alarmDefinitionId	M	T	F	T	F
alarmName	M	T	F	T	F
alarmLastChange	M	T	F	T	F
alarmChangeType	M	T	F	T	F
alarmDescription	M	T	F	T	F
proposedRepairAction	M	T	F	T	F
clearingType	M	T	F	T	F
standardReference	M	T	F	T	F
supportedInterfaces	M	T	F	T	F
extensions	M	T	F	T	F

15 5.2.3.13.3 Attribute constraints

16 None

17 5.2.3.13.4 Notifications

18 This class does not support any notification.

19 5.2.3.13.5 State diagram

20 None

21 5.2.3.14 ProbableCause <<data Type>>

22 5.2.3.14.1 Definition

23 The Probable Cause is intended to provide an indication of what the root cause of the event could be. This intends to
24 help operators to focus on where to look for to determine the true root cause. There are industry suggested lists of
25 probable causes that could be used. When used the probable cause definition should allow for an indication of such a
26 source.

1 Alarm Definitions may provide one or more probable causes as part of their extended fields. However, each alarm event
2 is expected to have a probable cause that is specific to the instance. To facilitate the aspect of the alarm event the
3 probable causes used by the product vendor for alarm events are listed independently in the alarm dictionary.

4 5.2.3.14.2 Attributes

5 The Probable Cause is a structured data type consisting of the following attributes:

Attribute name	S	isReadable	isWritable	isInvariant	isNotifiable
probableCauseCode	M	T	F	T	F
probableCauseDescription	M	T	F	T	F
standardReference	M	T	F	T	F

6 5.2.3.14.3 Attribute constraints

7 None

8 5.2.3.14.4 Notifications

9 This class does not support any notification.

10 5.2.3.14.5 State diagram

11 None.

1 5.2.4 Attribute definitions

Attribute Name	Documentation and Allowed Values	Properties
applicationVersion	This attribute contains the application version. allowedValues: Not applicable.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
applicationName	This attribute contains the name (human readable) of the application. allowedValues: Not applicable.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: True
hostDN	This attribute contains the DN of the hosting entity (e.g., NearRTRICFunction). allowedValues: Not applicable.	type: DN multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
3GPPPerformanceMeasurementDefinition.collectionMethod	This attribute identifies the collection method for an 3GPP based measurement definition. allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(b).	type: 3GPPCollectionMethod multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
3GPPPerformanceMeasurementDefinition.description	This attribute contains an explanation of the measurement operation allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(a).	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
clause	This attribute identifies the clause in a specification that defines a measurement definition. allowedValues: N/A.	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
condition	This attribute the condition in which the measurement will be updated. allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(c).	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
ETSIPerformanceMeasurementDefinition.collectionMethod	This attribute identifies the collection method for an ETIS based measurement definition. allowedValues: conforms to ETSI NFV IFA027 clause 5(b) [14]	type: ETSICollectionMethod multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
ETSIPerformanceMeasurementDefinition.description	This attribute contains the description of the performance measurement allowedValues: conforms to ETSI NFV IFA027 clause 5(a) [14]	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
generation	This attribute identifies the cellular technology generation(s) that a performance measurement definition is applicable to. allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(h).	type: 3GPPGeneration multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

managementInterfaceId	<p>This attribute identified the management interface that a performance measurement definition can be reported on.</p> <p>allowedValues: O1 O2DMS O2IMS OpenFH</p>	<p>type: ManagementInterface</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
measurementName	<p>This attribute is a descriptive name of the measurement type.</p> <p>allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3.</p>	<p>type: string</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
measurementResult	<p>This attribute is a description of expected result value(s).</p> <p>allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(d).</p>	<p>type: string</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
measurementType	<p>This attribute describes a short form of the measurement name specified in the header, which is used to identify the measurement type</p> <p>allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(e).</p>	<p>type: String</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
measurementUnit	<p>This attribute describes the unit of the measurement value.</p> <p>allowedValues: conforms to ETSI NFV IFA027 clause 5(d) [14]</p>	<p>type:</p> <p>multiplicity:</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
measureObjectClass	<p>This attribute describes the object class.</p> <p>allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(f).</p>	<p>type: string</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
performanceDictionarySchemaVersion	<p>This attribute defines the version of the schema version used to create the measurement definitions.</p> <p>allowedValues: N/A</p>	<p>type: string</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
performanceDictionaryVersion	<p>This attribute defines the version of the dictionary itself.</p> <p>allowedValues: N/A</p>	<p>type:</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: False</p>
PerformanceMeasureDefinition.supportedInterfaces	<p>This attribute when present this defines the specific subset of interfaces over which the measurement is transmitted and may define an override of the interface key field mapping. If omitted, then the measure is transmitted over all interfaces defined in the dictionary level map.</p> <p>allowedValues: N/A</p>	<p>type: SupportedInterface</p> <p>multiplicity: 0..*</p> <p>isOrdered: N/A</p> <p>isUnique: N/A</p> <p>defaultValue: None</p> <p>isNullable: True</p>
performanceMeasureDefinitionId	<p>This attribute identifies a single performanceMeasurementDefinition within the dictionary.</p> <p>allowedValues: N/A</p>	<p>type: string</p> <p>multiplicity: 1</p> <p>isOrdered: N/A</p> <p>isUnique: True</p> <p>defaultValue: None</p> <p>isNullable: False</p>

