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5G RAN optimization using the O-RAN software community's RIC (RAN Intelligent Controller)

ONS Europe, Sep-23-2019

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1. **Near-RT RIC within the O-RAN alliance architecture**
2. xApps
3. RICP – near-RT RIC platform as open-source project
4. E2 concepts
5. E2 messages
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7. RIC components

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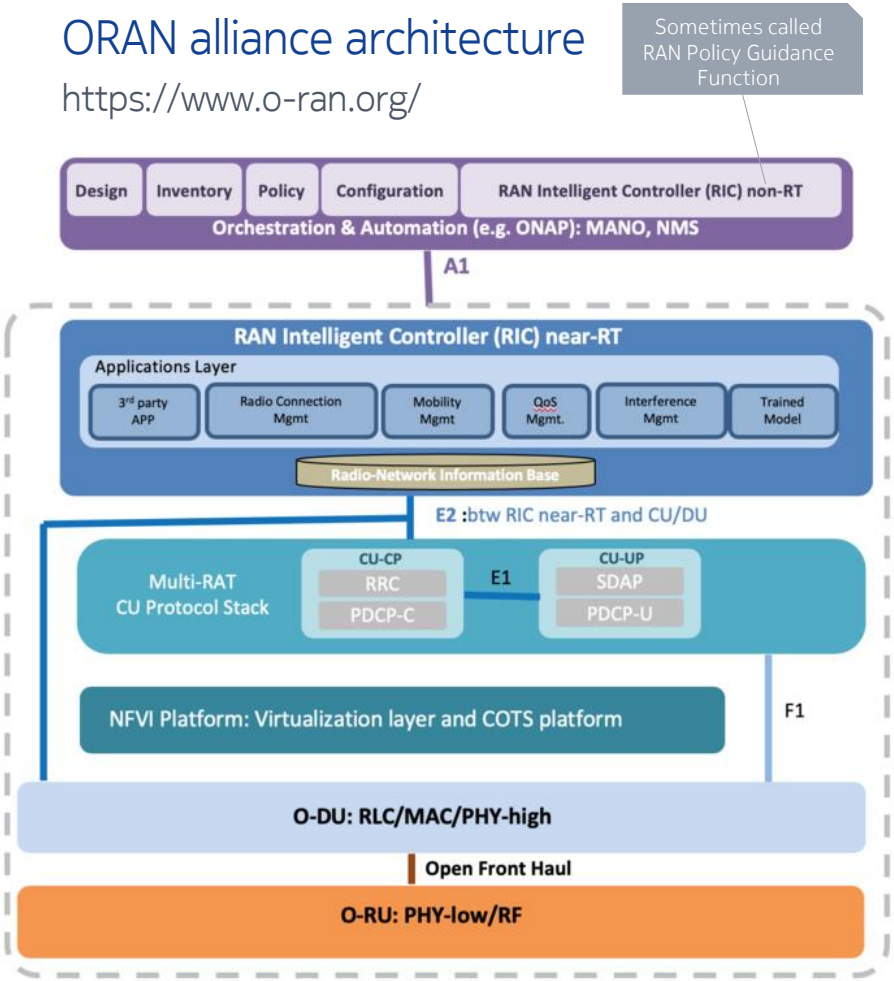
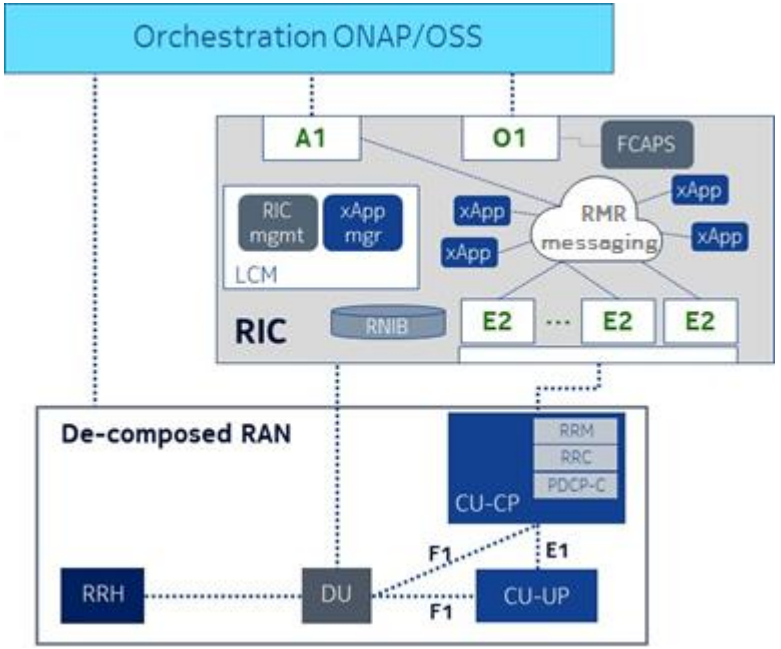
ORAN alliance architecture

https://www.o-ran.org/



ORAN software community architecture for near-RT RIC (this slideset just uses "RIC")



