State of RIC and E2 – A Practitioner's View

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Agenda

Vision of RIC

Introduction to RIC Protocol Stack Layering

Near-RT RIC and E2 Primer – Terminologies

Constituents of E2 Node

General Workflow of xApp Interface to E2 Nodes

Current Standard Defined E2SMs

Open Issues and Challenges

Vision of RAN Intelligent Controller

- Considered as SDN Controller for RAN

- RAN characteristics allow for controlling at:
  - Slow feedback loop – Non -Real Time
  - Fast feedback loop – Near-Real Time

- RAN optimization solutions as applications running over Near-RT or Non-RT RIC.

- Applications from any 3rd party – not necessarily from the baseband or radio vendor.
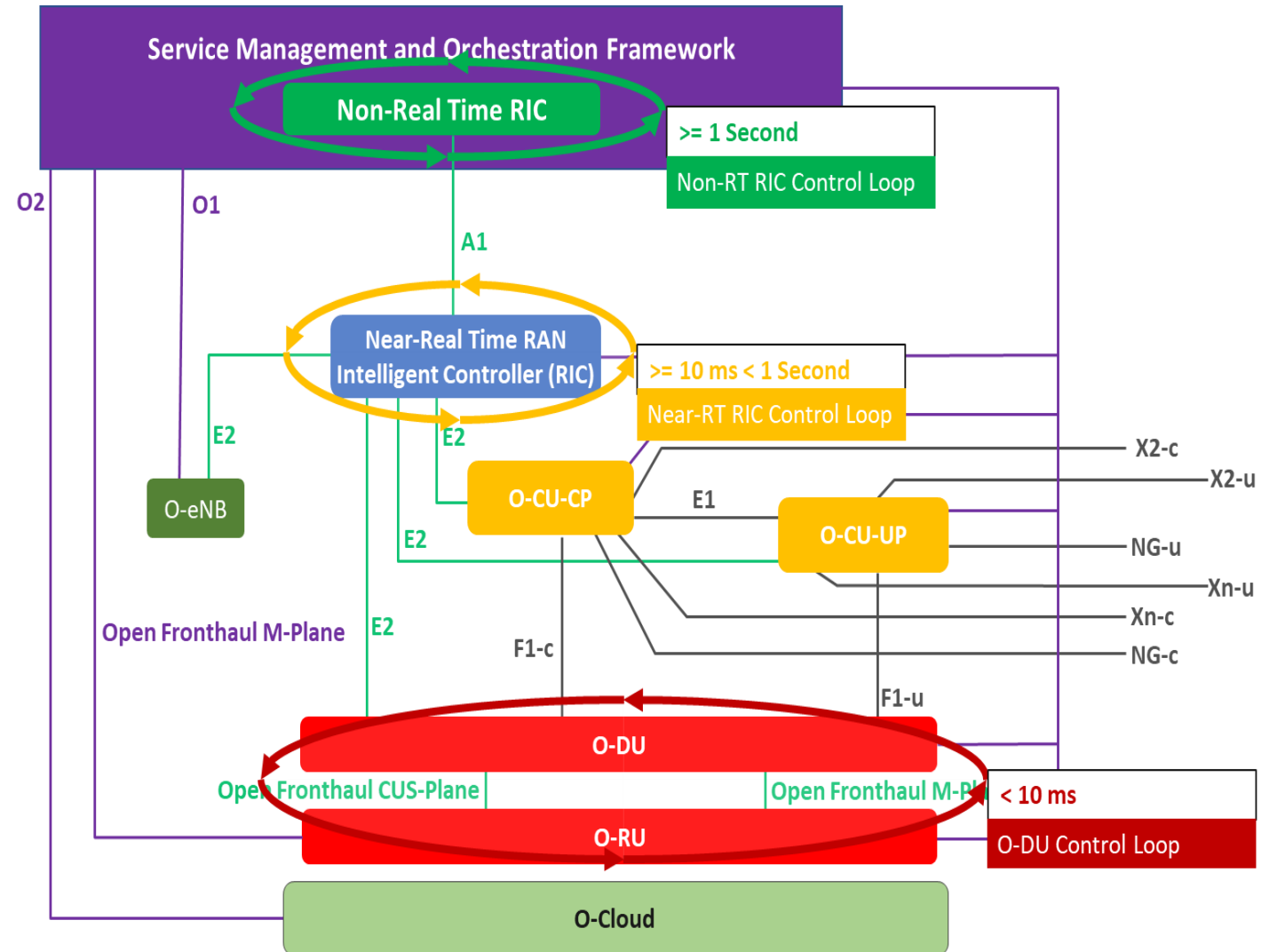
Protocol Stack and Near-RT RIC Architecture
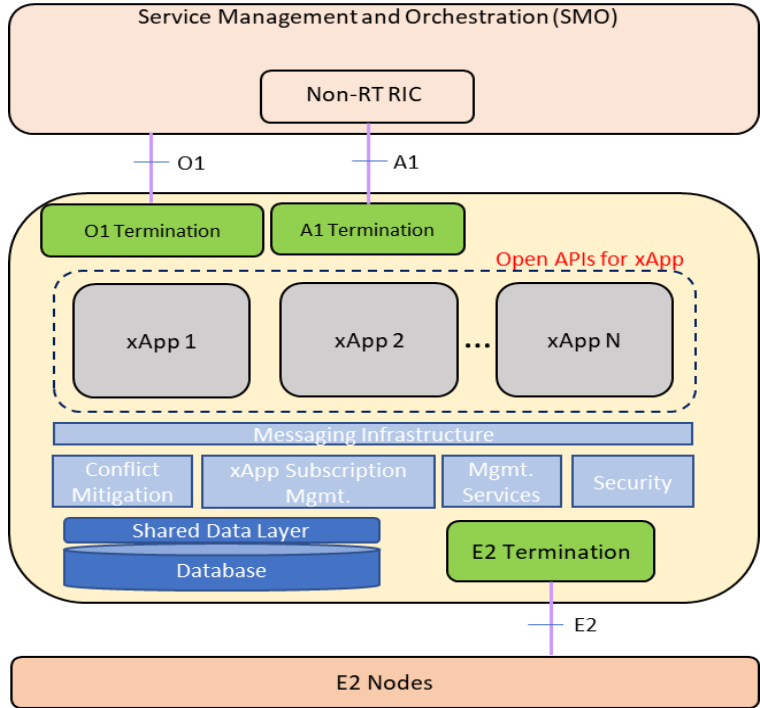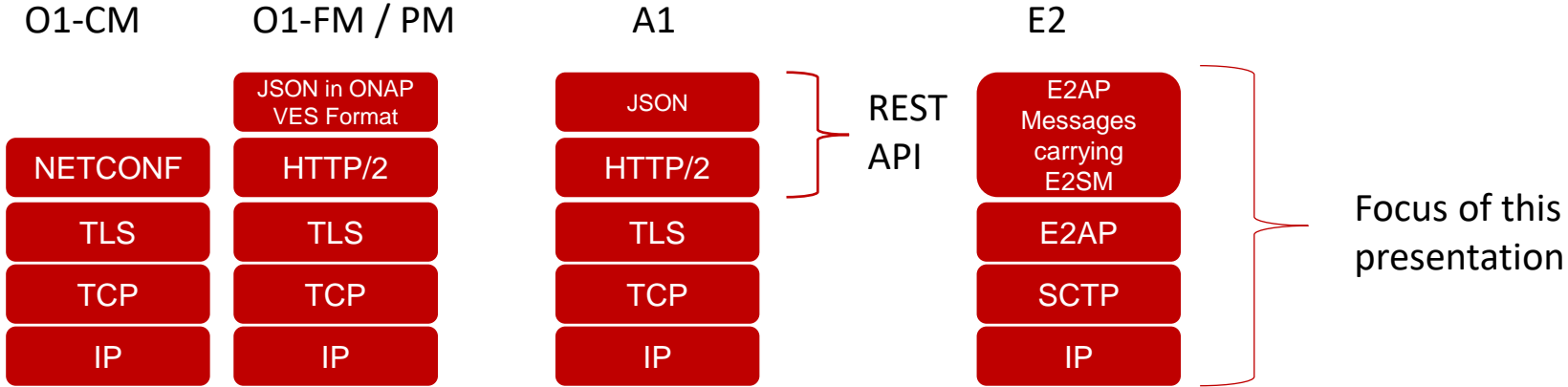
E2 – Key Terminologies

- **E2 node** – Refers to CU-CP, CU-UP and DU
  - E2 nodes support E2 interface towards near RT-RIC and O1 interface towards non-RT RIC

- **RAN Function**: A specific Function in a E2 Node; examples include network interfaces (i.e. X2AP, F1, S1AP, Xn, NGc) and RAN internal functions handling UE context handlers, Cell handlers, Paging etc.