PerformanceMeasureDictionary.supportedInterfaces	This attribute provides the list over which the performance measurements will be transmitted over. Not all performance measures are required to be over all supported interfaces. allowedValues: N/A	type: SupportedInterface multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
performanceMeasureId	This attribute identifies a single performanceMeasurementDefinition with a numeric value which can be used during serialization over a streaming interface to support data compaction. allowedValues: unsigned integer	type: Uint multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
eventToDictionaryMap	This attribute is a placeholder for an alternative set of fields based on a choice. This field should be replaced with those fields identified in the appropriate alternative of the choice.	type: EventToDictionaryMap multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
eventToMeasureDefinitionMap	This attribute identifies the field attribute in a performance report which will contain the value to be used as the measureDefinitionID in an PerformanceMeasureDictionary. AllowedValues: Any attribute name within an performance report.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
product	This attribute identifies the software product name provided by a vendor. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
purpose	This attribute when supplied tries to describe who will be using the measurement. allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(i).	type: String multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: True
standardReference	This attribute when provided identifies a standard where a performance measure is defined. allowedValues: N/A	type: StandardReference multiplicity: 0..1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: True
standardsDefinitionOrganization	This attribute identifies the standards definition organization such as but not limited to ETSI or 3GPP. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
standardSpecification	This attribute defines the standard title which contains the measurement definition. allowedValues: N/A.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
supportedMeasures	This attribute provides the list of measurement definitions contained within a performance dictionary. allowedValues: N/A	type: 3GPPPerformanceMeasureDefinition or ETSIPerformanceMeasureDefinition multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

switchingTechnology	This attribute defines the switching domain(s) this measurement is applicable to. allowedValues: conforms to 3GPP TS 32.404 [13] clause 3.3(g).	type: multiplicity: isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
trigger	This attribute describes the trigger which causes the counter to be updated. allowedValues: conforms to ETSI NFV IFA027 clause 5(c) [14]	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
vendor	This attribute identifies vendor of a vendor software product that the specified dictionary is provided for. allowedValues: N/A	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
vendorSoftwareProduct	This attribute identifies vendor software product that the specified dictionary is provided for. allowedValues: N/A	type: VendorSoftwareProduct multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
version	This attribute identifies specific version of a vendor software product that the specified dictionary is provided for. allowedValues: N/A	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
versionOrRelease	This attribute identifies the specification version, release, or date of publication that identifies a specific instance of the specification. allowedValues: N/A	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
alarmChangeType	This Indicates the type of last change that occurred during the alarm last change allowedValues: This type conforms to the enumerated type AlarmChangeType.	type: AlarmChangeType multiplicity: 1 isOrdered: True isUnique: N/A defaultValue: None isNullable: False
alarmDefinitions	This attribute contains the list of alarm definitions which are or have been supported by the entity type and are ordered ascending by AlarmDefinitionId. allowedValues: N/A	type: AlarmDefinition multiplicity: 1..* isOrdered: True isUnique: N/A defaultValue: None isNullable: False
alarmDefinitionId	This identifies a specific alarmDefinition instance in the AlarmDictionary. This is the Primary Key into the alarmDefinitions. allowedValues: N/A	type: String multiplicity: 1 isOrdered: False isUnique: True defaultValue: None isNullable: False
AlarmDefinition.supportedInterfaces	This attribute when present this defines the specific subset of interfaces over which the alarm is transmitted and may define an override of the interface key field mapping. If omitted, then the measure is transmitted over all interfaces defined in the dictionary level map. allowedValues: N/A	type: SupportedInterface multiplicity: 0..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: True

