***5G RAN***

5G RAN is the latest architecture in wireless communication and uses 5G radio frequencies to provide wireless connectivity to devices. A radio access network (RAN) is a key component of a mobile telecommunication system that connects devices like smartphones to a network via a radio link. This is achieved by converting voice and data into digital signals and transmitting them as radio waves to RAN transceivers, which then forward them onto the core network. From the core network, the data can be sent to the internet. RANs perform intense, complex processing.

**5G Open RAN Network Architecture Components**

<https://www.techplayon.com/5g-open-ran-network-architecture-components/>

[**Open RAN**](http://www.techplayon.com/open-ran-o-ran-reference-architecture/) network architecture is needed to address the specific needs of different mobile operators around the world, and it is expected that vendors will interoperate to create customized Open RAN solutions to meet these requirements. The following graphic shows the 4G RAN and core network as compared to the 5G RAN and core.

Diagram

Description automatically generated

The 5G NR with respect to 3GPP Release 15 and later, the specifications require the RAN to become disaggregated grouping of functional elements. The gNB which is a 5G base station, is comprised of following functional units:

#

Diagram

Description automatically generated

**Open Radio Unit (O-RU):** Open Radio Unit (O-RU) which comprises the RF chain, to transmit or receive the over-the-air signal and provide corresponding transformation of the analog radio signal and the digital signals. It connects through the fronthaul to Open Distributed Unit (O-DU). The details on reference architecture for O-RU is available here.

**Open Distributed Unit (O-DU):** The Open Distributed Unit (O-DU) which handles the lower layers of the baseband processing up through the PDCP layer of the protocol stack. In legacy RAN systems, this runs on a proprietary vendors hardware, but today’s software are capable to run on COTS hardware, allows this function to be virtualized. Since it is virtualized, this gives flexibility in terms of placing the processes at different locations which may include the cell site, far edge locations and/or the centralized locations. These functional layer splits are defined in the 3GPP specifications and their placement is selected based on type of transport network (fibre, microwave etc.) available to the cell sites. The details on reference architecture for O-DU is available here.

**Open Centralized Unit (O-CU):** Open Centralized Unit (O-CU) handles all higher layer functions of the protocol stack from PDCP and functions such as the functions of RRC, PDCP, SDAP, X2-U, F1-U, NG-U, S1-U, X2AP (X2-C), F1AP (F1-C), NGAP (NG-C), S1AP (S1-C) and OAM. O-CU software shall be capable to run on X86/ARM processors.

**Open RAN (O-RAN) Reference Architecture**

The O-RAN Reference Architecture is designed to enable next generation RAN infrastructures. It is designed with the principles of intelligence and openness, the O-RAN architecture is the foundation for building the virtualized RAN on open hardware, with embedded AI-powered radio control, that has been envisioned by operators around the globe.

The architecture is based on well-defined, standardized interfaces to enable an open, inter-operable supply chain ecosystem in full support of and complimentary to standards promoted by 3GPP and other industry standards organizations.

Timeline

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Orchestration/NMS layer with Non Real Time RAN Intelligent Controller

Non-RT control functionality (> 1s) and near-Real Time (near-RT) control functions(<1s) are decoupled in the RIC. Non-RT functions include service and policy management, RAN analytics and model-training for the near-RT RAN functionality. Trained models and real-time control functions produced in the RIC non-RT are distributed to the RIC near-RT for runtime execution.

O-RAN specification defined an A1 interface between Orchestration/NMS layer with RIC non-RT and eNB/gNB containing RIC near-RT.

Network management applications in non-RT RIC receives and act on highly reliable data from the modular Control Unit (CU) and Distributed Unit (DU) in a standardized format over A1 Interface.

AI-enabled policies and ML-based models generated messages in RIC non-RT and conveyed to RIC near-RT.

The core algorithm of non-RT RIC is owned and deployed by network operators

This algorithms provides the capability to modify the RAN behaviors based by deployment of different models optimized to individual operator policies and optimization objectives

RAN Intelligent Controller (RIC) near-Real Time function layer

The O-RAN reference architecture provides next generation RRM with embedded intelligence,while optionally accommodating legacy RRM. This resides within the RIC Near RT function layer. The RIC near-RT is completely compatible with legacy RRM and its design is started to enhancing the operational challenging functions such as per-UE controlled load-balancing, RB management, interference detection and mitigation.

This layer has following functions

It provides new functions leveraging embedded intelligence,such as QoS management, connectivity management and seamless handover control.

The RIC near-RT delivers a robust, secure, and scalable platform that allows for flexible on-boarding of third-party control-applications.

RIC near-RT functions leverages a database called the Radio-Network Information Base (R-NIB) which captures the near real-time state of the underlying network

It feeds various RAN measurements data, to the near-RT RIC to facilitate radio resource management

It also provides initiate configuration commands to CU/DU.

The near-RT RIC can be provided by traditional TEMs or 3rd-party players

RIC near-RT receives an AI model from RIC non-RT and execute it to change the functional behavior of the network

Interface Reference Points (A1 & E2)

A1, as described above, is the interface between non-RT RIC and modular CU which contains near-RT RIC.

E2 is a standard interface between the near-RT RIC and CU/DU in the context of an O-RAN architecture.

Multi-RAT CU protocol stack Function

The function of the Multi-RAT protocol stack supports 4G, 5G and other protocol processing.

The basic functions of the protocol stack are implemented according to the control commands issued by the near-RT RIC module e.g. handovers

Multi-RAT CU function shall be deployed on virtualization platform

This virtualization provides a highly-efficient execution environment for CU and near-RT RIC, with the ability to distribute capacity across multiple network elements with security isolation, virtual resource allocation, accelerator resource encapsulation, etc. benefits

The current architecture is using existing interface definitions for F1/E1/X2/Xn provided by 3GPP

This interfaces can be enhanced to support inter operation among multi-vendors and the CU provided by TEMs offer a regional CP and UP anchor for DUs

DU and RRU Function

The DU and RRU function includes real-time L2 functions, base band processing and radio frequency processing

The interface between the DU and the RRU provides standard function segmentation, including the DU-RRU lower layer split interface (Open front-haul Interface), and the CU-DU higher layer split interface (F1), which ensures inter-operability between different TEMs