- **RIC Service**: A Service provided on an E2 Node to provide access to messages and measurements and / or enable control of the E2 Node from the Near-RT RIC. RIC Services Include:
  - REPORT
  - INSERT
  - CONTROL
  - POLICY
  - QUERY

- **RAN Function ID**: Local identifier of a specific RAN Function within an E2 Node that supports one or more RIC Services using a specific E2 Service Model. Note that same E2SM may be used by more than one RAN Function in the same E2 Node.

- **Style**: For each RIC Service, different types of data can be grouped as a style. A given E2SM may support many styles for each RIC service.

E2 Node - Constituents
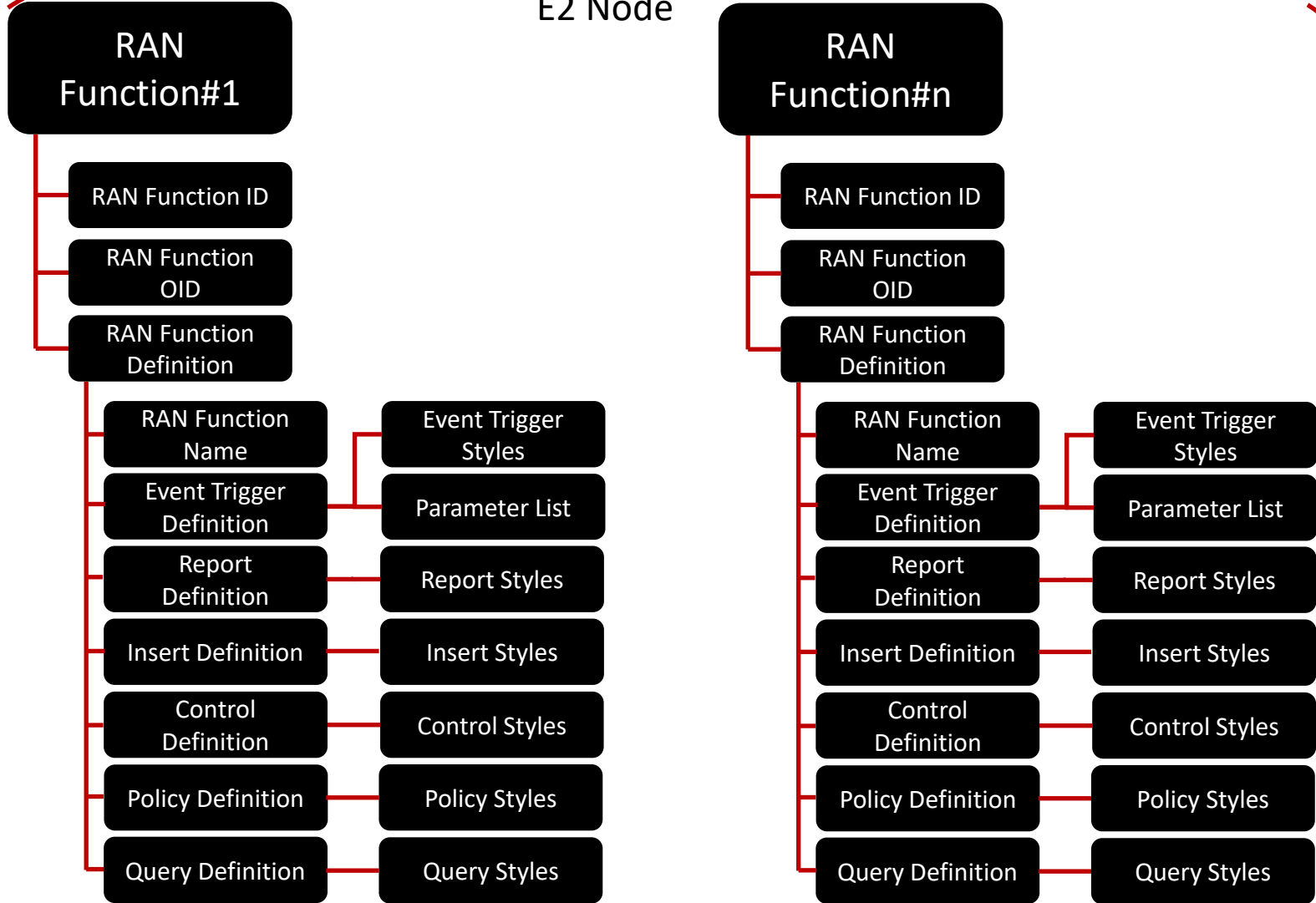
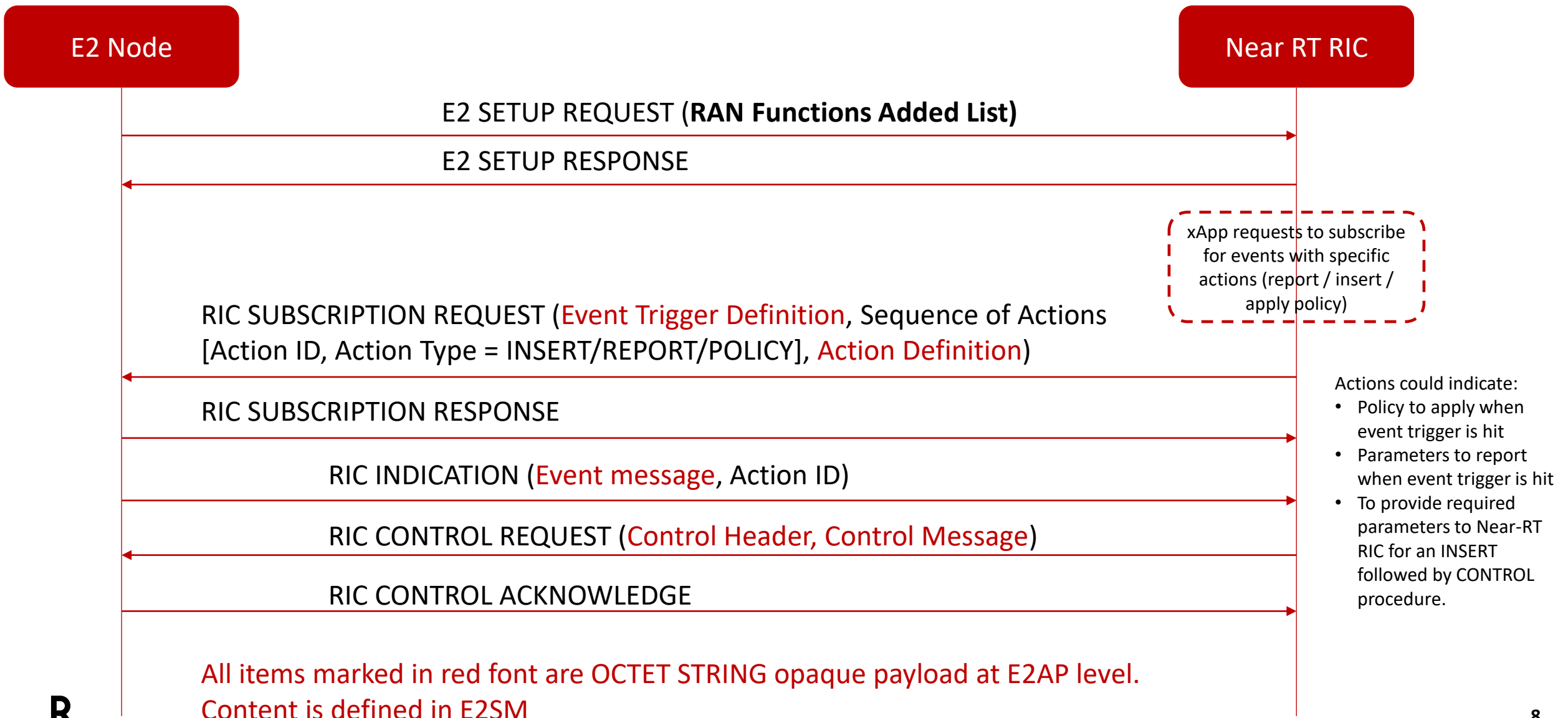- Each E2 node advertises their RAN functions and the definition of each RAN function.
- Each RAN function is associated with an E2SM.
- A given E2SM can be associated with multiple RAN functions.
  - However, the multiple RAN functions may support different parts / capabilities of the E2SM.
  - For e.g. RAN Function#1 may only support event trigger styles 1 and 2 while FAN Function#2 may support event trigger styles 3 and 4.

