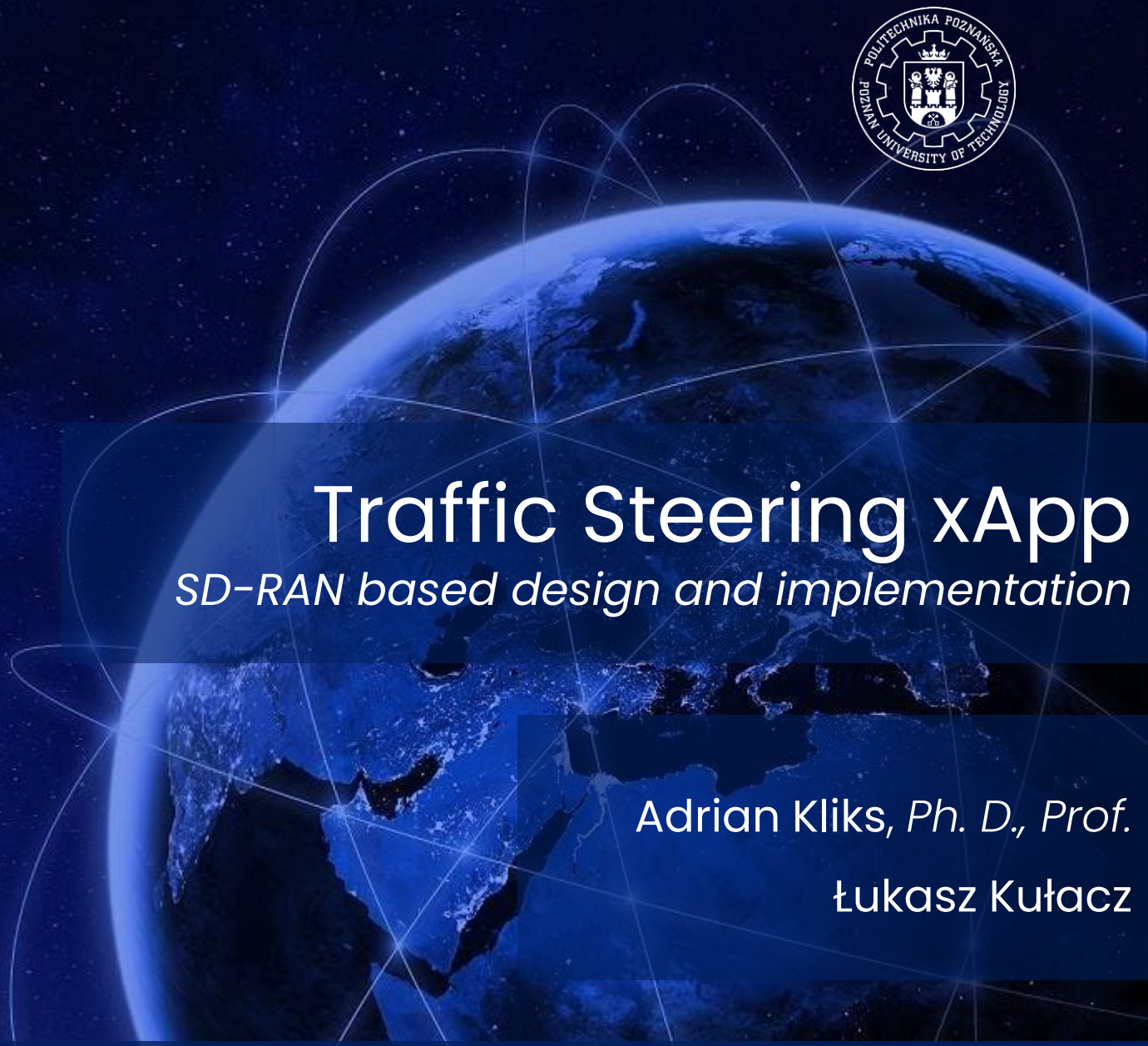
TIMEDO LABS



Traffic Steering xApp

SD-RAN based design and implementation

Adrian Kliks, *Ph. D., Prof.*

Łukasz Kułacz

All things wireless

Outline

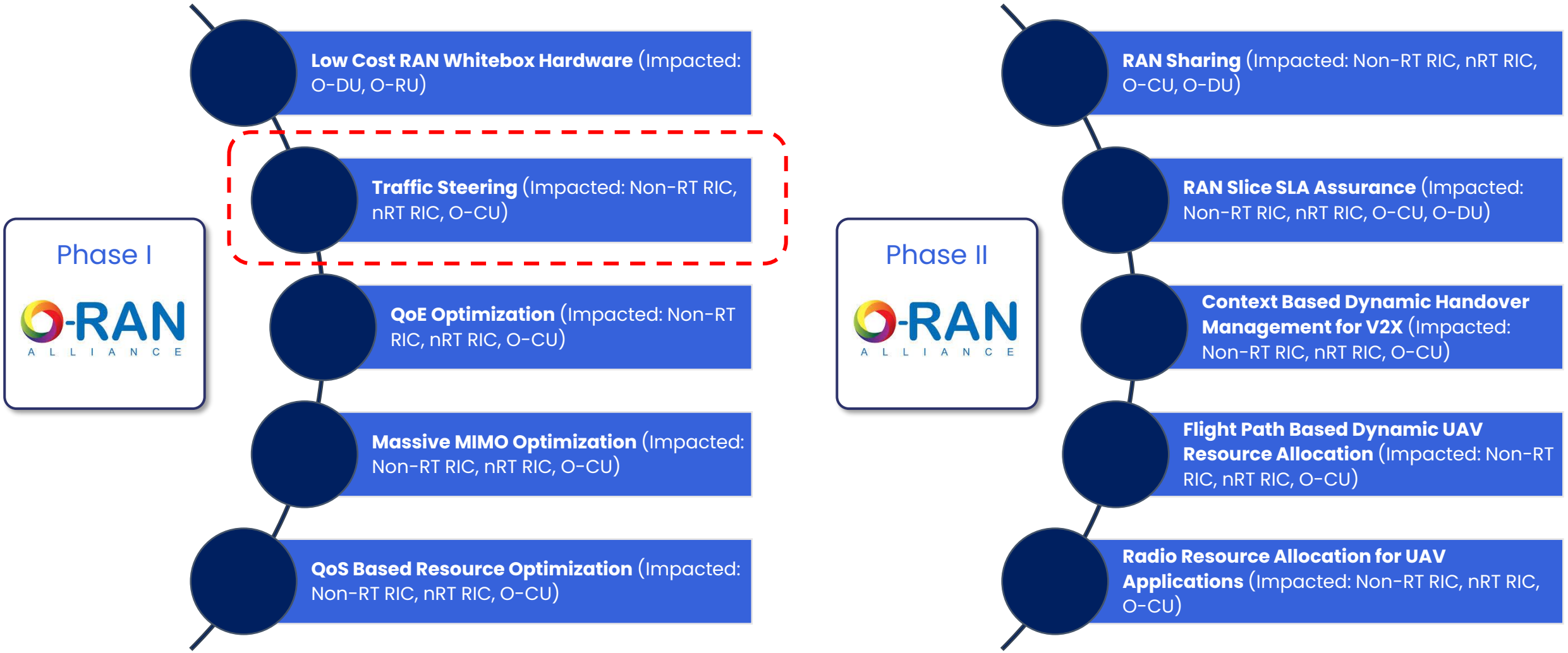

TS xApp
Use Case Selection
O-RAN Traffic Steering Use Case
Initial Simulation Results – Reference Scenario (Local)
RANSim and SD-RAN Implementation
Future Directions
Summary

Rimedo Labs


Spin-off at Poznan University of Technology in Poland
Established in 2020
Core competences: Applied Research, Consulting, Training (e.g., O-RAN System Training) and Technical Content Delivery
Areas – regular networks domain: regular networks (LTE, 5G, 6G, IoT, Wi-Fi)
Areas – subject matter: spectrum sharing and management (CBRS), RRM, AI for wireless systems, private mobile networks, V2X
Strategic goal: xApp development

Use Case Selection

O-RAN Use Cases



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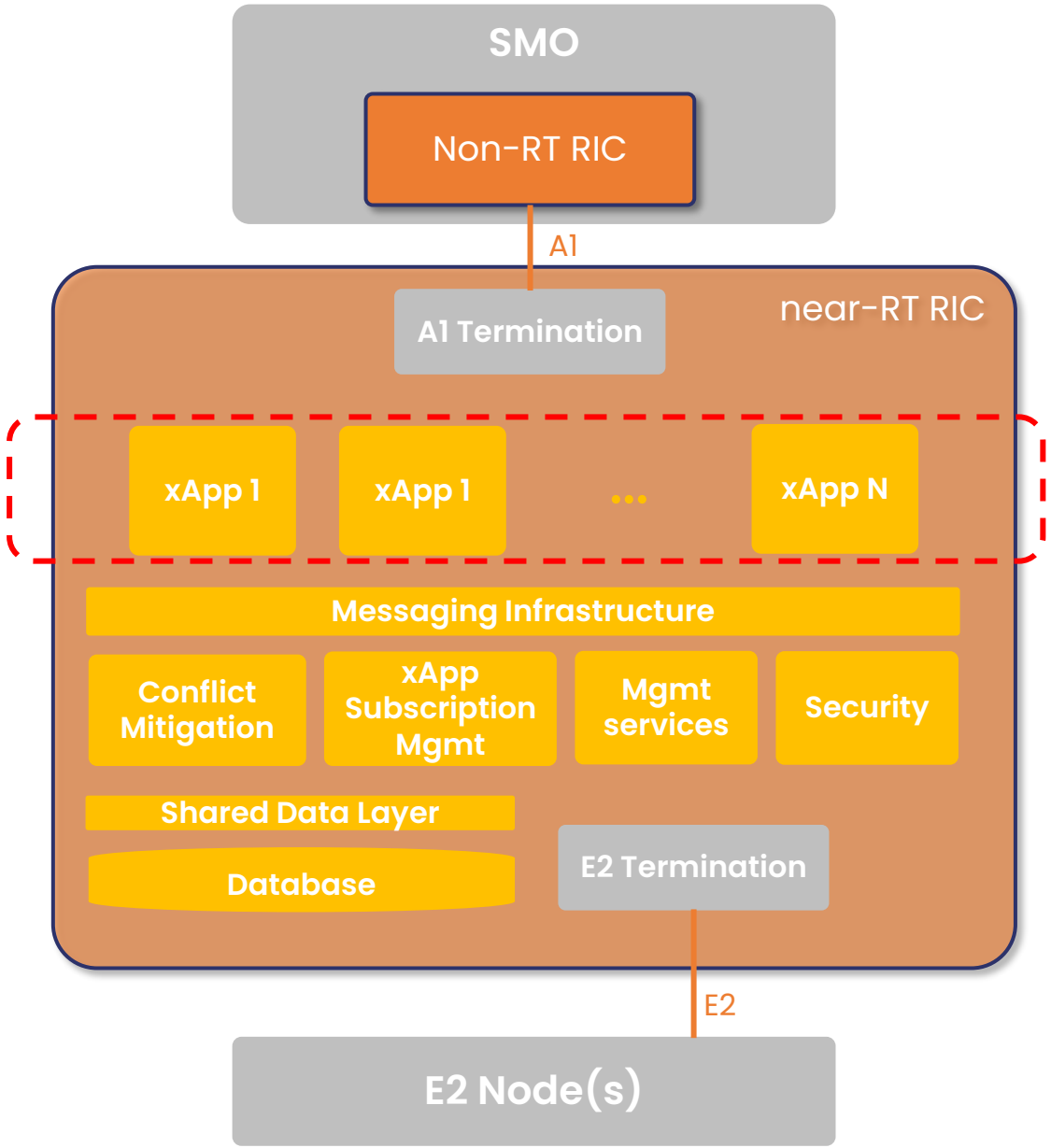
Based on: O-RAN Alliance WP (O-RAN Use Cases and Deployment Scenarios)

