Test Report

The test report provides a comprehensive overview of the performance of BATS, TCP, and UDP protocols under varying conditions. The report is structured into sections for each protocol, with detailed tables presenting the summarized results.

Setup

The testbed consists of one router (running openWRT) and several computers (e.g., Raspberry Pis) interconnected by Ethernet cables. This physical network serves as the foundation for our experiments. In contrast, the network used for testing is a virtual construct, simulated by the interactions within the physical network, and is referred to as the test network.

The test network comprises multiple network nodes, each simulated by a computer. Each of these computers can simulate one or more network nodes within the test network. The network topology, governing the connections between these simulated nodes, is defined by the router. All inter-node communications traverse the router, allowing simulation of diverse network link behaviors such as packet loss, latency, wireless interference, and more.

The test topology for this report is as follows:

n-hop router | (enp5s0: 10.0.0.3) → (eth0: 10.0.0.11) n-hop slave1
        |_(enp4s0: 10.0.0.2) → (eth0: 10.0.0.12) n-hop slave2

The bandwidth of the link between the n-hop router and n-hop slave is set to 100Mbps.

BATS Test Summary

The BATS section of the report outlines the test outcomes for the BATS protocol. It highlights the impact of link loss rates and coding methods on various performance metrics. The table displays the following details for each unique link status configuration:

- Link Loss Rate: The percentage of simulated link loss.
- Coding Method: The coding strategy employed, categorized as "identity," "random," or "unknown" based on parameters.
- Throughput: The average received throughput in the given configuration.
- Link Send Rate: The average send rate of network interface of client.
- Link Recv Rate: The average received rate of network interface of server.
- Latency: The average latency of packet observed.
- Reliability: The reliability percentage, indicating the proportion of received data to sent data.
- Feedback: Indicates whether the feedback mechanism is restricted or unrestricted.

BATS Protocol Version: v1.0.0(ce02ec5) Build date: Aug 1 2023 18:10:16 Compiler: gcc10.2.1

BATS Test Result

link Loss Rate	Coding Method	Throughput	Link Send Rate	Link Recv Rate	Latency	Reliability	Feedback
0%	identity	79.66 Mbps	92.94 Mbps	92.94 Mbps	2.0 ms	99.43%	restricted
0%	identity	77.86 Mbps	94.36 Mbps	94.38 Mbps	7.0 ms	97.22%	unrestricted
0%	random	78.58 Mbps	95.6 Mbps	97.01 Mbps	34.0 ms	98.11%	restricted
0%	random	78.58 Mbps	95.45 Mbps	97.06 Mbps	36.0 ms	98.11%	unrestricted
5%	identity	74.91 Mbps	88.22 Mbps	88.31 Mbps	2.0 ms	93.58%	restricted
5%	identity	79.92 Mbps	95.3 Mbps	95.1 Mbps	505.0 ms	99.79%	unrestricted
5%	random	73.96 Mbps	92.24 Mbps	92.12 Mbps	3.0 ms	92.35%	restricted
5%	random	75.76 Mbps	95.65 Mbps	95.38 Mbps	56.0 ms	94.59%	unrestricted
10%	identity	58.62 Mbps	83.51 Mbps	83.79 Mbps	3.0 ms	73.19%	restricted
10%	identity	76.12 Mbps	95.34 Mbps	95.28 Mbps	44.0 ms	95.01%	unrestricted
10%	random	47.68 Mbps	87.26 Mbps	87.29 Mbps	3.0 ms	59.56%	restricted
10%	random	73.37 Mbps	95.51 Mbps	95.44 Mbps	48.0 ms	91.61%	unrestricted
15%	identity	38.63 Mbps	79.16 Mbps	78.99 Mbps	1003.0 ms	48.23%	restricted
15%	identity	78.51 Mbps	97.73 Mbps	97.67 Mbps	710.0 ms	98.03%	unrestricted
15%	random	69.67 Mbps	95.52 Mbps	95.51 Mbps	61.0 ms	87.03%	unrestricted
20%	identity	71.73 Mbps	95.43 Mbps	95.49 Mbps	728.0 ms	89.56%	unrestricted
20%	random	7.73 Mbps	77.74 Mbps	77.78 Mbps	2005.0 ms	9.65%	restricted
20%	random	67.5 Mbps	95.74 Mbps	95.68 Mbps	1080.0 ms	84.28%	unrestricted

TCP Test Summary

The TCP section of the report focuses on TCP protocol testing results. It analyzes the effects of different link loss rates and congestion conditions on performance. The summary table for TCP includes the following information for each unique link status:

- Link Loss Rate: The percentage of simulated link loss.
- Congestion: The congestion state during testing.
- Throughput: The average received throughput achieved.
- Link Send Rate: The average send rate of network interface of client.
- Link Recv Rate: The average received rate of network interface of server.
- Reliability: The reliability is uniformly set at 100% due to TCP's inherent reliability mechanisms.

TCP Test Result

Link Loss Rate	Congestion	Throughput	Link Send Rate	Link Recv Rate	Reliability
0%	cubic	94.38 Mbps	96.29 Mbps	96.72 Mbps	100%
0%	reno	94.22 Mbps	96.28 Mbps	96.22 Mbps	100%
0%	bbr	92.48 Mbps	96.19 Mbps	94.42 Mbps	100%
5%	cubic	19.02 Mbps	15.94 Mbps	15.99 Mbps	100%
5%	reno	59.34 Mbps	60.7 Mbps	60.13 Mbps	100%
5%	bbr	80.58 Mbps	85.64 Mbps	81.81 Mbps	100%
10%	cubic	4.62 Mbps	4.74 Mbps	4.72 Mbps	100%
10%	reno	4.26 Mbps	0.87 Mbps	0.78 Mbps	100%
10%	bbr	52.38 Mbps	43.16 Mbps	40.5 Mbps	100%
15%	reno	0.88 Mbps	0.07 Mbps	0.07 Mbps	100%
15%	bbr	30.98 Mbps	31.17 Mbps	29.58 Mbps	100%
20%	cubic	0.92 Mbps	0.85 Mbps	0.85 Mbps	100%
20%	reno	0.25 Mbps	0.27 Mbps	0.26 Mbps	100%

UDP Test Summary

In the UDP section, the report delves into the outcomes of UDP protocol testing. It evaluates the impact of varying link loss rates and Iperf send bandwidths on performance. The UDP summary table presents the following data for each distinct link status:

- Link Loss Rate: The percentage of simulated link loss.
- Iperf Send Bandwidth: The bandwidth used for Iperf send operations.
- Throughput: The average received throughput observed.
- Link Send Rate: The average send rate of network interface of client.
- Link Recv Rate: The average received rate of network interface of server.
- Reliability: The reliability percentage, indicating the proportion of received data to sent data.

UDP Test Result

Link Loss Rate	Iperf Send Bandwidth	Throughput	Link Send Rate	Link Recv Rate	Reliability
0%	97.2m	96.34 Mbps	96.13 Mbps	96.76 Mbps	99.14%
5%	97.2m	91.58 Mbps	91.34 Mbps	89.31 Mbps	94.24%
15%	97.2m	81.96 Mbps	81.6 Mbps	81.92 Mbps	84.34%

Please refer to the appendix for more detailed testing information.

Appendix - BATS Test Statics.

BATS Test Summary

Items	Count
Total BATS Test Num	20
Succeed Test Num	18
Failed Test Num	2

Failed Tests

Failed Test items	Link status and Parameters
# Failed Test5	Link status: link_loss_rate: 20, link_delay: 0ms, link_loss_model: random BATS specific: bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
# Failed Test14	Link status: link_loss_rate: 15, link_delay: 0ms, link_loss_model: random BATS specific: bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False

#BATS Test1

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.008 sec Total send packet number: 2445 Average Latency: 0.002 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 35.3%, User: 0.4%, System: 4.2%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.006 sec Total receive packet number: 2431 Recv Throughput: 79.56 Mbps CPU Utilization: Total: 41.3%, User: 0.4%, System: 6.1%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 2445 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 2445 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8587.4 packet/s Send Throughput: 92.94 Mbps
Server Network Traffic	Recv Packet: 8587.8 packet/s Recv Throughput: 92.94 Mbps

#BATS Test2

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.004 sec Total send packet number: 2443 Average Latency: 0.002 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 35.3%, User: 0.3%, System: 4.1%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.007 sec Total receive packet number: 2286 Loss rate: 6.43% Recv Throughput: 74.80 Mbps CPU Utilization: Total: 41.7%, User: 0.0%, System: 6.0%
Client Task View	TRANSPARENT, task count: 41 CHUNK_IDENTITY, task count: 2443 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 43 CHUNK_IDENTITY, task count: 2443 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8152.4 packet/s Send Throughput: 88.22 Mbps
Server Network Traffic	Recv Packet: 8160.4 packet/s Recv Throughput: 88.31 Mbps

#BATS Test3

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.003 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 35.2%, User: 0.6%, System: 4.3%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.007 sec Total receive packet number: 1789 Recv Throughput: 58.54 Mbps CPU Utilization: Total: 40.2%, User: 0.0%, System: 5.7%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 41 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 7716.77 packet/s Send Throughput: 83.51 Mbps
Server Network Traffic	Recv Packet: 7742.6 packet/s Recv Throughput: 83.79 Mbps

#BATS Test4

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 1.003 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 34.7%, User: 0.8%, System: 3.8%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.009 sec Total receive packet number: 1179 Loss rate: 51.76% Recv Throughput: 38.57 Mbps CPU Utilization: Total: 37.0%, User: 0.0%, System: 4.9%
Client Task View	TRANSPARENT, task count: 39 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 37 CHUNK_IDENTITY, task count: 2443 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 7315.2 packet/s Send Throughput: 79.16 Mbps
Server Network Traffic	Recv Packet: 7299.6 packet/s Recv Throughput: 78.99 Mbps

#BATS Test5

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 1.504 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 35.1%, User: 0.3%, System: 3.8%
Client Task View	TRANSPARENT, task count: 35 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 32 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 6865.8 packet/s Send Throughput: 74.3 Mbps
Server Network Traffic	Recv Packet: 6868.6 packet/s Recv Throughput: 74.33 Mbps

#BATS Test6

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.007 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 38.6%, User: 0.5%, System: 5.2%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.007 sec Total receive packet number: 2376 Recv Throughput: 77.75 Mbps CPU Utilization: Total: 47.6%, User: 0.4%, System: 5.4%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 2384 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8720.0 packet/s Send Throughput: 94.36 Mbps
Server Network Traffic	Recv Packet: 8721.4 packet/s Recv Throughput: 94.38 Mbps

#BATS Test7

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.505 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 38.2%, User: 0.5%, System: 4.9%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.004 sec Total receive packet number: 2439 Recv Throughput: 79.86 Mbps CPU Utilization: Total: 47.7%, User: 0.0%, System: 7.2%
Client Task View	TRANSPARENT, task count: 41 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8806.0 packet/s Send Throughput: 95.3 Mbps
Server Network Traffic	Recv Packet: 8787.0 packet/s Recv Throughput: 95.1 Mbps

