



Welcome to the Mosaic5G Track

Agile 4G/5G Service Delivery Platforms and UCs



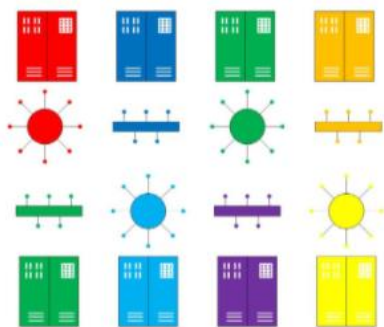
OSA Mosaic5G Project



5G RAN

OAI 5G RAN PROJECT GROUP
OpenAirInterface 5G Radio Access Network
Project The scope of the OAI 5G RAN project
is to develop...

[Read more](#)



5G CORE NETWORK

5G CORE NETWORK The scope of 5G CN
project developments is to deliver a 3GPP
compliant 5G Core Network under the OAI...

[Read more](#)



MOSAIC5G

OAI MOSAIC5G PROJECT GROUP
OpenAirInterface MOSAIC5G Project Group
The newly created MOSAIC5G (M5G) PROJECT
GROUP aims to transform radio access (RAN)
and...

[Read more](#)

Agenda of Today

- Mosaic5G presentation and Roadmap (10')
- Trirematics (T9S) Operator Demo (10')
- FlexRIC
 - Overview (10')
 - **Lab 1: Service Model (SM) architecture (30')**
 - How to develop an SM
 - **Lab 2: xApp and SDK development environments (50')**
 - Environment
 - Download and installation
 - HelloWorld
 - Monitor RAN stack
- **Revealing the challenges and Prizes (10')**

Download Materials

Check the link in the chat room



Mosaic5G?

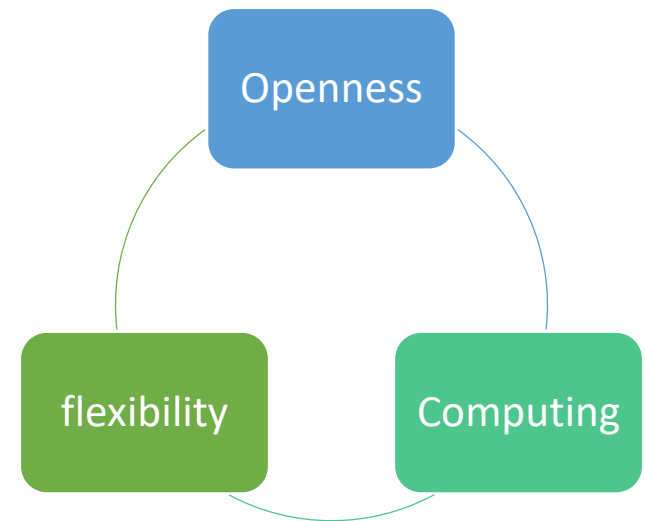
Agile 4G/5G Service Delivery Platforms and UCs



Mosaic5G

Use-case Driven

Agile 4G/5G Service Platforms



Founded by Eurecom and Launched in 2016

Merged with OpenAirInterface in May 2021

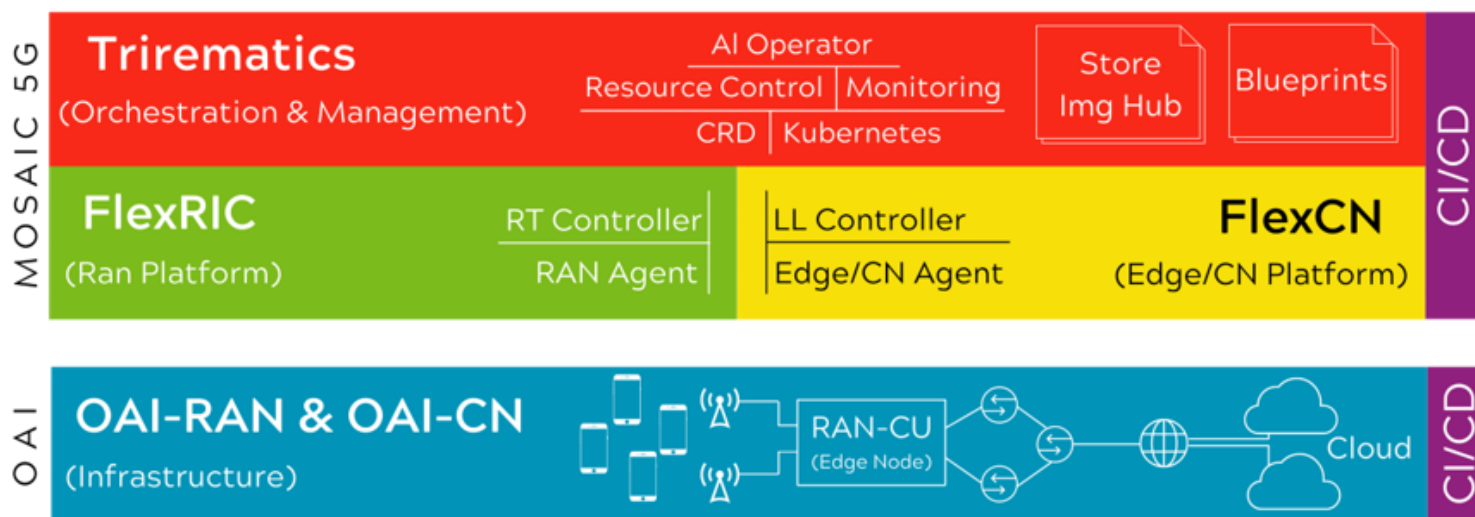
Mosaic5G Highlights

Unlocking OpenRAN and OpenCN Models

1. **FlexRIC (SD-RAN): Flexible RIC and E2 Agent**
2. **FlexCN (SD-CN): Flexible CN Controller**
3. **Trirematics: Intelligent RAN and CN service operator in a multi-x cloud-native environments**
4. **FlexSDK: Flexible xApp/SDK RAN+CN framework**

