Optimization and Intelligence through AI

Allows to run xApps

Orchestration of the RAN

O-RAN SC RIC
(Near-Real-time RIC)

https://github.com/srsran/oran-sc-ric/

E2

Access and Mobility Management

Session Management Function

Control Plane

Distribution Unit

User Plane

Central Unit

srsRAN Project
(gNodeB
5G-Base Station)

https://github.com/srsran/srsRAN_Project

srsRAN Project
(5G Core Network)

NG-C/NG-U

https://github.com/srsran/srsRAN_Project

Policy Control Function

User Plane Funciton

Uu (RF/NR-LTE protocols)

LTE/5G Protocol stack behavior

Software Defined LTE

srsRAN_4G
(UE
User Equipment)

https://github.com/srsran/srsran_4g

O-CU-UP

O-CU-CP

Service Data Adaptation Protocol
Handles 5G user data by assigning it to the right radio bearer based on its priority and service requirements.
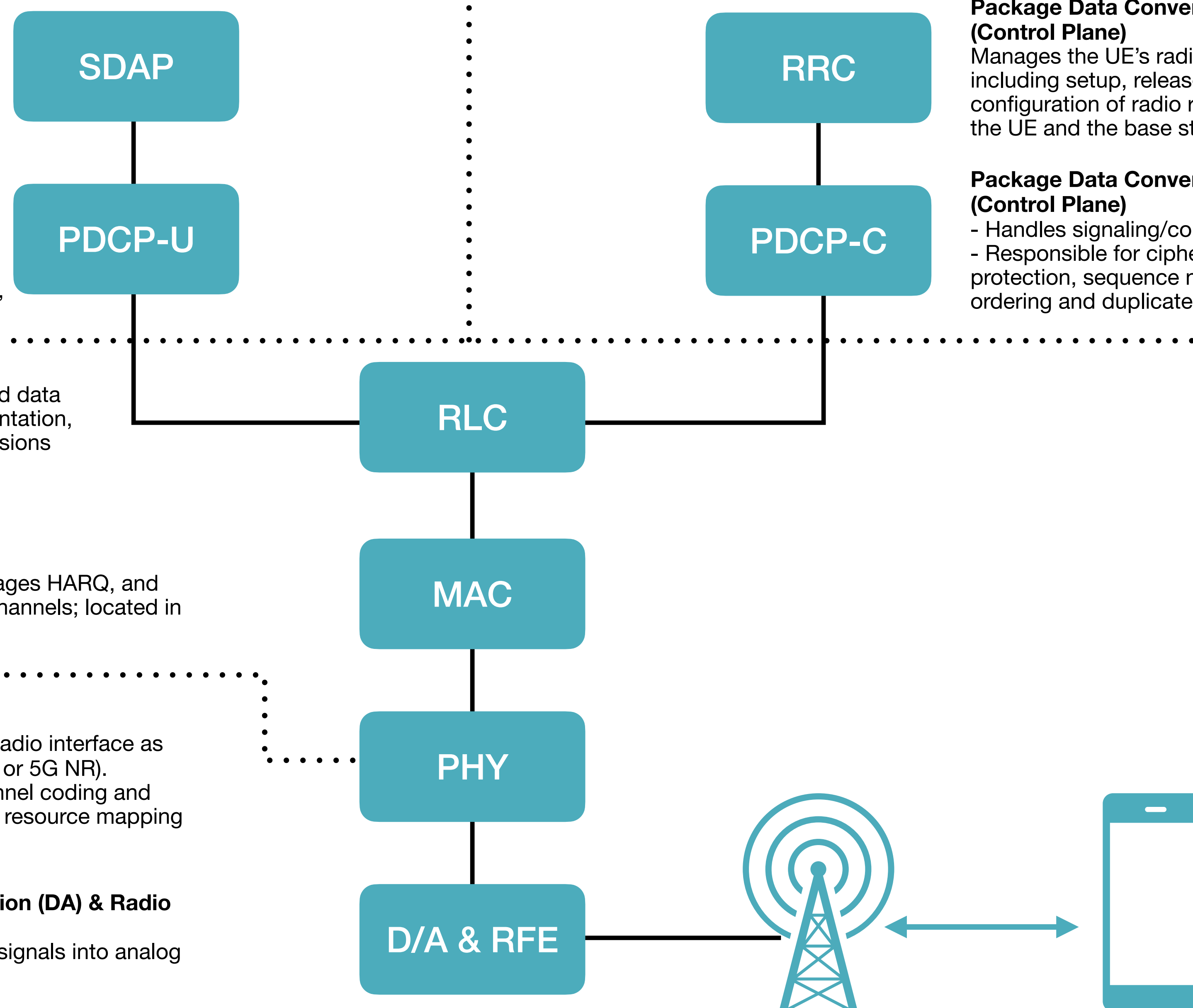
SDAP

RRC

Package Data Convergence (Control Plane)
Manages the UE's radio connection, including setup, release, mobility, and configuration of radio resources between the UE and the base station.

