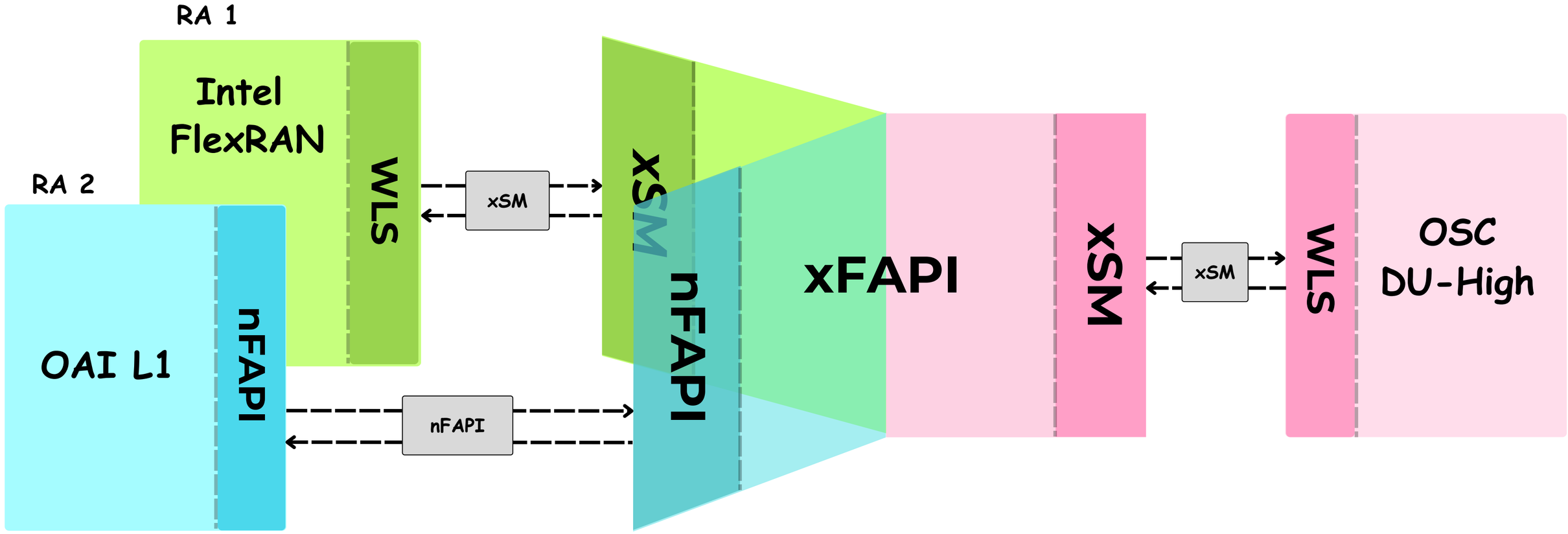
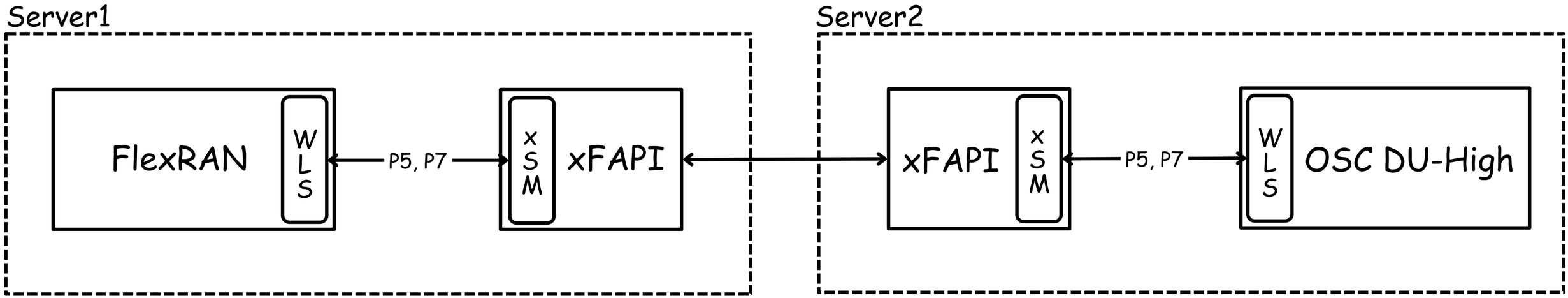
xFAPI Blueprint

