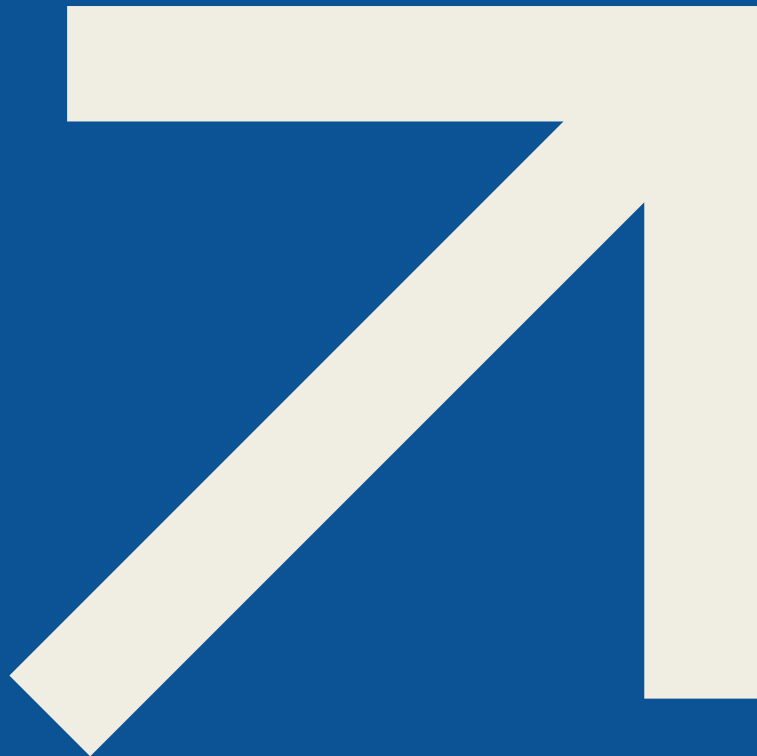


O-RAN Class Week 2

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O-RAN Architecture

Open Radio Access Network (Open RAN) is transforming the way mobile networks are built and operated. It centers on the principles of

- Disaggregation
- Open interfaces

Fostering a multi-vendor ecosystem, and paving the way for greater innovation and flexibility. This contrasts with traditional RANs, which often rely on proprietary hardware and software from a single vendor.

