Pre-Requisites

➢ Completion of LAB1 to re-use its environment

➢ Tutorial is in: https://gitlab.flux.utah.edu/powderrenewpublic/oai_fall_2021_workshop/-/blob/main/Lab-2-RAN.md


CU/DU split motivation

- Functional splits play a key role in 5G
  - More flexible, scalable, cost-effective network deployments
  - Promoting interoperability among different vendors through the use of common interfaces between disaggregated hardware and software components
  - Makes it easier to adapt to different 5G use cases and corresponding QoS support requirements

Figure from [https://www.5gtechnologyworld.com/functional-splits-the-foundation-of-an-open-5g-ran/](https://www.5gtechnologyworld.com/functional-splits-the-foundation-of-an-open-5g-ran/)
What you will see in this lab

- Control plane exchanges over F1-C, supporting UE end-to-end registration and PDU Session establishment with the OAI Core Network

- User plane traffic over F1-U using gtp-u
What you will see in this lab

- Experimental setup:
  - Single CU, DU and OAI UE
  - Validation in RFSIMULATOR mode

- What is in the roadmap:
  - CU-CP/CU-UP split over E1 interface
  - Support of multiple CUs/DUs
F1-C integrated functionality

- Majority of ASN1.0 F1AP messages integrated as per 3gpp 38.473, Rel. 15.6.0
  - F1 setup messages between the CU and the DU, as well as their configuration updates
    - SCTP association establishment and configuration exchanges between CU and DU
    - System Information transfer between DU and CU
  - F1 DL/UL RRC message containers for transparent transfer of RRC/NAS messages between the CU and the UE through the DU;
  - F1 UE context setup messages
    - Supporting the establishment of SRBs/DRBs
    - Transfer of RRC cellgroup configuration updates from the DU to the CU
    - Establishment of GTP-U tunnels between the CU and DU, required for enabling user-plane traffic transfer over F1-U
- Interfacing with RRC for triggering the generation and handling the reception of F1AP messages
F1-U integrated functionality

- F1-U interface using gtp-u protocol for user-plane traffic, as of 3gpp 28.281

- OAI updated implementation of gtp-u to support user-plane traffic over N3 and F1-U interfaces concurrently
  - Based on separate gtp-u instances for each interface
  - Tunnels management APIs (creation, update, deletion)
  - Incoming and outgoing traffic handled at the CU and DU, based on different callback functions specified at tunnel creation of each side
Implementation architecture in OAI

- Communication between tasks (threads) is mostly performed through ITTI (inter-task interface) messaging queues.
- F1AP CU/DU tasks interact with RRC task for triggering/handling F1AP control plane messages and scpt task for actual F1AP message exchanges over scpt protocol.
- GTP-U task interacting with CU, DU and RRC tasks for tunnel management API calls.
- GTP-U task interacting with L1+L2 task PDCP (CU) and RLC (DU) for user-plane traffic transfer.
- Reference: https://gitlab.eurecom.fr/oai/openairinterface5g/-/blob/NR_FIFO_FIFO_extensions/doc/F1-design.md
Code availability

> Active branches
>  - NR_F1C_F1U_extensions (the one you will be using in this lab)
>    - [https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/NR_F1C_F1U_extensions](https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/NR_F1C_F1U_extensions)
>    - Ready to be merged to develop branch
>  - F1C_extensions_develop
>    - Includes ongoing work on UE context management extensions
>    - Updates based on interoperability testing with commercial CU and COTS UE
>    - [https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/F1C_extensions_develop](https://gitlab.eurecom.fr/oai/openairinterface5g/-/tree/F1C_extensions_develop)

> Instructions for setting up the CU/DU testbed (besides this lab environment):
>  - Classic bare metal installation:
>    - [https://gitlab.eurecom.fr/oai/openairinterface5g/-/blob/NR_F1C_F1U_extensions/doc/TESTING_5GSA_setup.md](https://gitlab.eurecom.fr/oai/openairinterface5g/-/blob/NR_F1C_F1U_extensions/doc/TESTING_5GSA_setup.md)
>  - Direct deployment of OAI RAN and Core based on docker images and docker-compose:
>    - [https://gitlab.eurecom.fr/oai/openairinterface5g/-/blob/NR_F1C_F1U_extensions/ci-scripts/yaml_files/5g_rfsimulator/README.md](https://gitlab.eurecom.fr/oai/openairinterface5g/-/blob/NR_F1C_F1U_extensions/ci-scripts/yaml_files/5g_rfsimulator/README.md)
# Pcap trace over F1-C

