PoC Project name:

Open APN Flexible Bridge Service PoC

Classification: IOWN Global Forum Recognized PoC

Stage: SSF PoC Report

Confidentiality: Public

Version: 4.0

January 24, 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 v1.0".

2. Participants

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3. Confirmation of PoC Demonstration

- PoC was demonstrated in NEC Abiko Office
- Date of PoC was October 2022

4. PoC Goals Status Report

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:
- Feature 6: Flexible Bridging Service
    - Type D1/D2 service for DC interconnection
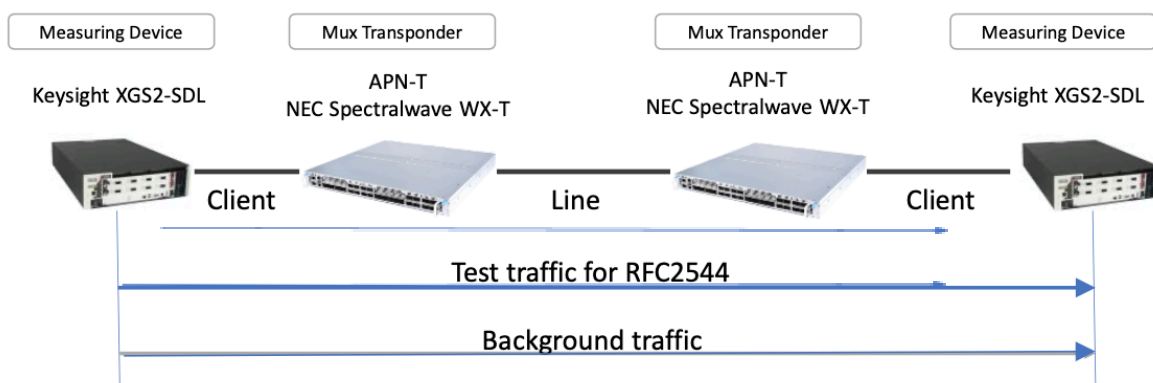   - Type D1/D2 service for Mobile xHaul

PoC Project Goal#2: measure benchmarks corresponding to the feature above:
- Benchmark 5: QoS performance of Flexible Bridging Service
    - Type D1/D2 service for DC interconnection
    - Type D1/D2 service for Mobile xHaul

5. Technical Report

5.1 Implemented system

PoC was achieved with the following system.

Mux Transponder	NEC Spectralwave WX-T	NOS v0.9
Measuring device	Keysight XGS2-SDL	IxOS v9.20, IxNetwork v9.20
Client Interface	10GbE/25GbE/100GbE	
Line Interface	100G/200G/400G	

Note
Background traffic is 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	64,128,256,512,1024,1280,1518,9000 bytes
Stream duration	60 seconds

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.

5.3   Results
5.3.1 10GbE Client

[ns]

Frame size	400G/dp-16qam/ofec						200G/dp-16qam/ofec						200G/dp-qpsk/ofec						100G/dp-qpsk/ofec					
	Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation		
		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.
64	100	11157	11877	0	342	6	100	15862	16700	0	295	6	100	15777	16435	0	290	6	100	24950	25852	0	360	6
128	100	11242	11965	0	282	6	100	16015	16780	0	257	6	100	15867	16525	0	250	6	100	25162	25940	0	282	6
256	100	11682	12205	0	245	6	100	16132	16985	0	262	6	100	15855	16755	0	385	6	100	25320	26177	0	245	6
512	100	12377	12920	0	232	6	100	16985	17702	0	280	6	100	16777	17482	0	232	6	100	26142	26900	0	232	6
1024	100	13817	14465	0	272	6	100	18602	19237	0	270	6	100	18212	19020	0	340	6	100	27572	28437	0	282	6
1280	100	14442	15227	0	255	6	100	19407	20005	0	242	6	100	19217	19795	0	242	6	100	28620	29207	0	245	7
1518	100	15032	15760	0	265	6	100	19822	20537	0	265	6	100	19740	20325	0	265	6	100	28877	29732	0	305	6
9000	100	27347	27977	0	225	6	100	32205	32785	0	225	5	100	31687	32532	0	255	6	100	41137	41945	0	225	5

5.3.2 25GbE Client

[ns]

Frame size	400G/dp-16qam/ofec						200G/dp-16qam/ofec						200G/dp-qpsk/ofec						100G/dp-qpsk/ofec					
	Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation		
		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.
64	100	10347	10747	0	217	2	100	14997	15532	0	217	2	100	14815	15325	0	217	2	100	24322	24732	0	217	2
128	100	10137	10795	0	317	3	100	15092	15565	0	202	3	100	14775	15362	0	205	3	100	24050	24767	0	317	3
256	100	10310	10882	0	200	2	100	15042	15660	0	170	2	100	15037	15465	0	190	2	100	24395	24882	0	170	2
512	100	10595	11150	0	235	2	100	15435	15927	0	202	2	100	15197	15730	0	202	2	100	24575	25132	0	202	2
1024	100	11350	11762	0	212	2	100	15937	16542	0	207	2	100	15865	16340	0	210	2	100	25057	25742	0	245	2
1280	100	11487	11970	0	180	2	100	16165	16750	0	190	2	100	16082	16562	0	185	2	100	25452	25960	0	187	2
1518	100	11672	12192	0	205	3	100	16527	16962	0	200	2	100	16392	16765	0	210	2	100	25712	26175	0	187	3
9000	100	16430	16977	0	185	2	100	21182	21755	0	182	2	100	21195	21560	0	185	2	100	30555	30952	0	182	2

5.3.3 100GbE Client

[ns]

Frame size	400G/dp-16qam/ofec						200G/dp-16qam/ofec					
	Throughput	Latency		Delay Variation			Throughput	Latency		Delay Variation		
		Min.	Max.	Min.	Max.	Avg.		Min.	Max.	Min.	Max.	Avg.
64	100	8125	8197	0	35	1	100	12982	13072	0	35	1
128	100	8127	8202	0	32	1	100	13002	13075	0	35	1
256	100	8155	8227	0	37	1	100	13025	13100	0	37	1
512	100	8205	8292	0	37	2	100	13090	13162	0	40	2
1024	100	8315	8392	0	42	1	100	13190	13262	0	45	1
1280	100	8302	8395	0	42	1	100	13190	13267	0	45	1
1518	100	8327	8405	0	40	1	100	13197	13280	0	40	1
9000	100	8327	8407	0	37	1	100	13215	13287	0	32	1

6. Summary

This PoC result is to show the benefits of using the Flexible Bridging Service (FlexBr) to aggregate traffic over the APN while maintaining the advantages of optical transport, such as reserved bandwidth and bounded delay variation. It is important to increase these kinds of PoC report to verify FlexBr advantages and determine the practical QoS of use cases which are defined by IOWN Global Forum.

7. Document History

Version	Date	By	Description of Change
1.0	23, 08, 2023	Minoru Imura, NEC	Initial draft
2.0	20, 09, 2023	Minoru Imura, NEC	Added Note for the Definition of Packet Delay and Packet Delay Variation
3.0	12, 12, 2023	Minoru Imura, NEC	Modified as per review comments
4.0	23.02.2024	Minoru Imura, NEC	Cover sheet applied