IOWN GLOBAL FORUM

PoC Project name:

MobileFrontHaul_over_APN PoC Step2-1

Classification: IOWN Global Forum Recognized PoC

Stage: SSF PoC Report

Confidentiality: Public

Version: 2.0

April 22, 2025

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IOWN-GF-RD-MFH_over_APN PoC Step2-1 Report

1. PoC Project Completion Status

Overall PoC Project Completion Status:

Phase 2-1 of the multi-phase POC is successfully completed.

PoC Stage Completion Status:

- **Phase 2-1** Focusing on establishing the switching procedures for Elastic Load Balancing (ELB) in a Meshed APN topology, and demonstrating that base stations operate normally after executing optical path switching with the APN. In this document, point-to-point refers to the logical connection ~~state~~ where two RU interfaces are connected to two DU interfaces via the APN, and then confirming the process of switching the two RUs to be accommodated by one DU. In this phase, using the current RAN and optical transmission technologies, we clarify the operation contents, operation time, and the impact time and scope on call processing during the switch. This aims to identify the technical challenges for practical implementation of this use case.

⇨ **Phase 2-1 of the POC is successfully completed.**

- **In phase 2-2,** As a continuation of Phase 2-1, Phase 2-2 will demonstrate the power-saving effects of ELB using more UEs in a traffic scenario that closely resembles actual mobile traffic.

⇨ **To be planned and target to be completed by end of March 2026 when relevant KPIs are defined.**

2. PoC Project Participants

PoC Project Name: IOWN-GF-RD-MFH_over_APN Step2-1

Company	Name
NOKIA	**Ben Zhao**
	Shien Yumoto
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	Tommy Choo
	Hideichi Oshima
	Lieven Levrau
NTT	**Manabu Sugihara**
	Sakaue Takashi
	Masayuki Furusawa
	Kenji Miyamoto
Anritsu	**Tomohiro Ito**

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	Soichiro Kai
	Daiki Mochizuki

Table 1 – List of PoC participants

3. Confirmation of PoC Demonstration

PoC Demonstration Event Details:

- The PoC was demonstrated at DOCOMO R&D Center in Yokosuka Research Park, 3-5 Hikari-no-oka, Yokosuka City, Kanagawa Prefecture, Japan.
- The date of PoC was Conducted during the period from 12th September to 2th October 2024
- PoC report submission date – 17th December 2024

4. PoC Goals Status Report

The PoC Project Goal #1: Goal Status: Achieved the original PoC objectives.

- Comply with PoC Reference of Mobile Fronthaul over APN Version 2.0
  - ⇨ Evaluation of feasibility of Mobile Fronthaul over APN, reference to
    - (1) Clarify the procedure from the communication state of RU-DU to the switching to a new RU and DU communication state. The procedure includes DU shutdown decisions triggered by performance monitoring.
    - (2) Clarify the time taken for the path switching.
    - (3) Clarify the impact of the content and time of service from the perspective of users and carriers when switching.

5. PoC Feedback Received from non-member (Optional)

Not applicable

6. PoC Technical Report (IMN)

This PoC was conducted in accordance with the Step 2-1 definition described in PoC Reference of Mobile Fronthaul over APN Version 2.0 and involved NTT, Nokia and Anritsu.

From PoC Reference Section 3.3

Reference 3.3 Step2 Evaluation of feasibility and energy efficiency with Elastic Load Balancing scenario

- Although DU interface must comply with O-RAN, it does not necessarily need to be virtualized RAN.
- Minimum number of devices
  - RU site : 2
  - RU per RU site : 1
  - DU site : 2
  - DU per DU site : 1
  - RU site per DU site : 1

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- Traffic volume from UE: Vary from daytime to nighttime.
- Time synchronization scenario ：
  Scenario 4 in IMN document 5.2.6.2, which is correspond to LLS-C3

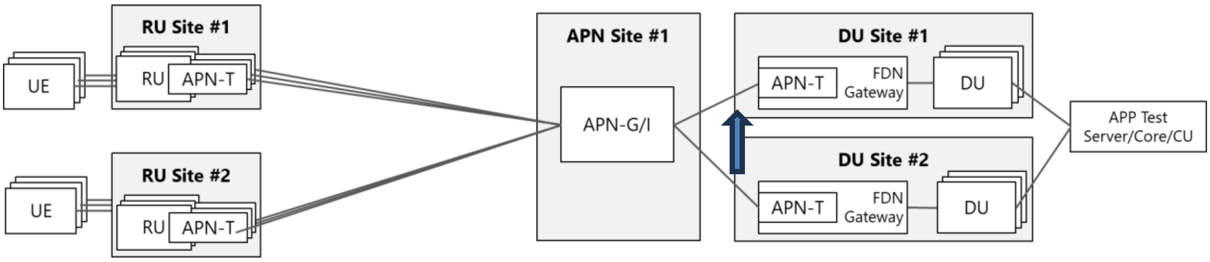

Figure 1 - Deployment scenario for Step 1

6.1. Implemented System

6-1-1. The Network Configuration - including fiber length

The network configuration comprises two Remote Units (RUs) and two Virtual Distributed Units (vDUs) interconnected through an All Photonic Network (APN). On the RU side, a single APN-G is present, whereas the vDU side comprises two APN-Gs that are interconnected through an APN-I. This configuration is designed to support the changing site location interconnectivity requirement. For the verification of the Flexible Bridge model, it is essential that each RU is connected to two Flexible Bridges, and similarly, each vDU is also connected to two Flexible Bridges.

