tsdsi Telecommunications Standards Development Society, India

Open RAN India 2021 Virtual Conference on 17th June 2021

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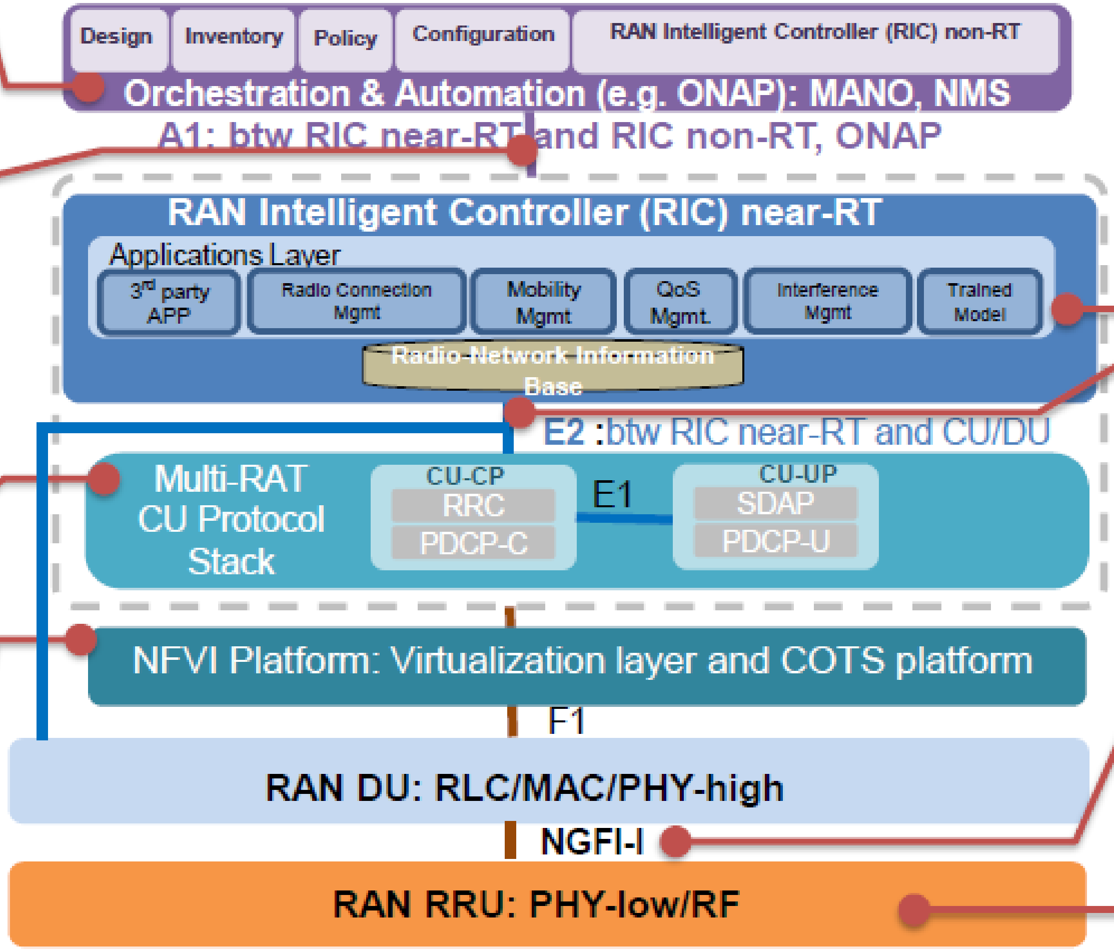
O-RAN Alliance - Introduction

WG1: Use cases & Overall architecture
Focus on all identifying use cases and requirements, and planning overall architecture of O-RAN and Proof-of-Concepts

WG2: RIC(non-RT) & A1 interface
Specify AI enabled RIC(non-RT) functionality for the operational supervision, radio optimization ; Specify the interface btw RIC(non-RT) NMS and Modular CU SW, based on AI. Focus on A1 interface to deliver non-RT data feeds for training AI models as well as to deploy new models in the near-RT RIC



WG3: RIC(near-RT) & E2 Interface
Specify RIC(near-RT) open architecture, functionality, Radio-Network Information Base and Network Topology, modular on boarding to new Control Applications; Specify E2 interface between RIC(near-RT) and CU/DU stack

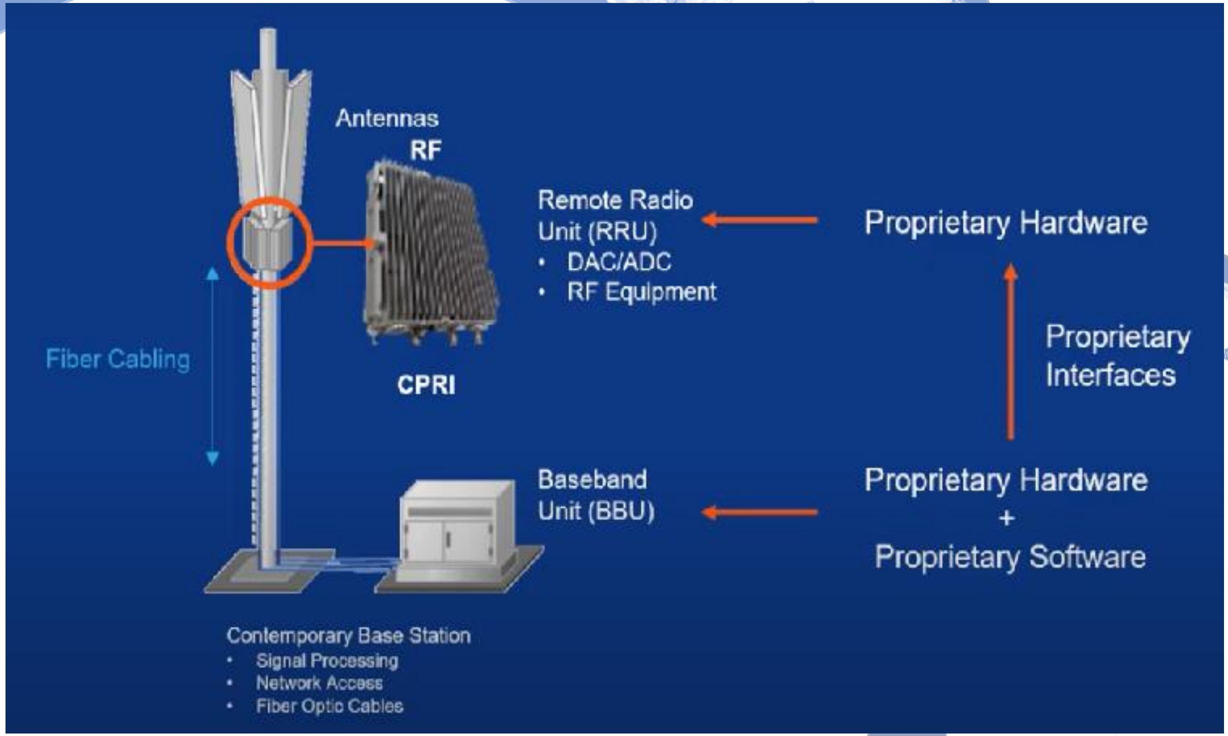
WG5: Stack Reference Design and E1 & F1/V1 Interfaces
Focus on design of Open CU, RAN virtualization and splits with related interfaces that intersect with 3GPP (E1 & F1/V1).

