O-RAN Curriculum Development, Cloud-Native O-RAN

Meet the team

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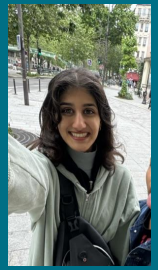

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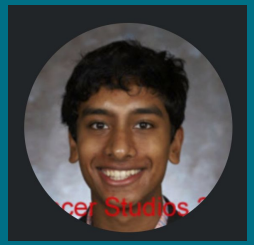

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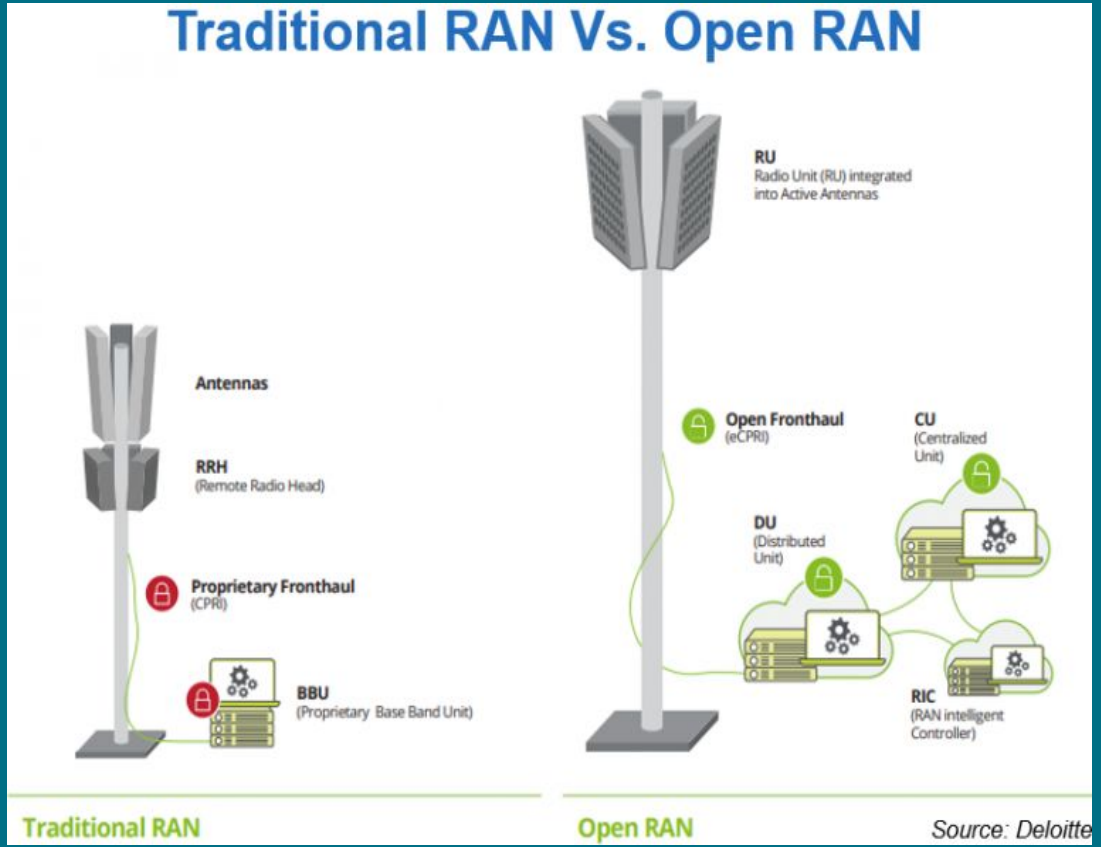
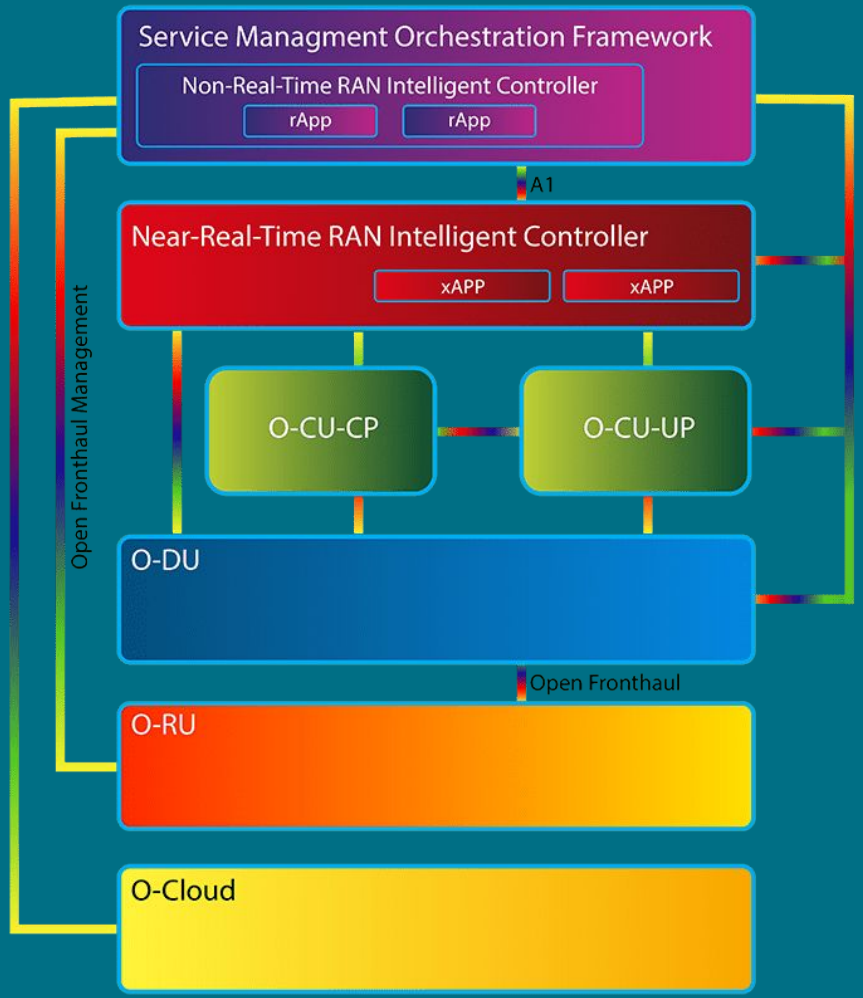
Radio Access Network (RAN)