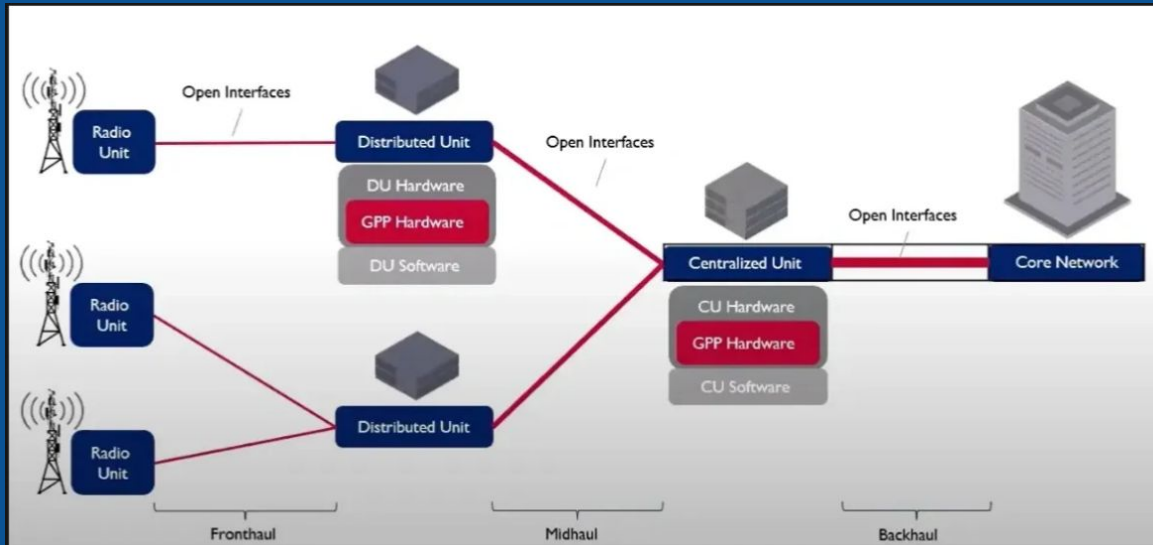


Image Source:
<https://www.asiaopenranacademy.org/about/what-is-open-ran/>

Disaggregation

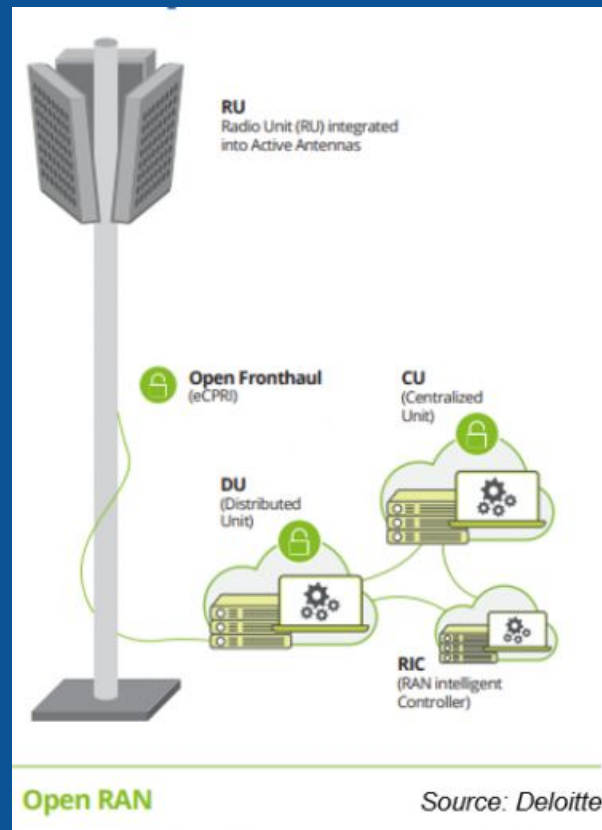
Disaggregation enables flexibility, cost-efficiency, and innovation by separating hardware and software components of the RAN. This allows:

- Multi-vendor interoperability through open interfaces and Independent scaling of CU, DU, and RU based on network demands
- Deployment agility—components can be distributed geographically or cloud-hosted
- Reduced vendor lock-in and increased competition leading to Faster innovation via modular upgrades (e.g., just update software in DU or CU)



Disaggregation

- **Radio Unit (RU)**
The RU is responsible for the radio frequency (RF) aspects of the network. It transmits, receives, amplifies, and digitizes radio signals. RUs are typically located near or integrated into the antennas.
- **Distributed Unit (DU)**
The DU handles the real-time baseband processing functions like encoding/decoding and modulation/demodulation. Executes parts of the physical layer (PHY), MAC (Media Access Control), and RLC (Radio Link Control) layers. The DU can be located at the cell site, near the RU, or further away.
- **Centralized Unit (CU)**
Centralized Resource Handling, serving multiple DUs, providing centralized decision-making and optimization. The CU manages the higher-layer protocols of the radio network. Also handles Control Plane Management and can even be deployed in a cloud environment.



SMO (Service Management and Orchestration)

Enables intelligent automation, configuration, monitoring, and orchestration of RAN functions.

Main Components

- **SMO Framework:** The overall control platform. The O-RAN defines interfaces to enable interoperability between the SMO, RAN functional entities and applications
- **Non-RT RIC (R1):** Non-Real-Time RAN Intelligent Controller for handling AI/ML-driven policy and optimization functions (time scale >1s).
- **External Data Source:** Provides enrichment data (e.g., weather, location, customer insights) to help optimize RAN decisions.

Benefits of SMO

- Vendor-neutral and open ecosystem.
- Supports zero-touch provisioning.
- Enables network slicing and intelligent service assurance.
- Drives down OPEX through automation