#BATS Test8

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.008 sec Total send packet number: 2445 Average Latency: 0.044 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 38.8%, User: 0.9%, System: 5.5%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.007 sec Total receive packet number: 2323 Recv Throughput: 76.02 Mbps CPU Utilization: Total: 50.3%, User: 0.0%, System: 8.8%
Client Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 2445 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 39 CHUNK_IDENTITY, task count: 2344 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8809.4 packet/s Send Throughput: 95.34 Mbps
Server Network Traffic	Recv Packet: 8803.6 packet/s Recv Throughput: 95.28 Mbps

#BATS Test9

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.006 sec Total send packet number: 2444 Average Latency: 0.710 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 44.7%, User: 1.4%, System: 7.0%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.011 sec Total receive packet number: 2396 Recv Throughput: 78.34 Mbps CPU Utilization: Total: 48.9%, User: 0.0%, System: 9.4%
Client Task View	TRANSPARENT, task count: 35 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 36 CHUNK_IDENTITY, task count: 2436 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 9027.8 packet/s Send Throughput: 97.73 Mbps
Server Network Traffic	Recv Packet: 9022.0 packet/s Recv Throughput: 97.67 Mbps

#BATS Test10

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.006 sec Total send packet number: 2444 Average Latency: 0.728 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 40.7%, User: 1.6%, System: 5.5%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.004 sec Total receive packet number: 2189 Recv Throughput: 71.67 Mbps CPU Utilization: Total: 48.9%, User: 0.0%, System: 8.7%
Client Task View	TRANSPARENT, task count: 37 CHUNK_IDENTITY, task count: 2444 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 35 CHUNK_IDENTITY, task count: 2232 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 0 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 8816.6 packet/s Send Throughput: 95.43 Mbps
Server Network Traffic	Recv Packet: 8822.6 packet/s Recv Throughput: 95.49 Mbps

#BATS Test11

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.034 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 43.2%, User: 1.0%, System: 5.2%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.005 sec Total receive packet number: 2398 Recv Throughput: 78.50 Mbps CPU Utilization: Total: 65.7%, User: 0.5%, System: 11.2%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2405 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15056.2 packet/s Send Throughput: 95.6 Mbps
Server Network Traffic	Recv Packet: 15278.0 packet/s Recv Throughput: 97.01 Mbps

#BATS Test12

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.003 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 42.9%, User: 1.0%, System: 7.4%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.007 sec Total receive packet number: 2257 Recv Throughput: 73.85 Mbps CPU Utilization: Total: 57.8%, User: 0.0%, System: 7.5%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 14526.6 packet/s Send Throughput: 92.24 Mbps
Server Network Traffic	Recv Packet: 14506.8 packet/s Recv Throughput: 92.12 Mbps

#BATS Test13

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.005 sec Total send packet number: 2443 Average Latency: 0.003 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 43.4%, User: 1.5%, System: 6.4%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.008 sec Total receive packet number: 1455 Loss rate: 40.44% Recv Throughput: 47.60 Mbps CPU Utilization: Total: 52.2%, User: 0.0%, System: 5.5%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2443 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 43 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2443 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 13742.0 packet/s Send Throughput: 87.26 Mbps
Server Network Traffic	Recv Packet: 13747.4 packet/s Recv Throughput: 87.29 Mbps

#BATS Test14

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.008 sec Total send packet number: 2445 Average Latency: 0.253 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 43.9%, User: 1.8%, System: 6.5%
Client Task View	TRANSPARENT, task count: 39 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2445 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2445 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 13219.4 packet/s Send Throughput: 83.94 Mbps
Server Network Traffic	Recv Packet: 13189.6 packet/s Recv Throughput: 83.75 Mbps

#BATS Test15

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.006 sec Total send packet number: 2444 Average Latency: 2.005 sec Send Throughput: 79.99 Mbps CPU Utilization: Total: 43.4%, User: 1.3%, System: 6.6%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.008 sec Total receive packet number: 236 Loss rate: 90.34% Recv Throughput: 7.72 Mbps CPU Utilization: Total: 43.1%, User: 0.0%, System: 4.7%
Client Task View	TRANSPARENT, task count: 37 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 37 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 12243.0 packet/s Send Throughput: 77.74 Mbps
Server Network Traffic	Recv Packet: 12250.8 packet/s Recv Throughput: 77.78 Mbps

#BATS Test16

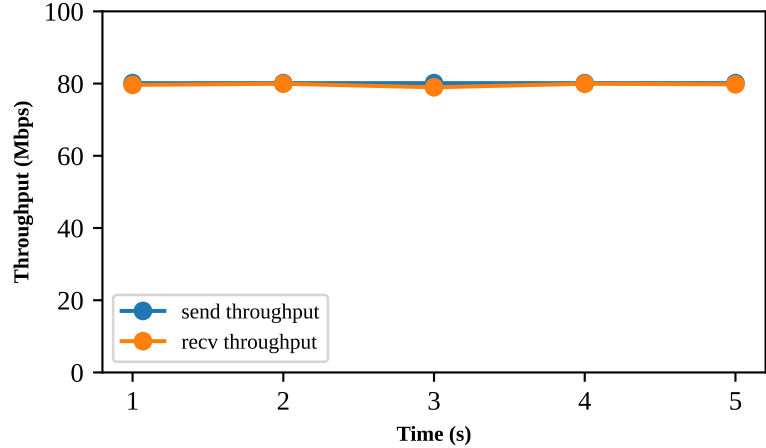| Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.006 sec Total send packet number: 2444 Average Latency: 0.036 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 49.7%, User: 1.5%, System: 7.1%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.006 sec Total receive packet number: 2398 Recv Throughput: 78.49 Mbps CPU Utilization: Total: 70.6%, User: 0.0%, System: 11.8%
Client Task View	TRANSPARENT, task count: 42 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2417 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15033.4 packet/s Send Throughput: 95.45 Mbps
Server Network Traffic	Recv Packet: 15285.8 packet/s Recv Throughput: 97.06 Mbps

#BATS Test17

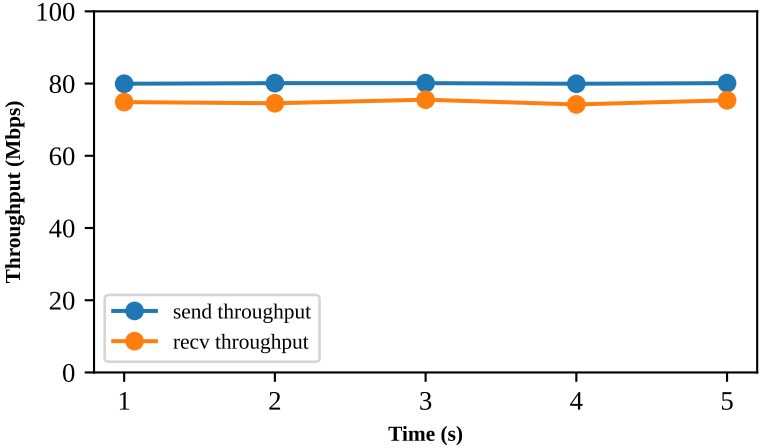| Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.056 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 51.8%, User: 0.9%, System: 9.5%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.003 sec Total receive packet number: 2312 Recv Throughput: 75.72 Mbps CPU Utilization: Total: 70.8%, User: 0.0%, System: 10.9%
Client Task View	TRANSPARENT, task count: 41 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 39 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2387 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15064.8 packet/s Send Throughput: 95.65 Mbps
Server Network Traffic	Recv Packet: 15023.4 packet/s Recv Throughput: 95.38 Mbps

#BATS Test18

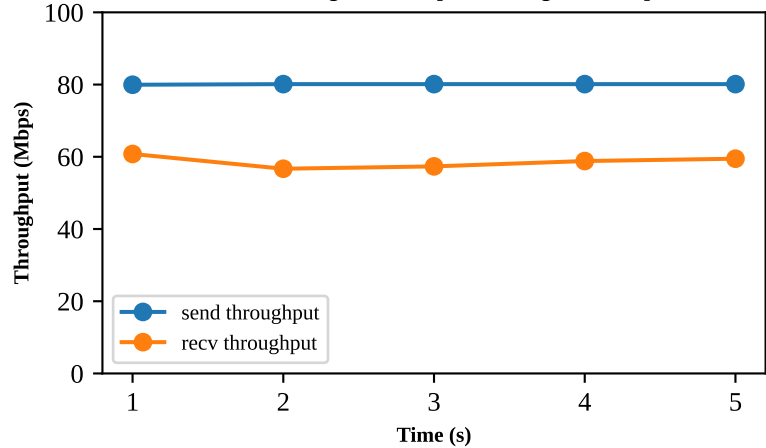| Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 0.048 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 49.4%, User: 0.9%, System: 8.8%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.009 sec Total receive packet number: 2239 Recv Throughput: 73.24 Mbps CPU Utilization: Total: 67.2%, User: 0.0%, System: 12.6%
Client Task View	TRANSPARENT, task count: 41 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 35 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2372 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15042.0 packet/s Send Throughput: 95.51 Mbps
Server Network Traffic	Recv Packet: 15031.0 packet/s Recv Throughput: 95.44 Mbps

#BATS Test19

Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.005 sec Total send packet number: 2443 Average Latency: 0.061 sec Send Throughput: 79.97 Mbps CPU Utilization: Total: 54.4%, User: 0.7%, System: 9.0%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.011 sec Total receive packet number: 2126 Recv Throughput: 69.51 Mbps CPU Utilization: Total: 66.2%, User: 0.0%, System: 11.5%
Client Task View	TRANSPARENT, task count: 40 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2443 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 34 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2352 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15043.2 packet/s Send Throughput: 95.52 Mbps
Server Network Traffic	Recv Packet: 15040.2 packet/s Recv Throughput: 95.51 Mbps