alarmDescription	This provides a longer descriptive meaning of the alarm condition and a description of the consequences of the alarm condition. This is intended to be read by an operator to give an idea of what happened and a sense of the effects, consequences, and other impacted areas of the system. allowedValues: N/A	type: String multiplicity: 1 isOrdered: False isUnique: N/A defaultValue: None isNullable: False
AlarmDictionary.supportedInterfaces	This attribute provides the list over which the alarms will be transmitted over. Not all alarms are required to be over all supported interfaces. allowedValues: N/A	type: SupportedInterface multiplicity: 1..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
alarmDictionarySchemaVersion	This attribute defines the version of the schema version used to create the measurement definitions. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
alarmDictionaryVersion	This attribute defines the version of the dictionary itself. allowedValues: N/A	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
alarmLastChange	This defines the date and time of the last change to an alarm definition. allowedValues: N/A	type: DateTime multiplicity: 1 isOrdered: False isUnique: N/A defaultValue: None isNullable: False
alarmName	This describes the human readable name of the alarm allowedValues: N/A	type: String multiplicity: 1 isOrdered: False isUnique: N/A defaultValue: None isNullable: False
clearingType	This Indicates the type of change that occurred during the alarm last change allowedValues: This type conforms to the enumerated type AlarmClearingType.	type: AlarmClearingType multiplicity: 1 isOrdered: True isUnique: N/A defaultValue: None isNullable: False
entityType	This attribute defines the type of entity generating the alarm. Allowed values are not limited due to the extensibility of the O-Cloud Resource Types.	type: string multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
eventToAlarmDefinitionMap	This attribute identifies the attribute in an alarm event record which will contain the value to be used as the alarmDefinitionID in an AlarmDictionary. AllowedValues: Any attribute name within an alarm event record.	type: String multiplicity: 1 isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False
extensions	This attribute provides a list of key value pairs denoting extended attributes of the Information Object Class allowedValues: N/A	type: KeyValuePair multiplicity: 0..* isOrdered: N/A isUnique: N/A defaultValue: None isNullable: False

probableCauseCode	This identifies a specific probableCause instance in the AlarmDictionary. This is the Primary Key into the probableCauses. allowedValues: N/A	type: String multiplicity: 1 isOrdered: False isUnique: True defaultValue: None isNullable: False
probableCauseDescription	This provides any additional information beyond the probableCauseCode to describe the probableCause	type: String multiplicity: 0..1 isOrdered: False isUnique: False defaultValue: None isNullable: False
probableCauses	This attribute contains the list of probable causes which may be referenced in an InfrastructureAlarmEventNotification and are ordered ascending by probableCauseCode. allowedValues: N/A	type: ProbableCause multiplicity: 1..* isOrdered: True isUnique: N/A defaultValue: None isNullable: False
proposedRepairAction	This describes guidance for proposed repair actions. allowedValues: N/A	type: String multiplicity: 1 isOrdered: False isUnique: False defaultValue: None isNullable: False

1

2

5.3 Classes/components and interfaces that comprise the O-RAN Information Model and Data Models

4

Following are a list of classes/components as well as interfaces that should be part of the O-RAN Information model, along with the working group developing this entity, any SDO references if appropriate, followed by comments and the status. This is based on the premise that each WG is responsible for modeling the entity, and WG10 is responsible for stewarding the overarching model inclusive of the input from the other groups.