Structure of E2AP

- Global Procedures
  - E2 interface setup
  - E2 node configuration update
  - E2 service update
  - E2 connection update
  - E2 reset
  - E2 error indication
- Functional Procedures
  - RIC subscription request / deletion request
  - RIC indication (for REPORT service and for INSERT service from E2 Node to Near-RT RIC)
  - RIC control request (for controlling parameters in E2 node – from Near-RT RIC to E2 node)

# General Workflow of E2 Node to Near RT RIC Interaction

E2 Node

Near RT RIC

E2 SETUP REQUEST (**RAN Functions Added List)**

E2 SETUP RESPONSE

> xApp requests to subscribe for events with specific actions (report / insert / apply policy)

RIC SUBSCRIPTION REQUEST (Event Trigger Definition, Sequence of Actions [Action ID, Action Type = INSERT/REPORT/POLICY], Action Definition)

RIC SUBSCRIPTION RESPONSE

RIC INDICATION (Event message, Action ID)

RIC CONTROL REQUEST (Control Header, Control Message)

RIC CONTROL ACKNOWLEDGE

Actions could indicate:
- Policy to apply when event trigger is hit
- Parameters to report when event trigger is hit
- To provide required parameters to Near-RT RIC for an INSERT followed by CONTROL procedure.

All items marked in red font are OCTET STRING opaque payload at E2AP level.
Content is defined in E2SM

Current Standard Defined E2SM

E2SM	Description
E2SM-NI	Allows subscribing for and reporting network interface messages like F1, X2, S1, NG, E1, Xn etc.,.
E2SM-KPM	Allows subscribing for and reporting performance counters on a periodic basis. Lowest periodicity of report is 1ms.
E2SM-RC	This is the biggest E2SM that allows for subscribing for number of events, applying policies on specific event occurrence, reporting the events, controlling E2 node parameters on per UE / group of UE / cell basis.
E2SM-CCC [Ongoing]	This E2SM allows for subscribing cell level events, applying cell level policies, reporting cell level events and controlling E2 node parameters on per cell basis.