- Connects User Devices to cellular network core
- Traditionally closed system





O-RAN Architecture

Project Overview

- Develop O-RAN Curriculum
- Develop rApps
- Setup SMO and O-RU frameworks for testing Hybrid Management-plane

Acronyms:

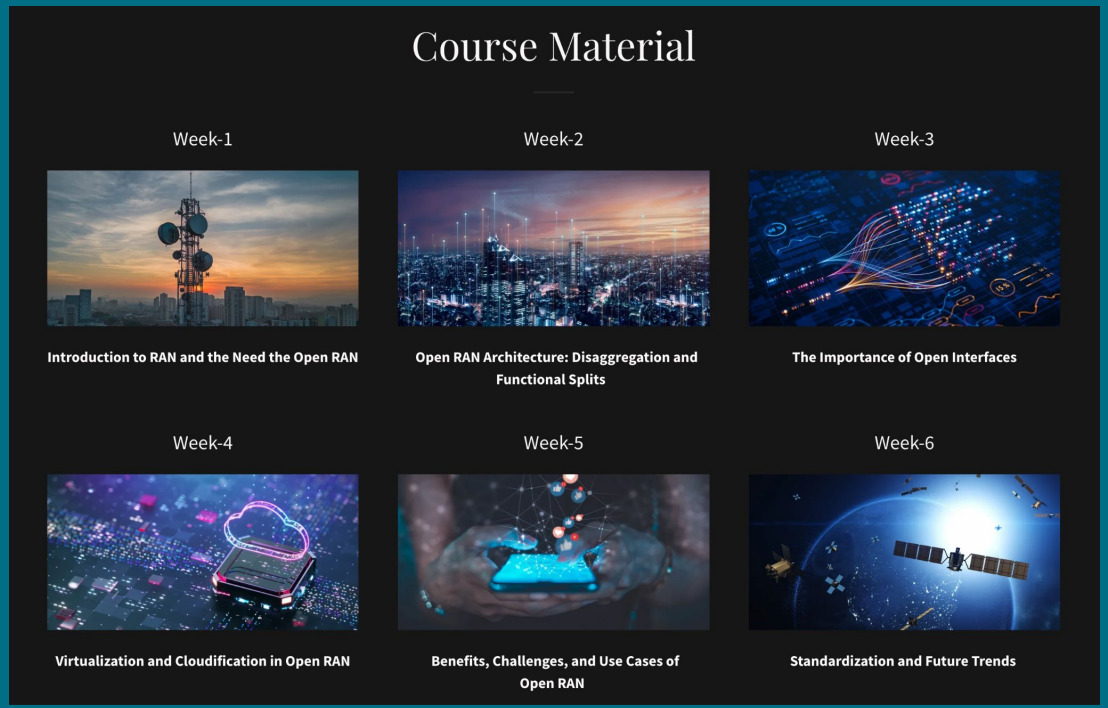
- SMO: Service Management and Orchestration
- O-RU: Open-Radio Unit (Antenna)

O-RAN CLASS

Taught about O-RAN fundamentals over 6 weeks

Goal: Create resource for students by students to educate future workforce on Open RAN

Website: https://praxeum.com/



PRAXEUM

HOME CURRICULUM

Additional Resources

This page links to several websites that we at Praxeum have found helpful in learning about O-RAN. From the O-RAN Alliance itself, to MNO's and Suppliers, these sites have great information on O-RAN and it's benefits.