O-RAN near-RT RIC – Internal Architecture



Based on defs from: O-RAN Alliance Specifications

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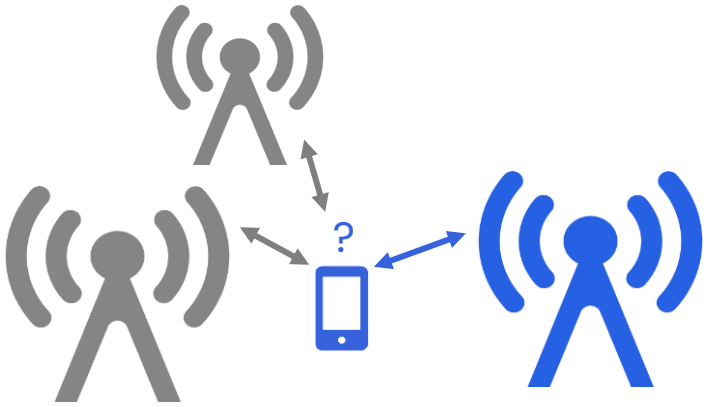
O-RAN Traffic Steering Use Case

O-RAN Traffic Steering – Use Case Description



TS – directs traffic
to specific cell(s)

Challenge:

- Typical TS mechanisms:
  - use radio conditions of cell by **treating all UEs in the same way** with average values,
  - are **limited to adjusting** the cell reselection, handover parameters, cell priorities.

Aims/Objectives:

- **Customization** of UE-centric strategies and proactive optimization by predicting network condition
- Allow operators to **specify** different **objectives** for traffic management: by optimizing the network/UE performance, achieving balanced cell load, etc.
- Allow operators to **flexibly configure** desired optimization **policies**, utilize right performance criteria, leverage ML to enable intelligent and proactive TS control.

Realization:

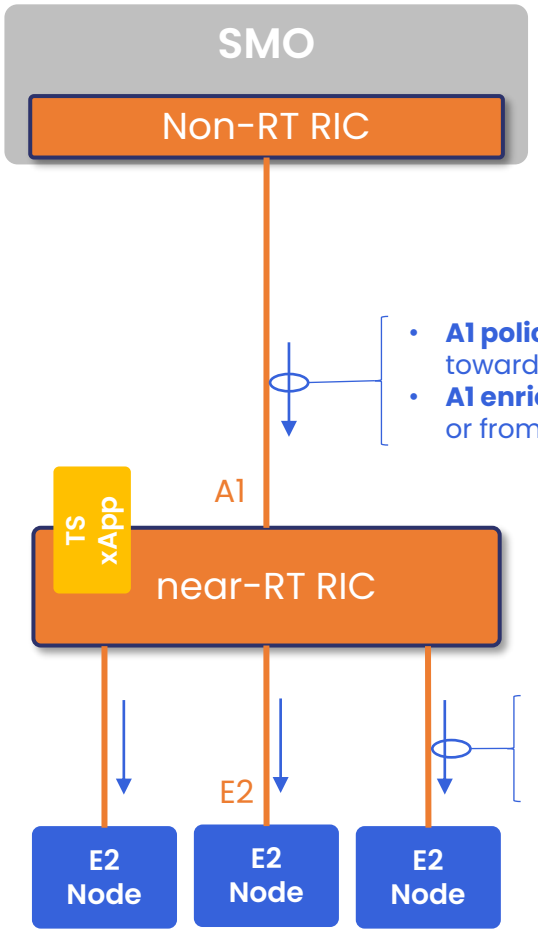
- **RIC to control** the **adaptation** of diverse scenarios and objectives.
- **Non-RT RIC and nRT RIC control TS strategies** through AI/ML learning from data collected by O1 I/F from O-CU and O-DU

Required data:

- **Measurement reports** - RSRP/RSRQ/CQI of serving and neighbor cells, cell quality thresholds, measurement gaps on per-UE/layer/freq basis, etc.,
- **Connection and mobility/HO stats** - indication of successful and failed HOs, etc.,
- **Cell load stats** – # active users/connections, # scheduled active users per TTI, PRB utilization, etc.,
- **Per UE performance stats** – PDCP thrpt, RLC/MAC latency, etc.

Based on: O-RAN.WG2.Use-Case-Requirements-v02.00

O-RAN TS Use Case – Node Responsibilities



- **Defines and updates policies** - to guide the behavior of TS xApp in nRT RIC (e.g. optimization objectives to guide carrier/band preferences for UE/UE-group)
- **Performs statistical analysis** to provide enrichment info for nRT RIC to assist TS function (e.g., RF fingerprint based on UE meas. report like RSRP/RSRQ/CQI info for serving/neighboring cells)
- **Comunicates policies and enrichment info** (e.g. RF fingerprints) to nRT RIC & **measurement configuration** parameters to RAN nodes.

- **A1 policy** – declarative policy to enable Non-RT RIC to guide nRT RIC on steering the behavior of RAN fcns towards stated objectives
- **A1 enrichment info** – additional info used by nRT RIC collected at SMO/non-RT RIC from non-network data or from NFs

- **Interprets and enforces policies** from Non-RT RIC
- **Uses enrichment info** to optimize control function, e.g., nRT RIC can use RF fingerprint to predict inter-freq cell measurement based on the intra-freq cell measurement to speed up TS reduced signaling overhead

- **Control messages**

- **Collects and transmits** data with required granularity to SMO over O1
- **Executes** actions

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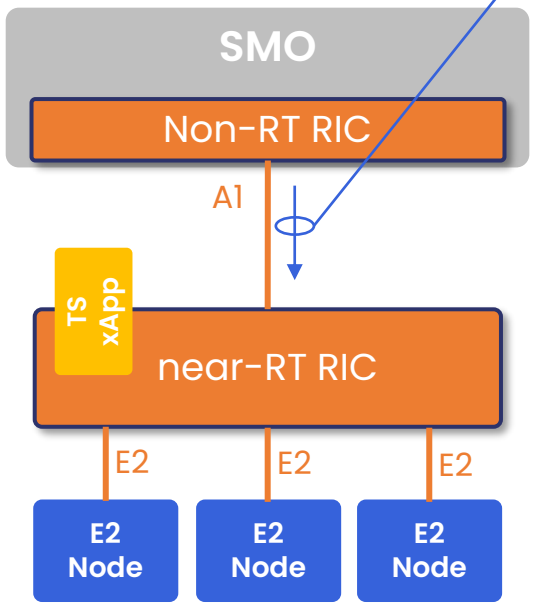
Based on: O-RAN.WG2.Use-Case-Requirements-v02.00

A1: TS Policies



B.1.3 Traffic Steering Preferences

PolicyTypeId: ORAN_TrafficSteeringPreference_1.0.1

```
{
  "$schema": "http://json-schema.org/draft-07/schema#",

  "description": "O-RAN standard Traffic Steering Preference policy",
  "type": "object",
  "properties": {
    "scope": {
      "anyOf": [
        {
          "type": "object",
          "properties": {
            "ueId": {"type": "string"},
            "sliceId": {"type": "number"},
            "qosId": {"type": "number"},
            "cellId": {"type": "number"}
          },
          "additionalProperties": false,
          "required": ["ueId"]
        },
        {
          "type": "object",
          "properties": {
            "sliceId": {"type": "number"},
            "qosId": {"type": "number"},
            "cellId": {"type": "number"}
          },
          "additionalProperties": false,
          "required": ["sliceId"]
        }
      ]
    },
```

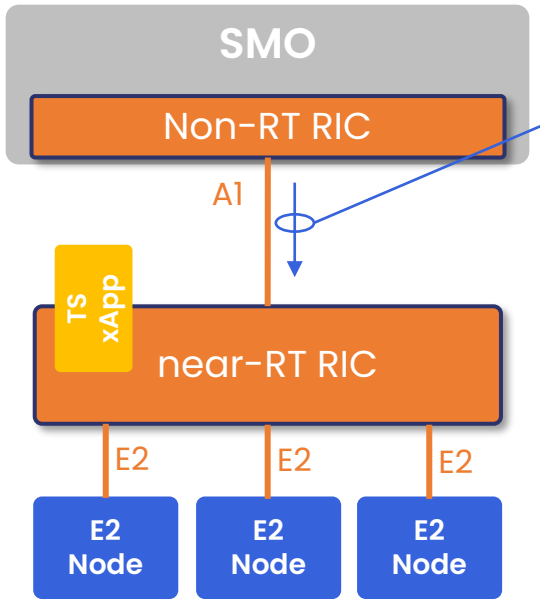
Policy can relate to:
- Single/group UE ID
- Slice ID
- QoS ID
- Cell ID

```
    "tspResources": {
      "type": "array",
      "items": {
        "type": "object",
        "properties": {
          "cellIdList": {
            "type": "array",
            "minItems": 1,
            "uniqueItems": true,
            "items": {
              "type": "string"
            }
          },
          "preference": {
            "type": "string",
            "enum": [
              "SHALL",
              "PREFER",
              "AVOID",
              "FORBID"
            ]
          },
          "primary": {"type": "boolean"}
        },
        "required": ["cellIdList", "preference"],
        "additionalProperties": false
      },
      "minItems": 1
    }
  },
  "additionalProperties": false,
  "required": ["scope", "tspResources"]
}
```

e.g. which cell shall be preferred

Based on: O-RAN.WG2.A1AP-v02.00

A1: TS Policies Examples



B.2.3 TSP

B.2.3.1 Traffic steering per-UE

```
{
  "scope": {
    "ueId": "855"
  },
  "tspResources": [
    {
      "cellIdList": [
        "39",
        "40"
      ],
      "preference": "PREFER"
    },
    {
      "cellIdList": [
        "81",
        "82",
        "83"
      ],
      "preference": "FORBID"
    }
  ]
}
```