Package Data Convergence (User Plane)
- Handles user data traffic (e.g., Internet, apps, media)
- performs tasks such as header compression, ciphering, sequence numbering and reordering, and duplicate detection.

PDCP-U

PDCP-C

Package Data Convergence (Control Plane)
- Handles signaling/controlling messages
- Responsible for ciphering and integrity protection, sequence numbering and ordering and duplicate detection

O-DU

Radio Link Control
Ensures reliable and ordered data delivery by handling segmentation, reassembly, and retransmissions between PDCP and MAC.

RLC

Medium Access Control
Schedules resources, manages HARQ, and maps logical to transport channels; located in the O-DU in O-RAN.

MAC

O-RU

Physical Layer
- Implements the physical radio interface as defined by 3GPP (e.g., LTE or 5G NR).
- Handles modulation, channel coding and decoding, HARQ, MIMO or resource mapping

PHY

Digital-to Analog conversion (DA) & Radio Frequency Equipment
Converts digital baseband signals into analog RF signals

D/A & RFE

Scope: Standardized Radio Access technologies across generations (2G, 3G, 4G, 5G)

Responsibilities: Defines protocol stacks (PHY, MAC, RLC, PDCP, RRC, NAS, SDAP), interfaces (N2, N3, E1, F1), UE categories, QoS, signaling, and base station behavior (gNB/eNB) with the core network.

3GPP (3rd Generation Partnership Project)

- **Scope:** Specifies open, disaggregated RAN architectures and interfaces for multi-vendor interoperability.

- **Responsibilities:**
  - Defines functional splits (O-CU-CP, O-CU-UP, O-DU, O-RU).
  - Specifies E2, A1, and open fronthaul interfaces.
  - Defines Near-RT RIC and control loops.

O-RAN Alliance

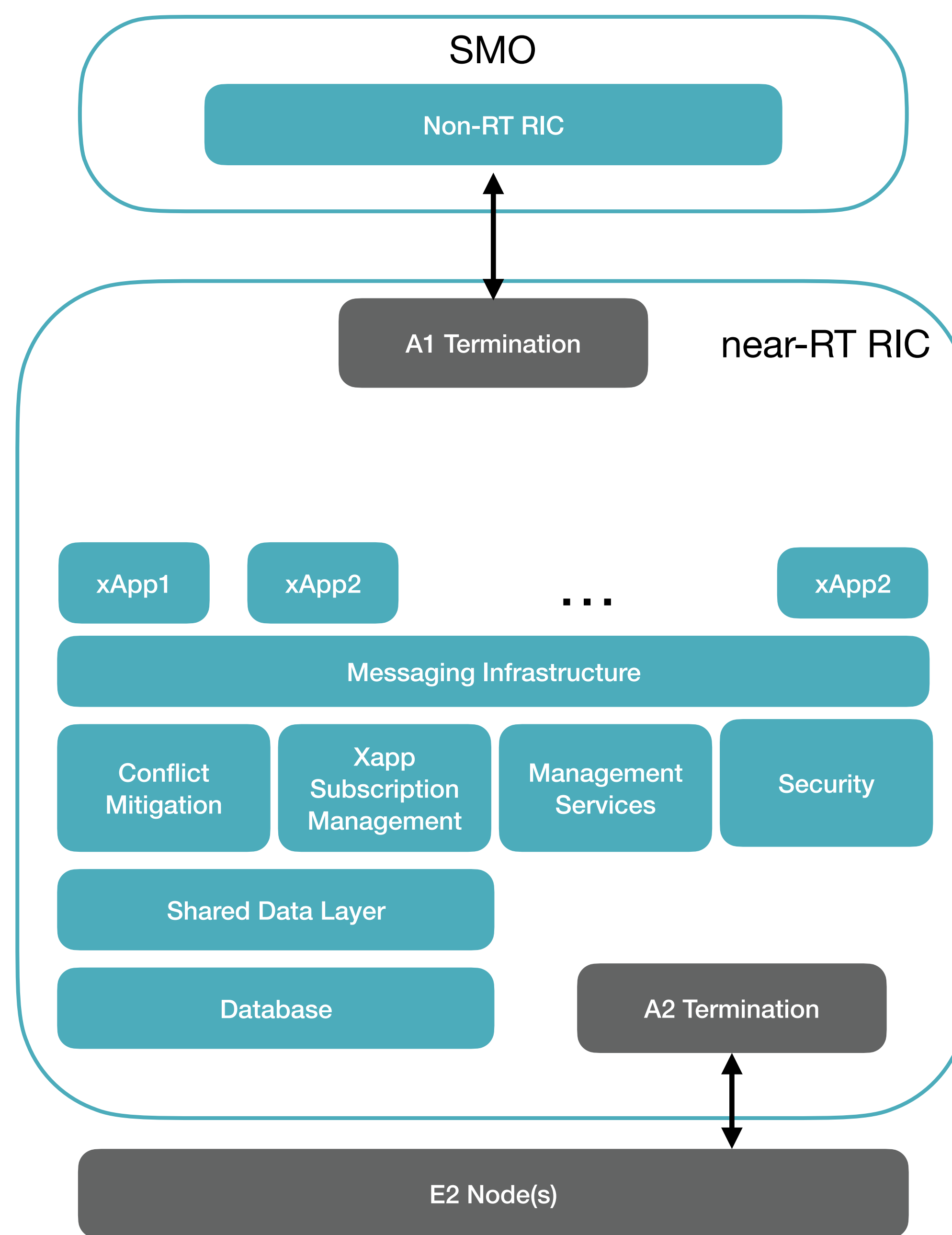**Scope:** Focuses on software-defined RAN controllers and orchestration.