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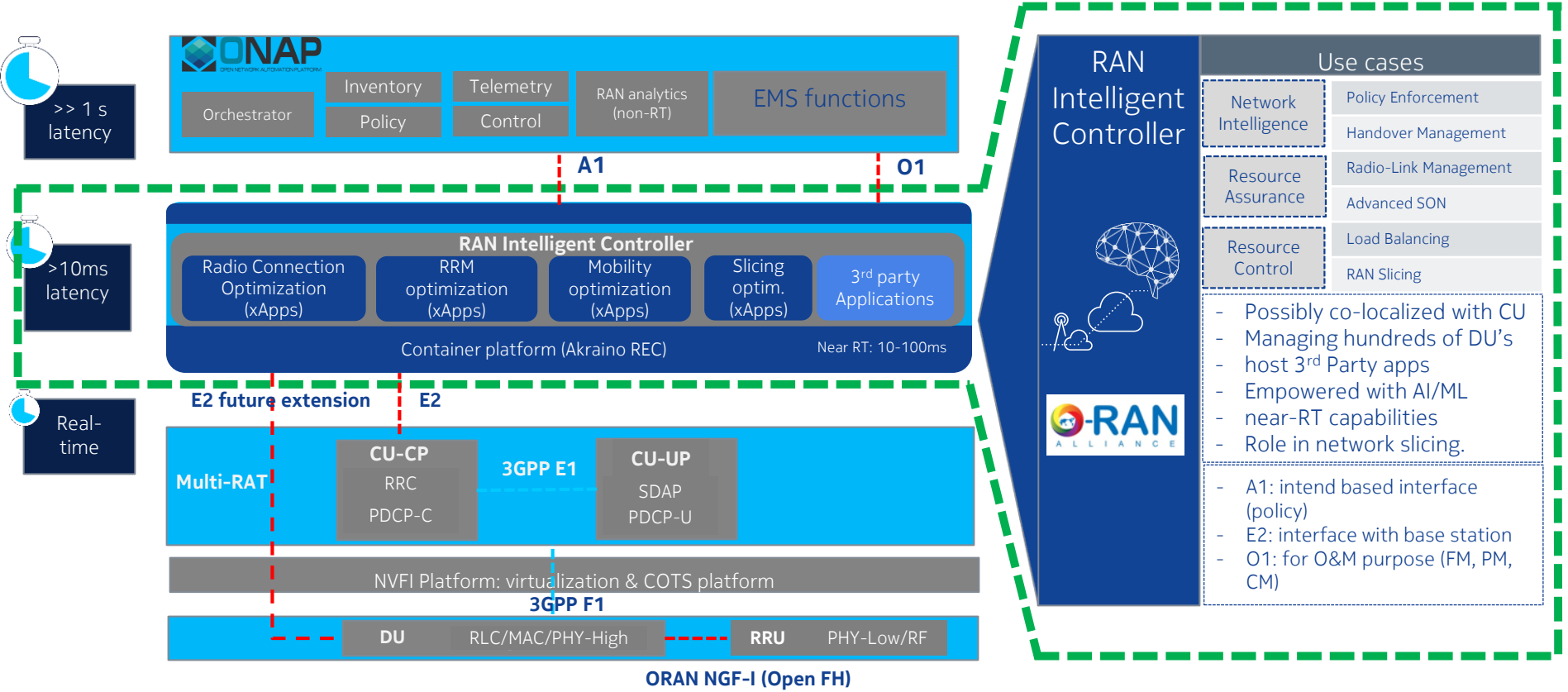
What is RIC: architecture and key requirements



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xApps

Example xApps (under O-RAN SC's RICAPP project)

- **Measurement campaign xApp** - general and procedure-specific KPIs for ~18 EN-DC related messages, using gs-lite stream processing tool
- **Admission control xApp** – uses E2 to play with EN-DC's SgNBAdditionRequest to implement simple admission control on gNB.
- **kpimon xApp** - collects information from O-CU and O-DU using the E2 interface and calculates KPIs based on this information. Provides information to other xApps
- Proprietary closed-source xApps
- A good way to start getting involved

Generally in areas of

- (from ORAN) Quality of experience (QoE)
- (from ORAN) Traffic steering
- (from ORAN) Massive MIMO, e.g., for customized beam sets
- (from ORAN) RAN slicing
- …

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RICP - Near-RT RIC as a O-RAN SC (Software community) project

- RIC and the O-RAN alliance specifications (in the eight O-RAN working groups) are being developed in parallel. The current RIC platform is **build around an experimental E2AP specification** proposal that also includes the ASN.1 definitions
- RIC as project of the ORAN software community (https://o-ran-sc.org/) has **formally started in June 2019**. Candidate seed code is under https://gerrit.o-ran-sc.org/r/#/admin/projects/ (all under "ric-plt" and under some under "com") and based on code developed by Nokia and AT&T.
- First formal release will be O-RAN SC's **"Amber" (end of November 2019**) with requirements listed in "O-RAN SC Ver A SW Requirements 20190731a" in https://wiki.o-ran-sc.org/display/RSAC/Contributions
- Source code is distributed under the **Apache 2 license**.
- Simulators are used for development. O-RAN-SC's O-CU eventually also needs to implement them.