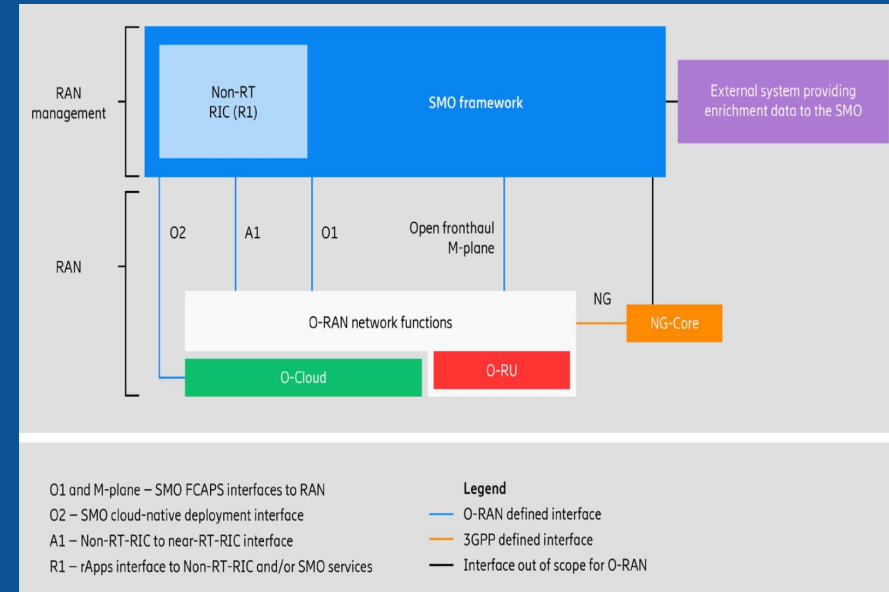
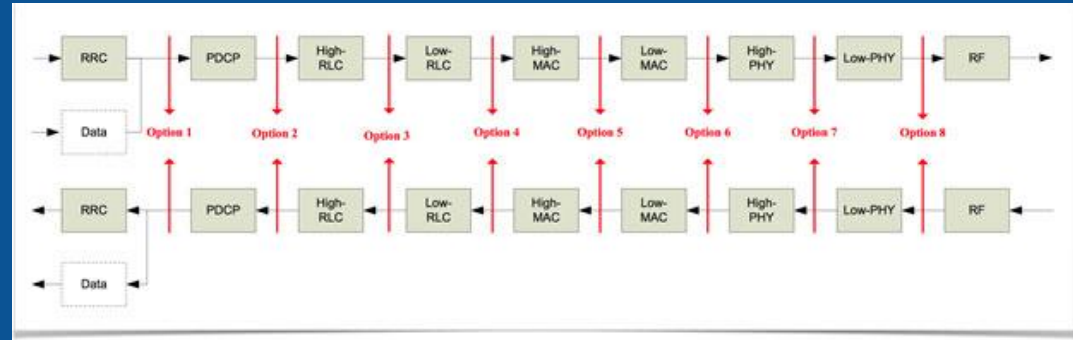


Image Source:

<https://www.ericsson.com/en/reports-and-papers/white-papers/smo-enabling-intelligent-ran-operations>

Functional Splits

- Refers to how network functions are divided between the DU, CU, and RU.
- There are varying ways to split (low-level vs high-level) that each have their own benefits.
- Lower-level splits, where more functions are in the RU, requires higher bandwidth for the Fronthaul (the interface for the RU and DU) and has stricter latency requirements.
- Higher-level splits, where more functions are in the DU or CU and requirements for fronthaul bandwidth are reduced.



Control and User Planes

- 5G introduced CUPS: Control(C-Plane) & User Plane(U-Plane) Separation.
- In Open RAN, the CU is split into the CU-UP and the CU-CP (Central Unit Control/User Plane).
- Control plane manages connections, user mobility, and enforces network protocols.
- User plane handles sending and receiving of user data, data encryption, and ensures quality of service(QoS).

Control Plane

- Open RAN Fronthaul packet scheduling commands for both Downlink and Uplink data transfers
- Beamforming commands

User Plane

- DL and UL IQ Data in FFT Frequency Domain
- PRACH IQ Data in Uplink

Image Source:

<https://moniem-tech.com/2022/05/05/what-are-c-u-m-s-fronthaul-fh-planes-in-5g/>

Control and User Planes

Why CUPS is useful in Open RAN

- Independent Scaling: Can grow the U-Plane or C-Plane depending on demand.
- Flexibility: U-Plane can be deployed closer to users to reduce latency.
- Efficiency and Reliability: Better use of network resources can help lower costs, and if one part goes down the other can continue to run.

Control Plane

- Open RAN Fronthaul packet scheduling commands for both Downlink and Uplink data transfers
- Beamforming commands

User Plane

- DL and UL IQ Data in FFT Frequency Domain
- PRACH IQ Data in Uplink

Image Source:

<https://moniem-tech.com/2022/05/05/what-are-c-u-m-s-fronthaul-fh-planes-in-ora/>

Logical Interfaces

- In O-RAN the logical interfaces ensures interoperability, flexibility, and openness.
- Logical interfaces are protocol-defined connections that can be Implemented over different kinds of medium.

