# PoC Project name:

# Open APN Flexible Bridge Service PoC

Classification: IOWN Global Forum Recognized PoC

Stage: SSF PoC Report

Confidentiality: Public

Version: 4.0

March 6th , 2024

# Open APN Flexible Bridging Service PoC Report

## 1. PoC Project Completion Status

This document is a report on the results of Flexible Bridging Service PoC listed in the PoC reference document “Open APN Architecture PoC Reference “.

## 2. Participants


- Fujitsu
  - Kentaro Nakamura n.kentaro@fujitsu.com
  - Kenichi Kawarai kawarai@fujitsu.com
  - Kazuto Nishimura nisimura.kazuto@fujitsu.com
  - Daijiro Tanaka tanaka.daijiro@fujitsu.com
- Keysight Technologies
  - Masami Kogure masami.kogure@keysight.com
  - Kiyoshi NODA Kiyoshi.noda@keysight.com


## 3. Confirmation of PoC Demonstration

- Venue: Fujitsu Shin-Kawasaki office.
- Date: December 2022

## 4. PoC Goals Status Report

- Objective
  - Open APN Architecture PoC Reference v1.0 specifies some PoCs related to Flexible Bridging Service as follows. This PoC is to measure some key measurement parameters and provide use case study group with these as practical KPIs such as QoS.
- PoC Project Goal#1: Confirm corresponding a feature of PoC Document 3.6 Feature 6
- PoC Project Goal#2: Measure benchmarks corresponding to the feature of 4.5 Benchmark 5
- References in the PoC reference document.

**2. Reference Cases**

2.6. Flexible Bridging Services

(1) Type D1/D2 service for DC interconnection

(3) Type D1/D2 service for Mobile xHaul

**3. Desired Features**

3.6 Feature 6: Flexible Bridging Service

This feature will verify the forwarding service that aggregates and forwards multiple data flows into a single optical path with extreme QoS performance.

**4. Key Benchmarks**

4.5 Benchmark 5: QoS performance of Flexible Bridging Service

(1) Throughput: packet loss between user devices (unit: bit per second (bps)).

(2) Delay: packet delay between user devices (unit: μs).

(3) Delay variation: packet delay variation between user devices (unit: μs).

**Note**

Definition of Packet Delay and Packet Delay Variation

Packet Delay:

Difference between sent and received time of a packet

PacketDelay = Packet received time – Packet sent time

Packet Delay Variation:

The difference between the Packet delays of two consecutive packets is calculated and expressed as an absolute value.

DV(i) = |PacketDelay(i) - PacketDelay(i-1)|

Avg Delay Variation(ns): Average of All measured Packet Delay Variation

Min Delay Variation(ns): Minimum Packet Delay Variation during measurement.

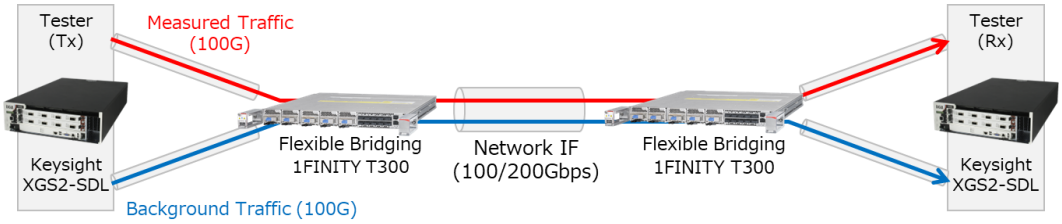
Max Delay Variation(ns): Maximum Packet Delay Variation during measurement.

# 5. Technical Report

## 5.1 PoC Setup and conditions

PoC was achieved with the following system.

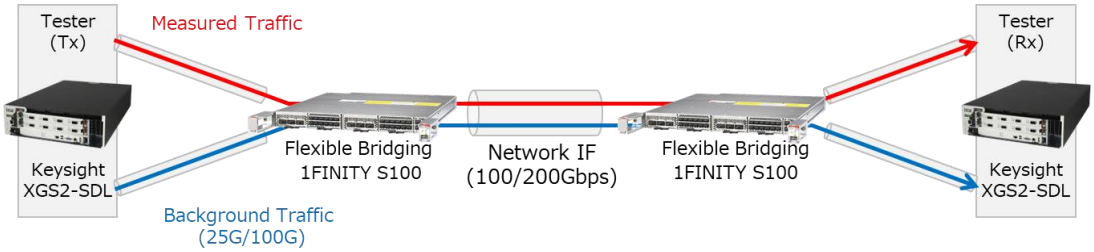
(1) Type D1/D2 service for DC interconnection




| | | |
|---|---|---|
| Transponder | Fujitsu 1FINITY T300 | V1.4.5 |
| Measuring device | Keysight XGS2-SDL | IxOS v9.20<br>IxNetwork v9.20 |
| Client Interface | 100G | |
| Line Interface | 100G/200G | |