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E2 concepts adapted from O-RAN WG3 E2GAP (General Aspects and Principles)

- **RAN Function definition.** Defines the RAN Function Name and **describes the E2 services that the specific RAN Function** is currently configured to present over the E2 interface. Typical functions are X2AP, F1AP, E1AP, S1AP, NGAP interfaces and RAN internal functions like UE, cell, node management.
  - More detailed **E2SM** (**E2 Service Model) specifications** define the function-specific protocols that are implemented on top of the E2 specification.
  - In some of RICAPP's xApps, we use an **experimental E2 service model "E2SM for X2AP"** for some of the xApps being developed**.**
  - For example, while the E2AP specification proposal defines the concept of event triggers, it is the E2SM for X2AP that defines the specific gNB/eNB-side triggers in the X2AP function based on matching X2AP message type, or X2AP IE.
- **RIC Event Trigger approach.** Describes the approach to be used in RIC Subscription messages to set RIC Event Trigger Definition in the RAN Function. **For example**, the X2 interface RAN Function may support event triggers for **a specific X2 interface** (i.e. connected to a specific LTE eNB), **for a given interface direction, interface Message type and one or more specific values in one or more nominated IEs (Information Elements).**
- **RIC Action Definition approach.** Describes the approach to be used in subsequent RIC Subscription messages to set required sequence of RIC Action in the RAN Function. **For example**, the X2 interface RAN Function may support INDICATION messages of **complete interface message** for Report and Insert RIC Services and a particular mechanism to configure one or more POLICY services.
- **RIC Indication header and message approach.** Describes the approach to be used by RAN when composing Indication messages for RIC Report and Insert services. **For example**, the X2 interface RAN Function uses X2AP based ASN.1 encoding of either **whole messages or selected Information Elements**
- **RIC Control header and message approach.** Describes the approach to be used by RIC when composing Control messages. **For example**, the X2 interface RAN Function could use **X2AP based ASN.1 encoding of whole messages**.
- **RAN Function Policies.** Describes the set of policies that the RAN Function is configured to support and the **corresponding parameters that may be used to configure the policy** using RIC Policy services

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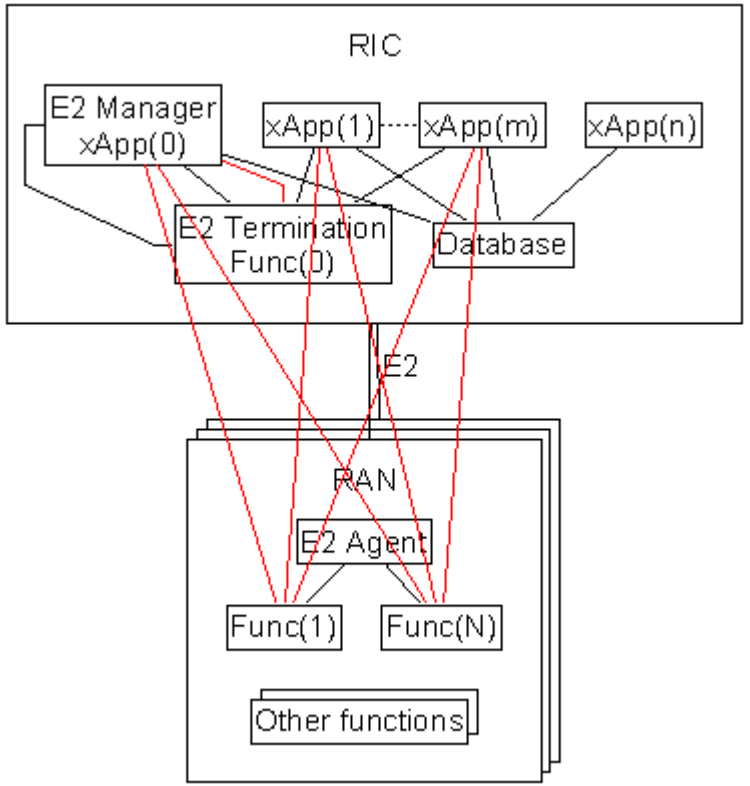
Many-to-many relationships, but only zero or one RIC per RAN node

The E2 manager is the one that initiates E2 connections with the RAN nodes. It is often referred to as xApp ”zero” – even if it is actually part of the RIC platform. RAN configuration information learned from the RAN during connection establishment (and later RAN Configuration Update procedures) is stored by the RIC E2 manager.

The RAN (gNB/eNB) shall be able to function independently of the RIC and shall maintain normal RAN functionality when and if the E2 interface and/or RIC fails. To this end the E2 interface is functionally an optional interface.