The vRAN implemented in this configuration is classified as an LLS-C3 type, functioning in conjunction with an L2 switch. The switch supplied by the carrier operates as the grandmaster for Precision Time Protocol (PTP) synchronization and is utilized in its unaltered state. Due to environmental constraints, a single physical L2 switch is implemented, which is logically partitioned to serve two virtual Distributed Units (vDUs). Bi-directional transmission is established between the Radio Units (RUs) and Flexible Bridges, as well as between the virtual Distributed Units (vDUs) and Flexible Bridges. A 30 km fiber spool is positioned between the APN-G on the RU side and the APN-I.

The positions of the inserted fiber spools are detailed in the subsequent test diagrams and tables. The configuration is designated as LLS-C3 in the O-RAN WG4 CUS-Plane specification.

A Core NW simulator is connected to the DU, enabling the establishment of C-plane and U-plane connections and the transfer of user data flow between the UE and APL server. An Anritsu Network Tester was used for latency and jitter measurements.

Figure 2 shows the environment for this PoC.

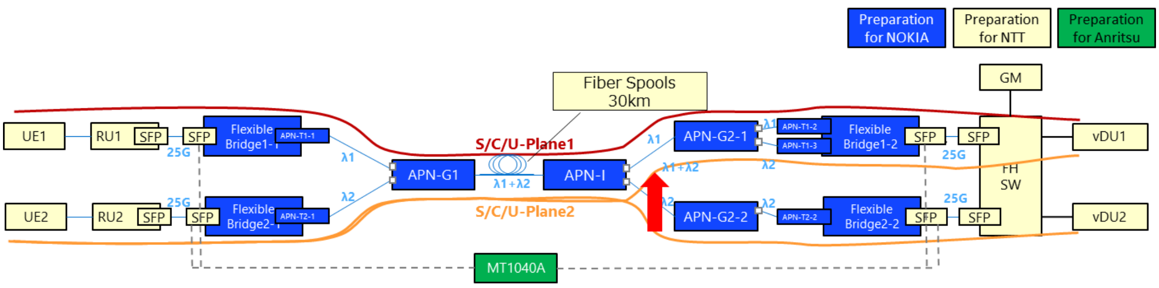

Figure 2 - The APN-G Pattern1 details network topology with the different fiber spool locations

Additionally, Table 1 summarizes the comparison of the conditions between the PoC Reference and this PoC.
Due to environmental constraints, there was only one switch in this setup. However, we confirmed that the logical separation was maintained, so there were no issues with the PoC switching procedure.

Item	PoC reference	Conditions for this PoC
The assumed mobile functional layer split architecture	Option7.2	Option7.2
The traffic	eMBB, though it is not restricted to this type only.	eMBB,
The interface of the interconnections：	10G/25G/50G	25G
Distance between RU and DU (L1+L2) ：	As close to 30km as possible	30km
RAN de vices (RU, DU, CU)	Physical device, simulator, emulator. All vRAN devices must comply with the O-RAN specifications.	Physical device
APN devices (APN-I, APN-G, APN-T, Flexible Bridge)	Physical device. All APN devices comply with the APN technology defined by the OAA.	Physical device
Other device (UE, Packet simulator, etc)	Allow physical, simulator, emulator, and software as necessary.	UE: Physical device Packet simulator:
RU site：	2	2
RU per RU site：	1	1
DU site：	2	2
DU per DU site：	1	1
RU site per DU site：	1	1
Traffic volume from UEs:	Consider daytime and nighttime traffic fluctuations.	Consider daytime and nighttime traffic fluctuations
Time synchronization scenario:	Either LLS-C2/C3/C4	LLS-C3

Table 2 - PoC characteristics and configuration specifics

Table 3 shows the detailed configuration photos of NOKIA's APN devices.

Front rack From top to bottom: Flexible Bridge2-2, Flexible Bridge1-2, Flexible Bridge2-1, Flexible Bridge1-1, APN-G2-2 and APN-G2-1	Rear rack APN-I(Top) and APN-G1(Bottom)

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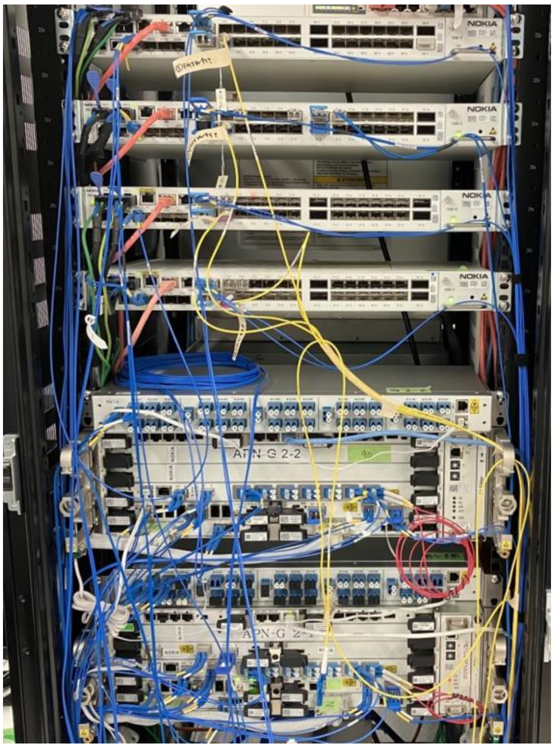