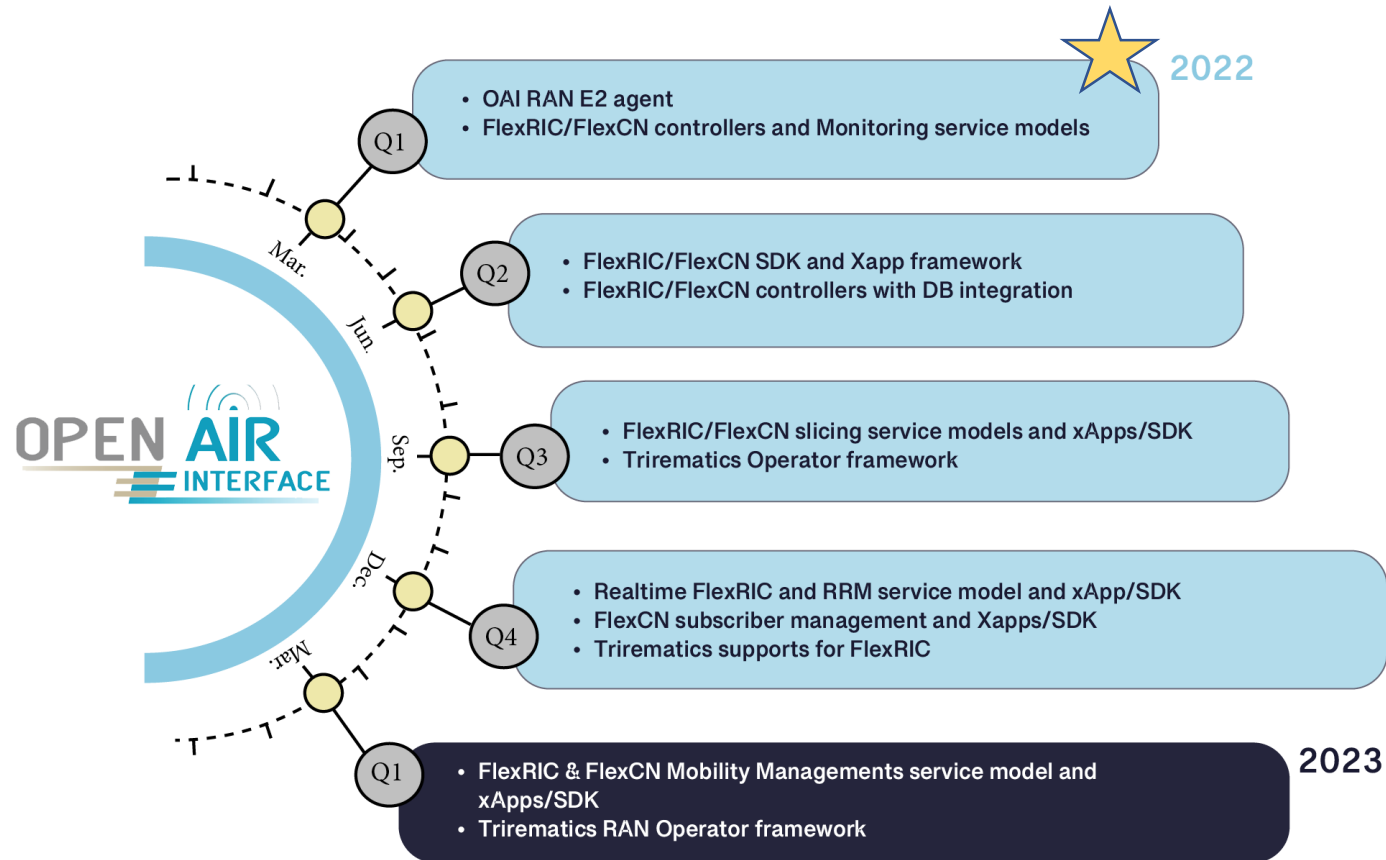
➔ Data-driven 4G and 5G networking and more ...

OSA/Mosaic5G 3 Platforms

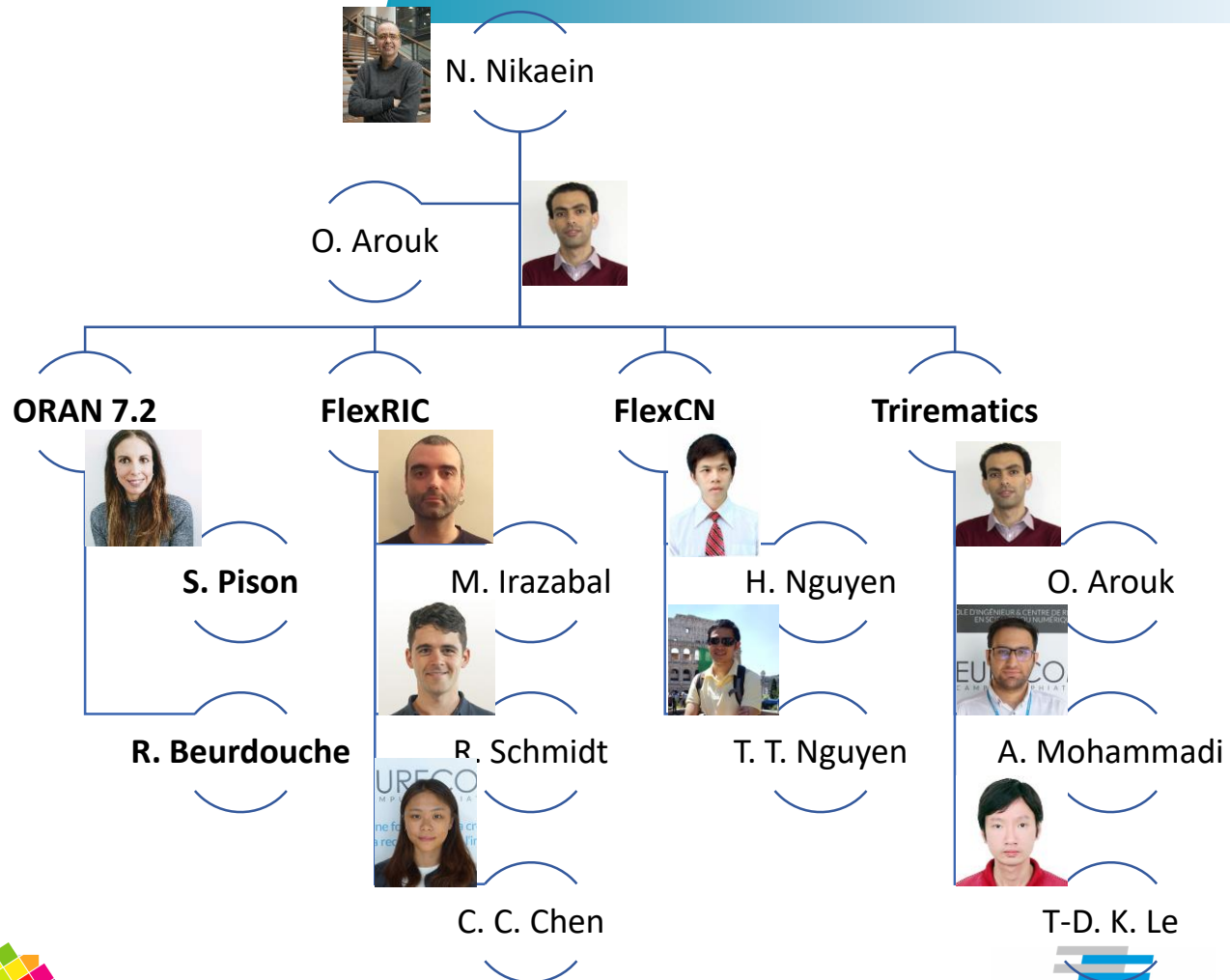


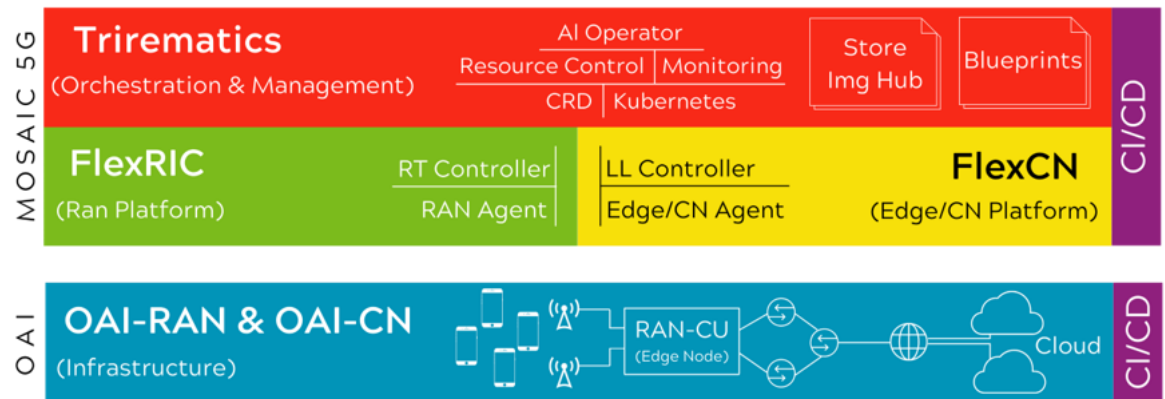
OAI public license 1.1 (4G+5G RAN, 5GCN, SPGW-C, SPGW-U, Mosaic5G)
3-Clause BSD License (4G MME & HSS, Mosaic5G SDK/xAPP)