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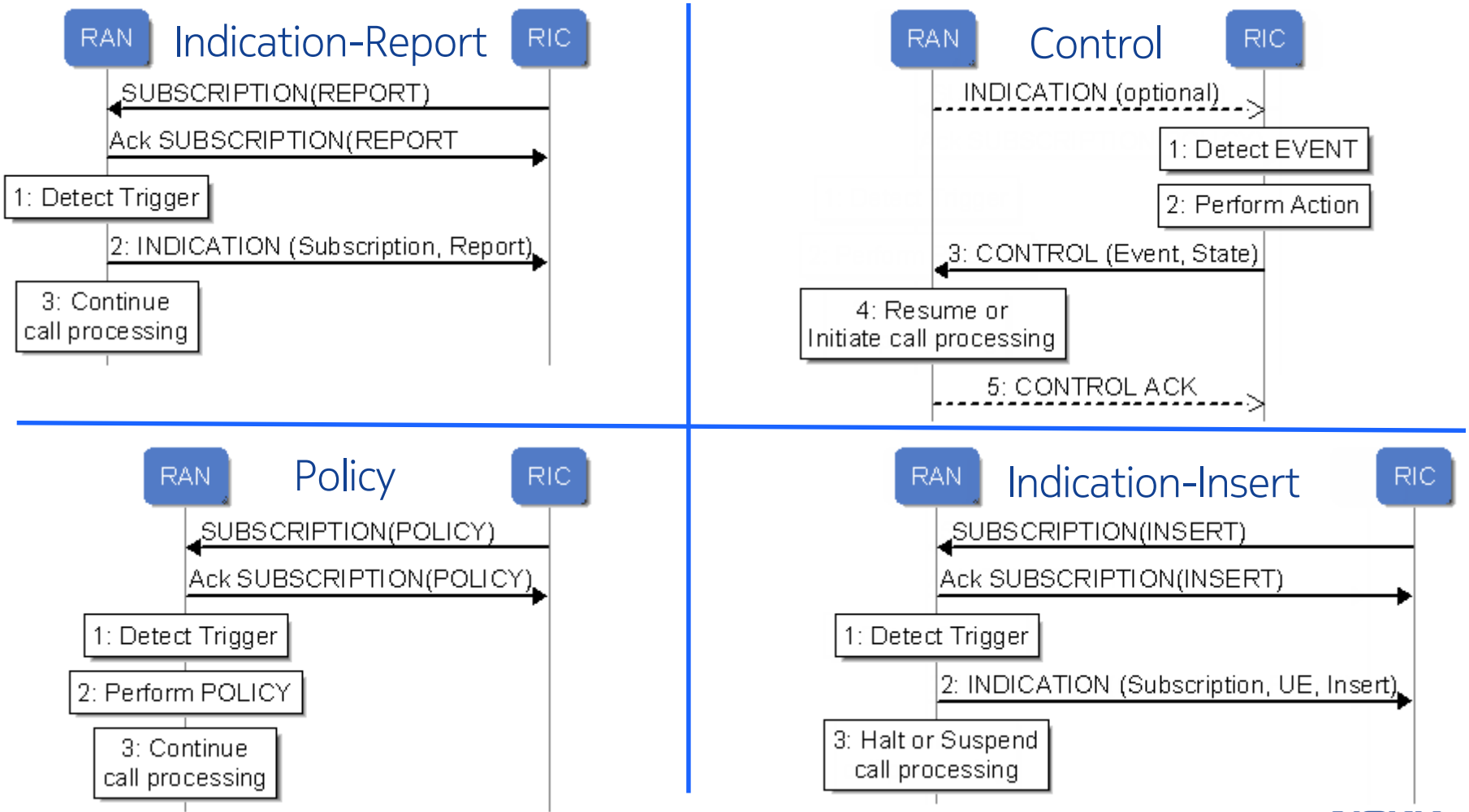

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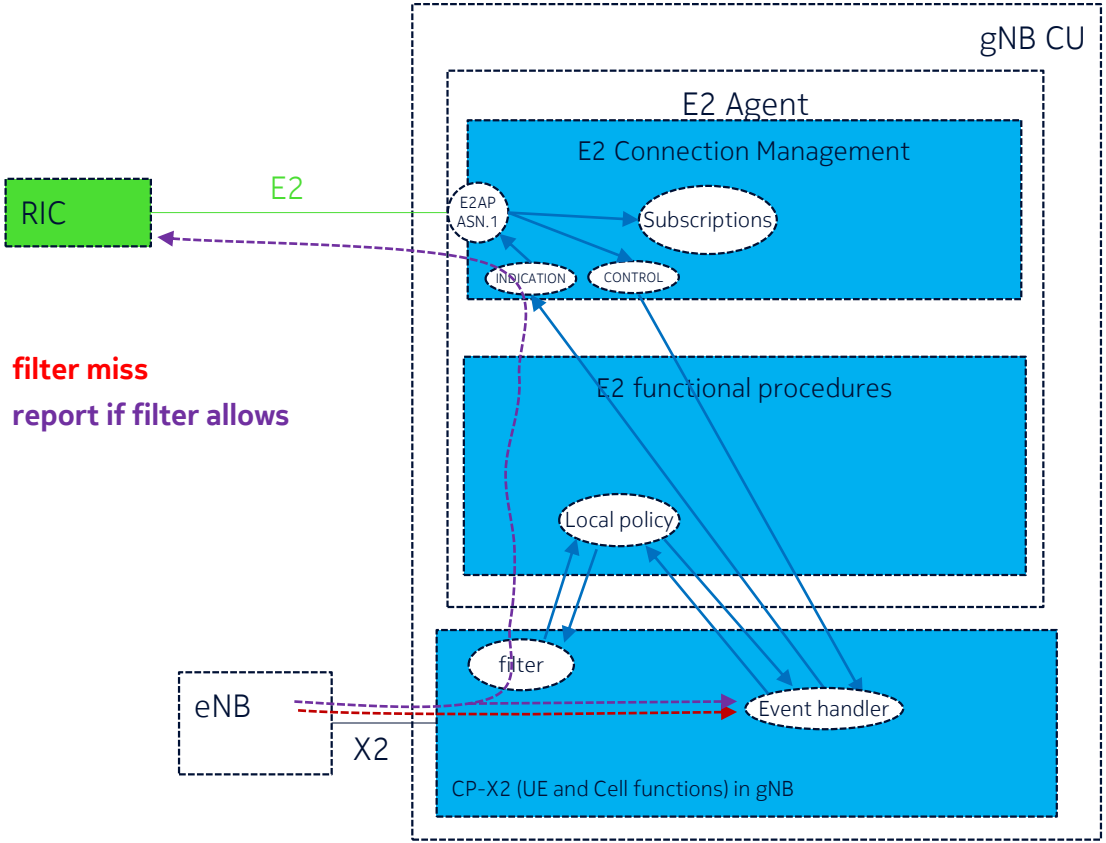
Expected gNB side of E2 implementation
Example E2 indication report