O-RAN Alliance

As the organization leading the way in establishing standards for O-RAN architecture, the O-RAN Alliance's website has tons of great information for anyone wanting to learn more.

Nokia

Nokia, the Finnish Telecommunications company is a member of the O-RAN Alliance, and is working to help develop the open architecture.

Ericsson

Ericsson is a Telecom and networking company based out of Stockholm, Sweden. As a member of the O-RAN Alliance they are actively involved with the development of NON-RT RIC architecture and requirements.

PRAXEUM

HOME CURRICULUM

YANG Models

What are they?

The YANG (Yet Another Next Generation) modeling language is used for configuring and managing data in networking, both in a configuration and operational state. Created by the NETMOD working group of the IETF (Internet Engineering Task Force), it is defined in several technical documents published by the IETF, RFC 6020 and RFC 7950. YANG is used by networking protocols such as NETCONF and RESTCONF.

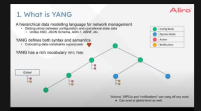


Image Source: https://www.youtube.com/watch?v=wucotJqW5O

These models can be represented by trees for easier readability using tools like Pyang, a Python tool used to validate, transform, and generate YANG models. Below is a sample of a YANG tree from the IETF.

```
+--rw interfaces
  | +--rw interface* [name]
  |    +--rw name                string
  |    +--rw description?        string
  |    +--rw type                identityref
  |    +--rw enabled?            boolean
  |    +--rw link-up-down-trap-enable?  enumeration
```

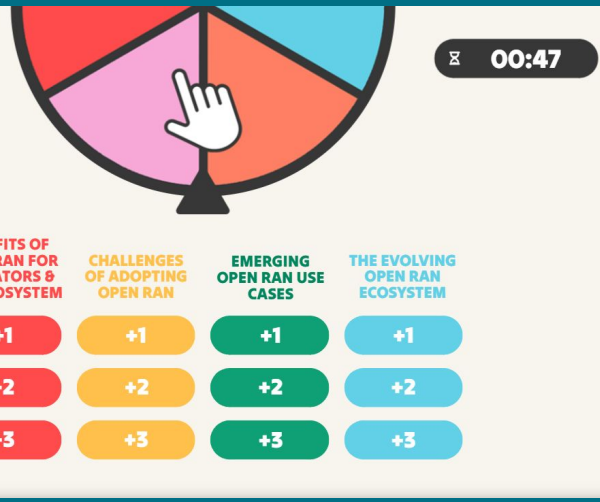
In the context of Open RAN, YANG is particularly important to the m-plane, which falls under Working Group 4 and the Open Fronthaul interface as the m-plane relies on NETCONF. Due to the standardization and flexibility the YANG models provide, they are a great way to enable interoperability.

Powered by

Journey Map

Click each circle and follow the timeline!