Mosaci5G News and Timelines



Mosaic5G Team



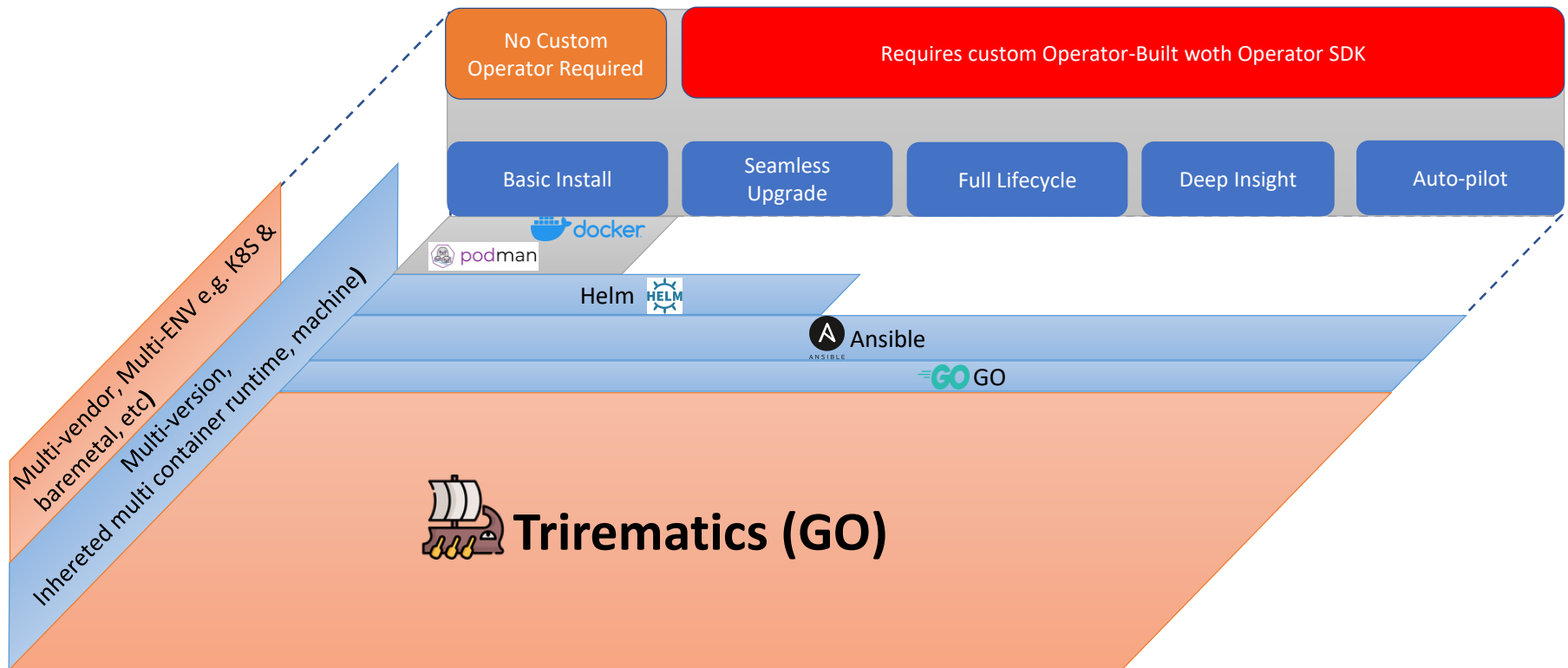


Trirematics (T9s) Operator

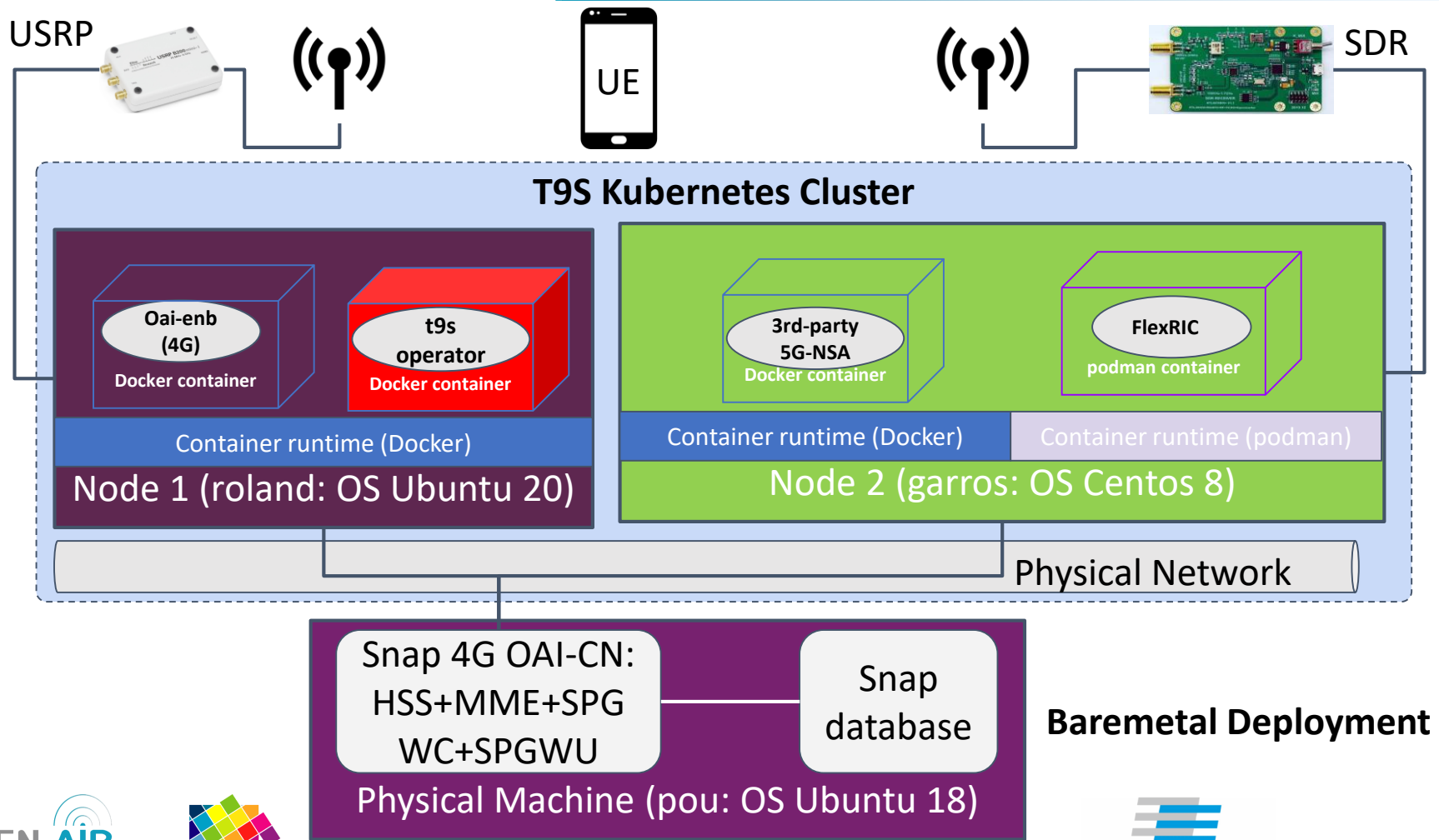
An Intelligent RAN and CN service operator in a multi-x cloud-native environments

On-the-Fly network upgrade from 4G to 5G

Why Trirematics?



