ATIS-I-0000100.v1.1

MVP

Open RAN Minimum Viable Profile

An ATIS Initiative

ATIS Open RAN Minimum Viable Profile

Published October 24, 2024

ABSTRACT

Mobile network operators are adopting Open RAN (Radio Access Network) with the goal of furthering innovation and interoperability in their RAN deployments. Existing standards and specifications provide the technical basis for Open RAN deployment, but contain considerable optionality in areas including Open RAN architecture, functional capabilities, and performance. Navigating the range of optionality may be challenging for vendors and mobile network operators. This profile can assist that process by establishing a minimum common set of requirements based on existing standards and specifications as guidance for the North American Open RAN Market.

FOREWORD

As a leading technology and solutions development organization, the Alliance for Telecommunications Industry Solutions (ATIS) brings together the top global ICT companies to advance the industry's most pressing business priorities. ATIS is accredited by the American National Standards Institute (ANSI). The organization is the North American Organizational Partner for the 3rd Generation Partnership Project (3GPP), a member of and major U.S. contributor to the International Telecommunication Union (ITU) – Radio Sector, as well as a member of the Inter-American Telecommunication Commission (CITEL).
For more information, visit www.atis.org.

The ATIS Open RAN Minimum Viable Profile Initiative aims to promote innovation, diversity and accelerated adoption in the Open RAN market by establishing guidance on North American Open RAN Market requirements.

Suggestions for improvement of this document may be sent to the Alliance for Telecommunications Industry Solutions, Open RAN Initiative, 1200 G Street NW, Suite 500, Washington, DC 20005.

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1 SCOPE, PURPOSE, & APPLICATION

1.1 Scope and Purpose

The current Open Radio Access Network (RAN) market faces challenges that may impede innovation, diversity, and accelerated adoption:

> The present vendor market is established, and Mobile Network Operators (MNOs) have distinct requirements.

> Interoperability is difficult because of multiple interpretations of the same specification, varying vendor implementations and configurations, and the existence of numerous optional features/parameters.

The goal of this Minimum Viable Profile (MVP) is to establish a minimum common set of requirements based on existing standards and specifications as guidance for the North American Open RAN market. Adherence to the requirements defined in this document is intended to serve as an enabler for leveraging Open RAN opportunities in the North American market. The scope of the MVP requirements encompasses the following areas:

> Architectural related

> Common feature/functional capabilities

> Performance

It also encompasses a set of requirements for key Open RAN interfaces.

This MVP is limited to 5G standalone (SA) based deployment of outdoor macro/micro cells.

1.2 Application

Vendors that are seeking to meet the Open RAN requirements of MNOs may use this MVP as a baseline to build products. This MVP is not exhaustive and is intended that practical solutions augment this MVP with the vendor's unique technology innovations and performance capabilities.

Figure 1 illustrates the development process of the MVP and the possible use of it within the industry.

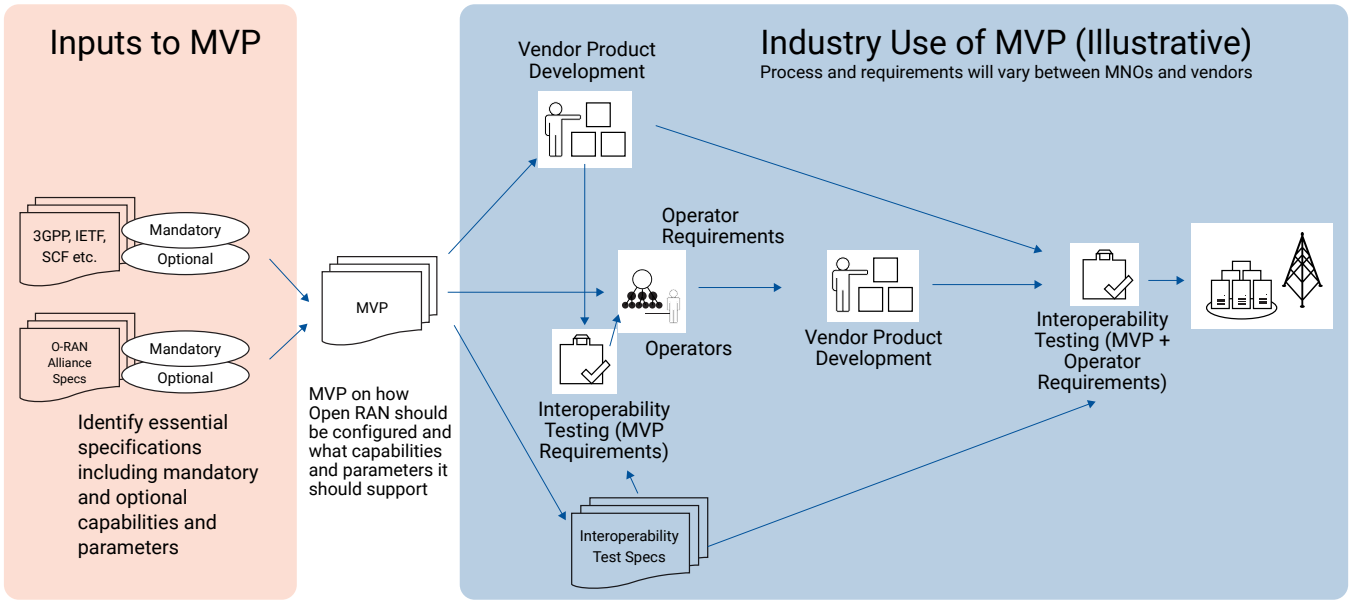

Figure 1: Inputs to and use of the MVP

As highlighted in Figure 1, the specifications developed within the 3rd Generation Partnership Project (3GPP), O-RAN Alliance, and other standards groups will be used to develop the MVP.

The right-hand side of Figure 1 illustrates potential use of the MVP. It can serve as a guide to vendors and assist them in development of interoperable Open RAN products that support a set of features and performance that the North American MNOs desire. It can also facilitate test equipment vendors and test laboratories to develop equipment and test cases to assist not only with interoperability testing across Open RAN products but also to verify their functional capabilities and performance. Finally, the MVP can also be leveraged by the MNOs as an input to the development of incremental operator specific requirements required for deployment within their networks as well as streamlining the integration of the solutions.

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3 ACRONYMS, & ABBREVIATIONS

For a list of common communications terms and definitions, please visit the ATIS Telecom Glossary, which is located at https://glossary.atis.org/.

3.1 Acronyms & Abbreviations

3GPP ..... The 3rd Generation Partnership Project
5QI ..... 5G Quality of Service Indicator
ACLR ..... Adjacent Channel Leakage Ratio
ANR ..... Automatic Neighbor Relations
API ..... Application Programming Interface
ATIS ..... Alliance for Telecommunications Industry Solutions
BMC ..... Board Management Controller
BWP ..... Bandwidth Part
CCO ..... Coverage and Capacity Optimization
CG ..... Configured Grant
CMP ..... Certificate Management Protocol
CNF ..... Cloud-Native Network Function
CPU ..... Central Processing Unit
CRD ..... Custom Resource Definitions
CSI ..... Channel State Information
CUS ..... Control User Synchronization
DDoS ..... Distributed Denial of Service
DL ..... Downlink
DME ..... Data Management and Exposure
DM-RS ..... Demodulation Reference Signal
DNS ..... Domain Name System
DPDK ..... Data Plane Development Kit
DRX ..... Discontinuous Reception
DTLS ..... Datagram Transport Layer Security
DTLS ..... Datagram Transport Layer Security
ECID ..... Enhanced Cell Identity
EPS ..... Evolved Packet System
ETSI ..... European Telecommunications Standards Institute
FCAPS ..... Fault, Configuration, Accounting, Performance, and Security
FDD ..... Frequency Division Duplex
FH ..... Fronthaul
FPGA ..... Field Programmable Gate Array
GBR ..... Guaranteed Bit Rate
GPU ..... Graphics Processing Unit
IOT ..... Interoperability Testing

IPSec ..... Internet Protocol Security
LAN ..... Local Area Network
LCM ..... Life Cycle Management
MBR ..... Maximum Bit Rate
MCS ..... Modulation and Coding Scheme
MFA ..... Multi-Factor Authentication
MIMO ..... Multiple Input Multiple Output
MLB ..... Mobility Load Balancing
MN ..... Master Node
MNO ..... Mobile Network Operator
MO ..... Mobile Originating
MOCN ..... Multi-Operator Core Network
MORAN ..... Multi-Operator RAN
MRO ..... Mobility Robustness Optimization
MT ..... Mobile Terminating
mTLS ..... Mutual Transport Layer Security
MVP ..... Minimum Viable Profile
NACM ..... Network Access Control Model
Near-RT RIC ..... Near Realtime RIC
NF ..... Network Function
NFV ..... Network Functions Virtualization
NG ..... Next-Generation
NRPP ..... New Radio Positioning Protocol
OAM ..... Operations, Administration, and Management
OAuth ..... Open Authorization
O-CU ..... O-RAN Central Unit
O-CU-CP ..... O-RAN Control Unit Control Plane
O-CU-UP ..... O-RAN Central Unit User Plane
O-DU ..... O-RAN Distributed Unit
ORAN ..... Open Radio Access Network
O-RU ..... O-RAN Radio Unit
OTA ..... Over the Air
PAPR ..... Peak-to-Average Power Ratio
PCell ..... Primary Cell
PCI ..... Physical Cell ID
PDCP ..... Packet Data Convergence Protocol
PKI ..... Public Key Infrastructure
PRACH ..... Physical Random Access Channel
PRS ..... Positioning Reference Signal
PTP ..... Precision Time Protocol
PUCCH ..... Physical Uplink Control Channel
PUSCH ..... Physical Uplink Shared Channel
PWS ..... Public Warning System
RACH ..... Random Access Channel