For example: SgNB Addition Request

- Event filter:
  - Triggers on matching events
- Call flow (Report case):
  - Event filter always forwards message to event handler
  - If filter matches, event filter forwards to E2 indication handler which then sends it to RIC as Report-Indication
  - xApp(s) in RIC perform analysis

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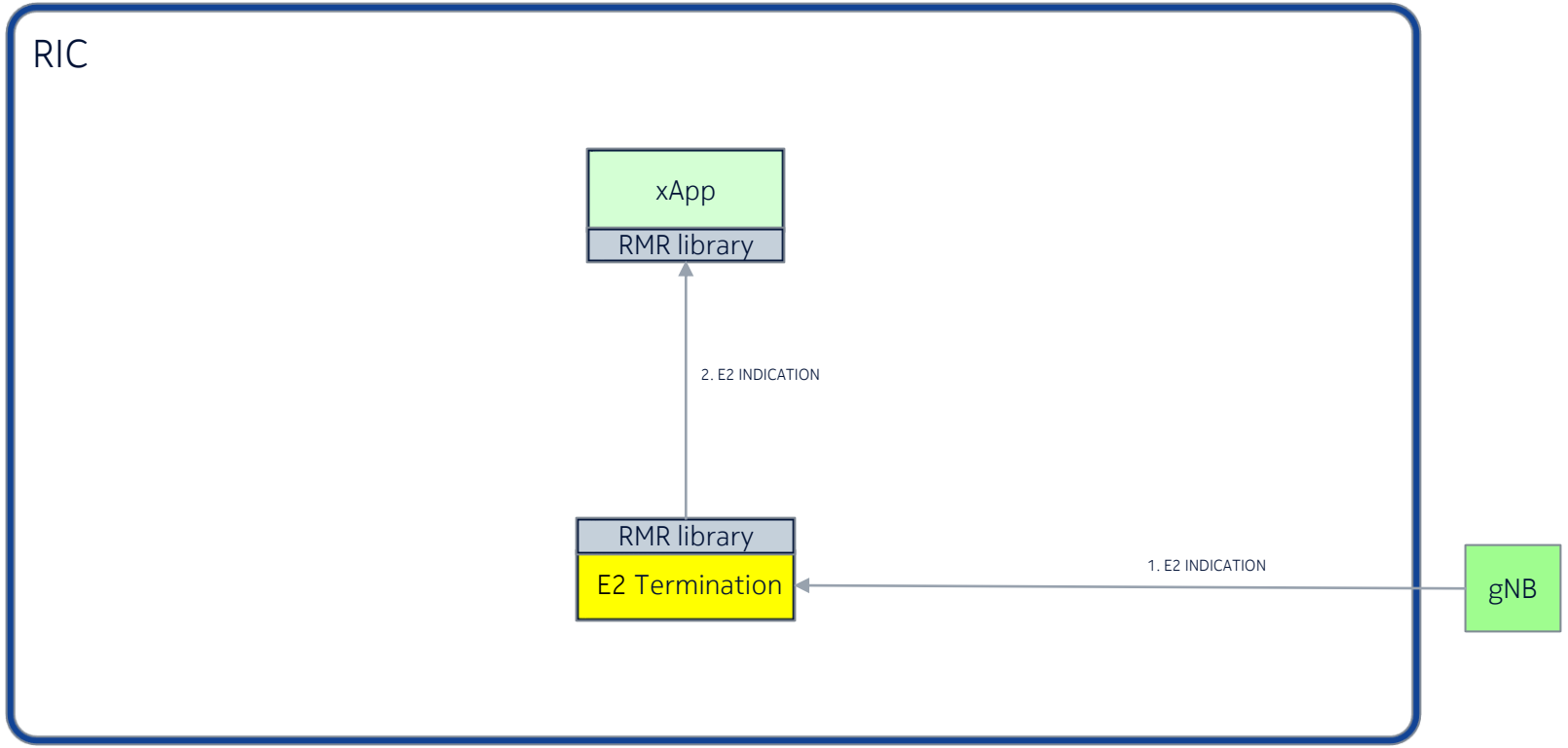
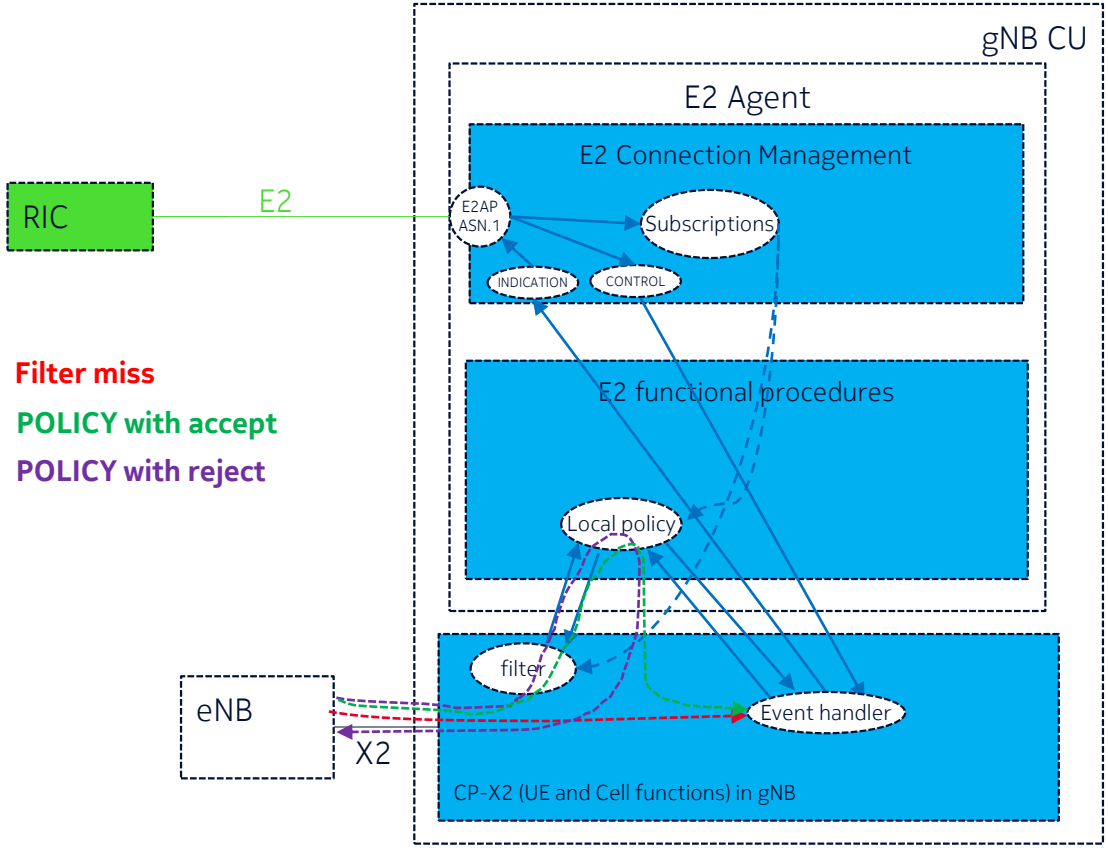
Incoming E2 INDICATION – general flow