Structure of E2AP (Deeper Look)
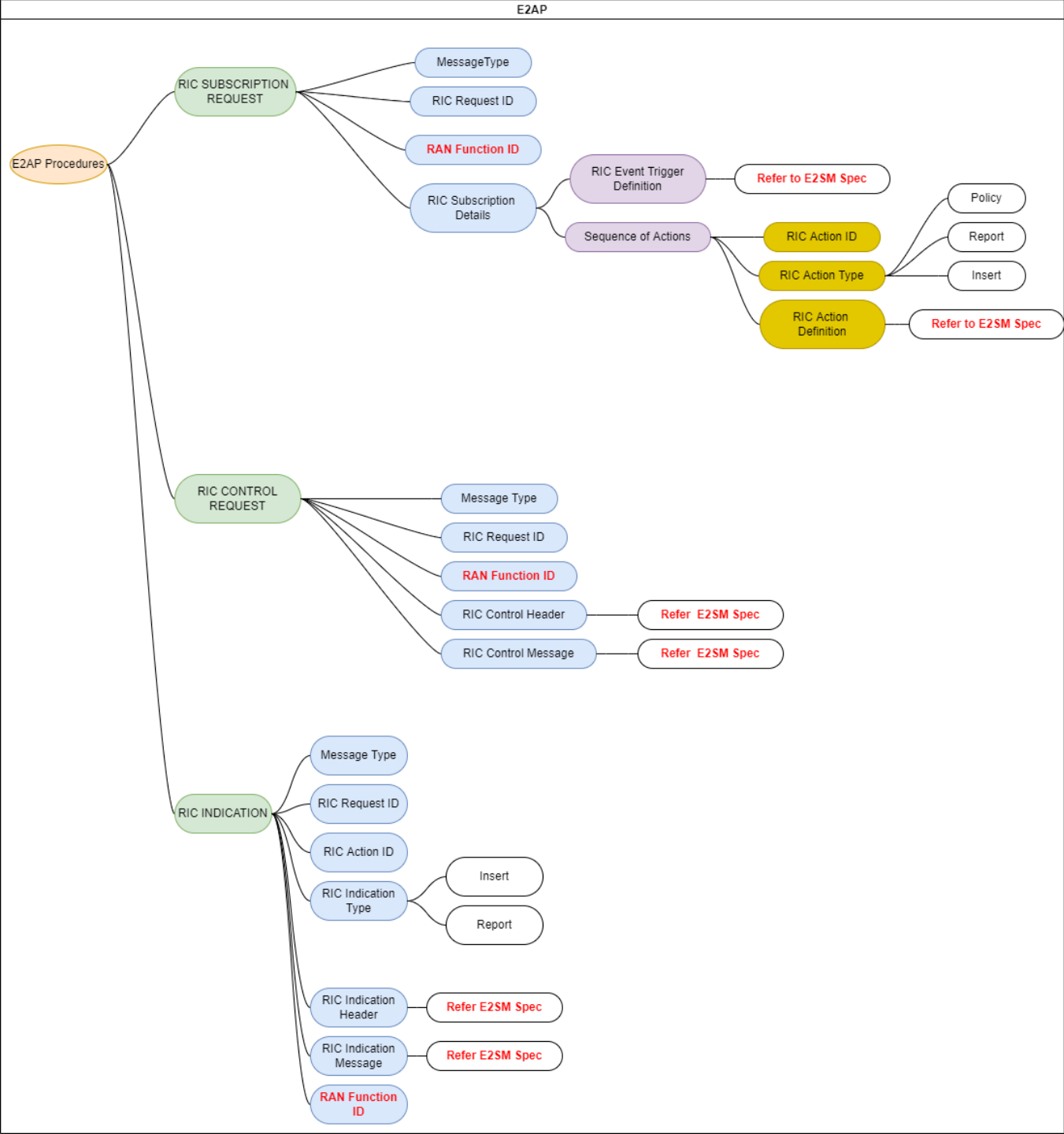
Structure of E2SM-RC
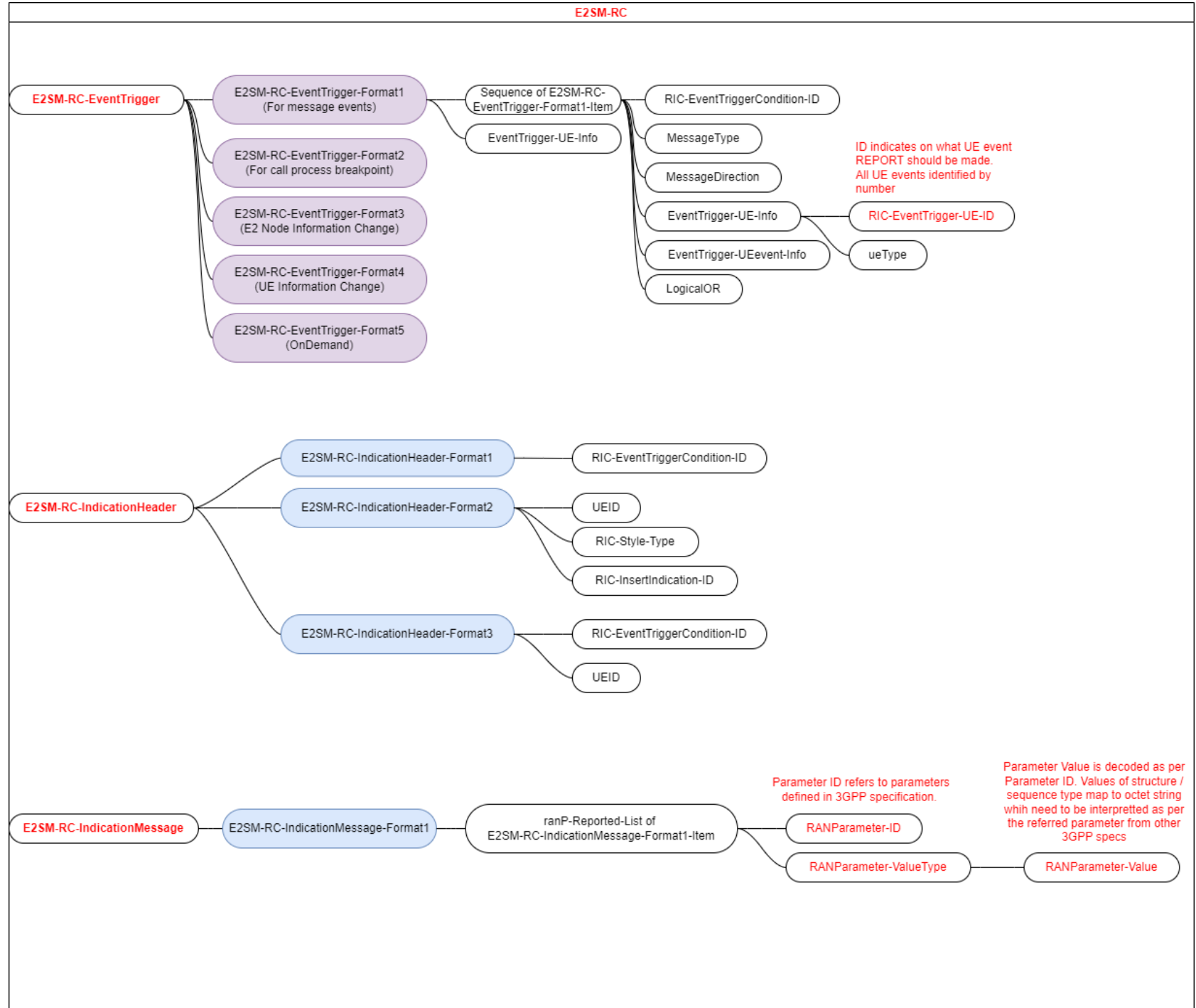
Currently Standard Specified Application Use Cases