#BATS Test20

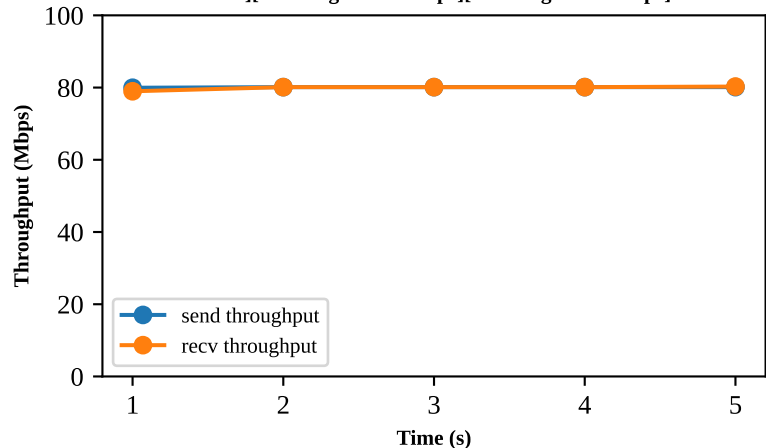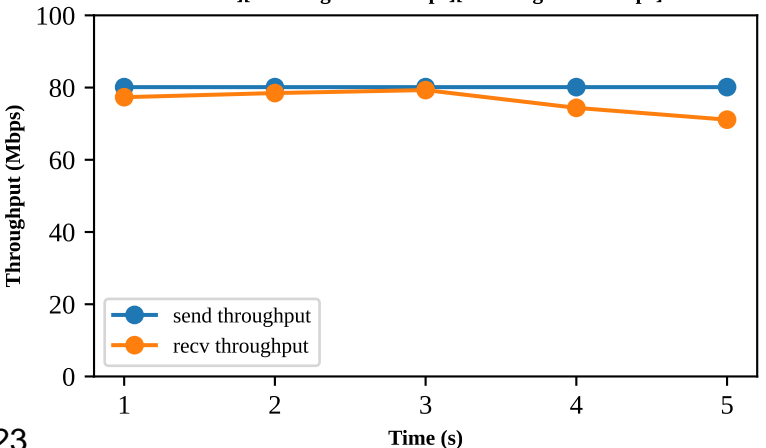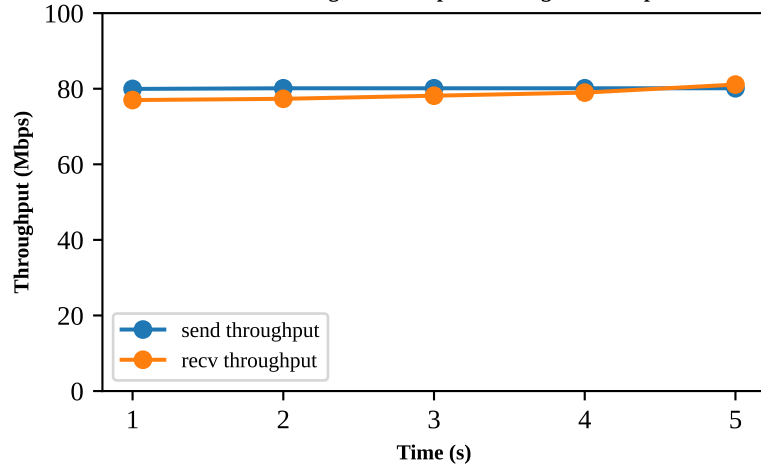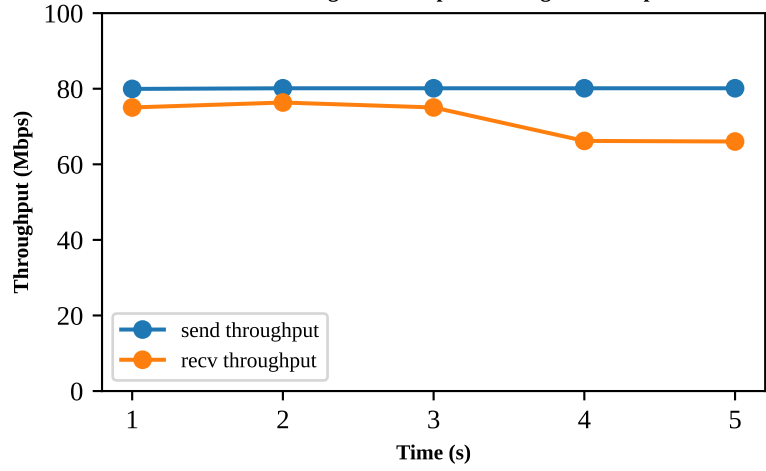| Items	Result
BATS Specific Parameters	bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Summary	server ip: 10.0.0.12, server port: 12345 Total send time span: 5.007 sec Total send packet number: 2444 Average Latency: 1.080 sec Send Throughput: 79.98 Mbps CPU Utilization: Total: 53.5%, User: 0.6%, System: 10.1%
Server Summary	server ip: 10.0.0.12, server port: 12345 Total receive time span: 5.009 sec Total receive packet number: 2060 Recv Throughput: 67.38 Mbps CPU Utilization: Total: 66.7%, User: 0.0%, System: 11.3%
Client Task View	TRANSPARENT, task count: 38 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2444 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Server Task View	TRANSPARENT, task count: 34 CHUNK_IDENTITY, task count: 0 CHUNK_RANDOM_BINARY, task count: 0 CHUNK_RANDOM, task count: 2351 CHUNK_SYSTEMATIC, task count: 0 SYSTEMATIC_AGGREGATION_IDENTITY, task count: 0
Client Network Traffic	Send Packet: 15078.0 packet/s Send Throughput: 95.74 Mbps
Server Network Traffic	Recv Packet: 15068.4 packet/s Recv Throughput: 95.68 Mbps

Appendix - BATS Test Figures.

#BATS Test1, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.002][RecvAvg: 79.66 Mbps][SendAvg: 80.12Mbps]

#BATS Test2, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.002][RecvAvg: 74.91 Mbps][SendAvg: 80.05Mbps]

#BATS Test3, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.003][RecvAvg: 58.62 Mbps][SendAvg: 80.09Mbps]

#BATS Test4, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][LatencyAvg: 1.003][RecvAvg: 38.63 Mbps][SendAvg: 80.09Mbps]
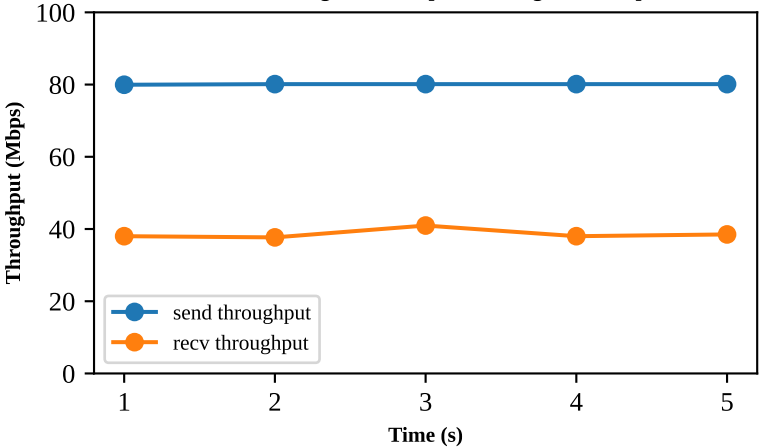
#BATS Test5, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][LatencyAvg: 1.504][RecvAvg: 22.53 Mbps][SendAvg: 80.09Mbps]
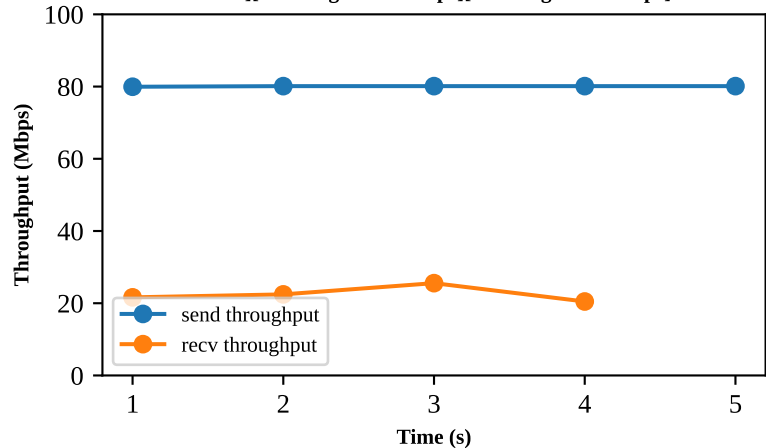
#BATS Test6, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.007][RecvAvg: 77.86 Mbps][SendAvg: 80.09Mbps]
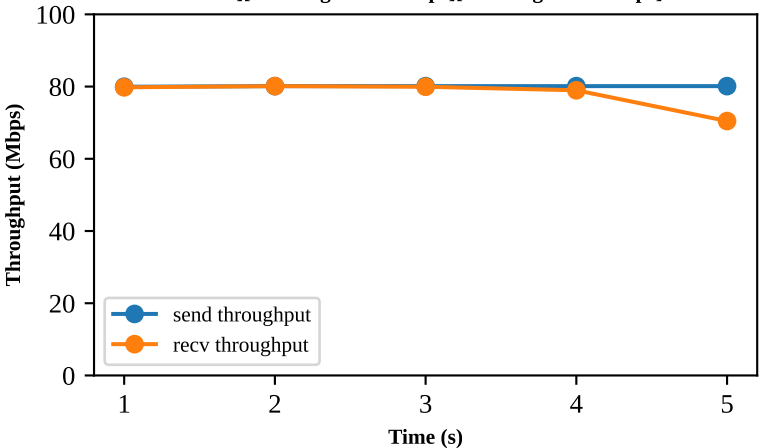
#BATS Test7, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.505][RecvAvg: 79.92 Mbps][SendAvg: 80.09Mbps]