RAN ..... Radio Access Network
RBAC ..... Role-Based Access Control
RedCap ..... Reduced Capability
RF ..... Radio Frequency
RIC ..... RAN Intelligent Controller
RIM ..... Remote Interference Management
RoHC ..... Robust Header Compression
RRC ..... Radio Resource Control
RTP ..... Real-time Transport Protocol
SA ..... Standalone
SBOM ..... Software Bill of Material
SCell ..... Secondary Cell
SCS ..... Subcarrier Spacing
SDLC ..... Software Development Life Cycle
SE ..... Spectral Efficiency
SIB ..... System Information Broadcast
SINR ..... Signal-to-Interference-plus-Noise Ratio
SME ..... Service Management and Exposure
SMO ..... Service Management and Orchestration
SR-IOV ..... Single Root IO Virtualization
SRS ..... Sounding Reference Signal
SSH ..... Secure Shell Protocol
TDD ..... Time Division Duplex
TIFG ..... Test and Integration Focus Group
TLS ..... Transport Layer Security
TTFG ..... Time to First Byte
Tx ..... Transmit
UAC ..... Unified Access Control
UE ..... User Equipment
UL ..... Uplink
VM ..... Virtual Machine
VoLTE ..... Voice over Long-Term Evolution
VoNR ..... Voice over New Radio
WPS ..... Wireless Priority Service
WUS ..... Wake Up Signal

4 ARCHITECTURE REQUIREMENTS

The following Sections specify the architecture and requirements of the MVP.

The O-RAN reference architecture for an Open RAN system supported by the present MVP specification is shown in Figure 2. The basis for the O-RAN architecture is the normative and informative specifications developed by the O-RAN Alliance in WG1, WG2, WG4, WG5, WG6, WG10 and WG11. Figure 2 depicts functions and interfaces that are normatively and informatively specified as part of the O-RAN Alliance specifications.

Refer to [1] for descriptions of each network function and associated interfaces.

The Open RAN system is expected to meet all mandatory aspects of 3GPP and O-RAN specifications irrespective of whether they are explicitly listed as requirements in this MVP or not.

The O-RAN based deployments compliant to the present MVP specification must comprise the in-scope functions and interfaces shown in Figure 2 and listed in Sections 4.1 and 4.2.

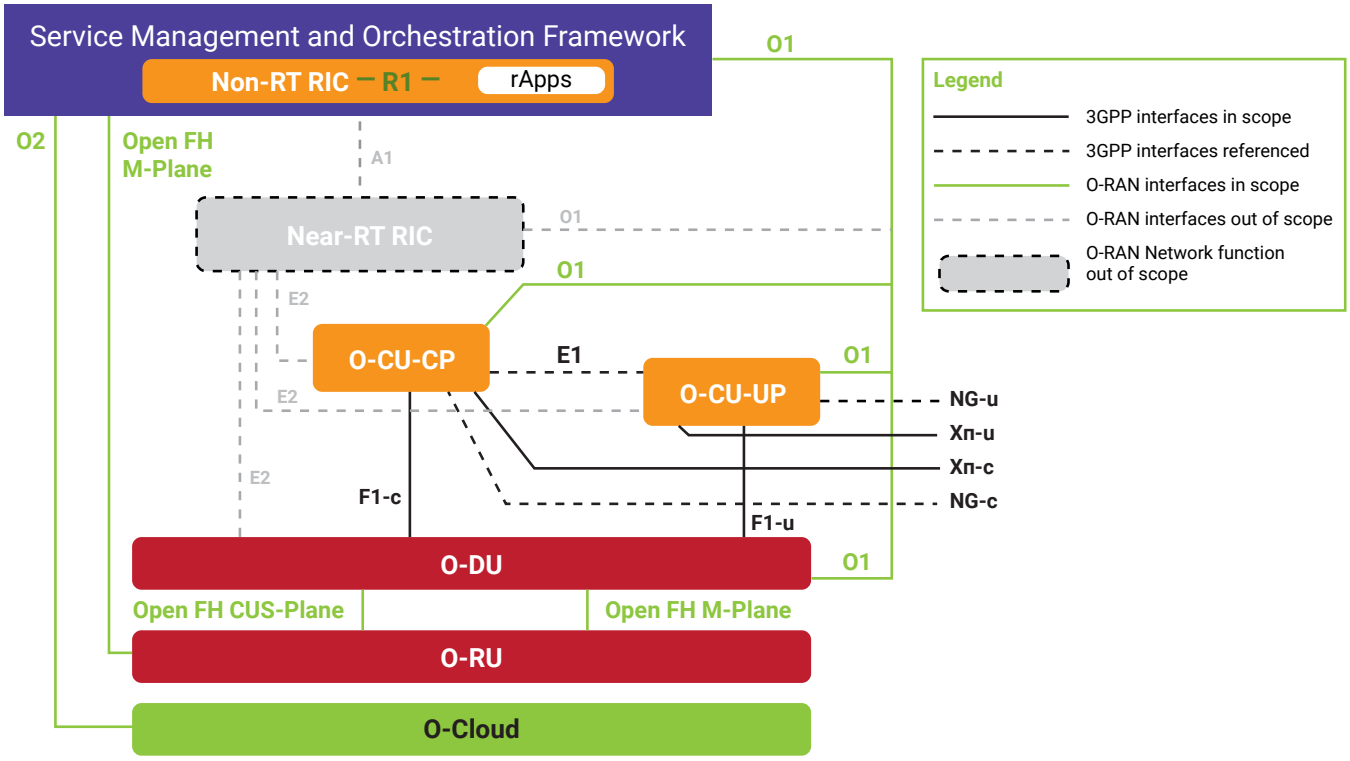

Figure 2: Open RAN Functional Architecture of this MVP (Source: [1])

NOTE: 3GPP referenced interfaces – Interfaces that are required to be supported by the network function but the Interoperability Testing (IOT) profile for that interface is not in the scope of this MVP.

NOTE: Out of scope O-RAN interfaces – Interfaces that do not need to be supported by the network functions as part of this MVP.

4.1 Supported Network Functions

MVP-ARCH-GEN-1: The Open RAN functional architecture shall support the following O-RAN functions:

- O-RU
- O-DU
- O-CU-CP
- O-CU-UP
- SMO including Non-RT RIC
- O-Cloud

NOTE: The scope of the present MVP excludes the Near Realtime RAN Intelligent Controller (Near-RT RIC). The Near-RT RIC and associated interface profiles will be developed in a subsequent release of the MVP.

NOTE: All other out-of-scope network functions and interfaces may be considered in a future revision of the MVP based upon operator needs.

MVP-ARCH-GEN-2: The network functions shall support the functional requirements specified in Section 5 of this MVP.

MVP-ARCH-GEN-3: The network functions shall support the performance requirements specified in Section 6 of this MVP.

MVP-ARCH-GEN-4: The network functions shall support the O-Cloud requirements specified in Section 7 of this MVP.

MVP-ARCH-GEN-5: The network functions shall support the management requirements specified in Section 8 of this MVP.

MVP-ARCH-GEN-6: The network functions shall support the security requirements specified in Section 9 of this MVP.

4.2 Supported Interfaces

MVP-ARCH-INTF-1: The O-RU shall support the following O-RAN specified interfaces including associated protocol stacks:

- O-RAN Fronthaul (FH) Control User Synchronization (CUS)-Plane interface specified in O-RAN Alliance [2]
- O-RAN FH Management (M) -Plane interface specified in O-RAN Alliance [3]

MVP-ARCH-INTF-2: The O-RU shall be capable of being configured to be managed using hybrid M-Plane specified in O-RAN Alliance [3].

MVP-ARCH-INTF-3: The O-RU shall support of being configured and managed using the hierarchical M-Plane specified in O-RAN Alliance [3].

MVP-ARCH-INTF-4: The O-DU shall support the following O-RAN specified interfaces including associated protocol stacks:

- O-RAN FH CUS-Plane interface specified in O-RAN Alliance [2]
- O-RAN FH M-Plane interface specified in O-RAN Alliance [3]

MVP-ARCH-INTF-5: The O-DU shall support the management O1 interface to SMO specified in O-RAN Alliance [6].

MVP-ARCH-INTF-6: The O-DU shall support F1-C interface to O-CU-CP specified in 3GPP [25].

MVP-ARCH-INTF-7: The O-DU shall support F1-U interface to O-CU-UP specified in 3GPP [26].

MVP-ARCH-INTF-8: The O-CU-CP shall support the management O1 interface to Service Management and Orchestration (SMO) specified in O-RAN Alliance [5].

MVP-ARCH-INTF-9: The O-CU-CP shall support F1-C interface to O-DU specified in 3GPP [25].

MVP-ARCH-INTF-10: The O-CU-UP shall support F1-U interface to O-DU specified in 3GPP [26].

MVP-ARCH-INTF-11: O-CU-CP shall support E1 interface to O-CU-UP specified in 3GPP [27].

MVP-ARCH-INTF-12: The Non-RT RIC framework of the SMO shall support the R1 interface as specified in O-RAN Alliance [20].

MVP-ARCH-INTF-13: The SMO shall support O1 interface to O-DU, O-CU-CP and O-CU-UP functions specified in O-RAN Alliance [4].

NOTE: NG-c (N2) and NG-u (N3) interfaces will be profiled in a future MVP release.

5 FUNCTIONAL REQUIREMENTS

This Section captures the overall functional requirements for an end-to-end O-RAN based Open RAN system as specified in section 4. The functional capabilities identified are a subset of those specified in 3GPP as part of following Releases 16 and 17 specifications [21] [22].

5.1 Functional Requirements based on 3GPP Release 16

This Section specifies Open RAN system's functional capabilities as specified in 3GPP Release 16.

