OPEN RAN TECHNICAL PRIORITIES

EXECUTIVE SUMMARY

UNDER THE OPEN RAN MOU

by Deutsche Telekom, Orange, Telefónica, TIM and Vodafone

This Executive Summary provides a high level description of the MoU signatories' requirements on Open RAN.

1. Overall objectives

The primary objective of the European operators working under the Open RAN MoU is to guide and foster the development of a non-fragmented Open RAN ecosystem and vendors' roadmaps while ensuring Open RAN reaches parity with best-in-class traditional RAN solutions. Special attention is paid to encourage a competitive European Open RAN ecosystem of technology providers and system integrators, hence strengthening the European RAN industry.

This "Technical Priorities Document" provides a list of technical requirements that the signatories of the Open RAN MoU consider priorities for Open RAN architecture. It serves as a guidance to the RAN supplier industry on where to focus to accelerate market deployments in Europe, focusing on commercial product availability in the short term, as well as solution development in the medium term.

In terms of timeframe, the operators wish to ensure the readiness of Open RAN solutions for large scale network roll-out from 2022 onwards. Macro deployment is identified as the primary target for the operators.

To ease the deployment of a fully disaggregated multi-vendor RAN, the operators are setting out a list of essential requirements for implementation by suppliers. A gap analysis between the operator requirements and current standards has been performed to indicate areas where further standardization is required in order to accelerate the specification of non-mature defined open interfaces and functions. For the avoidance of doubt, this Executive Summary, and the Technical Priority Document, only indicate areas where the operators consider further standardization is required; they do not define any Open RAN standards. Standardization will be subject to the established standard setting bodies such as the O-RAN Alliance.

Open Fronthaul is considered as the key interface to implement a disaggregated, multi-vendor RAN, including Massive MIMO, as a baseline for first macro deployments.

To become a competitive alternative to traditional RAN, the operators require solutions that will not compromise on network quality, security, high energy efficiency, as support for 4G and 5G based on both SA and NSA, efficient RAN sharing and legacy band support.

Other capabilities related to an intelligent and programmable RAN are expected to emerge later, offering the potential for specialist start-ups to emerge and play an active role. All are essential in the long run to build a competitive Open RAN ecosystem.

To support this phased approach, the first set of requirements are structured to mainly focus on the Releases R2 and R3 of the MoU, i.e.

- R2: Second Release – interoperability with open FH interface & HW/SW separation
- R3: Third Release – full intelligence and automation system, with RIC based operation and associated open interfaces and APIs

2. Main scenarios and overall architecture

2.1 Scenarios

Macro deployment is the primary target for the operators, with a virtualized infrastructure hosting O-CU/O-DU functions, and Open Fronthaul support as a baseline requirement.

- Flexibility is required to match various network topologies in terms of centralization. Both centralized and distributed vRAN deployments are targeted, depending on the operators' scenarios or local constraints (e.g. transport, distance to edge cloud for rural sites). In case of centralization, Open Distributed Units (O-DU) would be located in edge cloud, and Open Centralized Units (O-CU) in either edge or regional cloud.
- Small cell deployment for both outdoor and indoor scenarios is being targeted with different architectural splits and centralization options. Indoor deployment does also include a multi-operator scenario with shared or dedicated infrastructure, and seen as an alternative to DAS.
- RAN sharing is a key requirement for the operators. While MORAN with shared O-RU only and MOCN support is unanimously requested, both shared infra and dedicated infra per operator is relevant, depending on whether the infra is deployed on the same site or deployed autonomously by each operator in their target location (e.g. in their own cloud). Efficient RAN sharing management is required to allow sufficient independence between operators to manage their own CNFs on a shared infra, while avoiding any potential conflicts.

2.2 Technologies & spectrum

Focus should be on 4G/5G, as specified by the O-RAN ALLIANCE, operating in 3.4 – 3.8 GHz and legacy FDD bands.

- Open RAN requirements are targeting both 4G and 5G, with open interfaces and virtualized infrastructure.
- To operate legacy 2G/3G, the operators are interested in inter-operability between 2G/3G baseband units and RUs, based on proprietary interfaces, since no open interface has been specified successfully. This applies mainly to hybrid Radio Units supporting 2G/3G/4G/5G, but also for legacy 2G/3G only RUs already deployed.
- The operators' needs globally cover all available bands in their markets, although timing may differ from one market to another. A clear focus for Open RAN is on 3.4-3.8 GHz and a number of legacy FDD bands, while the interest in millimeter wave is tied to specific country availabilities.