Including latest updates (slightly different from what you will see at the lab shortly)

<table>
<thead>
<tr>
<th>No.</th>
<th>Time</th>
<th>Source</th>
<th>Destination</th>
<th>Protocol</th>
<th>Length</th>
<th>Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.000000</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP</td>
<td>260</td>
<td>F1SetupRequest, MIB, STBI[UNKNOWN PER: too long integer(per normally small nonnegative whole n]</td>
</tr>
<tr>
<td>2</td>
<td>0.000204</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP</td>
<td>90</td>
<td>F1SetupResponse</td>
</tr>
<tr>
<td>3</td>
<td>0.000335</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP</td>
<td>118</td>
<td>GNBConfigurationUpdate SID2[UNKNOWN PER: too many extensions][Malformed Packet]</td>
</tr>
<tr>
<td>4</td>
<td>0.001022</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP</td>
<td>94</td>
<td>GNBConfigurationUpdateAcknowledge</td>
</tr>
<tr>
<td>5</td>
<td>5.121955</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP/NR</td>
<td>166</td>
<td>RRC Setup Request</td>
</tr>
<tr>
<td>6</td>
<td>6.133467</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP/NR</td>
<td>102</td>
<td>RRC Setup Request</td>
</tr>
<tr>
<td>7</td>
<td>6.133162</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP/NR</td>
<td>129</td>
<td>RRC Setup Complete, Registration request MAC=0x00000000</td>
</tr>
<tr>
<td>8</td>
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<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP/NR</td>
<td>160</td>
<td>DL Information Transfer, Authentication request MAC=0x00000000</td>
</tr>
<tr>
<td>9</td>
<td>9.222123</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP/NR</td>
<td>142</td>
<td>UL Information Transfer, Authentication response MAC=0x00000000</td>
</tr>
<tr>
<td>10</td>
<td>10.226551</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP/NR</td>
<td>140</td>
<td>DL Information Transfer, Security mode command MAC=0x00000000</td>
</tr>
<tr>
<td>11</td>
<td>11.389800</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP/NR</td>
<td>170</td>
<td>UL Information Transfer, Security mode complete, Registration request MAC=0x00000000</td>
</tr>
<tr>
<td>12</td>
<td>12.317813</td>
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<td>126</td>
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<tr>
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<td>110</td>
<td>Security Mode Complete MAC=0x00000000</td>
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<tr>
<td>14</td>
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<td>FIAP/NR</td>
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<td>UE Capability Enquiry MAC=0x8b57637b</td>
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<tr>
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<td>127.0.0.4</td>
<td>FIAP/NR</td>
<td>130</td>
<td>UE Capability Information MAC=0x8b57637b</td>
</tr>
<tr>
<td>16</td>
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<td>FIAP</td>
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<td>UEContextRequest</td>
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<tr>
<td>17</td>
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<td>127.0.0.1</td>
<td>FIAP</td>
<td>110</td>
<td>UEContextRequest</td>
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<tr>
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<td>18.488661</td>
<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP</td>
<td>174</td>
<td>RRC Reconfiguration, Registration accept MAC=0xb8cfd0f62</td>
</tr>
<tr>
<td>19</td>
<td>19.657799</td>
<td>127.0.0.1</td>
<td>127.0.0.4</td>
<td>FIAP/NR</td>
<td>119</td>
<td>RRC Reconfiguration Complete MAC=0x00000000</td>
</tr>
<tr>
<td>20</td>
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<td>127.0.0.4</td>
<td>127.0.0.1</td>
<td>FIAP/NR</td>
<td>114</td>
<td>UL Information Transfer, Registration complete MAC=0x00000000</td>
</tr>
</tbody>
</table>

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[Oct 10, 2021] 22:77:36.655 127.0.0.4 127.0.0.1 FIAP
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Ongoing work and next integration steps

- **Ongoing work**
  - Interoperability testing between our DU and a commercial CU (AccelleRan)
  - Testing with COTS UE and real RF

- **Next integration steps**
  - CU-C/CU-U split integration based on E1 interface
  - Support for more complex deployments of multiple DUs/CUs
LAB 2 session

Now let’s start our lab 2 session