B.2.3.2 Traffic steering per-slice

```
{
  "scope": {
    "sliceId": "11",
    "qosId": "67"
  },
  "tspResources": [
    {
      "cellIdList": [
        "55",
        "65"
      ],
      "preference": "SHALL"
    },
    {
      "cellIdList": [
        "01",
        "02",
        "03"
      ],
      "preference": "AVOID"
    }
  ]
}
```

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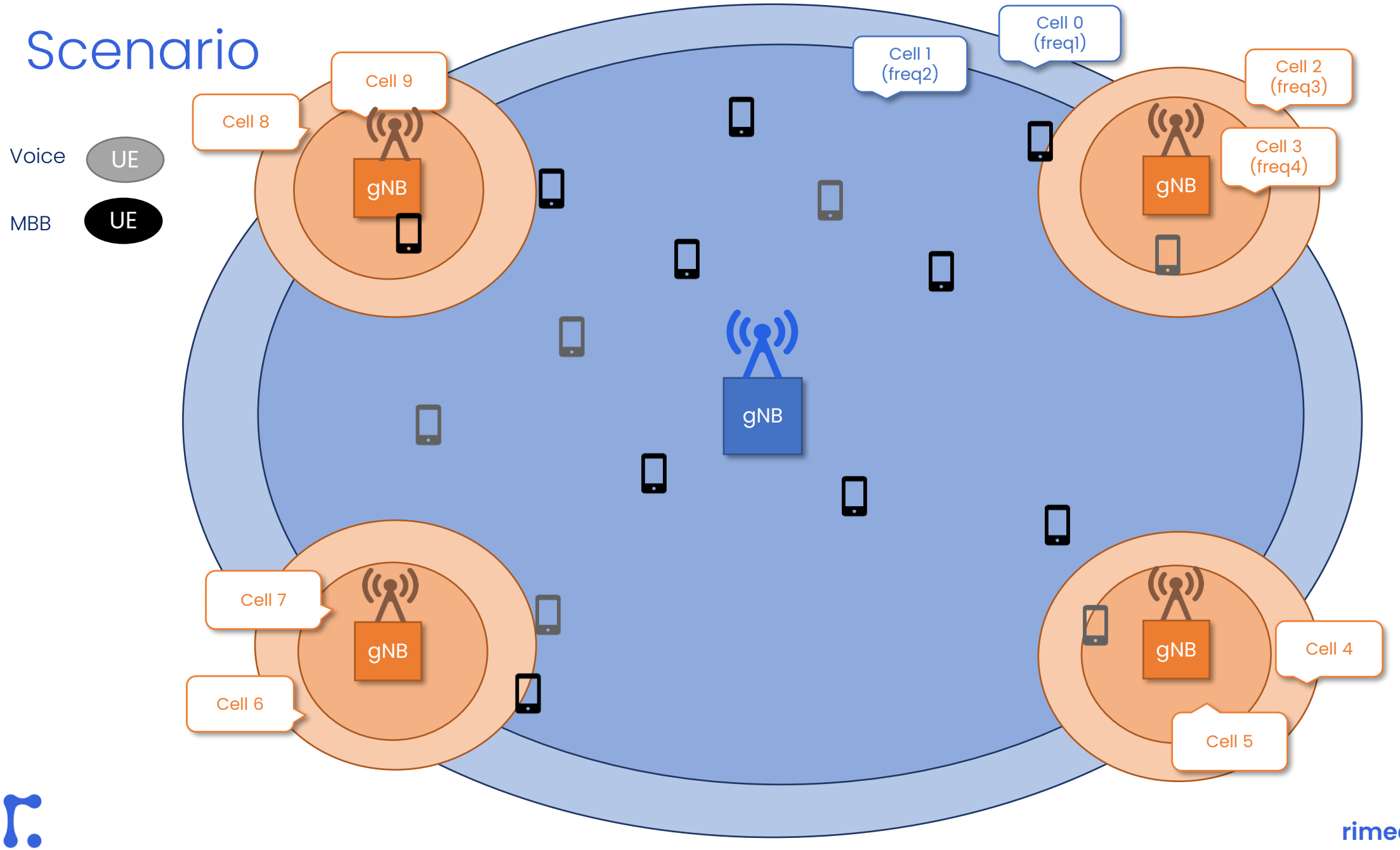
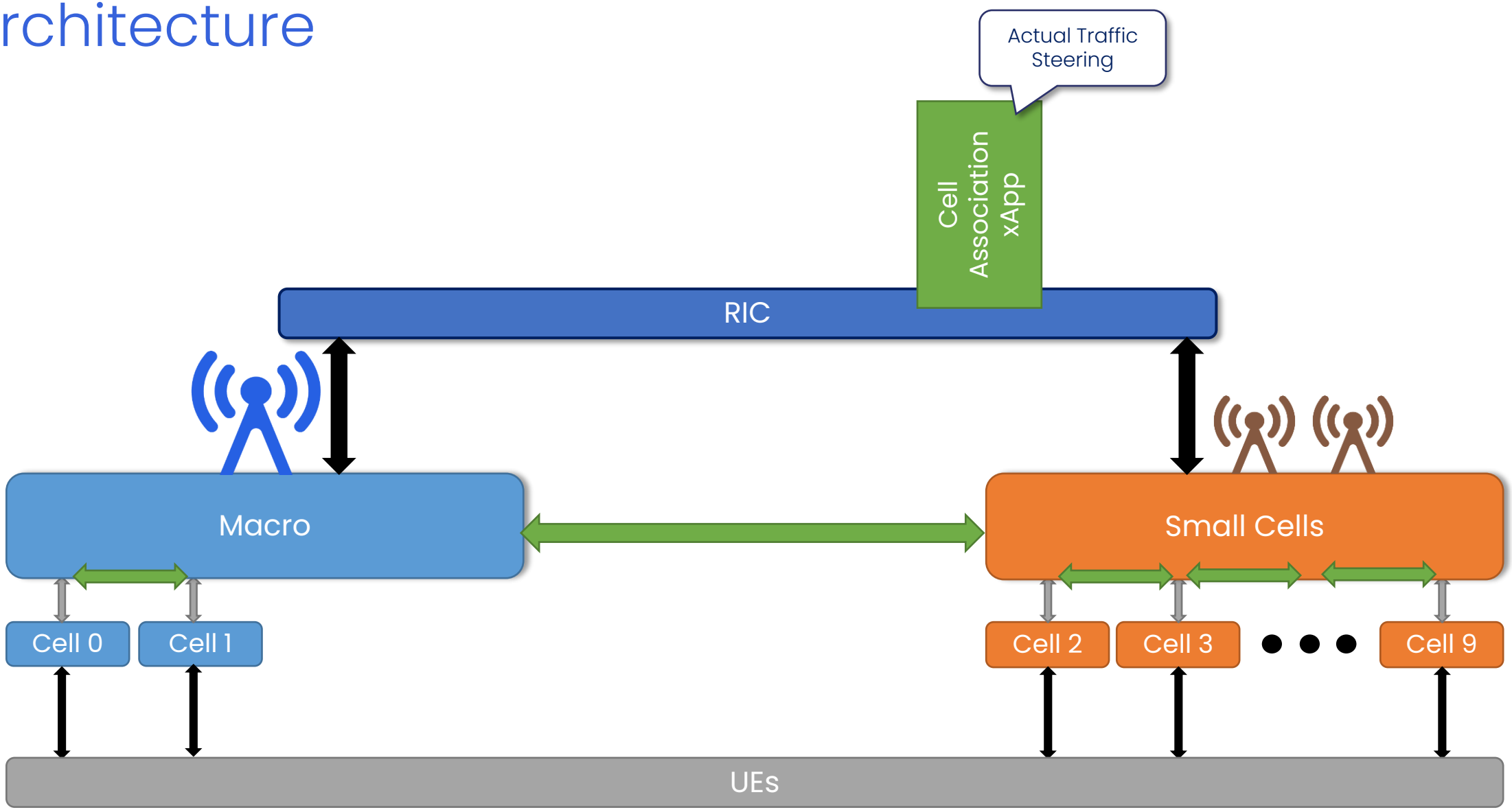
Based on: O-RAN.WG2.A1AP-v02.00

Traffic Steering Example Implementation

Scenario


Voice
UE
MBB
UE
Cell 0 (freq1)
Cell 1 (freq2)
Cell 2 (freq3)
Cell 3 (freq4)
Cell 4
Cell 5
Cell 6
Cell 7
Cell 8
Cell 9
gNB
gNB
gNB
gNB
gNB