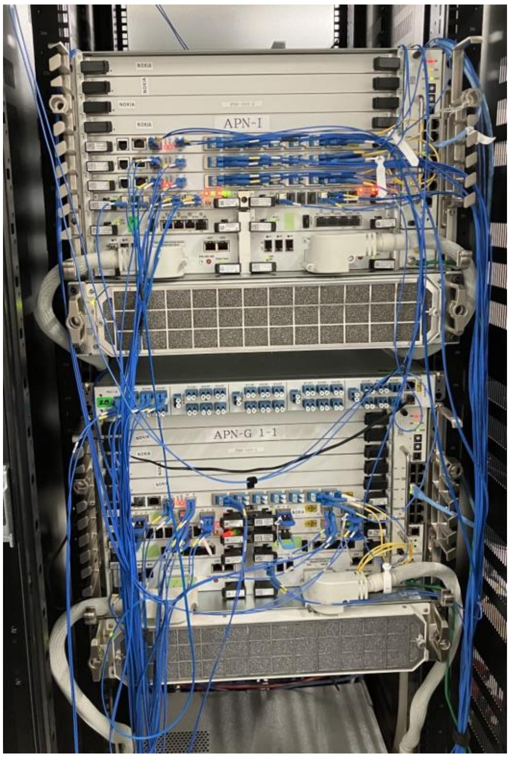

Table 3 - Photographs of the PoC rack installed equipment in the lab.

6-1-2. Bill of Materials

Table 4 is the list of equipment that was used during the Proof of Concept tests.

Equipment	Detail	Preparation
UE	The commercially used equipment by NTT DOCOMO	NTT
RU		NTT
vDU/vCU	Using test equipment	NTT
CoreNW Simulator	Simulator for AMF/UPF/Application server to establish C/U-plane connections and transfer user data flow.	NTT DOCOMO
Flexible Bridge/APN-T	1830 TPS-24 (code Version Release 2.1)	NOKIA
APN-G	1830 PSS-16II (code Version Release 22.12) S2AD200 – 3KC69659AA	NOKIA
APN-I	1830 PSS-8 (code Version Release 22.12) Modules iROADMv (8DG62445AA/AB)	NOKIA
Network Tester	Anritsu MT1040A	Anritsu
Fiber spool	two 10-kilometer-long drum-type optical fibers two 25-kilometer-long drum-type optical fibers	NTT
SFP-25G-LR (Flexblebridge)	Exclusive product of NTT DOCOMO with Bi-Directional compatibility	NTT

Table 4 - Network element equipment Bill of material for the POC

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6.2. PoC scenario

Currently, there is no standardized procedure for switching RU and DU in O-RAN.

Therefore, we have created our own procedure by combining the steps for switching RU and DU on the RAN side with the steps for switching paths on the APN side.

- •Pre-task : vRAN - Register Required Information
- •Switching task : vRAN - Change Network Settings
  : APN - Change the Wavelength Path Route
  : vRAN - Restart each device
- •Post-task : vRAN, APN - Shutdown any unnecessary equipment

Figure 3 shows the procedure.

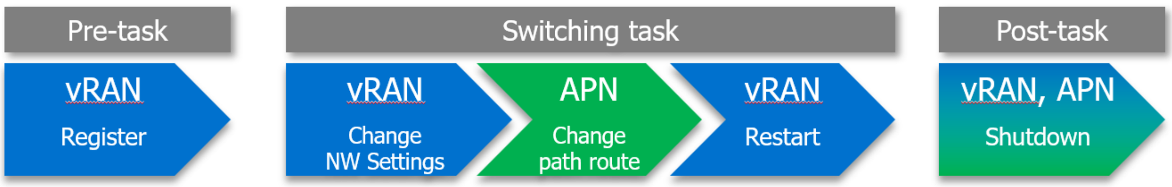

Figure 3 - Implementation Procedure

6.2.1 Measurement Method

The Measuring Method of Section 6.2.1 in PoC Reference of Mobile Fronthaul over APN Version 2.0 is as follows:

(1) Confirm whether this model can be carried out according to the procedure. Ensure that the communication between RU and DU is functions normally before and after the switch.

(2) Measure the working time for each procedure when switching.

(3) Obtain data of the S/C/U-Plane sequence during the switching, and the U-Plane's Uplink and downlink throughout.

6.2.2 Procedure Of PoC Scenario

We created the PoC scenario in accordance with the Measuring Method of Section 6.2.1 in PoC Reference of Mobile Fronthaul over APN Version 2.0.

The detailed procedures for each device are as follows:

	vRAN devices	APN devices
[Pre-task]	**Task1:** Register RU2 information on vDU1	
Pre-Check	Functional Verification, Power Consumption Measurement	
[Switching task]	**Task2:** Shutting Down FHSW Ports for vDU2	–
	Task3: Added RU2 information to FHSW port for vDU1	–
	–	**Task4:** Setting for APNG2-1 in APN-I
	Task5: Restart vDU1,RU1,RU2	–
Status Check	Functional Verification, Power Consumption Measurement	
[Post-task]	**Task6** Shutting Down vDU2	**Task7** Shutting Down APN-G2-2/FB2-2
Post-Check	Functional Verification, Power Consumption Measurement	

Table 5 - Procedures and tasks for vRAN and APN

6.2.3 PoC Scenario details

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6.2.3.1 Pre-task

Figure 4 illustrates the preparation process. Under normal conditions, as shown in the "Normal State," each virtual Distributed Unit (vDU) holds information about the Radio Unit (RU) it communicates with. Specifically, vDU1 holds information about RU1, and vDU2 holds information about RU2. This is depicted in the upper part of Figure 4 - Pre-task Procedure.

In this PoC, after the switch, vDU1 needs to communicate with RU2. Therefore, the information of RU2 is registered into vDU1. This operation is designated as Task 1 and is illustrated in the lower part of Figure 4 - Pre-task Procedure.