Interface	Purpose
A1	Policy, ML model management
E2	Real-time control & monitoring
E1	Control/User plane separation
F1	CU/DU split for flexible deployment
Open FH	Fronthaul; splits low/high PHY
X2/Xn/NG	Mobility, bearer management

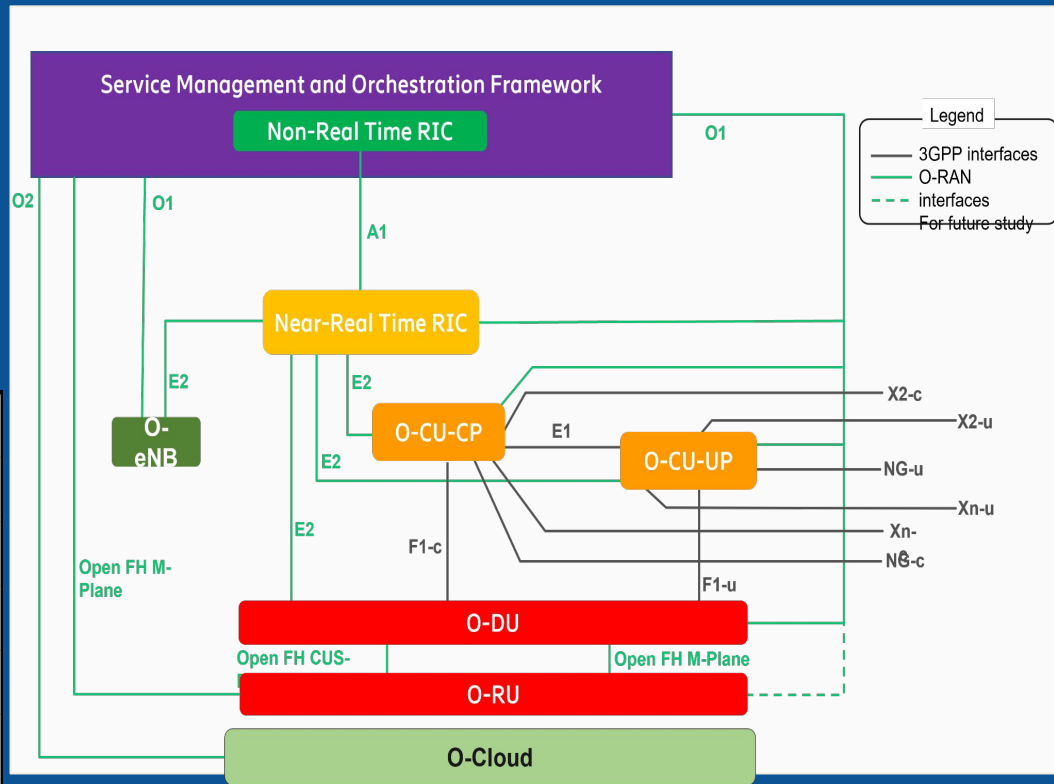


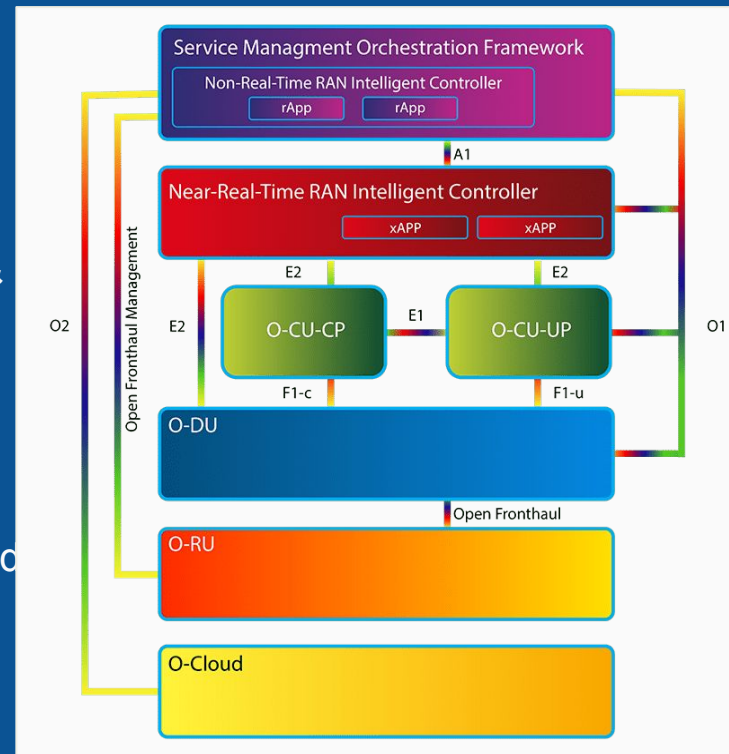
Image Source:

<https://docs.o-ran-sc.org/en/latest/architecture/architecture.html>

Coming in week 3

The Importance of Open Interfaces

- The critical role of open and standardized interfaces for interoperability.
- Introduction to key Open RAN interfaces: Open Fronthaul & Midhaul.
- The O-RAN Alliance specifications for open interfaces and their impact.
- Benefits of open interfaces: Vendor diversity, innovation, and cost reduction.



Thank you!

Questions?