#BATS Test8, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.044][RecvAvg: 76.12 Mbps][SendAvg: 80.12Mbps]
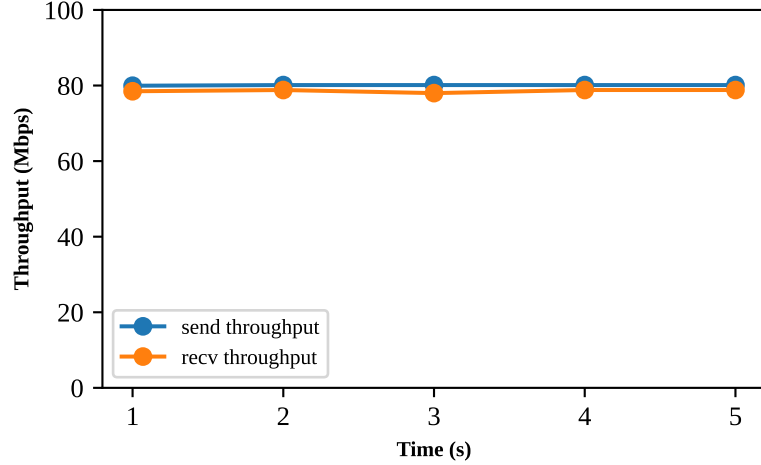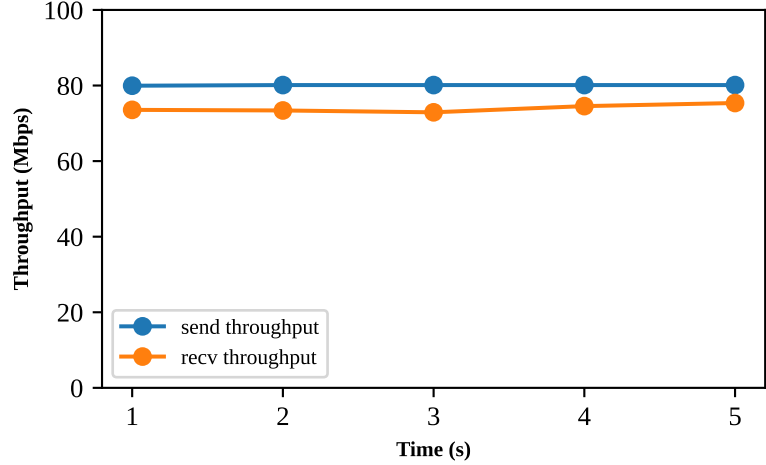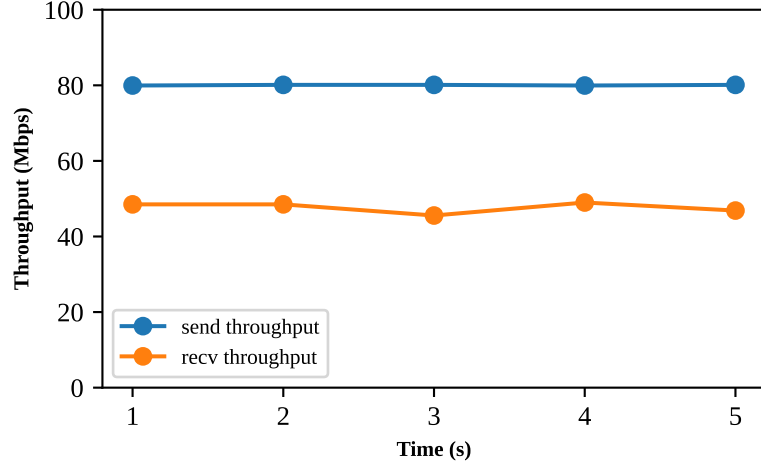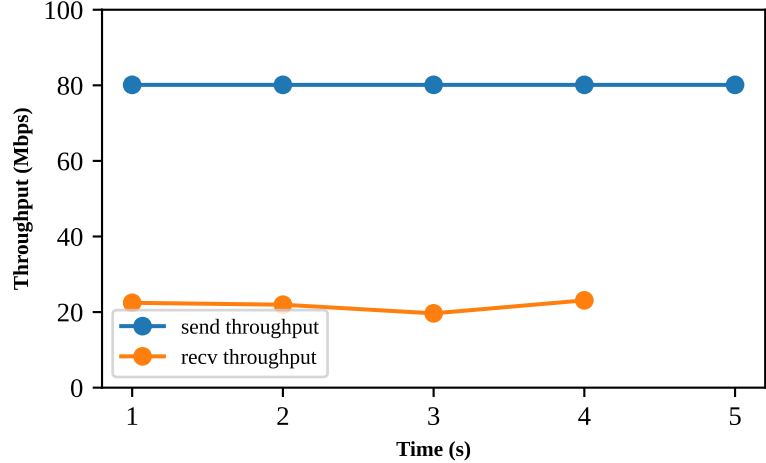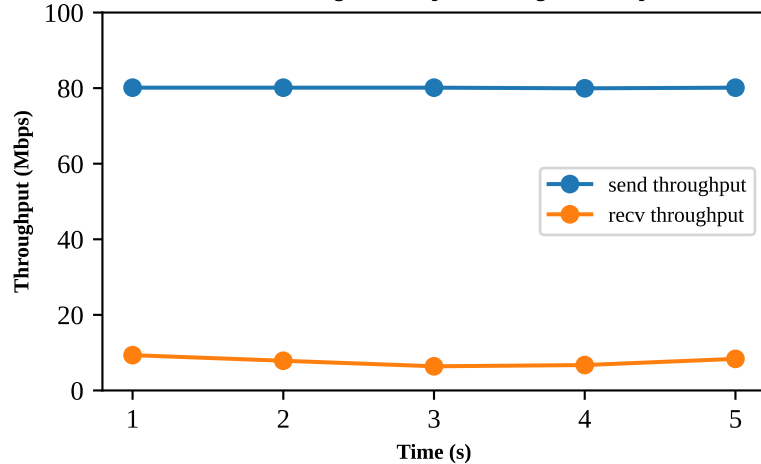
#BATS Test9, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.710][RecvAvg: 78.51 Mbps][SendAvg: 80.09Mbps]

#BATS Test10, bats_bandwidth: 80Mbps, coding_method: 1, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.728][RecvAvg: 71.73 Mbps][SendAvg: 80.09Mbps]
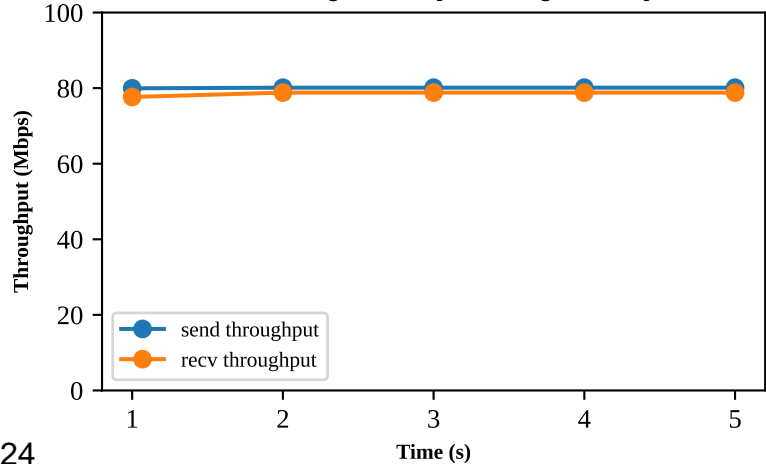
#BATS Test11, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.034][RecvAvg: 78.58 Mbps][SendAvg: 80.09Mbps]

#BATS Test12, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.003][RecvAvg: 73.96 Mbps][SendAvg: 80.09Mbps]

#BATS Test13, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.003][RecvAvg: 47.68 Mbps][SendAvg: 80.05Mbps]

#BATS Test14, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.253][RecvAvg: 21.79 Mbps][SendAvg: 80.12Mbps]
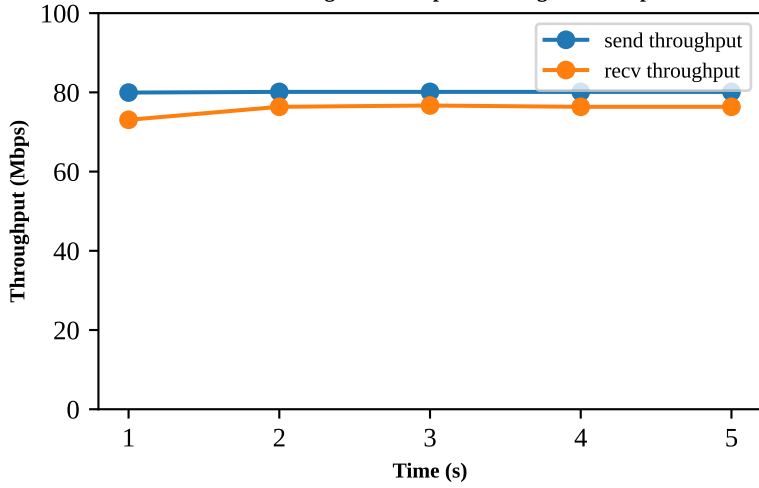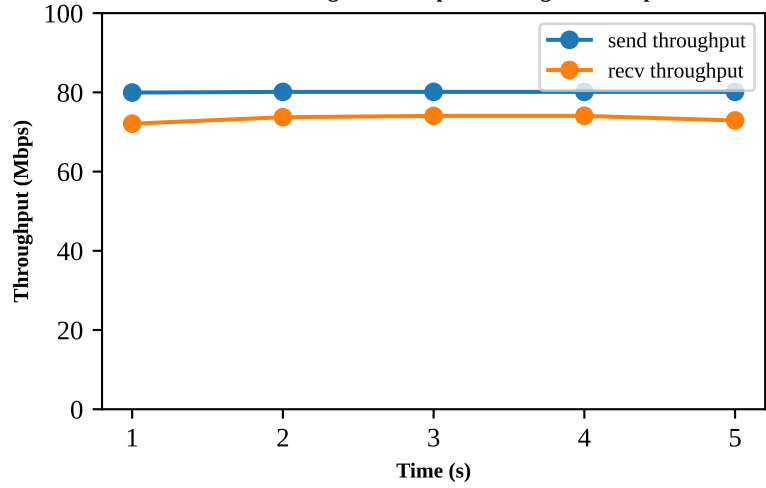
#BATS Test15, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: False[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][LatencyAvg: 2.005][RecvAvg: 7.73 Mbps][SendAvg: 80.09Mbps]

#BATS Test16, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.036][RecvAvg: 78.58 Mbps][SendAvg: 80.09Mbps]
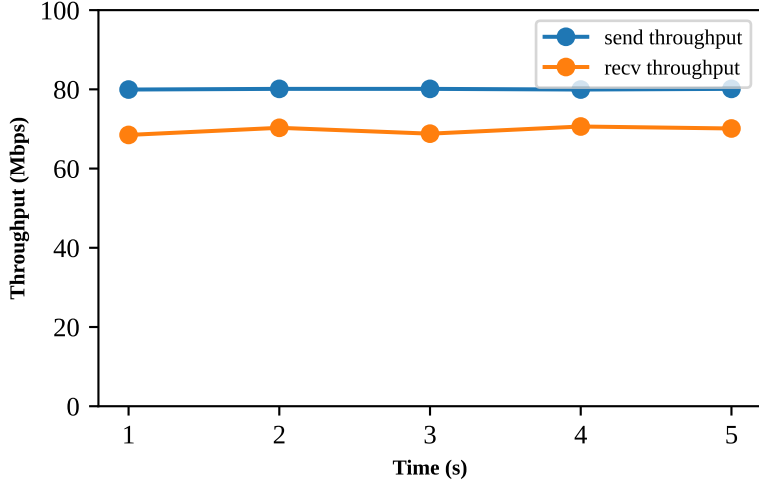
24

#BATS Test17, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.056][RecvAvg: 75.76 Mbps][SendAvg: 80.09Mbps]

#BATS Test18, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.048][RecvAvg: 73.37 Mbps][SendAvg: 80.09Mbps]

#BATS Test19, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][LatencyAvg: 0.061][RecvAvg: 69.67 Mbps][SendAvg: 80.05Mbps]

#BATS Test20, bats_bandwidth: 80Mbps, coding_method: 3, chunk_data_size: 22000, bcmp_enable: True[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][LatencyAvg: 1.080][RecvAvg: 67.5 Mbps][SendAvg: 80.09Mbps]

25
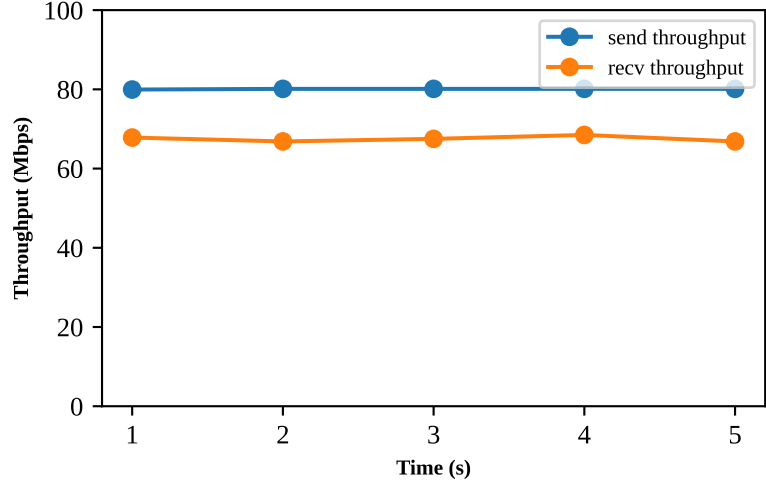
Appendix - TCP Test Statics.