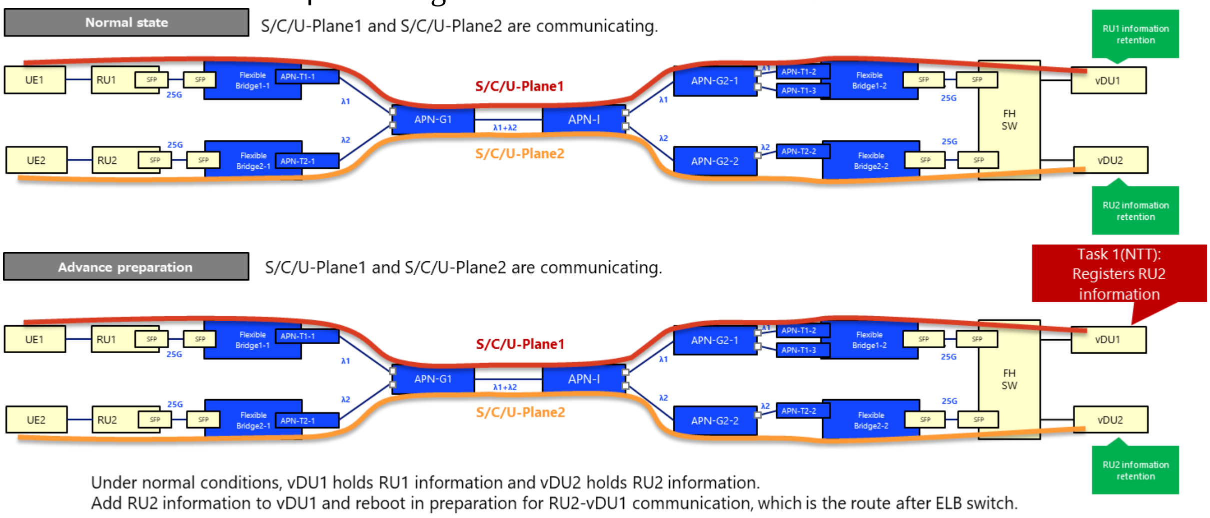

Figure 4 - Pre-task Procedure

6.2.3.2 Switching task

The process now shifts to the switching phase. The upper part of Figure 5 shows a state where the configuration is complete, and communication is established successfully. In the lower part of Figure 5, we switch the communication from RU2 to vDU1 by disconnecting the communication between RU2 and vDU2 at the port of the Front Haul Switch (FHSW).To accomplish this, the network settings for RU2 configured at the FHSW port for vDU2 are removed (Task 2), and these settings are then configured at the FHSW port for vDU1 (Task 3). This ensures that the FHSW configuration necessary for communication between RU2 and vDU1 is completed.

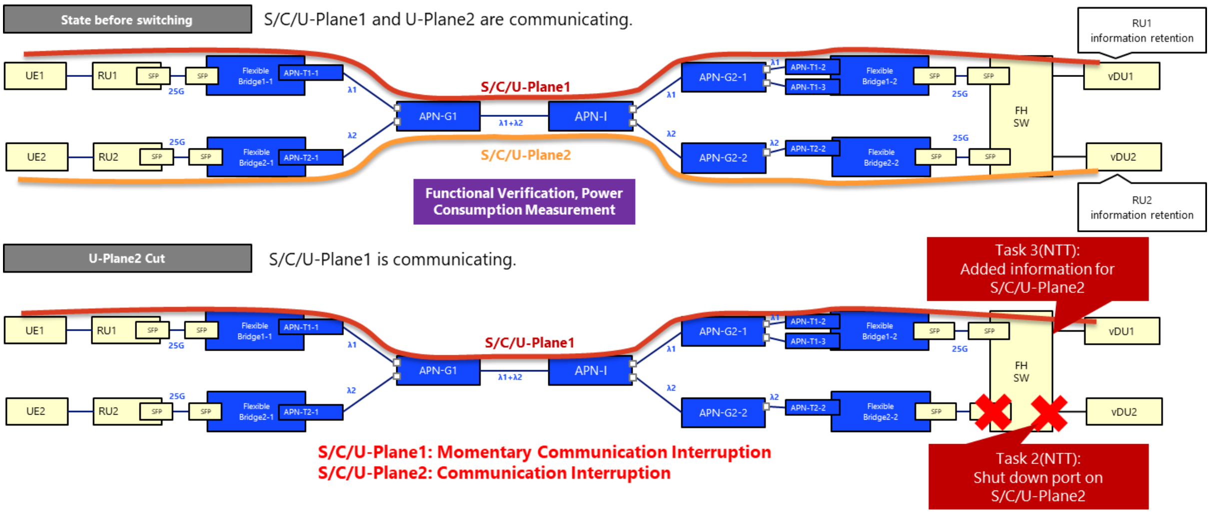

Figure 5 - Switching Procedure1

Next, to enable communication between RU2 and vDU1, we configure the route switching settings on the APN device. In the upper part of

