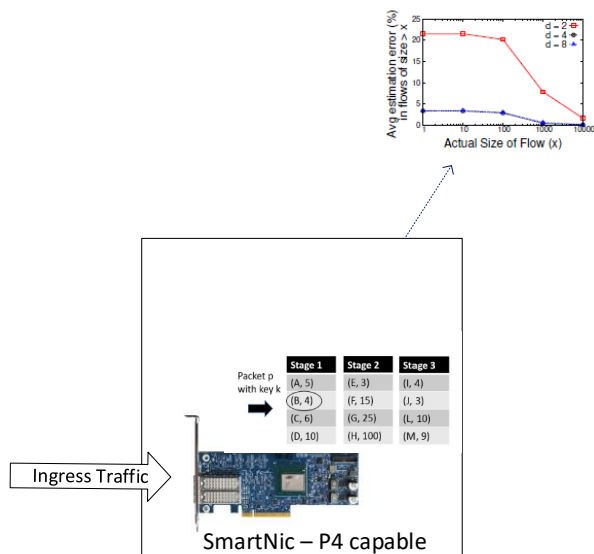# Heavy-Hitter Detection on SmartNIC - using P4

Abstract:

Many network management applications can benefit from finding the set of flows contributing significant amounts of traffic to a link. Such flows are called "Heavy Hitters". Monitoring heavy hitters is required for example, to relieve link congestion or to detect network anomalies and attacks. Furthermore, heavy-hitters identification is done in small time scales, it can enable dynamic routing of the heavy flows and also dynamic flow scheduling.

In order to respond quickly to short-term traffic variations, it is desirable to run heavy-hitter monitoring at all switches and (Network Interface Card) NICs in the network all the time. It should identify packets belonging to heavy–hitter flows in a reasonable accuracy and by meeting hardware constrains such as limited number of accesses to memory storing state and a limited amount of memory available.

The target of HashPipe algorithm is to track the k heaviest flows with high accuracy using limited available memory. The HashPipe can be implemented on a programmable hardware such as Netronome SmartNic using P4 language.

Goals:

- Paper Reference - Refer to https://www.cs.princeton.edu/~jrex/papers/hashpipe17.pdf
- Learn P4 Basics
  - Future of Networking and Past of Protocols - https://www.youtube.com/watch?v=YHeyuD89n1Y
  - Why we need programmable data plane - https://www.youtube.com/watch?v=zR88Nlg3n3g
  - P4-16 Programming Language - https://karpef.cs.technion.ac.il/index.php/s/kkHkDjCjEEcWBgC
- Install P4-16 Behavior-model environment and perform P4 tutorial basic forwarding exercise with Mininet. Refer to: https://github.com/p4lang/tutorials
- Build Netronome SmartNIC environment that includes:
  - Agilio CX SmartNIC
    - Interfaces: 2x10Gb
    - Processor: NFP-4000
    - Memory: 2GB
  - Windows-based program to develop in Micro-C, P4 and assembly for the Agilio SmartNIC - NFP-4xxx/NFP-6xxx SDK 6.1-preview Programmer Studio IDE - r3286 - (2018/10/23) - https://karpef.cs.technion.ac.il/index.php/s/rXLGDFwIAH76diG
    In addition, refer to: https://www.netronome.com/media/documents/PB_Programmer_Studio_6.0.pdf
- Perform the basic SmartNic labs. Refer to: https://github.com/open-nfpsw/p4_basic_lb_metering_nic/blob/master/workbook.pdf
    Sources can be found in: https://github.com/open-nfpsw/p4_basic_lb_metering_nic
- Implement HashPipe with P4/C on the Netronome SmartNic. As reference refer to: https://github.com/open-nfpsw/M-Sketch
- Inject traffic using real captured ISP backbone link traffic (from CAIDA) and produce the following statistics:
  - Overall Flow count
  - When reporting xxx (TBD) heavy hitters : % of False Negative (Real heavy-hitter that was not detected)
  - When reporting xxx (TBD) heavy hitters : % of False Positive ("fake" heavy-hitter detection)

Requirements:

Introduction to Networking (236334), Internet Networking (236341)

 Python