5.1.1 Functional Requirements on Architecture

MVP-FUNC-ARCH-16-1: The Open RAN system specified in Section 4.1 shall support 5G core SA option as specified in 3GPP [21] and [22].

5.1.2 Functional Requirements on Basic Physical Layer Capabilities

MVP-FUNC-PHY-16-1: The Open RAN system specified in Section 4.1 shall support mixed numerology in O-DU across different bands (e.g., Subcarrier Spacing (SCS) 30 kHz for n41 band and 15 kHz for n66 band).

MVP-FUNC-PHY-16-2: The Open RAN system specified in Section 4.1 shall support Physical Random Access Channel (PRACH) preamble formats of 0, 1, A3, B4, C0, C2.

MVP-FUNC-PHY-16-3: The Open RAN system specified in Section 4.1 shall support periodic Sounding Reference Signal (SRS).

MVP-FUNC-PHY-16-4: The Open RAN system specified in Section 4.1 shall support aperiodic SRS.

MVP-FUNC-PHY-16-5: The Open RAN system specified in Section 4.1 shall support wideband SRS.

MVP-FUNC-PHY-16-6: The Open RAN system specified in Section 4.1 shall support narrowband SRS.

MVP-FUNC-PHY-16-7: The Open RAN system specified in Section 4.1 with outdoor O-RU shall support 4T4R downlink (DL) for low bands authorized in North America.

MVP-FUNC-PHY-16-8: The Open RAN system specified in Section 4.1 with outdoor O-RU shall support 4T4R DL for mid bands authorized in North America.

MVP-FUNC-PHY-16-9: The Open RAN system specified in Section 4.1 with outdoor O-RU shall support 8T8R DL for mid bands authorized in North America.

MVP-FUNC-PHY-16-10: The Open RAN system specified in Section 4.1 with outdoor O-RU shall support 2T2R uplink (UL) for low bands authorized in North America.

MVP-FUNC-PHY-16-11: The Open RAN system specified in Section 4.1 with outdoor O-RU shall support 2T2R UL for mid bands authorized in North America.

MVP-FUNC-PHY-16-12: The Open RAN system specified in Section 4.1 shall support SCS of 15 kHz for FR1 Frequency Division Duplex (FDD) bands as specified in [23].

MVP-FUNC-PHY-16-13: The Open RAN system specified in Section 4.1 shall support SCS of 30 kHz for FR1 Time Division Duplex (TDD) bands as specified in [23].

MVP-FUNC-PHY-16-14: The Open RAN system specified in Section 4.1 shall support SCS of 120 kHz for FR2 bands as specified in [23].

MVP-FUNC-PHY-16-15: The Open RAN system specified in Section 4.1 shall support modulation of up to 256QAM DL and 256QAM UL.

MVP-FUNC-PHY-16-16: The Open RAN system specified in Section 4.1 shall support UL transmit (Tx) switching.

5.1.3 Functional Requirements on Basic Capabilities

MVP-FUNC-BAS-16-1: The Open RAN system specified in Section 4.1 shall support the configuration, transmission, and reception of the following features:

a) Paging
b) System Information Broadcast (SIB)
c) DL unicast transmission
d) UL unicast reception
e) Random access by the UE

MVP-FUNC-BAS-16-2: The Open RAN system specified in Section 4.1 shall support the configuration and broadcast of the following SIBs, e.g., SIB1-5 and SIB8.

MVP-FUNC-BAS-16-3: The Open RAN system specified in Section 4.1 shall support Closed Loop Power Control.

MVP-FUNC-BAS-16-4: The Open RAN system specified in Section 4.1 shall support Access Barring with Unified Access Control (UAC).

5.1.4. Functional Requirements for Multiple Input Multiple Output (MIMO)

MVP-FUNC-MIMO-16-1: The Open RAN system specified in Section 4.1 shall support Channel State Information (CSI) report for periodic and aperiodic Type-I codebook.

MVP-FUNC-MIMO-16-2: The Open RAN system specified in Section 4.1 shall support CSI report for periodic and aperiodic Type-II codebook.

MVP-FUNC-MIMO-16-3: The Open RAN system specified in Section 4.1 shall support CSI feedback for Type-I and Type-II codebook.

MVP-FUNC-MIMO-16-4: The Open RAN system specified in Section 4.1 shall support Single User MIMO with 2T2R and up to 2 DL layers and up to 2 UL layers.

MVP-FUNC-MIMO-16-5: The Open RAN system specified in Section 4.1 shall support Single User MIMO with 4T4R and up to 4 DL layers and up to 4 UL layers.

MVP-FUNC-MIMO-16-6: The Open RAN system specified in Section 4.1 shall support UL Multiuser MIMO with up to 2 layers per user and up to a total of 8 layers.

MVP-FUNC-MIMO-16-7: The Open RAN system specified in Section 4.1 shall support DL Multiuser MIMO with up to 4 layers per user and up to a total of 16 layers.

MVP-FUNC-MIMO-16-8: The Open RAN system specified in Section 4.1 shall support Massive MIMO with 32T32R and up to 16 DL layers and up to 8 UL layers.

MVP-FUNC-MIMO-16-8a: The Open RAN system specified in Section 4.1 shall support Massive MIMO with 64T64R and up to 16 DL layers and up to 8 UL layers.

MVP-FUNC-MIMO-16-9: The Open RAN system specified in Section 4.1 shall support Reciprocity -based beam forming for FR1 TDD bands.

MVP-FUNC-MIMO-16-10: The Open RAN system specified in Section 4.1 shall support Reciprocity -based beam forming for FR2 TDD bands.

MVP-FUNC-MIMO-16-11: The Open RAN system specified in Section 4.1 shall support hybrid beam forming for FR2.

MVP-FUNC-MIMO-16-12: The Open RAN system specified in Section 4.1 shall support Release 15/16 legacy beam management for FR2.

MVP-FUNC-MIMO-16-13: The Open RAN system specified in Section 4.1 shall support SRS Antenna Switching.

MVP-FUNC-MIMO-16-14: The Open RAN system specified in Section 4.1 shall support Demodulation Reference Signal (DM-RS) enhancement of Peak-to-Average Power Ratio (PAPR).

5.1.5 Functional Requirements for Bandwidth

MVP-FUNC-BW-16-1: The Open RAN system specified in Section 4.1 shall support the following carrier bandwidths:

a) FR1 bands:
   - FDD bands: 5, 10, 20, 25, 30, 40, 45 MHz if that specific bandwidth is specified for a band specified in TS 38.104
   - TDD bands: 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100 MHz if that specific bandwidth is specified for a band specified in TS 38.104

b) FR2 bands:
   100 MHz bandwidth as specified in TS 38.104

MVP-FUNC-BW-16-2: The Open RAN system specified in Section 4.1 shall support UL pre-scheduling.

MVP-FUNC-BW-16-3: The Open RAN system specified in Section 4.1 shall support UL Configured Grant (CG) Type 1 and Type 2.

MVP-FUNC-BW-16-4: The Open RAN system specified in Section 4.1 shall support Bandwidth Parts (BWPs) for FDD and TDD bands in both DL and UL and for both Primary Cell (Pcell) and Secondary Cell (Scell) with the following:

a) Minimum 2 BWPs, including one initial BWP and one dedicated BWP
b) Maximum 4 BWPs, including the initial BWP

5.1.6 Functional Requirements for TDD Pattern

MVP-FUNC-TDD-16-1: The Open RAN system specified in Section 4.1 shall support configurable TDD patterns through static or semi-static configuration, via Radio Resource Control (RRC).

MVP-FUNC-TDD-16-2: The Open RAN system specified in Section 4.1 shall support TDD pattern 4:1 DDDSU where S slot has 10 DL, 2 GP, 2 UL symbols for FR1 bands as defined for relevant Open FH CUS IOT profiles.

MVP-FUNC-TDD-16-3: The Open RAN system specified in Section 4.1 shall support TDD pattern 4:1 DDDSU where S slot has 10 DL, 2 GP, 2 UL symbols for FR2 bands as defined for relevant Open FH CUS IOT profiles.

MVP-FUNC-TDD-16-4: The Open RAN system specified in Section 4.1 shall support TDD pattern 8:2 DDDSUUDDDD where S slot has 6 DL, 4 GP, 4 UL symbols for FR1 bands as defined for relevant Open FH CUS IOT profiles.

MVP-FUNC-TDD-16-5: The Open RAN system specified in Section 4.1 shall support TDD pattern 6:4 DDDSUUUUDD where S slot has 6 DL, 4 GP, 4 UL symbols for FR1 bands as defined for relevant Open FH CUS IOT profiles.

5.1.7 Functional Requirements on Carrier Aggregation

MVP-FUNC-CA-1: The Open RAN system specified in Section 4.1 shall support both Intra-band and Inter-band Carrier Aggregation.

MVP-FUNC-CA-2: The Open RAN system specified in Section 4.1 shall support Intra-DU Carrier Aggregation.

MVP-FUNC-CA-3: The Open RAN system specified in Section 4.1 shall support FR1 FDD Carrier Aggregation across both inter-band and intra-band component carriers, with up to 4 Component Carriers in DL and up to 2 Component Carriers in UL.

MVP-FUNC-CA-4: The Open RAN system specified in Section 4.1 shall support FR1 FDD and TDD Carrier Aggregation both inter-band and intra-band, with up to 6 Component Carriers in DL and up to 2 Component Carriers in UL.

MVP-FUNC-CA-5: The Open RAN system specified in Section 4.1 shall support FR1 TDD Carrier Aggregation both inter-band and intra-band, with up to 3 Component Carriers DL and 1 Component Carrier in UL.

MVP-FUNC-CA-6: The Open RAN system specified in Section 4.1 shall support FR2 Carrier Aggregation both inter-band and intra-band, with up to 8 Component Carriers in DL and up to 4 Component Carriers in UL.