Reference Architecture

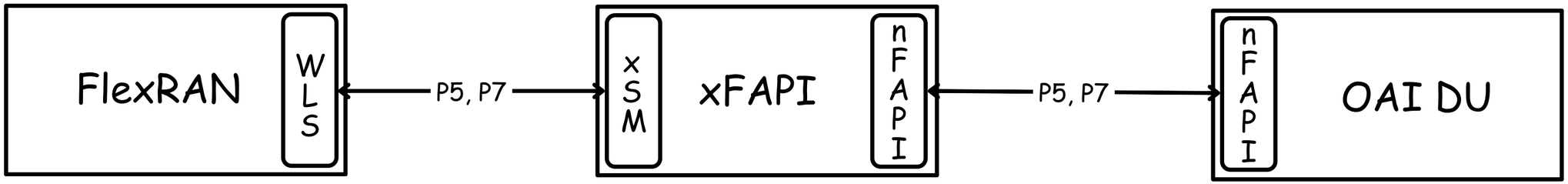


xFAPI Scenarios

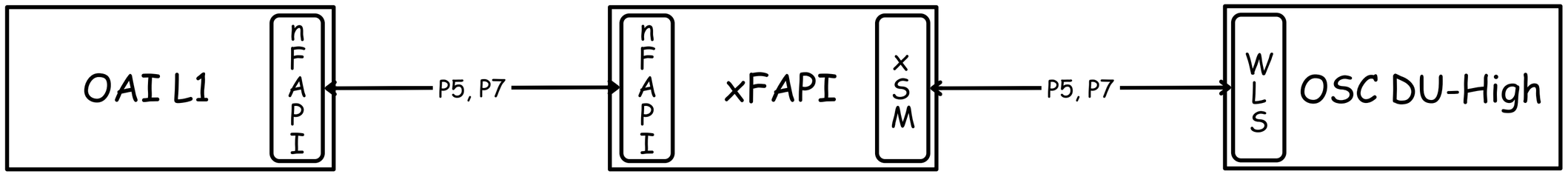
Scenario 1: Disaggregated L1-L2



Scenario 2: FlexRAN with OAI DU



Scenario 3: OAI with OSC DU-High

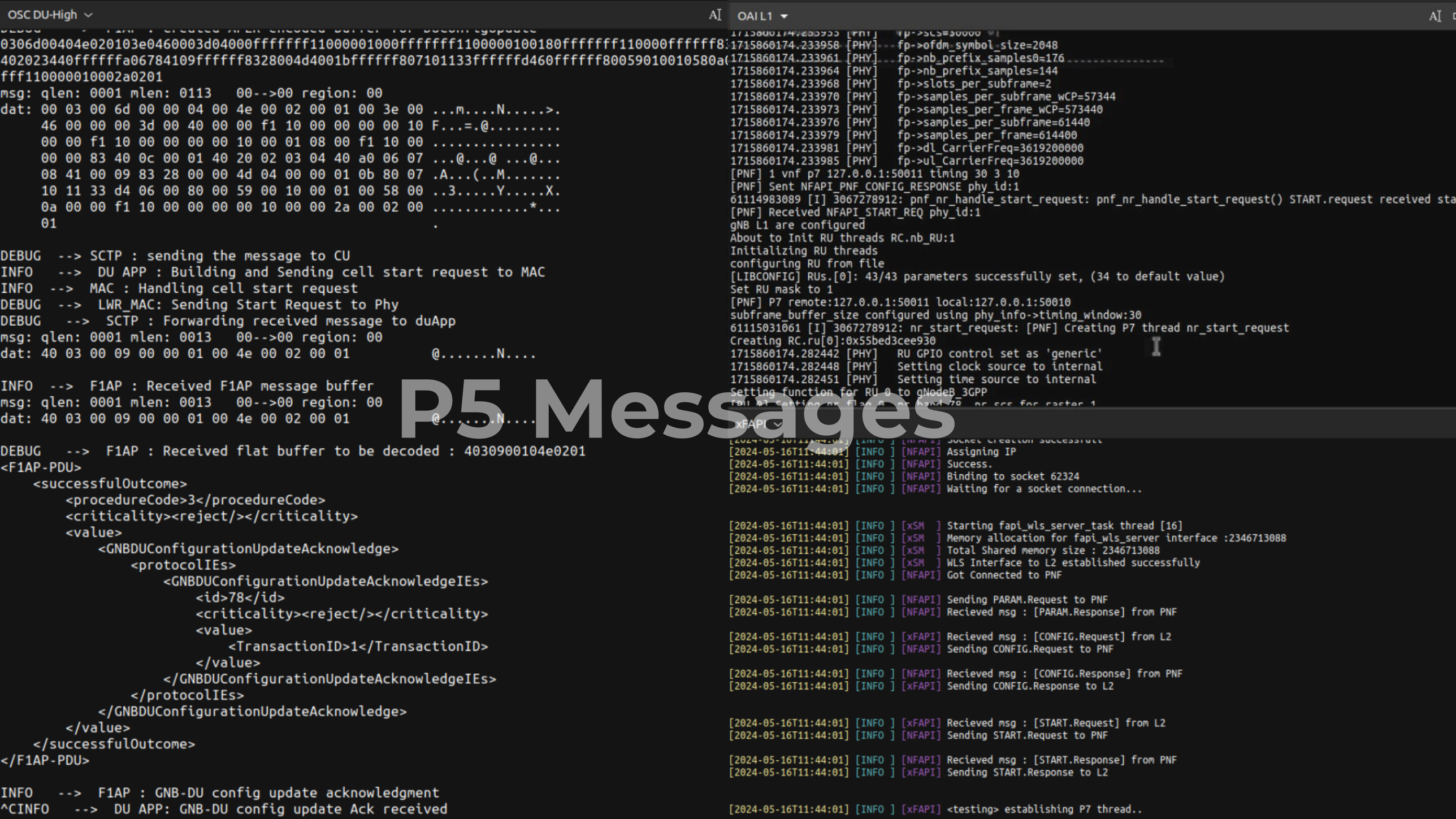


xFAPI

- xFAPI is an intermediate component that establishes the connections b/w any L1 and L2 layers and operates in both FAPI and nFAPI modes
- Used xFAPI as a universal connector to connect OSC DU-High with various versions of FlexRAN successfully
- Includes a debugging capability that provides message statistics for analysis after each connection establishment
- Integrated capability for OAI L1 in nFAPI mode, which can be activated on runtime based on compilation flags
- Adding connectivity support b/w OAI L1 and OSC DU-High