9

Entity	WG Developing Model	Doc Reference	Comments	Status
<i>Class / Component</i>				
NonRTRIC	WG2		Not present in model	
NearRTRIC	WG3		Presently shell only in model.	
O-CU-CP	WG5	O-RAN-WG5.O-CU-O1.0 Error! Reference source not found.		
O-CU-UP	WG5	O-RAN-WG5.O-CU-O1.0 Error! Reference source not found.		
O-DU	WG5	O-RAN.WG5.O-DU-O1.0 Error! Reference source not found.		
O-RU	WG4		Shell only	
ManagedApplication	WG10		Abstract Class	
ManagedElement		3GPP TS 28.622 0	Class and attributes	

xApp	WG3, (WG6)		Not present in model	
rApp	WG2, (wg6)		Not present in model	
<i>Interfaces</i>				
A1-P	WG2	O-RAN.WG2.A1AP Error! Reference source not found.		
A1-ML	WG2		Shell Only - to be pursued in a later release	
A1-EI	WG2		Shell Only - to be pursued in a later release	
O1	WG10	O-RAN.WG10.O1 Interface.0 0		
E1	WG5	3GPP TS 38.460 Error! Reference source not found.	3GPP start, including operations list	
E2	WG3	O-RAN.WG3.E2GAP Error! Reference source not found.	Interface with 9 operations	
F1-c	WG5	3GPP TS 38.470 Error! Reference source not found.	3GPP start, including 24 operations	
F1-u	WG5	3GPP TS 38.470 Error! Reference source not found.	3GPP start, including limited operation list	
OpenFrontHaul	WG4	O-RAN-WG4.MP.0 0	Shell only	
X2	WG5	3GPP TS 36.423 Error! Reference source not found.	3GPP based start, including a large number of operations	
O2	WG6		Not present in model	
R1	WG2		Not present in model	

1 **Table 5.3-1 Classes/components and interfaces that comprise the O-RAN Information Model and Data Model(s)**

6. O-RAN Data Models

6.1 Formal relationship (traceability) between O-RAN Data Models and the O-RAN Information Model

For O1 interfaces, the O-RAN Information Model development should precede and serve as the basis for the Data Model development within each working group (WG1 through WG10).

At present, there is no formal relationship and/or traceability between the O-RAN Data Models and O-RAN Information Model; however, this is expected to evolve over time.

As indicated within Clause 4 “Overview and Philosophy,” there is a modeling continuum that aims to establish and evolve one common and coherent Information Model for 5G/LTE RAN from which Data Models may be generated.

As the modeling practices and processes within O-RAN mature, the Information Model and Data Models are expected to co-evolve to develop the APIs required by specific use cases, as depicted below.

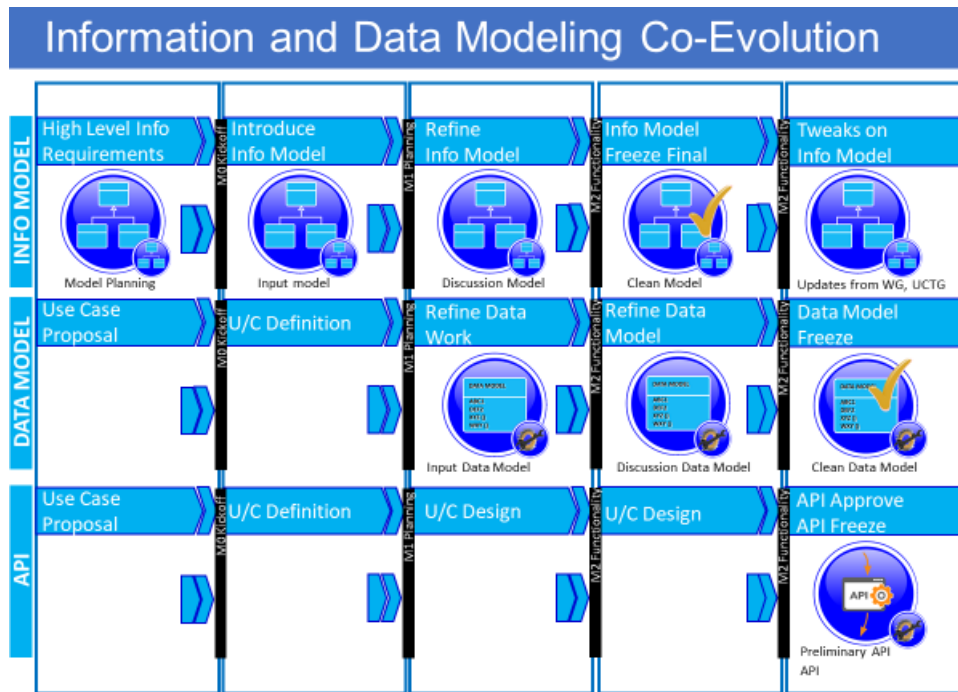


Figure 6.1-1 Information and Data Modeling Co-Evolution Error! Reference source not found.