Expected gNB side of E2 implementation

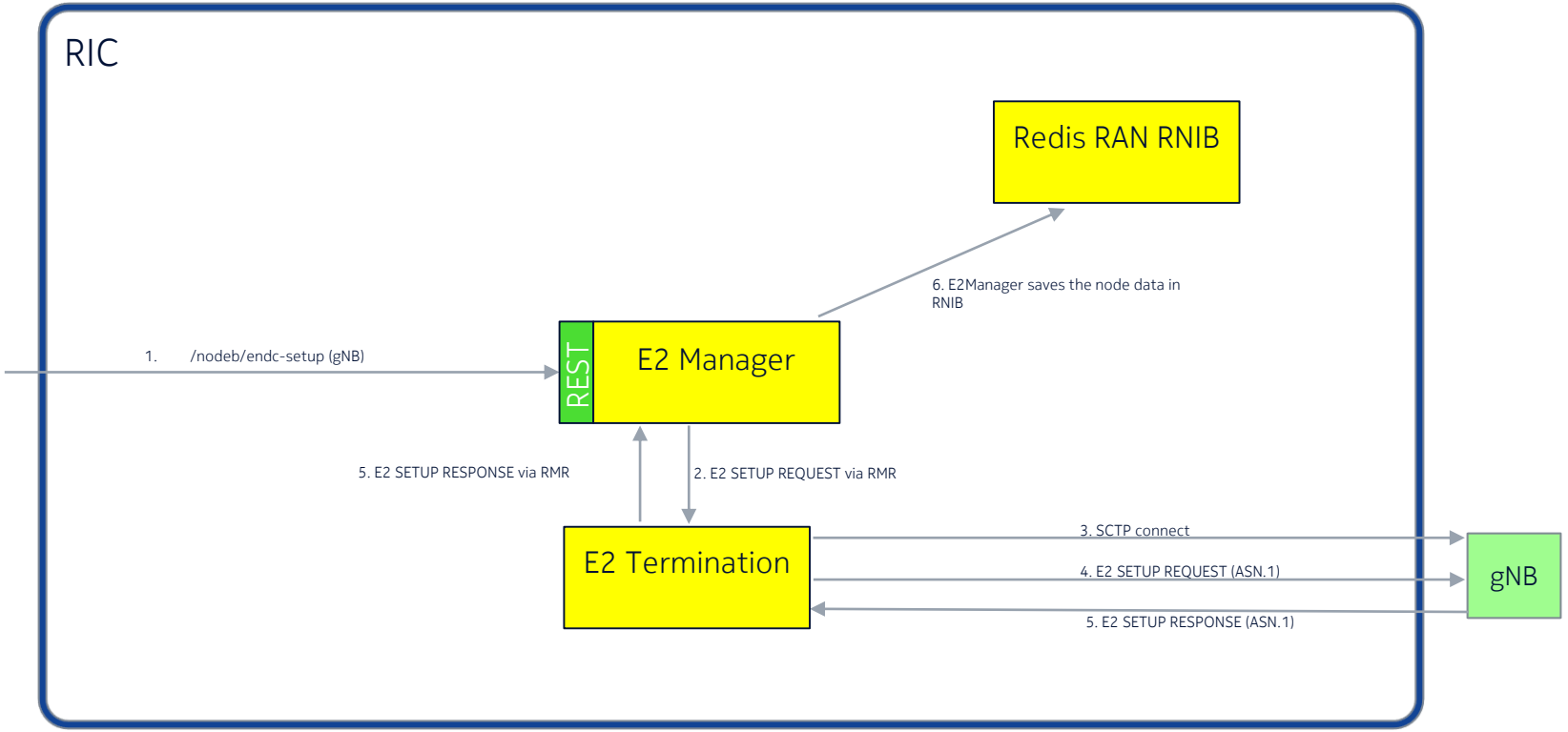
Example E2 policy



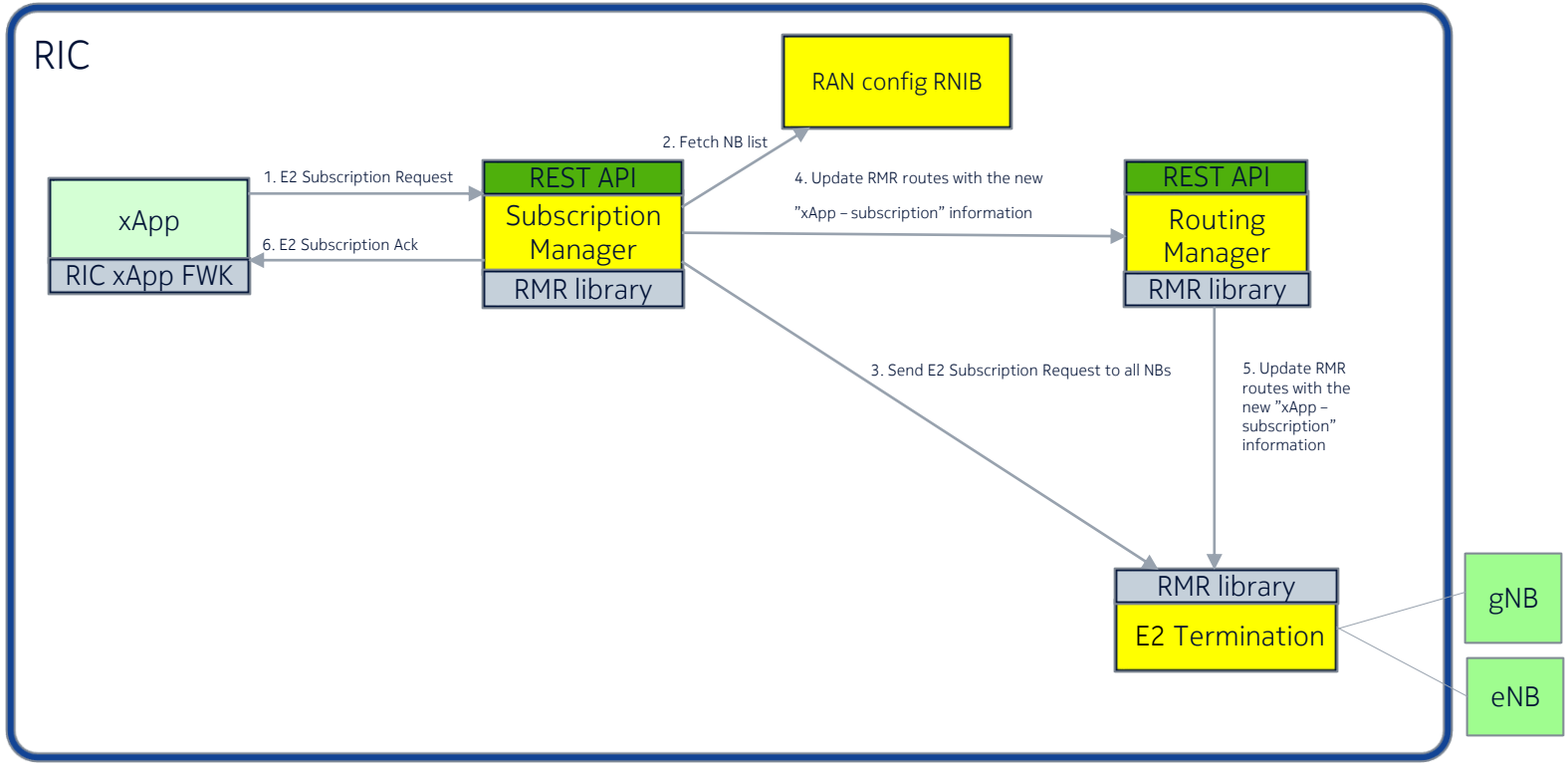
For example, SgNB Addition Request

- Event filter:
  - Triggers on matching events
- Call flow (Policy case):
  - Event trigger forwards message to Local Policy
  - Local policy applies rules and either proceeds with original/modified message or replies with SgNB Addition Reject
  - Event handler processes the message as before