Note: Background traffic is constant traffic generated by Keysight XGS2-SDL

(3) Type D1/D2 service for Mobile xHaul




| | | |
|---|---|---|
| Transponder | Fujitsu 1FINITY S100 | v5.1 |
| Measuring device | Keysight XGS2-SDL | IxOS v9.20<br>IxNetwork v9.20 |
| Client Interface | 25G/100G | |
| Line Interface | 100G/200G | |

Note: Background traffic is constant traffic generated by Keysight XGS2-SDL

## 5.2 Measurement Method

Throughput, Delay and Delay variation were measured using RFC2544 method.
Measurement parameters were the followings.

| | |
|---|---|
| Buffer mode | Cut through |
| Frame size | 64(66),128,256,512,1024,1280,1518,9000 bytes |
| Stream duration | 60 seconds |

## 5.3 Results

### 5.3.1 (1) Type D1/D2 service for DC interconnection

Case1-1: Network 100G/DP-QPSK/SDFEC+SCFEC, Client 100G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 66 | 100 | 42015 | 42042 | 0.000 | 0 | 5 |
| 128 | 100 | 42015 | 42045 | 0.000 | 0 | 5 |
| 256 | 100 | 42015 | 42042 | 0.500 | 0 | 5 |
| 512 | 100 | 42015 | 42042 | 1.000 | 0 | 2 |
| 768 | 100 | 42015 | 42042 | 1.000 | 0 | 5 |
| 1024 | 100 | 42015 | 42045 | 0.000 | 0 | 5 |
| 1280 | 100 | 42015 | 42045 | 0.000 | 0 | 5 |
| 1518 | 100 | 42015 | 42045 | 0.000 | 0 | 5 |
| 9000 | 100 | 42015 | 42042 | 0.500 | 0 | 5 |

Case1-2: Network 100G/DP-QPSK/SDFEC+RSFEC, Client 100G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 66 | 100 | 26277 | 26295 | 0.000 | 0 | 5 |
| 128 | 100 | 26277 | 26295 | 0.000 | 0 | 5 |
| 256 | 100 | 26277 | 26295 | 0.000 | 0 | 5 |
| 512 | 100 | 26277 | 26295 | 0.500 | 0 | 2 |
| 768 | 100 | 26277 | 26300 | 1.000 | 0 | 5 |
| 1024 | 100 | 26277 | 26305 | 0.000 | 0 | 5 |
| 1280 | 100 | 26277 | 26305 | 0.000 | 0 | 5 |
| 1518 | 100 | 26277 | 26305 | 0.000 | 0 | 5 |
| 9000 | 100 | 26277 | 26305 | 0.500 | 0 | 5 |

Case1-3: Network 200G/DP-16QAM/SDFEC+SCFEC, Client 100G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 66 | 100 | 35735 | 35757 | 0.000 | 0 | 5 |
| 128 | 100 | 35735 | 35760 | 0.000 | 0 | 5 |
| 256 | 100 | 35735 | 35760 | 0.000 | 0 | 5 |
| 512 | 100 | 35740 | 35760 | 0.000 | 0 | 2 |
| 768 | 100 | 35737 | 35760 | 0.500 | 0 | 5 |
| 1024 | 100 | 35737 | 35760 | 0.000 | 0 | 5 |
| 1280 | 100 | 35740 | 35760 | 0.000 | 0 | 5 |
| 1518 | 100 | 35735 | 35760 | 0.000 | 0 | 5 |
| 9000 | 100 | 35735 | 35760 | 0.000 | 0 | 5 |

## 5.3.2 (3) Type D1/D2 service for Mobile xHaul

Case2-1: Network 100G/DP-QPSK/SDFEC+SCFEC, Client 25G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 64 | 99 | 47087 | 61905 | 2 | 0 | 7050 |
| 128 | 99 | 47295 | 61902 | 2 | 0 | 7357 |
| 256 | 99 | 48060 | 59630 | 2 | 0 | 5717 |
| 512 | 99 | 47930 | 61222 | 4 | 0 | 6922 |
| 768 | 99 | 48307 | 60610 | 5 | 0 | 3117 |
| 1024 | 99 | 49502 | 61102 | 6 | 0 | 4627 |
| 1280 | 99 | 50020 | 61530 | 8 | 0 | 6827 |
| 1518 | 99 | 49882 | 61335 | 10 | 0 | 5212 |
| 9000 | 99 | 57037 | 63787 | 55 | 0 | 2305 |

