







# An Implementation of Bandwidth Emulation of DEMU

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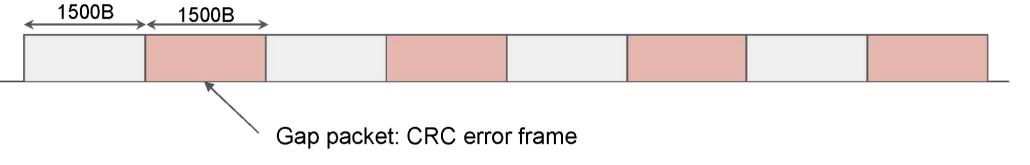
#### **Abstract**

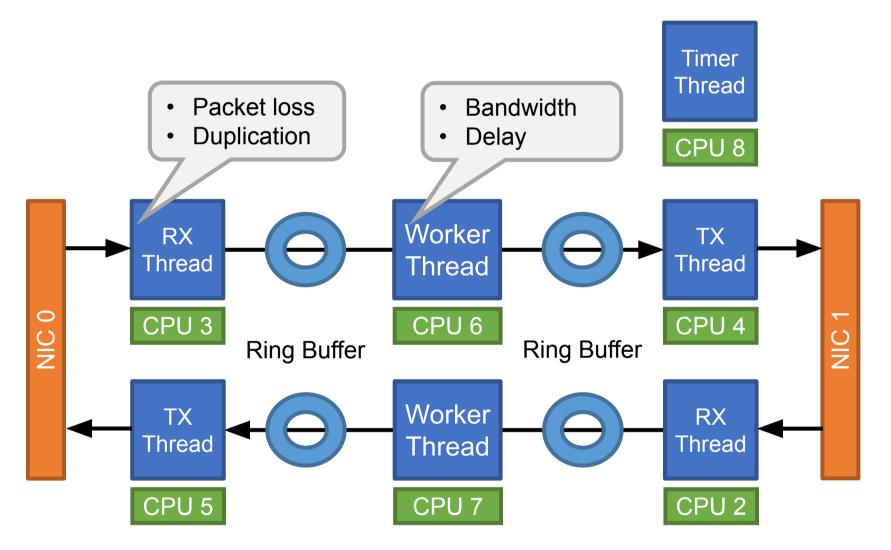
A network emulator is essential for testing the performance of the network especially in a place that requires very high performance such as data centers. It should have features that emulate the important characteristics of the network such as delay, packet loss, bandwidth. A DPDK-based network emulator (DEMU) is one of software-based network emulators [1]. DEMU has primitive features to emulate a network, including delay, packet duplication, and packet loss. This poster presents a bandwidth emulation feature of DEMU. We propose two methods to do bandwidth limitation on DEMU, token bucket-based conventional mechanism and a gap packet-based packet pacing mechanism. We have demonstrated the accurate bandwidth limitation on a 10GbE network environment.

### **DEMU: DPDK-based Network Emulator**

- **DEMU** is a software-based network emulator implemented as a DPDK application. It contains three threads and two ring buffers for each direction.
- We have implemented two methods for bandwidth emulation in the worker thread: (1) token bucket and (2) gap packet-based packet pacing.
- **Token bucket method**: the timer thread adds tokens to a bucket every 1 microsecond as follows: tokens per  $\mu s$  = bandwidth (bps) /  $10^6$  The worker thread keeps packets in a ring buffer until sufficient tokens are accumulated in the bucket.
- **Gap packet method**: the worker thread inserts gap packets between the target flow' packets, where the total length of gap packets depends on the target rate. We use a CRC error packet as a gap packet like MoonGen [2].

When the target rate is half of the physical rate, the sender inserts gap packets between the target flow's packets. Note: Gap packets are discarded at the intermediate switch or the receiver.

