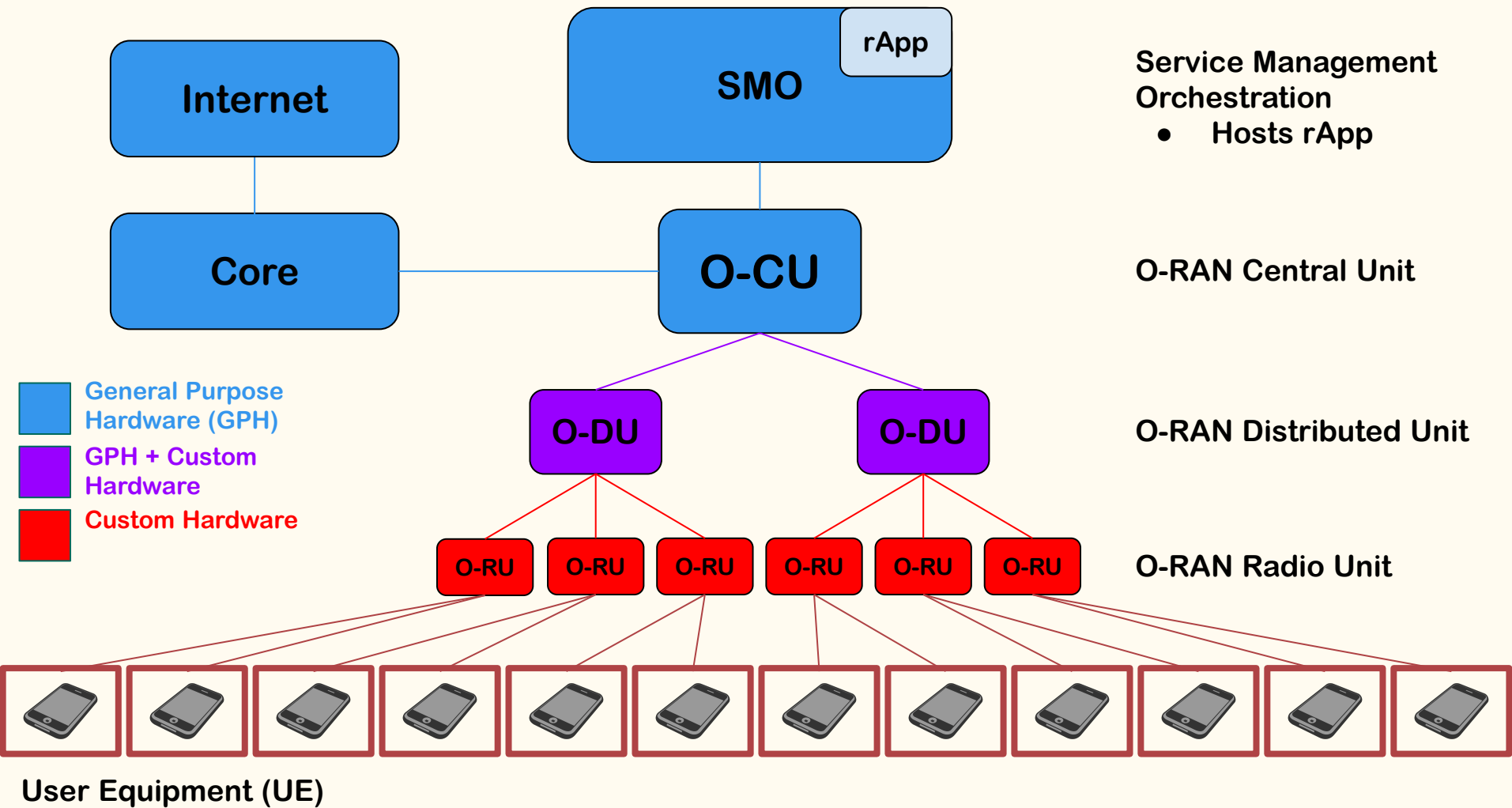# 5G/NextG

—

By Jeff Acevedo, Sanskar Shah, Nikhil Sampath, Ryan Lin, Sreeram Mandava

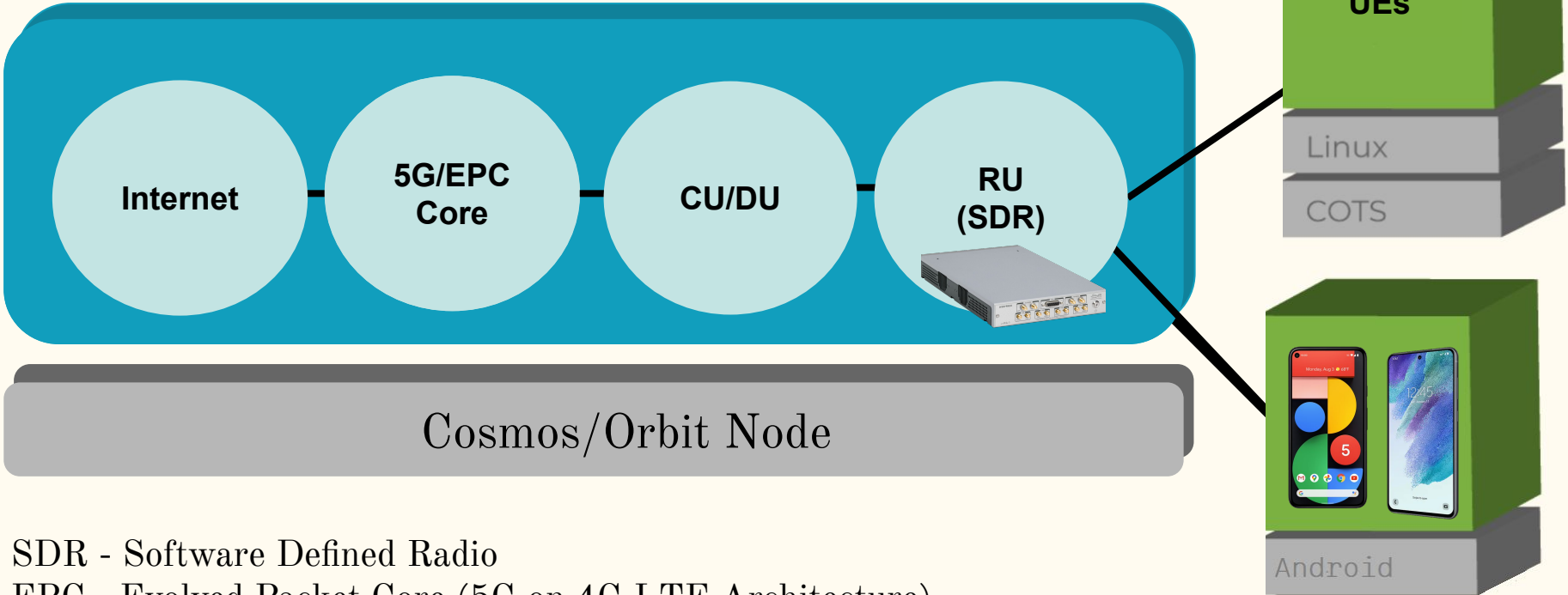# Project Objectives:

- Open source implementation of 5G
- Network control applications
  - Resilience
  - Security
- Done in context of Open RAN (O-RAN)

Internet

SMO   rApp

Service Management Orchestration
- Hosts rApp

Core

O-CU

O-RAN Central Unit

General Purpose Hardware (GPH)

GPH + Custom Hardware

Custom Hardware

O-DU   O-DU

O-RAN Distributed Unit

O-RU O-RU O-RU O-RU O-RU O-RU

O-RAN Radio Unit

User Equipment (UE)

O-RAN Implementation

OPEN AIR
INTERFACE

amarisoft

UEs

Linux

COTS

Internet — 5G/EPC Core — CU/DU — RU (SDR)

