Performance Evaluation of the White Rabbit switch (RFC 2889 Benchmarking)

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Table of Contents

1. Overview

The performance of the White Rabbit switch is evaluated by the methods defined in RFC 2889. This RFC deals with networking devices at the Medium Access Control (MAC) layer and provides a methodology for checking the capabilities given below:
- frame forwarding performance (forwarding rate and throughput)
- congestion control
- forward pressure and maximum forwarding rate
- broadcast forwarding and latency
- address handling

The testbed includes:
- chassis: XenaBay (140.181.139.228)
- software: Xena2889 **v1.46** (former Valkyrie2889), Windows 10 Enterprise LTSC 2021
- configuration: https://github.com/GSI-CS-CO/network_testing
    - wr_RFC_2889/xena_cfg/RFC_2889_1_switch_Xena.v2889
    - wr_RFC_2889/xena_cfg/RFC_2889_4_switches_Xena.v2889

As a device under test the WR switch from Creotech (model WRS-3/18) with the HW version v3.4 and SW version **v7.0** is chosen.

In general, 2 test setups are built for benchmarking:
- single WR switch and
- 4 layers of the WR switch

Some sub-tests have been failed because of not optimal configuration and repeated again with suitable parameters. All test results are recorded into following files:
- xena2889-report_1_wrs_v70-20241003-055713.pdf (1 switch, complete test with tuned setups)

Similar to the previous test, which was done in 2023, the test results are color coded to indicate if the WR switch **passes** or **fails** each test. The results that cannot be concluded are in **orange.**

Moreover, test results are compared with the results of previous test with **v6.1** and comparison results are coded as follows: better than previous (**+**), worse than (**-**) and not much different (**=**).

For previous test report of 2023 refer to:
https://github.com/GSI-CS-CO/network_testing/blob/master/wr_RFC_2889/xena_results/report_valkyrie2889_v1.40_wrs_v6.1.pdf

1 WR switch

Test results in ‘xena2889-report_1_wrs_v70-20241003-055713.pdf’ are evaluated.

- Traffic test(=): for all predefined frame lengths (64-1518 bytes) and bandwidths (10-100%, 100M-1Gb/s) there are frame losses. RX rates never achieve corresponding TX rates. Throughput cannot be determined for all frame lengths by a single test.
    - full mesh: maximum total throughput (+) reached to 90,9Mb/s (41Kframe/s) for the frame size 256 bytes. For a single port it correspond to 5,05Mb/s (2287

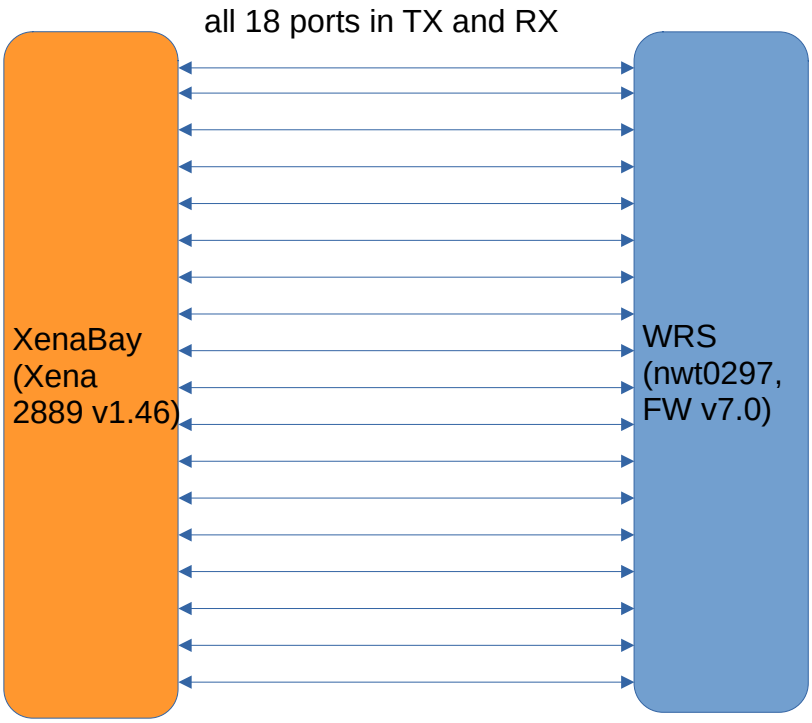
frame/s) data rate. The throughput tests were passed for the frame sizes of 128, 256, 512 and 1518 bytes. No significant difference in the forwarding test results (=).
    - partial 1:N mesh: maximum total throughput (=) reached to 91,25Mb/s (41Kframe/s) for the frame size of 256 bytes. The throughput tests were passed for the frame sizes of 64 and 256 bytes. No significant difference in the forwarding test results (=).
    - partial N:N mesh: maximum total throughput (=) reached 12,04Mb/s (5451 frame/s) for the frame size of 256 bytes. The throughput tests were passed for the frame sizes of 64, 128, 256 and 1280 bytes. No significant difference in the forwarding test results (=).
- Congestion control (=): no congestion control. Neither ‘head of line blocking’ (for uncongested port) nor back pressure (for congested port) is detected.
- Forward pressure (=): no ‘forward pressure’ is detected and switch can guarantee the interfame gap (IFG) of 96-bits.
- Maximum forwarding rate (=): maximum TX rate is achieved with frame loss. For shorter frame sizes (128 bytes) the loss rates are higher (2,63%). The frame loss decreases when frame size gets larger (0,49% to 0,25%).
- Address caching capacity and learning rate (=): switch has inherently the slow address learning capability (< 1ms). Therefore, at the relative low frame rate (20f/s) the switch can learn up to 1074 MAC addresses (and it starts flooding with more MAC addresses). There is a problem in MAC aging: switch keeps MAC addresses beyond the aging time. This means that if ‘aging time’ (or ‘toggling sync state’) is selected for address reset condition, then test is failed. This behavior is observed in all previous software versions including v4.2, v5.0.1, v6.0 and v6.1.
- Errored frames filtering (=): oversized and undersized frames cannot be filtered, but invalid FCS frames. Ignore lost frames at the highest data rate (refer to maximum forwarding rate test).
- Broadcast forwarding (=): better broadcasting performance (over 91,5%, 915 Mb/s) for frames equal or larger than 512 bytes. The lowest forwarding rate is 66% (663 Mb/s) for 64 bytes frame length.

4 layers of the WR switch

Test results from following files and not evaluated in details, but depicted in graphs:
- xena2889-report_4_wrs_v70-20241010-062838.pdf (4 switches, tests except 1:N and N:N meshes)
- xena2889-report_4_wrs_v70-20241010-113027.pdf (4 switches, 1:N mesh)
- xena2889-report_4_wrs_v70-20241010-172320.pdf (4 switches, N:N mesh)

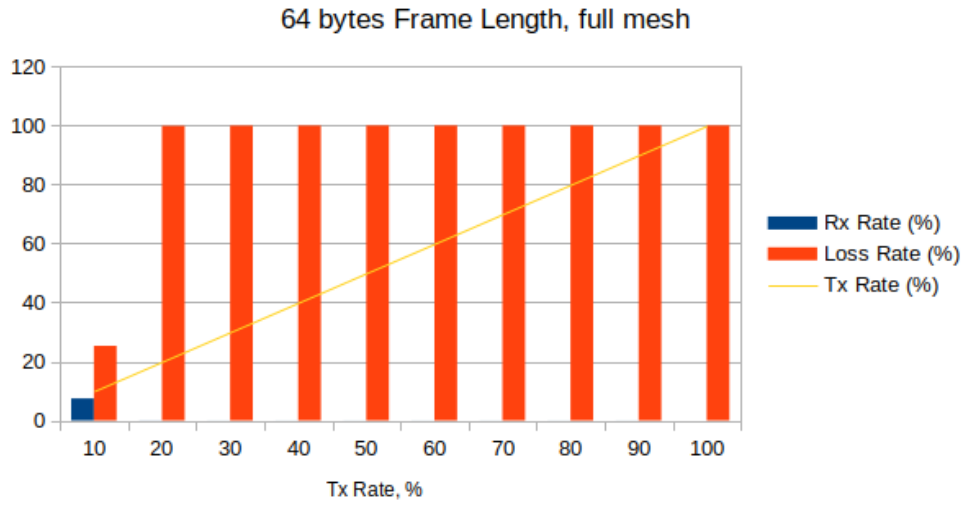
Next sections present the all test results (1 and 4 layers) in graphs.

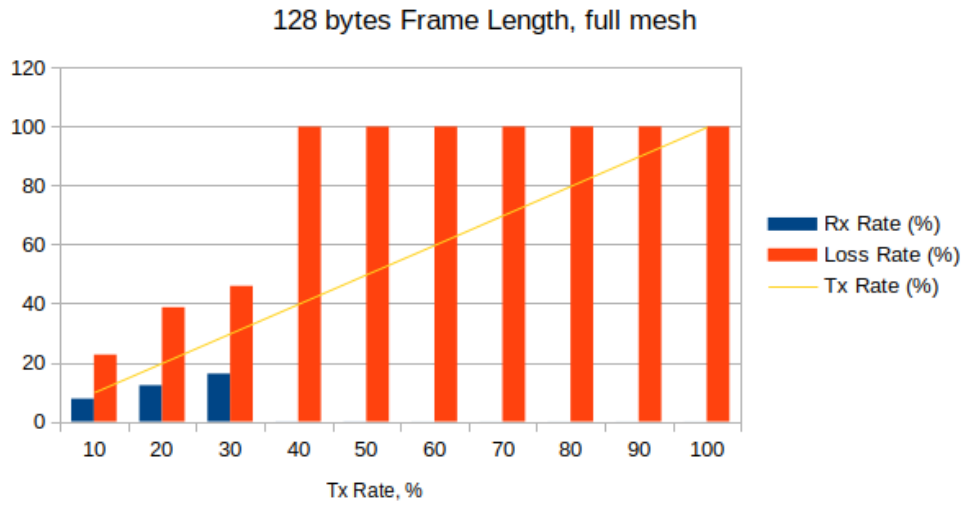
1.1. Full Mesh Results

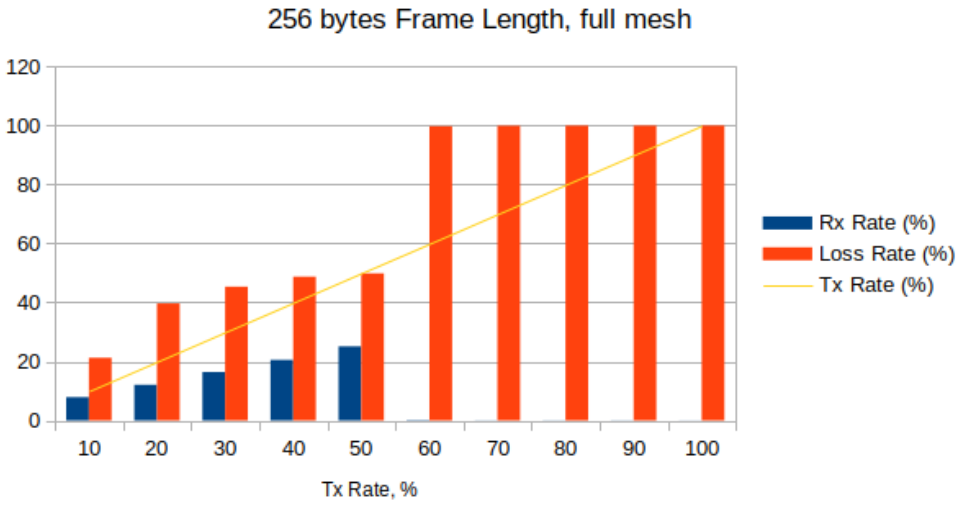


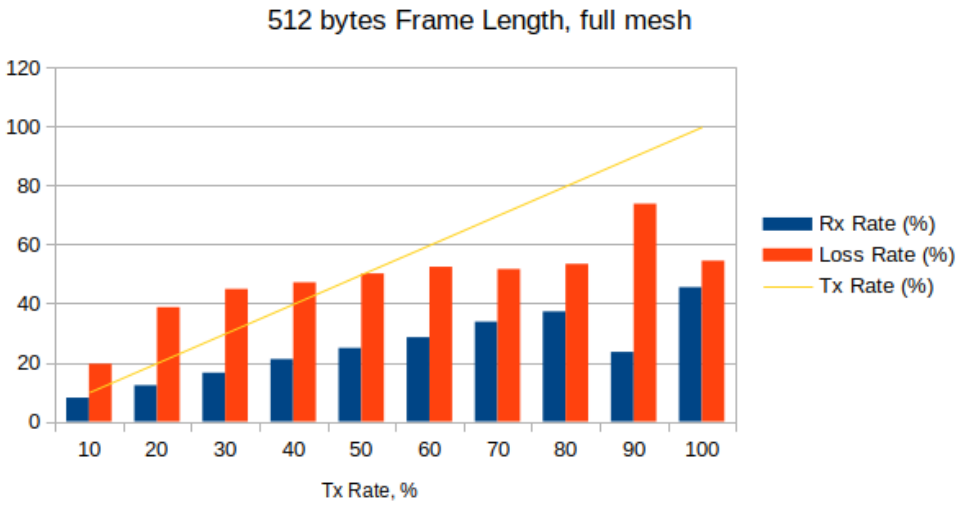
Forwarding test

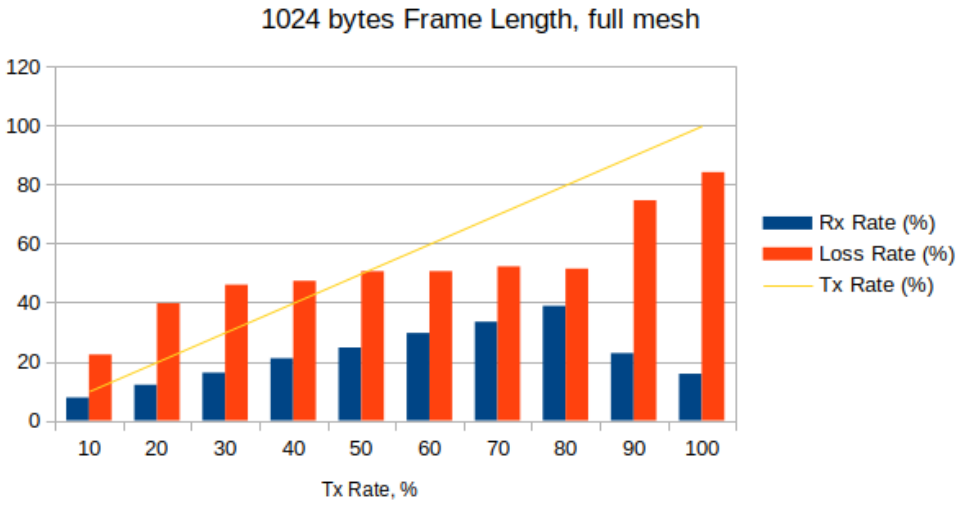
Frame Length	64 bytes		128 bytes		256 bytes		512 bytes		1024 bytes		1518 bytes	
Tx Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %
10	7,47	25,27	7,73	22,65	7,88	21,22	8,04	19,58	7,77	22,35	7,55	24,45
20	0,03	99,87	12,26	38,71	12,1	39,66	12,26	38,72	12,1	39,74	11,96	40,18
30	0,02	99,94	16,21	45,95	16,4	45,33	16,53	44,89	16,2	46,01	16,67	44,44
40	0,01	99,97	0,03	99,92	20,5	48,73	21,14	47,14	21,08	47,31	20,88	47,79
50	0,01	99,98	0,03	99,95	25,1	49,84	24,92	50,16	24,71	50,57	24,91	50,18
60	0,01	99,98	0,02	99,96	0,16	99,73	28,55	52,41	29,65	50,59	29,82	50,3
70	0,01	99,99	0,02	99,97	0,06	99,91	33,83	51,66	33,46	52,21	33,62	51,97
80	0,01	99,99	0,02	99,98	0,05	99,94	37,29	53,39	38,84	51,44	35,56	55,56
90	0,01	99,99	0,01	99,99	0,05	99,94	23,56	73,82	22,83	74,63	22,25	75,27
100	0	100	0,01	99,99	0,04	99,96	45,51	54,49	15,81	84,19	11,72	88,28