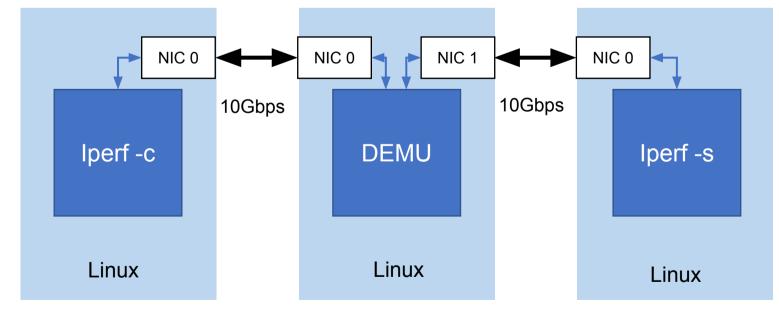




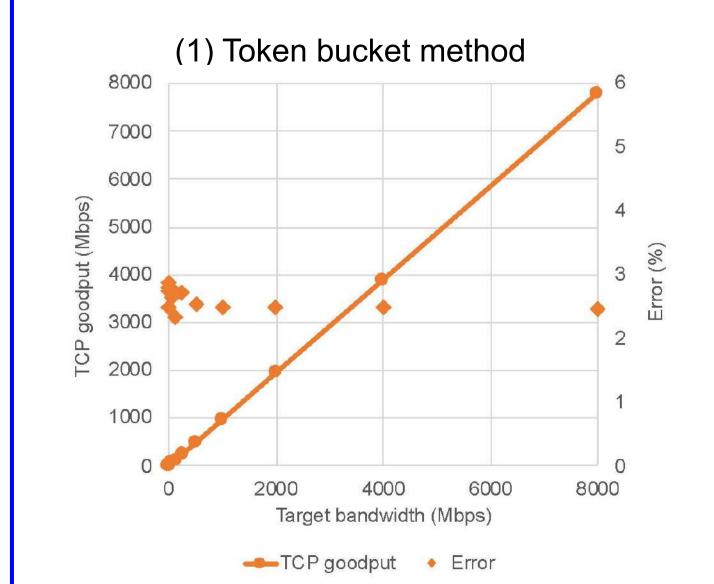
The overview of DEMU

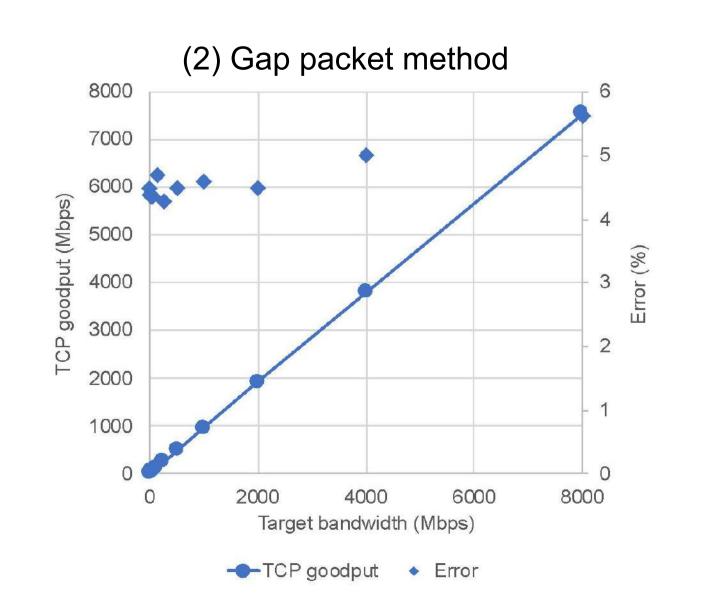
## **Experimental Setting and Results**

We set up three Linux machines that were connected through 10GbE. Iperf was running for 60 seconds under several bandwidth limitation conditions with both token bucket-based and gap packet-based methods. The average TCP goodput was calculated from three trials for each condition.



**Experimental Setting** 





## Conclusion

Through experiments of TCP/IP performance on our emulated network environment, we have confirmed the error rate comparing to the target bandwidth is small enough, i.e., 3% with token bucket method and 5% with gap packet method.

We continue to develop DEMU toward a production-level tool.

The source code is available from https://github.com/ryousei/demu/.

#### Reference

- 1] S. Aketa, T. Hirofuchi and R. Takano, "DEMU: A DPDK-based network latency emulator," IEEE International Symposium on Local and Metropolitan Area Networks (LANMAN), 2017.
- P. Emmerich, S. Gallenmüller, D. Raumer, F. Wohlfart, and G. Carle, "MoonGen: A Scriptable High-Speed Packet Generator," ACM Internet Measurement Conference (IMC), 2015.

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