WG4: Open FH Interface
Specify open front-haul interface(NGFI-I) btw DU and AAU (supporting both LTE and 5G NR implementations), based on C-RAN, xRAN and DOCOMO's work (IEEE 1914, eCPRI, CPRI)

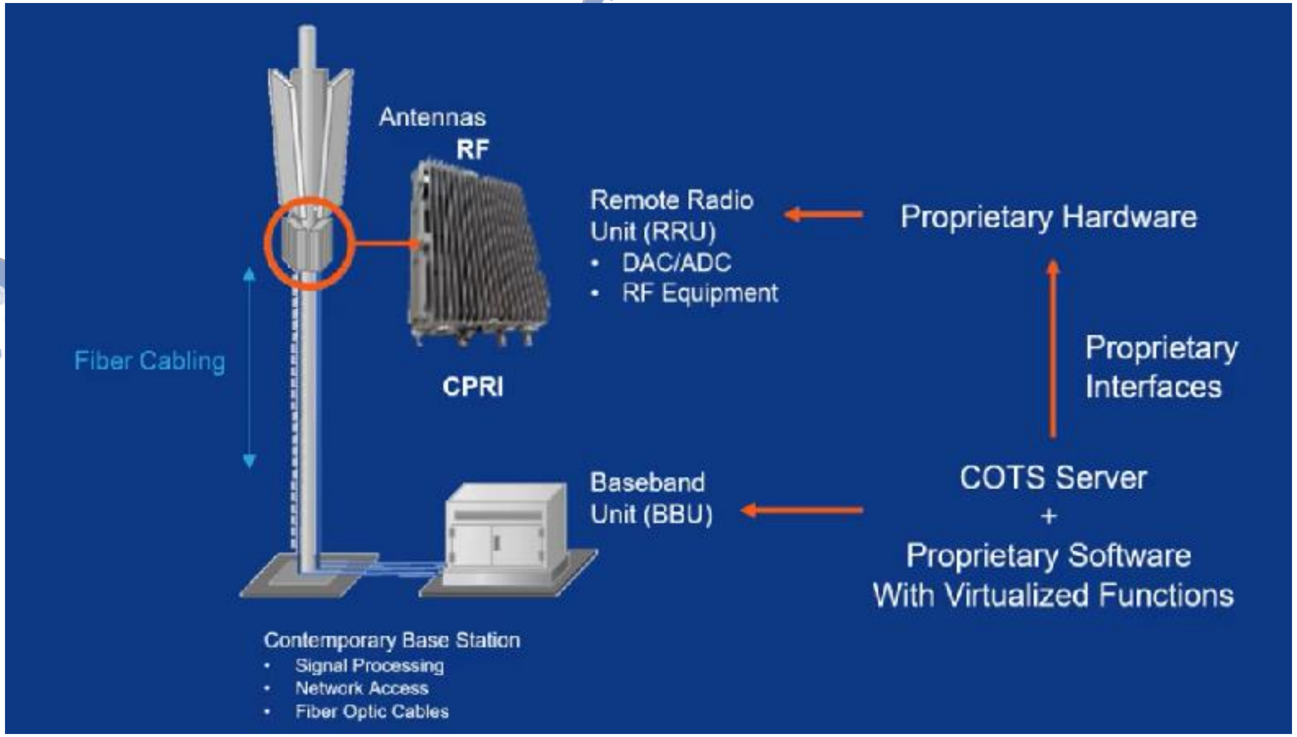
WG6: Cloudification and MANO Enhancement
Focus on specifying virtualization layer and HW, decoupling VNF and NFVI and MANO Enhancement (specially expansion of IFA5/IFA6/IFA7 interface)

WG7: White-Box Hardware
Focus on Reference Design of AAU or DU/AAU

Virtualized RAN ≠ O-RAN

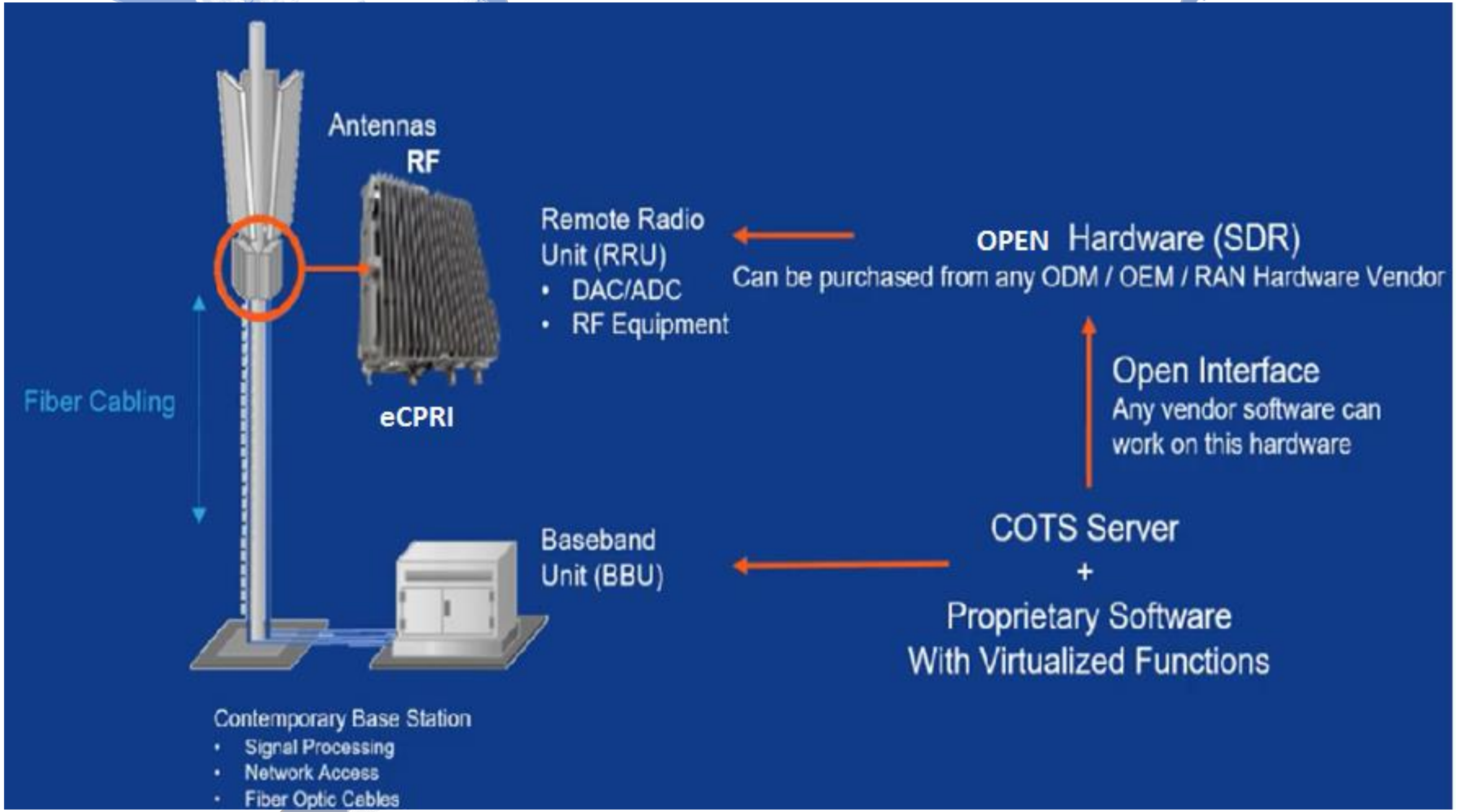


Traditional RAN



Virtualized RAN

O-RAN (Open RAN from O-RAN Alliance)