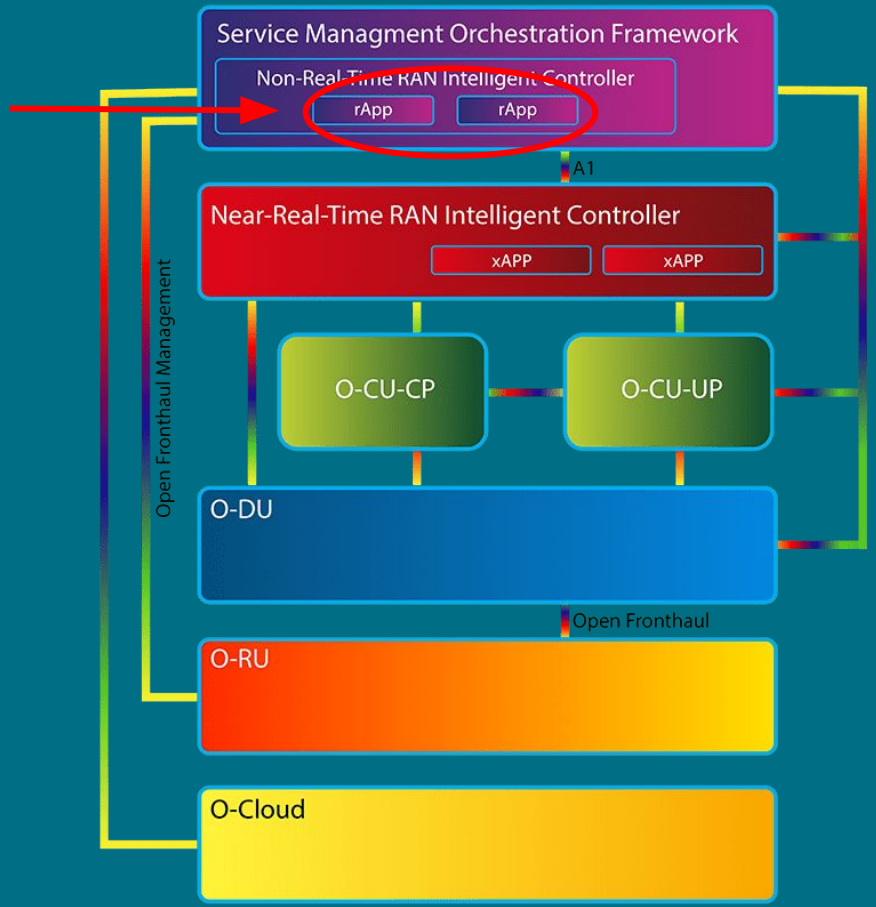
1. 2G
2. 3G
3. 4G
4. 5G
5. New Trends



rApp

Worked on several rApp use cases:

- Security
- HelloWorld
- Dynamic UAV Resource Allocation



Security rApp

- TACACS+ (Cisco Network Security Protocol)
- Centralized AAA (Authentication, Authorization, Accounting)
- Python script acting as user

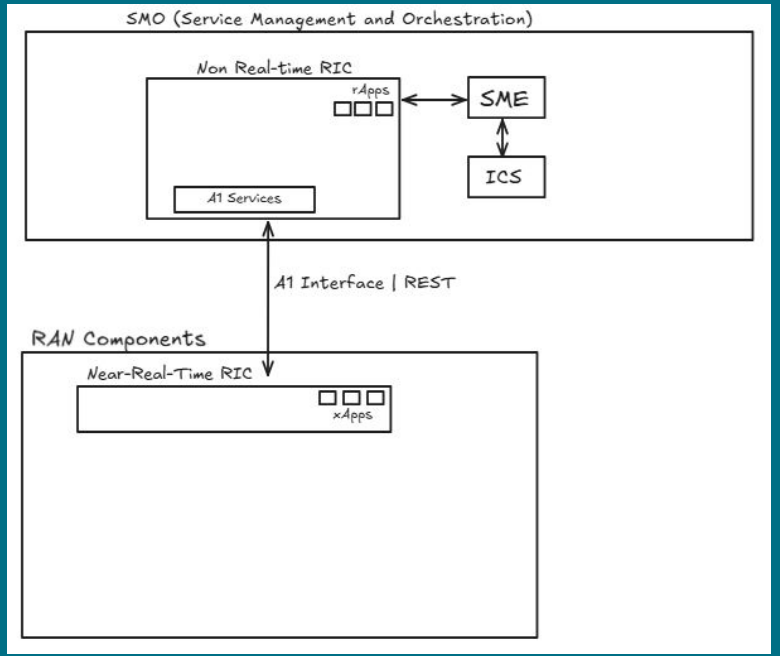
```
#************************
#***   GROUPS HERE     ***
#************************
group = Advisors {
        default service = permit
        login = file /etc/passwd
        enable = file /etc/passwd
}

group = Oran_interns {
        default service = deny
        login = file /etc/passwd
        enable = file /etc/passwd
        service = exec {
        priv-lvl = 2
        }
```

```
root@node1-1:~# python3 intern1.py
Creating TACACS+ client...
Authenticating...
Authentication successful!
root@node1-1:~# python3 advisor1.py
Creating TACACS+ client...
Authenticating...
Authentication failed.
Reason: 2
root@node1-1:~#
```

HelloWorld rApp

- Set up several RIC services
- Working on pushing basic policies via A1

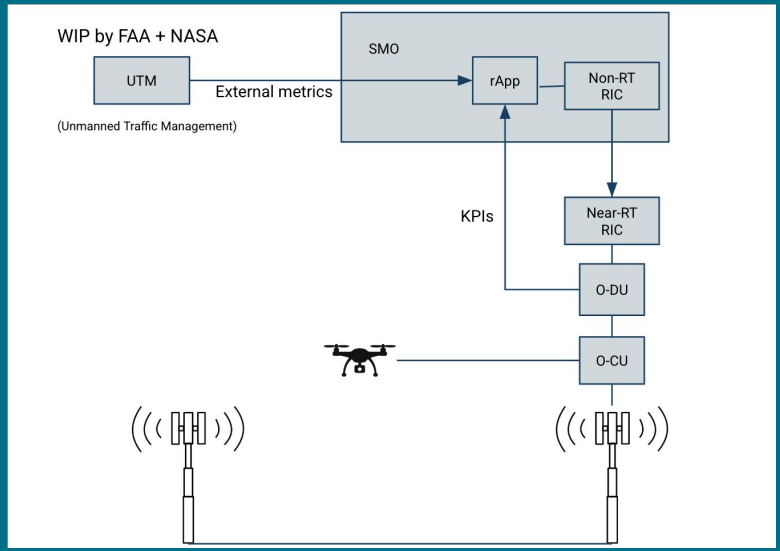


Acronyms:

- SMO: Service Management and Orchestration
- SME: Service Management and Exposure
- ICS: Information Coordination Service
- RIC: RAN Intelligent Controller

UAV Resource rApp

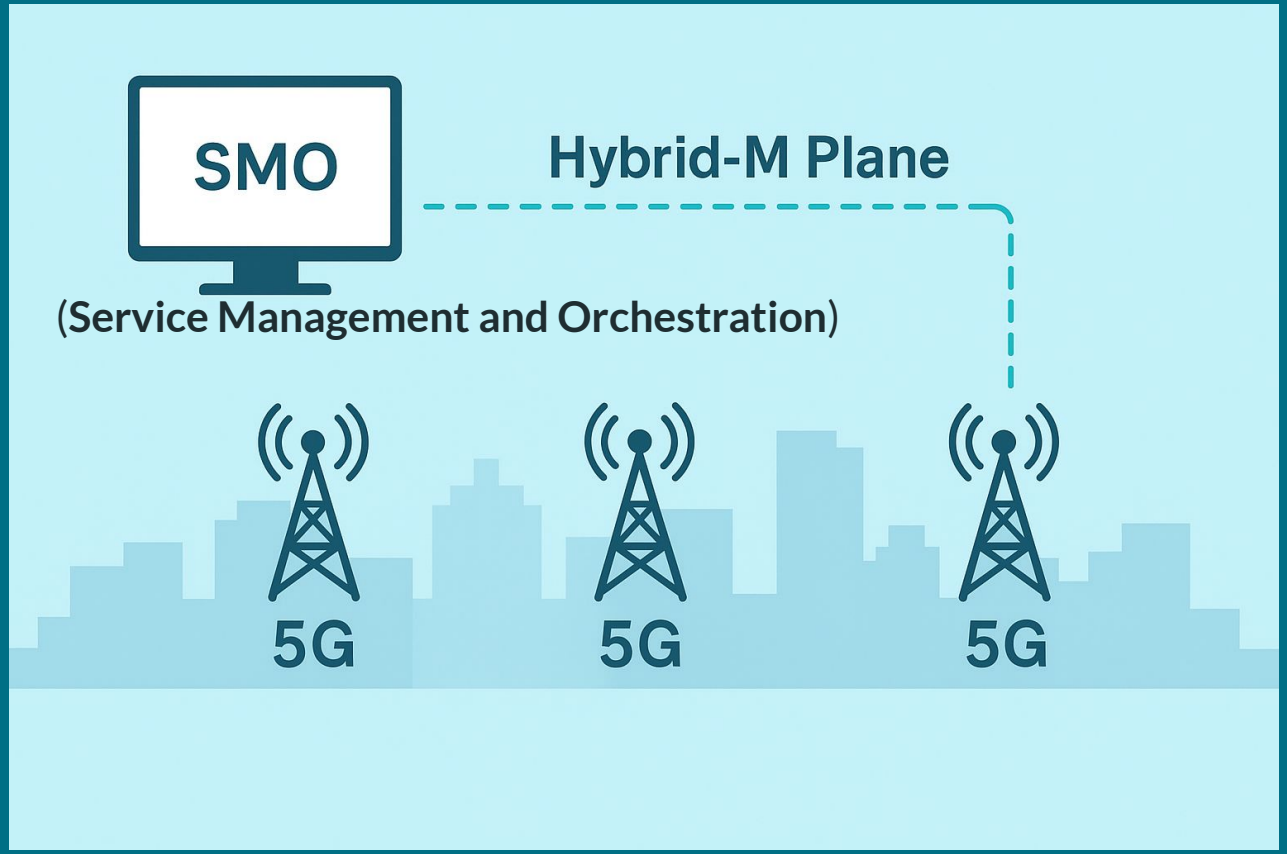
- Outlined by O-RAN Alliance Technical Specification
- Dynamically manage resources for UAVs
- Addresses challenges for UAVs above ~300 meters.



