GEANT P4 lab (aka GP4L)

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Agenda

GÉANT-4 Programme
GP4L Mission statement
A bit of context ...
   Programming Protocol-independent Packet Processors: P4 language
   Network Operating System
   P4 Programmable Switches: EdgeCore Wedge100BF-32QS
GP4L - GÉANT P4 LAB footprint
GP4L - Use case at CERN
How can you benefit from GP4L?
GÉANT-4 Programme

39 participants country
- NREN participants
- But also NREN staff members!

GN4 phase 3 cooperation programme
- 44 months
- Budget 78 M€

GN4-3 divided in “Work Package”
- 9 WP divided in “Tasks”
- Task 1 encompasses 6 Sub-tasks
- RARE/GP4L within a sub-task
GP4L Mission statement

• Primarily used to validate the software code inherently part of RARE/freeRtr open source routing stack.

• It is a service that is under development with the aim to provide experimental dataplane programming facilities where researchers can elaborate and test representative and geographically distributed network experiment
  • With the usage of RARE/freeRtr Operating System
  • Or simply use a clean slate environment.

  (i.e use exclusively GP4L without RARE/freeRtr dataplane & control plane)
A bit of context...

P4 language, Network Operating System and P4 Programmable Switches
A bit of context...
Programming Protocol-independent Packet Processors: P4 language

Language for programming the data plane of network devices
• Define how packets are processed
• P4 program structure: header types, parser/deparser, match-action tables, user-defined metadata and intrinsic metadata

Domain-specific language designed to be implementable on a large variety of targets
• Programmable network interface cards, FPGAs, software switches and hardware ASICs.
A bit of context...
Network Operating System

RARE/FreeRtr
- Controls the data plane by managing entries in routing tables
- Free and open source router operating system
- Export forwarding tables to DPDK or hardware switches
  - via OpenFlow or P4lang
- No global routing table
- Every routed interface must be in a virtual routing table
A bit of context...

P4 Programmable Switches

EdgeCore Wedge100BF-32QS:

100GbE Data Center Switch

- Bare-Metal Hardware
- L2/L3 Switching
- 32xQSFP28 Ports

Data-Plane Programmability

- Intel Tofino Switch Silicon
- Barefoot Networks

Quad-Pipe Programmable Packet Processing Pipeline

- 6.4 Tbps Total Bandwidth

CPU: Intelx86 Xeon 2.0GHz

- 8-core/48GB/2TB SSD
GP4L

GÉANT P4 LAB footprint
GP4L – GÉANT P4 LAB: topology rendering via BGP-LS [1]

http://gp4l.geant.org/
GP4L AMT relay / AMT gateway / Unicast --> Multicast

MULTICAST
BIER
AMT relay/gateway
Unicast2multicast translator

AN INNOVATIVE MULTICAST STREAMING SERVICE!

GP4L – GÉANT P4 LAB
GP4L

Use case at CERN
Research Network Technology WG proposed a packet marking technique to identify the LHC experiment and the application that has generated a transmission packet [1]

- The Experiment-Application tag is inserted in the flow label field of the IPv6 packet header.
- The original purpose of the field was never implemented, so it has been neglected by most of the existing network devices.

Primary goal of the marking is to count the traffic, but special routing polices could also be applied.

Flow label field of IPv6 header: 20 bits

- 5 entropy bits to match RFC 6436
- 9 bits to define the science domain
- 6 bits to define the application/type of traffic

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Packet Marking Specification: IPv6 Flow Label

<table>
<thead>
<tr>
<th>Bits 12 - 13</th>
<th>Bits 14 - 22</th>
<th>Bit 23</th>
<th>Bits 24 - 29</th>
<th>Bits 30 - 31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entropy</td>
<td>Science Domain</td>
<td>Entropy</td>
<td>Application</td>
<td>Entropy</td>
</tr>
</tbody>
</table>

- Astro/HEP Science Domains:
  - Reserved - 0
  - Default - 65536
  - ATLAS - 92768
  - CMS - 93394
  - LHCb - 16384
  - ALICE - 81920
  - BelleII - 48384
  - BTF - 14496
  - LSST - 73728
  - DUNE - 8192

- Application:
  - Reserved - 0
  - Default - 4
  - performance - 8
  - Cache - 12
  - DataChallege - 16

[1] www.scitags.org
Programmable Switches for Flow Label Accounting and Routing

Flow label is inserted transparently on LHCOPN link to a Tier1

*The traffic is separated-counted-aggregated internally*
Programmable Switches for Flow Label Accounting and Routing

Network configuration:
- Emulates a Tier 1/0 link
- Tier1/0 routers
  - IPv4/IPv6 BGP peerings
- Tier0 router
  - LHCOPN production border router
- Pure layer 2 bridges
  - VLAN 1000: IPv4 traffic
  - VLAN 1001: IPv6 traffic
- Tier0 servers
- OpenStack product servers
Programmable Switches for Flow Label Accounting and Routing

P4 switch network configuration: pure layer 2 bridges

```
access-list acl_all_ipv6_flowlabels
    # Match <Experiment> and <ANY Application>
    sequence 10 permit all any any any all flow 121076 & 261084
    sequence 11 permit all any any any all flow 65540 & 261084
    sequence 12 permit all any any any all flow 196612 & 261084
    sequence 13 permit all any any any all flow 32772 & 261084
    # Match <Experiment> and <perfSONAR Application>
    sequence 20 permit all any any any all flow 131072 & 261632
    sequence 21 permit all any any any all flow 65536 & 261632
    sequence 22 permit all any any any all flow 196608 & 261632
    sequence 23 permit all any any any all flow 32768 & 261632
    # Permit the rest of the traffic
    sequence 30 permit all any any any all
exit

interface sdn1.1000
    description [VLAN ID=1000]
    bridge-group 1
    no shutdown
    no log-link-change
exit

interface sdn1.1001
    description [VLAN ID=1001]
    bridge-group 2
    bridge-filter ipv6in acl_all_ipv6_flowlabels
    no shutdown
    no log-link-change
exit
```

VLAN 1000 belongs to bridge 1

VLAN 1001 belongs to bridge 2 Filter IPv6 traffic at the input based on the access-list sentences
MultiONE multiple “LHCONEs”: Traffic separation with IPv6 flow labels

Route the traffic of the different LHC experiments into the appropriate VPN.

- A prototype of a flow label router is being developed using a P4 programmable switch (EdgeCore Wedge100BF-32QS with Intel Tofino processor)
Useful links

Project:

GP4L project page: https://wiki.geant.org/display/GP4L/Home
RARE/freeRtr: https://www.rare.freertr.net
https://docs.freertr.net
https://blog.freertr.net

Contact:

Users: gp4l-users@lists.geant.org
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Project: gp4l@lists.geant.org
Looking ahead: Finalize transition to production

Orchestrate and automate GP4L:
- Lab reservation
- Persistent testbed interaction at global scale

New hardware:
- TOFINO2
- NVIDIA DPU
- P4 SmartNIC
- TOFINO/FPGA

Global worldwide footprint:
- Interconnection with other persistent testbed

→ New idea:
- Validate new use cases
- Scalability
- 100/400 GE DTN automation
- Control plane scalability

Validate your use case with GP4L!
Thank you

Any questions?

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