Architecture

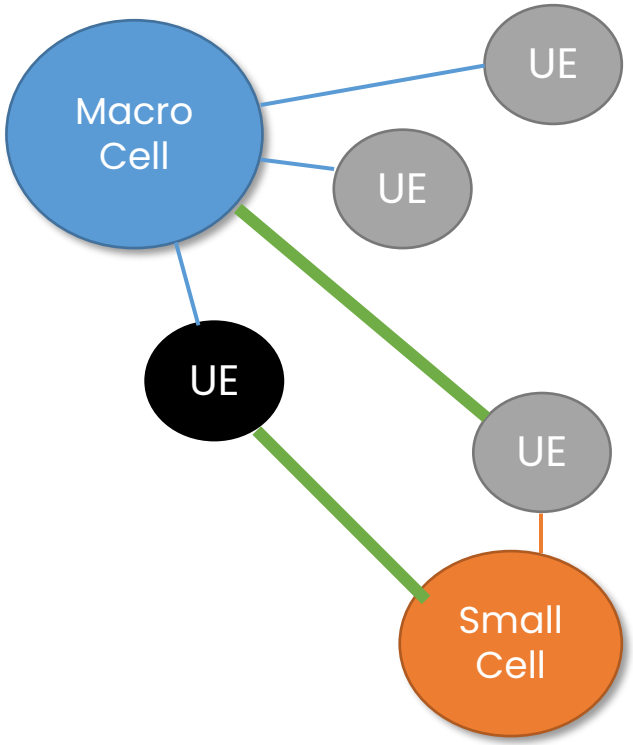


Cell Association xApp Operation

CA xAPP

Voice UE

MBB UE



Cell Association xApp

CA xAPP

```
# IN:
# - ue_rx_power - [no_of_cells, no_of_UEs] - received power for each UE from each cell [dBm]
# - cell_cre    - [no_of_cells]            - CRE value set for each cell [dB]
# - cell_class  - [no_of_cells]            - class of each cell [index]
# - ue_class    - [no_of_UEs]              - class of each UE [index]
# - association_policy - [1]               - object of class: PolicyAssociation (selected policy)
# OUT:
# - association - [no_of_UEs]              - association table with indexes of selected cells
```

Vendor One

```
POLICY_WEIGHT = {
  "DEFAULT": 0,
  "PREFER": 10,
  "AVOID": -10,
  "SHALL": 1000,
  "FORBID": -1000
}
```

Vendor Two

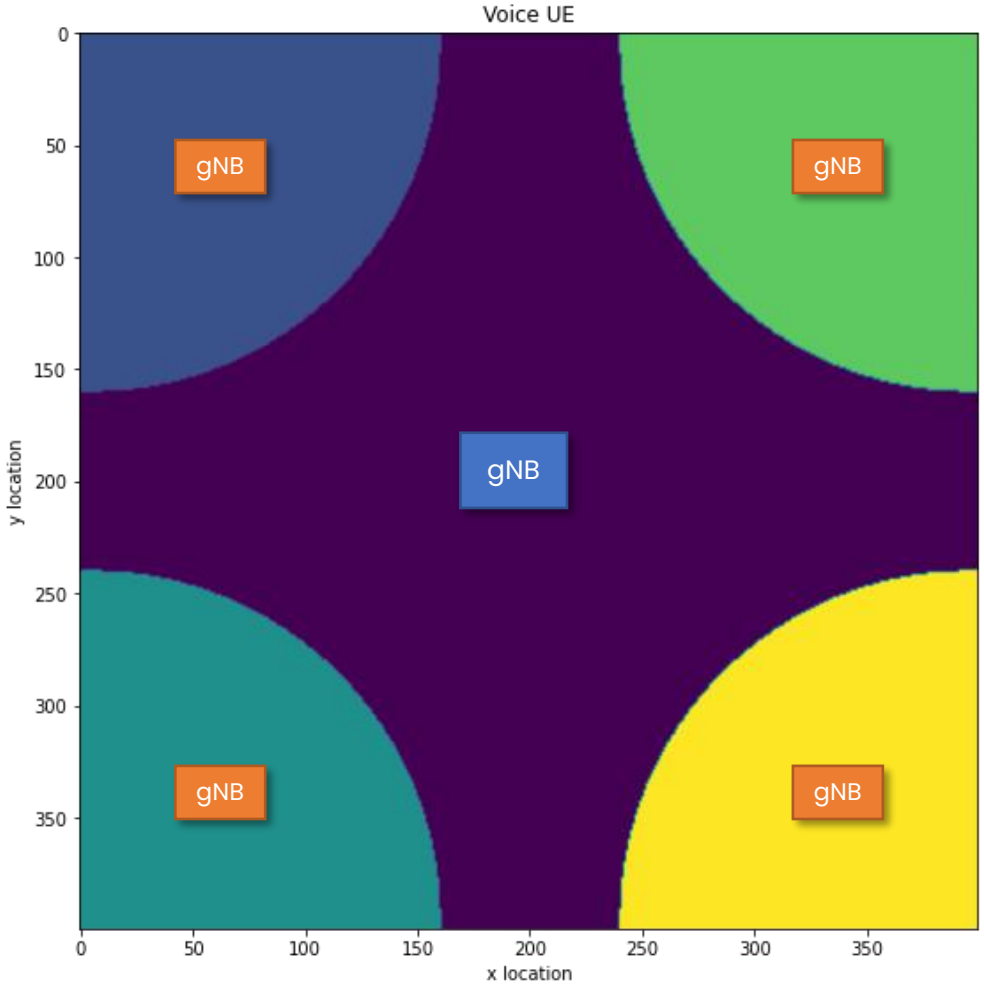
```
POLICY_WEIGHT = {
  "DEFAULT": 0,
  "PREFER": 10,
  "AVOID": 0,
  "SHALL": 1000,
  "FORBID": 0
}
```

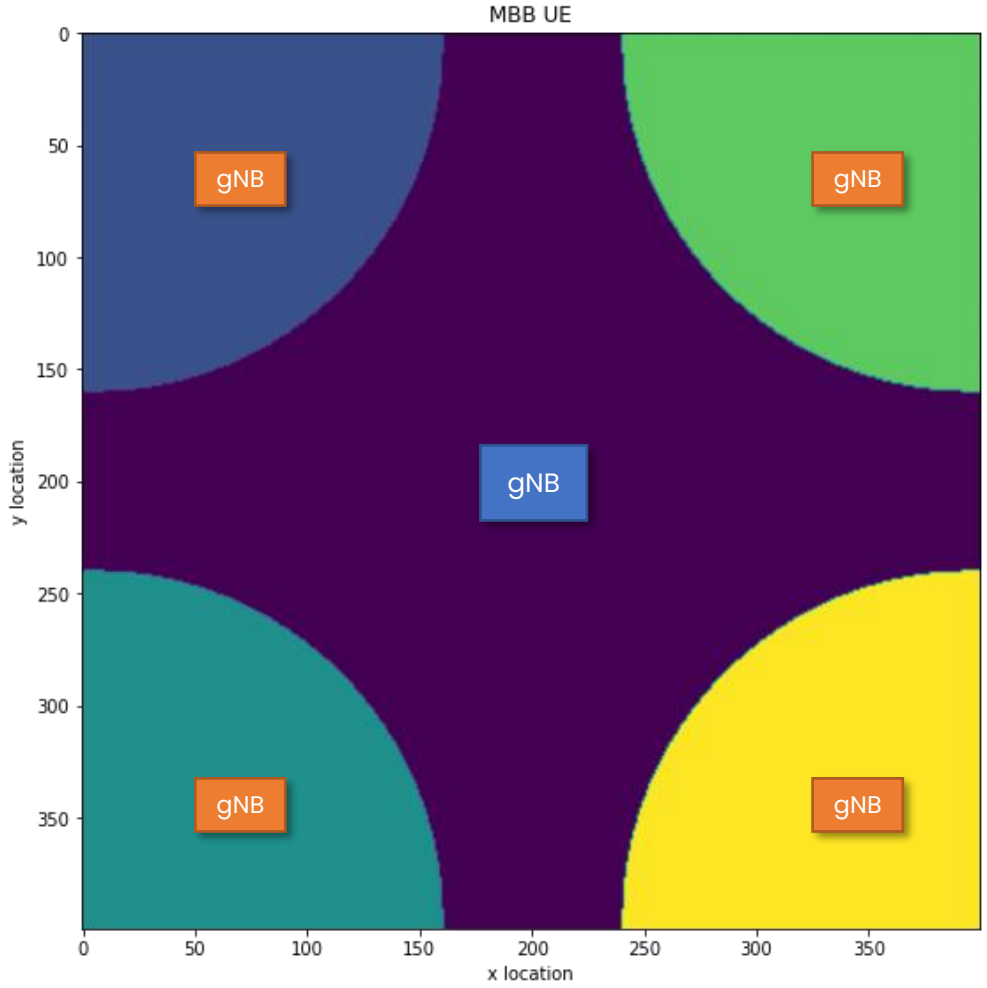
```
policies:
- id: 0
  label: DEFAULT
  name: defaultPolicySet
  rules:
  - user_type_id: 0   Voice
    cell_type_id: 1   Pico
    preference: DEFAULT
  - user_type_id: 1   MBB
    cell_type_id: 1   Pico
    preference: DEFAULT
- id: 1
  label: OFFLOAD
  name: offloadingPolicySet
  rules:
  - user_type_id: 0   Voice
    cell_type_id: 1   Pico
    preference: AVOID
  - user_type_id: 1   MBB
    cell_type_id: 1   Pico
    preference: PREFER
- id: 2
  label: SEPARATE
  name: separatingPolicySet
  rules:
  - user_type_id: 0   Voice
    cell_type_id: 1   Pico
    preference: FORBID
  - user_type_id: 1   MBB
    cell_type_id: 1   Pico
    preference: SHALL
```

Initial Simulation Results – Reference Scenario (Local)