Android

Cosmos/Orbit Node

SDR - Software Defined Radio
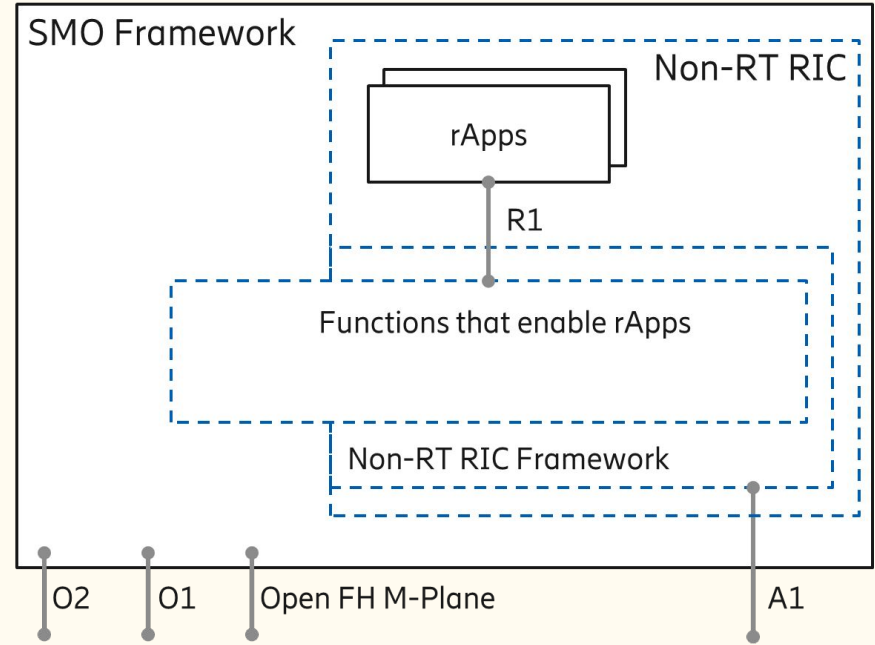EPC - Evolved Packet Core (5G on 4G LTE Architecture)

SMO and rApps:

SMO:
- Service Management and Orchestration responsible for RAN domain management and workflow optimization

RIC:
- Non-Real-Time RAN Intelligent Controller that hosts/enables the application.

rApp:
- Modular application providing non-real time control of RAN
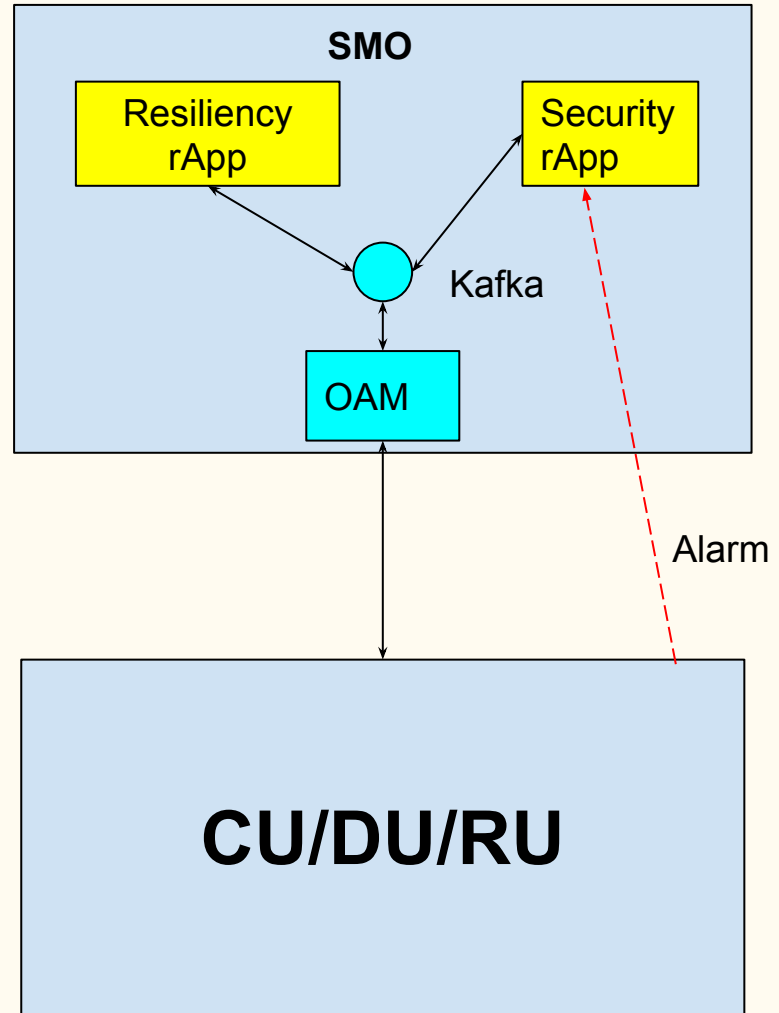