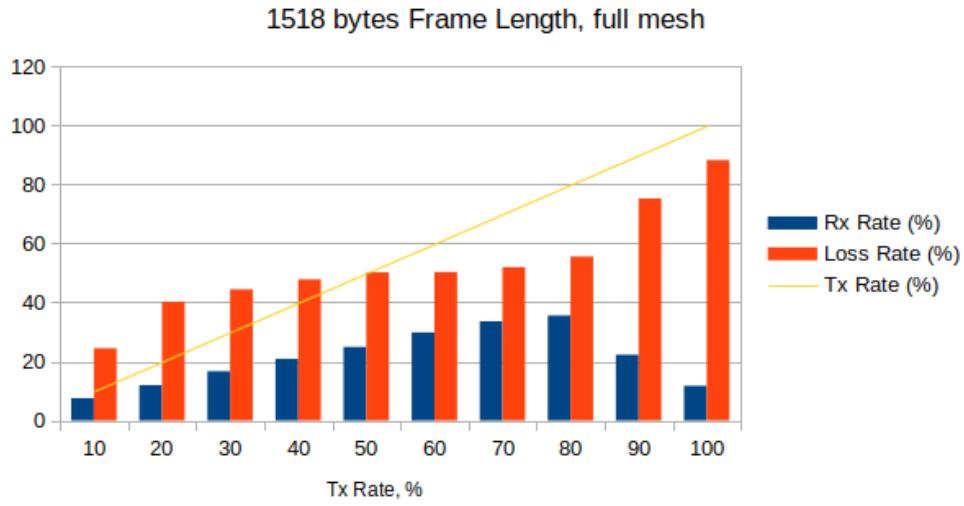





256 bytes Frame Length, full mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

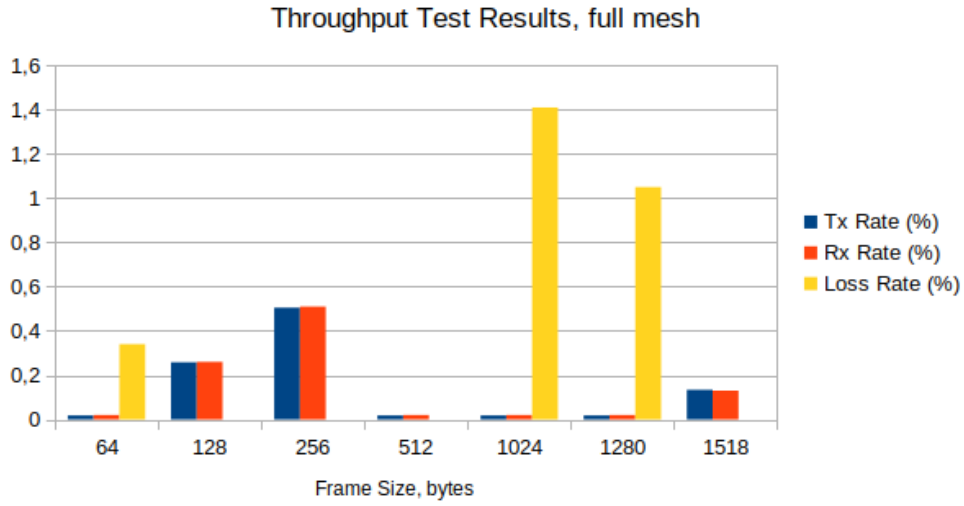

512 bytes Frame Length, full mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


1024 bytes Frame Length, full mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

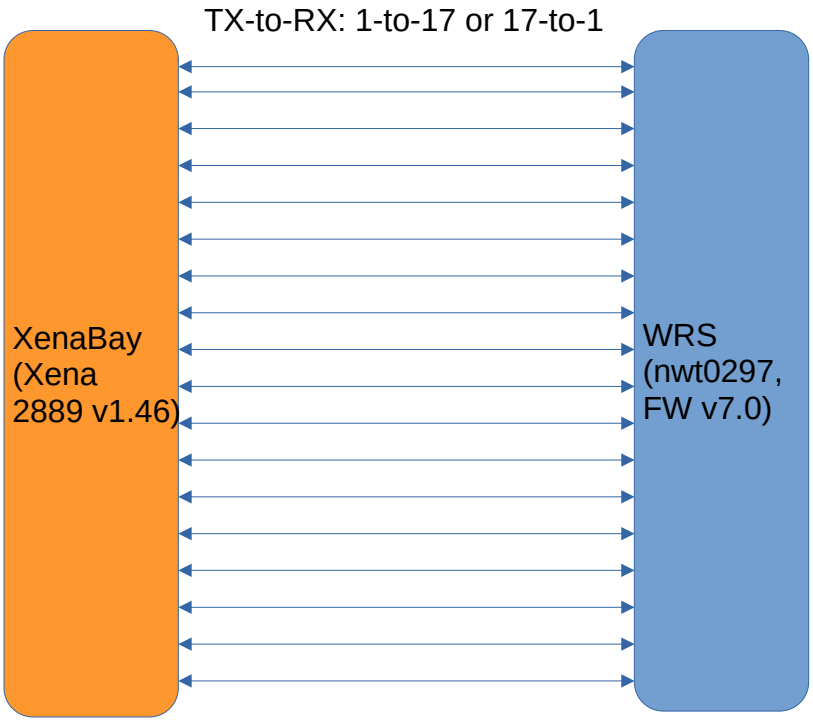


Throughput test

Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	0,018	3,19M	4743	0,02	0,34 (490)	Fail
128	0,258	46,34M	39137	0	0 (0)	Pass
256	0,505	90,9M	41167	0	0 (0)	Pass
512	0,018	3,17M	745	0,02	0 (0)	Pass
1024	0,018	3,15M	377	0,02	1,41 (160)	Fail
1280	0,018	3,18M	306	0,02	1,05 (96)	Fail
1518	0,134	23,97M	1948	0,13	0 (0)	Pass

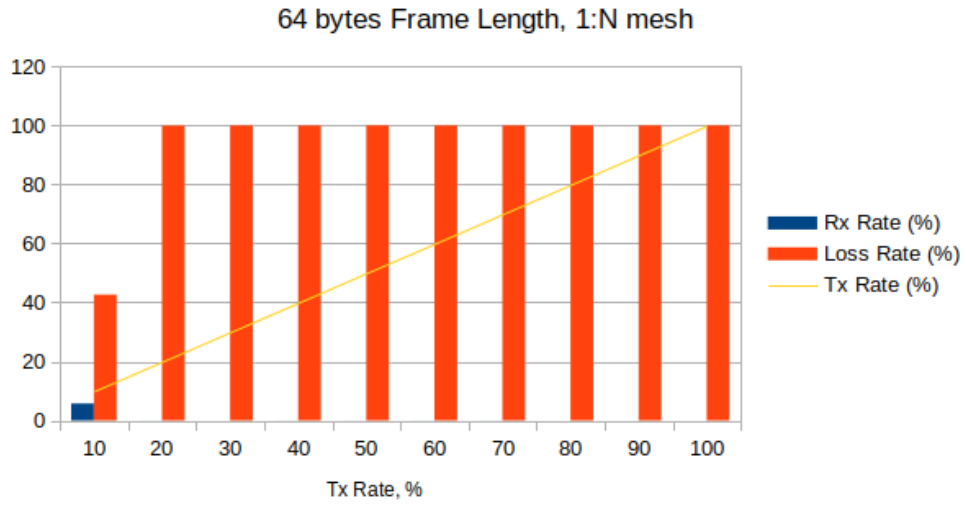


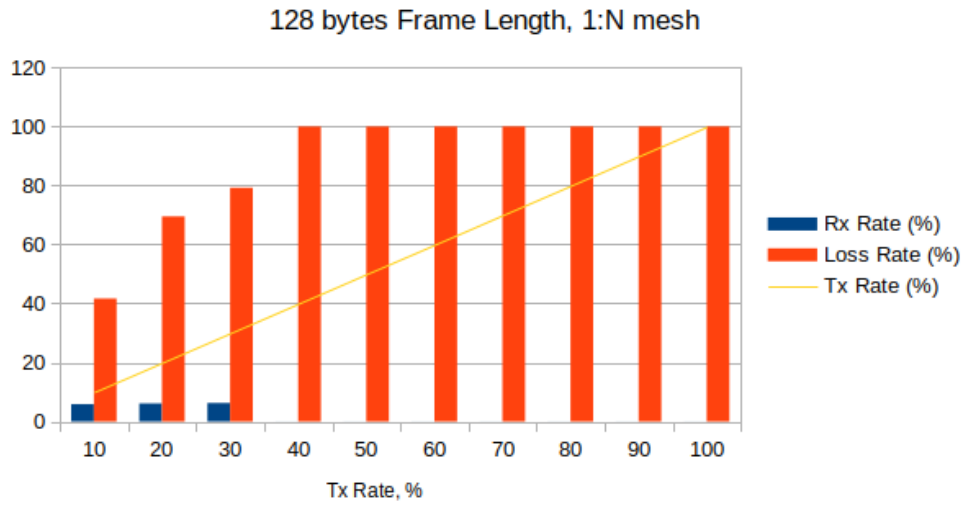
1.2. Partial 1:N Mesh Results

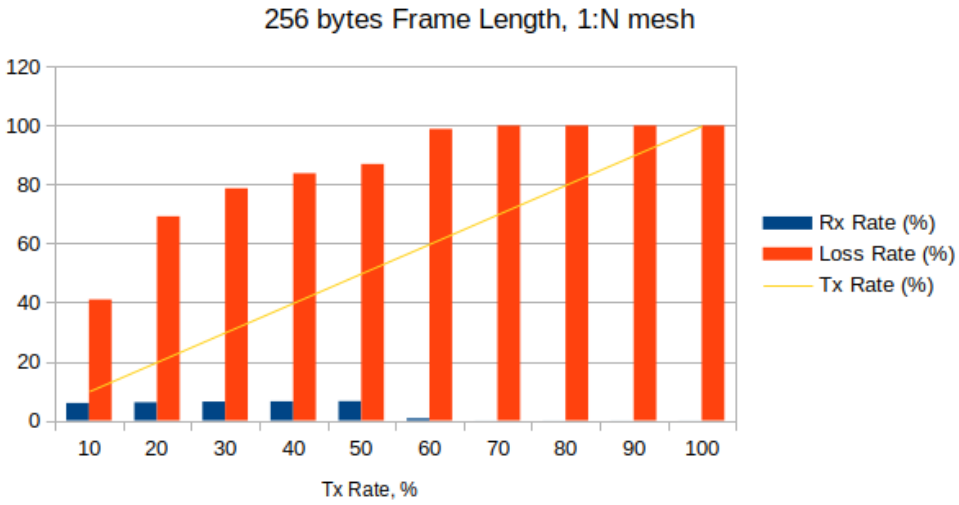


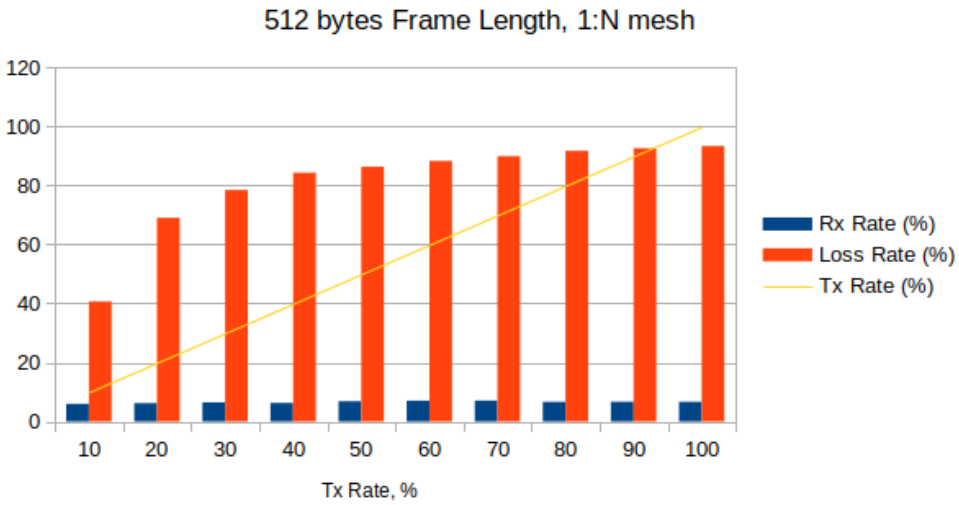
Forwarding test

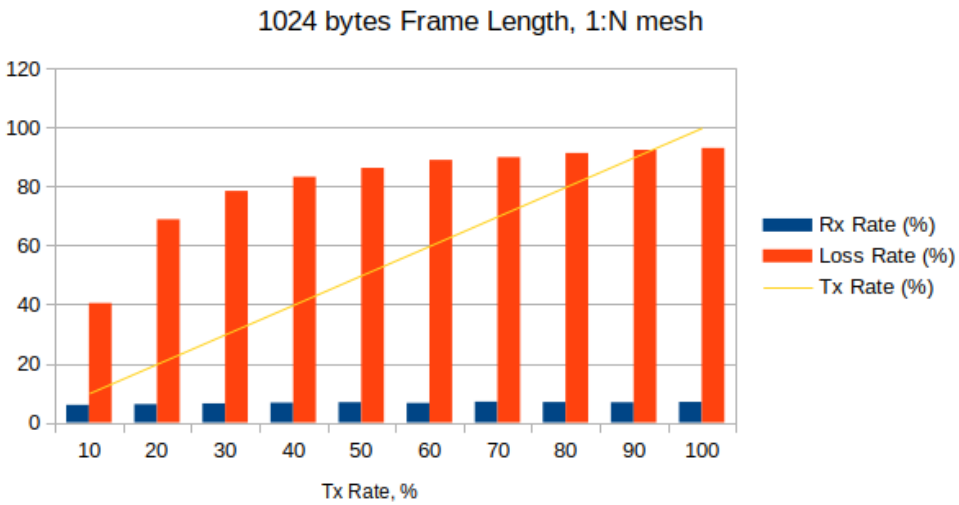
Frame Length	64 bytes		128 bytes		256 bytes		512 bytes		1024 bytes		1518 bytes	
Tx Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %
10	5,74	42,63	5,84	41,64	5,9	40,99	5,94	40,63	5,95	40,46	5,7	42,87
20	0,02	99,92	6,09	69,5	6,16	69,21	6,2	69,02	6,2	68,87	5,78	71,1
30	0	99,98	6,24	79,21	6,4	78,69	6,47	78,43	6,46	78,48	5,83	80,56
40	0,01	99,97	0,02	99,96	6,48	83,79	6,27	84,31	6,7	83,26	5,9	85,24
50	0,01	99,98	0,01	99,97	6,53	86,93	6,83	86,35	6,85	86,29	5,99	88,03
60	0,01	99,99	0,01	99,98	0,71	98,81	7,03	88,29	6,6	89	6,04	89,93
70	0,01	99,99	0,01	99,98	0,02	99,97	7,06	89,91	7,04	89,94	6,05	91,36
80	0	100	0,01	99,99	0,01	99,98	6,63	91,72	6,92	91,35	6,1	92,37
90	0	99,99	0,01	99,99	0,02	99,98	6,66	92,6	6,84	92,4	6,02	93,31
100	0	100	0,01	99,99	0,02	99,99	6,64	93,36	6,95	93,05	6,23	93,77