Simulation Results – Association Map

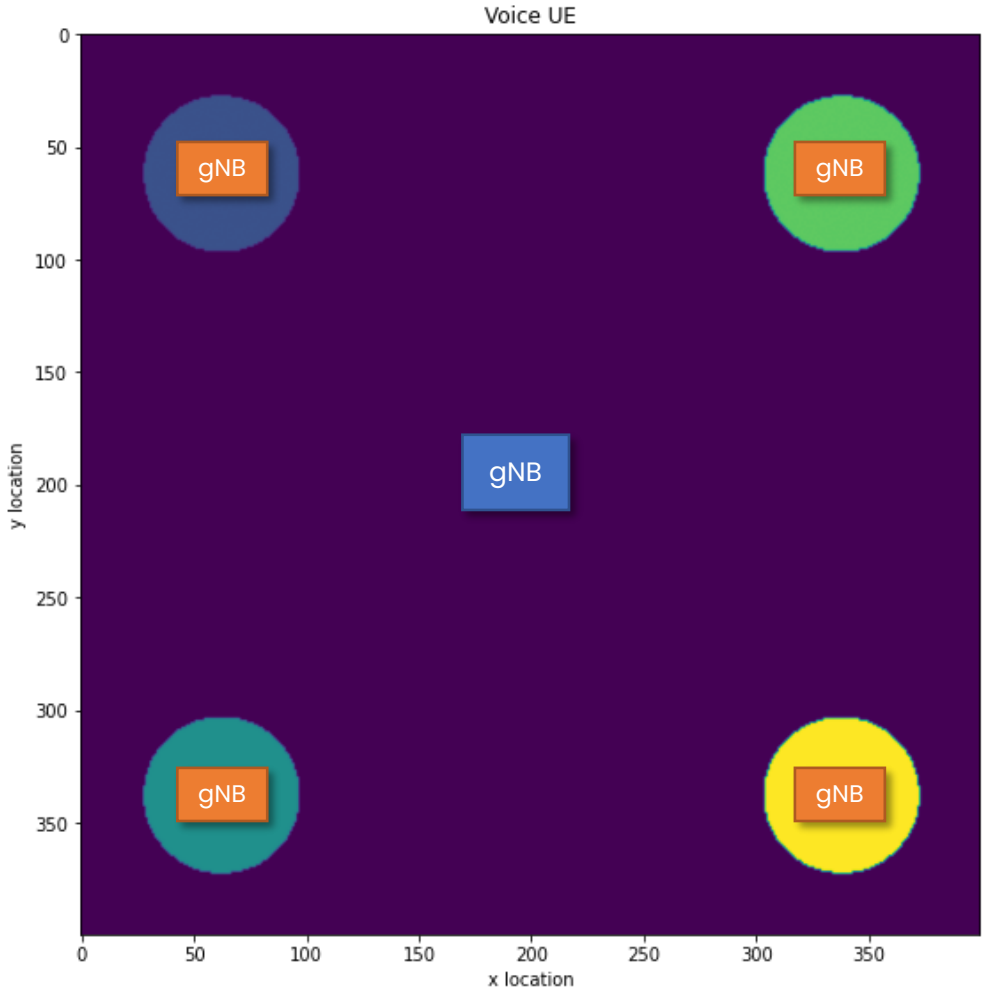
Policy: "**Default**"

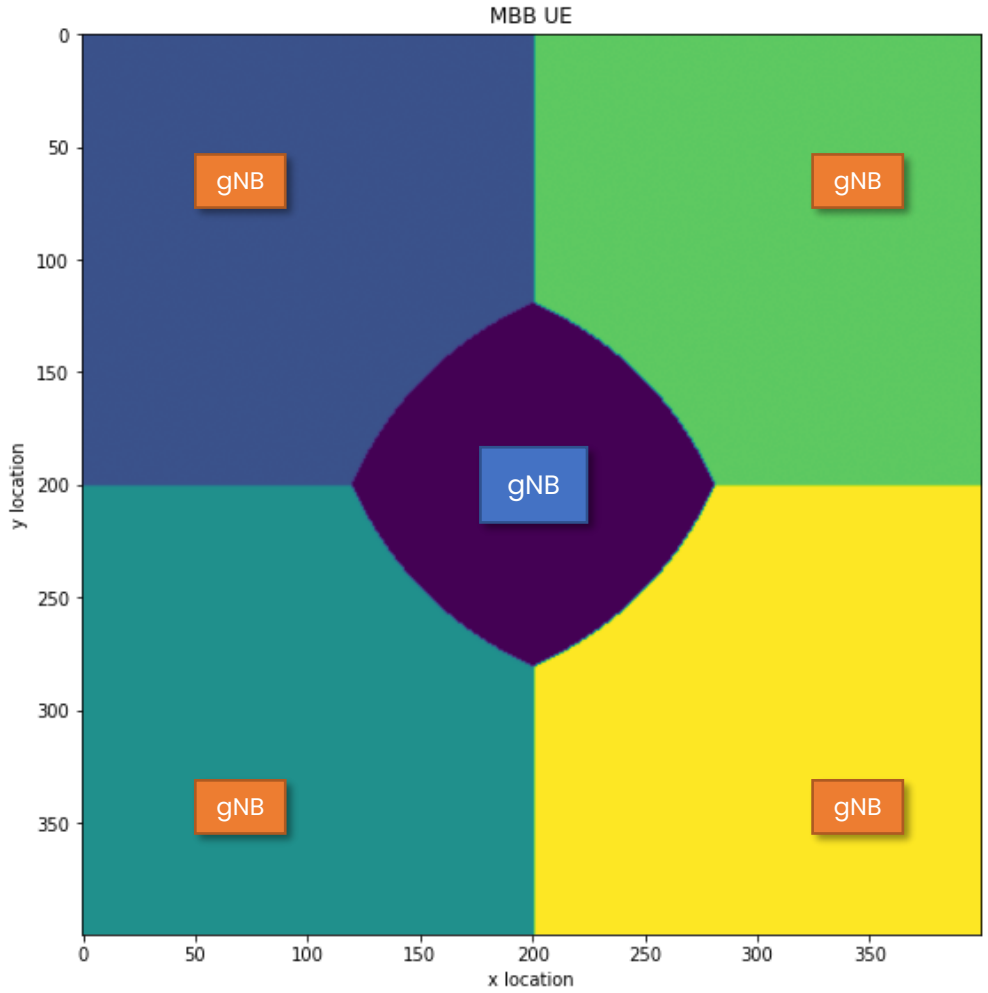




Simulation Results – Association Map

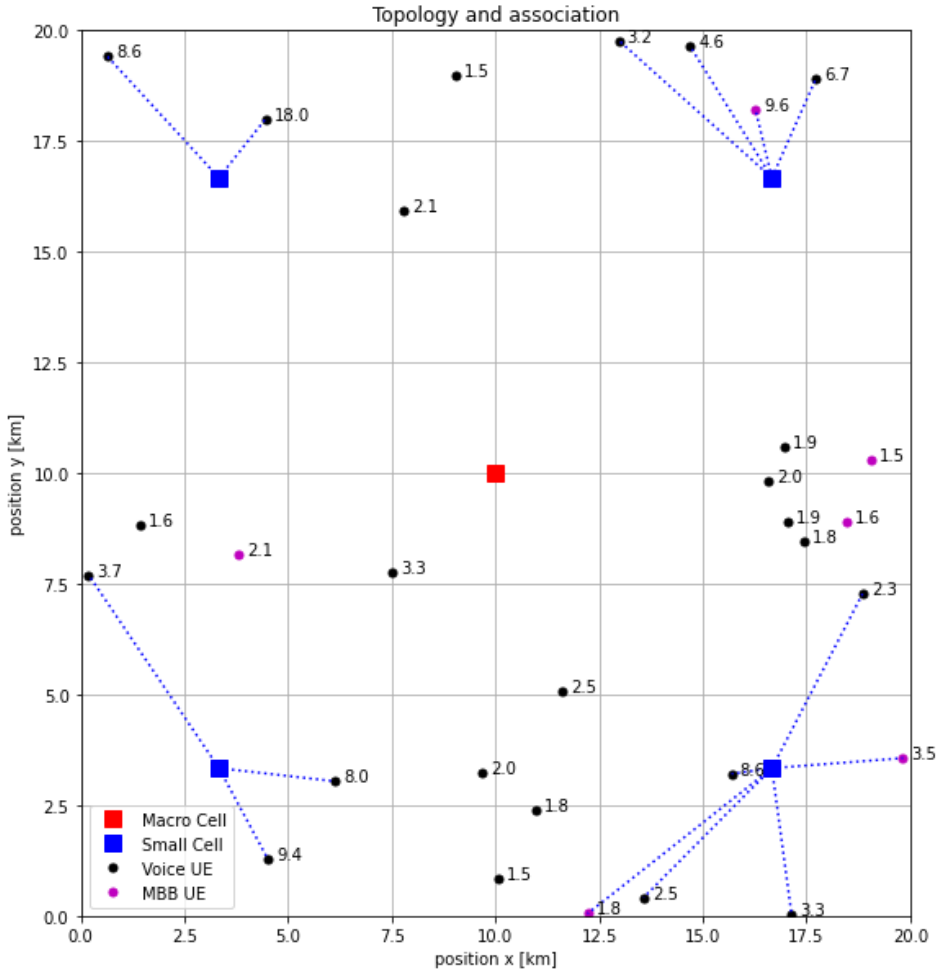
Policy: "**Offload**"

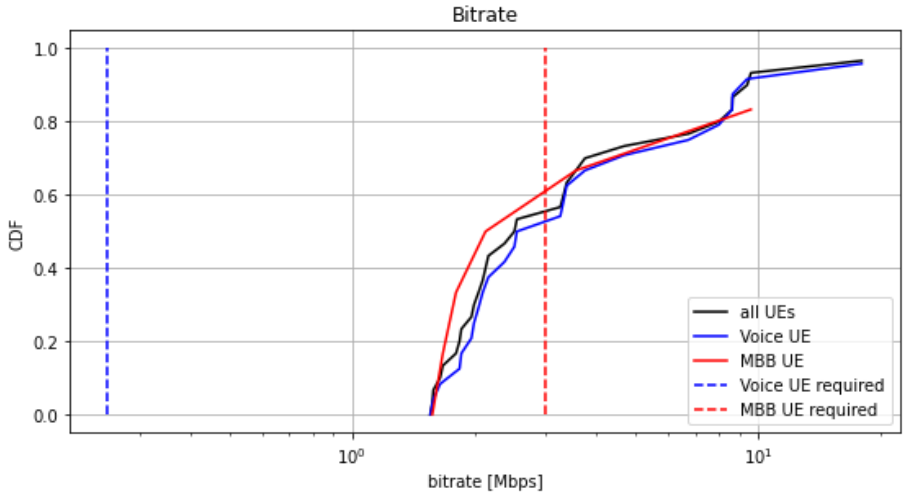


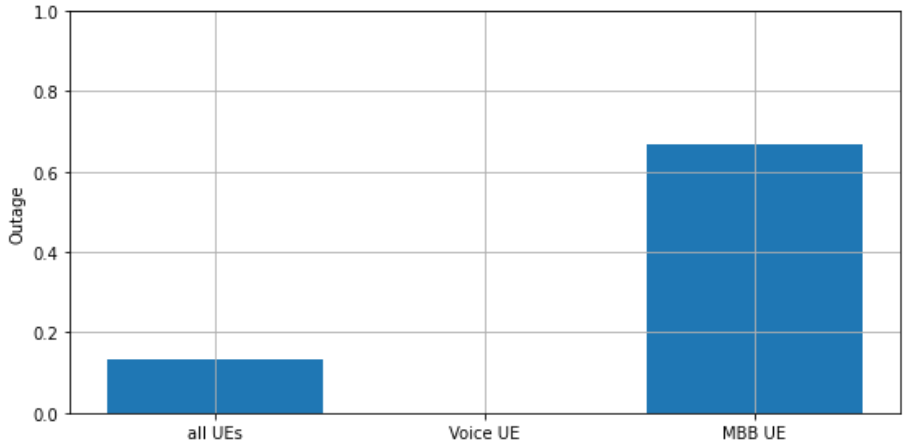


Simulation Results – Single Shot Performance

Policy association: "**Default**"

