Data Plane Programming and In-Band Network Telemetry

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11 June 2021

The authors have been testing data plane programming technologies since the start of the GN4-3 project in 2018. The use cases tested are DDoS detection and In-Band Network Telemetry using the P4 language on different types of hardware (FPGA, Barefoot/Intel Tofino and a switch emulation environment for Tofino, the Behavioral Model v2).
Detailed information is available at https://wiki.geant.org/display/NETDEV/INT

Results
In the case of DDoS detection, a custom P4 program was installed in a Tofino switch, and provided an efficient real time detection of an attack using a threshold-based algorithm and sketches structures to efficiently store and process store statistics despite the limited memory and computational capabilities of the programmable ASIC. The use case was used to gauge the capabilities of the chip: the amount of internal memory to allocated to data structures and the number of processing stages consumed are the main constraints that limit the complexity of the application. Yet the amounts in current switches are adequate.

Testing of In-Band Network Telemetry (INT) was performed over the production circuits with a distributed testbed between three European NRENs, and focused on monitoring packet IP delay variation, loss and reordering. INT proved to be an excellent magnifying glass to study the behaviour of individual packets. INT using FPGA and Tofino platforms can reach microsecond-level precision and enables debugging capabilities not achievable using traditional methods like SNMP or streaming Telemetry.

Gaps and challenges
The need of specialized hardware supporting P4 programming may be a challenge, if the use case requires a large number of participating nodes. The cost however is decreasing and the number of available platforms is increasing. Alternative solutions based on virtual environments or software acceleration (e.g. DPDK, etc.) perform adequately up to speeds of many Gigabit per second.
A second challenge faced in the deployment of the INT testbed is handling of the large amount of data that it can produce. While data plane (P4) programs work at wire speed (by design, enforced by the compilers targeting hardware platforms), the information exported may be comparable to the flows size. Scaling requires an adequate ICT backend for data collection and presentation.
The third main challenge is using timestamps in a distributed environment. Synchronizing the nodes with at least microseconds precision may require specific hardware in the linecards, and the accuracy required for time synchronization has to be defined during planning.

Potential areas of collaboration.
Monitoring a network using In-band Network Telemetry explores packet behaviour in greater detail than current monitoring systems in operation allow. Collaboration will benefit not just the technical operation, but mostly contribute to the understanding of the network behaviour, especially at very high throughput and/or fine grained time granularity.
The collaboration should include OpenSource code and standardization of interfaces and data representation.

REFERENCES
GN4-3 WP6 Task1 activity on Data Plane Programming and In-Band Network Telemetry
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