Trirematics T9S: Multi-x deployment Example

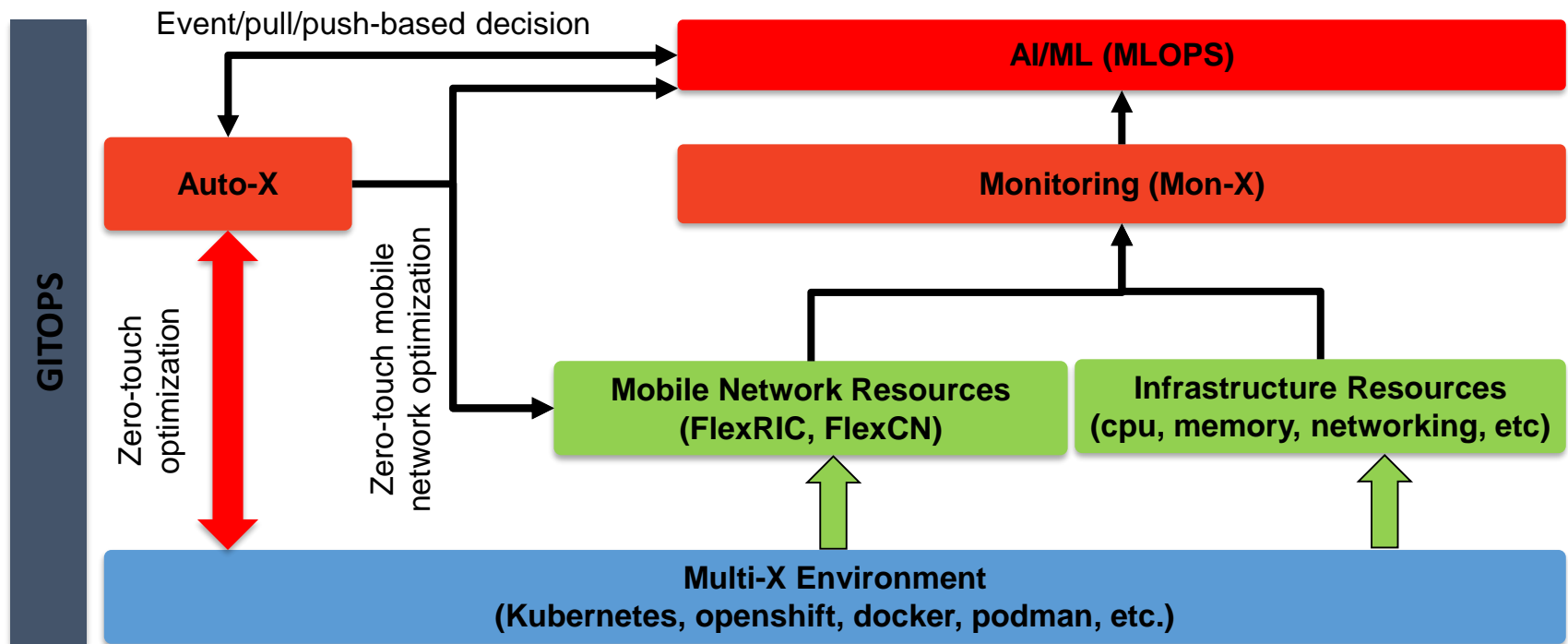


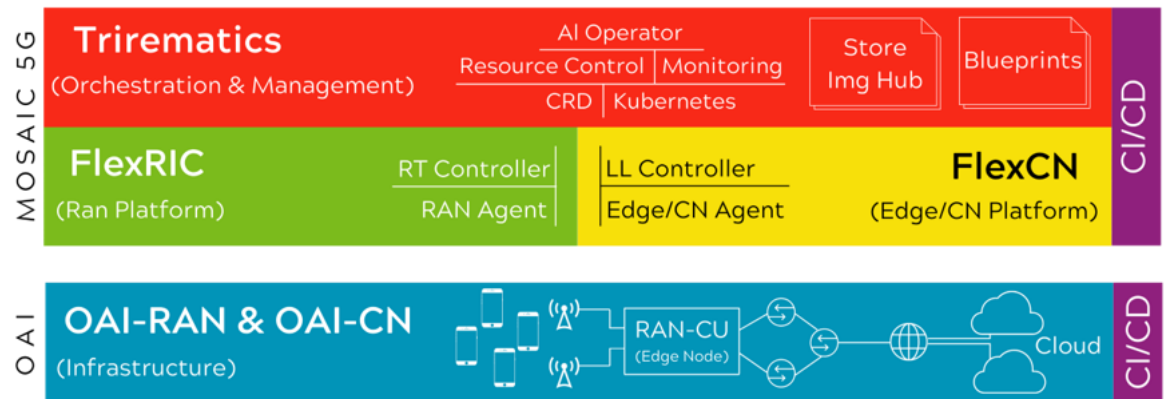
Trirematics: Demo

The screenshot shows a Code - Insiders editor window with a dark theme. The active file is `network.deployment_v1alpha1_trirematics.yaml`. The editor displays a YAML configuration for a Trirematics deployment. The configuration includes a `kind: Trirematics` resource with a `spec` section containing `common`, `containers`, `services`, and `volumes` definitions. The `containers` section lists several containers with names like `oai-enb-wlc`, `oai-gnbnsa-wlc`, `third-enb-wlc`, `third-gnbnsa-wlc`, `oai-enb-wmc`, `oai-gnbnsa-wmc`, `third-enb-wmc`, and `third-gnbnsa-wmc`. The `services` section lists `oai-4g`, `oai-5gnsa`, `third-4g`, and `third-5gnsa`. The `volumes` section lists `sys-fs-cgroup`, `lib-modules`, `dev-bus-usb`, `dev-sdr0`, `dev-sdr1`, `shared-volume`, and `config-ran`.

```
config > samples > demo-2021 > ! network.deployment_v1alpha1_trirematics.yaml
1
2  apiVersion: network.deployment.trirematics.com/v1alpha1
3  kind: Trirematics
4  metadata:
5    name: t9s-demo
6  spec:
7    common:
8      t9sVersion: amber/v1Beta1
9      action: keepIfNotPresent # keepIfNotPresent;deleteIfNotPresent;onlyInstanceUpdate
10     namespace: default
11     labels:
12       author: trirematics
13     containers:
14 >   - name: oai-enb-wlc ...
36 >   - name: oai-gnbnsa-wlc ...
59 >   - name: third-enb-wlc ...
89 >   - name: third-gnbnsa-wlc ...
124 >   - name: oai-enb-wmc ...
152 >   - name: oai-gnbnsa-wmc ...
181 >   - name: third-enb-wmc ...
210 >   - name: third-gnbnsa-wmc ...
240   services:
241 >   - name: oai-4g ...
266 >   - name: oai-5gnsa ...
288 >   - name: third-4g ...
310 >   - name: third-5gnsa ...
332   volumes:
333 >   - name: sys-fs-cgroup ...
338 >   - name: lib-modules ...
342 >   - name: dev-bus-usb ...
346 >   - name: dev-sdr0 ...
350 >   - name: dev-sdr1 ...
354 >   - name: shared-volume ...
356 >   - name: config-ran ...
```