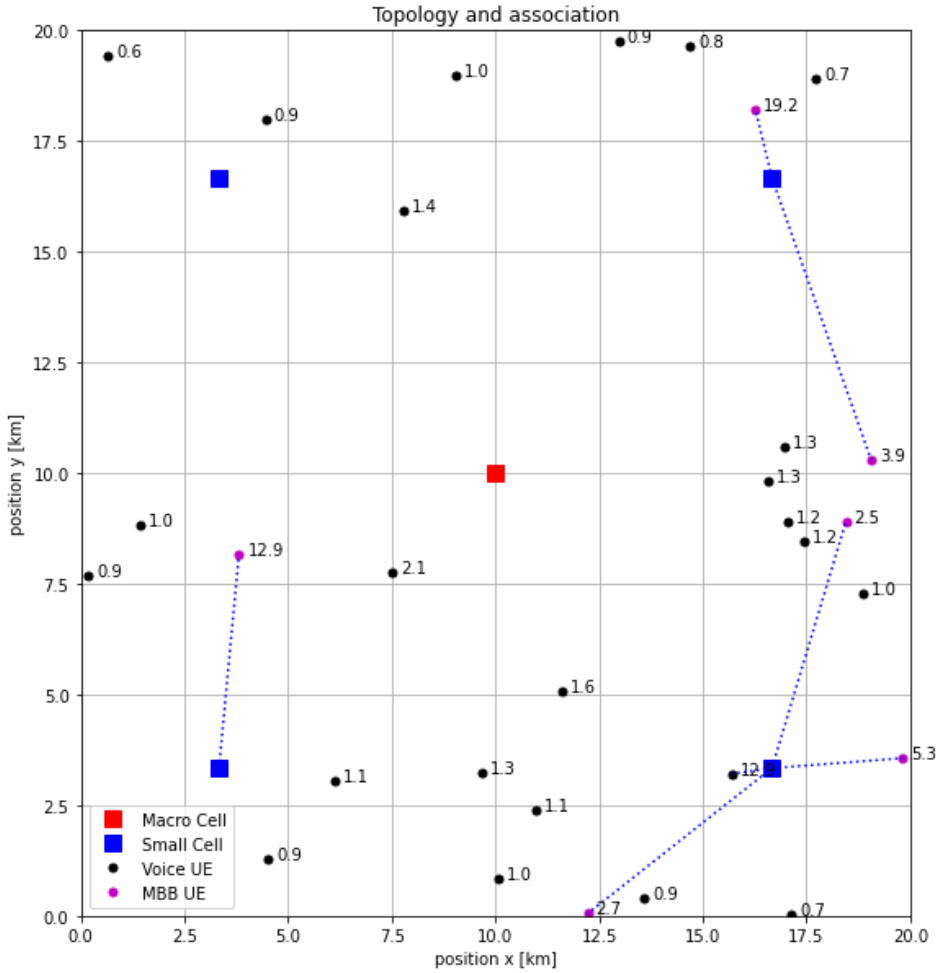


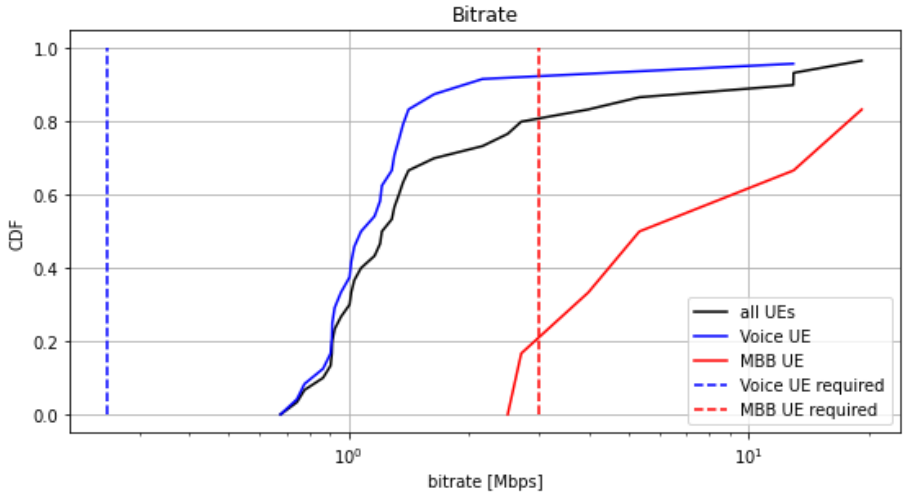


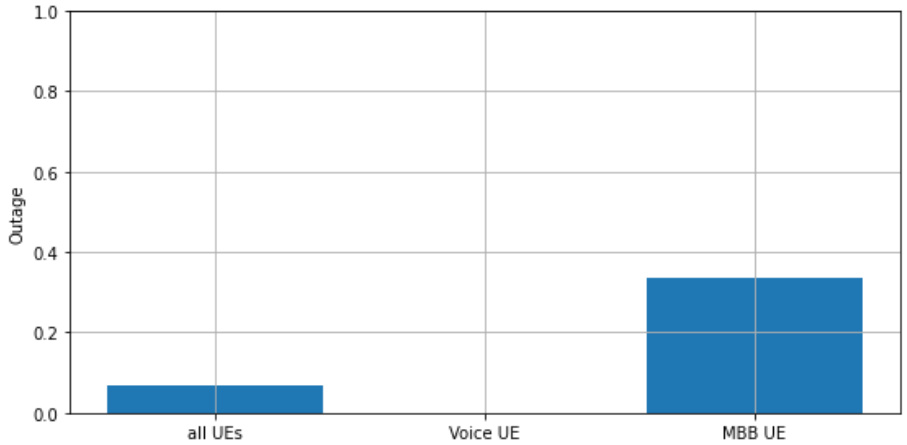


Simulation Results – Single Shot Performance

Policy association: "**Offload**"