2.3 Architecture & main open interfaces

The Open Fronthaul interface is key to enable a disaggregated, multi-vendor RAN with a common management framework.

- The overall Open RAN target architecture relies on the model described by the O-RAN ALLIANCE, based on the following building blocks:
  - A disaggregated RAN, allowing multi-vendor deployment of the main RAN elements, Open Radio Units (O-RU) and O-DU / O-CU in a fully interoperable manner.
  - A Cloud infrastructure (O-Cloud), based on General Purpose Processors (GPPs) and accelerators, running Containerized Network Functions (CNFs).
  - An automation framework, with a non and near real-time RAN Intelligent Controller (RIC), allowing optimization modules customized per operator.
  - A Service Management and Orchestration (SMO) framework, managing the RAN nodes, the Transport, and the Cloud Infrastructure in a unified manner.
- Main open interfaces
  - Open Fronthaul is the prime interface to be supported in a fully interoperable manner, without compromising network performance, especially for Massive-MIMO.
  - While Open X2/ Xn interfaces are seen as the baseline for interconnection between base stations, a fully disaggregated RAN will also require an Open F1 interface for the CU-DU split of gNBs.
  - Open E2 and A1 interfaces are also required and shall comply with the O-RAN ALLIANCE specifications to allow multi-vendor / multi-technology RIC deployment mid-term.
  - For a unified SMO approach, interoperable O1 interfaces towards all the RAN nodes will be required, while the O2 interface will be needed for the SMO to operate the CNFs running on the O-Cloud infrastructure.

3. Technical Building block requirements

3.1 O-Cloud infrastructure

A Kubernetes-based O-Cloud platform supporting the necessary RAN SW shall be the mainstream implementation.

- An Open Cloud software platform, compliant with O-RAN ALIANCE specifications, should be defined in order to build a common ground to facilitate CNF integration by European operators, according to their needs.
- The O-Cloud infrastructure is a key component enabling O-RAN hardware and software disaggregation, and allowing O-RAN application to be implemented

onto General Purpose Processors (GPPs) based Commercial Off-The-Shelf (COTS) hardware.

- Kubernetes based infrastructure shall be the mainstream implementation of the O-Cloud platform to host O-RAN functionalities such as O-CU, O-DU, and near real-time RIC.
- Containerized Network Function (CNF) on Bare Metal is the target solution, to support high throughput and low latency O-RAN applications.
- The O-Cloud platform should support the definition of auto-scaling policies for a given node pool, allowing the number of nodes to be scaled automatically according to metrics such as CPU and number of users, as a mid-term target.
- The O-Cloud platform shall support time-synchronization (PTP, SyncE, GPS) and Hardware accelerators as well as an Acceleration Abstraction Layer (AAL) that provides a set of Open APIs to CNF applications for offloading the hardware accelerated functions.
- Appropriate isolation enforcement for critical components at compute/network/storage physical infrastructure is seen beneficial to respond to regulatory requirements for emergency services and/or public-safety, and to facilitate RAN sharing deployment.

3.2 O-CU / O-DU

Implemented as CNFs on power-efficient and reliable GPP CPUs with HW acceleration support for O-DU processing.

- O-CU / O-DU must support fully containerized CU/DU functions, fulfilling requirements on power efficiency, connectivity, physical, mechanical and environmental constraints, reliability, scalability and availability.
- O-CU / O-DU Central Processing Unit (CPU) must be equipped with the latest generation of General Purpose Processors (GPP) to support various scenarios, from full radio layer processing, typically for low bandwidth, to partial radio layer processing combined with accelerators for high bandwidth and Massive MIMO scenarios.
- Various options are considered for acceleration, e.g. FPGA, GPU or (e)ASIC, for compute-intensive algorithms in the O-DU.

3.3 O-RU

Ease of deployment and operation is key, facilitated by multi-band RRUs and AAUs, both with low weight and high-power efficiency.

- O-RU variants are required for legacy bands, 3.4-3.8 GHz and millimetre wave spectrum, with various transmission modes (number of TRX), output power values and bandwidth requirements depending on frequency bands.