MVP-FUNC-CA-7: The Open RAN system specified in Section 4.1 shall support NR-Dual Connectivity with FR1 and FR2 Dual Connectivity with 1 FR1 FDD or TDD along with FR2 up to 8 Component Carriers in DL, and FR2 up to 4 Component Carriers in UL.

5.1.8 Functional Requirements on Mobility

MVP-FUNC-MOB-1: The Open RAN system specified in Section 4.1 shall support Intra-band mobility within supported FR1 and FR2 bands for the following scenarios:

a) Intra-RU, Intra-DU, Intra-CU
b) Inter-RU, Intra-DU, Intra-CU
c) Inter-RU, Inter-DU, Intra-CU
d) Inter-RU, Inter-DU, Inter-CU handovers without CU-UP change
e) Inter-RU, Inter-DU, Inter-CU handovers with CU-UP change

MVP-FUNC-MOB-2: The Open RAN system specified in Section 4.1 shall support Inter-band mobility such as between supported FR1 bands, between supported FR1 and FR2 bands, and between supported FR2 bands for the following scenarios:

a) Intra-multiband RU, Intra-DU, Intra-CU
b) Inter-RU, Intra-DU, Intra-CU
c) Inter-RU, Inter-DU, Intra-CU
d) Inter-RU, Inter-DU, Inter-CU handovers without CU-UP change
e) Inter-RU, Inter-DU, Inter-CU handovers with CU-UP change

MVP-FUNC-MOB-3: The Open RAN system specified in Section 4.1 shall support Xn-based Handover.

MVP-FUNC-MOB-4: The Open RAN system specified in Section 4.1 shall support Next-Generation (NG)-based Handover.

MVP-FUNC-MOB-5: The Open RAN system specified in Section 4.1 shall support Intra-Master Node (MN) Handover with Secondary Node (SN) change.

MVP-FUNC-MOB-6: The Open RAN system specified in Section 4.1 shall support Intra-MN Handover without SN change.

MVP-FUNC-MOB-7: The Open RAN system specified in Section 4.1 shall support Inter-MN Handover with SN change.

MVP-FUNC-MOB-8: The Open RAN system specified in Section 4.1 shall support Inter-MN Handover without SN change.

MVP-FUNC-MOB-9: The Open RAN system specified in Section 4.1 shall support RRC_CONNECTED state mobility.

MVP-FUNC-MOB-10: The Open RAN system specified in Section 4.1 shall support RRC_INACTIVE state mobility.

MVP-FUNC-MOB-11: The Open RAN system specified in Section 4.1 shall support RRC_IDLE state mobility.

MVP-FUNC-MOB-12: The Open RAN system specified in Section 4.1 shall support FR2 coverage-based SN release.

MVP-FUNC-MOB-13: The Open RAN system specified in Section 4.1 shall support Secondary Cell Group (SCG) Radio Link Failure (RLF) detection and recovery.

MVP-FUNC-MOB-14: The Open RAN system specified in Section 4.1 shall support Fast Handover failure recovery based on T312.

MVP-FUNC-MOB-15: The Open RAN system specified in Section 4.1 shall support Conditional handover.

5.1.9 Functional Requirements for Essential Services

This Section will enumerate the functional requirements for Services.

MVP-FUNC-SVCS-16-1: The Open RAN system specified in Section 4.1 shall support Admission control, Priority, and Preemption.

MVP-FUNC-SVCS-16-2: The Open RAN system specified in Section 4.1 shall support User Equipment (UE) Power Savings enhancements for the following:

a) Wake Up Signal (WUS)
b) UE Assistance Information

MVP-FUNC-SVCS-16-3: The Open RAN system specified in Section 4.1 shall support Emergency Call Prioritization.

MVP-FUNC-SVCS-16-4: The Open RAN system specified in Section 4.1 shall support Wireless Priority Service (WPS) and Multimedia Priority Service.

MVP-FUNC-SVCS-16-5: The Open RAN system specified in Section 4.1 shall support Public Warning Systems (PWS).

MVP-FUNC-SVCS-16-6: The Open RAN system specified in Section 4.1 shall support Connected Mode Discontinuous Reception (DRX).

MVP-FUNC-SVCS-16-7: The Open RAN system specified in Section 4.1 shall support Evolved Packet System (EPS) Fallback to Voice over Long-Term Evolution (VoLTE).

MVP-FUNC-SVCS-16-8: The Open RAN system specified in Section 4.1 shall support the following Voice over New Radio (VoNR) features:

a) Robust Header Compression (RoHC) Profile 1
b) Guaranteed Bit Rate (GBR) support
c) 5G QoS Indicator (5QI) 1, 2 for GBR
d) Slot Aggregation (TTI bundling)

5.1.10 Functional Requirements for other Capabilities

MVP-FUNC-OTH-16-1: The Open RAN system specified in Section 4.1 shall support Remote Interference Management (RIM) for RIM-RS Type 1 backhaul framework.

MVP-FUNC-RANS-16-1: The Open RAN system specified in Section 4.1 shall support Multi-Operator Core Network (MOCN).

MVP-FUNC-RANS-16-2: The Open RAN system specified in Section 4.1 shall support Multi-Operator RAN (MORAN).

MVP-FUNC-POS-16-1: The Open RAN system specified in Section 4.1 shall support New Radio Positioning Protocol (NRPPa) based Enhanced Cell Identity (ECID) positioning method.

MVP-FUNC-POS-16-2: The Open RAN system specified in Section 4.1 shall support DL Positioning Reference Signal (PRS) for FDD and TDD bands with Comb-4 or higher configuration.

MVP-FUNC-POS-16-3: The Open RAN system specified in Section 4.1 shall support for the following positioning methods:

a) Power
b) Time for all bands
c) Angle for FR2 bands

MVP-FUNC-RLM-16-1: The Open RAN system specified in Section 4.1 shall support both SSB and CSI-RS based Radio Link Monitoring.

MVP-FUNC-RACH-16-1: The Open RAN system specified in Section 4.1 shall support the 4-step Random Access Channel (RACH).

MVP-FUNC-RACH-16-2: The Open RAN system specified in Section 4.1 shall support the 2-step RACH as specified in Release 16.

5.2 Functional Requirements based on 3GPP Release 17

This Section specifies Open RAN system's functional capabilities as specified in 3GPP Release 17.

5.2.1 Functional Requirements for MIMO

MVP-FUNC-MIMO-17-1: Void.

MVP-FUNC-MIMO-17-2: The Open RAN system specified in Section 4.1 shall support Type-II codebook Release 17 enhancements related the following:

a) Reliability
b) Repetition and time bundling
c) Aperiodic SRS triggering

MVP-FUNC-MIMO-17-3: The Open RAN system specified in Section 4.1 shall support SRS coverage enhancements related the following:

a) Reliability
b) Repetition and time bundling
c) Aperiodic SRS triggering

5.2.2 Functional Requirements for Bandwidth

MVP-FUNC-BW-17-1: The Open RAN system specified in Section 4.1 shall support UL Dynamic Physical Uplink Control Channel (PUCCH) repetition factor indication.

MVP-FUNC-BW-17-2: The Open RAN system specified in Section 4.1 shall support UL Tx switching Release 17 enhancements.

5.2.3 Functional Requirements for Essential Services

MVP-FUNC-SVCS-17-1: The Open RAN system specified in Section 4.1 shall support Power Classes of 1, 1.5, and 2.

MVP-FUNC-SVCS-17-2: The Open RAN system specified in Section 4.1 shall support Reduced Capability (RedCap) features for both TDD and FDD.

MVP-FUNC-SVCS-17-3: The Open RAN system specified in Section 4.1 shall support the following RAN slicing enhancements:

a) Slice aware reselection
b) Slice specific RACH configuration
c) Slice specific Maximum Bit Rate (MBR)
d) Slice specific multi-carrier resource sharing
e) Slice specific resource partitioning

5.2.4 Functional Requirements for Other Capabilities

MVP-FUNC-SMO-17-1: The Open RAN system specified in Section 4.1 shall support appropriate data to be ingested by the SMO to enable the following use cases via rApps:

a) Automatic Neighbor Relations (ANR)
b) Physical Cell ID (PCI) Optimization
c) Mobility Load Balancing (MLB)
d) Mobility Robustness Optimization (MRO)
e) Coverage and Capacity Optimization (CCO)
f) RACH Optimization

6 PERFORMANCE REQUIREMENTS

This Section lists a minimum number of performance metrics related to the Open RAN system specified in Section 4 that the MNOs will be considering in evaluating the viability of the developed Open RAN system as part of their deployment.

For each metric, the recommended test method and configuration and a value range are also listed.

NOTE 1: The value ranges provided are for guidance only, and individual MNOs may require values for certain metrics that fall outside the specified value range. Some metrics do not have a value range specified. Irrespective of whether a value range is specified or not, vendors are expected to submit the measured value for all metrics as part of the test report. MNOs may also have additional operator specific performance metrics that the system may have to meet.

NOTE 2: The test procedure is assumed to include enough repetitions to ensure adequate confidence in the measured value of each performance metric.