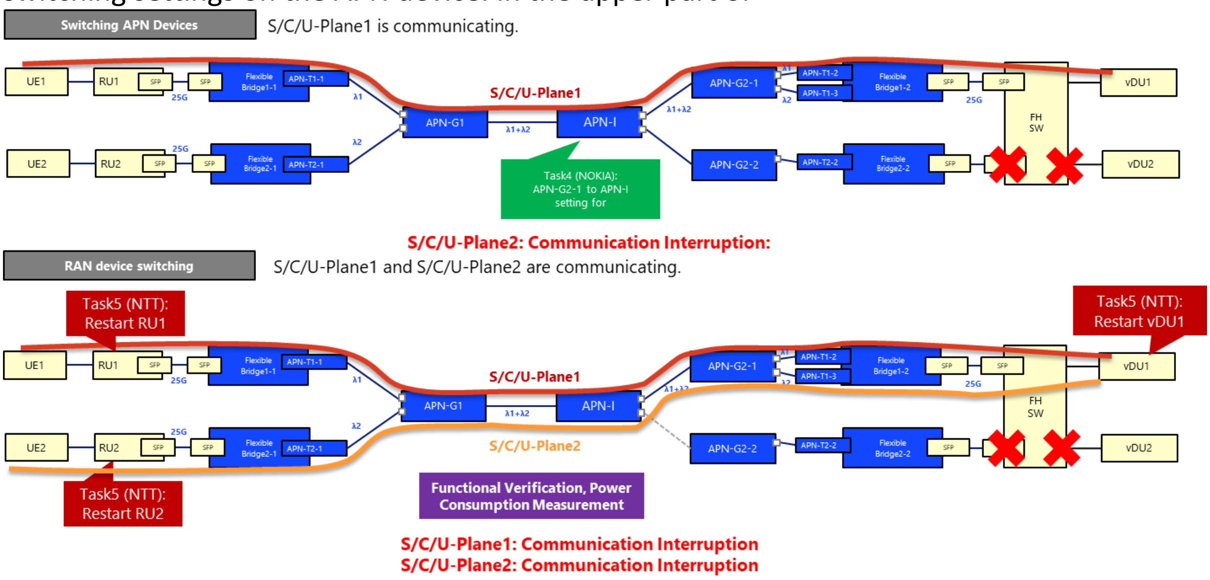

Figure 6 - Switching Procedure2, the route on the APN-I from APN-G2-2 is switched to APN-G2-1 (Task 4). With this, all the necessary network configuration information

for communication between RU2 and vDU1 has been registered. In the lower part of

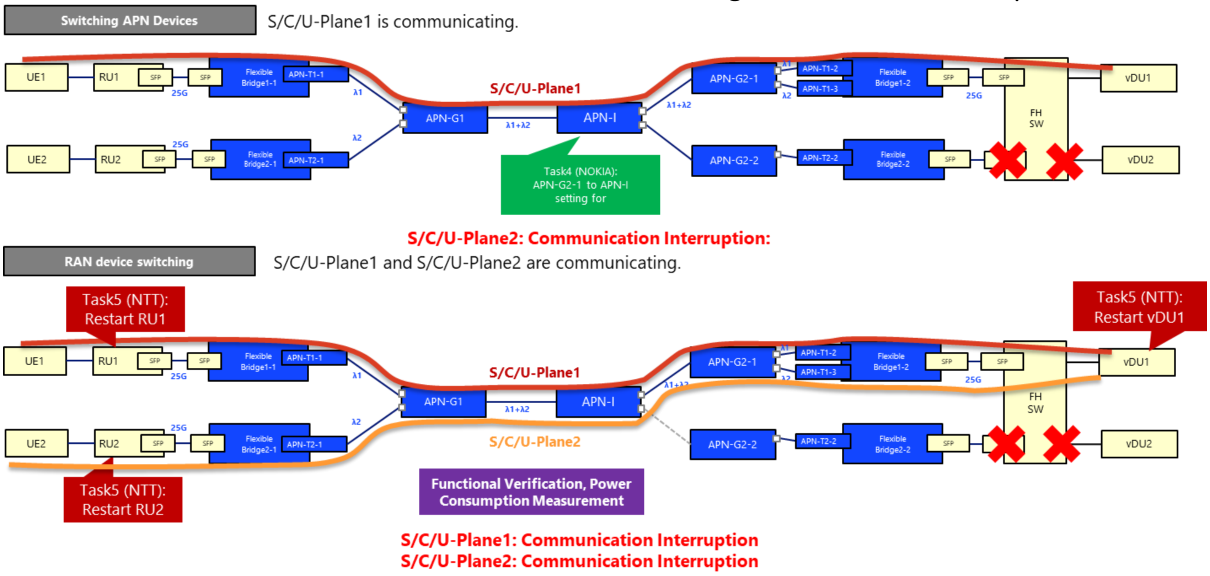

Figure 6 - Switching Procedure2, to trigger the new communication, we proceed with the reboot of the RAN devices, specifically vDU1, RU1, and RU2 (Task 5). This reboot will result in the interruption of the communication between RU1 and vDU1.