Development and Testing

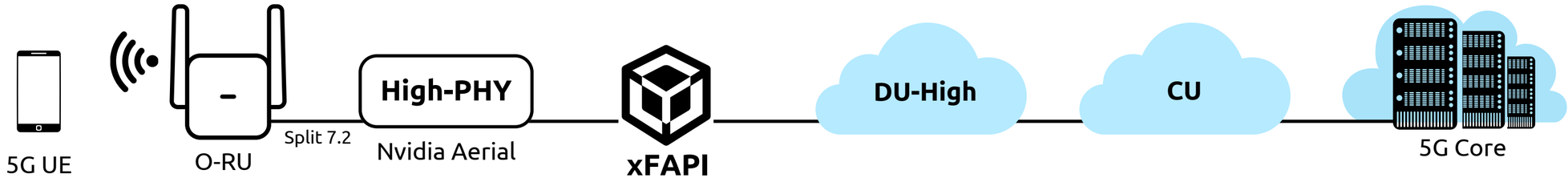
- Developed support in the xSM library of xFAPI to access the shared memory region filled by the OSC DU-High WLS Lib
- Established the xFAPI-OAI L1 (PNF) connection at the nFAPI interface
- Enhanced xFAPI to support message translation functionalities for P5 messages
- Successfully facilitated the exchange of P5 messages b/w OAI L1 & OSC DU-High through xFAPI
- Simultaneously working on API support for debugging and log display on the dashboard
- Continuously refining xSM and xFAPI log outputs for clearer, more actionable insights
- Enhanced debugging capabilities, now include support for both horizontal and vertical log levels, which represent component/message types and their respective log levels