6.1 Accessibility Related Metrics

MVP-PERF-ACC-1: PRACH Success Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of successfully resolving contentions and assign initial resources. PRACH failure is RACH procedure getting aborted due to no MSG2 from the Open RAN system.	3GPP TS 38.141-1, TS 38.141-2 (Note 2)	>99% (Note 1)

MVP-PERF-ACC-2: RRC Setup Success Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of successfully setting up radio resource connection and represents the percentage of radio connection attempts that were successful.	**NOTE:** There is no Test and Integration Focus Group (TIFG) or 3GPP specification clause that directly specifies configuration and method for performing tests to evaluate this performance metric. However, test methods and procedures in clause 6.4/6.7/8.3 could be leveraged to develop the procedure/ configuration for this performance metric (Note 2).	>99% (Note 1)

MVPC-PERF-ACC-3: 5G SA registration success rate:

Description	Test Method and Configuration	Performance Value Range
Measure of successfully registering the UE with the SA core and represents the ratio of the number times Registration Complete was successful to the number of Registration Request attempts.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 5.3 (Note 2)	100% (Note 1)

MVPC-PERF-ACC-4: 5G SA deregistration success rate:

Description	Test Method and Configuration	Performance Value Range
Measure of successfully registering the UE with the SA core and represents the ratio of the number times Connection Release was successful to the number of De-Registration Request attempts (Note 2).	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 5.3 (Note 2)	100% (Note 1)

6.2 Retainability Related Metrics

MVP-PERF-RET-1: RRC Dropped Call Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of drop call over the total number of successfully established RRC calls for radio conditions varying from excellent to poor. A RRC dropped call refers to release of an RRC connection for reasons other than inactivity and radio link failures (RLF).	**NOTE:** There is no TIFG or 3GPP specification clause that directly specifies configuration and method for performing tests to evaluate this performance metric. However, test methods and procedures in clauses 6.4/6.7/8.3 could be leveraged to develop the procedure/configuration for this performance metric (Note 2).	<0.01% (Note 1)

MVP-PERF-RET-2: VoNR Dropped Call Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of VoNR drop call over the total number of successfully established VoNR calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00 **NOTE**: This metric and associated value has not been captured in the TIFG specifications **NOTE**: The VoNR call duration for this may repetition of shorter call duration than those specified in clause 7.5.1-4 as per typical values for the call hold time. This may require further updates to clause 7.5.1-4 of the TIFG specifications (Note 2)	<0.05% (Note 1)

6.3 Throughput Related Metrics

MVP-PERF-THR-1a: L1 Downlink peak throughput,
MVP-PERF-THR-1b: Application-level Downlink peak throughput,
MVP-PERF-THR-1c: L1 Downlink peak spectral efficiency:

Description	Test Method and Configuration	Performance Value Range
Measure of sustaining 100% allocation of available DL resource assignments to a single user in excellent signal condition at the highest Modulation and Coding Scheme (MCS) based on UE capability.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8, 6.1, 6.2 (Note 2)	As per formula in clause 6.1.2 for a given numerology, frequency band, channel bandwidth and TDD configuration using DL overhead specified for FR1/FR2.

MVP-PERF-THR-2a: L1 Uplink peak throughput,
MVP-PERF-THR-2b: Application-level Uplink peak throughput,
MVP-PERF-THR-2c: L1 Uplink peak spectral efficiency:

Description	Test Method and Configuration	Performance Value Range
Measure of sustaining 100% allocation of available UL resource assignments to a single user in excellent signal condition at the highest MCS based on UE capability.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8 6.1, 6.3 (Note 2)	As per formula in clause 6.1.2 for a given numerology, frequency band, channel bandwidth and TDD configuration using UL overhead specified for FR1/FR2.

MVP-PERF-THR-3a: Bidirectional L1 Downlink and Uplink throughput in excellent, good, fair and poor radio conditions,
MVP-PERF-THR-3b: Bidirectional Application-level Downlink and Uplink throughput in excellent, good, fair and poor radio conditions,
MVP-PERF-THR-3c: Bidirectional L1 Downlink and Uplink spectral efficiency in excellent, good, fair and poor radio conditions:

Description	Test Method and Configuration	Performance Value Range
Measure of DL and UL throughputs for simultaneous bidirectional data transmissions for excellent, good, fair and poor radio conditions.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8, 6.6 (Note 2)	

MVP-PERF-THR-4a: Downlink L1 throughput for varying channel conditions to plot between throughput and Signal-to-Interference-plus-Noise Ratio (SINR),
MVP-PERF-THR-4b: Downlink Application throughput for varying channel conditions to plot between throughput and SINR,
MVP-PERF-THR-4c: Downlink Spectral Efficiency (SE) for varying channel conditions to plot between SE and SINR:

Description	Test Method and Configuration	Performance Value Range
Measure of UE DL throughput when the radio conditions of UE change gradually.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8, 6.7 (Note 2)	

MVP-PERF-THR-5a: Uplink L1 throughput for varying channel conditions to plot between throughput and SINR,
MVP-PERF-THR-5b: Uplink Application throughput for varying channel conditions to plot between throughput and SINR,
MVP-PERF-THR-5c: Uplink Spectral Efficiency for varying channel conditions to plot between SE and SINR:

Description	Test Method and Configuration	Performance Value Range
Measure of UE UL throughput when the radio conditions of UE change gradually.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8, 6.8 (Note 2)	

6.4 Latency Related Metrics

MVP-PERF-LAT-1: RRC Setup Time:

Description	Test Method and Configuration	Performance Value Range
Amount of time to setup a radio connection. Setup time is time difference between MSG3 and MSG5 under varying radio conditions from excellent to poor.	**NOTE:** There is no TIFG or 3GPP specification clause that directly specifies configuration and method for performing tests to evaluate this performance metric. However, test methods and procedures in clauses 6.4/6.7/8.3 could be leveraged to develop the procedure/configuration for this performance metric (Note 2).	<= 25ms (Note 1)

MVP-PERF-LAT-2: Ping Round Trip Time:

Description	Test Method and Configuration	Performance Value Range
Measure of E2E latency incurred within the Open RAN system.	**NOTE:** There is no TIFG or 3GPP specification clause that directly specifies configuration and method for performing tests to evaluate this performance metric and needs to be developed. The test configuration shall facilitate configuration of different size of ping messages of up to 1340 bytes (Note 2).	Lab: <= 23 ms Field: <= 60 ms <= 25 ms median (Note 1)

MVP-PERF-LAT-3: 5G SA registration time:

Description	Test Method and Configuration	Performance Value Range
Amount of time to successfully register the UE with the SA core. The Registration Time latency is measured by calculating the time between Registration Request to Registration Complete.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 5.3 (Note 2)	

MVP-PERF-LAT-4: 5G SA deregistration time:

Description	Test Method and Configuration	Performance Value Range
Amount of time to successfully deregister the UE with the SA core. The De-registration Time latency is measured by calculating the time between De-registration Request to Signaling Connection Release.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 5.3 (Note 2)	

6.5 Capacity Related Metrics

MVP-PERF-CAP-1a: Downlink aggregated cell L1 throughput,
MVP-PERF-CAP-1b: Cell based average DL L1 spectral efficiency:

NOTE: Vendor shall evaluate and report the SE results for different configurations including but not limited to channel bandwidths, layers, and MCS as standardized within 3GPP for North American spectrum bands.

Description	Test Method and Configuration	Performance Value Range
Measure of DL spectrum use in terms of throughput (bps) per spectrum bandwidth (Hz).	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 4.8, 6.9 (Note 2)	

MVP-PERF-CAP-2a: Uplink aggregated cell L1 throughput,
MVP-PERF-CAP-2b: Cell based average UL L1 spectral efficiency:

NOTE: Vendor shall evaluate and report the SE results for different configurations including but not limited to channel bandwidths, layers, and MCS as standardized within 3GPP for North American spectrum bands.

Description	Test Method and Configuration	Performance Value Range
Measure of UL spectrum use in terms of throughput (bps) per spectrum bandwidth (Hz).	O-RAN.TIFG.E2E-Test.0-R003-v06.00, 4.8, Clause 6.10 (Note 2)	

MVP-PERF-CAP-3: Simultaneous RRC_CONNECTED UEs (max. # of RRC_CONNECTED UEs):

Description	Test Method and Configuration	Performance Value Range
Measure of the maximum number of UEs (each with minimal U-Plane traffic) that can be simultaneously maintained in RRC_CONNECTED state to benchmark C-plane capacity	O-RAN.TIFG.E2E-Test.0-R003-v06.00, 4.8, Clause 8.1 (Note 2)	

6.6 Mobility Related Metrics

NOTE: Intra-O-RU handovers in this Section refers to inter-frequency handovers within the same O-RU.

MVP-PERF-MOB-1: Handover Success Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of sustaining an active connection as the user moves across coverage of different cells for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU (Central Unit) handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	>99.99% (Note 1)

MVP-PERF-MOB-2: Handover Interruption Time:

Description	Test Method and Configuration	Performance Value Range
Measure of service interruption during a handover. It is time difference between the RRCReconfiguration message (to initiate Handover) received by the UE to RRC reconfiguration complete received at the target cell for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	<= 52 ms for FR1 – FR1 <= 72 ms for FR2 – FR1 <= 157 ms for FR2 – FR2 <= 177 ms for FR1 – FR2 For field As specified in TS 38.133, Clause 6.1

MVP-PERF-MOB-3: DL packet loss during handover:

Description	Test Method and Configuration	Performance Value Range
Measure of DL packet loss during a handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	

MVP-PERF-MOB-4: UL packet loss during handover:

Description	Test Method and Configuration	Performance Value Range
Measure of UL packet loss during a handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	

MVP-PERF-MOB-5: Call drop due to unsuccessful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of session failure due to unsuccessful handover procedure for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	

MVP-PERF-MOB-6: Application DL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of to ensure application level DL throughput before and after a successful handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

MVP-PERF-MOB-7: L1 DL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of L1 DL throughput before and after a successful handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

MVP-PERF-MOB-8: L3 DL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of L3 DL throughput before and after a successful handover or the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

MVP-PERF-MOB-9: Application UL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of application level UL throughput before and after a successful handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

MVP-PERF-MOB-10: L1 UL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of L1 UL throughput before and after a successful handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

MVP-PERF-MOB-11: L3 UL Throughput before and after a successful handover:

Description	Test Method and Configuration	Performance Value Range
Measure of L3 UL throughput before and after a successful or the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 5.4, 5.5, 5.6 (Note 2)	$Throughput_{after} \geq Throughput_{before}$