Trirematics T9S Components



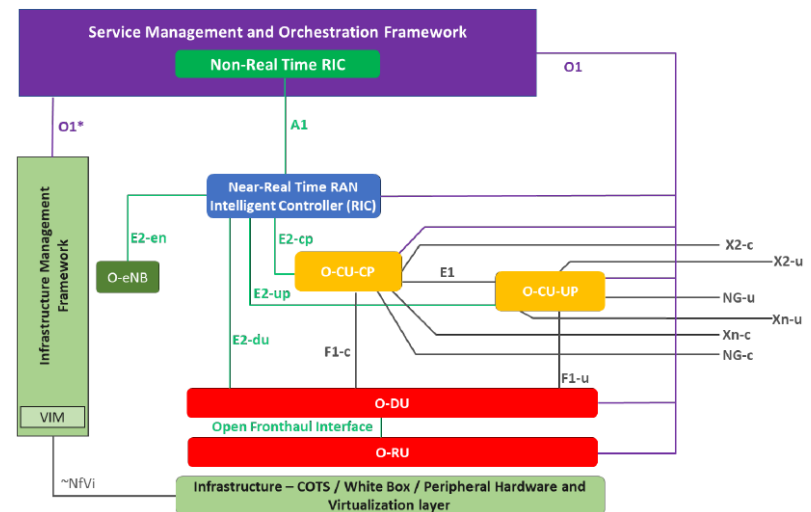
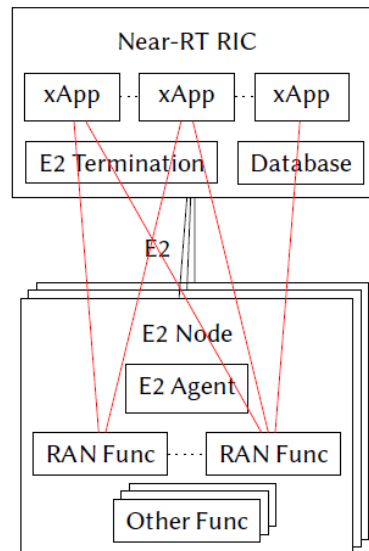


FlexRIC

A Flexible RAN Intelligent Controller and SD-RAN platform

SD-RAN and RIC: General Aspects

- Connects RAN (E2 nodes) and controller (RIC)/xApps
 - Send pre-defined information on pre-defined trigger events from the RAN to the RIC (**reports**)
 - Send **control** messages and **policies** from RIC to RAN
 - Enable the RIC to process procedures at the RAN's place (**insert**)



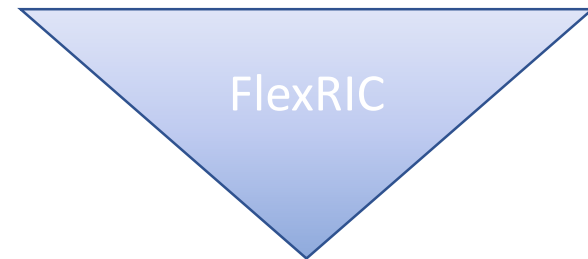
Why FlexRIC ?

Lack of SD-RAN design that flexibly adapts to use-cases.

- FlexRIC
 - SD-RAN platform in the form of a **software development kit (SDK)**

Dedicated
e.g. FlexRAN

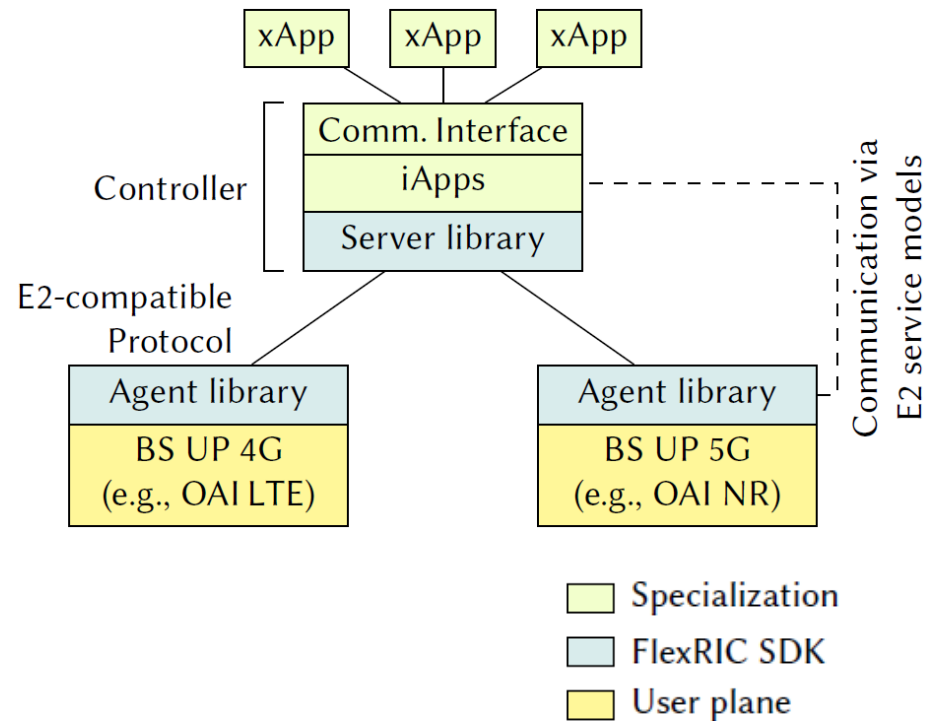
Generic
e.g. O-RAN RIC



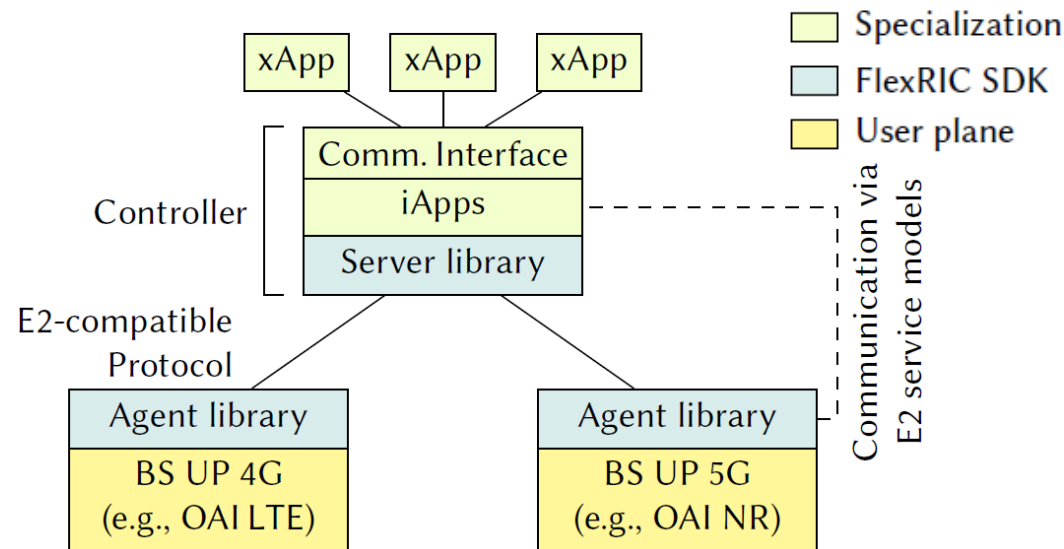
SD-RAN Virtualization
e.g. new use-cases

FlexRIC Design and Features

- **Agent/Server library → SDK**
 - Compliant with ORAN-SC RIC/E2
 - Extendable and plug-and-play service models
 - Command line interface (CLI)
- **Controller Specialization, such as**
 - Slicing (FlexRAN like)
 - Recursive (in a same way as Flowvisor)
 - Realtime down to sub ms
- **Advanced Service models (SM)**
 - Fine-grained monitoring
 - Slicing Control, Traffic Control, Mobility Control
 - Network store
- **Design Features**
 - Ease-of-use, efficiency, reusability
 - SOLID design pattern