Case2-2: Network 200G/DP-16QAM/SDFEC+SCFEC, Client 25G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 64 | 99 | 40800 | 55945 | 2 | 0 | 6235 |
| 128 | 99 | 40942 | 56427 | 2 | 0 | 6525 |
| 256 | 99 | 41147 | 56765 | 2 | 0 | 5372 |
| 512 | 99 | 41470 | 57685 | 4 | 0 | 7775 |
| 768 | 99 | 41702 | 57520 | 5 | 0 | 6270 |
| 1024 | 99 | 42062 | 58130 | 6 | 0 | 6222 |
| 1280 | 99 | 42212 | 57867 | 8 | 0 | 7285 |
| 1518 | 99 | 42905 | 57642 | 10 | 0 | 7300 |
| 9000 | 99 | 48007 | 58615 | 57 | 0 | 4250 |

Case2-3: Network 100G/DP-QPSK/SCFEC, Client 25G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 64 | 100 | 28612 | 42725 | 20 | 0 | 1202 |
| 128 | 100 | 28781 | 43246 | 4 | 0 | 6518 |
| 256 | 100 | 28957 | 44441 | 3 | 0 | 7336 |
| 512 | 100 | 29230 | 43655 | 3 | 0 | 7296 |
| 768 | 100 | 29438 | 45138 | 5 | 0 | 6526 |
| 1024 | 100 | 29631 | 45764 | 5 | 0 | 2597 |
| 1280 | 100 | 29775 | 45018 | 5 | 0 | 2646 |
| 1518 | 100 | 29751 | 43960 | 5 | 0 | 6767 |
| 9000 | 100 | 35019 | 45531 | 8 | 0 | 4714 |

Case2-4: Network 100G/DP-QPSK/SDFEC+SCFEC, Client 100G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 64 | 100 | 46297 | 94495 | 0 | 0 | 6735 |
| 128 | 100 | 46507 | 97232 | 1 | 0 | 3357 |
| 256 | 100 | 46457 | 92895 | 0 | 0 | 3552 |
| 512 | 100 | 46530 | 91275 | 1 | 0 | 4787 |
| 768 | 100 | 46615 | 89615 | 2 | 0 | 4012 |
| 1024 | 100 | 48112 | 90697 | 1 | 0 | 4635 |
| 1280 | 100 | 48110 | 89807 | 1 | 0 | 2752 |
| 1518 | 100 | 46932 | 90807 | 0 | 0 | 4502 |
| 9000 | 100 | 50420 | 94647 | 1 | 0 | 3170 |

Case2-5: Network 200G/DP-16QAM/ SDFEC+SCFEC, Client 100G

| Frame Size[B] | Throughput [%] | Latency [ns] | | Delay Variation [ns] | | |
|---|---|---|---|---|---|---|
| | | Min | Max | Avg. | Min. | Max. |
| 64 | 100 | 40205 | 86590 | 1 | 0 | 3687 |
| 128 | 100 | 40240 | 89910 | 1 | 0 | 3805 |
| 256 | 100 | 40312 | 90317 | 2 | 0 | 5362 |
| 512 | 100 | 40365 | 90595 | 1 | 0 | 3082 |
| 768 | 100 | 40627 | 89857 | 1 | 0 | 4160 |
| 1024 | 100 | 41412 | 90857 | 1 | 0 | 5877 |
| 1280 | 100 | 40707 | 88940 | 1 | 0 | 3672 |
| 1518 | 100 | 40870 | 88635 | 0 | 0 | 6995 |
| 9000 | 100 | 44985 | 92807 | 1 | 0 | 3680 |

### 5.3.3 Summary

- As a result of PoC, it was found that the maximum delay for 2 devices was about 20-40us for (1), and 40-60us (25G) and about 90us (100G) for (3). It was also found that the packet length did not significantly affect any of the tests.
- Since narrow band optics (NBO) is used between devices, it is considered that the internal delay such as FEC has a large influence.
- For the 25G interface of (1) and (3), the device delay was found to be less than 60us. As a result, it was considered to meet the requirements as a Flexible Bridge to accommodate D1/D2.

## 6. Document History

| Version | Date | By | Description of Change |
|---|---|---|---|
| 1.0 | 08/28/2023 | Kentaro Nakamura, Fujitsu | Initial draft |
| 2.0 | 01/23/2024 | Kentaro Nakamura, Fujitsu | Updated reflecting reviewer's comments |
| 3.0 | 02/14/2024 | Kentaro Nakamura, Fujitsu | Added the original word of the abbreviation of NBO. |
| 4.0 | 3/19/2024 | Kentaro Nakamura, Fujitsu | Applied SSF PoC report cover sheet and formant. |