TCP Test Summary

Items	Count
Total TCP Test Num	15
Succeed Test Num	13
Failed Test Num	2

Failed Tests

Failed Test items	Link status and Parameters
# Failed Test4	Link status: link_loss_rate: 15, link_delay: 0ms, link_loss_model: random TCP specific: tcp_congestion_type: cubic
# Failed Test15	Link status: link_loss_rate: 20, link_delay: 0ms, link_loss_model: random TCP specific: tcp_congestion_type: bbr

#TCP Test1

Items	Result
TCP Specific Parameters	tcp_congestion_type: cubic
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:33:50 GMT Connecting to host 10.0.0.12, port 12345 Cookie: c65bgi23hljtgg2z67tfh6petkipedashwxt TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 57.1 MBytes 95.8 Mbits/sec 256 sender [5] 0.00-5.04 sec 56.8 MBytes 94.4 Mbits/sec receiver CPU Utilization: local/sender 2.2% (0.3%u/1.8%s), remote/receiver 22.2% (1.5%u/20.7%s) snd_tcp_congestion cubic rcv_tcp_congestion cubic
Client Network Traffic	Send Packet: 8142.0 packet/s Send Throughput: 96.29 Mbps
Server Network Traffic	Recv Packet: 8177.6 packet/s Recv Throughput: 96.72 Mbps

#TCP Test2

Items	Result
TCP Specific Parameters	tcp_congestion_type: cubic
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:34:00 GMT Connecting to host 10.0.0.12, port 12345 Cookie: ebjclcah6742uczfdxng5wrruahwq4tgmkq4 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 12.0 MBytes 20.1 Mbits/sec 488 sender [5] 0.00-5.04 sec 11.8 MBytes 19.7 Mbits/sec receiver CPU Utilization: local/sender 1.3% (0.1%u/1.2%s), remote/receiver 4.6% (0.3%u/4.3%s) snd_tcp_congestion cubic rcv_tcp_congestion cubic
Client Network Traffic	Send Packet: 1349.0 packet/s Send Throughput: 15.94 Mbps
Server Network Traffic	Recv Packet: 1353.0 packet/s Recv Throughput: 15.99 Mbps

#TCP Test3

Items	Result
TCP Specific Parameters	tcp_congestion_type: cubic
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:34:10 GMT Connecting to host 10.0.0.12, port 12345 Cookie: 53wuxg2zar6yd6rv6me266miyc5ujpo5epbg TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.01 sec 2.87 MBytes 4.81 Mbits/sec 223 sender [5] 0.00-5.05 sec 2.74 MBytes 4.56 Mbits/sec receiver CPU Utilization: local/sender 0.9% (0.1%u/0.8%s), remote/receiver 1.0% (0.2%u/0.7%s) snd_tcp_congestion cubic rcv_tcp_congestion cubic
Client Network Traffic	Send Packet: 401.8 packet/s Send Throughput: 4.74 Mbps
Server Network Traffic	Recv Packet: 399.8 packet/s Recv Throughput: 4.72 Mbps

#TCP Test4

Items	Result
TCP Specific Parameters	tcp_congestion_type: cubic
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Client Network Traffic	Send Packet: 0.4 packet/s Send Throughput: 0.0 Mbps
Server Network Traffic	Recv Packet: 0.4 packet/s Recv Throughput: 0.0 Mbps

#TCP Test5

Items	Result
TCP Specific Parameters	tcp_congestion_type: cubic
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:34:36 GMT Connecting to host 10.0.0.12, port 12345 Cookie: fydi5jexe6ptw2jh2izis6jioohxx7f7bqdn TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 683 KBytes 1.12 Mbits/sec 98 sender [5] 0.00-5.00 sec 564 KBytes 924 Kbits/sec receiver CPU Utilization: local/sender 0.1% (0.1%u/0.0%s), remote/receiver 0.2% (0.0%u/0.2%s) snd_tcp_congestion cubic rcv_tcp_congestion cubic
Client Network Traffic	Send Packet: 74.0 packet/s Send Throughput: 0.85 Mbps
Server Network Traffic	Recv Packet: 74.0 packet/s Recv Throughput: 0.85 Mbps

#TCP Test6

Items	Result
TCP Specific Parameters	tcp_congestion_type: reno
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:34:46 GMT Connecting to host 10.0.0.12, port 12345 Cookie: sq5fmftblakze4dh2sa4lqrrt5j4h7pb3rsr TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 56.9 MBytes 95.5 Mbits/sec 353 sender [5] 0.00-5.04 sec 56.6 MBytes 94.2 Mbits/sec receiver CPU Utilization: local/sender 2.4% (0.2%u/2.1%s), remote/receiver 20.3% (1.6%u/18.8%s) snd_tcp_congestion reno rcv_tcp_congestion reno
Client Network Traffic	Send Packet: 8140.8 packet/s Send Throughput: 96.28 Mbps
Server Network Traffic	Recv Packet: 8135.0 packet/s Recv Throughput: 96.22 Mbps

#TCP Test7

Items	Result
TCP Specific Parameters	tcp_congestion_type: reno
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:34:57 GMT Connecting to host 10.0.0.12, port 12345 Cookie: kee3lfoz3o2nmqi63qntgdqrimyn7vxn2y4v TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 36.1 MBytes 60.5 Mbits/sec 1697 sender [5] 0.00-5.04 sec 35.8 MBytes 59.6 Mbits/sec receiver CPU Utilization: local/sender 2.6% (0.1%u/2.6%s), remote/receiver 12.5% (1.3%u/11.2%s) snd_tcp_congestion reno rcv_tcp_congestion reno
Client Network Traffic	Send Packet: 5132.8 packet/s Send Throughput: 60.7 Mbps
Server Network Traffic	Recv Packet: 5085.0 packet/s Recv Throughput: 60.13 Mbps

#TCP Test8

Items	Result
TCP Specific Parameters	tcp_congestion_type: reno
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:35:10 GMT Connecting to host 10.0.0.12, port 12345 Cookie: pxcouwbcp4lbs2bofm3kkdtkpl63ax4e5ur5 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 2.83 MBytes 4.75 Mbits/sec 235 sender [5] 0.00-5.04 sec 2.54 MBytes 4.22 Mbits/sec receiver CPU Utilization: local/sender 0.6% (0.1%u/0.5%s), remote/receiver 0.9% (0.1%u/0.8%s) snd_tcp_congestion reno rcv_tcp_congestion reno
Client Network Traffic	Send Packet: 75.4 packet/s Send Throughput: 0.87 Mbps
Server Network Traffic	Recv Packet: 68.0 packet/s Recv Throughput: 0.78 Mbps

#TCP Test9

Items	Result
TCP Specific Parameters	tcp_congestion_type: reno
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:35:19 GMT Connecting to host 10.0.0.12, port 12345 Cookie: 7s33656fqicm44z5455dliqrxu4zzp4y6e6u TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 645 KBytes 1.06 Mbits/sec 72 sender [5] 0.00-5.21 sec 535 KBytes 840 Kbits/sec receiver CPU Utilization: local/sender 2.8% (0.4%u/2.5%s), remote/receiver 0.3% (0.0%u/0.3%s) snd_tcp_congestion reno rcv_tcp_congestion reno
Client Network Traffic	Send Packet: 7.4 packet/s Send Throughput: 0.07 Mbps
Server Network Traffic	Recv Packet: 7.4 packet/s Recv Throughput: 0.07 Mbps

#TCP Test10

Items	Result
TCP Specific Parameters	tcp_congestion_type: reno
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:35:33 GMT Connecting to host 10.0.0.12, port 12345 Cookie: maqlrz7fblb2l5zhtihuajaii7mimc55sep4 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 441 KBytes 723 Kbits/sec 37 sender [5] 0.00-5.04 sec 156 KBytes 253 Kbits/sec receiver CPU Utilization: local/sender 0.8% (0.3%u/0.5%s), remote/receiver 0.1% (0.0%u/0.1%s) snd_tcp_congestion reno rcv_tcp_congestion reno
Client Network Traffic	Send Packet: 24.6 packet/s Send Throughput: 0.27 Mbps
Server Network Traffic	Recv Packet: 23.8 packet/s Recv Throughput: 0.26 Mbps

#TCP Test11

Items	Result
TCP Specific Parameters	tcp_congestion_type: bbr
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:35:44 GMT Connecting to host 10.0.0.12, port 12345 Cookie: xmol67ptnuts6b2kes5pyl3x4yipzut3mnxi TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 56.6 MBytes 95.0 Mbits/sec 1033 sender [5] 0.00-5.05 sec 55.6 MBytes 92.5 Mbits/sec receiver CPU Utilization: local/sender 2.0% (0.0%u/2.0%s), remote/receiver 20.4% (2.2%u/18.2%s) snd_tcp_congestion bbr rcv_tcp_congestion bbr
Client Network Traffic	Send Packet: 8133.6 packet/s Send Throughput: 96.19 Mbps
Server Network Traffic	Recv Packet: 7983.0 packet/s Recv Throughput: 94.42 Mbps

#TCP Test12

| Items	Result
TCP Specific Parameters	tcp_congestion_type: bbr
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:35:54 GMT Connecting to host 10.0.0.12, port 12345 Cookie: 6gxseraan5nml2vxk4vk4dg3rp622q56df35 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 49.5 MBytes 83.0 Mbits/sec 4026 sender [5] 0.00-5.04 sec 48.5 MBytes 80.7 Mbits/sec receiver CPU Utilization: local/sender 1.9% (0.2%u/1.7%s), remote/receiver 13.7% (2.0%u/11.7%s) snd_tcp_congestion bbr rcv_tcp_congestion bbr
Client Network Traffic	Send Packet: 7242.0 packet/s Send Throughput: 85.64 Mbps
Server Network Traffic	Recv Packet: 6918.2 packet/s Recv Throughput: 81.81 Mbps

#TCP Test13

| Items	Result
TCP Specific Parameters	tcp_congestion_type: bbr
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:36:04 GMT Connecting to host 10.0.0.12, port 12345 Cookie: mte2yie5lxt3lupbbeo5hoky7v5rd6benvo4 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 32.3 MBytes 54.1 Mbits/sec 4328 sender [5] 0.00-5.00 sec 31.2 MBytes 52.4 Mbits/sec receiver CPU Utilization: local/sender 0.6% (0.0%u/0.6%s), remote/receiver 8.5% (0.8%u/7.6%s) snd_tcp_congestion bbr rcv_tcp_congestion bbr
Client Network Traffic	Send Packet: 3650.8 packet/s Send Throughput: 43.16 Mbps
Server Network Traffic	Recv Packet: 3427.2 packet/s Recv Throughput: 40.5 Mbps

#TCP Test14

Items	Result
TCP Specific Parameters	tcp_congestion_type: bbr
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Time: Wed, 09 Aug 2023 08:36:14 GMT Connecting to host 10.0.0.12, port 12345 Cookie: dpj6rosprrqge26iis4b6r7rlc3cvrqwr7l4 TCP MSS: 1448 (default)
Summary	[ID] Interval Transfer Bitrate Retr [5] 0.00-5.00 sec 19.5 MBytes 32.7 Mbits/sec 3490 sender [5] 0.00-5.04 sec 18.5 MBytes 30.7 Mbits/sec receiver CPU Utilization: local/sender 1.2% (0.2%u/0.9%s), remote/receiver 4.4% (0.7%u/3.7%s) snd_tcp_congestion bbr rcv_tcp_congestion bbr
Client Network Traffic	Send Packet: 2637.2 packet/s Send Throughput: 31.17 Mbps
Server Network Traffic	Recv Packet: 2504.8 packet/s Recv Throughput: 29.58 Mbps

#TCP Test15

| Items	Result
TCP Specific Parameters	tcp_congestion_type: bbr
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Network Traffic	Send Packet: 1.8 packet/s Send Throughput: 0.0 Mbps
Server Network Traffic	Recv Packet: 1.8 packet/s Recv Throughput: 0.0 Mbps

Appendix - TCP Test Figures.

