APPENDIX

A Reactive protocols may waste bandwidth

HPCC uses accurate in-network information, *i.e.*, queue length and link bandwidth capacity to adjust sending window. Because queue length is transient, adjustment of sending window may mismatch the current network state. We demonstrate how accurate information may lead to inaccurate bandwidth allocation by conducting simulations where small flows arrive periodically. There are two Hosts A and B transmitting messages to one Host C. Host A generates small flows whose size are one BDP (*i.e.*, 7 MTU) periodically, while Host B transmits a large flow. Bandwidth utilization on Host C is shown in Figure 15. Two lines correspond to different flow's arriving interval on Host A. When one small flow and one long flow compete in network bottleneck, the queue builds up. INT carries back network state to Host A and Host B, and the sending window of the long flow decreases. Unfortunately, the small flow on Host A has already finished and does not use bandwidth anymore. Therefore, the bandwidth on Host C can be wasted. Waste can stack up when small flows arrive at the same time, as the orange line shows.

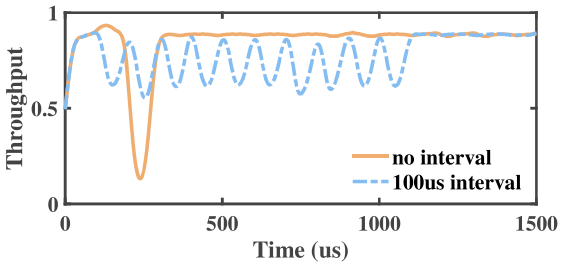

Figure 15. Reactive protocols may waste bandwidth.