Use Case	Description
Traffic Steering	• Load balancing handovers • Selection of CA Scell / ENDC SN • Service based traffic steering • CA / ENDC packet drain / buffer occupancy tuning per carrier
QoS Based Resource Optimization	• Monitor QCI / 5QI specific statistics • Update resource allocation policies in E2 nodes
RAN Slice SLA Assurance	• Monitor slice specific KPIs • Update resource partition per slice to meet SLA
Massive MIMO Optimization	• Stage 3 ongoing
RAN Analytics Information Exposure	• Stream near-real time RAN statistics for analytics on QoE
General reporting of PM counters for all the above	• All measurements are identified based on 3GPP defined measurement names (TS 28.552 and TS 32.425) • Reporting granularity from 1ms

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Key Protocol Challenges to Overcome

Every parameter subscription, report and control is done through <parameter ID, parameter value> pairs where parameter ID to corresponding ASN.1 mapping is specified in normative table (and not in E2SM's ASN.1 itself)

- The mapping ASN.1 is usually in some other 3GPP spec
- Errors in incorrect mapping of ID **X** to ASN.1 of some other parameter **Y** can't be caught directly in ASN.1 schema validation itself.

Debugging E2 interface with everything in E2SM carried as OCTET STRING (opaque payload) of E2AP will be difficult.

- Even if protocol trace tools like Wireshark come up with E2SM decoders, the parameters within the E2SM themselves are again opaque OCTET STRING which then need to be decoded by loading another 3GPP ASN.1 (depending on the Parameter ID).

For the success of E2 and ease of development, tooling is very important. Contributions required for Wireshark for:

- Dissectors (Decoders) for each E2SM
- Key challenge is to know which E2SM ASN.1 to load based on RAN Function ID. As mentioned earlier a given E2SM can be used by multiple RAN Functions.
- To know the mapping of RAN Function ID to E2SM ASN.1 a stateful knowledge of linking prior E2 SETUP (which has RAN Function ID to E2SM OID mapping) to current message decoded is required – making the dissector stateful.
- Dissectors (Decoders) for parameter values carried within E2SM where the decoding of the parameter happens based on Parameter ID. The ASN.1 schema for the parameter value shall be loaded based on the normative mapping of Parameter ID in the E2SM spec.

Summary

- Near RT RIC standardization is slowly maturing.

- E2 base protocol stable.

- E2SMs for use cases getting standardized one by one.

- Needs tooling for making development and debugging of E2 easier.

- Near-RT RIC internal interfaces are still work in progress.

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