Acronyms:

- UAV- Unmanned Aerial Vehicle
- SMO: Service Management and Orchestration
- O-RU: Open-Radio Unit
- O-DU: Open-Distributed Unit
- RIC: RAN Intelligent Controller
- RT: Real Time
- KPI: Key Performance Indicators

Cloud-Native O-RAN

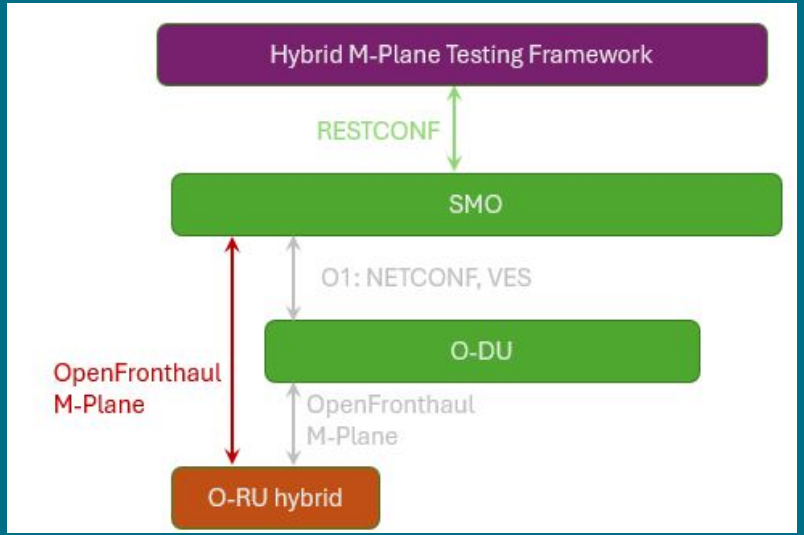


Cloud-Native O-RAN

Project Overview

Goal: To set up O-RU framework for testing Hybrid-Management plane

- **Task-1:** To set up SMO for OAM of O-RU test framework ✅
- **Task-2:** Run test cases to test Hybrid-M plane communication with the O-RU ✅



Acronyms:

- O-RU: Open-Radio Unit (Antenna)
- SMO: Service Management and Orchestration
- OAM: Operations and Maintenance
- O-DU: Open-Distributed Unit

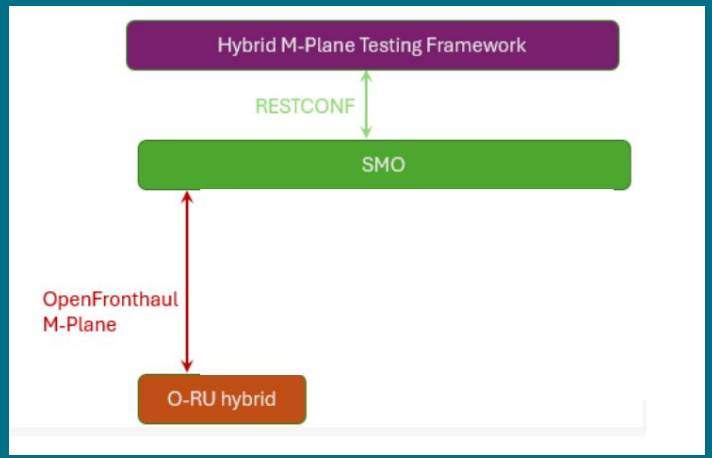
Cloud-Native O-RAN

Test Cases:

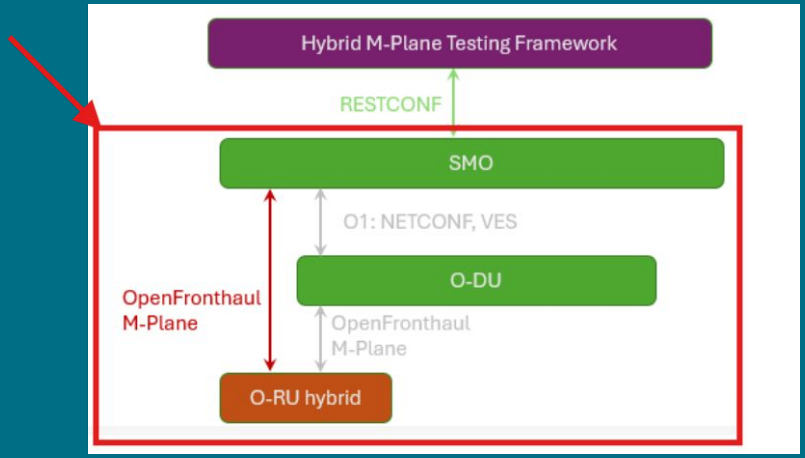
- **Test 1:** An O-RU can send its current configuration settings to SMO's O-RU controller via Hybrid M-Plane. The controller then sends to SMO by RESTCONF.

- **Test 2:** An O-RU can send its current configuration setting to both O-RU controller and O-DU.