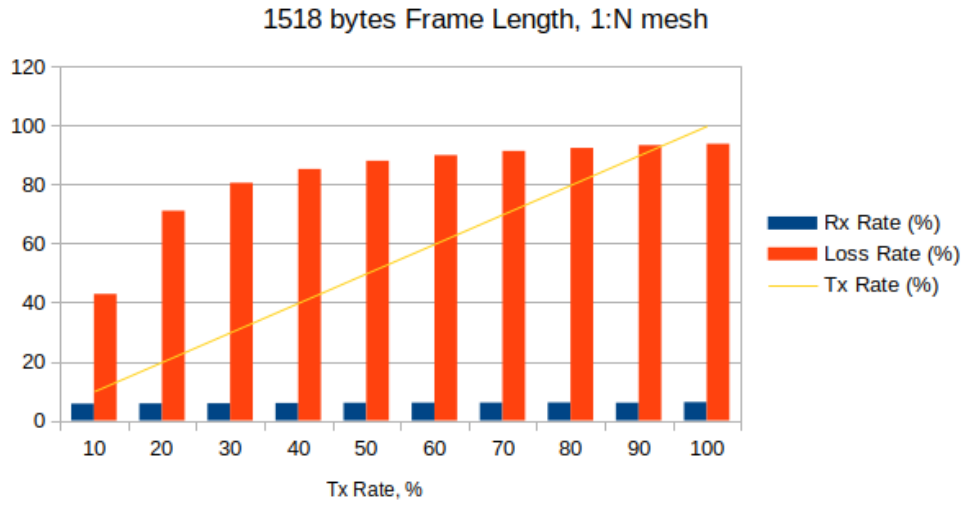





256 bytes Frame Length, 1:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

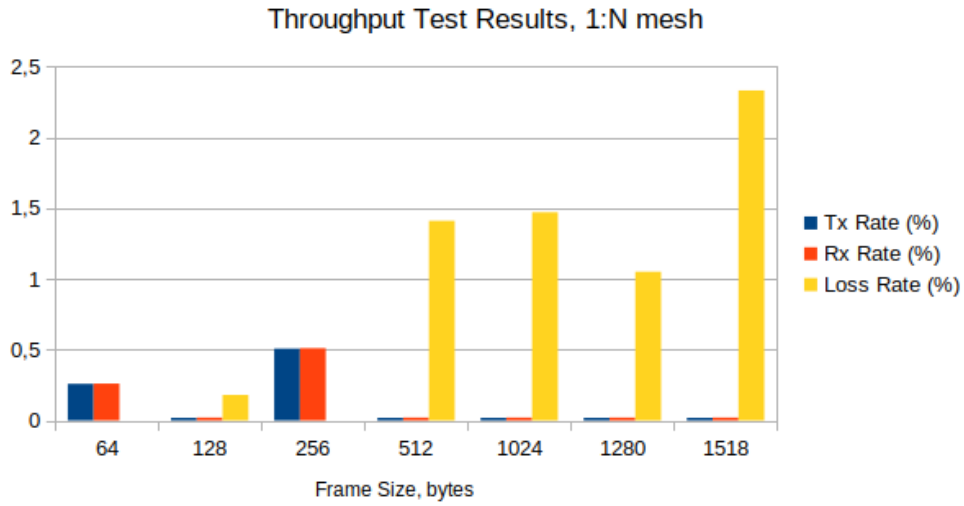

512 bytes Frame Length, 1:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


1024 bytes Frame Length, 1:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

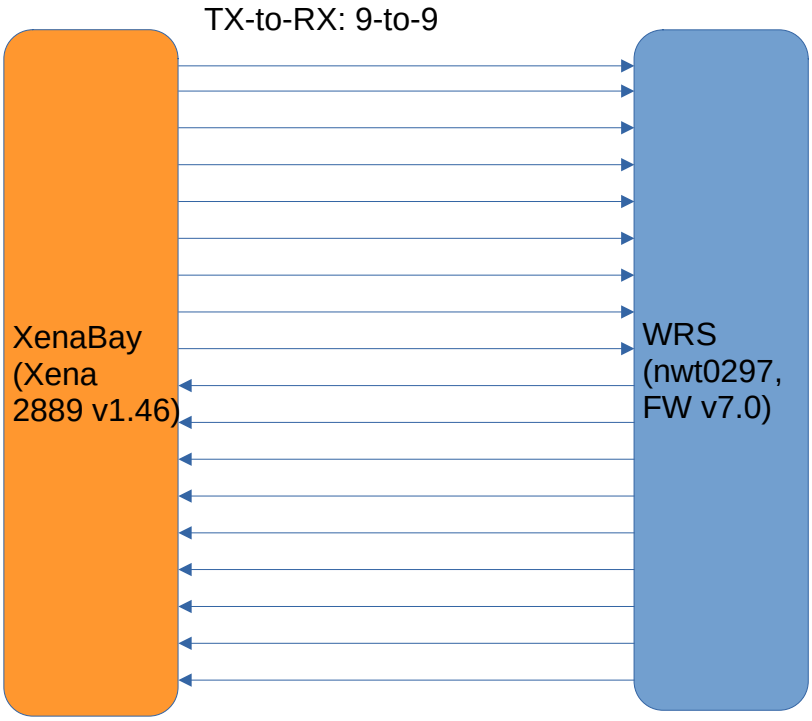


Throughput test

Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	0,258	46,35M	68973	0,26	0 (0)	Pass
128	0,018	3,19M	2696	0,02	0,18 (142)	Fail
256	0,507	91,25M	41325	0,51	0 (0)	Pass
512	0,018	3,19M	750	0,02	1,41 (317)	Fail
1024	0,018	3,19M	382	0,02	1,47 (168)	Fail
1280	0,018	3,19M	307	0,02	1,05 (97)	Fail
1518	0,018	3,19M	259	0,02	2,33 (181)	Fail

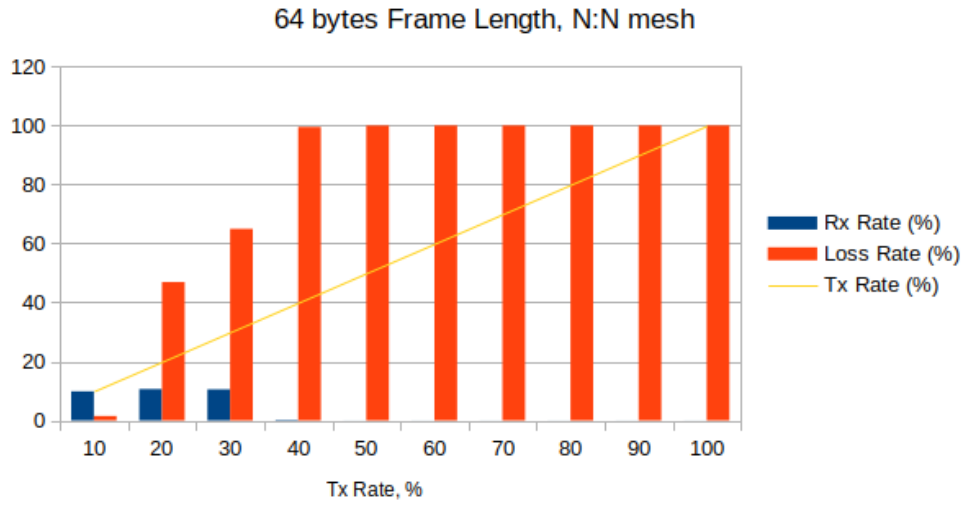


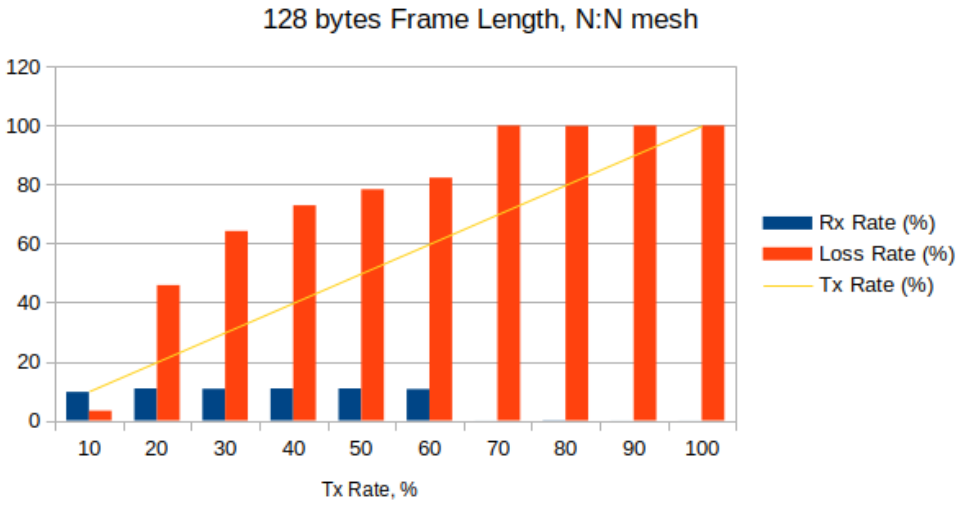
1.3. Partial N:N Mesh Results

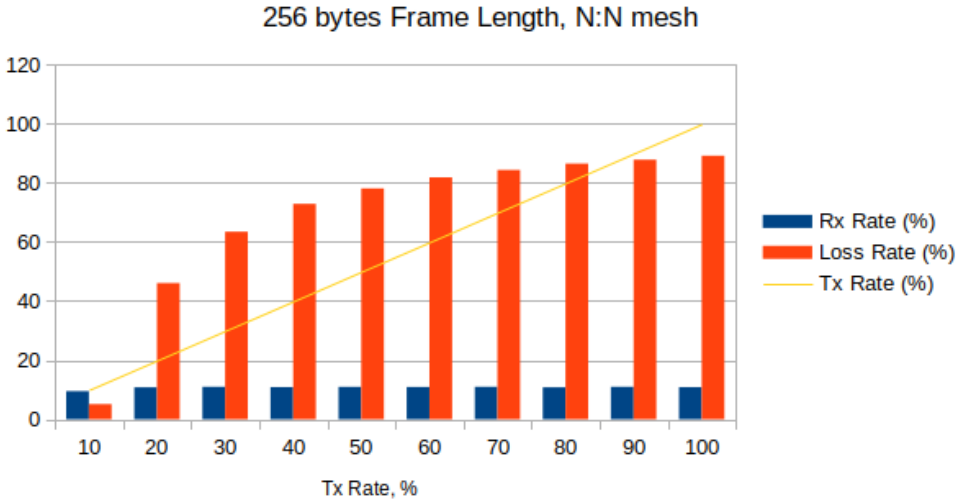


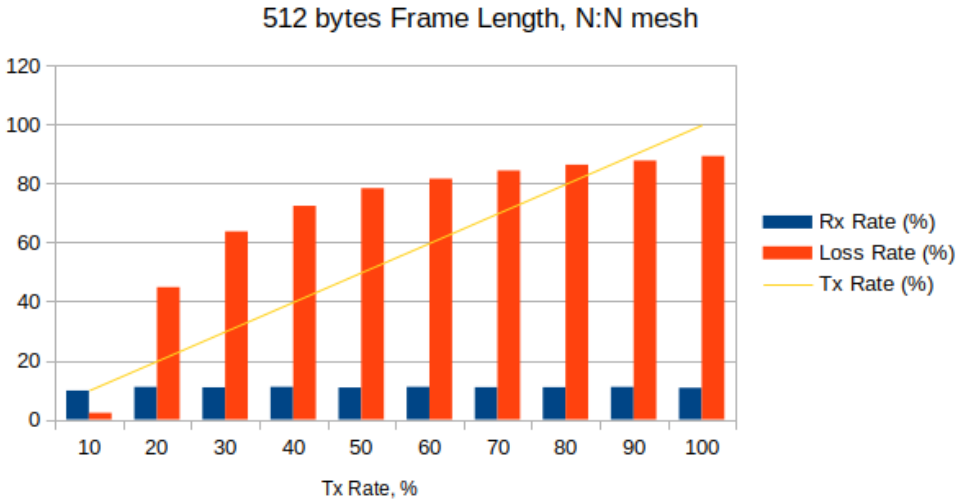
Forwarding test

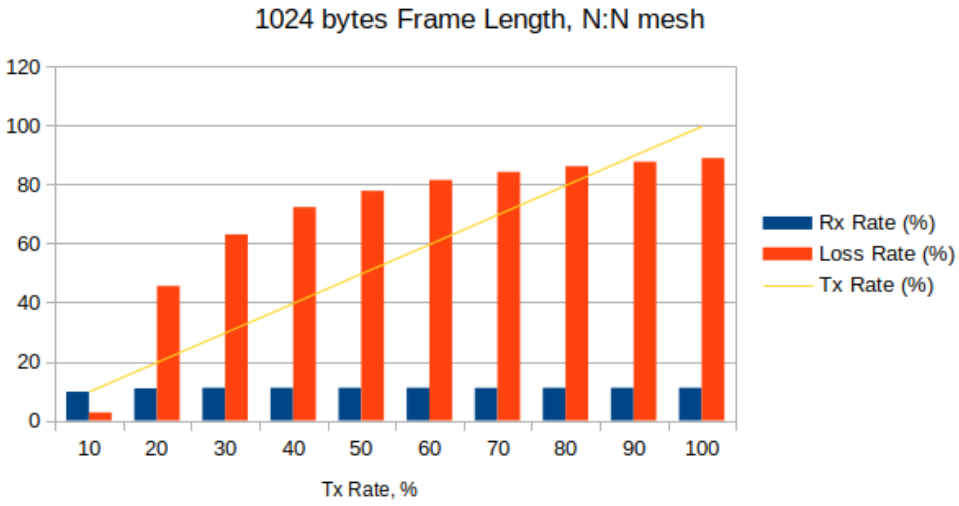
	Frame Length, bytes											
	64		128		256		512		1024		1518	
Tx Rate, %	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**
10	9,85	1,51	9,67	3,3	9,49	5,11	9,78	2,23	9,73	2,7	10	0
20	10,62	46,9	10,83	45,86	10,79	46,06	11,03	44,84	10,88	45,6	10,71	46,46
30	10,52	64,95	10,73	64,22	10,96	63,46	10,88	63,74	11,08	63,08	10,96	63,46
40	0,21	99,47	10,83	72,93	10,85	72,87	11,04	72,41	11,08	72,31	11,09	72,27
50	0,02	99,97	10,83	78,35	10,95	78,1	10,81	78,37	11,08	77,84	11,09	77,81
60	0,01	99,98	10,62	82,3	10,9	81,83	11,04	81,6	11,08	81,53	10,88	81,86
70	0,01	99,98	0,02	99,97	10,96	84,34	10,93	84,38	11,03	84,25	11,09	84,16
80	0,01	99,99	0,1	99,87	10,8	86,5	10,93	86,34	11,08	86,15	11,09	86,14
90	0,01	99,99	0,02	99,98	10,96	87,82	11,03	87,75	11,08	87,69	11,09	87,68
100	0,01	99,99	0,02	99,98	10,83	89,17	10,72	89,28	11,07	88,93	10,92	89,08

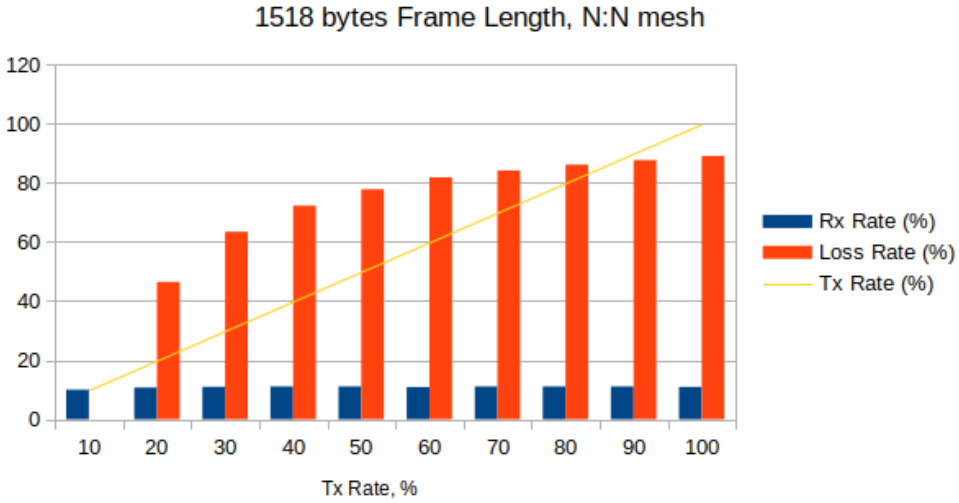



128 bytes Frame Length, N:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


256 bytes Frame Length, N:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

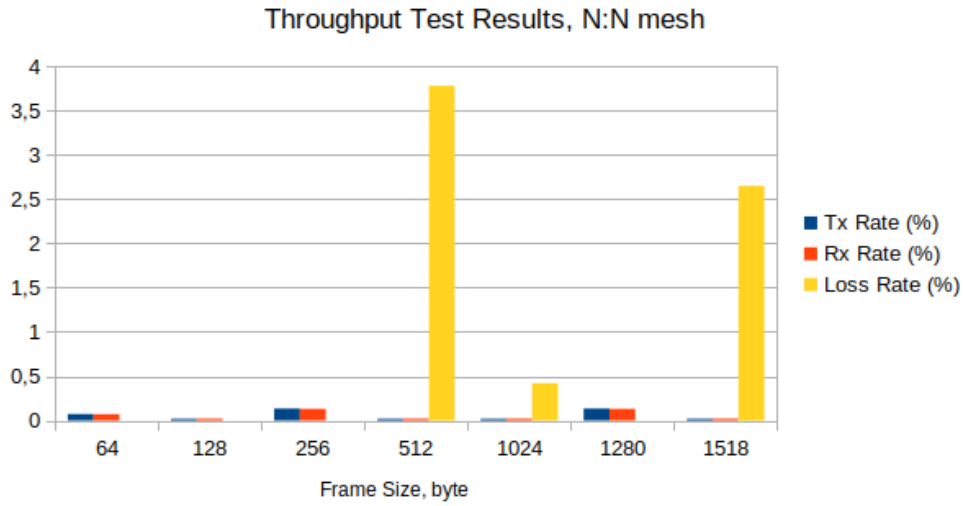

512 bytes Frame Length, N:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


1024 bytes Frame Length, N:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

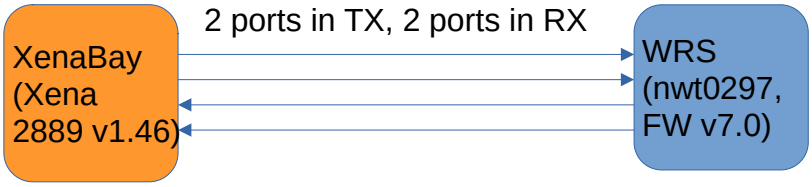

1518 bytes Frame Length, N:N mesh
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