6.7 Services Related Metrics

MVP-PERF-VNR-1: VoNR Call Setup Success Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of successfully setting up voice calls and represents the percentage of Mobile Originating (MO) and Mobile Terminating (MT) call attempts that were successful	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note 1)	> 99% (Note 1)

MVP-PERF-VNR-2: VoNR Call Setup Time:

Description	Test Method and Configuration	Performance Value Range
Amount of time to setup a MO VoNR call. VoNR call setup time is the difference between transmission of SIP invite by the UE to reception of the 180 ringing by the UE	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note 2)	< 2.5 seconds (Note 1)

MVP-PERF-VNR-3: VoNR Handover Success Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of sustaining voice media and signaling radio bearers as the user moves across coverage of different sites for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn based handovers -- Inter-RU, Inter-DU, Inter-CU N2 based handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 7.5.2, 7.5.3, 7.5.4 (Note 2)	≥ 99.99% (Note 1)

MVP-PERF-VNR-4: VoNR Handover - Real-time Transport Protocol (RTP) Packet loss %:

Description	Test Method and Configuration	Performance Value Range
Measure of DL and UL RTP packets lost during a handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 7.5.2, 7.5.3, 7.5.4 (Note 2)	

MVP-PERF-VNR-5: VoNR Handover - UE Packet delay:

Description	Test Method and Configuration	Performance Value Range
Measure of DL and UL delay experienced for voice media packets during a handover for the following scenarios: -- Intra-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-O-RU, Intra-O-DU, Intra-O-CU handover -- Inter-RU, Inter-O-DU, Intra-O-CU handover -- Inter-RU, Inter-DU, Inter-CU Xn handovers -- Inter-RU, Inter-DU, Inter-CU N2 handovers	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clauses 7.5.2, 7.5.3, 7.5.4 (Note 2)	

MVP-PERF-VNR-6: VoNR Mean Opinion Score:

Description	Test Method and Configuration	Performance Value Range
Measure of sustaining and maintain VoNR call quality for MT and MO calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.51-4 (Note 2)	> 3.5 (Note 1)

MVP-PERF-VNR-7: VoNR Packet Loss Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of ensuring minimal RTP packet drops for MT and MO calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note 2)	< 1% (Note 1)

MVP-PERF-VNR-8: VoNR muting Rate:

Description	Test Method and Configuration	Performance Value Range
Measure of minimizing the occurrence of a dropped VoNR packets that results in muting for MT and MO calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note 2)	< 1% (Note 1)

MVP-PERF-VNR-9: VoNR One way call:

Description	Test Method and Configuration	Performance Value Range
Measure of minimizing the occurrence of a way-one way call setup for MT and MO calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note 2)	< 1% (Note 1)

MVP-PERF-VNR-10: VoNR Call Block rate:

Description	Test Method and Configuration	Performance Value Range
Measure of minimizing the occurrence of a VoNR call setup failure for MT and MO calls.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.5.1-4 (Note w)	< 0.01%

MVP-PERF-WEB-1: Domain Name System (DNS) Resolution Time:

Description	Test Method and Configuration	Performance Value Range
Time measured from when the client sends a DNS query to when the DNS responds with an IP address in milliseconds/seconds. This KPI should be recorded if DNS is used.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.1 (Note 2)	< 1 seconds (Note 1)

MVP-PERF-WEB-2: Time to First Byte (TTFB):

Description	Test Method and Configuration	Performance Value Range
Time measured from when the client makes the HTTP request to when the first byte of the page (page size: 2MB) is received in milliseconds/seconds.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.1 (Note 2)	< 3 seconds (Note 1)

MVP-PERF-WEB-3: Page Load Time:

Description	Test Method and Configuration	Performance Value Range
Time measured from when the client places the request to when the page (page size: 2 MB) is completely loaded in seconds.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.1 (Note 2)	<12 seconds (Note 1)

MVP-PERF-WEB-4: Application DL throughput (Mbps):

Description	Test Method and Configuration	Performance Value Range
This is the average application layer throughput to download the page (page size: 2 MB) in kbps.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.1 (Note 2)	Same as for DL throughput performance metric for comparable radio condition in MVP-PERF-THR-3a (Note 1).

MVP-PERF-FILDL-1: Time taken to Download File:

Description	Test Method and Configuration	Performance Value Range
This is the time required to upload the file (file size: 1 GB) in seconds.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.2 (Note 2)	

MVP-PERF-FILDL-2: Application DL throughput (Mbps):

Description	Test Method and Configuration	Performance Value Range
This is the average application layer throughput to download the file (file size: 1 GB) in kbps.	O-RAN.TIFG.E2E-Test.0 R003-v06.00, Clause 7.1.2 (Note 2)	Same as for DL throughput performance metric for comparable radio condition in MVP-PERF-THR-3a (Note 1).

MVP-PERF-FILUL-1: Time taken to Upload File:

Description	Test Method and Configuration	Performance Value Range
This is the time required to upload the file (file size: 1 GB) in seconds.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.2 (Note 2)	

MVP-PERF-FILUL-2: Application UL throughput (Mbps):

Description	Test Method and Configuration	Performance Value Range
This is the average application layer throughput to upload the file (file size: 1 GB) in kbps.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 7.1.2 (Note 2)	Same as for UL throughput performance metric for comparable radio condition MVP-PERF-THR-3a (Note 1).

6.8 Availability and load/stress testing related metrics

MVP-PERF-LOAD-1: Long hours stability Testing (successfully tested hours):

Description	Test Method and Configuration	Performance Value Range
Measure of the ability to continuously operate for a minimum of 24 hours.	O-RAN.TIFG.E2E-Test.0-R003-v06.00 **NOTE:** The traffic model example specified in 8.4 of the TIFG specification can be utilized, Clauses 8.4, 8.5 (Note 2).	

MVP-PERF-LOAD-2: RRC Access Success Rate:

NOTE: Unlike metric # which is for a single UE, this metric is for an emulated load comprising of a large number of UEs sending and receiving user data.

Description	Test Method and Configuration	Performance Value Range
Measure of successfully setting up radio resource connection and represents the percentage # of radio connection attempts that were successful across all UEs.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 8.3 (Note 2)	

MVP-PERF-LOAD-3: Packet Error Rate:
NOTE: Unlike metric # which is for a single UE, this metric is for an emulated load comprising of a large number of UEs sending and receiving user data.

Description	Test Method and Configuration	Performance Value Range
Measure of the rate of PDUs processed by the RLC layer but are not successfully delivered to the Packet Data Convergence Protocol (PDCP) layer [3GPP TS 23.501]. Average DL and UL packet error rates are to be measured and reported.	O-RAN.TIFG.E2E-Test.0-R003-v06.00, Clause 8.3 (Note 2)	

6.9 Radiofrequency (RF) Performance

MVP-PERF-RF-1: RF Transmitter:

Description	Test Method and Configuration	Performance Value Range
Measure of transmitter performance for Conducted and Over the Air (OTA) RF setups related to each of the following: signal quality, transmitter ON/OFF, dynamic range, Adjacent Channel Leakage Ratio (ACLR), operating band unwanted emissions, spurious emissions and intermodulation metrics specified in [23].	38.141-1 38.141-2 (Note 2)	As specified in [23] (Note 1)

MVP-PERF-RF-2: RF Receiver:

Description	Test Method and Configuration	Performance Value Range
Measure of receiver performance for Conducted and OTA RF setups related to each of the following: receiver sensitivity, dynamic range, adjacent channel selectivity, in-band and out of band blocking, receiver spurious emissions, receiver intermodulation metrics specified in [23].	38.141-1 38.141-2 (Note 2)	As specified in [23] (Note 1)

MVP-PERF-RF-3: RF Demodulation:

Description	Test Method and Configuration	Performance Value Range
Measure of demodulation performance for Conducted and OTA RF setups related to each of the following: Physical Uplink Shared Channel (PUSCH), PUCCH, PRACH specified in [23].	38.141-1 38.141-2 (Note 2)	As specified in [23] (Note 1)

7 O-CLOUD REQUIREMENTS

This Section describes the O-Cloud requirements based primarily upon a subset of O-RAN WG6: Cloudification & Orchestration Workgroup technical specifications. The requirements cover general O-Cloud infrastructure, hardware accelerator management, precision time protocol, and the O-Cloud O2 interface to the SMO as depicted in Figure 2.

NOTE: This section may include O-RAN O2 interface requirements that have not yet fully attained stage 3 specifications.

MVP-OCLOUD-O2-1: For O-Clouds that support the O2DMS Kubernetes profile, Kubernetes shall provide workload lifecycle management services as specified in [9].

MVP-OCLOUD-O2-2: For O-Clouds that support the O2dms European Telecommunications Standards Institute (ETSI) Network Functions Virtualization (NFV) profile for Virtual Machine (VM)-based deployments, ETSI NFV shall provide lifecycle management services as specified in [10].

MVP-OCLOUD-O2-3: All O-Cloud implementations shall support the O2 services, and their requirements allocated to the role of the O-Cloud as specified in [12].

MVP-OCLOUD-O2-4: O-Cloud telemetry shall minimally consist of Fault, Performance, and Configuration Data as specified in [12].

MVP-OCLOUD-O2-5: O-Cloud shall provide the collection of fault information for O-Cloud resources as specified in [12].

MVP-OCLOUD-O2-6: O-Cloud shall provide the enforcement of placement rules when associated with a workload as specified in [12].

MVP-OCLOUD-O2-7: O-Cloud shall provide an O2 interface to facilitate (Fault, Configuration, Accounting, Performance, and Security) FCAPS for its infrastructure as specified in [12].

MVP-OCLOUD-O2-8: O-Cloud shall provide an O2 interface to facilitate FCAPS for workloads that utilize its infrastructure as specified in [12].