FlexRIC Design and Features



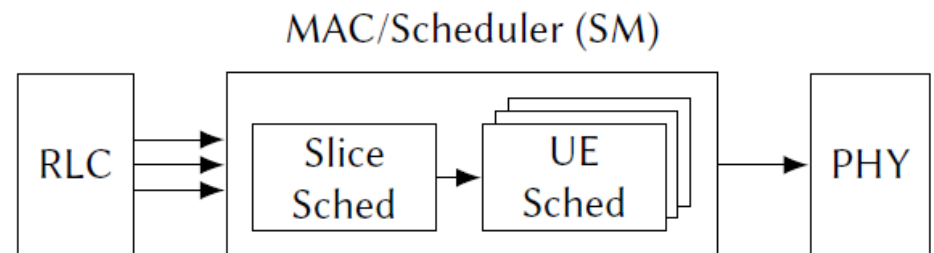
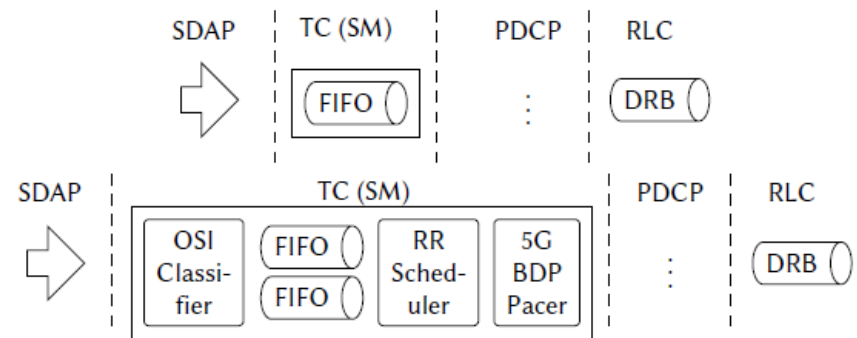
Design choices to consider

- E2AP Transport and handling (enc/dec)
- E2SM and handling (enc/dec)
- iApps/Communication Interface/xApps

Criterion	RIC [5]	FlexRAN [4]	EmPOWER [6]	Orion [7]	FlexRIC
Specialization	✗	✗	✗	✗	✓
Multi-Service	✗	✗	✗	✓	✓
Multi-RAT	✓ (E2)	✗	(✓)	✗	✓ (E2)
Fast/RT	✗	✓	✗	✓	✓

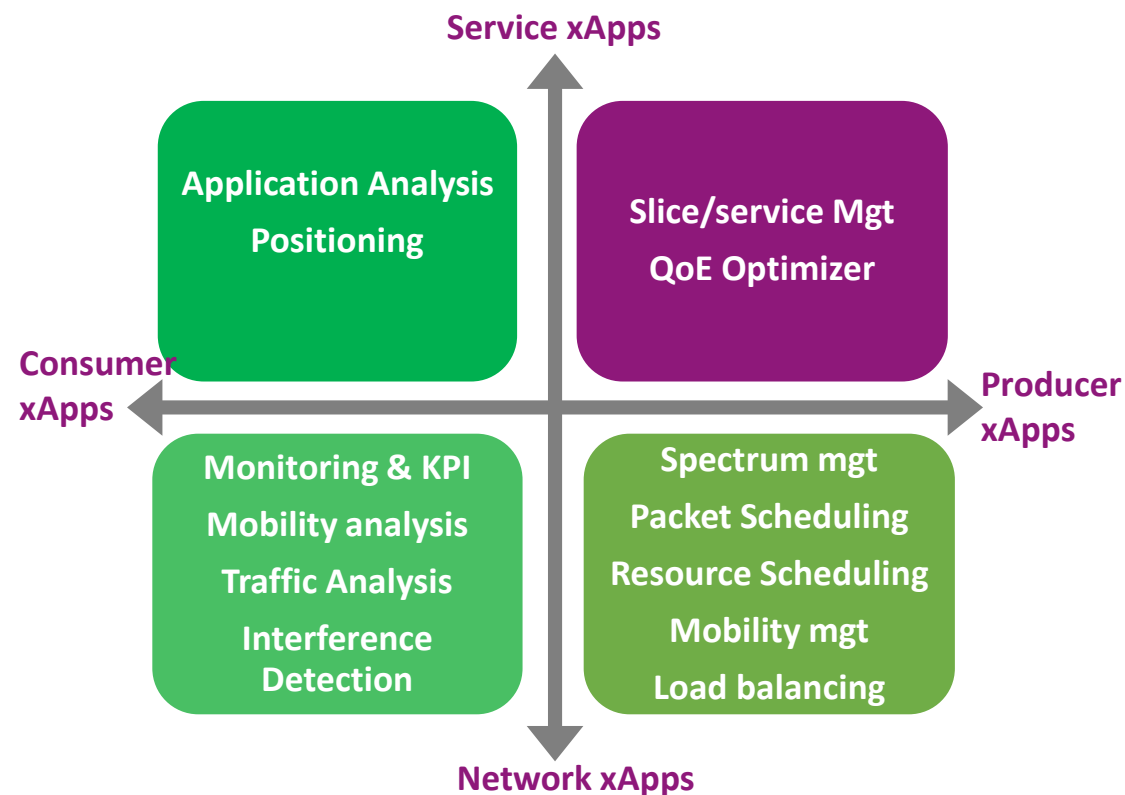
FlexRIC Service Models

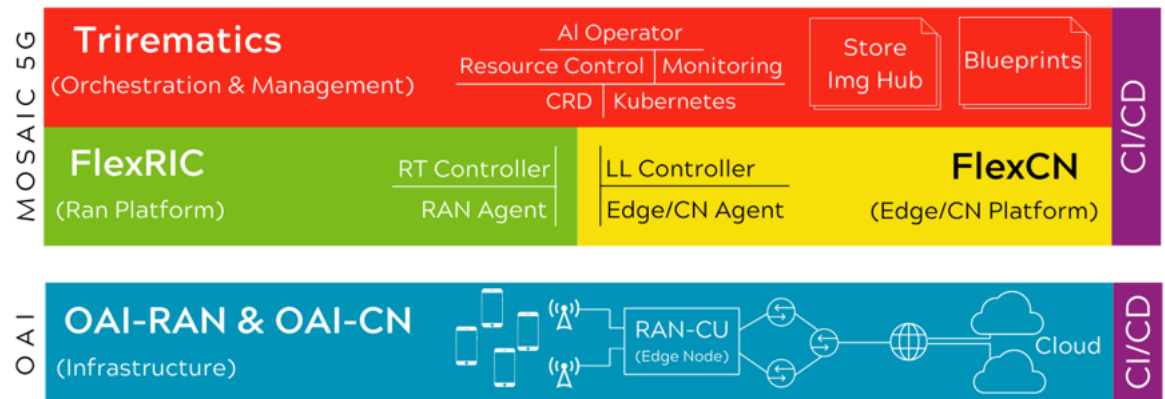
- Layer-based Monitoring
- Flow-Based Traffic Controller (TCSM)
- RAT-neutral Slicing Control (SCSM)