Throughput test

Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	0,072	6,47M	9626	0,07	0 (0)	Pass
128	0,018	1,6M	1347	0,02	0 (0)	Pass
256	0,134	12,04M	5451	0,13	0 (0)	Pass
512	0,018	1,59M	373	0,02	3,78 (422)	Fail
1024	0,018	1,58M	189	0,02	0,42 (24)	Fail
1280	0,134	12,02M	1156	0,13	0 (0)	Pass
1518	0,018	1,59M	130	0,02	2,65 (103)	Fail



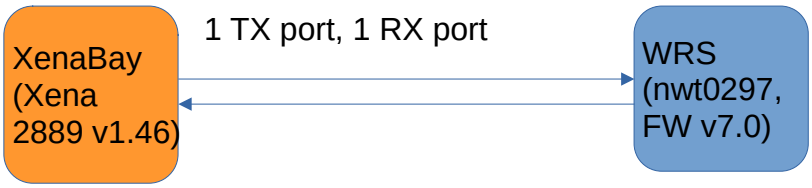
1.4. Congestion Control Results



Frame Size	Tx Rate, %	Tx Frames	UC-Port: Tx	UC-Port: Rx	UC-Port: Loss, %	C-Port: Tx	C-Port: Rx	C-Port: Loss, %	Result
64	100	89285714	22321429	22321429	0	66964285	42621976	36,35	Pass
128	100	50675676	12668919	12668919	0	38006757	24672475	35,08	Pass
256	100	27173914	6793479	6793479	0	20380435	13393737	34,28	Pass
512	100	14097746	3524437	3524437	0	10573309	6996709	33,83	Pass
1024	100	7183909	1795977	1795977	0	5387932	3578522	33,58	Pass
1280	100	5769232	1442308	1442308	0	4326924	2875979	33,53	Pass
1518	100	4876464	1219116	1219116	0	3657348	2432099	33,50	Pass

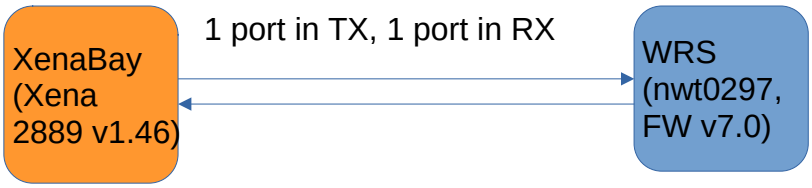
C-Port: Congested Port
UC-Port: Uncongested Port

1.5. Forward Pressure Results



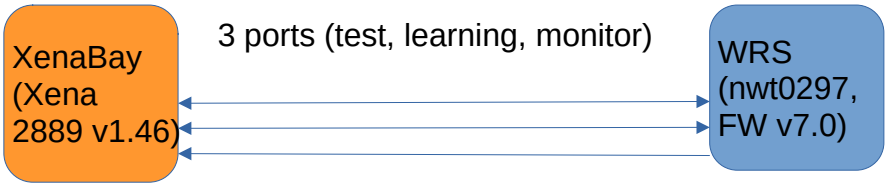
Frame Size, bytes	Tx Frames	Tx max. util., %	Rx Frames	Rx max. util., %	Loss, %	Result
64	45180722	101,205	42613635	95,45	5,68	Pass
128	25510204	100,68	24671080	97,368	3,29	Pass
256	13636363	100,364	13392896	98,571	1,79	Pass
512	7062146	100,188	6996319	99,253	0,93	Pass
1024	3595397	100,096	3578299	99,618	0,48	Pass
1280	2886836	100,077	2875824	99,693	0,38	Pass
1518	2439817	100,065	2431962	99,74	0,32	Pass

1.6. Maximum Forwarding Rate Results



Frame Size, bytes	Tx Rate, %	Tx Rate, f/s	Tx Frames	Rx Frames	Loss, % (calculated)	Result
64	90	1339,3K	40178571	40178571	0	Pass
128	100	844,6K	25337837	24671142	2,63	Pass
256	90,51	409,9K	12296875	12296875	0	Pass
512	90,018	211,5K	6345235	6345235	0	Pass
1024	100	119,7K	3591954	3574416	0,49	Pass
1280	100	96,1K	2884615	2875830	0,304	Pass
1518	100	81,3K	2438231	2431968	0,25	Pass

1.7. Address Caching Capacity and Learning Rate Results



Address Caching Capacity (Learning Rate=20 Frames/s, DUT aging=310 seconds)

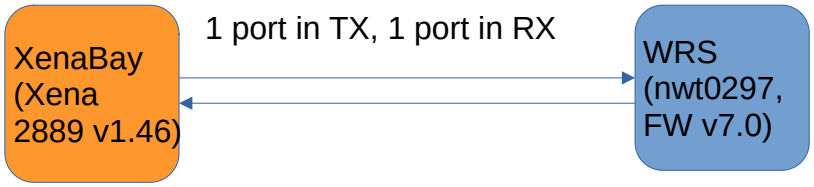
Frame Size, bytes	Address Count	Test Port Tx Frames	Learn Port Rx Frames	Monitor Port Rx Frames	Result
64	1074	22	22	22	Fail
128	100	22	22	22	Fail
256	100	22	22	22	Fail
512	100	22	22	22	Fail
1024	100	22	22	22	Fail
1280	100	22	22	22	Fail
1518	100	22	22	22	Fail

Address Learning Rate, frame/s (DUT aging=310 seconds)

Frame size, byte Address count	**64**	**128**	**256**	**512**	**1024**	**1280**	**1518**
100	20	20	20	20	20	20	20
300	20	20	20	20	20	20	20
500	20	20	20	20	20	20	20
700	20	20	20	20	20	20	20
900	20	20	20	20	20	20	20
1100	20	20	20	20	20	20	20
1300	20	20	20	20	20	20	20
2048	20	20	20	20	20	20	20

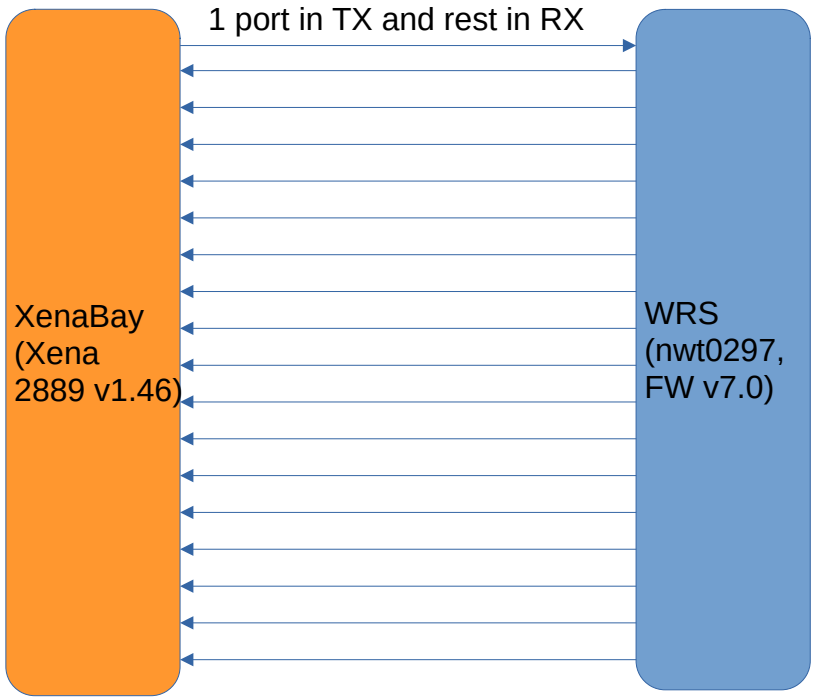
Issue: With the aging time of 310 seconds (300 seconds for WR switches by default) is chosen for the reset condition, the **address caching capacity test is failed**. Here, switch starts to forward test packets (100, 1074) properly, no flooding. At iteration with the critical number of packets (1561) it floods, and then it remains to flood in all further iterations with decreasing number of the test packets (1317, 1195, …, 1075, 1074). The test is failed because the switch floods even with the same number of packets (1074), with which no flooding was happened in previous iteration.

1.8. Errored Frames Filtering Results

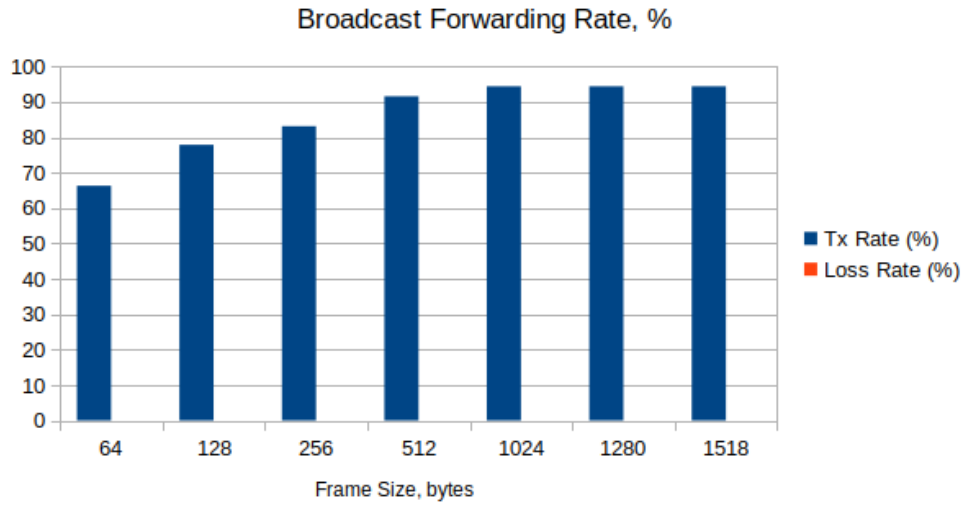


Tx Rate, %	Tx Frames	Rx Frames	Tx Valid	Rx Valid	Tx Over size	Rx Over size	Tx Under size	Rx Under size	Tx FCS Error	Rx FCS Error	Result
10	1741375	1741294	154130	154130	81221	81221	1506024	1505943	58	0	Fail
20	3482752	3474141	308261	308261	162443	162443	3012048	3003437	58	0	Fail
30	5224128	5151028	462392	462392	243664	243664	4518072	4444972	58	0	Fail
40	6965406	6688704	616522	616522	324788	324778	6024096	5747394	58	0	Fail
50	8706880	8278244	770653	770653	406107	406107	7530120	7101484	58	0	Fail
60	10448257	9751072	924784	924784	487329	487329	9036144	8338959	58	0	Fail
70	12189633	11107208	1078914	1078914	568551	568551	10542168	9459743	58	0	Fail
80	13931009	12613751	1233045	1233045	649772	649772	12048192	10730934	58	0	Fail
90	15672386	14062292	1387176	1387176	730994	730994	13554216	11944122	58	0	Fail
100	17413762	13728422	1541307	1477426	812215	629434	15060240	11621562	58	0	Fail

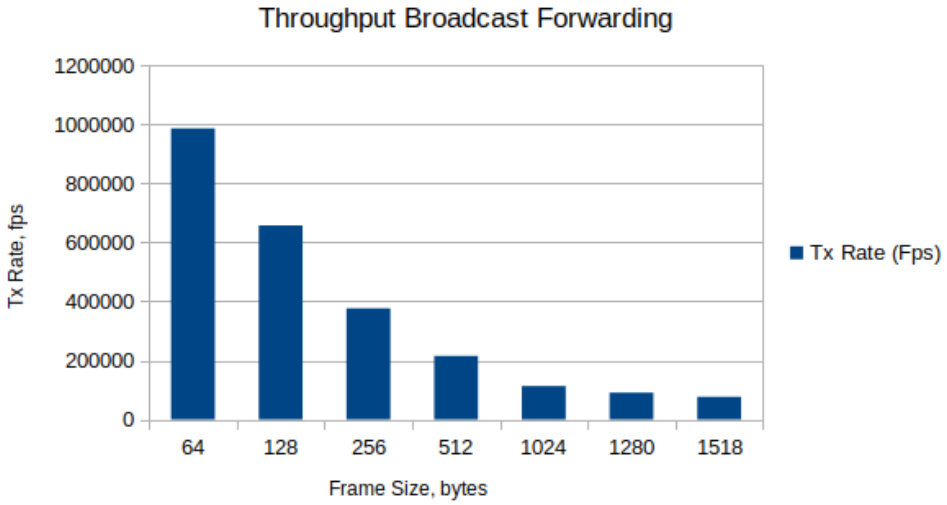
1.9. Broadcast Forwarding Results



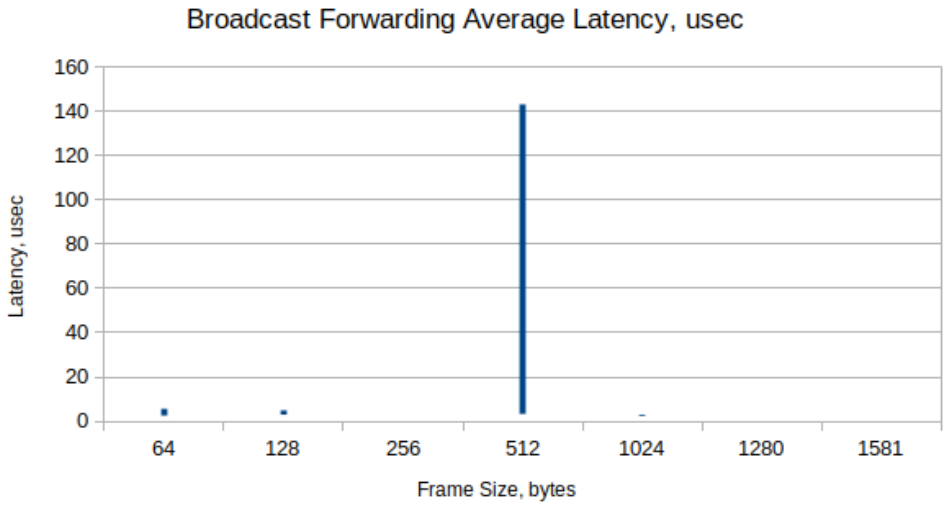
Frame Size, bytes	Tx Rate, %	Loss Rate, %	Loss Frames	Result
64	66,29	0	0	Pass
128	77,85	0	0	Pass
256	83,12	0	0	Pass
512	91,56	0	0	Pass
1024	94,37	0	0	Pass
1280	94,37	0	0	Pass
1518	94,37	0	0	Pass



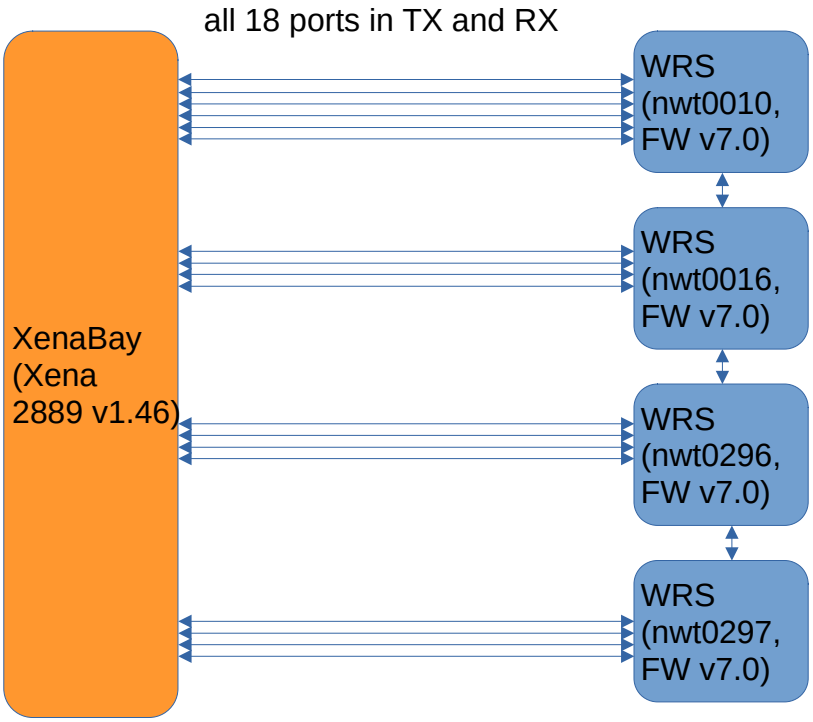
Frame Size, bytes	Tx Rate (Fps)
64	986517
128	657530
256	376472
512	215137
1024	112997
1280	90745
1518	76703



Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	2,58-5,57	1,67-2,29	5,97-11,52	0,003-0,003	0	2,04-2,84
128	2,98-4,91	2,13-2,73	6,31-9,72	0,002	0	2,04-2,3
256	2,4-2,98	2,13-2,74	4,83-6,21	0,008-0,01	0	2,12-2,5
512	3,32-143,2	2,13-2,75	10,91-262	0,002	0	2,07-2,24
1024	2,44-3,03	2,17-2,77	4,77-5,51	0,003-0,004	0	2,21-2,6
1280	2,37-2,97	2,13-2,75	4,21-5,37	0,004-0,006	0	2,24-2,65
1518	2,38-2,97	2,14-2,74	4,47-5,4	0,002-0,003	0	2,04-2,8

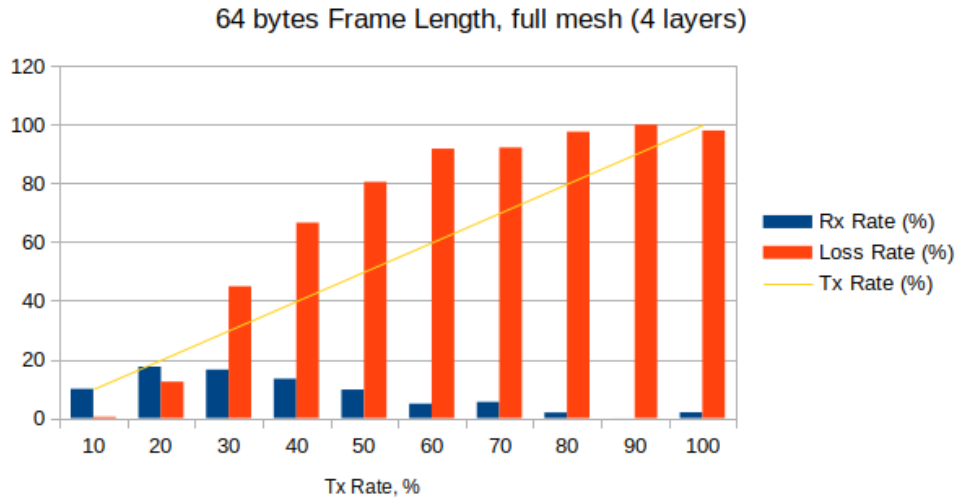


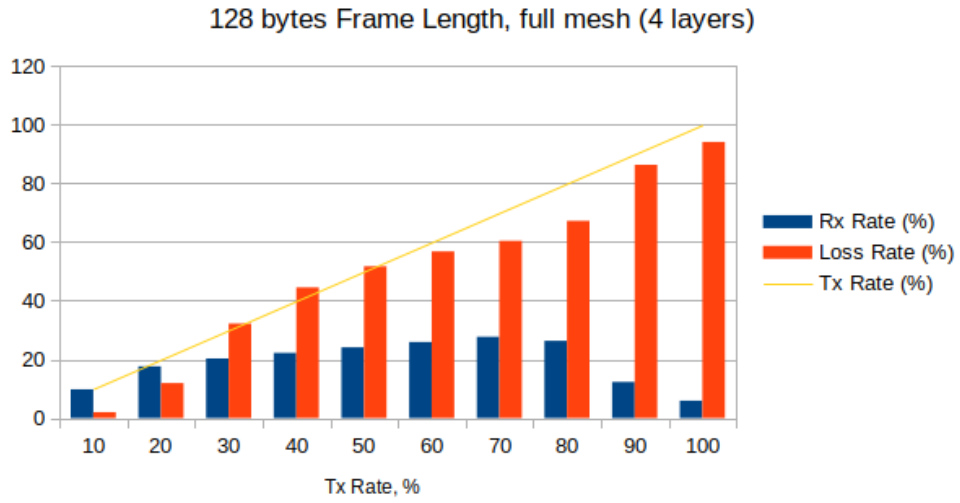
2.1. Full Mesh Results, 4 layers

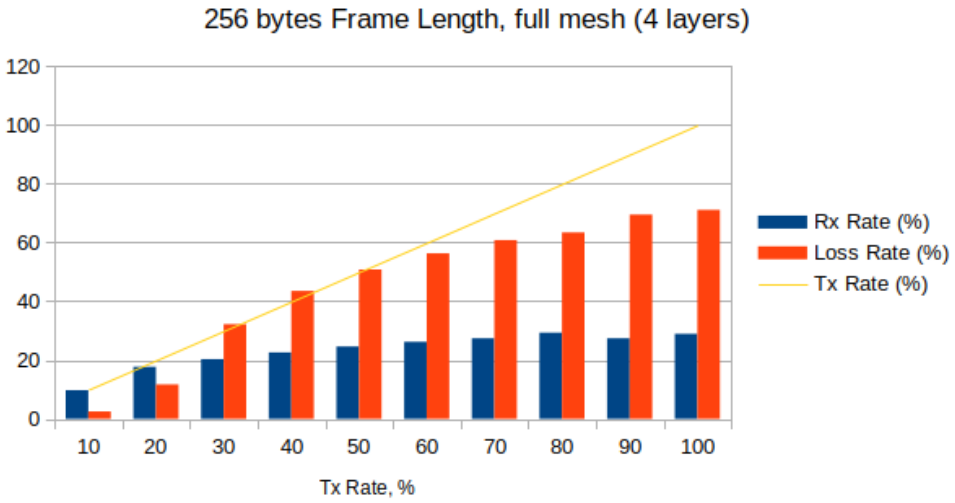


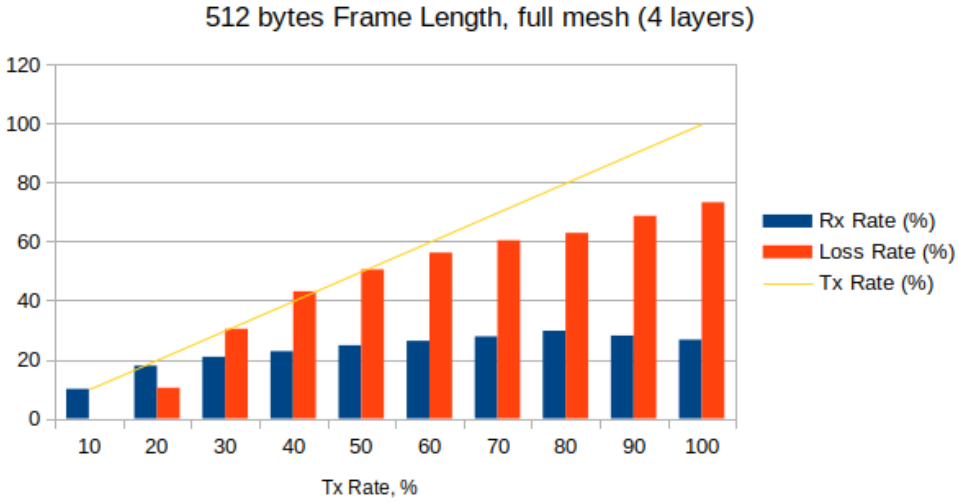
Forwarding test

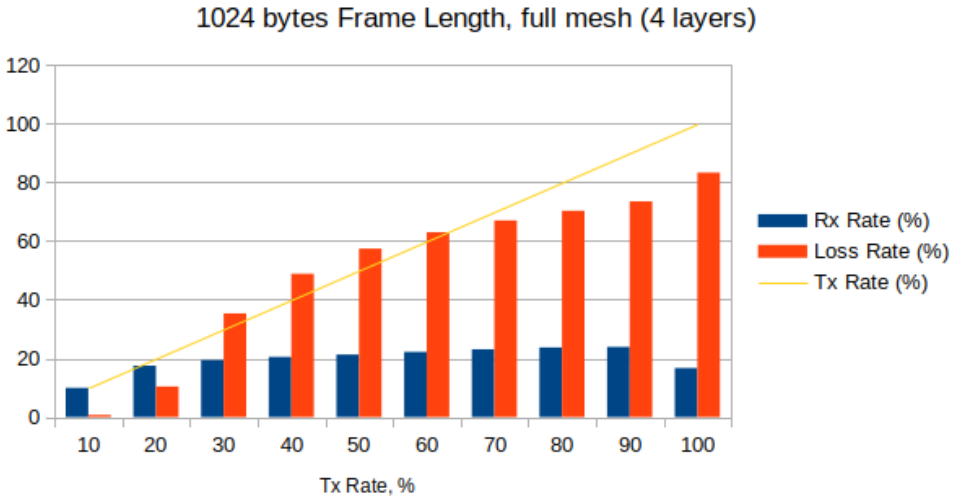
Frame Length	64 bytes		128 bytes		256 bytes		512 bytes		1024 bytes		1518 bytes	
Tx Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %
10	9,93	0,69	9,95	0,48	9,93	0,67	9,88	1,21	9,7	2,96	9,91	0,86
20	17,59	12,03	17,83	10,87	18,08	9,62	18,03	9,86	17,42	12,91	15,39	23,05
30	16,82	43,95	20,6	31,35	21,31	28,98	20,97	30,09	20,03	33,23	13,3	55,68
40	13,17	67,08	22,68	43,29	23,08	42,31	23,16	42,1	21,23	47	12,74	68,15
50	9,7	80,61	25,06	49,88	24,94	50,12	24,89	50,22	22,53	54,95	11,94	76,13
60	4,72	92,13	26,66	55,57	26,73	55,45	26,17	56,39	22,91	62	11,57	80,72
70	5,47	92,18	28,54	59,23	28,57	59,19	28,9	58,71	23,65	66,22	10,47	85,05
80	2,29	97,14	26,87	66,42	29,9	62,62	30,06	62,42	24,95	68,82	11,37	85,78
90	0,01	99,98	14,52	83,87	28,67	68,14	23,4	74	23,16	74,26	9,33	89,63
100	0,89	99,11	11,7	88,3	21,35	78,65	28,11	71,89	20,66	79,34	9,01	90,99

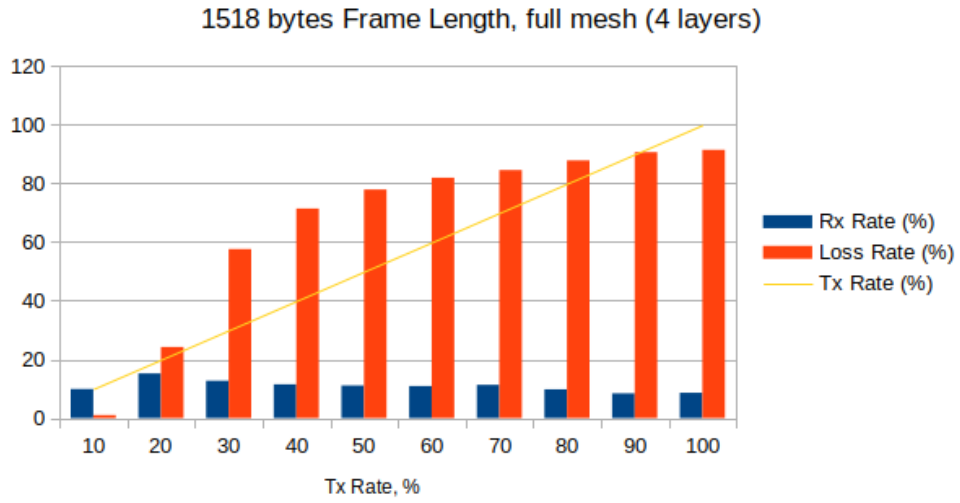




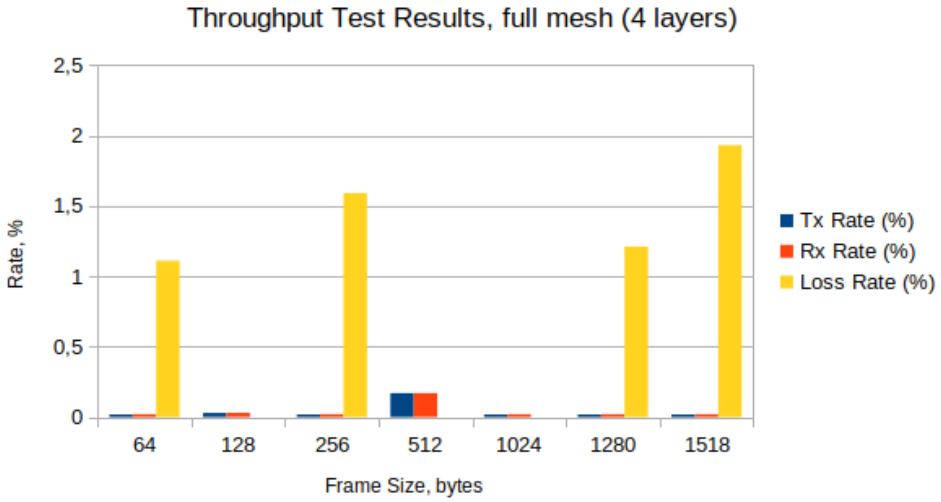

256 bytes Frame Length, full mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


512 bytes Frame Length, full mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


1024 bytes Frame Length, full mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

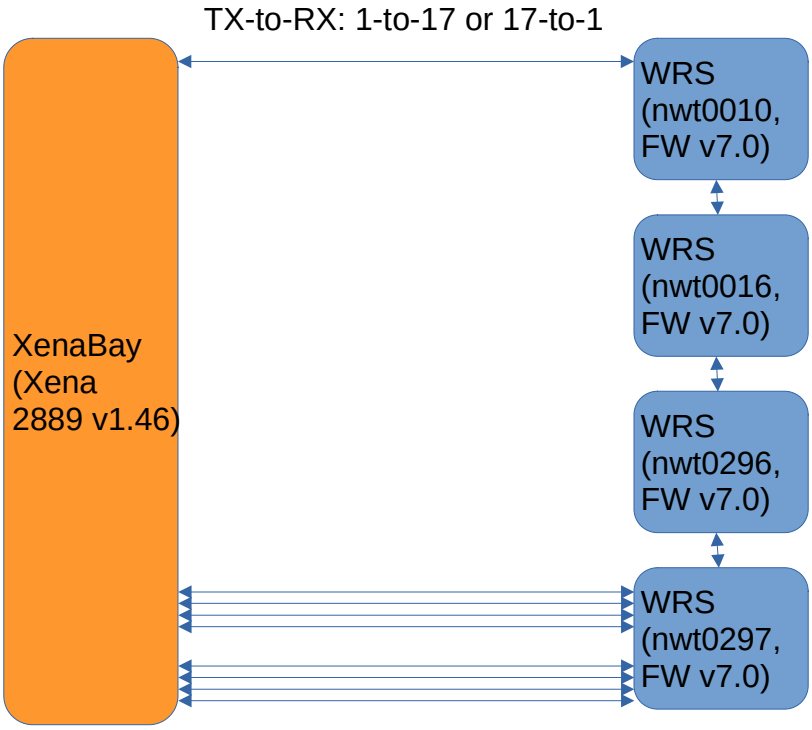


Throughput test



Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	0,02	2,9M	4,3K	0,02	1,11 (1426)	Fail
128	0,03	4,75M	4K	0,03	0 (0)	Pass
256	0,02	2,9M	1,3K	0,02	1,6 (618)	Fail
512	0,17	26,8M	6,3K	0,17	0 (0)	Pass
1024	0,02	2,8M	337	0,02	0 (0)	Pass
1280	0,02	2,9M	275	0,02	1,21 (100)	Fail
1518	0,02	2,8M	224	0,02	1,93 (130)	Fail

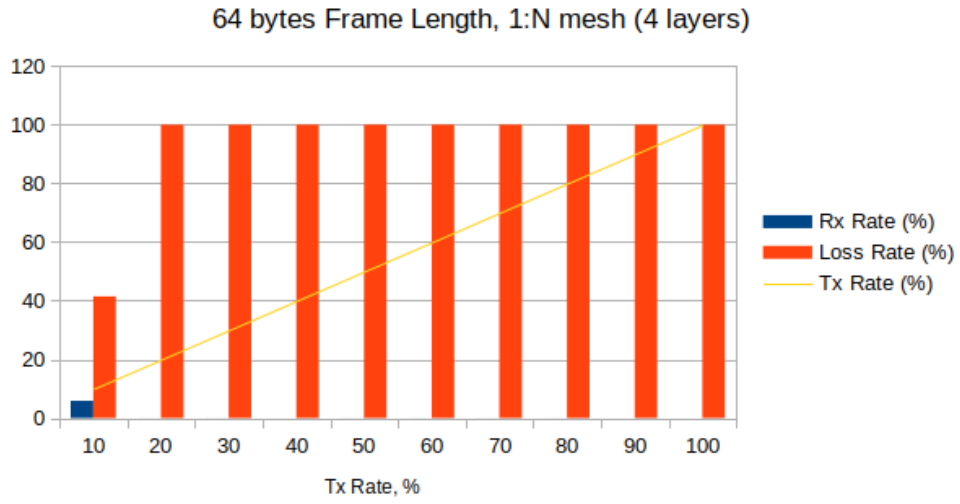
2.2. Partial 1:N Mesh Results[1], 4 layers