MVP-OCLOUD-O2-9: O-Cloud shall provide an O2 interface to provide Life Cycle Management (LCM) of its infrastructure as specified in [12].

MVP-OCLOUD-O2-10: O-Cloud shall provide an O2 interface to provide LCM for workloads that utilize its infrastructure as specified in [12].

MVP-OCLOUD-O2-11: O-Cloud platform shall support discovering server hardware node features as specified in [12].

MVP-OCLOUD-O2-12: O-Cloud platform shall integrate with physical hardware Board Management Controller (BMC) and provide all FCAPS data for that hardware via O2 interface as specified in [12].

MVP-OCLOUD-O2-13 O-Cloud platform shall support continuous logging as specified in [12].

MVP-OCLOUD-GEN-1: O-Cloud shall have the ability to time-correlate its log entries as specified in [12].

MVP-OCLOUD-GEN-2: O-Cloud platform shall support Kubernetes worker node and controller node all-in-one node implementation topology for RAN site applications (e.g., CU/DU application). As specified in [15].

MVP-OCLOUD-GEN-3: O-Cloud platform shall support Kubernetes worker nodes and controller nodes as separate implementations at different servers or/and at different physical locations. i.e., K8s worker nodes and K8s controller nodes are deployed at separate servers. As specified in [15].

MVP-OCLOUD-GEN-4: O-Cloud platform shall support the Multi Networking feature in Kubernetes using Custom Resource Definitions (CRD)-based network objects in Kubernetes as specified in [15].

MVP-OCLOUD-GEN-5: O-Cloud platform shall support Single Root IO Virtualization (SR-IOV) and provides a low-latency interface for both packet I/O and acceleration interfaces as specified in [15], Clause 4.1.4.

MVP-OCLOUD-GEN-6: O-Cloud platform shall support PCI pass-through in case only one container needs to use the networking interface to provide high performance and low latency without using a virtual switch as specified in [15].

MVP-OCLOUD-GEN-7: O-Cloud platform shall support basic core affinity for Cloud-Native Network Functions (CNFs). It is required to pin real- time threads to specific Central Processing Unit (CPU) cores in order to improve performance and meet real-time latency as specified in [15].

MVP-OCLOUD-GEN-8: O-Cloud platform shall support the implementation of userspace networking for K8S containers, e.g., Data Plane Development Kit (DPDK) as specified in [15].

MVP-OCLOUD-GEN-9: O-Cloud platform shall support Shared Storage solution with High Availability to provide resiliency and support automatic failover of the workload with multi-node deployment as specified in [15], clause 3.2.1.

MVP-OCLOUD-GEN-10 O-Cloud platform shall support isolation and guarantee workload performance requirements in the use case where multiple workloads share the same physical host as specified in [15], clause 5.2.4.

MVP-OCLOUD-PTP1: O-Cloud shall support the O-Cloud Notification Application Programming Interface (API) event producer requirements to enable cloud workloads to receive PTP events/status as specified in [11].

MVP-OCLOUD-PTP2: O-Cloud platform shall support Precision Time Protocol (PTP) with IEEE1588v2 in compliance with G.8275.1 to provide synchronization for Open Fronthaul as specified in [15].

MVP-OCLOUD-PTP3: O-Cloud platform shall support all ORAN defined S-plane configurations (LLS-C1, LLS-C2, LLS-C3,) as specified in [15], Clause 4.2.

MVP-OCLOUD-AAL-1: O-Cloud platform shall support configuration, lifecycle management of firmware, and interfacing with hardware accelerators providing offload functions (e.g., Field Programmable Gate Arrays (FPGAs), Graphics Processing Unit (GPU), eASIC) as specified in [13].

8 MANAGEMENT REQUIREMENTS

This Section describes the management requirements for O-RAN system primarily focusing on SMO. The requirements cover general SMO functionalities needed to manage O-RAN Network Functions, O-Cloud, and rApps as depicted in Figure 2.

NOTE: This Section may include interface requirements that have not yet fully attained stage 3 specifications.

MVP-MGMT-O1-1: SMO shall support the O1 services and their requirements allocated to the role of the SMO as specified in [17] [18].

MVP-MGMT-O2-1: SMO shall support the O2 services and their requirements allocated to the role of the SMO as specified in [12].

MVP-MGMT-O2-2: SMO shall be able to correlate Managed Element telemetry to Infrastructure telemetry to aggregate faults and alarms to a root cause as specified in [12].

MVP-MGMT-O2-3: SMO shall be able to correlate a Managed Element to its deployment telemetry to aggregate faults and alarm to a root cause as specified in [12].

MVP-MGMT-O2-4: SMO shall be able to correlate a Managed Element to its deployment components as specified in [12].

MVP-MGMT-OFMP-1: SMO shall support Open Fronthaul M-Plane services and their requirements allocated to the role of the SMO as specified in [17].

MVP-MGMT-NonRTRIC-1: SMO shall support the Non-RT RIC framework as specified in [18].

MVP-MGMT-NonRTRIC-2: SMO shall support Non-RT RIC rApp Management service as specified in [20].

MVP-MGMT-NonRTRIC-3: SMO shall support Non-RT RIC R1 service as specified in [20].

MVP-MGMT-CoreSvcs-1: SMO shall support Data Management and Exposure (DME) Service to both expose and discover data elements made available as specified in [18].

MVP-MGMT-CoreSvcs-2: SMO shall support Service Management and Exposure (SME) Service to both expose and discover services available within SMO and Non-RT RIC as specified in [18].

MVP-MGMT-CoreSvcs-3: SMO shall support Inventory of the O-Cloud as specified in [12].

MVP-MGMT-CoreSvcs-4: SMO shall support inventory of the RAN Network Functions (NFs) as specified in [12].

MVP-MGMT-CoreSvcs-5: SMO shall support inventory of the transport used for the mid-haul as specified in [12].

MVP-MGMT-CoreSvcs-6: SMO shall support topology of the RAN NFs as specified in [12].

MVP-MGMT-CoreSvcs-7: SMO shall support topology of the O-Cloud as specified in [12].

MVP-MGMT-CoreSvcs-8: SMO shall support orchestration of the NF deployments as specified in [12].

MVP-MGMT-CoreSvcs-9: SMO shall support on-boarding of the NFs and rApps as specified in [12].

MVP-MGMT-LCM-1: SMO shall provide the full LCM of multiple Kubernetes clusters, and O-Cloud nodes deployed on multiple geographically distributed sites as specified in [15] [19].

9 SECURITY REQUIREMENTS

This Section describes security requirements primarily based upon the O-RAN Security Requirements and Controls Specification [8] and 3GPP TS 33.501 [24]. The security specifications from the O-RAN Alliance are guided by NIST SP 800-207, Zero Trust Architecture [30] to protect against external and internal threats. The specified security controls provide confidentiality, integrity, availability, authentication and authorization protections to mitigate risks from internal and external threats.

The remainder of this section provides the specified security controls for the O-RAN assets considered in-scope for the MVP, as specified in section 4. Security controls are also provided to follow industry best security practices as specified by the O-RAN Alliance in [8].

NOTE: The location of security servers (e.g., Key Management server, Open Authentication (OAuth) server, Public Key Infrastructure (PKI) server, etc.) is operator implementation dependent.

NOTE: Developers are recommended to put security at the core of the Software Development Life Cycle (SDLC) by utilizing best practices such as NIST DevSecOps [32], NIST SSDF [33], BSA Framework for Secure Software [34], or SAFECode [35]. See [31], Recommendation-SWDev-Indus-1, and Secure by Design [36].

9.1 SMO Security Requirements

MVP-SEC-SMO-01: SMO shall support confidentiality and integrity protection for the O1 interface using Transport Layer Security (TLS) 1.2 and 1.3 as specified in [8], clauses 5.1.1 and 5.2.2.

MVP-SEC-SMO-02: SMO shall support authentication for the O1 interface using Mutual Transport Layer Security (mTLS) 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clauses 5.1.1 and 5.2.2.

MVP-SEC-SMO-03: SMO shall support confidentiality and integrity protection for the O2 interface using TLS 1.2 and 1.3 as specified in [8], clauses 5.1.1 and 5.2.3.

MVP-SEC-SMO-04: SMO shall support authentication for the O2 interface using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clauses 5.1.1 and 5.2.3.

MVP-SEC-SMO-05: SMO shall support confidentiality and integrity protection for SMO internal communication using TLS 1.2 and 1.3 as specified in [8], clause 5.1.1.

MVP-SEC-SMO-06: SMO shall support authentication for SMO internal communication using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clause 5.1.1.

MVP-SEC-SMO-07: SMO shall support authorization using OAuth 2.0 as specified in [8], clause 5.1.1.

MVP-SEC-SMO-08: SMO shall support confidentiality and integrity protection using TLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.6 and 5.2.5.

MVP-SEC-SMO-09: SMO shall support authentication using mTLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.6 and 5.2.5.

MVP-SEC-SMO-10: SMO shall support authorization using Network Access Control Model (NACM) for the Open Fronthaul M-Plane interface as specified in [8], clause 5.2.5.4.

MVP-SEC-SMO-11: Non-RT RIC shall support confidentiality and integrity protection for SMO internal communication using TLS 1.2 and 1.3 as specified in [8], clause 5.1.1.2.2.

MVP-SEC-SMO-12: Non-RT RIC shall support authentication for SMO internal communication using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clause 5.1.1.2.2.

MVP-SEC-SMO-13: Non-RT RIC shall support authorization using OAuth 2.0 as specified in [8], clauses 5.1.2.

MVP-SEC-SMO-14: rApps shall support confidentiality and integrity protection using TLS 1.2 and 1.3 for the R1 interface as specified in [8], clauses 5.1.1.2.2 and 5.2.6.