#TCP Test1, tcp_congestion_type: cubic[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][Retr: 256][RecvAvg: 94.38 Mbps][SendAvg: 95.82Mbps]
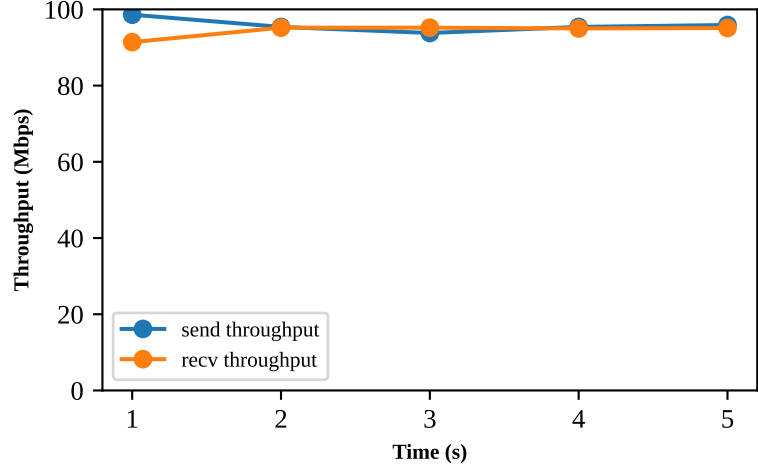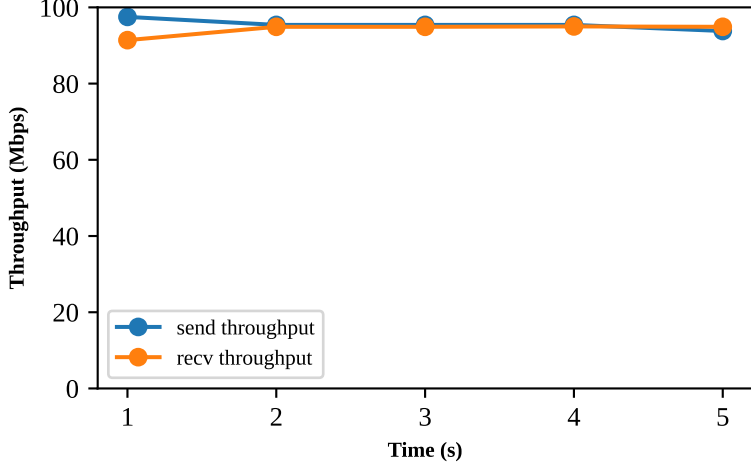
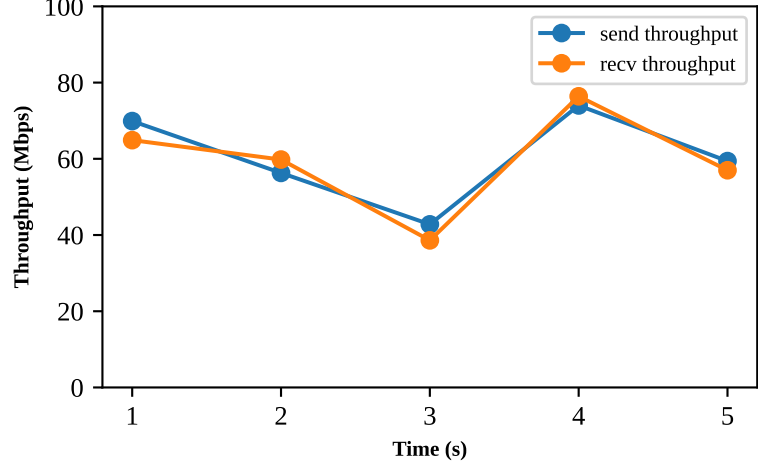#TCP Test2, tcp_congestion_type: cubic[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][Retr: 488][RecvAvg: 19.02 Mbps][SendAvg: 20.15Mbps]
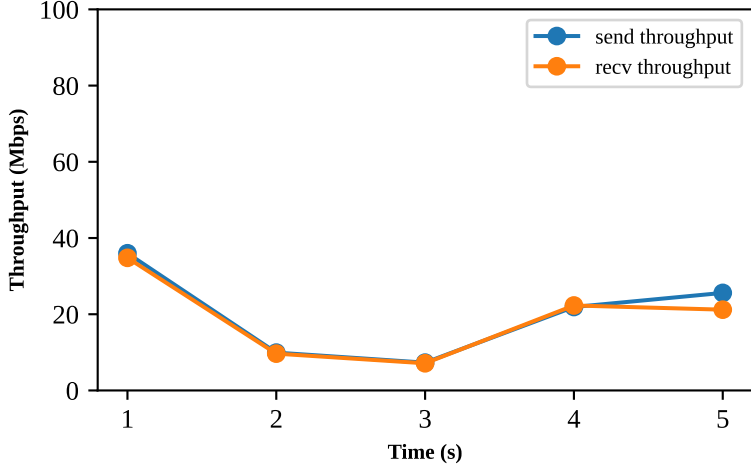
#TCP Test3, tcp_congestion_type: cubic[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][Retr: 223][RecvAvg: 4.62 Mbps][SendAvg: 4.83Mbps]
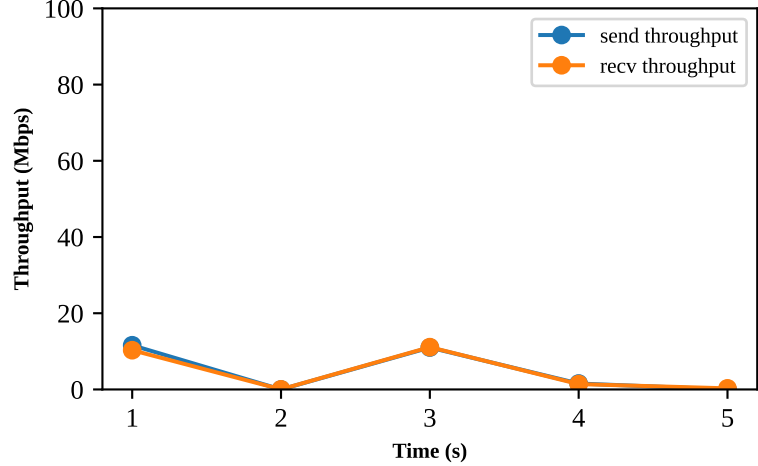
#TCP Test4, tcp_congestion_type: cubic[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][Retr: 0]
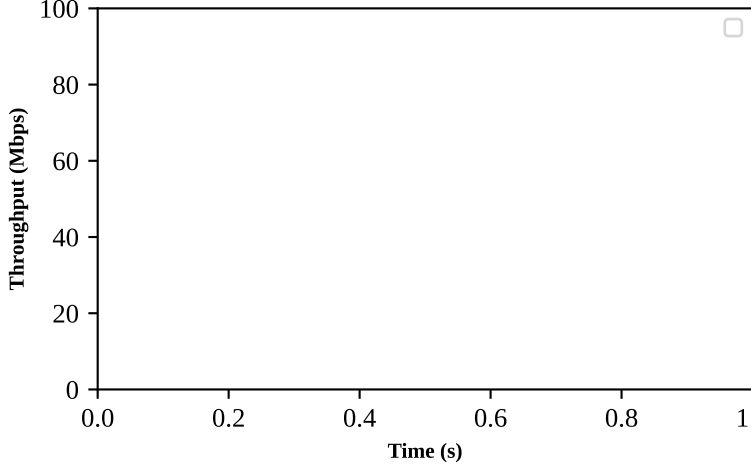