6.2 Usage of 3GPP Data Models

The O-RAN Alliance complements the work of other SDOs. 3GPP is the primary source for management plane specifications for O-RAN components.

Please refer to Annex A for the 3GPP-source Data Models that are approved for use.

The following table (snapshot) shows a subset of the 3GPP yang data models to O-RAN model construct.

3GPP yang data model	3GPP spec for YANG model	o-ru (O1 in hybrid mode currently not supported)	o-du	o-cu-up	o-cu-cp	near-rt-ric
_3gpp-5g-common-yang-types	3GPP TS 28.541 Error! Reference source not found.	imported by _3gpp-common-managed-element (3GPP TS 28.623 0)	imported by _3gpp-common-managed-element (3GPP TS 28.623 0)	imported by _3gpp-common-managed-element (3GPP TS 28.623 0)	imported by _3gpp-common-managed-element (3GPP TS 28.623 0)	imported by _3gpp-common-managed-element (3GPP TS 28.623 0)
_3gpp-common-ep-rp	3GPP TS 28.623 0	[open] o-ran-m-int.yang & o-ran-ru-rtf.yang defines the interface of O-RU, maybe it is not needed to O-RU	imported by _3gpp-nr-nrm-ep (3GPP TS 28.541 Error! Reference source not found.) abstract superclass for all 3GPP endpoints [open] as O-RU remote PORT, to configure eCPRI port of O-DU just EP_RP looks not enough	imported by _3gpp-nr-nrm-ep (3GPP TS 28.541 Error! Reference source not found.) abstract superclass for all 3GPP endpoints	imported by _3gpp-nr-nrm-ep (3GPP TS 28.541 Error! Reference source not found.) abstract superclass for all 3GPP endpoints	[open] need discussion , if RIC modeled as O-RU which need detailed configuration to interfaces, the common part probably from IETF
_3gpp-common-fm	3GPP TS 28.623 0	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for alarm list handling	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for alarm list handling	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for alarm list handling	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for alarm list handling	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for alarm list handling
_3gpp-common-managed-element	3GPP TS 28.623 0	root object class	root object class	root object class	root object class	root object class
_3gpp-common-managed-function	3GPP TS 28.623 0	needed to extend MF for O-RU functionality	imported by _3gpp-nr-nrm-gnbdufunction (3GPP TS 28.541 0)	imported by _3gpp-nr-nrm-gnbdufunction (3GPP TS 28.541 0)	imported by _3gpp-nr-nrm-gnbdufunction (3GPP TS 28.541 0)	needed either for a standalone RIC or combined RIC ME
_3gpp-common-measurements	3GPP TS 28.623 0	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for PM job control and threshold monitoring	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for PM job control and threshold monitoring	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for PM job control and threshold monitoring	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for PM job control and threshold monitoring	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) needed for PM job control and threshold monitoring

_3gpp-common-subnetwork	3GPP TS 28.623 0	imported by _3gpp-common-subscription-control (3GPP TS 28.623 0) not needed from O-RAN point of view but can't be removed with modification of the yang, Contribution to 3GPP required	imported by _3gpp-common-subscription-control (3GPP TS 28.623 0) not needed from O-RAN point of view but can't be removed with modification of the yang, Contribution to 3GPP required	imported by _3gpp-common-subscription-control (3GPP TS 28.623 0) not needed from O-RAN point of view but can't be removed with modification of the yang, Contribution to 3GPP required	imported by _3gpp-common-subscription-control (3GPP TS 28.623 0) not needed from O-RAN point of view but can't be removed with modification of the yang, Contribution to 3GPP required	imported by _3gpp-common-subscription-control (3GPP TS 28.623 0) not needed from O-RAN point of view but can't be removed with modification of the yang, Contribution to 3GPP required
_3gpp-common-subscription-control	3GPP TS 28.623 0	needed for VES subscription	needed for VES subscription	needed for VES subscription	needed for VES subscription	needed for VES subscription
_3gpp-common-top	3GPP TS 28.623 0	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) abstract class supplying a naming attribute	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) abstract class supplying a naming attribute	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) abstract class supplying a naming attribute	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) abstract class supplying a naming attribute	imported by _3gpp-common-managed-element (3GPP TS 28.623 0) abstract class supplying a naming attribute
_3gpp-common-yang-extensions	3GPP TS 28.623 0	expected for inVariant	expected for inVariant	expected for inVariant	expected for inVariant	expected for inVariant
_3gpp-common-yang-types	3GPP TS 28.623 0	imported by many other 3GPP yang modules essential 3GPP typedefs, in particular DistinguishedName, and other useful typedefs like OperationalState, AdministrativeState, AvailabilityStatus	imported by many other 3GPP yang modules essential 3GPP typedefs, in particular DistinguishedName, and other useful typedefs like OperationalState, AdministrativeState, AvailabilityStatus	imported by many other 3GPP yang modules essential 3GPP typedefs, in particular DistinguishedName, and other useful typedefs like OperationalState, AdministrativeState, AvailabilityStatus	imported by many other 3GPP yang modules essential 3GPP typedefs, in particular DistinguishedName, and other useful typedefs like OperationalState, AdministrativeState, AvailabilityStatus	imported by many other 3GPP yang modules essential 3GPP typedefs, in particular DistinguishedName, and other useful typedefs like OperationalState, AdministrativeState, AvailabilityStatus

