SoNIC: Precise Realtime Software Access and Control of Wired Networks

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1 Introduction

The physical and data link layers of the network stack offer untapped potential to systems programmers and network researchers. In particular, idle characters that only reside in the physical layer can be used to accurately measure interpacket delays which are used for various network research [1].

Unfortunately, the physical and data link layers are usually implemented in hardware and not easily accessible to systems programmers. Further, systems programmers often treat these lower layers as a black box. Not to mention that commodity network interface cards (NICs) do not provide nor allow an interface for users to access the physical layer in any case. Consequently, operating systems cannot access the physical layer either. Software access to the PHY is only enabled via special tools such as BiFocals [1] which uses physics equipment, including a laser and an oscilloscope.

In this poster, we will present SoNIC, Software-defined Network Interface Card [2] which provides users with unprecedented flexible realtime access to the 10 Gigabit Ethernet (GbE) physical layer from software. SoNIC consists of commodity off-the-shelf multi-core processors and a field-programmable gate array (FPGA) development board with peripheral component interconnect express (PCIe) Gen 2.0 bus. High-bandwidth PCIe interfaces and powerful FPGAs can support full bidirectional data transfer for two 10 GbE ports. Further, we created and implemented optimized techniques to achieve not only high-performance packet processing, but high-performance 10 GbE bitstream control in software. Parallelism and optimizations allow SoNIC to process multiple 10 GbE bitstreams at line-speed.

With software access to the PHY, SoNIC provides the opportunity to improve upon and develop new network research applications which were not previously feasible. Along with the poster, we will demonstrate following applications. First, as a powerful network measurement tool, SoNIC can generate packets at full data rate with minimal interpacket delay. It also provides fine-grain control over the interpacket delay; it can inject packets with no variance in the interpacket delay. Second, SoNIC accurately captures incoming packets at any data rate including the maximum, while simultaneously timestamping each packet with sub-nanosecond granularity. In other words, SoNIC can capture exactly what was sent. Lastly, when the SoNIC packet generator and capturer are combined, it can be used to profile network switches. In particular, one port of SoNIC can transmit packets to a commercial switch while the other port captures and timestamps packets routed from the switch (Figure 1).

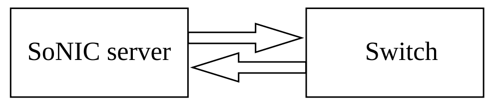

Figure 1: Demo setup

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References

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