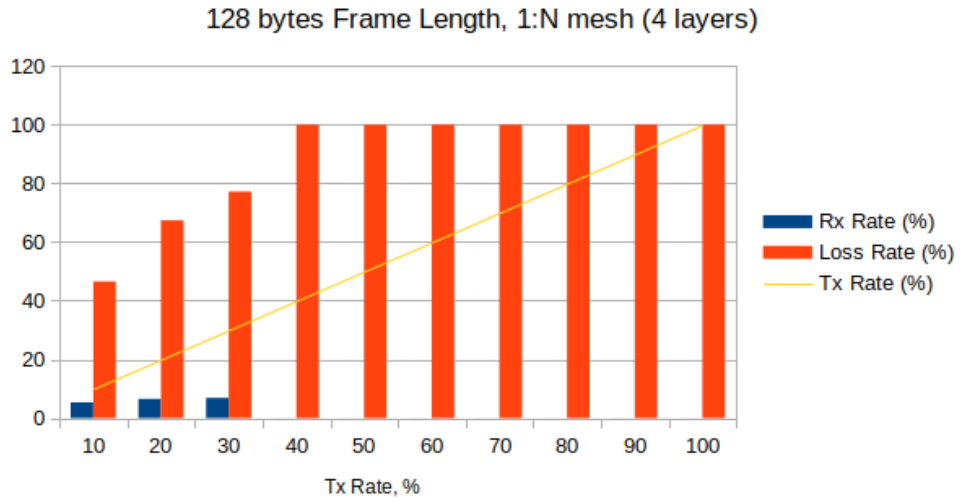


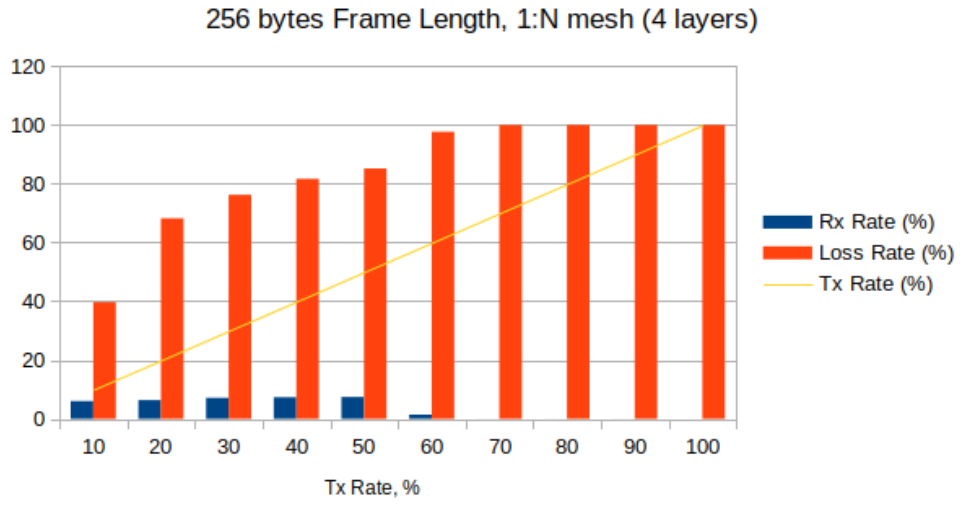
1 Source: xena2889-report_4_wrs_v70-20241010-113027.pdf

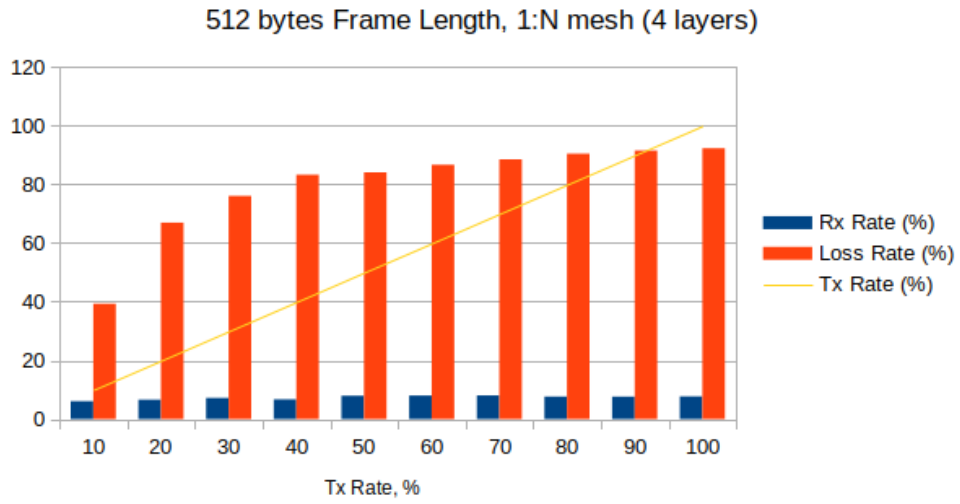
Forwarding test

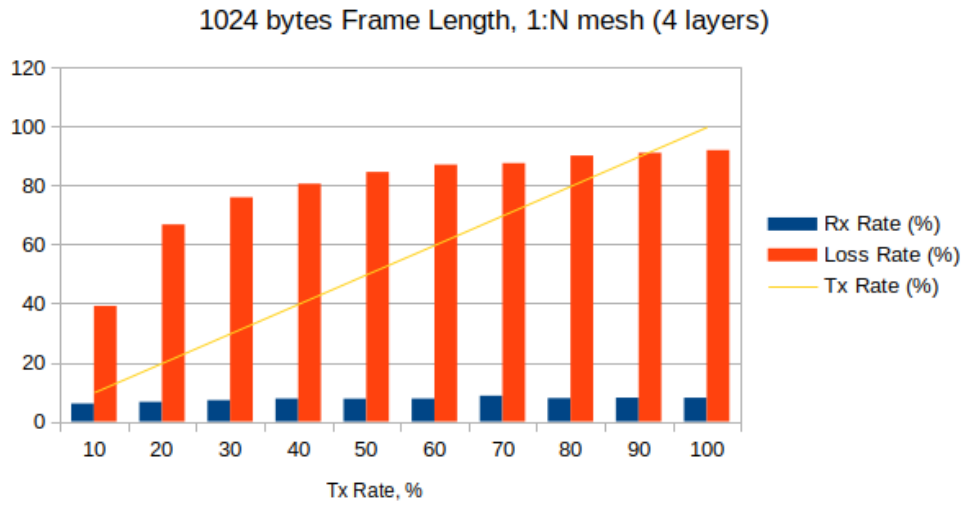
Frame Length	64 bytes		128 bytes		256 bytes		512 bytes		1024 bytes		1518 bytes	
Tx Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %	Rx Rate, %	Loss Rate, %
10	5,9	41,4	5,4	46,5	6	39,7	6,1	39,3	6,1	39,2	5,9	41,5
20	0,01	99,9	6,5	67,4	6,4	68,	6,6	66,9	6,6	66,8	5,9	70,2
30	0,01	99,9	6,9	77,2	7,1	76,2	7,2	76	7,2	76	5,8	80,7
40	0	100	0,01	99,9	7,3	81,6	6,7	83,3	7,8	80,6	6,1	84,8
50	0,01	99,9	0,02	99,9	7,4	85,2	8	84,1	7,7	84,6	6,2	87,6
60	0,01	99,9	0,01	99,9	1,4	97,6	8	86,7	7,8	87,1	6,3	89,5
70	0,01	99,9	0,01	99,9	0,02	99,9	8	88,5	8,7	87,6	6,3	91
80	0,01	99,9	0,01	99,9	0,01	99,9	7,6	90,5	7,9	90,1	6,5	92
90	0	100	0,01	99,9	0,02	99,9	7,6	91,5	8	91,1	6,5	93
100	0	100	0,01	99,9	0	100	7,7	92,3	8	92	6	94

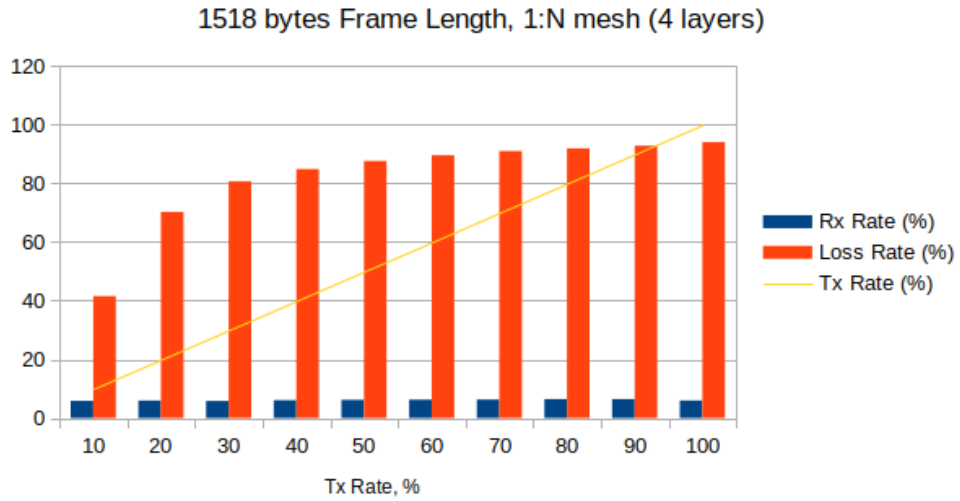





256 bytes Frame Length, 1:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

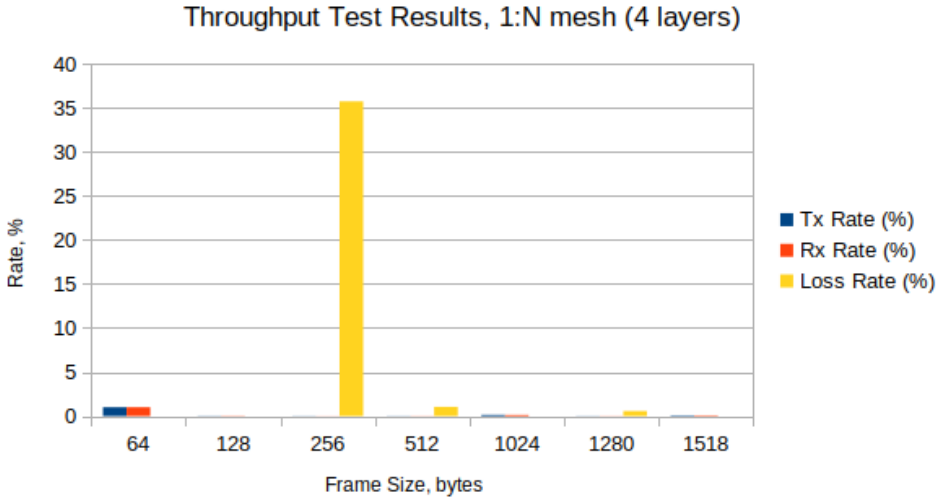

512 bytes Frame Length, 1:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


1024 bytes Frame Length, 1:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

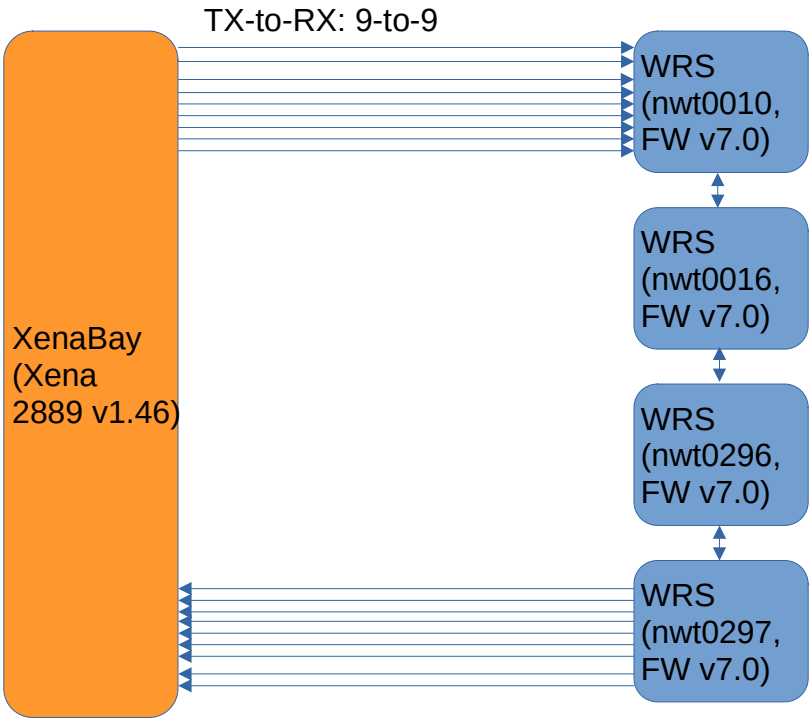


Throughput test

Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	1	162M	241K	1	0 (0)	Pass
128	0,03	4,1M	3,5K	0,03	0 (0)	Pass
256	0,018	2,9M	1,3K	0,01	35,74 (14K)	Fail
512	0,02	2,9M	675	0,02	1,04 (210)	Fail
1024	0,135	21,8M	2,6K	0,13	0 (0)	Pass
1280	0,02	2,9M	276	0,02	0,56 (46)	Fail
1518	0,07	11,6M	946	0,07	0 (0)	Pass



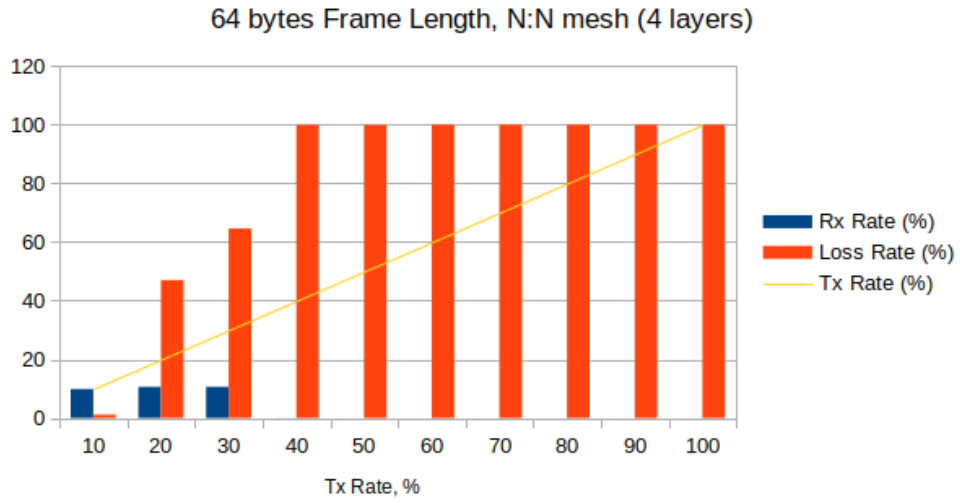
2.3. Partial N:N Mesh Results[2], 4 layers

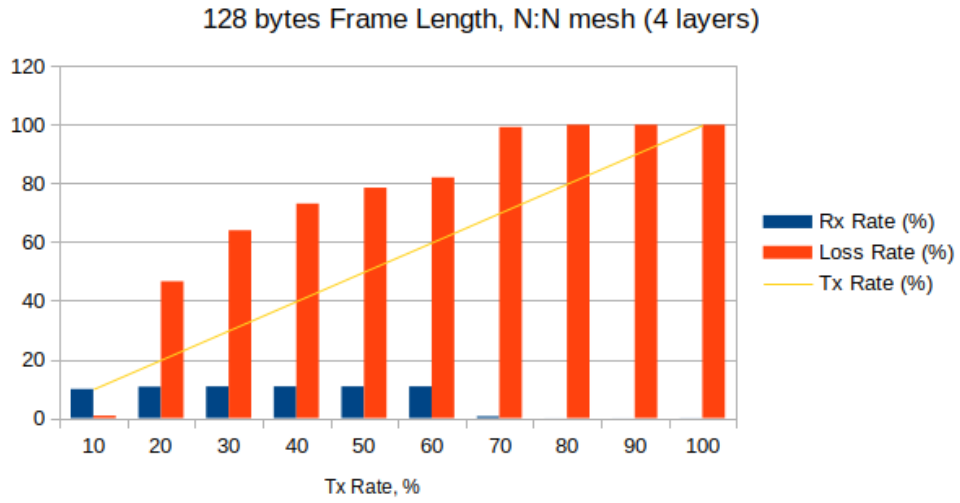


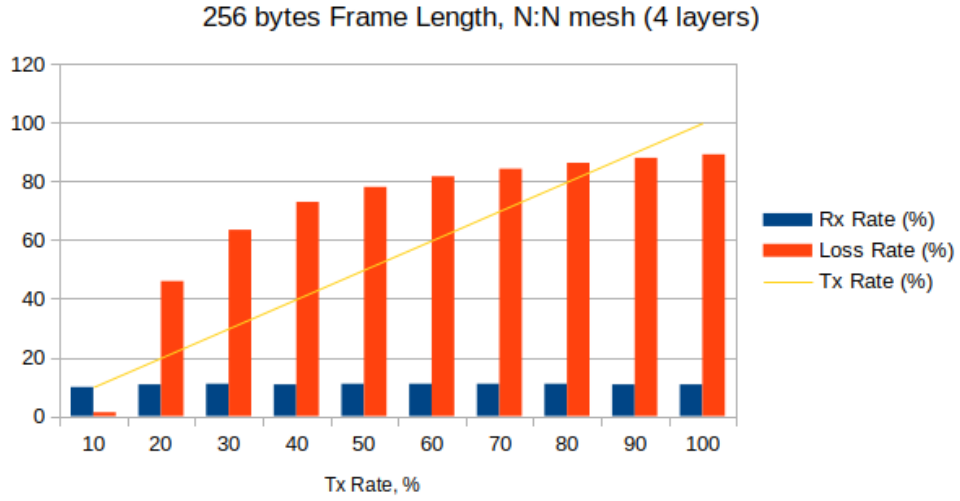
2 Source: xena2889_4_wrs_v70-report-20241010-172320.pdf

