Mosaic5G
Agile 4G/5G Service Delivery Platforms and UCs

Navid Nikaein (Eurecom, OSA, BubbleRAN)

Founded by Eurecom and Launched in 2016
Merged with OpenAirInterface in May 2021
Mosaic5G Dual Objectives

Unlocking OpenRAN and OpenCN Models in a multi-vendor env.

1. Provide an ecosystem of open source 4G/5G service platforms, reusable components (xApps, SM, ...) and use-case descriptions (deployment blueprint)

2. Provide an SDK to design and develop service models and xApps to compose a range of specialized 4G/5G network-service platforms tailored to divers use-cases
Mosaic5G Service Platforms

1. FlexRIC (SD-RAN): Flexible RIC and E2 Agent
2. FlexCN (SD-CN): Flexible CN Controller
3. Trirematics (T9s): Intelligent RAN and CN service operator in a multi-x cloud-native environments
4. FlexSDK: Flexible xApp/SDK RAN+CN framework

➔ Programmable and Data-driven 4G and 5G networking and more ...
Mosaic5G Stack

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

*A Flexible SD-RAN Platform*

- FlexRIC is an O-RAN compliant E2 Agent, near-RT RIC, and xAPP SDK
  - Multi-X support: Vendor, RAT, Language, Agent, xApp
  - E42 protocol: RIC-xAPP interface
  - Recursion and specialized controller
- Pluggable Service Models
  - E2SM-RRC, E2SM-PDCP, E2SM-RLC, E2SM-MAC, E2SM-SC
  - E2SM-HW, E2SM-KPM, E2SM-TC
- Highly Efficient and Ultra-lean
  - Low-Latency or resource-restricted UCs
## FlexRIC SDK Comparison

<table>
<thead>
<tr>
<th>Criteria</th>
<th>O-RAN RIC</th>
<th>ONOS RIC</th>
<th>FlexRIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero Overhead</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Enc/Dec</td>
<td>ASN1.c</td>
<td>ASN1.c</td>
<td>ASN1.c, FB, Plain</td>
</tr>
<tr>
<td>E2AP version</td>
<td>v2.0</td>
<td>v2.0</td>
<td>v1.26</td>
</tr>
<tr>
<td>E2AP Messages / IEs</td>
<td>7/26</td>
<td>10/26</td>
<td>20/26, 12/26</td>
</tr>
<tr>
<td>Multi-language</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>E2 Nodes</td>
<td>Radisys</td>
<td>OAI, SRS, Radisys</td>
<td>OAI, SRS, AMR</td>
</tr>
<tr>
<td>Memory footprint</td>
<td>1</td>
<td>?</td>
<td>0.17</td>
</tr>
<tr>
<td>E2 Agent-xApp latency</td>
<td>&gt;1ms</td>
<td>&gt;1ms</td>
<td>100us</td>
</tr>
<tr>
<td>Service Models</td>
<td>Embedded</td>
<td>Embedded</td>
<td>Pluggable, Extendable</td>
</tr>
</tbody>
</table>

FlexCN
A Flexible SD-CN Platform

Multi-Roles (scenario-dependent AF, NWDAF, )
Monitoring per UE/QFI/Slice
Traffic Control (AF/SMF/PCF/UPF)
UE management (UDM/UDR)
Mobility Management (AMF)
Slice management (NSSF)
Trirematics T9S

An Agile 4G/5G Operator

- Multi-X Devs
  - Packaging
  - Testing
  - Distribution

- Multi-X Ops
  - Provisioning
  - Automation
  - Control
  - Observability
T9S Cloud-Native Deployment

Full Automation and No Performance Loss

Distributed and Heterogeneous Infrastructure

Avg Jitter = 0.047ms

Throughput (Mbps)

<table>
<thead>
<tr>
<th></th>
<th>UDP-OAI</th>
<th>TCP-OAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare Metal</td>
<td>132</td>
<td>120</td>
</tr>
<tr>
<td>Snap</td>
<td>131</td>
<td>120</td>
</tr>
<tr>
<td>T9S</td>
<td>130</td>
<td>121</td>
</tr>
</tbody>
</table>

Remote Control
Remote Monitoring
Remote Observability

Remote Control
Remote Monitoring
Remote Observability
Mosaic5G RoadMap

- OAI RAN E2 Agent
- FlexRIC/FlexCN Controllers and Monitoring Service Models

Achieved milestones

- FlexRIC and FlexCN SDK / xApp Multi-LAN Framework
- FlexRIC/FlexCN Controllers with DB Integration
- O-RAN 7.2 Support