Table 6.2-1 Mapping of 3GPP yang data models to O-RAN element functions

6.3 Usage of non-3GPP data models

There are domains of data-models being considered by O-RAN WGs (Working Groups) that are not covered by 3GPP but are covered by other SDOs, e.g., IETF, MEF, IEEE, ONF, BBF, and occasionally imported by 3GPP.

The following table shows data models that are of interest and being considered within O-RAN and/or 3GPP:

Order No	yang data model	Specification	o-ru (M-Plane)	o-du	o-cu-up	o-cu-cp	near-rt-ric	Comments
001	ietf-yang-types	RFC 6991 Error! Reference source not found.	import by several models	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	
002	ietf-inet-types	RFC 6991 Error! Reference source not found.	import by several models	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	import by _3gpp-common-yang-types.yang (3GPP TS 28.623 0)	
011	ietf-netconf.yang	RFC6241 Error! Reference source not found.	used	used	used	used	used	
012	ietf-netconf-acm.yang	RFC8341 Error! Reference source not found.	baseline for access control					Network Configuration Access Control Model
013	ietf-netconf-monitoring	RFC6022 Error! Reference source not found.	used					NETCONF Monitoring Module
014	ietf-netconf-nmda	RFC8526 Error! Reference source not found.						NETCONF operations to support the Network Management Datastore Architecture
015	ietf-netconf-notifications	RFC6470 Error! Reference source not found.	used	not O1 but OpenFronthaul mPlane, O-RAN-WG4.MP.0 0				This module defines a YANG data model for use with the NETCONF protocol that allows the NETCONF client to receive common NETCONF base event notifications
016	ietf-netconf-partial-lock	RFC5717 Error! Reference source not found.						

017	ietf-netconf-time	RFC7758 Error! Reference source not found.						time-triggered configuration and management operations
018	ietf-netconf-with-defaults	RFC6243 Error! Reference source not found.						NETCONF client to control how default values are handled by the server in particular NETCONF operations
020	ietf-system	RFC7317 Error! Reference source not found.	overlaps with o-ran-operations but may be required to support 802.1X					configuration and identification of some common system properties within a device containing a NETCONF server <ul style="list-style-type: none"> time-zone management radius local users NTP
030	ietf-hardware	RFC8348 Error! Reference source not found.	used	not O1 but OpenFronthaul mPlane, O-RAN-WG4.MP.0 0				
031	iana-hardware	RFC8348 Error! Reference source not found.	import by ietf-hardware	import by ietf-hardware				IANA-defined identities for hardware class.
032	ietf-hardware-state	RFC8348 Error! Reference source not found.						hardware monitoring
033	ietf-interfaces	RFC8343 Error! Reference source not found.	foundation for fronthaul					
034	iana-if-type	RFC7224 Error! Reference source not found.	used	not O1 but OpenFronthaul mPlane, O-RAN-WG4.MP.0 0				YANG identities for IANA-registered interface types