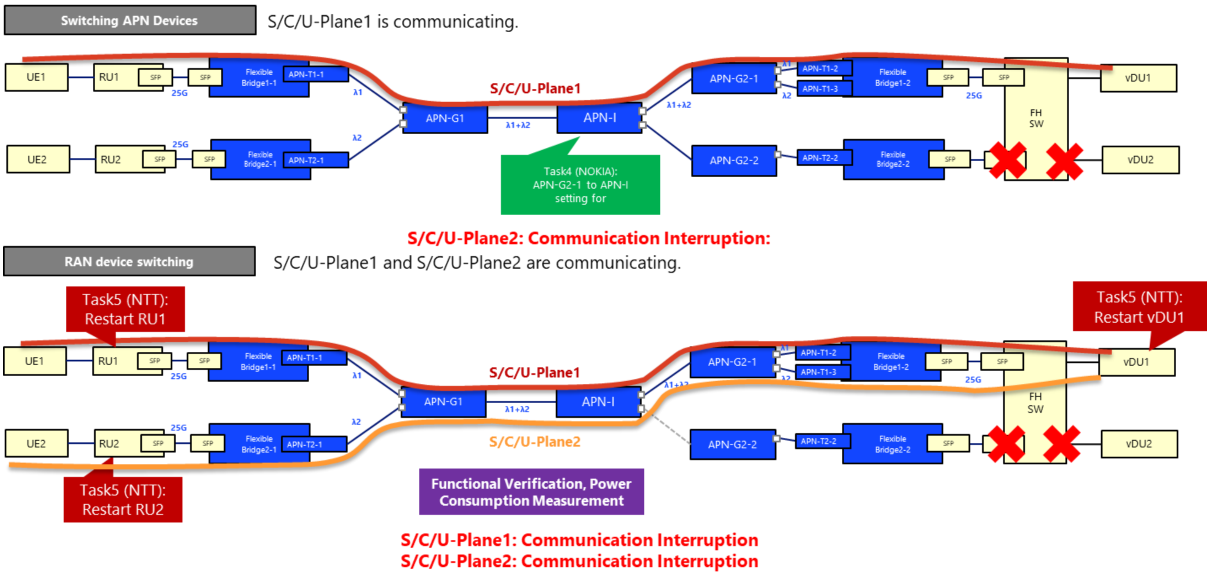

Figure 6 - Switching Procedure2

6.2.3.3 Post-task

The post-task phase is the final stage. The ELB use case aims to reduce power consumption. Therefore, it is desirable to shut down or put into sleep mode any devices that are no longer necessary for communication. As shown in Figure 7, the relevant devices on the route to vDU2 include APN-G2-2, FlexibleBridge2-2, and vDU2. If the FHSW were divided into two units, those would also be targeted, but due to the constraints of the current environment, it is a single unit and thus could not be shut down (Task 6, Task 7).

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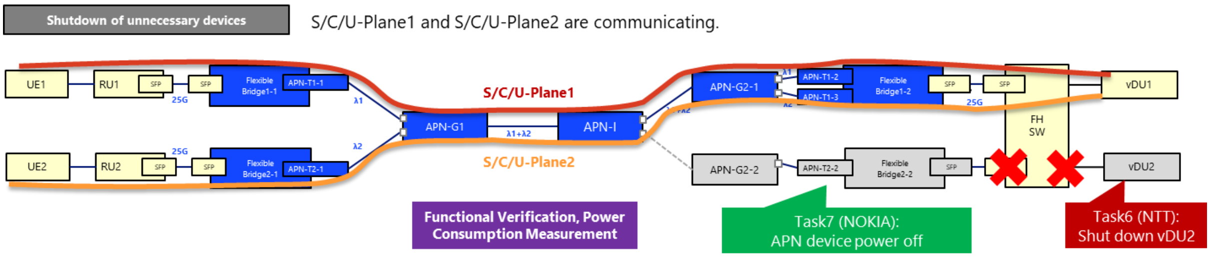

Figure 7 - Post-task Procedure

6.3. PoC Results

6.3.1 Evaluation Method

(1) Check whether the switch implementation procedure was appropriate (for instance, there were no unforeseen impacts on service or extensions to the service time).
(2) Verify if the time taken for the switch is acceptable (consider if there are any opportunities or methods to reduce the work switching duration).
(3) Confirm whether the nature and timing of the impact on service during the switch are suitable (evaluate if the degree/content of the impact on service is feasible as a use case and determine if there are any technical issues).

6.3.2 Result

(1) Switching procedures for RAN and APN: Established
- Successfully executed the switch as per the procedure.
- No unexpected communication interruptions or throughput degradation occurred.

Table 6 shows the results for Expectation and Result.

	Task	Expectation				Result			
		Work Time (min)	communication status			Work Time (min)	communication status		
			RU1-vDU1	RU2-vDU2	RU2-vDU1		RU1-vDU1	RU2-vDU2	RU2-vDU1
[Pre-task]	Task1	15min	○	○	–	15min	○	○	–
Pre-Check		–	○	○	–	–	○	○	–
[Switching task]	Task2	10min	○	After Port Shut ×	–	7min	○	After Port Shut ×	–
	Task3		△ momentary interruption	×	–		○	×	–
	Task4	3min	○	×		3min	○	×	
	Task5	15min	On restart ×	×	After Restart ○	15min	On restart ×	×	After Restart ○
Status Check		–	○	–	○	–	○	–	○
[Post-task]	Task6	10min	○	–	○	10min	○	–	○
	Task7	15min	○	–	○	13min	○	–	○
Post-Check		–	○	–	○	–	○	–	○

Table 6 - Comparison of Expectation and Result

(2) Working time for switching task: 25 (minutes) (all working hours 53(minutes))
- The work time matched the initial expectations.
- Work time on RAN device: 22 minutes, Work time on APN device: 3 minutes

- Verification time after each task not included.
Table 7 shows the results of the task durations.

Working time			
Pre-task	Switching task	Post-task	Total
15min	25min.	13min.	53min.

Table 7 - Time taken for each task

With the future advancements in vRAN technology, the reboot of vDU1 is expected to be executable as a part of pre-work. In that case, the communication interruption during the switch will only affect RU2, and the expected downtime will be approximately 8 minutes.

(3) Communication Interruption time : RU1: 15 (minutes) , RU2 : 25 (minutes)
A restart of vDU1 is required during the switching process, causing downtime for both RU1 and RU2.
Table 8 shows the duration of communication interruptions, and Table 9 illustrates the uplink and downlink throughput during communication.

Interruption time	Pre-task	Switching task	Post-task	Total
RU1 side	0	15min.	0	15min.
RU2 side	0	25min.	0	25min.