Test-1



Test-2

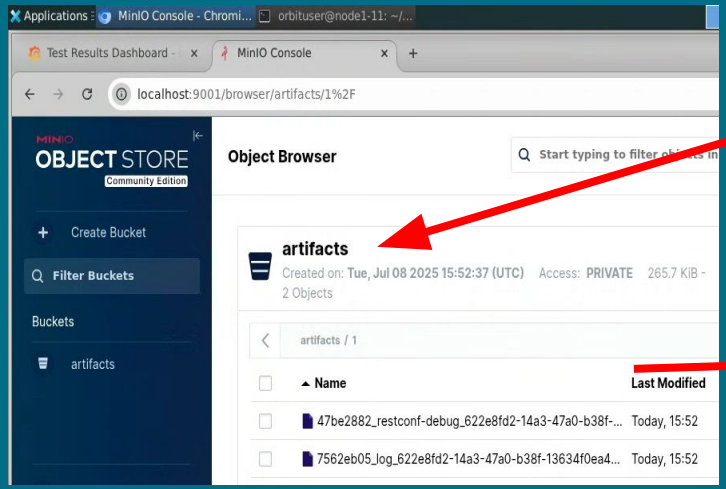


Cloud-Native O-RAN

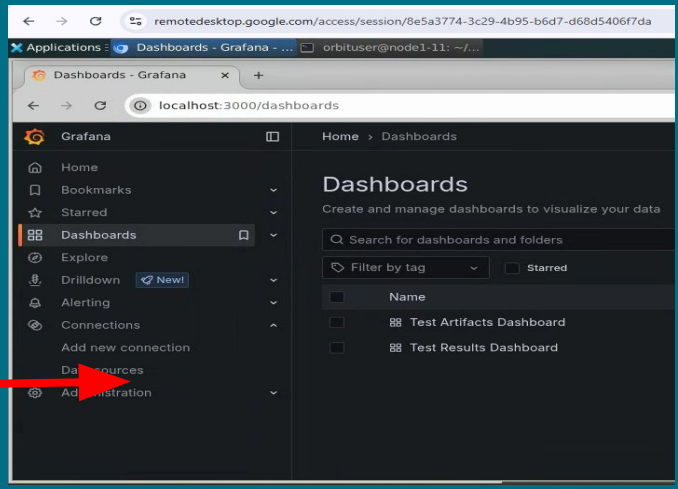
Test Cases Execution:

```
(.venv) root@node1-11:~/tifg# make run
Running test case with controller at ...
Simulator: pynts-o-ru-hybrid using src/hybrid_mplane_test_runner/tools/simulator/docker-compose.yaml
USE_SIMULATOR=false PYTHONPATH=src .venv/bin/python -m hybrid_mplane_test_runner.runner.main
Tests finished with an overall status of ResultType.PASS
Results and artifacts archived to: output/results_c5d07631-2f16-4712-ae63-b76ff215aefe_20250710T012912Z.zip
(.venv) root@node1-11:~/tifg#
```

MinIO Console (DATABASE)