- Single band, dual band or triple band products are required depending on the respective bands. Support for multi-band O-RUs for low and mid bands is important for cost effective deployment.
- Massive MIMO products (32 and 64 TRX) are demanded primarily in 3.4-3.8 GHz.
- The main focus is on macro cell products, but small cell products are also needed, both indoor and outdoor.

3.4 Open Fronthaul (OFH)

OFH IOT profiles specified in the O-RAN ALLIANCE are key for the operators.

- Open Fronthaul (OFH) is a seen as a fundamental building block of the Open RAN approach.
- The operators have prioritized the OFH profiles specified in the O-RAN ALLIANCE (details on options regarding beamforming and compression profiles will be provided in the supplemental list of requirements).
- Synchronization profiles between O-RU and O-DU shall be based on PTPv2, SyncE, or GPS, depending on scenarios.
- Selected profiles should allow differentiation between Massive MIMO and legacy FDD radio units, and between bands such as sub 6 GHz and millimeter waves.
- To allow re-use of already deployed radio units as an interim solution, the operators see an interest to use Fronthaul Gateways to be provided by the O-RU vendor. Fronthaul Gateway shall support 7.2x split towards O-DU, but its interface towards RU could remain proprietary.
- The reference split for the operators is the 7.2x interface as specified by the O-RAN ALLIANCE. While there is no interest for alternative split options 6 or 8, the operators acknowledge the need to further investigate UL enhancements for the 7.2x split in order to improve performance and robustness particularly in mobility scenarios.

3.5 Main RAN features

Both 4G and 5G are targeted, based on both NSA and SA architecture for single operator and RAN sharing scenarios.

- Vendors should provide a comprehensive set of features for Open RAN solutions to be on par with the best-in-class traditional RAN networks, and minimize any potential gaps in features roadmap of interest for Europe.
- Open RAN requirements are targeting both 4G and 5G, based on both NSA and SA architecture for single operator and RAN sharing scenarios.

- RAN features should support high performance in terms of user throughput, capacity and latency, with advanced MIMO and modulation schemes, and efficient spectrum management through band aggregation and support of DSS.
- Ubiquity of service should rely on software features to improve network coverage and mobility, including Massive MIMO.
- While eMBB is the prime service targeted, support of voice services and legacy IoT services such as NB-IoT and LTE-M is also requested.
- QoS shall be ensured through features to efficiently manage resources, such as admission control, load balancing, and network slicing.

3.6 RAN Intelligent Controller (RIC)

The RIC should bring enhancements in terms of intelligence and programmability.

- Near-RT and Non-RT RAN Intelligent Controllers are key components to support AI/ML enabled Radio Resource Management applications.
- AI/ML intelligence is expected to enhance the effectiveness of several SON-alike and Advanced RRM use cases, in particular those related to traffic steering, QoS/QoE optimization, RAN slicing and Massive MIMO.
- Open E2 and A1 interfaces are the baseline requirements to allow multi-vendor RIC deployment from an early phase.
- Internal Open APIs are required for both non and near real-time RIC, to host 3rd party rApps and xApps, and to foster the creation of a thriving App “marketplace”.
- Several platform functions in Near-RT RIC (e.g. API management services, xApp Subscription Management, Conflict Mitigation between xApp and Shared Data Layer) are also key features to ease the deployment of a wide range of xApps.

3.7 Automation & SMO

Vendors shall adopt a unified data and information model (aligned with O-RAN ALLIANCE, 3GPP, ETSI and ONAP) to increase service management efficiency and vendor independent automation.

- The Service Management and Orchestration framework is a central RAN domain function to manage and control disaggregated multi-vendor RAN Network Functions (NF).
- The vision is to avoid vendor specific adoption of proprietary EMS (Element Management System) functions by using a unified modelling approach (promote data models defined in 3GPP, O-RAN ALLIANCE, ETSI & ONAP).
- The SMO function requires defined Northbound Interfaces e.g., 3GPP, TM Forum Open API, or a defined functional split for OSS systems.

- The SMO platform shall support Southbound Interfaces towards the Network Functions or Controller e.g., O1, O2 and A1.
- The SMO shall be able to support the management and lifecycle of several deployment scenarios for O-RAN infrastructures e.g., RAN network sharing, K8s workload, …
- The SMO shall increase the overall automation gains to facilitate network operation by adopting zero-touch deployments (e.g. with CI/CD chains).

