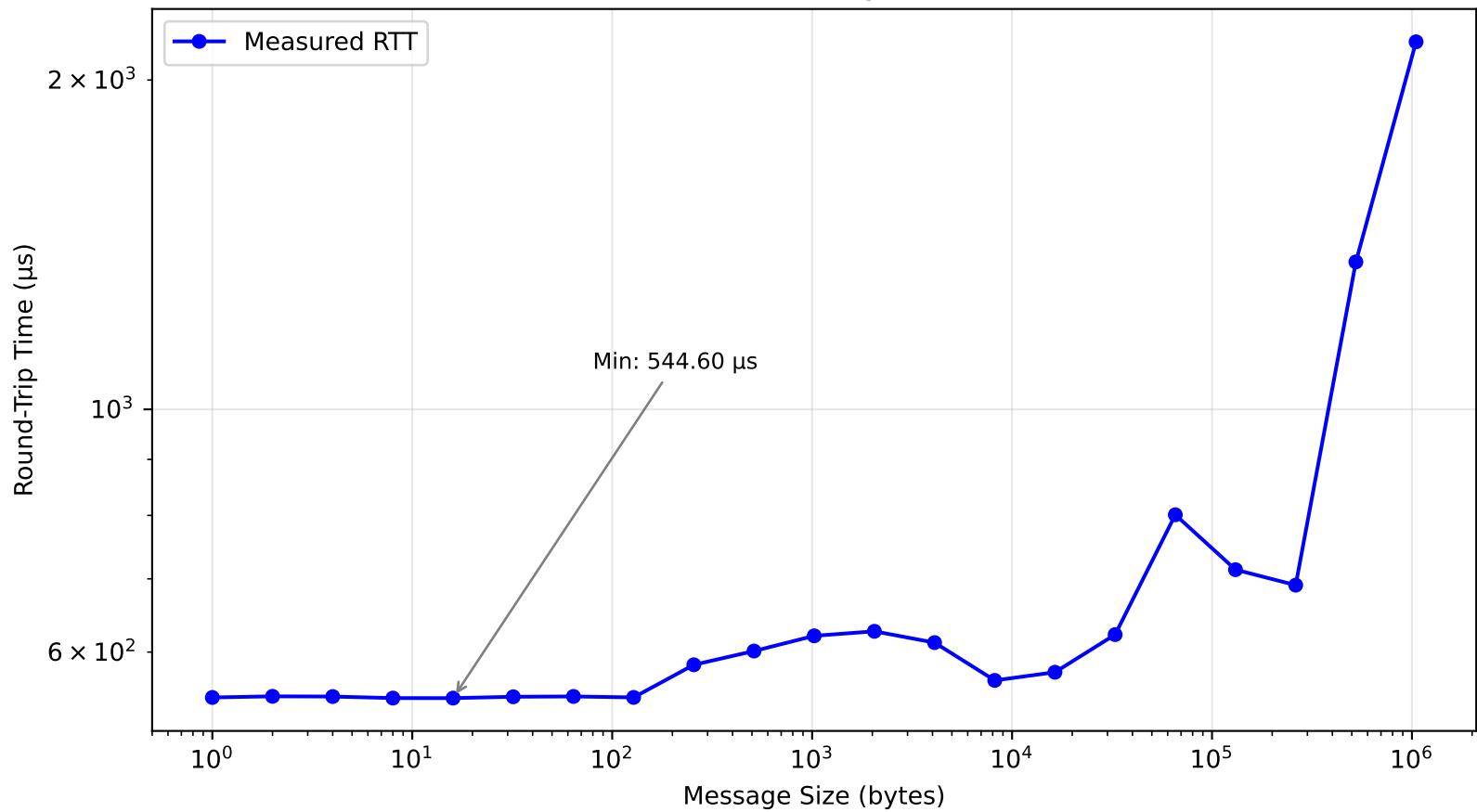
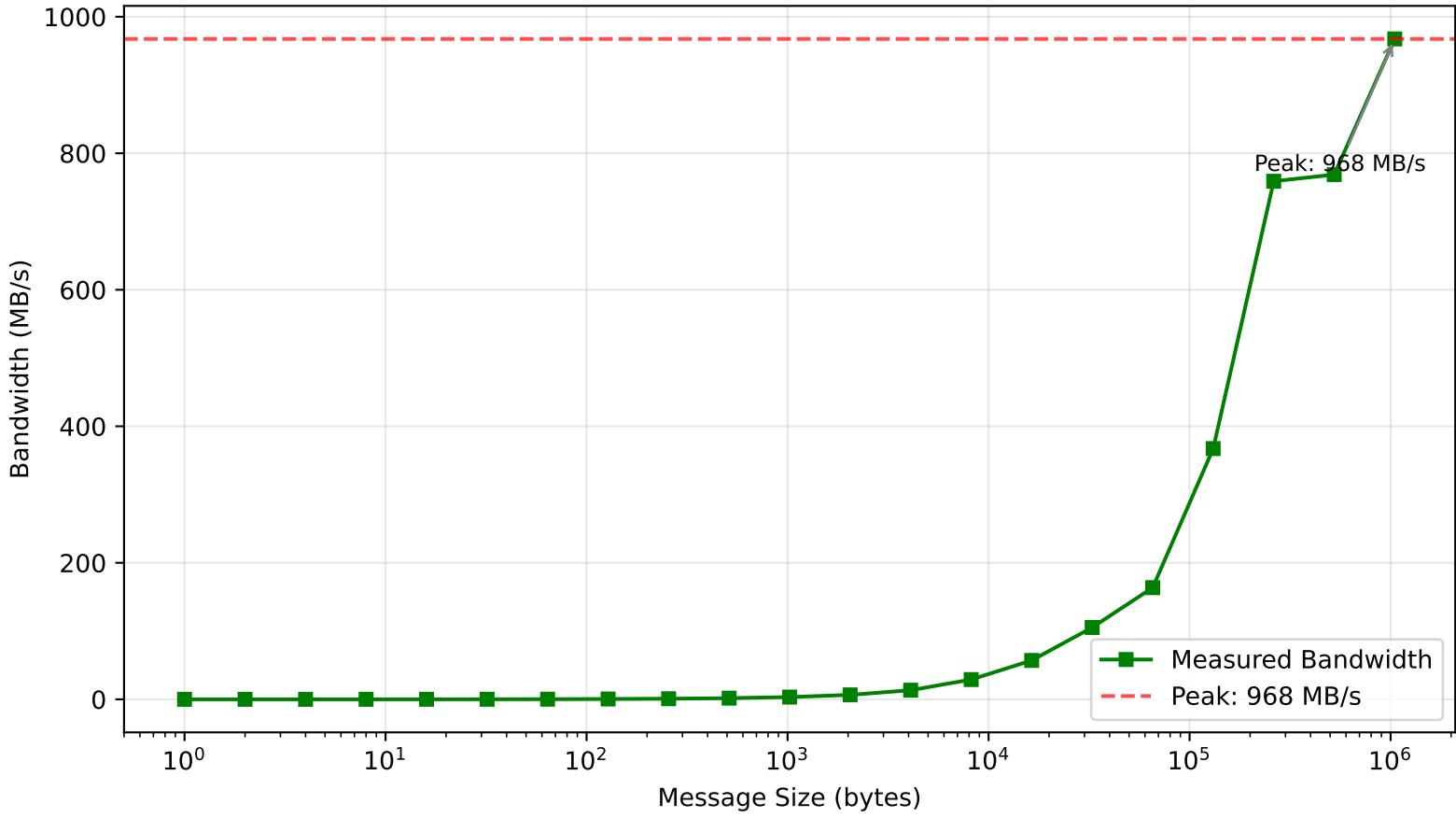