Responsibilities:
- Provides software platforms to control and manage disaggregated RAN elements.
- Implements policy-driven automation, network slicing, and optimization.
- Interfaces with O-RAN components via standard interfaces.

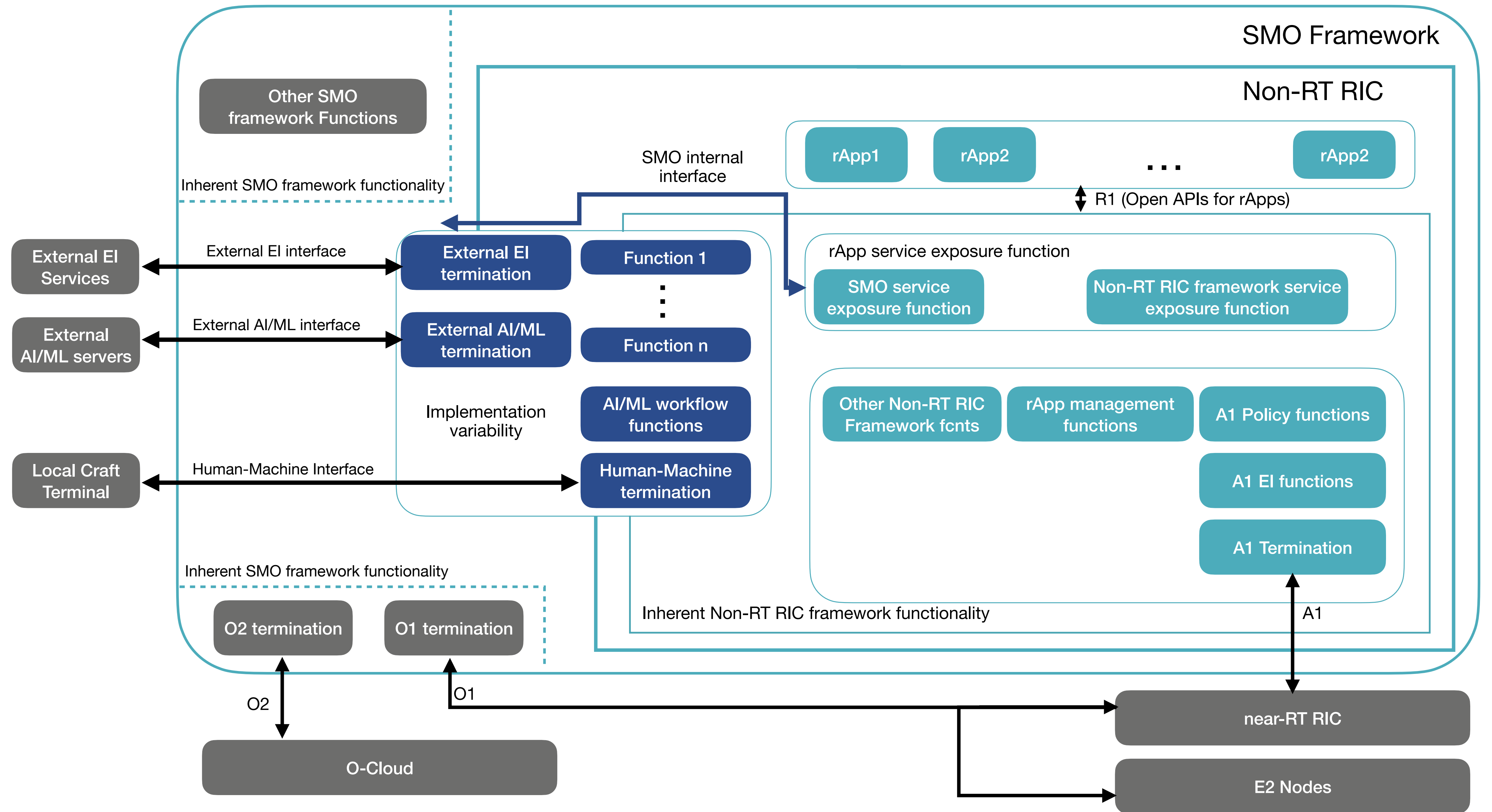**ONF SD-RAN**

Scope: Physical deployment of RAN components and networking infrastructure.

Responsibilities:
- Supply radio units (O-RU), antennas, fiber fronthaul/backhaul, and data centers.
- Ensure site installation, power, cooling, and maintenance.
- integrate O-RAN and 3GPP components into a working network.

Telecom Infra

SMO

Non-RT RIC

A1 Termination

near-RT RIC

xApp1   xApp2   . . .   xApp2

Messaging Infrastructure

Conflict Mitigation | Xapp Subscription Management | Management Services | Security

Shared Data Layer

Database   A2 Termination

E2 Node(s)

SMO Framework

Non-RT RIC

Other SMO framework Functions

Inherent SMO framework functionality

SMO internal interface

rApp1   rApp2   ...   rApp2

R1 (Open APIs for rApps)

External EI Services

External EI interface

External EI termination   Function 1

rApp service exposure function