#TCP Test5, tcp_congestion_type: cubic[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][Retr: 98][RecvAvg: 0.92 Mbps][SendAvg: 1.12Mbps]
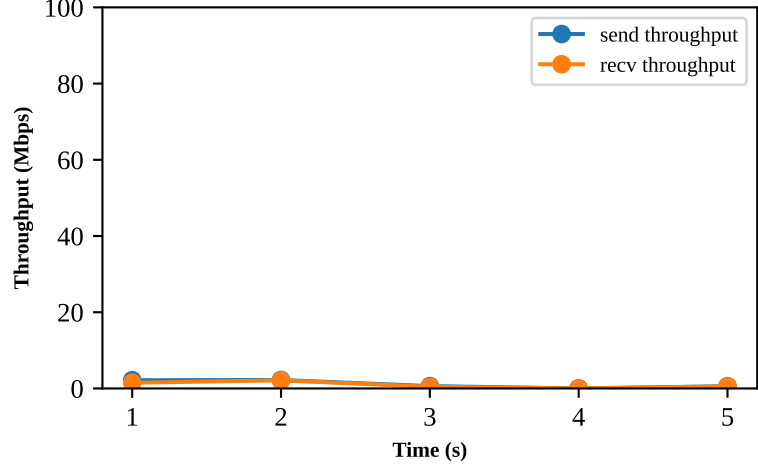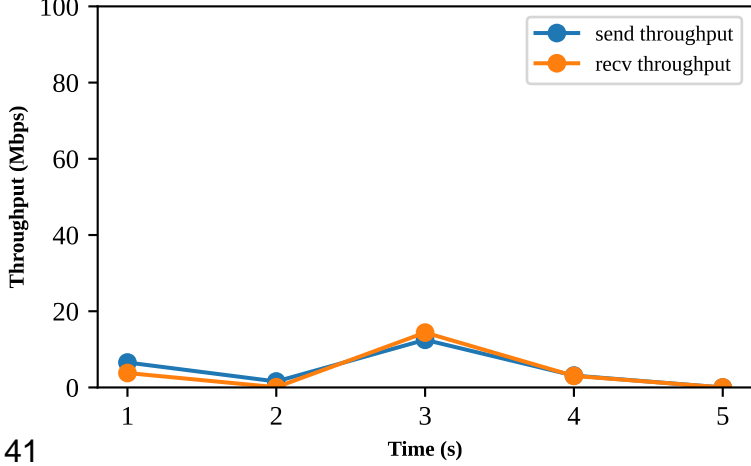
#TCP Test6, tcp_congestion_type: reno[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][Retr: 353][RecvAvg: 94.22 Mbps][SendAvg: 95.5Mbps]
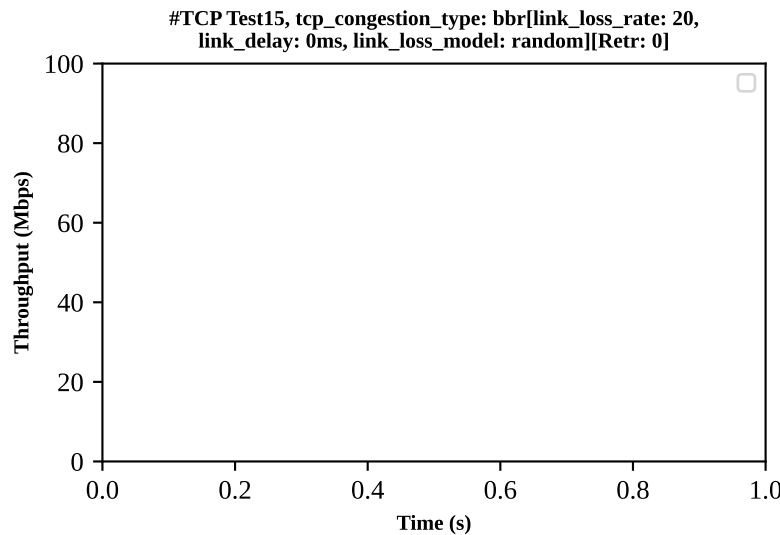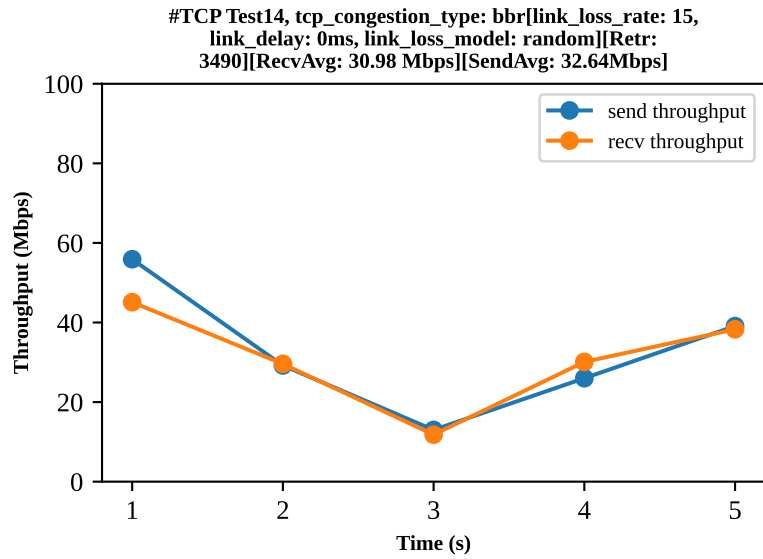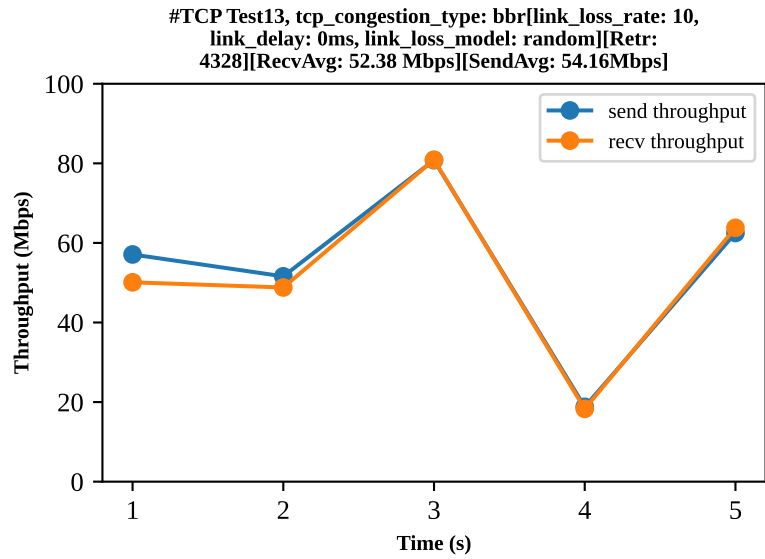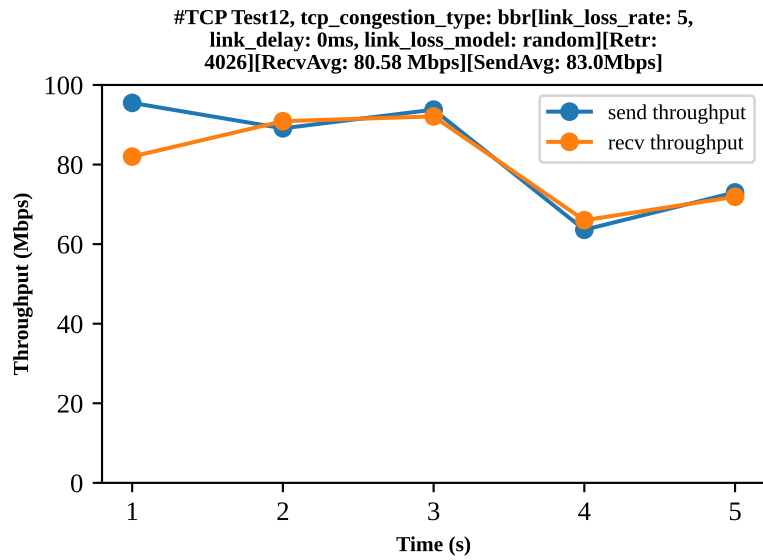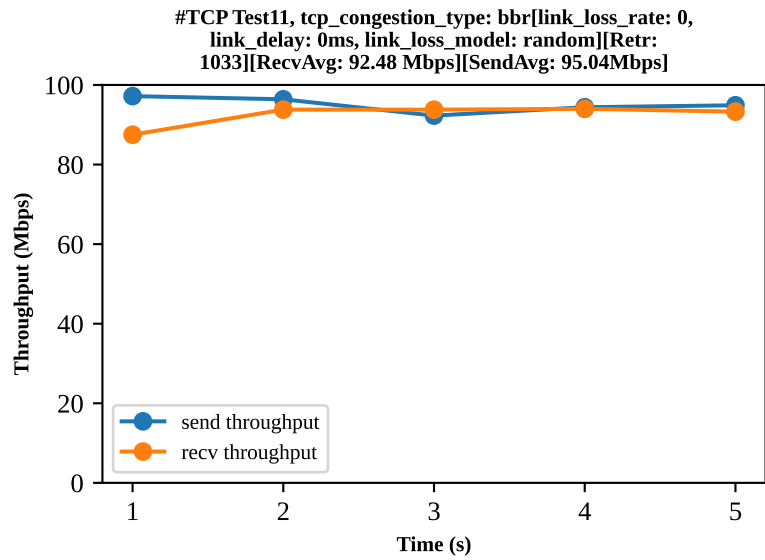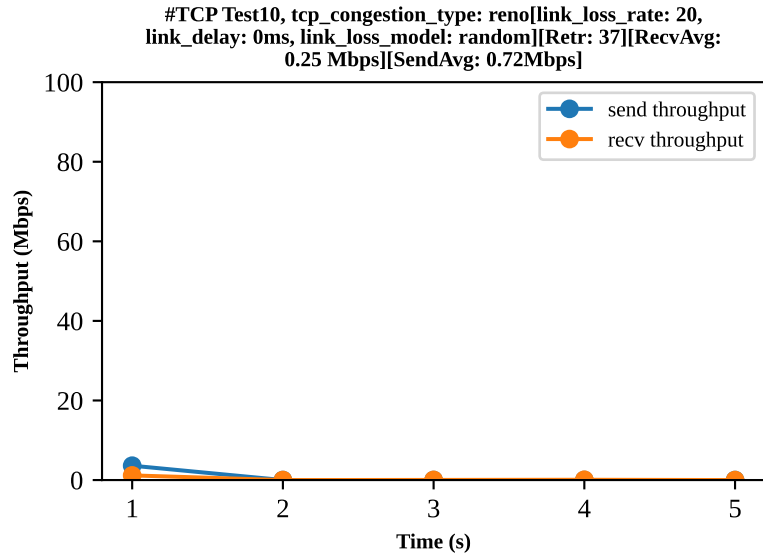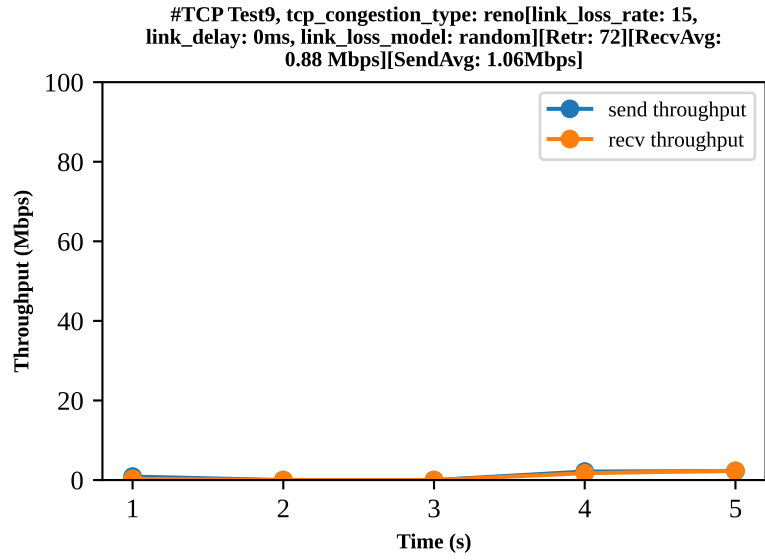
#TCP Test7, tcp_congestion_type: reno[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][Retr: 1697][RecvAvg: 59.34 Mbps][SendAvg: 60.48Mbps]