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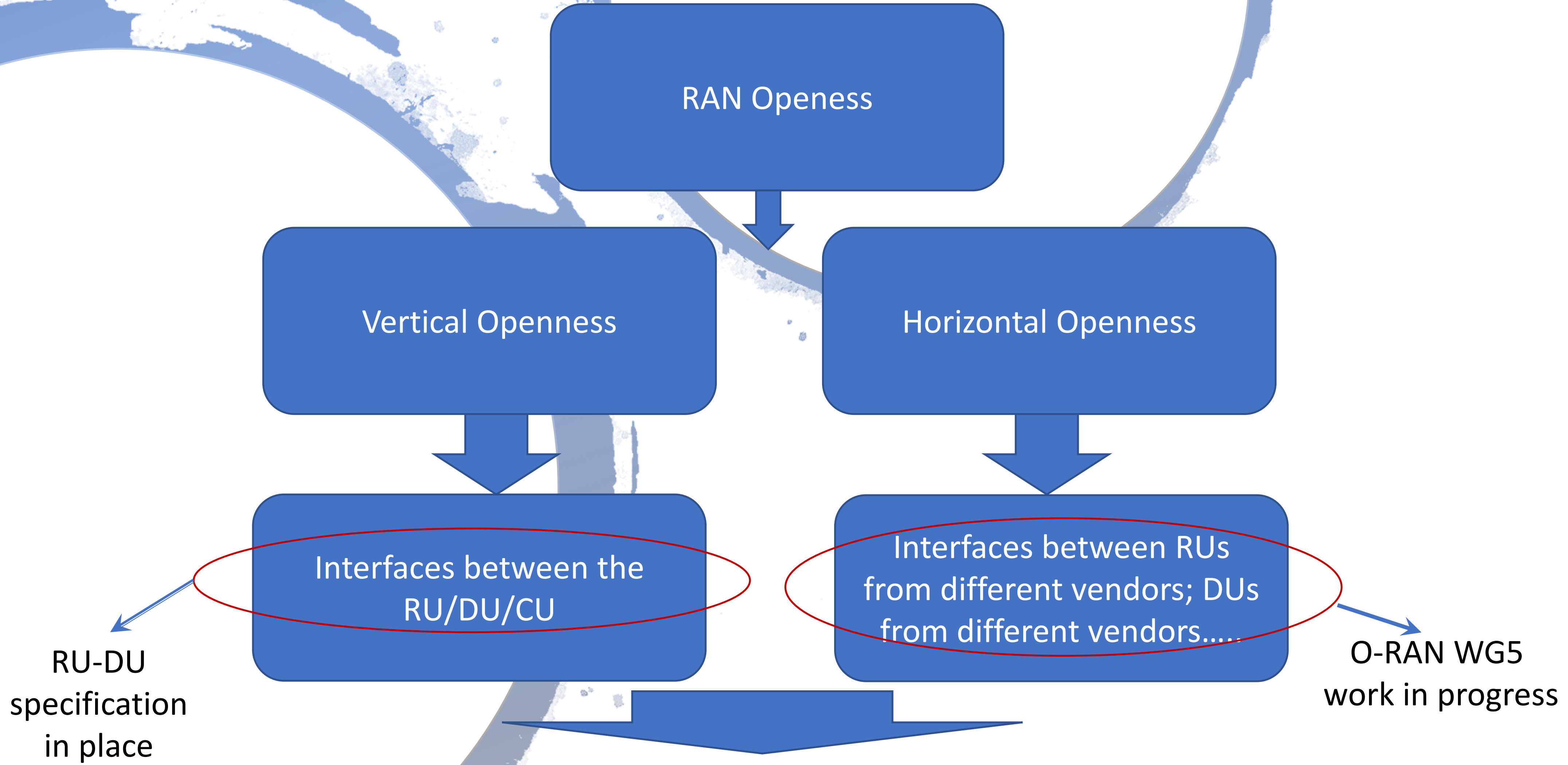
What is Openness?

Openness – is it all?



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Interoperability is a serious issue, Closed by design or closed by cartels?

Lets define RAN openness:

"Openness" should be defined along flexible service Enhancements.

Openness:

1. Operation efficiency (System level management)
2. Service innovation and enhancement flexibility

Disaggregation is often confused with openness, disaggregation is inevitable and does help.

Openness are all about designing "tight" interfaces between nodes so that multi vendor systems interop without any plugfests

Example 1: X2 interface ("Vendor Information Element (IE)"

Example 2: XRAN Categories / eCPRI-ROE

In the DL, Split Option 7-2x implements functions up to resource element mapping in the O-DU and supports both an O-RU that implements digital BF and later functions (Category A O-RU) and an O-RU that implements the above in combination with precoding (Category B O-RU). Here, Category A O-RU, which is easy to deploy, is expected to be the O-RU implementation of choice in 5G initial deployment. On the fronthaul an IQ sampling sequence of the OFDM signal in the frequency domain for each MIMO spatial stream (Category A O-RU) or each MIMO layer (Category B O-RU) will be transmitted. There is no need to transmit

→ Interoperability issues

TIFG and OTIC – to ensure interoperability

Addressing Interoperability

Interoperability is key to the success of both initiatives and a third element: Open Test and Integration Center (OTIC) has been launched. This aims to validate activities between disaggregated 5G access infrastructure providers, according to the O-RAN specifications.

O-RAN - TIFG - Test & Integration Focus Group

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The example of the Massive MIMO Gain Saturation

Openness is supposed to enable plug and play

Massive MIMO trials with 64T 64R has not shown much gains when compared to 4T4R LTE deployments

The Reasons are the following:

1. Use of the Right Precoders at the eNB?
2. New Beam forming algorithms?

Operators should have the provision to “ADD” algorithms for performance improvement.

Open Interfaces between AFE, DFE (RU and the DU)