Table 8 – Interruption time

Process	Interval	Communication OK/NG	Uplink Throughput(Mbps)	DownLink Throughput(Mbps)	Remarks
Pre-check (30km)	FB1-1 to FB1-2 (APN-T1-2)	OK	20	130	
	FB2-1 to FB2-2 (APN-T2-2)	OK	20	130	
Status Check (30km)	FB1-1 to FB1-2 (APN-T1-2)	OK	20	130	
	FB2-1 to FB1-2 (APN-T1-3)	OK	20	130	
Post-Check (30km)	FB1-1 to FB1-2 (APN-T1-2)	OK	20	130	
	FB2-1 to FB1-2 (APN-T1-3)	OK	20	130	

Table 9 - Uplink/Downlink Throughput

(4) Other measured reference information
The normal operation of the base station has been confirmed at each phase, and the measurement results for Latency and Jitter are shown in Table 10. Although the latency exceeded 160 μsec at 30 km, the base station was operating normally.

・Latency/Jitter

With or without Fiber Spools	Interval	Communication OK/NG	Latency(μs)	Jitter(μs)	Remarks
Without Fiber Spools	FB1-1 to FB1-2 (APN-T1-2)	OK	11.082	0.005	
	FB2-1 to FB2-2 (APN-T2-3)	OK	11.151	0.005	
With Fiber Spools (30km)	FB1-1 to FB1-2 (APN-T1-2)	OK	162.01	0.005	
	FB2-1 to FB2-2 (APN-T2-3)	OK	162.06	0.005	

Table 10 - Measurement Results of Latency and Jitter

・Amount of power consumption reduction : <u>vRAN No differences , APN 25 (%))</u>
- The vRAN was measured using the IA Server function, and the APN device was measured using an AC-DC converter.

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- The measurement results on the vRAN side were within the fluctuation range, and no significant differences were observed. (This was due to one UE and a low level of traffic.

The results of the power reduction are shown in Table 11.

Power consumption	vRAN device(vDU)	Power reduction ratio (Only APN)
Pre-check	No differences	−25%
Post-check		

Table 11 - Result of Power reduction ratio

If the IA Server of vRAN can be shut down, it would be possible to achieve corresponding power savings.

6.4. Technical Discoveries from the Proof of Concept (PoC)

Confirmed that the APN device, when applied within a 30km MFH section using the LLS-C3 model, is capable of multiplexed transmission.

Established the ELB switching procedure by combining current RAN technology and APN technology.

On the other hand, the following issues to be addressed in the future were identified:

- With current RAN and APN technology, switching takes approximately 30 minutes.
- During the switching time, communication of both the RU being switched and the RU not being switched is affected.
- RAN and APN operations need to be coordinated, and integration of controllers is necessary for automation.

In conclusion, realizing ELB will require the establishment of RAN technology to minimize communication impact and the integration technology of RAN and APN.

This will be taken up as a SI/WI of the IMN-TF.

Objective Id:	MFH/Basic Scenario Step2-1 ELB Feasibility	
Description:	Description of the PoC Demo Objective: In Step 2, we demonstrated the feasibility of switching from a technical perspective of ELB by combining current vRAN technology with APN technology. The switching procedure was successfully completed within approximately 30 minutes, as planned. Additionally, the impact on call processing during communication was consistent with preliminary considerations (see Table7), and no additional issues arose. However, it became clear that the current vRAN technology significantly impacts the procedure for changing the attachment of RU and DU, as it has not been standardized yet. This represents a future challenge that needs to be addressed. In additional, while this PoC focused on switching between two routes, actual use cases will require controlling multiple base stations and APN devices. Thus, collaboration and automation of vRAN and APN control will be necessary. For automation, technologies that monitor and predict traffic condition s to facilitate control will also be required. Furthermore, in order to implement ELB, it was found that prior resource allocation in the vRAN is necessary, and that APN requires pre-preparation of APN-T and fiber connections. Therefore, we need to assess the overall impact while taking into account the potential increase in TCO due to ELB.	
Pre-conditions	Not applicable	
Procedure:	1	Connect two RUs and a vDU via an APN and place them in a state of active communication. Insert a 30 km fiber spool into the communication path. Additionally, measure the power consumption.
	2	As a preparatory step, after the switchover, register the information of the new RU to be accommodated in the vDU.
	3	For the switchover procedure, disconnect the path between one of the RUs and the vDU, and then set up the path for the new RU to be accommodated in the vDU. Execute the path switch on the APN device, reboot both the RU and the vDU, and confirm that the two RUs are connected to the vDU and are in active communication.
	4	As a post-switchover task, shut down the equipment in the path of the vDU that is no longer needed, and measure the power consumption.

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Finding Details:	- In the current RAN technology, switching requires the restart of IAS, which takes approximately 30 minutes and significantly affects communication. - It is necessary to enable restarting in advance, not during the switching process. - Additionally, standardization of radio-side technology to eliminate the need for restarting is required. {this is rather a conclusion perhaps rephrase as a finding – there is no standardization of radio-side technology to eliminate the need for restarting is required - On the other hand, the APN side also needs to be standardized as APN-C. In this process, if the RAN side does not require a reboot, it must be taken into consideration that the switching time on the APN side should be minimized to avoid impacting the service. - Sequential/parallel control is required for vRAN and APN devices, and an automation feature to switch numerous base stations is essential. -To promote IOWN APN ELB solution, standard procedure of seamless RU switchover via SMO/RIC and APN orchestrator/controller needs to be addressed in both IOWN and O-RAN Alliance. Operators expect fully automated solution to shorten switchover time and service outage for power saving and resiliency enhancement. - It is necessary to clarify the power reduction effects with and without the application of APN in the current base station configuration and MFH. The current MFH configurations include C-RAN and D-RAN. In C-RAN, optical transmission devices are sometimes used. Therefore, when comparing the power consumption of the current setup, it is necessary to specify whether you are comparing with the setup using optical transmission devices or not. Without this clarification, a proper evaluation of the effects cannot be done. Particularly in cases where optical transmission devices are not included, it is necessary to confirm whether the increase in power consumption by adding the APN device can be offset by a greater reduction in power consumption due to ELB. - It was found that securing resources and laying fiber are necessary during the base station design phase. In vRAN's vDU, it is necessary to register the information of the RU after the switch in advance. Currently, each RU requires a fixed amount of radio resources in the vDU. Therefore, there is a limit to the number of RUs that can be accommodated based on the radio resource capacity. When allocating resources to an RU after switching in the vDU, the number of RUs that can be normally operated decreases. For example, if a DU can accommodate 4 RUs based on its radio resource capacity, it typically operates with 4 RUs. However, if 1 RU is reserved for ELB switching, only 3 RUs can be normally operated, leading to wasted resources. Solving this issue requires advancements in radio technology. On the other hand, there are also considerations on the APN side. In Figure 2, APN-T2-1 and APN-T2-2 are needed for communication between RU2 and vDU2. For communication between RU2 and vDU1 after switching, APN-T1-3 and new optical fiber will be required. Therefore, since APN-T1-3 needs to be pre-installed for path