SMO service exposure function   Non-RT RIC framework service exposure function

External AI/ML servers

External AI/ML interface

External AI/ML termination   Function n

Implementation variability   AI/ML workflow functions

Other Non-RT RIC Framework fcnts   rApp management functions   A1 Policy functions

A1 EI functions

Local Craft Terminal

Human-Machine Interface

Human-Machine termination

A1 Termination

Inherent SMO framework functionality

Inherent Non-RT RIC framework functionality

A1

O2 termination   O1 termination

O2   O1

near-RT RIC

O-Cloud

E2 Nodes

1.

Conventional Base Station
Combined RF + BB

2.

RRH
CPRI
BBU

Mobile Front-haul Network
Separated RRH and BBU

3.
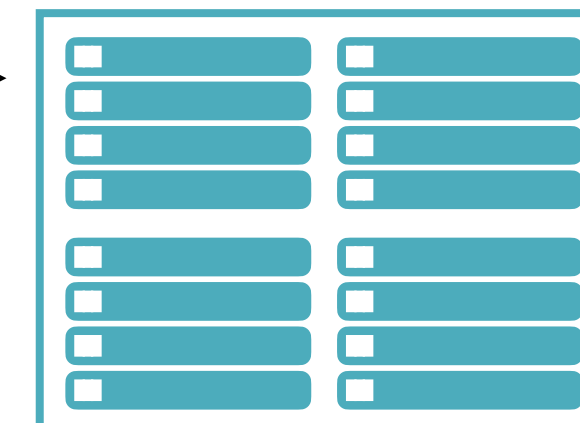

RRH
CPRI

RRH
CPRI

BBU Pool

Centralized RAN
Multiple BBUS Combined to Pools (often virtualized)

4.

Fronthaul
DU
Far Edge Data Center

Midhaul
CU
Edge Data Center

Backhaul
Mobile Core

Remote Radio Head

DU/RU   CU

Downlink

RF | LOW PHY | HIGH PHY | LOW MAC | HIGH MAC | LOW RLC | HIGH RLC | PDCP | RRC

DATA

Downlink

RF | LOW PHY | HIGH PHY | LOW MAC | HIGH MAC | LOW RLC | HIGH RLC | PDCP | RRC

DATA