O-RAN Interfaces:
- A1: Interface between Non-RT RIC and the Near-RT RIC
- O1: Interface between SMO framework and O-RAN managed elements
- O2: Interface between SMO and the O-Cloud
- Open FH M-Plane: Interface between SMO and O-RU

Security rApp

- Closed loop control in SMO

- Reads messages from Kafkabus

- Processes alarms from RAN

- Isolates compromised nodes

KAFKABUS

CODE

```
PROBLEMS   OUTPUT   DEBUG CONSOLE   TERMINAL   PORTS

Time:  2023-06-15T01:13:26.1Z

Source Name:  O-DU-1122
Event Severity:  MAJOR
Alarm Condition:  Hmm, I might have been hacked!
Specific Problem:  Hmm, I might have been hacked!
Time:  2023-06-15T01:13:46.1Z

Source Name:  O-DU-1123
Event Severity:  MAJOR
Alarm Condition:  CPRI Port Down
Specific Problem:  CPRI Port Down
Time:  2023-06-15T01:13:46.1Z

Source Name:  O-DU-1123
Event Severity:  NORMAL
Alarm Condition:  CPRI Port Down
Specific Problem:  CPRI Port Down
Time:  2023-06-15T01:14:06.2Z

Source Name:  O-DU-1122
Event Severity:  NORMAL
Alarm Condition:  Hmm, I might have been hacked!
Specific Problem:  Hmm, I might have been hacked!
Time:  2023-06-15T01:14:06.2Z

Source Name:  O-DU-1123
Event Severity:  MAJOR
Alarm Condition:  CPRI Port Down
Specific Problem:  CPRI Port Down
Time:  2023-06-15T01:14:26.2Z

Source Name:  O-DU-1122
Event Severity:  CRITICAL
Alarm Condition:  Yikes, I have been hacked!
Specific Problem:  Yikes, I have been hacked!
Time:  2023-06-15T01:14:26.2Z
```

```python
#!/usr/bin/env python3
import requests
import json
import time

# ================  GLOBALS  ========================
node_url  = "https://odlux.oam.smo.indigo.cosmos-lab.org"
alarm_url = "https://messages.smo.indigo.cosmos-lab.org"
username  = "admin"
password  = "Kp8bJ4SXszM0WXlhak3eHlcse2gAw84vaoGGmJvUy2U"
node_header  = {
        "Authorization": "Basic " + f"{username}:{password}",
        "Accept": "application/yang-data+json"
}
alarm_header = {
        "Authorization": "Basic " + f"{username}:{password}",
        "Accept": "application/json"
}
# NODES
#all nodes and pertaining info
get_all = "/rests/data/network-topology:network-topology/topology=topology-netconf?content=nonconfig"
#just the ids of the nodes
get_ids = "/rests/data/network-topology:network-topology/topology=topology-netconf?fields=node(node-id)"

# ALARMS
timeout = 5000
#all alarm topics
get_topics = "/topics"
#pnfRegistration
get_pnf = "/events/unauthenticated.VES_PNFREG_OUTPUT/1/1?timeout={{{timeout}}}"
#faults
get_faults = "/events/unauthenticated.SEC_FAULT_OUTPUT/1/1?timeout={{{timeout}}}"
# ==================================================

# function performs get request to get the node info
def get_request(url_ending:str, type:str):
        if type == "node":
                headers = node_header
                url = node_url + url_ending
```
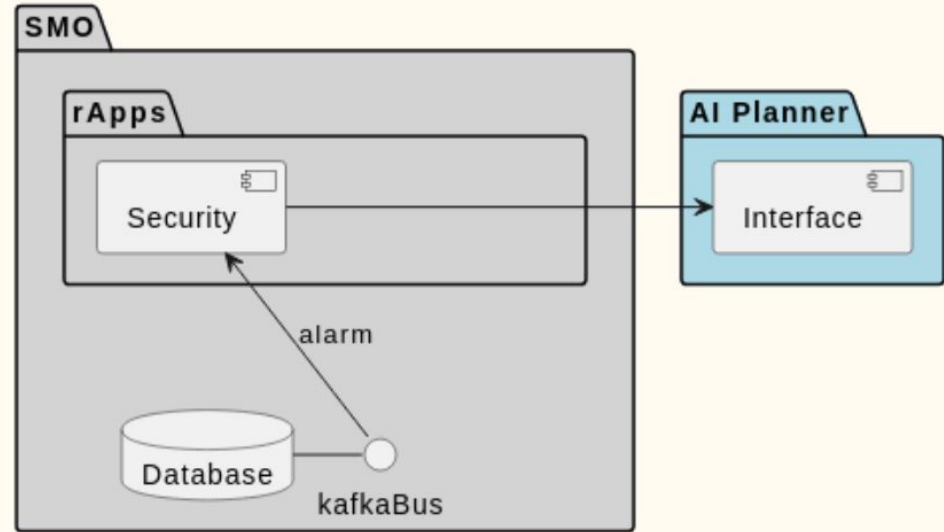
Network Topology and Resilience rApp