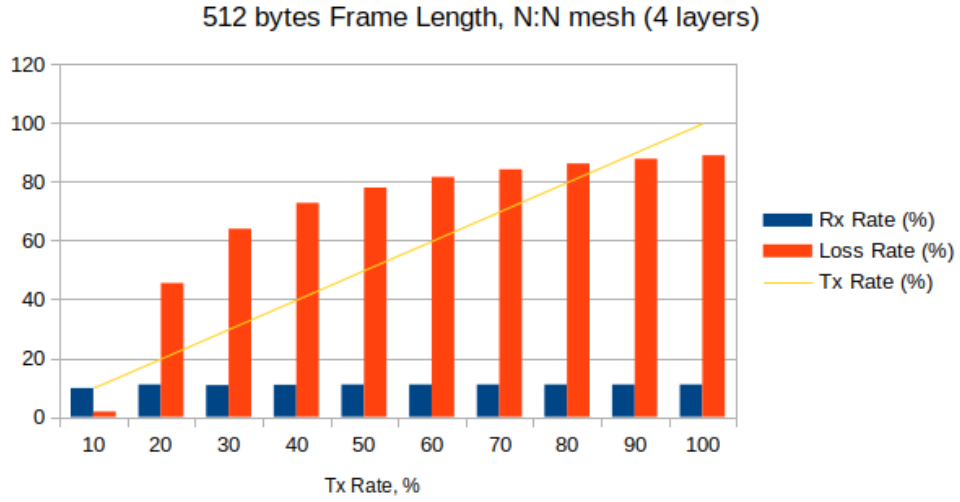
Forwarding test

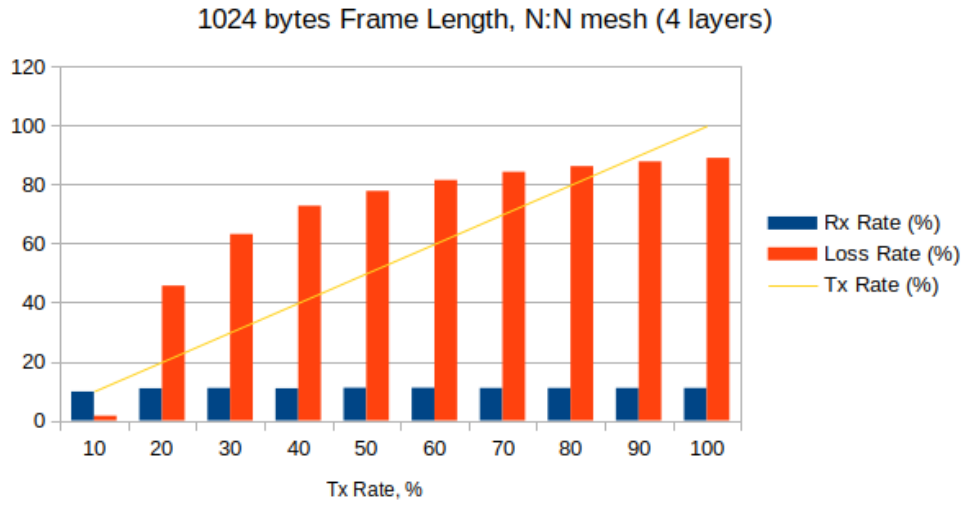
	Frame Length, bytes											
	64		128		256		512		1024		1518	
Tx Rate, %	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**	**Rx Rate, %**	**Loss Rate, %**
10	9,9	1,1	9,9	0,8	9,9	1,3	9,8	1,8	9,8	1,6	9,97	0,27
20	10,6	47	10,7	46,6	10,8	46	11	45,5	10,9	45,7	11	45
30	10,6	64,6	10,8	64	11	63,5	10,8	64	11	63,2	10,6	65
40	0,03	99,9	10,8	73,1	10,8	73	10,9	72,8	10,9	72,8	11,1	72,3
50	0,02	99,9	10,8	78,5	11	78,1	11	78	11,1	77,8	11	78
60	0,02	99,9	10,8	82	11	81,7	11	81,6	11,1	81,5	11	81,7
70	0,01	99,9	0,6	99,2	11	84,3	11	84,2	11	84,3	10,7	84,8
80	0,01	99,9	0,02	99,9	11	86,3	11	86,2	11	86,2	11,1	86,2
90	0,01	99,9	0,02	99,9	10,8	88	11	87,8	11	87,8	11,1	87,7
100	0,01	99,9	0,03	99,9	10,8	89,2	11	89	11	89	10,8	89,2

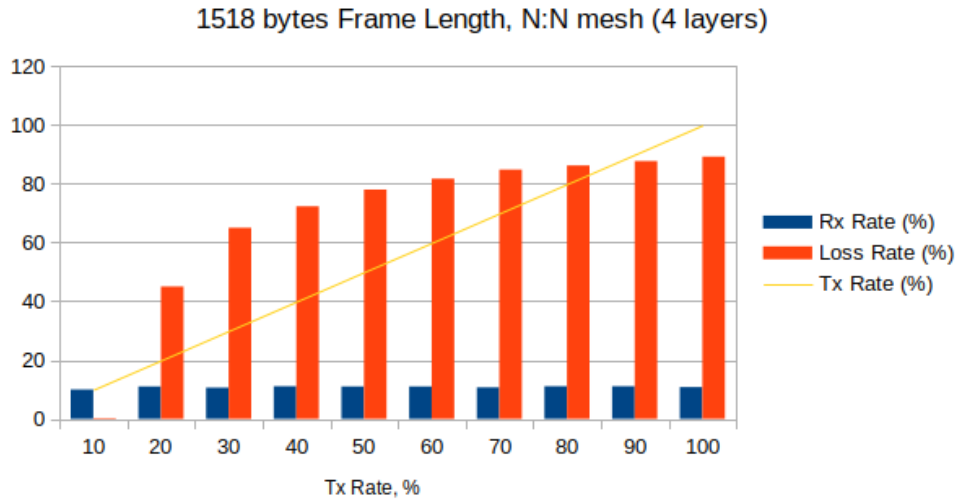



128 bytes Frame Length, N:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)


256 bytes Frame Length, N:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)

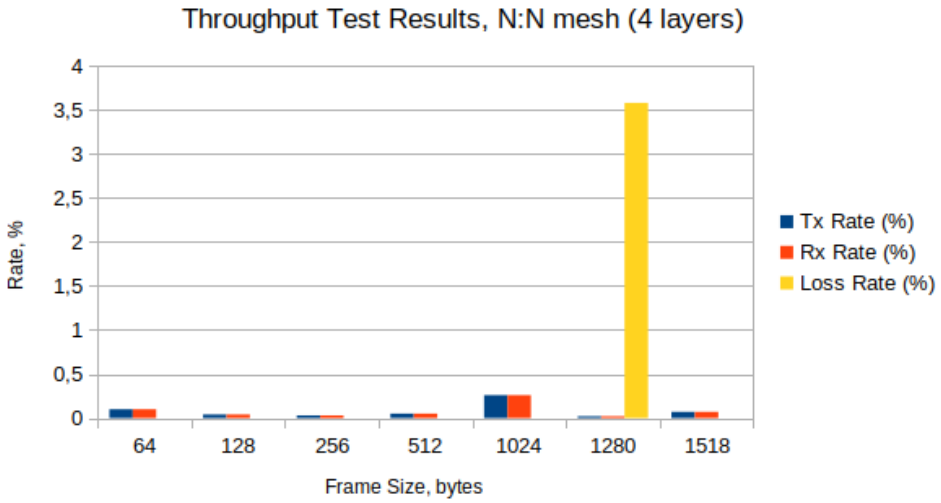

512 bytes Frame Length, N:N mesh (4 layers)
120
100
80
60
40
20
0
10
20
30
40
50
60
70
80
90
100
Tx Rate, %
Rx Rate (%)
Loss Rate (%)
Tx Rate (%)



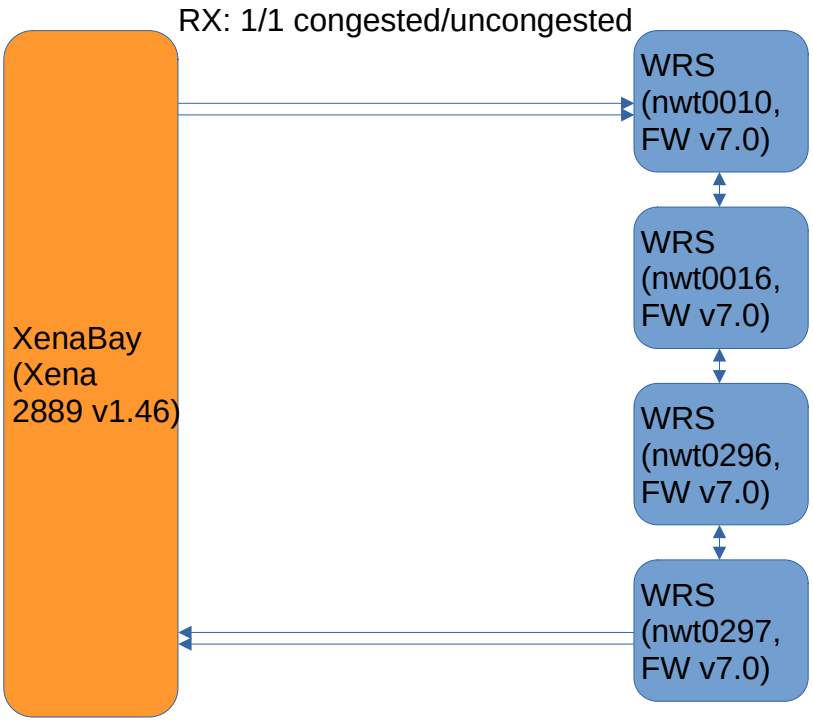


Throughput test

Frame Size, bytes	Tx Rate, %	Tx Rate, b/s	Tx Rate, f/s	Rx Rate, %	Loss Rate, % (frames)	Result
64	0,1	8,3M	12,4K	0,1	0 (0)	Pass
128	0,04	3,3M	2,8K	0,04	0 (0)	Pass
256	0,03	2,1M	934	0,03	0 (0)	Pass
512	0,05	3,9M	926	0,05	0 (0)	Pass
1024	0,26	20,9M	2498	0,26	0 (0)	Pass
1280	0,02	1,4M	138	0,02	3,58 (148)	Fail
1518	0,07	5,95M	483	0,07	0 (0)	Pass


Throughput Test Results, N:N mesh (4 layers)
Rate, %
4
3,5
3
2,5
2
1,5
1
0,5
0
64
128
256
512
1024
1280
1518
Frame Size, bytes
Tx Rate (%)
Rx Rate (%)
Loss Rate (%)

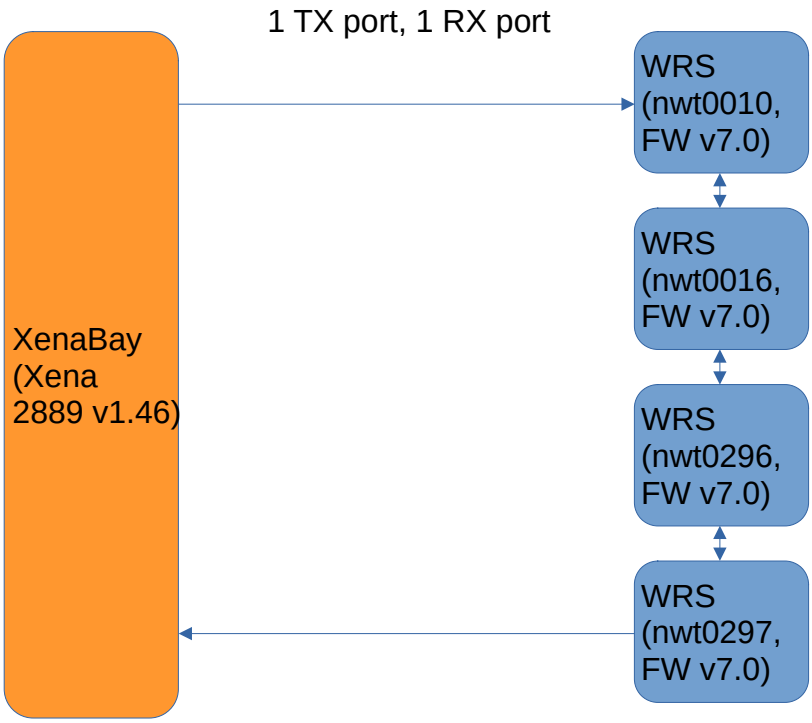
2.4. Congestion Control Results, 4 layers



Frame Size	Tx Rate, %	Tx Frames	UC-Port: Tx	UC-Port: Rx	UC-Port: Loss, %	C-Port: Tx	C-Port: Rx	C-Port: Loss, %	Result
64	100	89285715	22321429	9269359	58,47	66964286	33349067	50,2	Fail
128	100	50675677	12668919	3686396	29,1	38006758	15691528	58,7	Fail
256	100	27173914	6793479	3735599	45,01	20380435	9658785	52,6	Fail
512	100	14097746	3524437	2300678	34,7	10573309	4696485	55,6	Fail
1024	100	7183910	1795978	396592	77,9	5387932	3182163	40,9	Fail
1280	100	5769232	1442308	939844	34,8	4326924	1936288	55,3	Fail
1518	100	4876464	1219116	709159	41,8	3657348	1723077	52,9	Fail

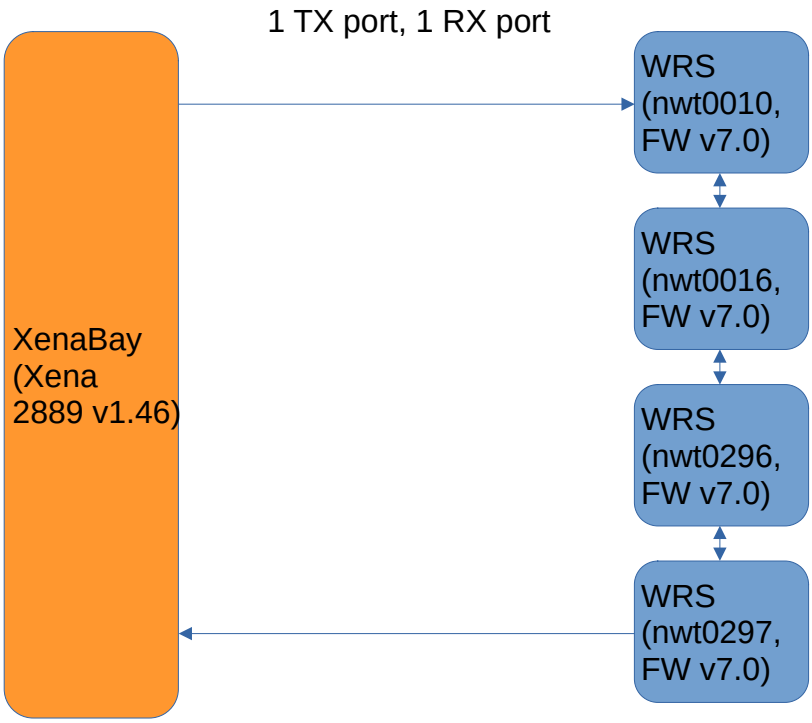
C-Port: Congested Port
UC-Port: Uncongested Port