OSC DU-High
0306d00404e020103e0460003d04000ffffff11000001000ffffff1100000100180ffffff110000ffffff8
402023440ffffffa06784109ffffff8328004d4001bffffff807101133ffffffd460ffffff80059010010580a
fff110000010002a0201
msg: qlen: 0001 mlen: 0113 00-->00 region: 00
dat: 00 03 00 6d 00 00 04 00 4e 00 02 00 01 00 3e 00 ...m....N.....>.
46 00 00 00 3d 00 40 00 00 f1 10 00 00 00 00 10 F...=.@.........
00 00 f1 10 00 00 00 00 10 00 01 08 00 f1 10 00 ....
00 00 83 40 0c 00 01 40 20 02 03 04 40 a0 06 07 ...@...@ ...@...
08 41 00 09 83 28 00 00 4d 04 00 00 01 0b 80 07 .A...(..M.......
10 11 33 d4 06 00 80 00 59 00 10 00 01 00 58 00 ..3.....Y.....X.
0a 00 00 f1 10 00 00 00 00 10 00 00 2a 00 02 00 ....*...
01 .
DEBUG --> SCTP : sending the message to CU
INFO --> DU APP : Building and Sending cell start request to MAC
INFO --> MAC : Handling cell start request
DEBUG --> LWR_MAC: Sending Start Request to Phy
DEBUG --> SCTP : Forwarding received message to duApp
msg: qlen: 0001 mlen: 0013 00-->00 region: 00
dat: 40 03 00 09 00 00 01 00 4e 00 02 00 01 @.......N....
INFO --> F1AP : Received F1AP message buffer
msg: qlen: 0001 mlen: 0013 00-->00 region: 00
dat: 40 03 00 09 00 00 01 00 4e 00 02 00 01 @.......N....
DEBUG --> F1AP : Received flat buffer to be decoded : 4030900104e0201
<F1AP-PDU>
<successfulOutcome>
<procedureCode>3</procedureCode>
<criticality><reject/></criticality>
<value>
<GNBDUConfigurationUpdateAcknowledge>
<protocolIEs>
<GNBDUConfigurationUpdateAcknowledgeIEs>
<id>78</id>
<criticality><reject/></criticality>
<value>
<TransactionID>1</TransactionID>
</value>
</GNBDUConfigurationUpdateAcknowledgeIEs>
</protocolIEs>
</GNBDUConfigurationUpdateAcknowledge>
</value>
</successfulOutcome>
</F1AP-PDU>
INFO --> F1AP : GNB-DU config update acknowledgment
^CINFO --> DU APP: GNB-DU config update Ack received
OAI L1
1715860174.233958 [PHY] fp->ofdm_symbol_size=2048
1715860174.233961 [PHY] fp->nb_prefix_samples0=176
1715860174.233964 [PHY] fp->nb_prefix_samples=144
1715860174.233968 [PHY] fp->slots_per_subframe=2
1715860174.233970 [PHY] fp->samples_per_subframe_wCP=57344
1715860174.233973 [PHY] fp->samples_per_frame_wCP=573440
1715860174.233976 [PHY] fp->samples_per_subframe=61440
1715860174.233979 [PHY] fp->samples_per_frame=614400
1715860174.233981 [PHY] fp->dl_CarrierFreq=3619200000
1715860174.233985 [PHY] fp->ul_CarrierFreq=3619200000
[PNF] 1 vnf p7 127.0.0.1:50011 timing 30 3 10
[PNF] Sent NFAPI_PNF_CONFIG_RESPONSE phy_id:1
61114983089 [I] 3067278912: pnf_nr_handle_start_request: pnf_nr_handle_start_request() START.request received sta
[PNF] Received NFAPI_START_REQ phy_id:1
gNB L1 are configured
About to Init RU threads RC.nb_RU:1
Initializing RU threads