MPI Ping-Pong Results

RTT vs Message Size



Bandwidth vs Message Size



Results Summary

Parameter	Value	Method
Latency (α)	272.30 μs	RTT/2 for small messages
Bandwidth (β)	968 MB/s	Peak observed throughput
Buffer Size	~128 B	Send time increase threshold

How These Parameters Were Derived:

LATENCY ($\alpha = 272.30 \mu\text{s}$)

The latency represents the fixed overhead for sending any message, regardless of size. To measure this, I used the RTT for small messages (1-64 bytes) where the actual data transfer time is negligible compared to overhead.

Minimum RTT observed: 544.60 μs

One-way latency = RTT / 2 = 272.30 μs

This overhead includes: initiating the send operation, network protocol processing, and receiver-side handling before data is available.

BANDWIDTH ($\beta = 968 \text{ MB/s}$)

Bandwidth measures the data transfer rate once the fixed overhead is excluded. It is calculated as: Bandwidth = (2 \times message_size) / RTT

The factor of 2 accounts for round-trip (data sent both directions). Peak bandwidth occurs at larger message sizes where transfer time dominates.

Peak observed: 968 MB/s = 7.7 Gbps

BUFFER SIZE (~128 B)

MPI uses an internal buffer for small messages, allowing MPI_Send to return before the receiver calls MPI_Recv (eager protocol). For messages exceeding this buffer, MPI_Send must wait for the receiver (rendezvous protocol).

The buffer threshold was identified by finding where send times increase sharply between consecutive message sizes.

COMMUNICATION MODEL

$$T(n) = \alpha + n/\beta = 272.30 + n/968 \quad (\mu\text{s})$$

This linear model predicts the time T to send n bytes as the sum of fixed latency α plus the transfer time n/β .