SC22 Network Research Exhibition: Demonstration Preliminary Abstract

[Coral: Fast Data Plane Verification for Large-Scale Science Networks via Distributed, On-Device Verification]

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Abstract

Data plane verification (DPV) is important for finding network errors, and therefore a fundamental pillar for achieving consistent-operating, autonomous-driving, high-performance science networks. Current DPV tools employ a centralized architecture, where a server collects the data planes of all devices and verifies them. Despite substantial efforts on accelerating DPV, this centralized architecture is inherently unscalable. To tackle the scalability challenge of DPV, we circumvent the scalability bottleneck of centralized design and design Coral, a distributed, on-device DPV framework. The key insight of Coral is that DPV can be transformed into a counting problem on a directed acyclic graph, which can be naturally decomposed into lightweight tasks executed at commodity network devices, enabling scalability.

Other than verifying IP-prefix based data plane, Coral could also be used in a segment routed complex network (e.g., PoIKA) to verify the overall topology and isolate faults. It could also function to efficiently extract and provide infra-segment topology and monitoring information from fixed function switches, supporting stateful programmable decisions on packet handling at the ingress and egress of each segment.

During SC'22, we will demonstrate, through both a testbed reconstruction of the Internet2 WAN environment and large-scale simulations of WAN/LAN/ DC with real-world datasets, that Coral consistently achieves scalable DPV under various scenarios and network data planes, from IP-prefix based data forwarding to segment routing, from single-domain networks to multi-domain networks. A preliminary manuscript of Coral can be found at [1] and a set of small-scale demos can be found on our website [2].

Goals

1. Demonstrate that Coral finishes verifying the complete IP-prefix based data plane of Internet2 in less than 1 second on a 9-switch testbed, which mimics the original Internet2 WAN environment;
2. Demonstrate that Coral achieves fast incremental verification of Internet2 data plane on the same testbed;
3. Demonstrate that Coral can verify a wide range of common correctness requirements, from the basic reachability to anycast/multicast reachability, on the same testbed;
4. Demonstrate Coral can verify a network with overlay segment routing and underlay IP-prefix based routing on the same testbed;
5. Demonstrate Coral can verify networks of various scales (WAN/LAN/DC) using an efficient, customized network simulator.

Resources

During SC'22, we will be working with the Caltech team, the UFES team, and multiple other teams together at the Caltech booth. We will use the commodity switches in the booth and the wide-area links connected to the booth. We will also deploy our demos at Amazon AWS. Therefore, we do not require additional resources.

Involved Parties

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References

[1] Qiao Xiang et al., Switch as a Verifier: Toward Scalable Data Plane Checking via Distributed, On-Device Verification, https://arxiv.org/abs/2205.07808

[2] Qiao Xiang et al., Coral System Functionality Demonstration, http://distributeddpvdemo.tech/