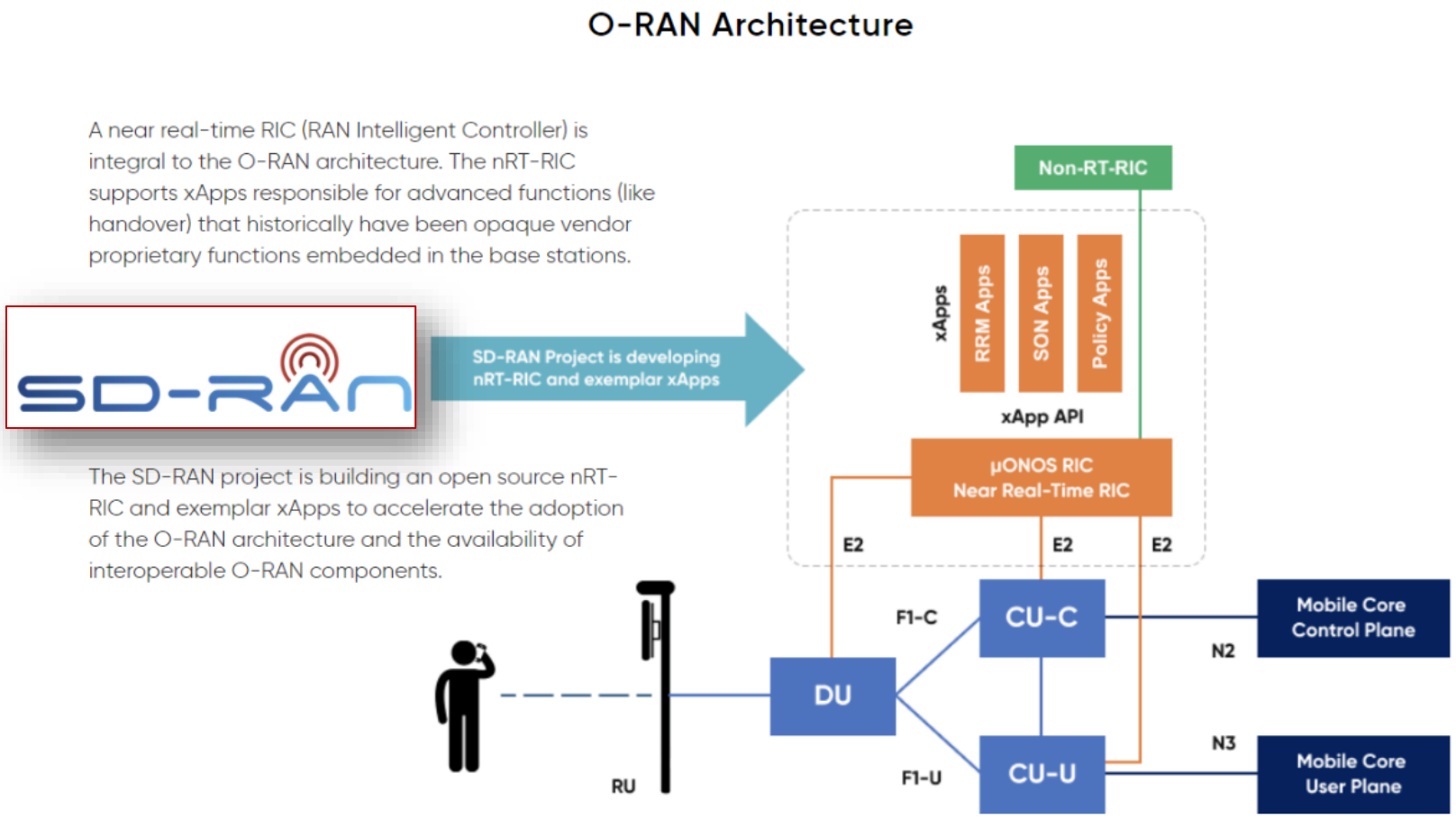






RANSim and SD-RAN Implementation

Open Networking Foundation SD-RAN Project



Open Networking Foundation SD-RAN Project

µONOS RIC

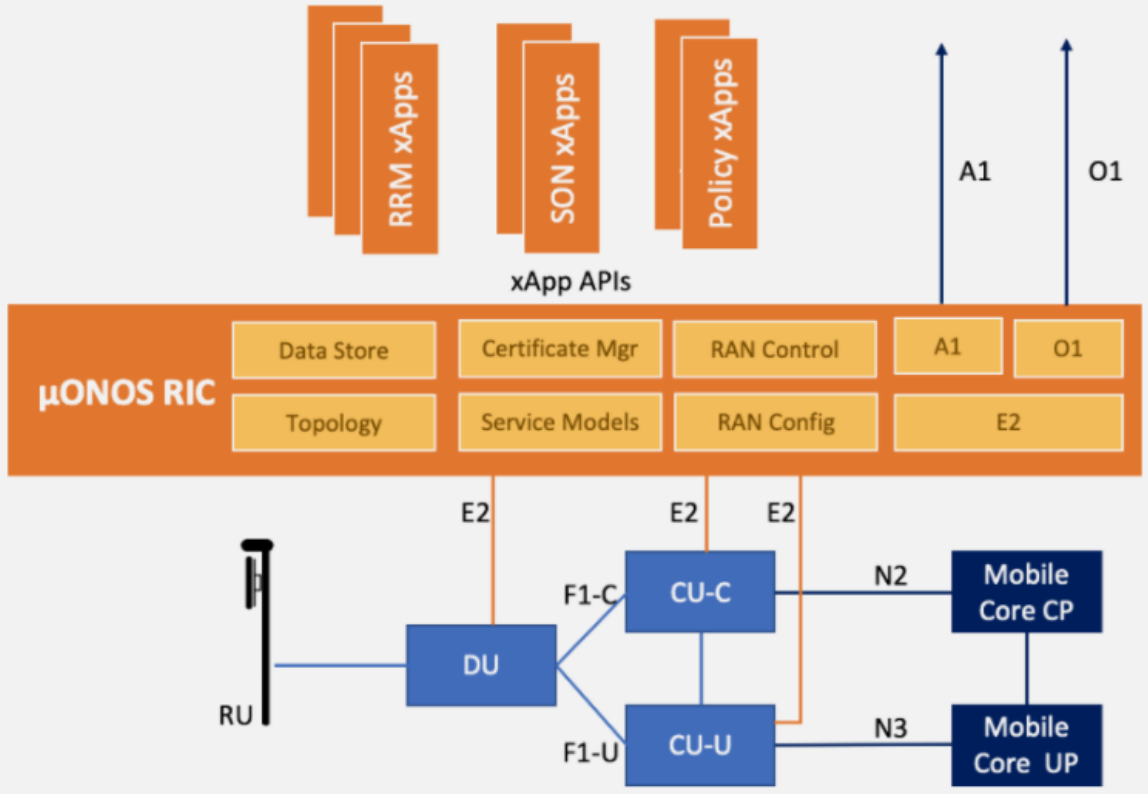
At the heart of ONF's SD-RAN architecture is the µONOS RIC, based on ONOS, the leading open source SDN control plane for operators.

ONOS RIC is a cloud-native, carrier-grade SDN controller that enables:

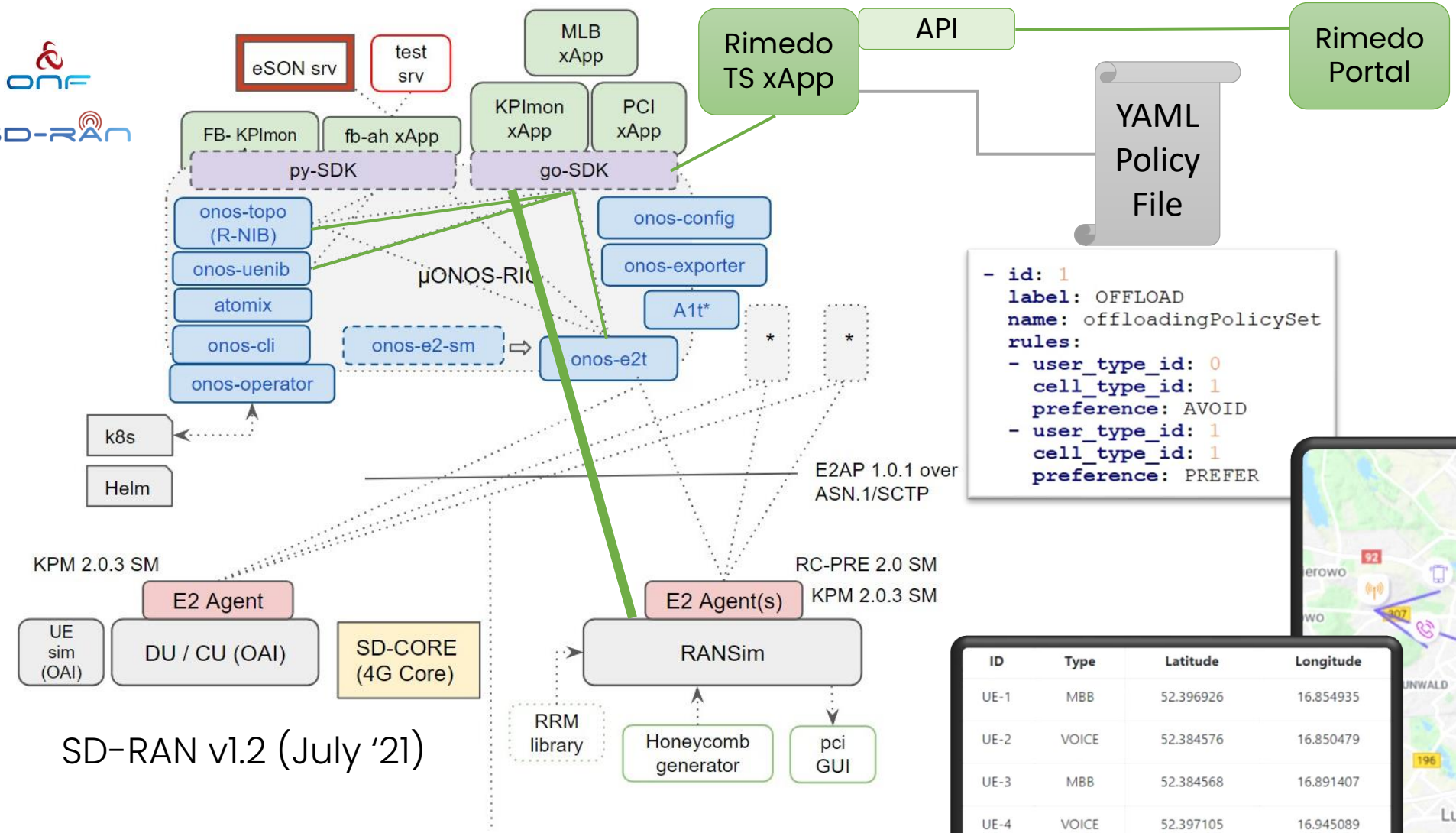
- Ease in scalability
- High performance
- High availability
- Support for multi-vendor equipment

The µONOS RIC uses a microservices architecture that includes the following elements:

- Certificate Manager
- Topology Manager
- Configuration Manager
- RAN Control Manager
- Distributed Store



RANSim-based Implementation



SD-RAN v1.2 (July '21)

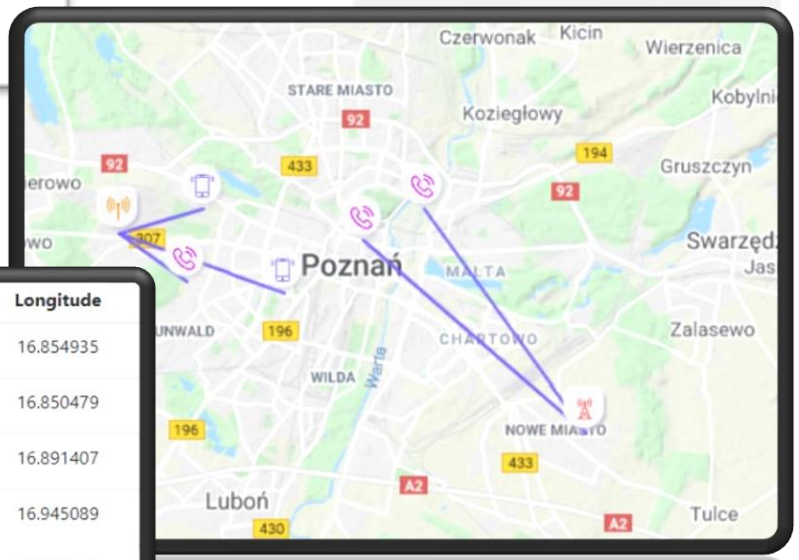
Rimedo TS xApp

API

Rimedo Portal

YAML Policy File

```
- id: 1
  label: OFFLOAD
  name: offloadingPolicySet
  rules:
  - user_type_id: 0
    cell_type_id: 1
    preference: AVOID
  - user_type_id: 1
    cell_type_id: 1
    preference: PREFER
```



ID	Type	Latitude	Longitude
UE-1	MBB	52.396926	16.854935
UE-2	VOICE	52.384576	16.850479
UE-3	MBB	52.384568	16.891407
UE-4	VOICE	52.397105	16.945089
UE-5	VOICE	52.384841	16.918695