- FlexRIC/FlexCN Slicing SM and xApps/SDK
- Triemetics Operator Framework

2022

- Realtime FlexRIC, RRM SM and xApp/SDK
- FlexCN Subscriber Management and xApps/SDK
- Triemetics Supports for FlexRIC

2023

- FlexRIC & FlexCN Mobility Managements SM and xApps/SDK
- Triemetics RAN Operator Framework
Final Word

Join us on the OSA Mosaic5G Project Group

To unlock open innovations in Open 4G/5G RAN/CN arenas from a rich ecosystem of reusable platforms, components, and use-cases
FlexRIC SDK
RAN Monitoring Service Models

```
“MacUeStats”:
{
  "rnti": 8442,
  "dlAggrPrb": 3279195,
  "ulAggrPrb": 8665,
  "dlAggrTbs": 80905976,
  "ulAggrTbs": 200474,
  "dlAggrSdus": 84133,
  "ulAggrSdus": 0,
  "dlAggrBytesSdus": 0,
  "ulAggrBytesSdus": 0,
  "dlAggrRetxPrb": 215790,
  "ulAggrRetxPrb": 3,
  "dlMcs1": 0,
  "ulMcs1": 0,
  "puschSnr": 23.5,
  "pucchSnr": 18,
  "phr": 34,
  "bsr": [{"lcgid": 0, "bufferSize": 0}],
  "dlHarq": [31401, 1401, 498, 360],
  "ulHarq": [1566, 1, 1, 1]
}
```

```
“RlcUeStats”:
{
  "rnti": 8442,
  "rb": [
    {
      "rbid": 3,
      "txPduPkts": 84133,
      "rxPduPkts": 1258,
      "txPduBytes": 80641545,
      "rxPduBytes": 30935,
      "txPduDdPkts": 0,
      "rxPduDdPkts": 0,
      "txPduDdBytes": 0,
      "rxPduDdBytes": 0,
      "txPduRetxPkts": 0,
      "txPduRetxBytes": 0,
      "rxPduOwPkts": 0,
      "rxPduOwBytes": 0,
      "rxPduDupPkts": 0,
      "rxPduDupBytes": 0
    }
  ]
}
```

```
“PdcpUeStats”:
{
  "rnti": 8442,
  "rb": [
    {
      "rbid": 1,
      "txPduPkts": 54810,
      "rxPduPkts": 129,
      "txPduBytes": 82259668,
      "rxPduBytes": 27095,
      "txPduSn": 54809,
      "rxPduSn": 128,
      "rxPduDdPkts": 2,
      "rxPduDdBytes": 160
    }
  ]
}
```
**FlexCN SDK**

**Monitoring per UE/QFI/Slice**

<table>
<thead>
<tr>
<th>API</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subscribe</strong></td>
<td>UP Path Change</td>
</tr>
<tr>
<td></td>
<td>UE IP Addr. Change</td>
</tr>
<tr>
<td></td>
<td>Access type Change</td>
</tr>
<tr>
<td></td>
<td>PLMN Change</td>
</tr>
<tr>
<td></td>
<td>PDU session release</td>
</tr>
<tr>
<td></td>
<td>Downlink data delivery status</td>
</tr>
<tr>
<td><strong>Status /[type]</strong></td>
<td>all</td>
</tr>
<tr>
<td></td>
<td>ue</td>
</tr>
<tr>
<td><strong>Status/[entity]</strong></td>
<td>smf</td>
</tr>
<tr>
<td></td>
<td>amf</td>
</tr>
<tr>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

```json
"SMF": {
  "plmn": { "mcc": "208", "mnc": "95"},
  "supi": "208950000000031",
  "ue_ipv4_addr": "12.1.1.2",
  "timeStamp": "3840272086",
  "snssai": { "sd": "123", "sst": "222" },
  "pduSId": 1,
  "pdu_session_type": "IPV4",
  "amf_addr": "192.168.70.132",
  "dnn": "default",
  "qos_flow": [ { "an_addr": { "ipv4": "192.168.70.136" }, "qfi": 6,
      "upf_addr": {
        "ipv4": "192.168.70.134" } } ]
}
```