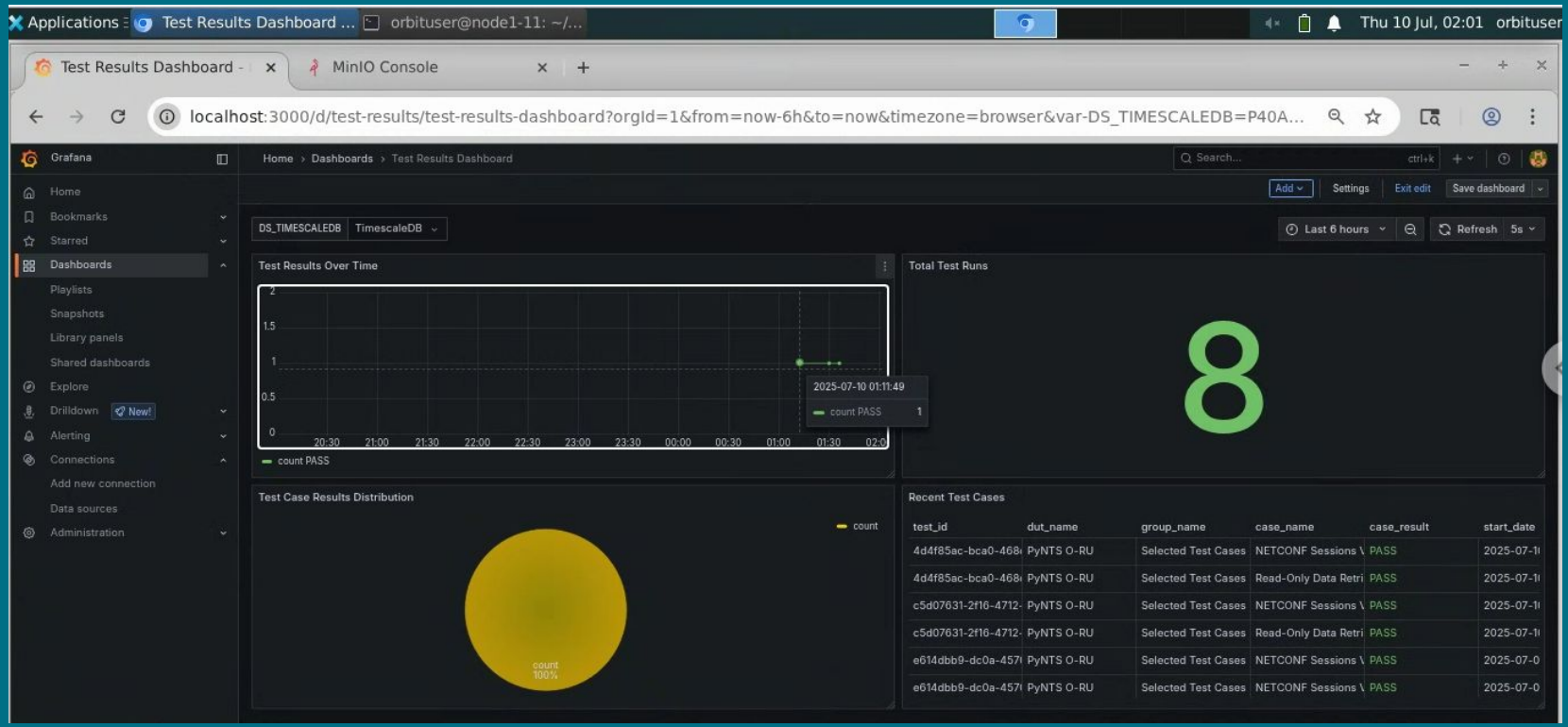


Grafana (Graph Visualization)



Cloud-Native O-RAN

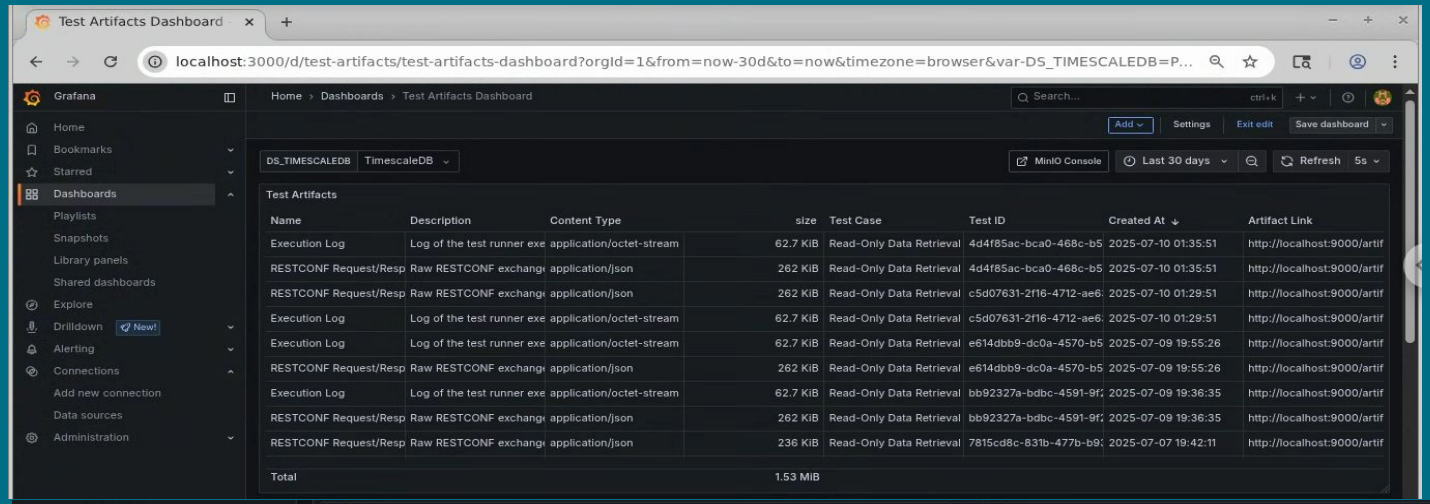
Results and Artifacts of Test cases in Grafana:



Results Dashboard

Cloud-Native O-RAN

Artifacts Dashboard



Cloud-Native O-RAN

Additional Contribution:

- Worked on adding new test case in testing the Hybrid-M plane,

  Gist:
  - Test 1 and Test 2 check if "**O-RU can tell us what it has?**"
  - Test 3 will check if "**O-RU can tell us what it can do (or what are its capable functions)?**"

  Test 3

Title	Description
O-RU Capabilities Retrieval	Verify that the O-RU advertises its supported capabilities and YANG modules via the NETCONF <hello> message and correctly responds to get-schema RPC requests for retrieving the associated module definitions.

- For detailed project information please visit https://www.orbit-lab.org/wiki/Other/Summer/2025/Cloud-Native-O-RAN#Cloud-nativeO-RAN

Thank you...