Enhanced Postcard on Mellanox Switch Programmed by P4

Abstract:

Programming Protocol-independent Packet Processor (P4) is a high-level language that can be deployed in the future into Software Defined Networks (SDN) and can actually serve as an alternative to OpenFlow that is currently used – due to its flexibility and ability program the data plane and support emerging new protocols.

Network monitoring plays a significant role in network management. It is used for a variety of applications such as QOS, billing, traffic engineering, security and anomaly detection. While some of these applications require only flow statistics, many require more specific packet-level information as well as networking hardware resource operational status. The new Mellanox SN3700 P4-capable Spectrum-2 based, supports the ability to perform mirror of sampled traffic, encapsulate it to GRE and add to it additional telemetry meta data like: Switch ID, time stamp, ingress/egress queues occupancy and congestion status, egress port link utilization and more. Unlike similar techniques like In-band Network Telemetry (INT) and in-situ Operation Administration and Maintenance (OAM), the Postcard-Based Telemetry (PBT) does not require inserting telemetry data into sampled user packets, but directly exports the telemetry data to a collector through separated OAM packets called postcards.
Goals:

The project’s objective is to learn P4 programming language and deploy it on Mellanox P4 Capable switch (SN37000). The project will include the following phases:

- Learn the P4-16 language
  - Read the paper *The P416 Programming Language*: [https://dl.acm.org/citation.cfm?id=3139648](https://dl.acm.org/citation.cfm?id=3139648)
  - Perform basic P4 exercise on Mininet - [https://github.com/p4lang/tutorials/tree/master/exercises/basic](https://github.com/p4lang/tutorials/tree/master/exercises/basic)
  - [https://github.com/p4lang/tutorials/tree/master/exercises/p4runtime](https://github.com/p4lang/tutorials/tree/master/exercises/p4runtime)

- Implement Traffic postcard sampling-on-Demand using P4 and P4RunTime on Mininet
- Learn the Mellanox p4 target architecture (See Appendix A)
- Learn the Mellanox p4 Architecture Schema (See Appendix B)
- Refer to previous student project - [https://gitlab.cs.technion.ac.il/lccn/w2018-mirror-sampling-mellanox-p4](https://gitlab.cs.technion.ac.il/lccn/w2018-mirror-sampling-mellanox-p4) and implement mirror sampling.
- Implement on the ingress sampled traffic GRE tunnel encapsulation with the additional telemetry params: switch ID, time stamp, ingress/egress queues occupancy and congestion status, Switch latency.
- Inject CAIDA traffic from Traffic Generator 1 along with random bursts generated by Traffic Generator 2 – in order to congest the egress queue.
- Implement on the collector side a GUI dash board that will show:
  - queue status and occupancy changes over time. Refer to previous student project [https://gitlab.cs.technion.ac.il/lccn/s2019-postcard-p4](https://gitlab.cs.technion.ac.il/lccn/s2019-postcard-p4)
  - List the 1st level and 2nd level congested flows
- (nice-to-have) Configure the above using Mellanox p4runtime API
Appendix A: Mellanox p4 target architecture

The current Mellanox p4 target architecture compress from 5 programmable blocks (1 parser block, and 4 control - match action).

Figure 1. Target architecture.

Programmable block 1: parser
Mellanox provides parsing graph base line user will be able to add up to 4 new nodes to the packet-parsing graph.

Programmable block 2: ingress port
Ability to define chain of multiple match action tables supported actions – drop, forward to port, mirror, packet modification, routing(including ECMP), tunnels encap, tunnel decap, set QoS, counters, meters, go to table.

Programmable block 3: ingress router
Ability to define chain of multiple match action tables supported actions – drop, mirror, packet modification, routing(including ECMP), tunnels encap, tunnel decap, set QoS, counters, meters, go to table.

Programmable block 4: egress router
Ability to define chain of multiple match action tables supported actions – drop, mirror, packet modification, set QoS, counters, meters, go to table.

Programmable block 5: egress port
Ability to define chain of multiple match action tables supported actions – drop, egress mirror, packet modification, set QoS, counters, meters, go to table “
Appendix B: Architectural schema

Requirements:
Introduction to Networking Course (236334)

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Resources:

1. P4 tutorials on GitHub (see readme for install instructions):
   
   https://github.com/p4lang/tutorials

2. P4 mailing list:
   
   http://mail.p4.org/pipermail/p4-dev_p4.org/

3. P4 runtime:
   
   https://p4.org/p4-runtime/

4. Mellanox SDK API:
   

5. Mellanox P4 compiler:
   
   Code repository will be shared with the students.