#TCP Test8, tcp_congestion_type: reno[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][Retr: 235][RecvAvg: 4.26 Mbps][SendAvg: 4.75Mbps]

#TCP Test9, tcp_congestion_type: reno[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][Retr: 72][RecvAvg: 0.88 Mbps][SendAvg: 1.06Mbps]

#TCP Test10, tcp_congestion_type: reno[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][Retr: 37][RecvAvg: 0.25 Mbps][SendAvg: 0.72Mbps]

#TCP Test11, tcp_congestion_type: bbr[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][Retr: 1033][RecvAvg: 92.48 Mbps][SendAvg: 95.04Mbps]

#TCP Test12, tcp_congestion_type: bbr[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][Retr: 4026][RecvAvg: 80.58 Mbps][SendAvg: 83.0Mbps]

#TCP Test13, tcp_congestion_type: bbr[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random][Retr: 4328][RecvAvg: 52.38 Mbps][SendAvg: 54.16Mbps]

#TCP Test14, tcp_congestion_type: bbr[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][Retr: 3490][RecvAvg: 30.98 Mbps][SendAvg: 32.64Mbps]

#TCP Test15, tcp_congestion_type: bbr[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random][Retr: 0]

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Appendix - UDP Test Statics.

UDP Test Summary

Items	Count
Total UDP Test Num	5
Succeed Test Num	3
Failed Test Num	2

Failed Tests

Failed Test items	Link status and Parameters
# Failed Test3	Link status: link_loss_rate: 10, link_delay: 0ms, link_loss_model: random UDP specific: udp_bandwidth: 97.2m
# Failed Test5	Link status: link_loss_rate: 20, link_delay: 0ms, link_loss_model: random UDP specific: udp_bandwidth: 97.2m

#UDP Test1

Items	Result
UDP Specific Parameters	udp_bandwidth: 97.2m
Link Status	link_loss_rate: 0, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Setting UDP block size to 1448 Time: Wed, 09 Aug 2023 08:36:43 GMT Connecting to host 10.0.0.12, port 12345 Cookie: l73o5lki5ehzun6dmsucednpnmuylr57zzuf Target Bitrate: 97200000
Summary	[ID] Interval Transfer Bitrate Jitter Lost/Total Datagrams [5] 0.00-5.00 sec 57.9 MBytes 97.2 Mbits/sec 0.000 ms 0/41949 (0%) sender [5] 0.00-5.04 sec 57.9 MBytes 96.3 Mbits/sec 0.148 ms 10/41949 (0.024%) receiver CPU Utilization: local/sender 17.1% (5.9%u/11.2%s), remote/receiver 19.1% (2.6%u/16.4%s)
Client Network Traffic	Send Packet: 8259.8 packet/s Send Throughput: 96.13 Mbps
Server Network Traffic	Recv Packet: 8313.6 packet/s Recv Throughput: 96.76 Mbps

#UDP Test2

Items	Result
UDP Specific Parameters	udp_bandwidth: 97.2m
Link Status	link_loss_rate: 5, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Setting UDP block size to 1448 Time: Wed, 09 Aug 2023 08:36:53 GMT Connecting to host 10.0.0.12, port 12345 Cookie: g5smjooksgdzr3owow6ogzqxzhpkj6aknesg Target Bitrate: 97200000
Summary	[ID] Interval Transfer Bitrate Jitter Lost/Total Datagrams [5] 0.00-5.00 sec 57.9 MBytes 97.2 Mbits/sec 0.000 ms 0/41950 (0%) sender [5] 0.00-5.04 sec 55.0 MBytes 91.6 Mbits/sec 0.072 ms 2090/41950 (5%) receiver CPU Utilization: local/sender 22.2% (2.9%u/19.3%s), remote/receiver 17.9% (2.1%u/15.8%s)
Client Network Traffic	Send Packet: 7848.0 packet/s Send Throughput: 91.34 Mbps
Server Network Traffic	Recv Packet: 7673.8 packet/s Recv Throughput: 89.31 Mbps

#UDP Test3

| Items	Result
UDP Specific Parameters	udp_bandwidth: 97.2m
Link Status	link_loss_rate: 10, link_delay: 0ms, link_loss_model: random
Client Network Traffic	Send Packet: 1.6 packet/s Send Throughput: 0.0 Mbps
Server Network Traffic	Recv Packet: 1.6 packet/s Recv Throughput: 0.0 Mbps

#UDP Test4

| Items	Result
UDP Specific Parameters	udp_bandwidth: 97.2m
Link Status	link_loss_rate: 15, link_delay: 0ms, link_loss_model: random
Information	Linux raspberrypi 6.1.21-v8+ #1642 SMP PREEMPT Mon Apr 3 17:24:16 BST 2023 aarch64 Control connection MSS 1448 Setting UDP block size to 1448 Time: Wed, 09 Aug 2023 08:37:19 GMT Connecting to host 10.0.0.12, port 12345 Cookie: geecr2uurbhc7j54hkwczzqagj5icp7m7r7y Target Bitrate: 97200000
Summary	[ID] Interval Transfer Bitrate Jitter Lost/Total Datagrams [5] 0.00-5.00 sec 57.9 MBytes 97.2 Mbits/sec 0.000 ms 0/41950 (0%) sender [5] 0.00-5.04 sec 49.3 MBytes 81.9 Mbits/sec 0.068 ms 6279/41950 (15%) receiver CPU Utilization: local/sender 22.9% (3.6%u/19.4%s), remote/receiver 15.8% (5.2%u/10.6%s)
Client Network Traffic	Send Packet: 7010.58 packet/s Send Throughput: 81.6 Mbps
Server Network Traffic	Recv Packet: 7038.4 packet/s Recv Throughput: 81.92 Mbps

#UDP Test5

| Items	Result
UDP Specific Parameters	udp_bandwidth: 97.2m
Link Status	link_loss_rate: 20, link_delay: 0ms, link_loss_model: random
Client Network Traffic	Send Packet: 1.0 packet/s Send Throughput: 0.0 Mbps
Server Network Traffic	Recv Packet: 1.0 packet/s Recv Throughput: 0.0 Mbps

Appendix - UDP Test Figures.

#UDP Test1, udp_bandwidth: 97.2m[link_loss_rate: 0, link_delay: 0ms, link_loss_model: random][RecvAvg: 96.34 Mbps][SendAvg: 97.18Mbps]
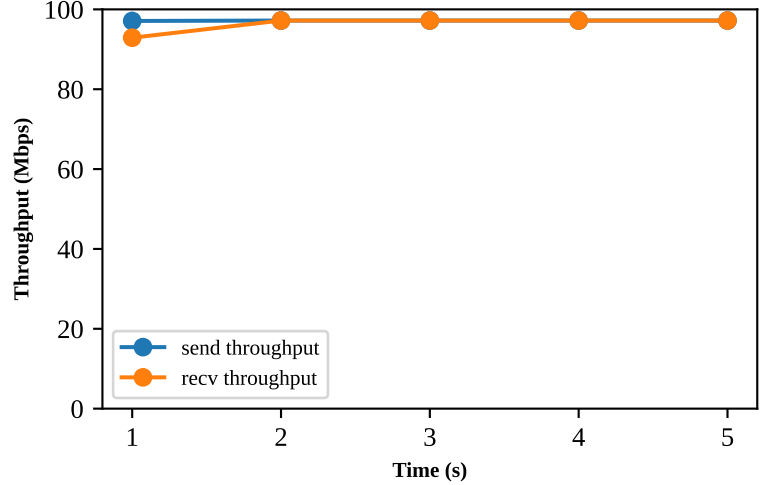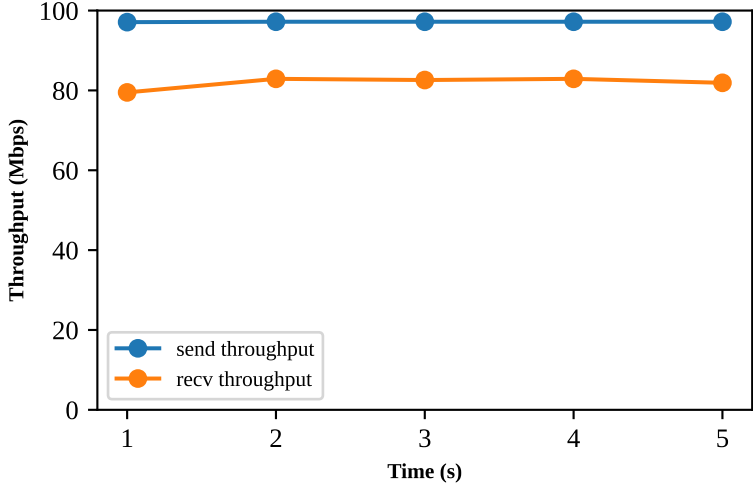

#UDP Test2, udp_bandwidth: 97.2m[link_loss_rate: 5, link_delay: 0ms, link_loss_model: random][RecvAvg: 91.58 Mbps][SendAvg: 97.18Mbps]
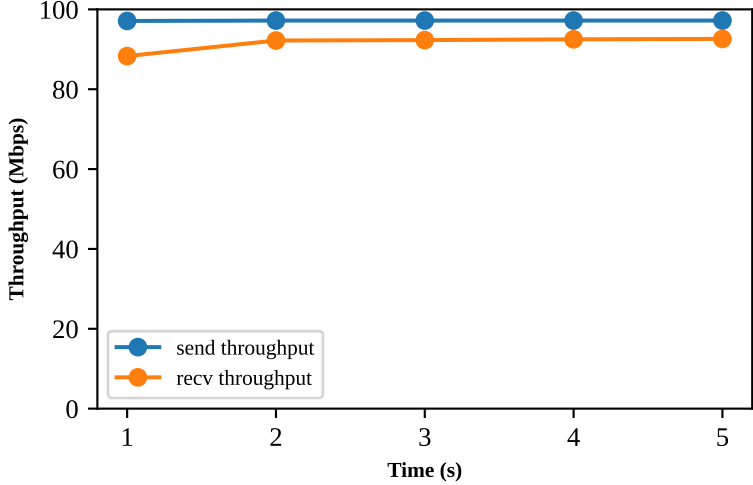
#UDP Test3, udp_bandwidth: 97.2m[link_loss_rate: 10, link_delay: 0ms, link_loss_model: random]
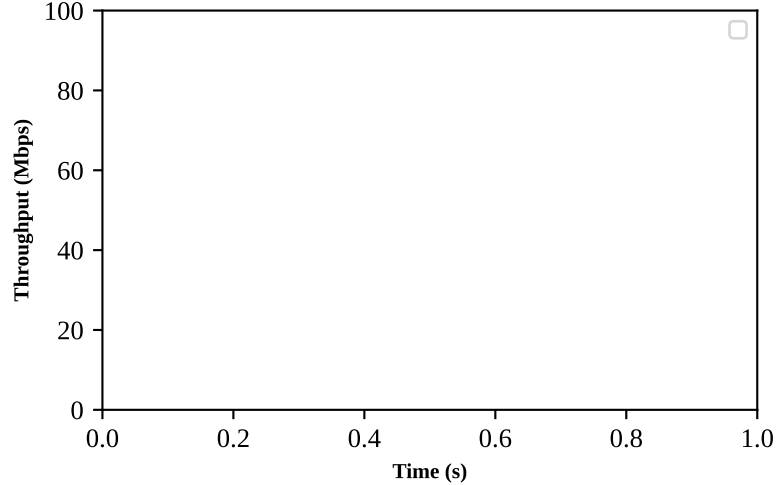
#UDP Test4, udp_bandwidth: 97.2m[link_loss_rate: 15, link_delay: 0ms, link_loss_model: random][RecvAvg: 81.96 Mbps][SendAvg: 97.18Mbps]

#UDP Test5, udp_bandwidth: 97.2m[link_loss_rate: 20, link_delay: 0ms, link_loss_model: random]