FlexRIC

SDK/xApp Framework & E42AP





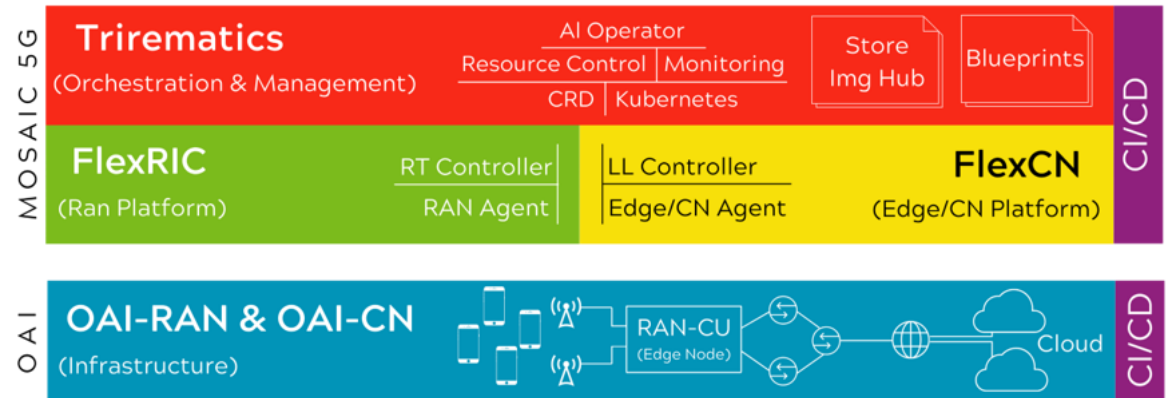
Lab 1

Lab 1: Service Model (SM) architecture (30')

How to develop a SM in FlexRIC?

Lab 1: Service Model (SM) architecture





Lab 2 xApp/SDK

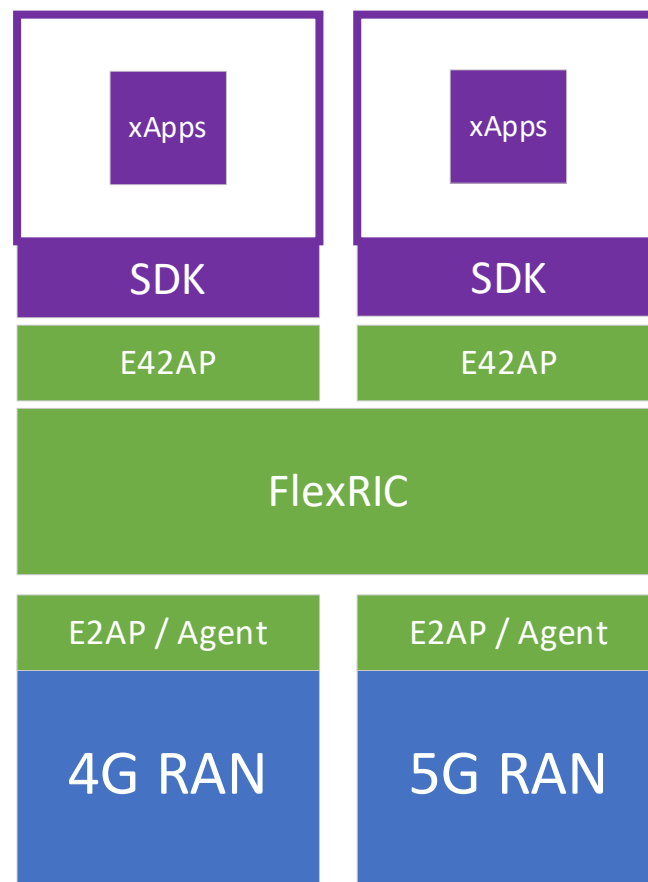
Flexible xApp/SDK framework

How to develop an xAPP for FlexRIC?

FlexRIC

SDK/xApp Framework & E42AP

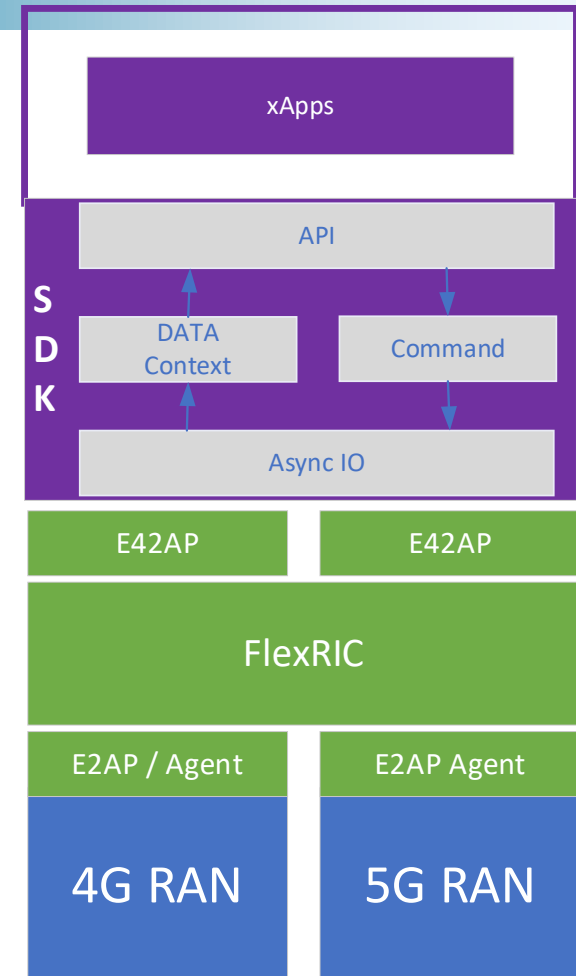
- Download
- Documentation
- Code Structure
- Installation
- Run “HelloWorld”