040	ietf-alarms	RFC8632 Error! Reference source not found.						This module defines an interface for managing alarms.
	ietf-ip	RFC8344 Error! Reference source not found.	foundation for fronthaul M-Plane, O-RAN-WG4.MP.0 0					managing IP implementations
	ietf-ptp	RFC8575 Error! Reference source not found.	considered - but decided o define own o-ran-sync.yang					configuration of IEEE Std 1588-2008 clocks
	ietf-yang-library	RFC8525 Error! Reference source not found.	foundation for YANG 1.1 (RFC 7950 0)					
	ietf-yang-metadata	RFC7952 Error! Reference source not found.						This YANG module defines an 'extension' statement that allows for defining metadata annotations
	ietf-yang-patch	RFC8072 Error! Reference source not found.						This module contains conceptual YANG specifications for the YANG Patch and YANG Patch Status data structures.
	ietf-yang-push	RFC8641 Error! Reference source not found.						
	ietf-yang-schema-mount	RFC8528 Error! Reference source not found.						This module defines a YANG extension statement that can be used to incorporate data models defined in other YANG modules in a module.
	ietf-yang-smiv2	RFC6643 Error! Reference source not found.						This module defines YANG extensions that are used to translate SMIV2 concepts into YANG.

	iana-crypt-hash	RFC7317 Error! Reference source not found.	used in CTI					
	ietf-crypto-types	draft-ietf-netconf-crypto-types Error! Reference source not found.	used by fronthaul file management					
	ieee802-dot1x	IEEE 802.1X-2020 0	being considered by STG					

Table 6.3-1 Non 3GPP yang models

6.4 YANG Conventions

6.4.1 General

This clause describes the recommended conventions to be used in the O-RAN Alliance when writing YANG models.

In particular, because the creation and maintenance of YANG models is expected to be distributed across different working groups, this guide is intended to ensure that the way the models are organized and presented will be consistent across the entirety of the O-RAN Alliance.

6.4.2 Naming

MODULE FILE NAMING: All YANG modules should have filenames of the form “o-ran-xxx.yang”. Additionally, to avoid collisions in the naming of YANG modules in O-RAN, in cases where a YANG module is dedicated to one O-RAN entity, such name should contain name of this O-RAN entity, i.e. o-ran-odu-**<unique-name>**.yang, o-ran-ocu-**<unique-name>**.yang. For O-RAN common YANG modules name shall follow the form of “o-ran-common-**<unique-name>**.yang”.

MODULE NAMESPACE: YANG modules should have a namespace defined of the form namespace "urn:o-ran:**<unique-name>**:version"; where version represents an increasing numerical integer value and where the value used in all newly defined models is "1". The module namespace version shall be incremented when any non-backwards compatible changes are introduced into a model. Namespaces, as well as module file name, shall contain name of the O-RAN entity or “common” for common YANG modules, i.e. “urn:o-ran-odu:**<unique-name>**:version”, “urn:o-ran-common:**<unique-name>**:version”.

PREFIX NAMING: Each module shall have a prefix statement with a prefix that other dependent modules will use (also used in path references within the same module). Prefixes should be short and clear, with abbreviations as appropriate. Module prefixes should be of the form: o-ran-**<unique-name>**, or or-**<unique-name>**, and shall be unique regardless of over which interface the YANG module is exposed (ex. O1 or Open FrontHaul M-Plane).

6.4.3 Revision Statement

The revision statement in all YANG models should include a reference statement used to cross-reference to the version of a particular O-RAN publication where the corresponding functionality was initially introduced. The revision statement of the YANG models also should include a description that is used to track the versioning of the YANG model. All revision statement descriptions shall begin with version a.b.c, where a, b and c are used to reflect the version of the YANG model, where:

- ‘a’ corresponds to the first digit of the O-RAN specification version where the corresponding description was first introduced;
- ‘b’ is incremented when errors in the YANG model have been corrected;
- ‘c’ is incremented only in working versions of the YANG model indicating incremental changes during the editing process. Hence, all published versions of O-RAN alliance YANG models should have this value set to zero.

6.4.4 Indents

O-RAN Alliance YANG models should use two-space tab indents.

6.4.5 YANG Language Usage

YANG VERSION: All models shall use YANG data modeling language version 1.1 (RFC 7950 0) and follow the Guidelines for Authors and Reviewers of Documents Containing YANG Data Models [RFC 8407 **Error! Reference source not found.**].

TOP-LEVEL DATA NODE: There should only be one top-level data node defined in each YANG module, if any data nodes are defined at all.