SD-RAN in a Box

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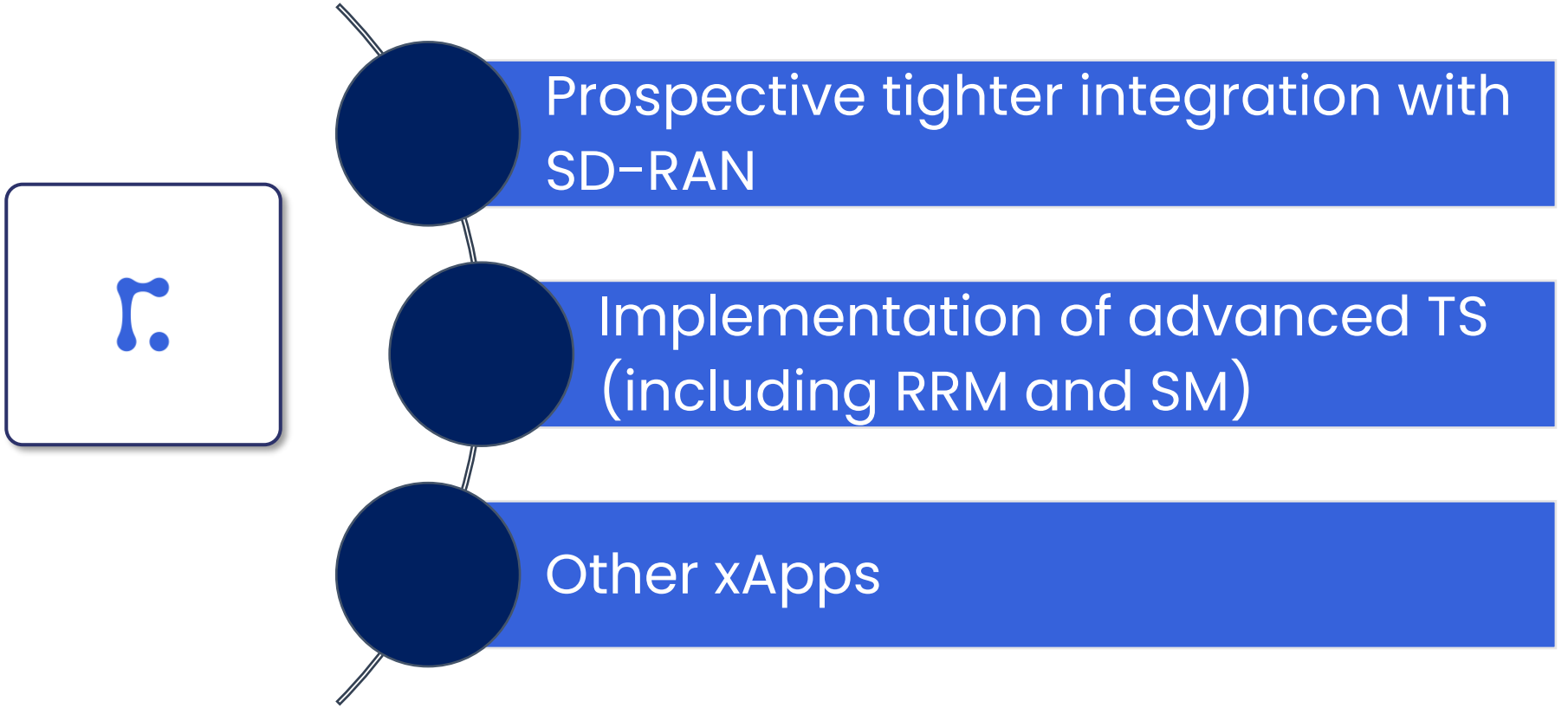
Future Directions

What's Next



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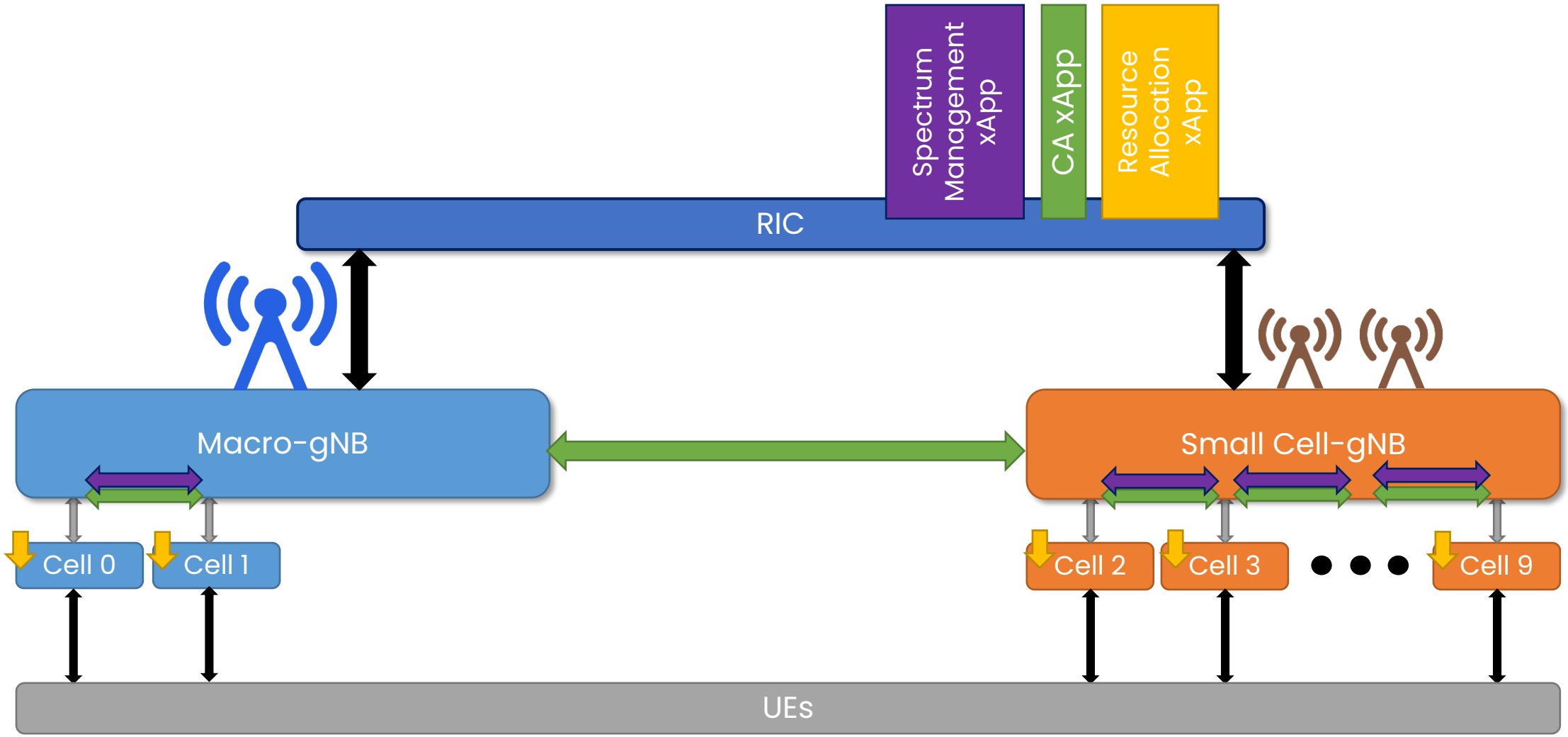
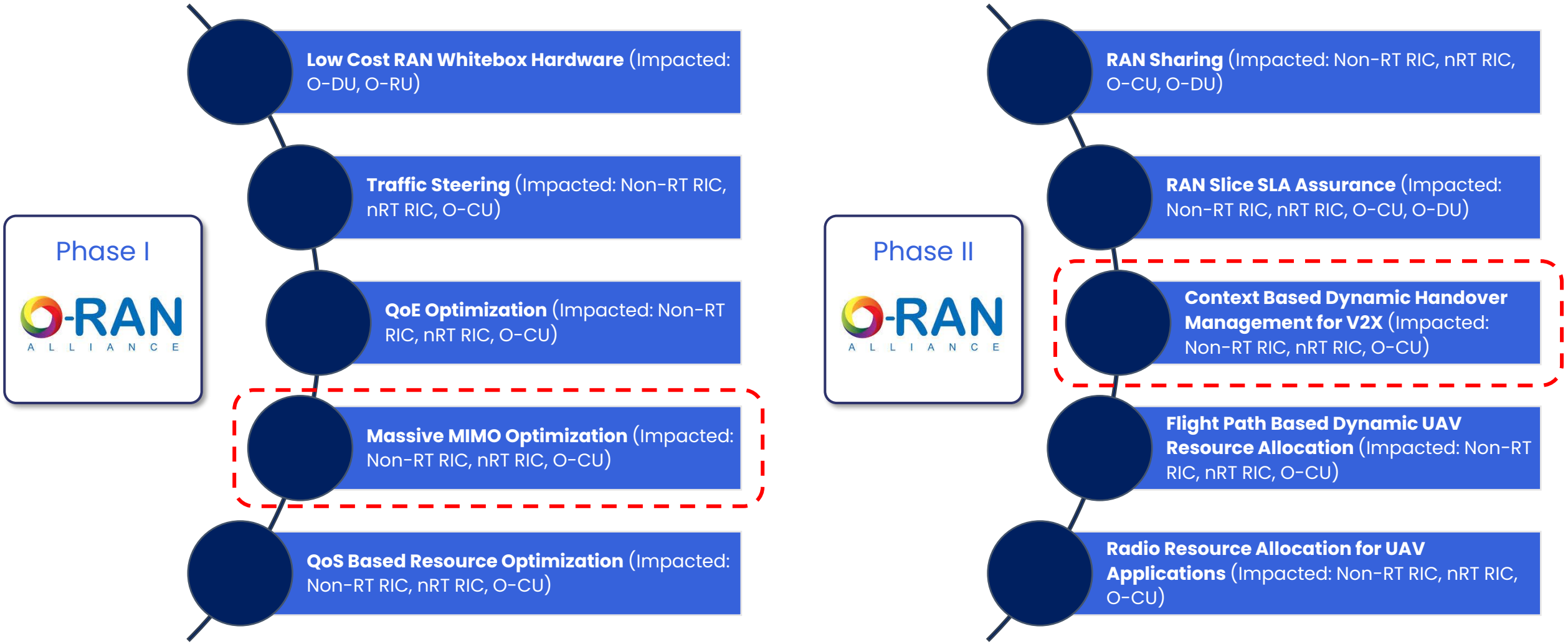
Based on: O-RAN Alliance WP (O-RAN Use Cases and Deployment Scenarios)

Traffic Steering Use Case – Adding More xApps



O-RAN Use Cases



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Based on: O-RAN Alliance WP (O-RAN Use Cases and Deployment Scenarios)

Summary

Using O-RAN Approach

Your trusted partner in:
LTE, 5G & Beyond, RRM, Wi-Fi, IoT, O-RAN, Private Mobile Networks.

Let's keep in touch!

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