FlexRIC

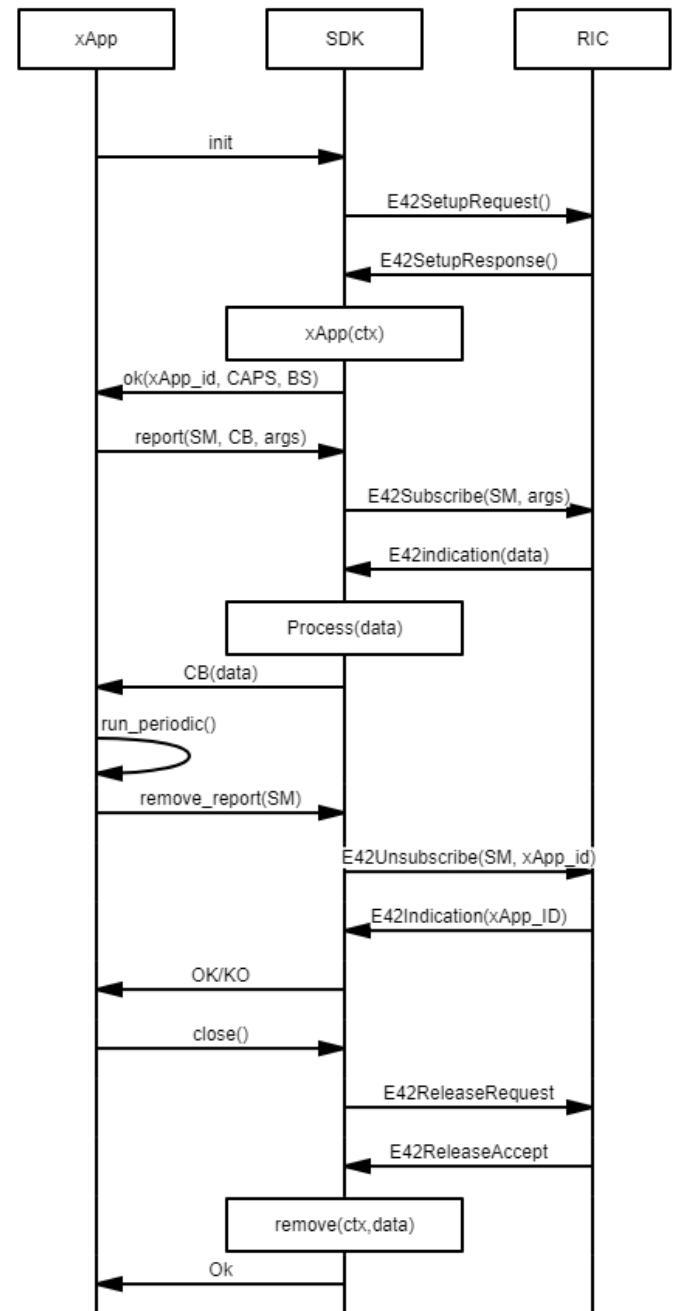
SDK/xApp Framework & E42AP

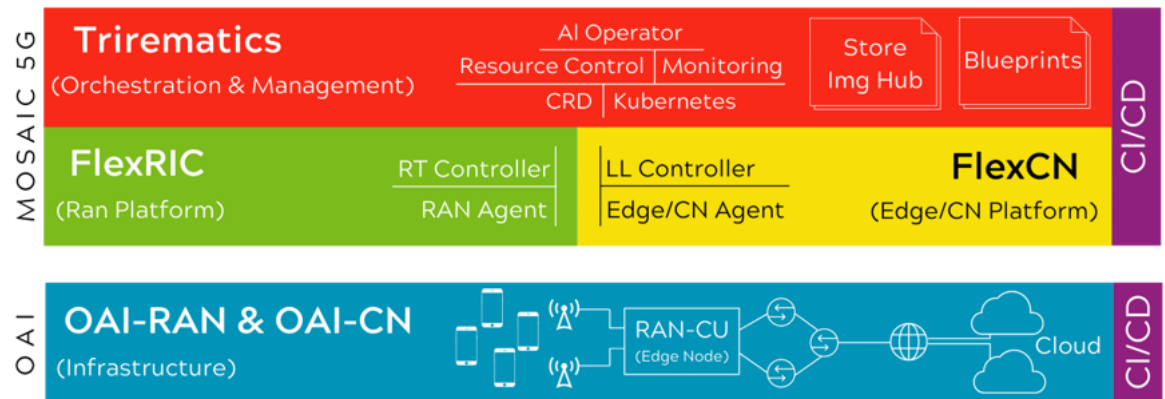
- Download
- Documentation
- Code Structure
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- Run “HelloWorld”



FlexRIC E42AP

- xApp/SDK interface
 - **Report**
 - Insert
 - Control
 - Policy





Challenges

Join us in this journey and go deep in Mosaic5G

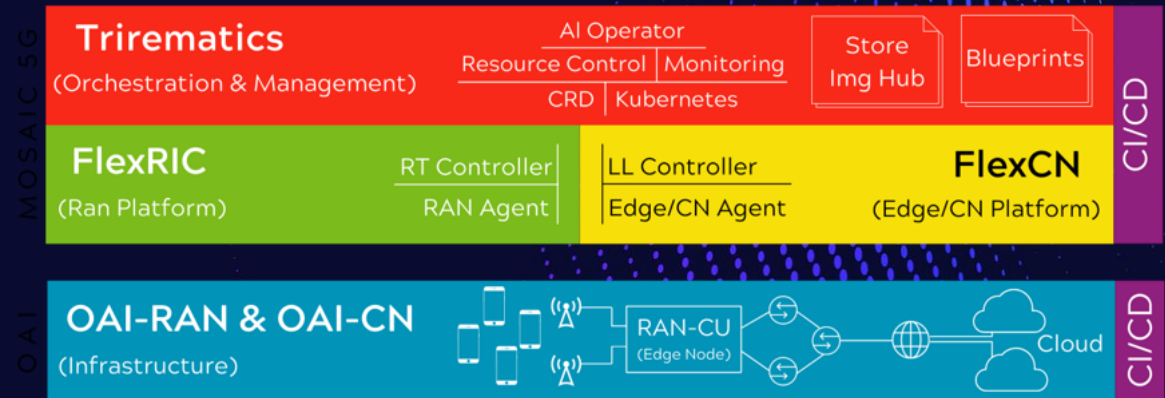
Challenge #1

Creating a SM

- Design a SM that monitors the statistics of the PHY or RRC layers.
 - We encourage the participants to read 3GPP specifications to identify the most relevant statistics.
 - The SM shall implement the plain, ASN.1 and Flatbuffers encoding and decoding schemes in C11.
 - A test file needs to be delivered similar to the PDCP SM that it has been provided.
- **Prize : 1000Euro**
 - Winning solution shall provide
 - a working demo
 - Has no leaks memory, has undefined behavior or is not thread safe.

Challenge #2

- **PDCP:** Compute the throughput and loss rate per UE and per BS for TX and RX, and visualize it over time (e.g. matplotlib).
 - Prize : 500Euro
- **RLC:** Compute the RLC throughput and ARQ retransmission statistics in last 1 second in terms of median, avg, deviation for TX, and visualize them over time (e.g. matplotlib).
 - Prize : 500Euro
- **MAC:** Compute the aggregated throughput rate per UE/RNTI for TX and RX, and visualize it over time (e.g. matplotlib).
 - Prize : 500Euro











Join us on this Journey
Discover more at:


<https://openairinterface.org/mosaic5g>

Agenda of Today

December 9th, 2021

Workshop program: **afternoon** ———→ **MOSAIC 5G**

<p>14h00 - 14h20</p> <p>16h00 - 16h20</p> <p>22h00 - 22h20</p>	<p>Navid/Osama</p>  	<ul style="list-style-type: none"> • Presentation + roadmap • Presentation of the challenges + reward • Demo: Deployment E2E OAI in 10 mins (Trirematics)
<p>14h20 - 14h45</p> <p>16h20 - 16h45</p> <p>22h20 - 22h45</p>	<p>Mikel</p> 	<p>Lab 1: Service Model architecture in FlexRIC</p>
<p>14h45 - 15h45</p> <p>16h45 - 17h45</p> <p>22h45 - 23h45</p>	<p>Navid / Hung / Mikel</p>   	<p>Lab 2: FlexRIC: use and development of a xApp</p>
<p>15h45 - 15h55</p> <p>17h45 - 17h55</p> <p>23h45 - 23h55</p>	<p>Navid/Mikel</p>  	<p>Revealing challenges</p>

<p>15h55 - 16h00</p> <p>17h55 - 18h00</p> <p>23h55 - 00h00</p>	<p>Raymond</p> 	<p>Closing of the day and ending the Workshop</p>
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Time slots	<p>Mountain Standard Time (Utah)</p> <p>Eastern Standard Time (Boston)</p> <p>Central European Time (Paris)</p>
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More information about the labs:

Lab 1: In this lab you will learn how to monitor and control the 5G RAN using FlexRIC, an SD-RAN platform that adheres to O-RAN WG3 specifications (i.e., the Near-real-time RIC and E2 Interface Workgroup). FlexRIC smoothly enables the creation of new Service Models (SM) to address specific use cases. To this end, we will together explore FlexRIC's SM architecture that smoothly enables the creation of new SMs «à la carte». We will also provide an application SDK to facilitate the development of xApps by exposing simplified APIs to implement the desired actions and behavior. We shall subsequently develop a monitoring xApp on top of the SDK that obtains the 5G RAN network state, leveraging FlexRIC's monitoring SMs (i.e., MAC, RLC and PDCP). We will also present the internals of the application SDK and xApp structure.