E2 SETUP



xApp E2 Subscription



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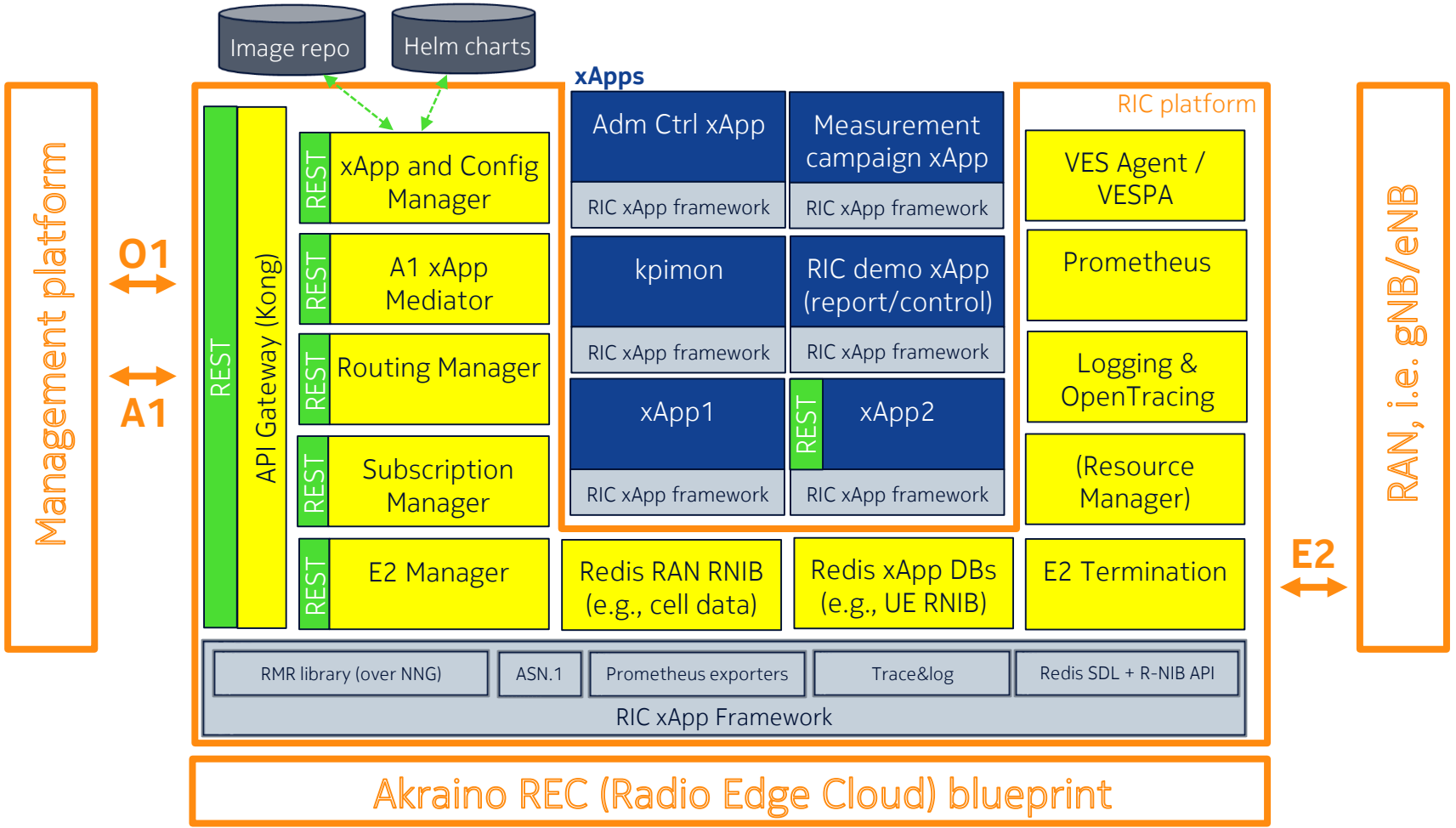
Image repo
Helm charts
xApps
RIC platform
Management platform
O1
A1
REST
API Gateway (Kong)
xApp and Config Manager
A1 xApp Mediator
Routing Manager
Subscription Manager
E2 Manager
Adm Ctrl xApp
Measurement campaign xApp
RIC xApp framework
kpimon
RIC demo xApp (report/control)
xApp1
xApp2
VES Agent / VESPA
Prometheus
Logging & OpenTracing
(Resource Manager)
Redis RAN RNIB (e.g., cell data)
Redis xApp DBs (e.g., UE RNIB)
E2 Termination
E2
RAN, i.e. gNB/eNB
RMR library (over NNG)
ASN.1
Prometheus exporters
Trace&log
Redis SDL + R-NIB API
RIC xApp Framework
Akraino REC (Radio Edge Cloud) blueprint


КОНКА

Abbreviations

SON	Self organizing networks
RRH	Remote Radio Head = RU Radio Unit
RNIB	Radio network information base (in RIC)
EPC	Evolved packet core (LTE core)
gNB	(next) generation node B 5G's base station. Further split into CU (centralized unit) – CU-CP, CU-UP, DU (distributed unit) and RU (e.g. via eCPRI)
eNB	Evolved node B = LTE's base station
MME	Mobility management entity
SGW	Serving gateway
S1-c	EPC's eNB-to-MME control plane traffic
S1-u	EPC's eNB-to-SGW user plane traffic
5G NSA	Non-standalone option 3 "EN DC" (eNB dual connectivity with various submodes for S1-u termination) and suboptions
5G SA	5G standalone achitecture
NR	New radio interface (5G)
NG-RAN (RAN)	Next generation radio (5G)
5GC	5G core
PDCP	Packet data convergence protocol (in 5G gNB split architecture typically the lowest layer still on CU)
SDAP	Service Data Adaptation Protocol (new in 5G)
ONAP	Open network automation platform
MANO	Management and orchestration
NMS	Network management system
VESPA	VNF event stream Prometheus Adapter
QoE	Quality of experience