

Demo: High-Fidelity Validation of P4 Networks with SONiC-P4 Software Switch and CrystalNet

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Abstract:

P4's language and ASICs provide flexible programmability to data-plane. This allows switches to perform complex in-network functionalities. Nonetheless, the programmability in data-plane also introduce a tremendous challenge on ensuring the reliability of networks, since bugs are unavoidable in customized P4 programs, the integration between control plane and P4 programs and the interactions between P4 switches and legacy network devices. Therefore, the validation of P4 devices' behaviors in realistic networks is critical to prevent network incidents proactively and accelerate the adoption of P4. The current practices of network validations, such as network verifications, testbed and network emulations (e.g. MiniNet, Emulab), have significant limitations on scalability and adaptivity to heterogeneous devices which prevent them from constructing scenarios those are close to production environments (low high-fidelity). In this demo, we present CrystalNet: a framework building high-fidelity validation environments for P4 networks with SONiC-P4 software switches. CrystalNet runs each device in a virtualized sandbox (container or VM), inter-connects the sandboxes with virtual network links according to real network topologies, and inject real configurations into the sandboxes. It has three essential features: (i) it is high-fidelity due to real control-plane configurations and software and P4 ASIC emulator; (ii) it naturally runs on clouds and can easily scale-out to emulate large-scale networks on server clusters; (iii) it accepts various network devices even black-box devices in hardware. We have deployed CrystalNet in Azure's production networks for 6 months and we will present our experiences of running large-scale, high-fidelity network validations for P4.

Demo details:

In this demo, we will show a large-scale, emulated data center network. It has the exactly same topology as a production data center network in Microsoft, with the exactly same switch OS and configuration. Specifically, it consists of 367 ToR switches, which are running SONiC, and 196 Leaf and Spine switches, which are running Arista EOS. The P4-based software switch enables this because it has been integrated with SONiC and serves as (the only available) ASIC emulator. Meanwhile, SONiC is the most mature switch OS that integrates with P4 software switch. Together with CrystalNet, this combination provides a fully programmable validation pipeline for P4 networks. EOS does not have P4 integration and uses Linux kernel for forwarding. This is not as ideal as SONiC+P4, but represents legacy devices. With CrystalNet, we verify the interaction between SONiC+P4 and EOS, and pave the road for potential P4 deployment.