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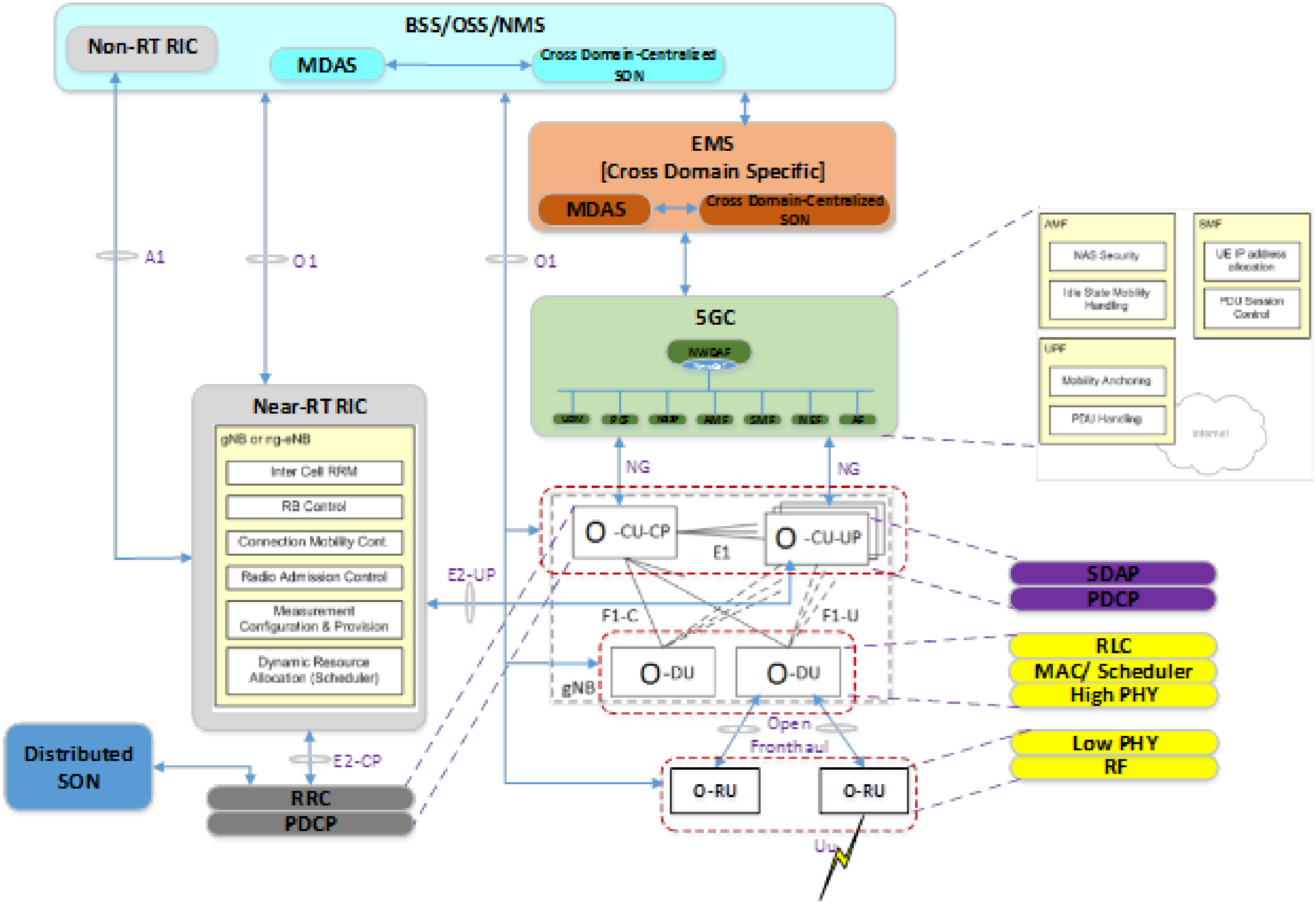
Along Comes the RIC



5G Network Architecture with oRAN Architecture recommendations.

SON, NWDAF, (MDAF) -> OAM, EMS, NMS,

RIC (Near Realtime, Non Real Time), RRM

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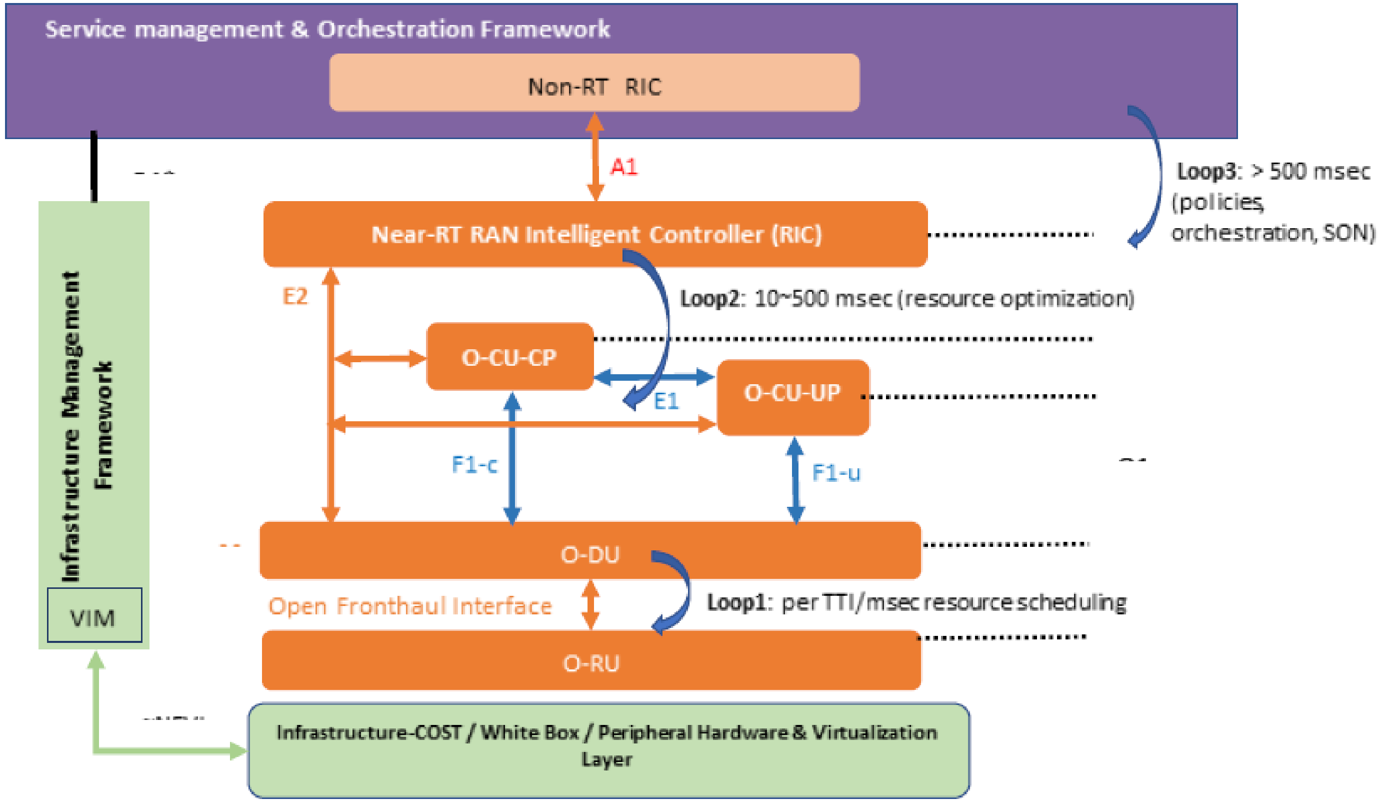
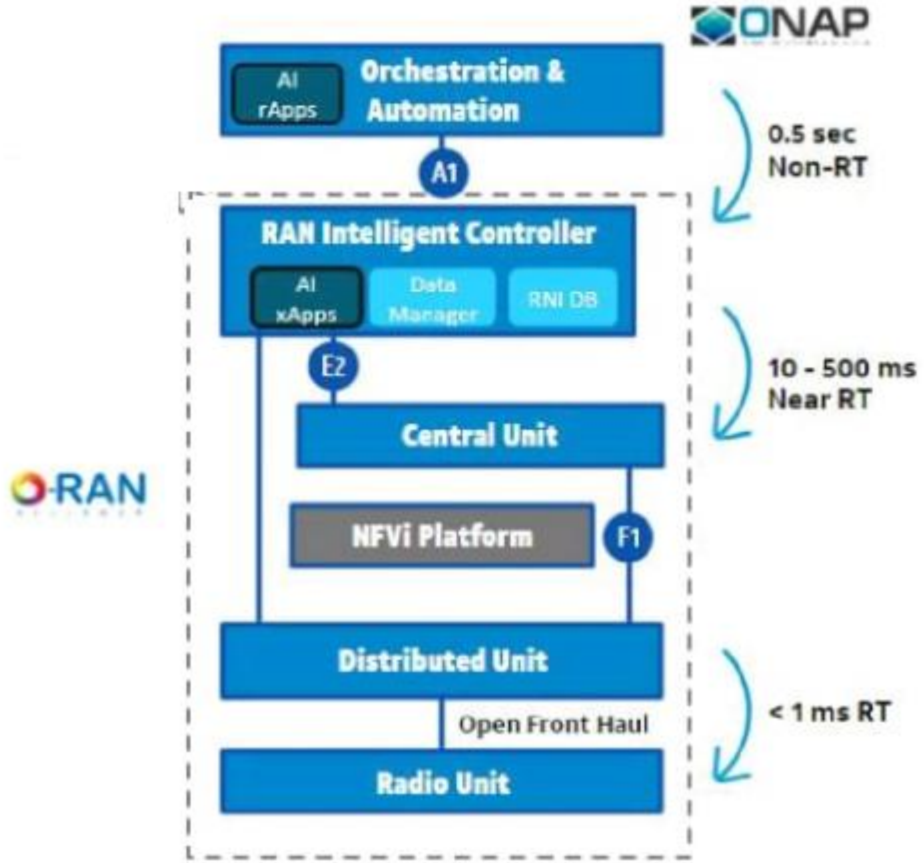
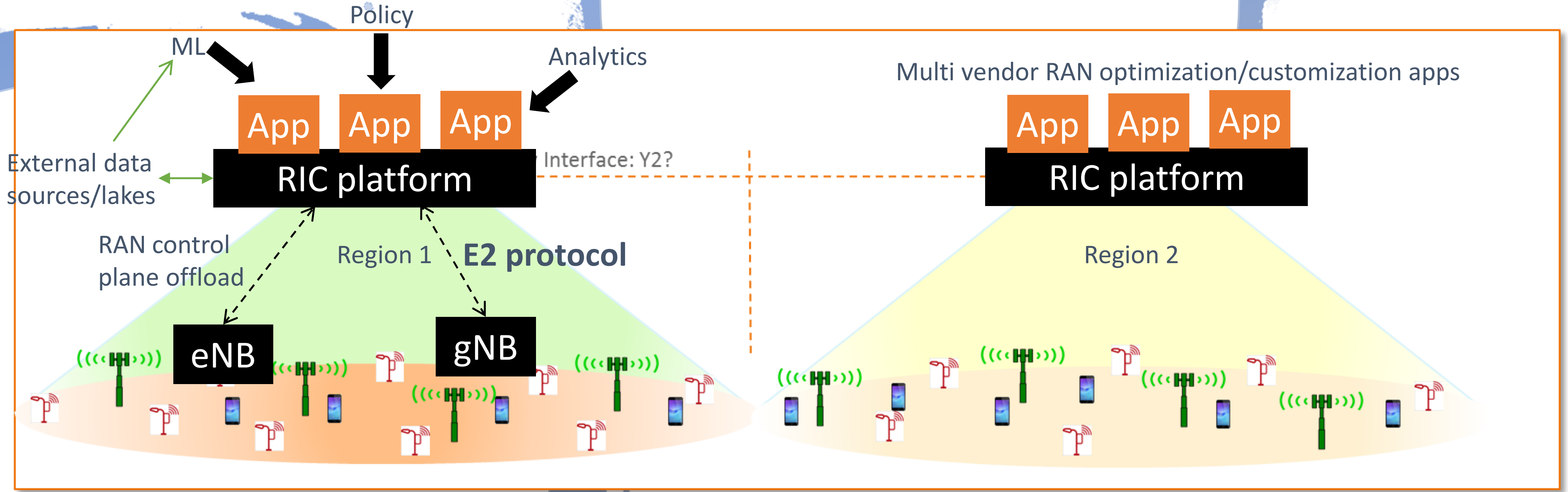
O-RAN RAN Intelligent Controller (RIC)