configuring RU from file
[LIBCONFIG] RUs.[0]: 43/43 parameters successfully set, (34 to default value)
Set RU mask to 1
[PNF] P7 remote:127.0.0.1:50011 local:127.0.0.1:50010
subframe_buffer_size configured using phy_info->timing_window:30
61115031061 [I] 3067278912: nr_start_request: [PNF] Creating P7 thread nr_start_request
Creating RC.ru[0]:0x55bed3cee930
1715860174.282442 [PHY] RU GPIO control set as 'generic'
1715860174.282448 [PHY] Setting clock source to internal
1715860174.282451 [PHY] Setting time source to internal
Setting function for RU 0 to gNodeB_3GPP
xFAPI
[2024-05-16T11:44:01] [INFO] [NFAPI] Assigning IP
[2024-05-16T11:44:01] [INFO] [NFAPI] Success.
[2024-05-16T11:44:01] [INFO] [NFAPI] Binding to socket 62324
[2024-05-16T11:44:01] [INFO] [NFAPI] Waiting for a socket connection...
[2024-05-16T11:44:01] [INFO] [xSM] Starting fapi_wls_server_task thread [16]
[2024-05-16T11:44:01] [INFO] [xSM] Memory allocation for fapi_wls_server interface :2346713088
[2024-05-16T11:44:01] [INFO] [xSM] Total Shared memory size : 2346713088
[2024-05-16T11:44:01] [INFO] [xSM] WLS Interface to L2 established successfully
[2024-05-16T11:44:01] [INFO] [NFAPI] Got Connected to PNF
[2024-05-16T11:44:01] [INFO] [NFAPI] Sending PARAM.Request to PNF
[2024-05-16T11:44:01] [INFO] [NFAPI] Recieved msg : [PARAM.Response] from PNF
[2024-05-16T11:44:01] [INFO] [xFAPI] Recieved msg : [CONFIG.Request] from L2
[2024-05-16T11:44:01] [INFO] [NFAPI] Sending CONFIG.Request to PNF
[2024-05-16T11:44:01] [INFO] [NFAPI] Recieved msg : [CONFIG.Response] from PNF
[2024-05-16T11:44:01] [INFO] [xFAPI] Sending CONFIG.Response to L2
[2024-05-16T11:44:01] [INFO] [xFAPI] Recieved msg : [START.Request] from L2
[2024-05-16T11:44:01] [INFO] [NFAPI] Sending START.Request to PNF
[2024-05-16T11:44:01] [INFO] [NFAPI] Recieved msg : [START.Response] from PNF
[2024-05-16T11:44:01] [INFO] [xFAPI] Sending START.Response to L2
[2024-05-16T11:44:01] [INFO] [xFAPI] <testing> establishing P7 thread..

P5 Messages

Integration and Enhancement Plans

- Plan to integrate the Nvidia Aerial support with the xFAPI intermediary to expand its capabilities
  - Integrate nvIPC support into the xSM Lib of xFAPI to access the shared memory b/w Nvidia Aerial and xFAPI
  - Perform E2E testing of Nvidia Aerial in FAPI and nFAPI mode:
    - Topology: 5G Core + CU + DU-High + xFAPI + Aerial + O-RU + UE



- Enable multiple L1 instances to run alongside L2 with xFAPI support in nFAPI mode, increasing xFAPI scalability and flexibility
- Add the support for the operation of FlexRAN in nFAPI mode on separate servers using xFAPI, with adjustable settings for greater deployment versatility

Reference Architecture Enhancements