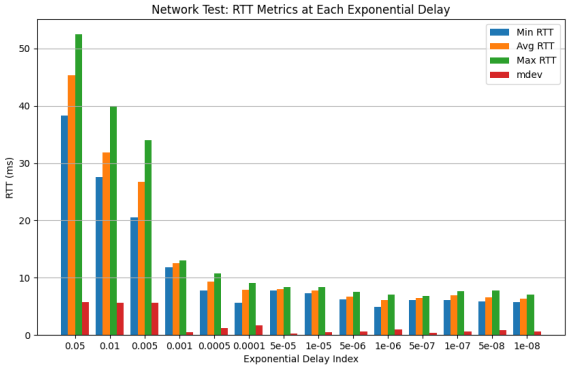
1 Report on RTT

Random delays can arise in real-world networks due to congestion, scheduling, or adversarial actions. Exponential distributions, in particular, are often used to model interarrival or service times in queueing theory due to their memoryless property. In this work, we deliberately introduce an exponential delay in a network path managed by a Man-in-the-Middle (MITM) setup and observe the resulting changes in RTT metrics.



2 Report

Our focus is on four RTT measurements:

- **Minimum RTT** (`rtt_min`)
- **Average RTT** (`rtt_avg`)
- **Maximum RTT** (`rtt_max`)
- **mdev** (mean deviation of the RTT)

2.1 Delay Parameters

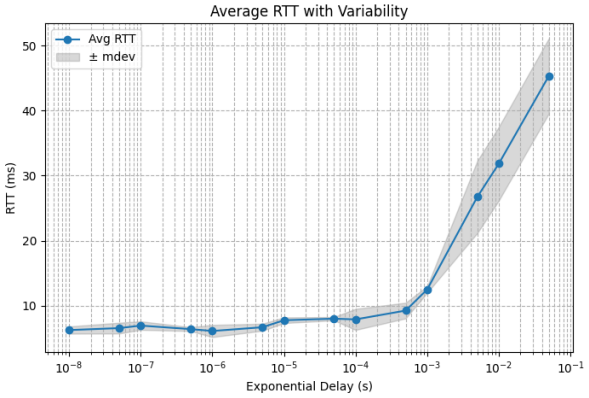
We tested a range of exponential delay parameters, from $5e-2$ seconds down to $1e-8$ seconds. The set of delay values is:

$$\Big\{5\times10^{-2},\ 1\times10^{-2},\ 5\times10^{-3},\ 1\times10^{-3},\ 5\times10^{-4},\ 1\times10^{-4},\ 5\times10^{-5},\ 1\times10^{-5},\ \ldots 5\times10^{-8},\ 1\times10^{-8}\Big\}.$$

In the Python code, these delays were generated via:

$$\text{delay} = \text{random.expovariate}\Big(\frac{1}{\lambda}\Big),$$

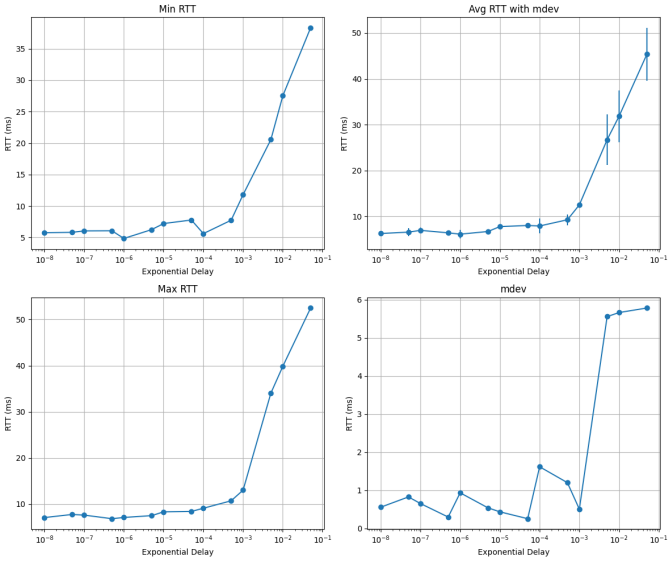
where λ is each of the values listed above.



3 Results

Table 1: Measured RTT Metrics for Each Exponential Delay Value

Delay (s)	rtt_min (ms)	rtt_avg (ms)	rtt_max (ms)
5e-2	38.318	45.346	52.486
1e-2	27.528	31.857	39.860
5e-3	20.562	26.728	34.034
1e-3	11.817	12.519	13.005
5e-4	7.750	9.269	10.692
1e-4	5.622	7.914	9.074
5e-5	7.785	8.024	8.384
1e-5	7.223	7.782	8.295
5e-6	6.261	6.708	7.473
1e-6	4.854	6.132	7.075
5e-7	6.074	6.419	6.809
1e-7	6.053	6.962	7.582
5e-8	5.827	6.573	7.730
1e-8	5.760	6.275	7.050



[1]

[1] https://github.com/tanrikuluatahan/middlebox