O-RAN – What is RIC

Objective: customize RAN functionality for regional resource optimization or new services



What? Area-wide data and controls

- UE/cell/DU/CU level L1/L2/L3 measurements
- UE locations and predicted trajectory
- UE context info(video, voice, non-GBR data)
- Per-UE policy-driven control of band/cell/bearer selection, admission control, handover, scheduler

Why? Customize RAN with short time-to-market for:

- **Efficient resource usage** – improve customer experience and optimize spectral efficiency by using policies/ML to tailor RAN for unique spectrum position and geography based on holistic area-wide network view
- **New RAN services** – customize RAN behavior for the needs of specific verticals. E.g., create RAN slices for drones, connected cars, IoT, etc.

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RIC Should solve Serious use cases – ex: SON

SON Brief Introduction

SON solutions can be divided into three categories: Self-Configuration, Self-Optimization and Self-Healing. The SON architecture can be a centralized, distributed or a hybrid solution.

- **SELF-CONFIGURATION**
  - This is the dynamic plug-and-play configuration of newly deployed eNBs/gNBs. The eNB/gNB will by itself configure the Physical Cell Identity, transmission frequency and power, leading to faster cell planning and rollout.
- **SELF-OPTIMISATION**
  - Functions for self-optimization are mainly included in Release 9. It includes optimization of coverage, capacity, handover and interference.
  - Mobility load balancing (MLB) is a function where cells suffering congestion can transfer load to other cells, which have spare resources. MLB includes load reporting between eNBs to exchange information about load level and available capacity.
- **SELF-HEALING**
  - Features for automatic detection and removal of failures and automatic adjustment of parameters. Coverage and Capacity Optimization and Minimization of drive tests (MDT) enables automatic correction of capacity problems depending on slowly changing environment.

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RIC Should solve Serious use cases – ex: SON

SON Brief Introduction

SON solutions can be divided into three categories: Self-Configuration, Self-Optimization and Self-Healing. The SON architecture can be a centralized, distributed or a hybrid solution.

- **Centralized SON**
  - Centralized SON (C-SON) means that the SON algorithm executes in the 3GPP management system.
- **Distributed SON**
  - Distributed SON (D-SON) means the SON algorithms are in the NFs. The NFs monitors the network events, analyses the network data, makes decisions on the SON actions and executes the SON actions in the network nodes.
- **SON Coordination**
  - This will coordinate multiple SON functions when they attempt to change some (same or associated) network configuration parameters that may conflict the overall operator KPIs. This will maintain system level objectives based on operator policies.

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RIC Should solve Serious use cases – ex: SON

SON function list for implementation in the O-RAN Architecture

- PCI initial allocation and conflict resolution
- ANR (Automatic neighbor relations)
- Mobility load balancing (MLB) – Traffic Steering
- Mobility robustness optimization (MRO)
- Coverage and Capacity Optimization (Power Optimization)

- RACH optimization
- Inter Cell Interference Mitigation
- Minimization of drive tests (MDT)
- Energy savings
- Cell outage (Sleeping cell, sick cell detection)
- Tracking Area optimization (Core network based)