3.8 Energy Efficiency

is a global requirement encompassing various domains of Open RAN (Radio Units, Infra, RIC, ...).

- Hardware should be the most energy efficient as possible, starting with radio transmitters, but also considering RAN infrastructure, where energy efficiency will be a criterion in the choice of accelerators.
- Vendors should also implement features to reduce the energy consumption in both networks and devices in low load situations, with more automation brought in particular by RIC modules.

3.9 Security

is a global priority for the operators requiring strict policies and features across all entities of the Open RAN network, which raises new challenges due to the multiplication of vendor solutions and open interfaces.

- This implies reliable security protocols, with certificate based authentication on the Open Fronthaul M-plane interface as the preferred option for management of the Open Fronthaul, IPSec on the midhaul interface, and replay protection and data origin authentication on the E2 interface.
- Cloud Infrastructure shall provide a secure and reliable platform to host O-RAN applications and to provide strict isolation between functions.
- The RIC should be able to authenticate Apps as part of the Life Cycle Management process in order to prevent malicious apps from compromising network information and functions.
- Databases holding data from xApp applications and E2 Nodes shall be securely stored with confidentiality, integrity, availability and authenticity protection.
- User data security should be ensured through cyphering and integrity protection.

3.10 High availability

is a key requirement to ensure the expected reliability of the operators' networks and services, encompassing various domains of Open RAN.

- O-Cloud shall support cloud platform redundancy to ensure high-availability services. Both local and geographical redundancies are targeted.
- O-CU/O-DU shall support high availability mechanisms on different levels (i.e., pods level, workers level, computes level and networks level). Geographical redundancy is mandatory for O-CU.
- O-RU shall support high MTBF targets in line with typical 4G/5G deployments.

ANNEX

ABBREVIATIONS

3GPP	3rd Generation Partnership Project
AAL	Acceleration Abstraction Layer
AAU	Active Antenna Unit
AI	Artificial Intelligence
API	Application Programming Interface
ASIC	Application-Specific Integrated Circuit
CI/CD	Continuous Integration / Continuous Delivery
CNF	Containerized Network Function
COTS	Commercial Off-The-Shelf
CPU	Central Processing Unit
CU	Centralized Unit
DAS	Distributed Antenna System
DSS	Dynamic Spectrum Sharing
DU	Distributed Unit
eASIC	enhanced Application-Specific Integrated Circuit
eMBB	enhanced Mobile Broadband
EMS	Element Management System
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
FH	Fronthaul
FPGA	Field-Programmable Gate Array
gNB	Next generation NodeB
GPP	General Purpose Processor
GPS	Global Positioning System
GPU	Graphics Processing Unit
HW	Hardware
IoT	Internet of Things
IOT	Inter-Operability Testing
IPSec	Internet Protocol Security

K8s	Kubernetes
LTE-M	Long Term Evolution for Machines
MIMO	Multiple Input Multiple Output
ML	Machine Learning
MOCN	Multi-Operator Core Network
MORAN	Multi-Operator Radio Access Network
MoU	Memorandum of Understanding
M-Plane	Management Plane
MTBF	Mean Time Between Failures
NB-IoT	Narrow Band Internet of Things
Near-RT	Near-Real-Time
NF	Network Function
Non-RT	Non-Real-Time
NSA	Non-Stand Alone
O-Cloud	Open Cloud
O-CU	Open Centralized Unit
O-DU	Open Distributed Unit
OFH	Open Fronthaul
ONAP	Open Network Automation Platform
O-RAN	Open Radio Access Network
OSS	Operations Support Systems
PTP	Precision Time Protocol
QoE	Quality of Experience
QoS	Quality of Service
RAN	Radio Access Network
rApp	non-real-time intelligence Application
RIC	Radio Access Network Intelligent Controller
RRM	Radio Resource Management
RRU	Remote Radio Unit
RU	Radio Unit
SA	Stand Alone
SMO	Service Management and Orchestration

SON	Self-Organizing Network
SW	Software
SyncE	Synchronous Ethernet
TM Forum	TeleManagement Forum
TRX	Transceiver
UL	Uplink
vRAN	virtualized Radio Access Network
xApp	near-real-time intelligence Application