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	switching, we must consider that the APN-T ports of the flexible bridge cannot be fully utilized during operation.
Lessons Learnt & Recommendations	**Challenges/objectives for the Next PoC** - When connecting the RU and vDU, a switch (SW) is installed on the vDU side. While the switch can be replaced with a FlexibleBridge, this possibility was not implemented in this PoC. - Due to environmental constraints, there was only one switch in this setup. However, we confirmed that the logical separation was maintained, so there were no issues with the PoC switching procedure. This point needs to be brought up earlier in the report.6.1.1. - For PTP/Sync-E, a distribution method per hop was adopted in this case. However, distribution through the lambda could also be considered. - In this PoC, the power consumption of the vRAN side was measured using the features of the hardware vendor, but no difference was observed. On the other hand, the APN devices were monitored using a DC-AC converter. - Although the PoC included a switching procedure, the verification of returning to the original state of connecting each of the two RUs to the vDU was not conducted.

7. PoC's Contribution to IOWN GF

Contribution	WG/TF	Study Item (SI)/Work Item (WI)	Comments
A	IMN	WI	This PoC demonstrated that, even in the absence of current standards, it is feasible to establish procedures for changing the connection between RU and vDU with vRAN and APN working in conjunction for the ELB use case. However, it also highlighted that the switching impact is significant, and for adoption by mobile carriers, future efforts in standardizing radio access network technologies are necessary. In this phase, we aimed to assess the feasibility of the use case and successfully completed Step2-1 of the PoC Reference. In the next phase, we plan to demonstrate Step2-2, which involves concretizing the power consumption reduction effects. This phase establishes the foundation for elastic load balancing and switching in optical fronthaul networks, highlighting potential energy savings from dynamic wavelength allocation. Nonetheless, detailed analysis on energy savings and modelling is set for subsequent phase, where focus is placed on quantifying power reductions, further energy efficiency enhancement opportunities, and evaluating the environmental and operational advantages toward a sustainable network architecture.

8. PoC Suggested Action Items

a) Gaps identified in relevant standardization.

Not applicable.

b) PoC Suggested Action Items

To achieve ELB, it is necessary to study and standardize RAN-side functions that minimize the impact on communication, and to establish technology for controllers that coordinate the control of RAN and APN. As part of the Global Forum's IMN-TF SI/WI, we aim to engage in discussions and establish these technologies for B5G/6G in collaboration with RAN and APN technology organizations.

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c) **Any Additional comments the PoC Team wishes to make?**

Not applicable.

d) **Next Step?**

Additionally, we conducted partial power measurements during this PoC and will continue our study based on these results to clarify the power effects in Step 2-2 of the PoC.

9. Acronym list

Acronym	**Definition**
AMF	Access and Mobility Management Function
APN-G	All Photonic Network- Gateway
APN-I	All Photonic Network - Interchange
APN-T	All Photonic Network – Transceiver
CUS	C/U/S-Plane
EPL	Ethernet Private Line
GUI	Graphical User Interface
IEEE	The Institute of Electrical and Electronics Engineers
IMN	IOWN GF Mobile Networking
IOT	Internet of Things
LLS	Low Layer Split
MEF	Metro Ethernet Forum
MFH	Mobile FrontHaul
NNI	Network to Network Interface
PDV	Packet Delay Variation
POC	Proof of Concept
PON	Passive Optical Network
PSS	Photonic Service Switch
PTP	Packet Timing Protocol
RAN	Radio Access Network
SFP	small form factor pluggable optical transceiver
TAP	Test Access Point
TDM	Time-Division Multiplexing
TPS	Time Sensitive Network Switch
TSN	Time Sensitive Network
UPF	User Plane Function
VLAN	Virtual Local Area Network

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10. Reference

[1] PoC Reference of Mobile Fronthaul over APN version2

[2] https://iowngf.org/wp-content/uploads/formidable/21/IOWN-GF-RD-MFH_over_APN_PoC_Reference_1.0.pdf・O-RAN specification (O-RAN Fronthaul Interoperability Test Specification (IOT))

[3] https://iowngf.org/technology/#poc-reference-of-mobile-fronthaul-over-apn MobileFrontHaul over APN PoC

11. Document History

Version	Date	By	Description of Change
1.0	11th Dec 2024	Manabu Sugihara – NTT Lieven Levrau - Nokia	Initial Version: This is the first draft of the document
2.0	16th April 2025	Manabu Sugihara - NTT	Revised for publication