SON Use case for RIC

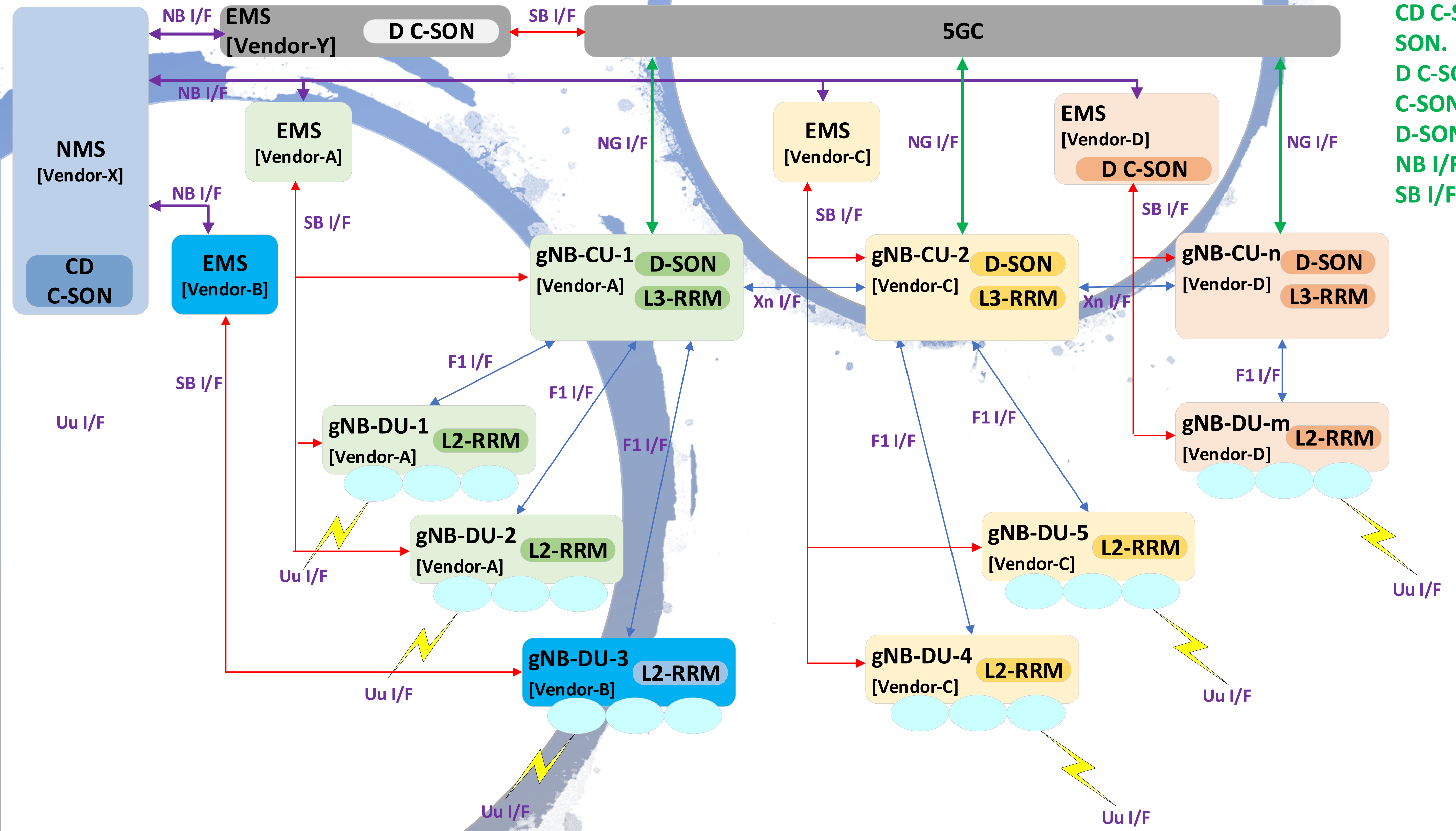
Issues with conventional SON implementation

Conventional SON implementations have serious interoperability / interworking issues (3GPP SON is left to implementation). We list a few of these issues with conventional SON implementation (Refer to Figure 1):

- If gNBs are from different vendors
  - D-SON of gNB-CU-1 and gNB-CU-2 may have interoperability issues (Xn interface).
  - D-SON of gNB-CU-2 and the Hybrid SON of gNB-CU-n [D-SON + D C-SON] may have multi vendor interoperability across Xn interface.
  - C-SON can be realized as either collocated with management entities [Like EMS/NMS] or as a standalone entity. Integrating the C-SON as a standalone entity with RAN nodes will be a nightmare. Cross Domain C-SON in the NMS may impact the performance of the Domain C-SON and D-SON functionalities, operating in the Multivendor environment.

- From our LTE deployment experience:
  - Integrating the 3rd party SON solutions partially in the HetNet, leads to degradation of the overall KPIs.
  - Serious GAPs exists in L3-RRM coordination across the neighbor gNB-CUs irrespective of the Same or Multivendor deployment scenarios, This impacts the overall KPI.
  - L3-RRM and L2-RRM coordination across the Multi-vendor gNB-CU and gNB-DU will have impact on the dynamic resource sharing and allocation.

Reference Figure 1



CD C-SON : Cross Domain C-SON.
D C-SON : Domain C-SON.
C-SON : Centralized SON.
D-SON : Distributed SON.
NB I/F : North Bound I/F.
SB I/F : South Bound I/F.

SON Use case for RIC

Further Motivation:

- If we look at the existing O-RAN use cases, we find that they are isolated applications and will require a holistic view for viable implementation.
  - As an example: For "Traffic steering" it must be noted that the objectives are the same as MLB (Mobility Load Balancing). MLB considers both cell level and per UE level statistics for load balancing.
  - Any viable implementation of traffic steering will have to consider ANR, Mobility robustness optimization (MRO), Coverage and Capacity Optimization, Frequent HO (FHO) etc.

- In view of the serious interoperability issues in a conventional SON implementation, SON is the best usecase for RIC.