NMDA (Network Management Datastore Architecture): No O-RAN YANG models should prevent the use of NMDA [RFC 8342 **Error! Reference source not found.**].

KEY-LESS LISTS OF OPERATIONAL STATE: Although permitted in YANG, the use of a list that consists of operational-state without a defined key should be avoided.

VALIDATION: All YANG modules should be validated / compiled with pyang tool using the following flag: `pyang --lint <module>`. Note, successful compilation with pyang does not guarantee a working model, as xPATH expressions aren't evaluated and forbidden operational data dependencies in the configuration may not generate appropriate errors.

CONSTRAINTS: Generally, O-RAN systems should strive to consider a blank configuration to be a valid config.

6.4.6 Cross Working Group Co-ordination

Models that are likely to be applicable to more than one O-RAN Alliance working group should provide clear delineation between separate working groups configuration and/or state. The use of feature and if-feature is recommended to ensure that NETCONF servers are not required to implement the entire data model, e.g., when aspects of such relate to the individual working group defined use cases. The feature name should indicate which working group or which O-RAN entity the capabilities have been defined by.

6.4.7 Development of YANG Data Models compatible with O1

All YANGs created by O-RAN which intend to be used as O1 aligned YANG Data Models shall follow rules for:

- InformationObjectClass - abstract, please refer to 3GPP TS 32.160 0 clause 6.2.2.2
- Naming attribute, usually named ‘id’, please refer to 3GPP TS 32.160 0 clause 6.2.3.2
- InformationObjectClass, definition in YANG, please refer to 3GPP TS 32.160 0 clause 6.2.4.1
- Generalization Relationship – inheritance from a class, please refer to 3GPP TS 32.160 0 clause 6.2.5.2
- Name containment – composite aggregation association relationship, please refer to 3GPP TS 32.160 0 clause 6.2.6.2
- Recursive containment, please refer to 3GPP TS 32.160 0 clause 6.2.7
- Multi-root management tree, please refer to 3GPP TS 32.160 0 clause 6.2.8

Alternative containment, please refer to 3GPP TS 32.160 0 clause 6.2.9

When O-RAN defines IoCs then those shall be correlated to O-RAN documents produced by the WG which defines O1 aligned YANG Data Model.

When there are inconsistencies between definition in any of TS 32.156 0, TS 32.160 0 and definition in this document, definition in this document take precedence.

6.4.8 Augmentations of 3GPP YANG Data Models

All augmentations of 3GPP YANG Data Models, to be compliant, shall not violate rules mentioned in “Development of YANG Data Models compatible with O1” clause of this document.

Augmentations shall be made in separate O-RAN originated YANG Data Model file, as modification of original 3GPP YANG Data Model file is prohibited.

Annex A (informative): Links to Data Models approved for use

From O-RAN

The public facing web page that includes the formally released versions of models that are approved for use:

www.o-ran.org/specifications

From 3GPP

3GPP is one of the sources for management plane specifications for O-RAN components. 3GPP publishes its “SA5 Data models” including its yang data models in a publicly available git repository:

<https://forge.3gpp.org/rep/sa5/MnS>

From IETF

IETF is a complementary source for management plane specifications for O-RAN components. IETF publishes its yang data models (inclusive of IANA yang data models) in a publicly available git repository:

<https://github.com/YangModels/yang/tree/master/standard/ietf>

Change History

Date	Revision	Description
2020.11.25	01.00	First draft of O-RAN Information Model and Data Models
2021.11.19	02.00	Extension of YANG style guide with respect to O1 (3GPP) aligned models creation. Alignment of the document to respect the fact that it is owned by WG10. Addition of a link to WG10 repository Further editorial fixes.
2022.03.30	03.00	Editorial corrections References updates Papyrus installation description update Abbreviations update
2022.11.09	04.00	Guidance on how to create IMs provided Introduction of Managed Application IOC IM Removal of Anex ZZZ Updated copyright statement Updated references
2023.03.27	05.00	Performance Dictionary IM for O2 IMS provided Fault Dictionary IM for O2 IMS provided Alignment of descriptive text with OAM Architecture Removal of Papyrus installation clause Cleanup of text
2023.07.17	06.00	References cleanup Clause renumbering Figures renumbering 3GPP references update

1

2

3