- Topology: Info about parent/child relationship, node status, connections, etc.
- Resilience: Maintain and optimize connectivity
- Resilience rApp:
  - Uses topology to choose optimal paths
  - Communicates with Security rApp to update topology
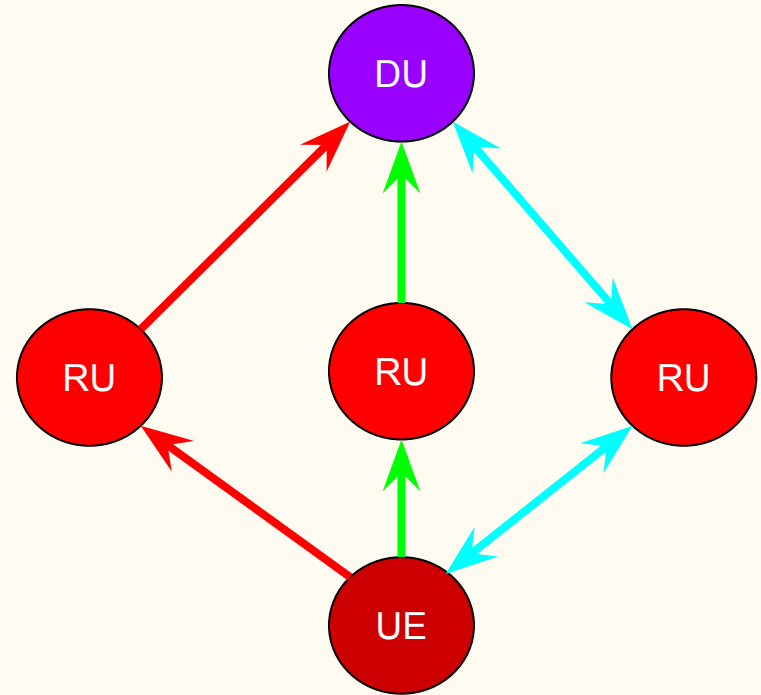
AI Planner

- AI planning: Given a task to perform, and a set of available actions, find a subset of these actions and a suitable ordering (the plan) that when executed achieves the task.
- Sophisticated management and coordination in multi-network, multi-SMO system
- In a single network setting, could help the rApps with more sophisticated plans (responses).

Questions?