2.5. Forward Pressure Results, 4 layers



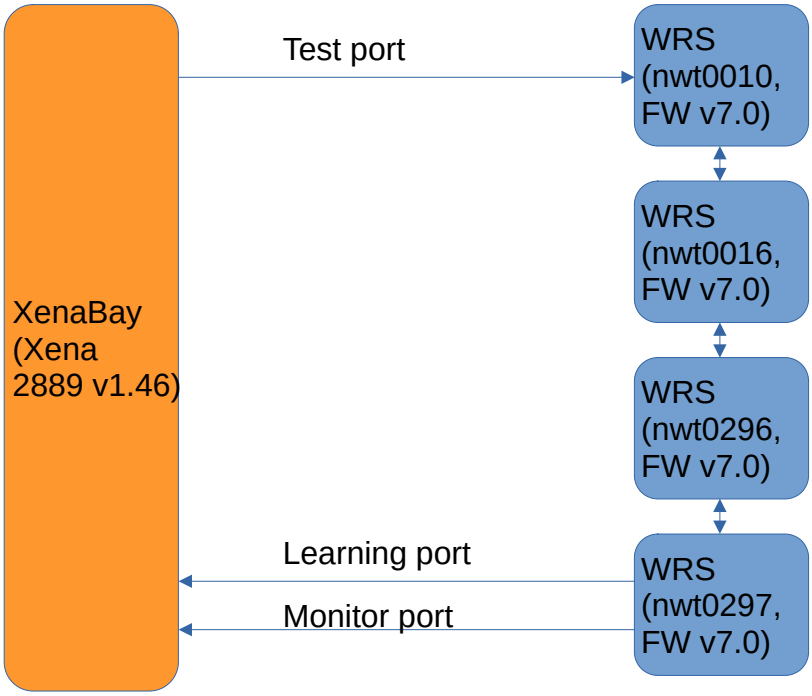
Frame Size, bytes	Tx Frames	Tx max. util., %	Rx Frames	Rx max. util., %	Loss, %	Result
64	40662650	95,4	38352262	89,4	5,7	Pass
128	22959183	94,5	22203966	90,7	3,3	Pass
256	12272727	93,8	12053605	91,5	1,8	Pass
512	6355932	93,2	6296690	93,5	0,9	Pass
1024	3235858	94,6	3220475	93,4	0,5	Pass
1280	2598152	94,2	2588246	93,2	0,4	Pass
1518	2195836	93,9	2188771	92,9	0,3	Pass

2.6. Maximum Forwarding Rate Results, 4 layers



Frame Size, bytes	Tx Rate, %	Tx Rate, f/s	Tx Frames	Rx Frames	Loss, % (calculated)	Result
64	100	1339,3K	40178571	38352284	4,54	Pass
128	100	760,1K	22804054	22203975	2,63	Pass
256	100	407,6K	12228260	12053609	1,43	Pass
512	100	211,5K	6343984	6296686	0,75	Pass
1024	100	107,8K	3232758	3220475	0,38	Pass
1280	90	77,9K	2336538	2336538	0	Pass
1518	100	73,1K	2194408	2188771	0,26	Pass

2.7. Address Caching Capacity and Learning Rate Results, 4 layers



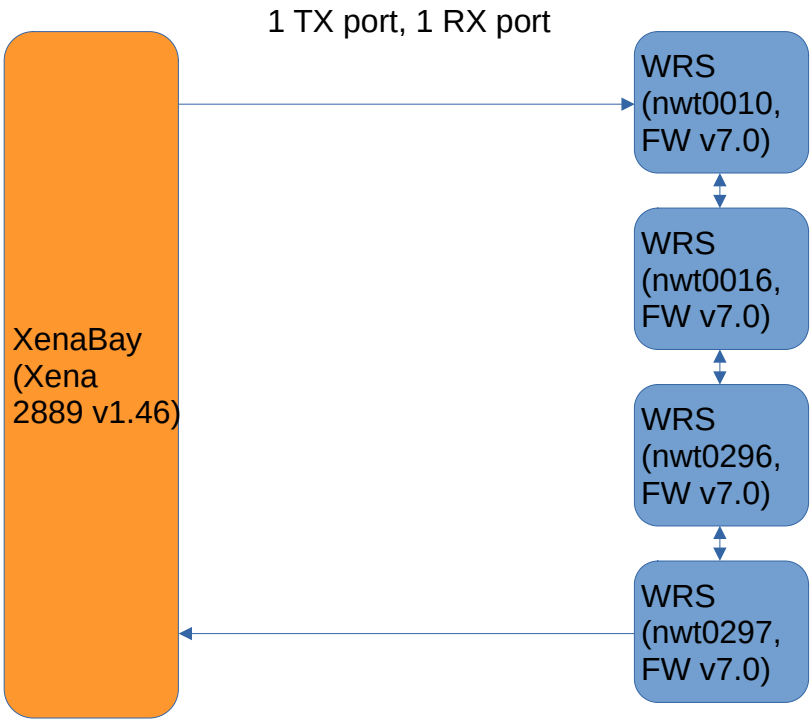
Address Caching Capacity (Learning Rate=20 frames/s)

Frame Size, bytes	Address Count	Test Port Tx Frames	Learn Port Rx Frames	Monitor Port Rx Frames	Result
64	1074	1074	1074	512	Fail
128	100	100	100	100	Fail
256	100	100	100	100	Fail
512	100	100	100	100	Fail
1024	100	100	100	100	Fail
1280	100	100	100	100	Fail
1518	100	100	100	100	Fail

Address Learning Rate, frame/s (Base Learning Rate=20 frames/s)

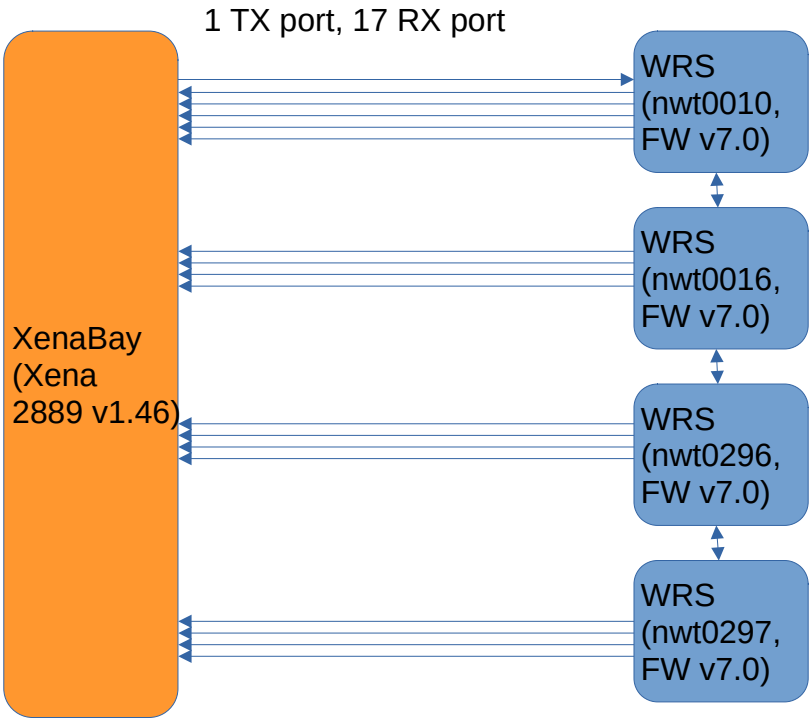
Frame size, byte Address count	64	128	256	512	1024	1280	1518
100	4	4	4	4	4	4	4
300	4	4	4	4	4	4	4
600	4	4	4	4	4	4	4
900	4	4	4	4	4	4	4
1200	4	4	4	4	4	4	4
1600	4	4	4	4	4	4	4
2000	4	4	4	4	4	4	4

2.8. Errored Frames Filtering Results, 4 layers

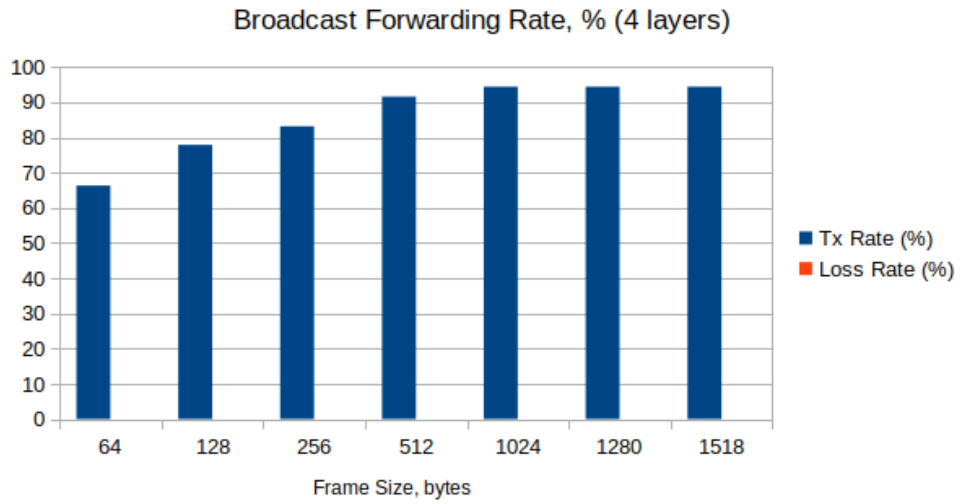


Tx Rate, %	Tx Frames	Rx Frames	Tx Valid	Rx Valid	Tx Over size	Rx Over size	Tx Under size	Rx Under size	Tx FCS Error	Rx FCS Error	Result
10	1567237	1566783	138717	138717	73099	73099	1355421	1354967	58	0	Fail
20	3134476	3132488	277435	277435	146198	146198	2710843	2708855	58	0	Fail
30	4701715	4699127	416152	416152	219298	219298	4066265	4063677	58	0	Fail
40	6268953	6262702	554870	554870	292397	292397	5421686	5415435	58	0	Fail
50	7836193	7830622	693588	693588	365497	365497	6777108	6771537	58	0	Fail
60	9403431	9392578	832305	832305	438596	438596	8132530	8121677	58	0	Fail
70	10970669	10958478	971023	971023	511695	511695	9487951	9475760	58	0	Fail
80	12537909	12516467	1109741	1109741	584795	584795	10843373	10821931	58	0	Fail
90	14105147	14089648	1248458	1248458	657894	657894	12198795	12183296	58	0	Fail
100	15672386	12312732	1387176	1328986	730994	573276	13554216	10410470	58	0	Fail

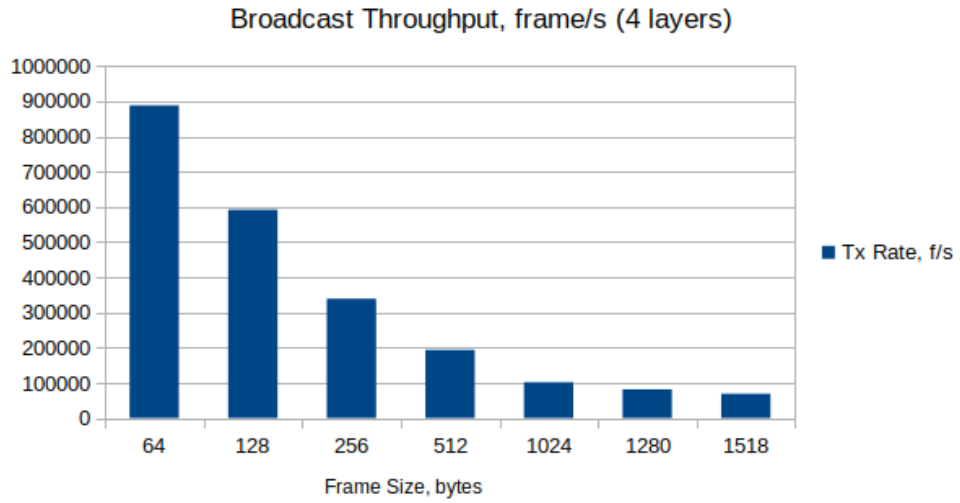
2.9. Broadcast Forwarding Results, 4 layers



Frame Size, bytes	Tx Rate, %	Loss Rate, %	Loss Frames	Result
64	66,3	0	0	Pass
128	77,8	0	0	Pass
256	83,1	0	0	Pass
512	91,6	0	0	Pass
1024	94,4	0	0	Pass
1280	94,4	0	0	Pass
1518	94,4	0	0	Pass

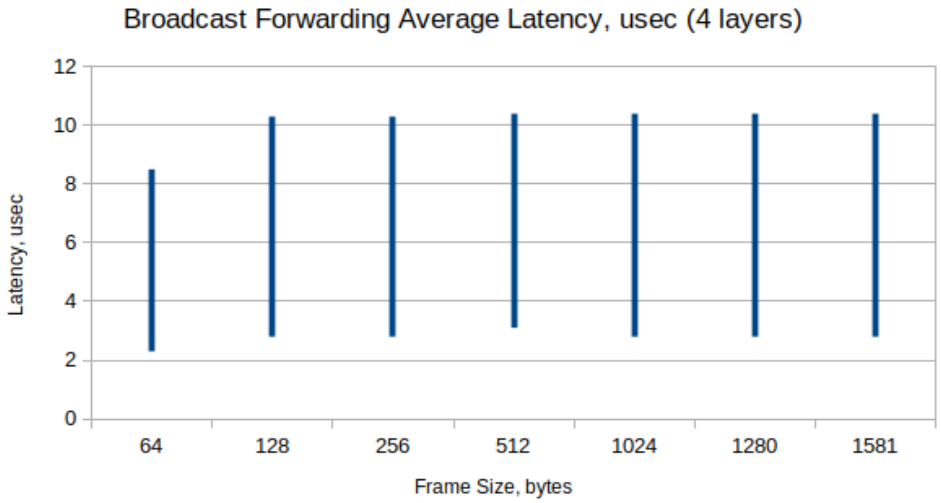


Frame Size, bytes	Tx Rate (Fps)
64	887865
128	591777
256	338825
512	193624
1024	101697
1280	81671
1518	69032



All layers

Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	2,3-8,5	2,2-8,3	6-13,7	0,002-0,03	0	2,6-2,8
128	2,8-10,3	2,7-10,3	6,1-14,7	0,001-0,001	0	2-2,2
256	2,8-10,3	2,7-10,2	4,9-12,5	0,003-0,08	0	2-2,3
512	3,1-10,4	2,7-10,2	7,6-16,6	0,001-0,004	0	2-2,2
1024	2,8-10,4	2,7-10,2	4,9-12,4	0,001-0,002	0	2-2,4
1280	2,8-10,4	2,7-10,2	4,8-12,5	0,001-0,002	0	1,9-2,1
1518	2,8-10,4	2,7-10,2	4,7-12,2	0,001	0	1,8-2



1st Layer

Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	2,3-2,4	2,2-2,3	6-6,1	0,002	0	2,6-2,8
128	2,8-3,4	2,7	6,1-7,5	0,001	0	2,1-2,2
256	2,8	2,7	4,9-5,1	0,003-0,004	0	2,1-2,3
512	3,1-7	2,7	7,6-16,6	0,001-0,002	0	2,2
1024	2,8	2,7	4,9-5,1	0,001	0	2,1-2,4
1280	2,8-2,9	2,7	4,8-5	0,001	0	1,9-2,1
1518	2,8-2,9	2,7	4,7-4,9	0,001	0	1,9-2

2nd Layer

Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	3,9	3,7	9	0,01	0	2,6
128	4,7-4,8	4,7	8,1-9	0,01	0	2-2,1
256	4,7-4,8	4,6-4,7	6,8-6,9	0,004-0,006	0	2-2,1
512	4,8-4,9	4,6-4,7	9-9,3	0,001-0,003	0	2,1
1024	4,8	4,6-4,7	6,8-7,4	0,001-0,002	0	2
1280	4,8	4,6-4,7	6,8-6,9	0,001-0,002	0	1,9-2,1
1518	4,8	4,7	6,6-6,7	0,001	0	1,9

3rd Layer

Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	6,1-6,2	5,8-6	11,3	0,01-0,02	0	2,6
128	7,5-7,6	7,3-7,5	10,8-10,9	0,001	0	2
256	7,4-7,6	7,3-7,5	9,5-9,7	0,004	0	2
512	7,5-7,7	7,3-7,5	11,6-11,9	0,001	0	2,1
1024	7,5-7,6	7,3-7,5	9,4-9,7	0,001-0,002	0	2
1280	7,5-7,6	7,3-7,5	9,5-9,6	0,001	0	1,9
1518	7,4-7,6	7,4-7,5	9,3-9,5	0,001	0	1,9

4th Layer

Frame Size, bytes	Latency, usec			Jitter, usec		
	Average	Min	Max	Average	Min	Max
64	8,5	8,3	13,6-13,7	0,01-0,02	0	2,6
128	10,3	10,1-10,2	13,7-14,7	0,001	0	2,1
256	10,3	10,1-10,2	12,4-12,5	0,005-0,08	0	2-2,1
512	10,4	10,1-10,2	14,4-14,8	0,001-0,004	0	2
1024	10,3-10,4	10,1-10,2	12,3-12,4	0,001-0,002	0	2
1280	10,3-10,4	10,1-10,2	12,4-12,5	0,001-0,002	0	2,1
1518	10,3-10,4	10,1-10,2	12,1-12,2	0,001	0	1,9