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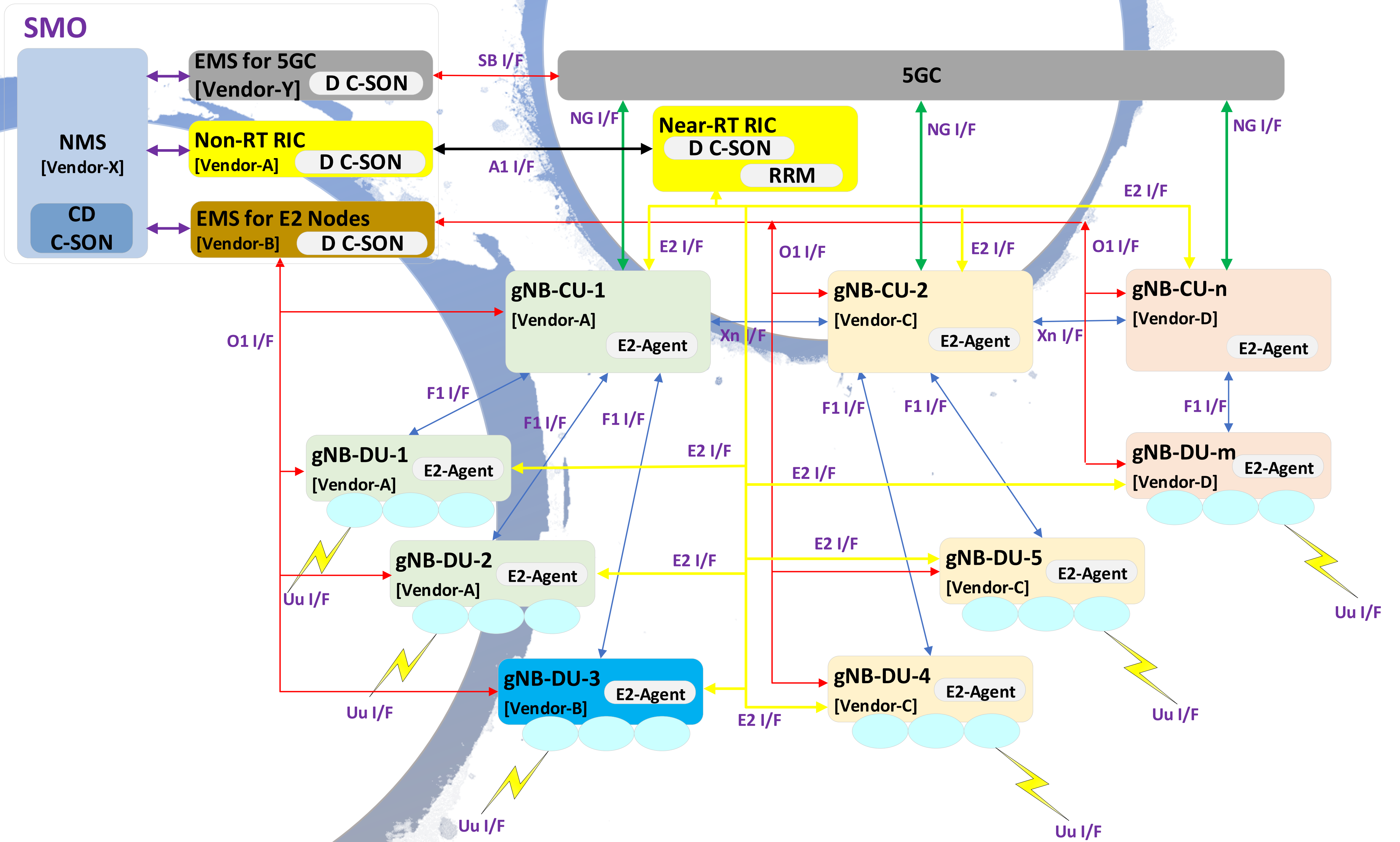
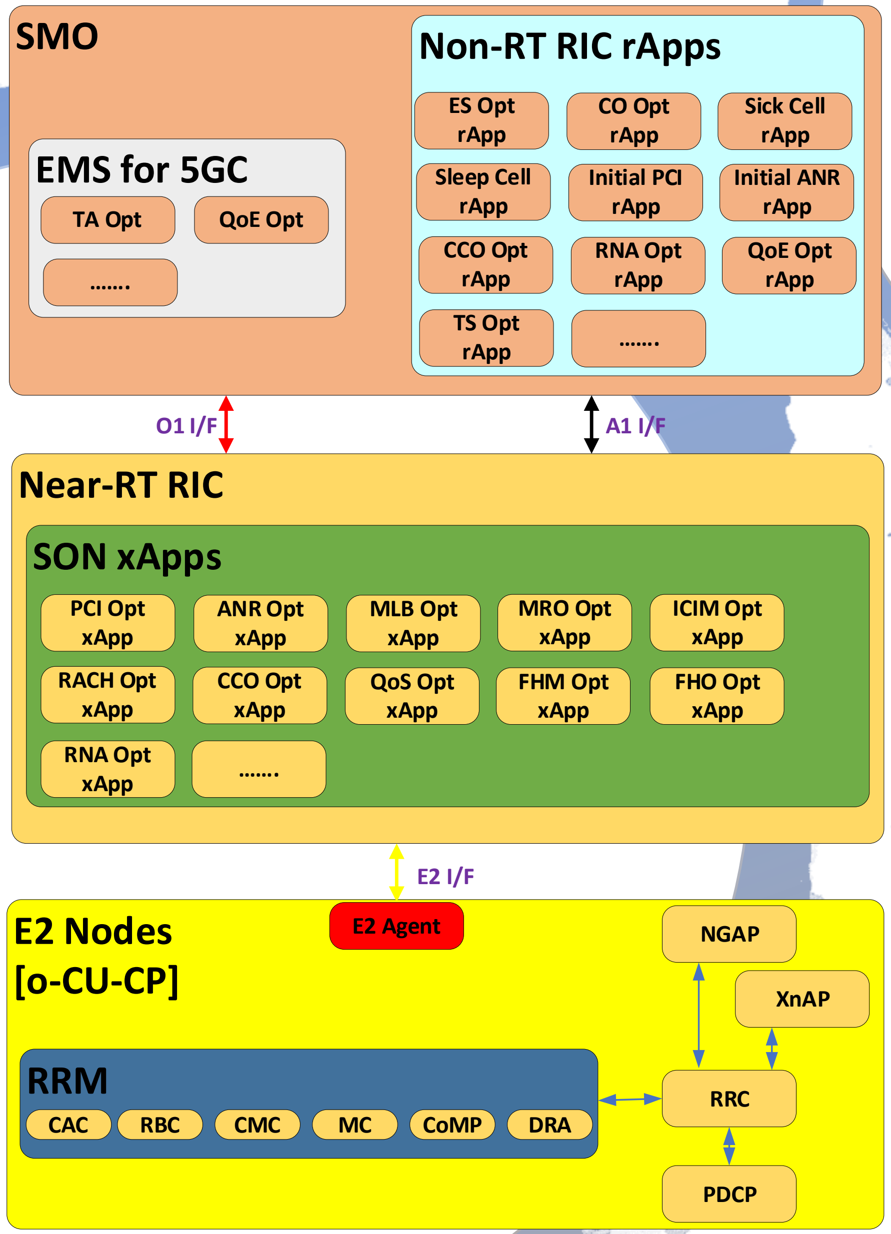
SON Use case in the RIC framework



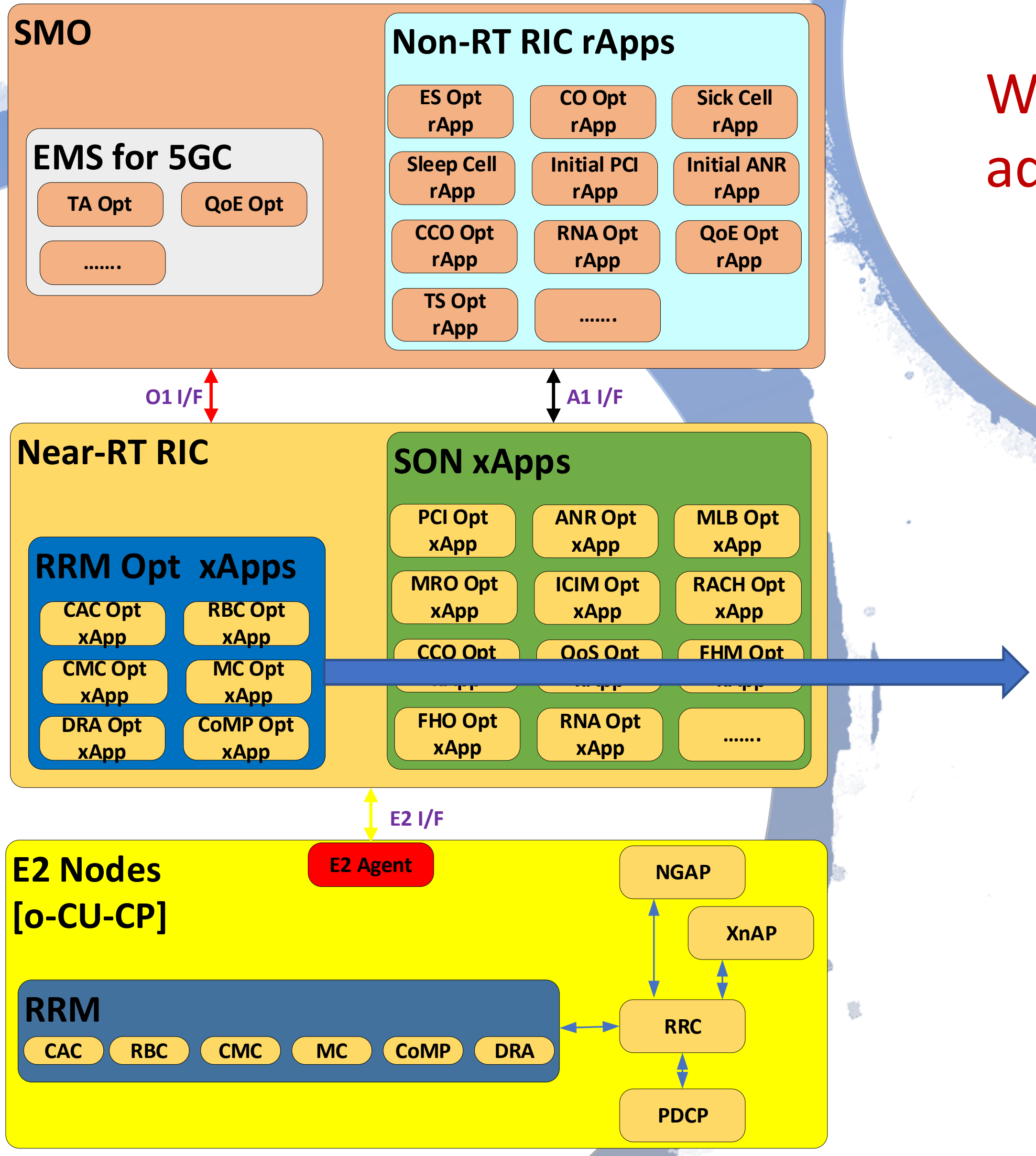
SON Use case in the RIC framework – Option 1