MVP-SEC-SMO-15: rApps shall support authentication using mTLS 1.2 and 1.3 and PKI-based X.509 certificates for the R1 interface as specified in [8], clauses 5.1.1.2.2 and 5.2.6.

MVP-SEC-SMO-16: rApps shall support authorization using OAuth 2.0 as specified in [8], clause 5.1.2.

9.2 O-CU Security Requirements

MVP-SEC-O-CU-01a: O-CU-CP shall support confidentiality, integrity, and replay protection using Internet Protocol Security (IPsec) for the F1-C interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-01b: O-CU-CP shall support confidentiality, integrity, and replay protection using Datagram Transport Layer Security (DTLS) for the F1-C interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-02: O-CU-UP shall support confidentiality, integrity, and replay protection using IPsec for the F1-U interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-03: O-CU-CP shall support mutual authentication and authorization for Operations, Administration, and Management (OAM) as specified in [24], clause 5.3.4.

MVP-SEC-O-CU-04: O-CU-UP shall support mutual authentication and authorization for OAM as specified in [24], clause 5.3.4.

MVP-SEC-O-CU-05: O-CU-CP shall support confidentiality and integrity protection for the O1 interface using TLS 1.2 and 1.3 as specified in [8], clause 5.2.2.

MVP-SEC-O-CU-06: O-CU-CP shall support authentication for the O1 interface using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clause 5.2.2.

MVP-SEC-O-CU-07: O-CU-UP shall support confidentiality and integrity protection for the O1 interface using TLS 1.2 and 1.3 as specified in [8], clause 5.2.2.

MVP-SEC-O-CU-08: O-CU-UP shall support authentication for the O1 interface using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clause 5.2.2.

MVP-SEC-O-CU-09a: O-CU-CP shall support confidentiality, integrity, and replay protection using IPsec for the E1 interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-09b: O-CU-CP shall support confidentiality and integrity protection using DTLS for the E1 interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-10a: O-CU-CP shall support confidentiality and integrity protection using IPsec for the Xn-C interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-10b: O-CU-CP shall support confidentiality, integrity, and replay protection using DTLS for the Xn-C interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-11: O-CU-UP shall support confidentiality, integrity, and replay protection using IPsec for the Xn-U interface as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-12: O-CU-CP shall support RRC confidentiality, integrity and replay protection with the PDCP protocol as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-13: O-CU-UP shall support user plane data confidentiality protection with the PDCP protocol as specified in [8], clause 5.1.4.

MVP-SEC-O-CU-14: O-CU-CP shall follow the security requirements in [24], clauses 5.3.5 and 5.3.7.

MVP-SEC-O-CU-15: O-CU-UP shall follow the security requirements in [24], clauses 5.3.5 and 5.3.6.

9.3 O-DU Security Requirements

MVP-SEC-O-DU-01a: O-DU shall support confidentiality and integrity protection using IPsec for the F1-C interface as specified in [8], clause 5.1.5.

MVP-SEC-O-DU-01b: O-DU shall support confidentiality and integrity protection using DTLS for the F1-C interface as specified in [8], clause 5.1.5.

MVP-SEC-O-DU-02: O-DU shall support confidentiality and integrity protection using IPsec for the F1-U interface as specified in [8], clause 5.1.5.

MVP-SEC-O-DU-03a: O-DU shall support confidentiality and integrity protection using TLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [3] clause 5.4 and [8], clauses 5.1.5 and 5.2.5.4.

MVP-SEC-O-DU-03b: O-DU shall support confidentiality and integrity protection using Secure Shell Protocol (SSH) v2.0 for the Open Fronthaul M-Plane interface as specified in [3], clause 5.4 and [8], clauses 5.1.5 and 5.2.5.4.

MVP-SEC-O-DU-04: O-DU shall support authentication using mTLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.5 and 5.2.5.4.

MVP-SEC-O-DU-05: O-DU shall support authorization using NACM for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.5 and 5.2.5.4.

MVP-SEC-O-DU-06: O-DU shall support port-based access control with authentication and authorization using IEEE 802.1X for the Open Fronthaul point-to-point Local Area Network (LAN) segments as specified in [8], clauses 5.1.5, 5.2.5.4, and 5.2.5.5.

MVP-SEC-O-DU-07: O-DU shall support mutual authentication and authorization for OAM as specified in [24], clause 5.3.4.

MVP-SEC-O-DU-08: O-DU shall support confidentiality and integrity protection for the O1 interface using TLS 1.2 and 1.3 as specified in [8], clause 5.2.2.

MVP-SEC-O-DU-09: O-DU shall support authentication for the O1 interface using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clause 5.2.2.

9.4 O-RU Security Requirements

MVP-SEC-O-RU-01a: O-RU shall support confidentiality and integrity protection using TLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [3] clause 5.4 and [8], clauses 5.1.6 and 5.2.5.4.

MVP-SEC-O-RU-01b: O-RU shall support confidentiality and integrity protection using SSH v2.0 for the Open Fronthaul M-Plane interface as specified in [3] clause 5.4 and [8], clauses 5.1.6 and 5.2.5.4.

MVP-SEC-O-RU-02: O-RU shall support authentication using mTLS 1.2 and 1.3 for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.6 and 5.2.5.4.

MVP-SEC-O-RU-03: O-RU shall support authorization using NACM for the Open Fronthaul M-Plane interface as specified in [8], clauses 5.1.6, and 5.2.5.4.

MVP-SEC-O-RU-04: O-RU shall support port-based access control with authentication and authorization using IEEE 802.1X for the Open Fronthaul point-to-point LAN segments as specified in [8], clauses 5.1.6, 5.2.5.4, and 5.2.5.5.

MVP-SEC-O-RU-05: O-RU shall support mutual authentication and authorization for OAM as specified in [24], clause 5.3.4.

9.5 O-Cloud Security Requirements

MVP-SEC-O-Cloud-01: O-Cloud Platform shall provide a hardware root of trust from which to build a chain of trust as specified in [8], clause 5.1.8.7.2.

MVP-SEC-O-Cloud-02: O-Cloud Platform shall verify the digital signatures of O-Cloud Platform software prior to installation of the software as specified in [8], clause 5.1.8.3.2.
MVP-SEC-O-Cloud-03: O-Cloud Platform shall support access management to O-Cloud resources based on Role-Based Access Control (RBAC) as specified in [3], clause 5.1.8.1.2.

MVP-SEC-O-Cloud-04: O-Cloud Platform shall support Multi-Factor Authentication (MFA) as specified in [8], clause 5.1.8.1.2.

MVP-SEC-O-Cloud-05: O-Cloud Platform software shall support confidentiality and integrity protection for the O2 interface using TLS 1.2 and 1.3 as specified in [8], clauses 5.1.1 and 5.2.3.

MVP-SEC-O-Cloud-06: O-Cloud Platform software shall support authentication for the O2 interface using mTLS 1.2 and 1.3 and PKI-based X.509 certificates as specified in [8], clauses 5.1.1 and 5.2.3.

MVP-SEC-O-Cloud-07: O-Cloud shall support encryption of all sensitive data at rest as specified in [8], clause 5.1.8.6.2.

NOTE: O-Cloud Platform software vendors are recommended to support Kubernetes hardening, including secure runtime, updates, and configuration as described in [37].

NOTE: O-Cloud Platform vendors are recommended to harden host operating systems, including restricted access to system calls and file systems, strong isolation between OS processes, and minimal privileges on the host by default.

9.6 Additional Security Requirements

MVP-SEC-ADD-01: Open RAN CNFs shall support Application Lifecycle Management as specified in [8], clause 5.3.2.

MVP-SEC-ADD-02: Open RAN architectural elements shall have unused protocols disabled as specified in [8], clause 5.3.3.

MVP-SEC-ADD-03: Open RAN architectural elements shall be able to withstand and recover from a volumetric Distributed Denial of Service (DDoS) attack, on any interface, without system crash as specified in [8], clause 5.3.5.

MVP-SEC-ADD-04: Open RAN architectural elements shall support password hygiene as specified in [8], clause 5.3.7.

MVP-SEC-ADD-05: Open RAN architectural elements shall support PKI with X.509 certificates as specified in [8], clause 5.3.9.

MVP-SEC-ADD-06: Open RAN architectural elements shall support Certificate Management Protocol (CMP) v2 as specified in [8], clause 5.3.9.

MVP-SEC-ADD-07: Open RAN architectural elements shall provide API security as specified in [8], clause 5.3.10.

MVP-SEC-ADD-08: Open RAN architectural elements shall be able to handle unexpected inputs to transport protocols as specified in [8], Clause 5.3.4.

MVP-SEC-ADD-09: Open RAN architectural elements shall provide security event logs as specified in [8], clause 5.3.8 and 5.3.11.

MVP-SEC-ADD-10: Vendors of Open RAN architectural elements shall provide a list of known vulnerabilities in the delivered software as specified in [8], clause 5.3.6.

MVP-SEC-ADD-11: Vendors of Open RAN architectural elements shall provide a Software Bill of Material (SBOM) for the delivered software as specified in [8], clause 6.3.

MVP-SEC-ADD-12: OAM sessions shall be protected as specified in [8], clause 4.2.3.5.

ANNEX: CHANGE HISTORY

Version	Date	Brief Description of Change
1.0	17 September, 2024	Initial version of the MVP
1.1	24 October, 2024	i) Addition of change history Annex ii) Editorial corrections across various sections iii)Technical updates to requirements MVP-FUNC-BAS-1, MVP-FUNC-TDD-16-2 to MVP-FUNC-TDD-16-4 iv) Addition of MVP-FUNC-MIMO-16-8a v) MVP-FUNC_MIMO-17-1 was removed because it is a 3GPP Rel-18 related requirement

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ATIS-I-0000100v.1.1

Published October 2024

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