With SON functions implemented in RIC

- ES : Energy Saving.
- CO : Cell Outage.
- PCI : Physical Layer Cell Identity.
- ANR : Automatic Neighbor Cell Relations.
- CCO : Coverage and Capacity Optimization.
- RNA : RAN based Notification Area.
- QoE : Quality of Experience.
- TS : Traffic Steering.
- MLB : Mobility Load Balancing.
- MRO : Mobility Robustness Optimization.
- ICIM : Inter-Cell Interference Mitigation.
- RACH : Random Access Channel.
- QoS : Quality of Service.
- FHM : Frequent Handover Mitigation.
- FHO : Forward Handover.

SON Use case in the RIC framework – Option 2



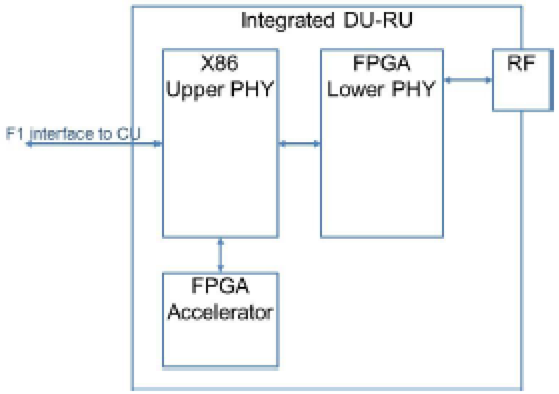
With SON functions implemented in RIC with additional RRM optimization support

The RRM Optimization xApp can be used to optimize the following RRM functions in the E2 node.

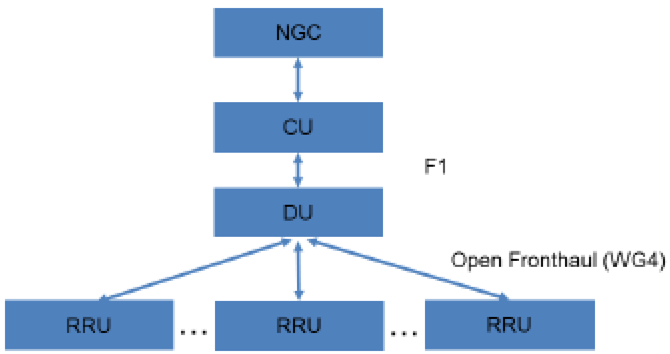
- CAC : Call Admission Control.
- RBC : Radio Bearer Control.
- CMC : Connection Mobility Control.
- DRA : Dynamic Resource Allocation.

O-RAN - White Box Hardware

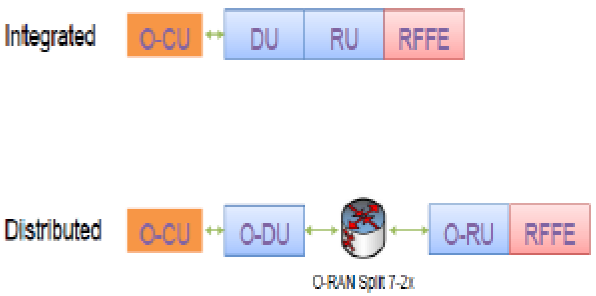
- AT&T Approach (both integrated and non-integrated)



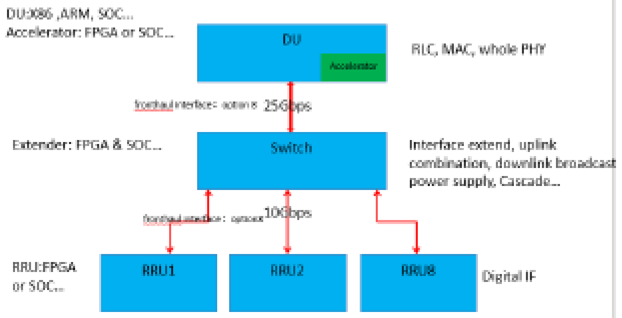
- Sprint Approach



- Intel Approach



- CMCC Approach (Split 8)



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5G NR – Is GPU the way to go

As 5G workloads become more complex, and data variety and volume explode, multiple chip architectures become a strategic key to 5G success.

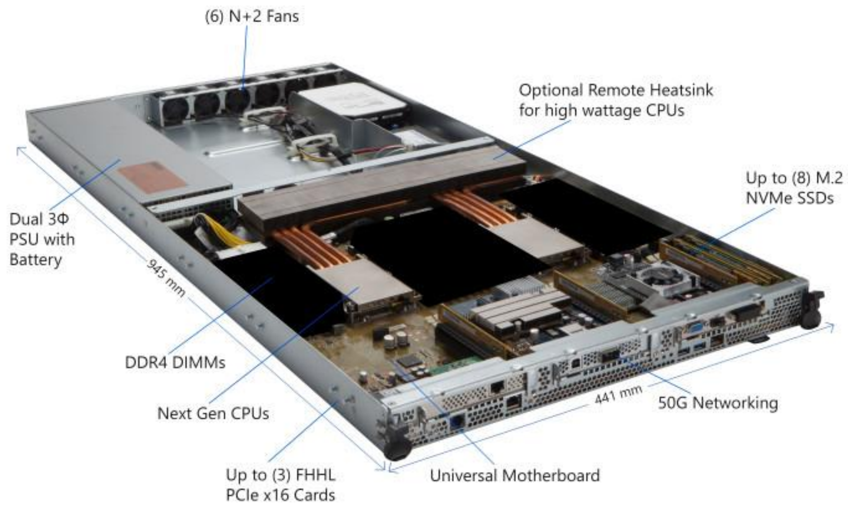
Processor and chipset manufacturers are already coupling GPU and CPU for optimal RAM management, speed, cost and performance management.

Features/ Attributes	**GPU**	**CPU**
Computing Capability	High	Low
Core complexity	Simple	Composite
Number of Cores	100 to 4000	4 to 30
Performance	Built for parallel computing, ideal for ML	Built to perform sequential operations.
Graphics rendering	1 to 2 milliseconds/ image (even lesser)	1 to 5 seconds/image
Core efficiency	1 to 5 Tera-Flops	100 to 500 Giga-Flops

Open Hardware - OCP / Open 19

The trend towards more open IT systems has accelerated, driven by lower costs and operational efficiency. Collaborative industry initiatives to drive this are the Open Compute Project (OCP) and Open19

Can well serve the needs of the 5G DU , CU and the 5G Core compute needs



The Big Questions

- O-RAN has to address all the aspects of Openness
- OPEN White Box Hardware is critical for O-RAN success BUT some way to go
- Openness from a service deployment / serious use case enablement is an issue

Thank You

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