Open and Programmable Networks

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Barefoot Networks
Evolution of Open Networking

“Control stops where Data Plane starts”

“Control & Ownership down to the wire”
Evolution of Programmable Hardware

Compute
- C/C++/...
- Compiler

Graphics
- OpenGL/OpenCL/...
- Compiler

Signal Processing
- C++/Matlab/...
- Compiler

Networking
- ?

“Networking is late to the game!”
How can you ...

Simplify and Scale the data plane

Create and Own data plane intellectual property

Get full visibility into the data plane

Tailor the network to meet specific needs
Need a couple of things ...

1. Programmable Switch Architecture (PISA™)

   Giving end-users a programmable target for their data plane

2. Industry-wide Programming Language (P4™)

   Allowing end-users to define and modify their data plane
PISA™: Protocol Independent Switch Architecture
PISA: Protocol Independent Switch Architecture
P4™: Programming Protocol-Independent Packet Processors

High-level programming language

Networking domain specific

Protocol/Target Independent

Growing adoption and ecosystem

```c
/* Router MAC lookup */
action rmac_hit() {
    modify_field(l3_metadata.rmac_hit, TRUE);
}

action rmac_miss() {
    modify_field(l3_metadata.rmac_hit, FALSE);
}

table rmac {
    reads {
        l3_metadata.rmac_group : exact;
        l2_metadata.lkp_mac_da : exact;
    }
    actions {
        rmac_hit;
        rmac_miss;
    }
    size : ROUTER_MAC_TABLE_SIZE;
}
```
P4 - Programming Language for Networking

“Programmable Networking across the Entire Network”
What does a P4 program look like?

```
header_type ethernet_t {
    fields {
        dstAddr : 48;
        srcAddr : 48;
        etherType : 16;
    }
}
```

```
parser parse_ethernet {
    extract(ethernet);
    return select(latest.etherType) {
        0x8100 : parse_vlan;
        0x800  : parse_ipv4;
        0x86DD : parse_ipv6;
        0xface : parse_my_encap;
    }
}
```
What does a P4 program look like?

table ipv4_lpm
{
  reads {
    ipv4.dstAddr : lpm;
  }
  actions {
    set_next_hop;
    drop;
  }
}

control ingress
{
  apply(l2);
  apply(my_encap);
  if (valid(ipv4) {
    apply(ipv4_lpm);
  } else {
    apply(ipv6_lpm);
  }
  apply(acl);
}

action set_next_hop(nhop_ipv4_addr, port)
{
  modify_field(metadata.nhop_ipv4_addr, nhop_ipv4_addr);
  modify_field(standard_metadata.egress_port, port);
  add_to_field(ipv4.ttl, -1);
}
P4 and PISA

P4 code

Compiler

Compiler Target

Programmable Parser
Now you can ...

- Quickly add new protocols.
- Remove unused protocols.
- Flexibly assign table memory to features.
- Create new diagnostics, telemetry, OAM etc.
- Compose forwarding behavior from libraries.
- Specify forwarding behavior once; compile to many devices.
- Keep your data plane IP from going to your competitors!
Clarifying the differences between P4 and OpenFlow
Independent CA non-profit
Membership is FREE
Open source
Apache 2.0 CLA
40+ members from industry and academia

Website: http://p4.org/join-us
GitHub: https://github.com/p4lang
Workshops: June 2015, Nov 2015, May 2016
Developer Resources

Spec
http://p4.org/spec/

Compiler
https://github.com/p4lang/p4c-bm

L2/L3 Switch
https://github.com/p4lang/switch

Packet Test Framework (PTF)
https://github.com/p4lang/ptf

... much more at
https://github.com/p4lang
Get involved!


Try P4 development tools and programs (switch.p4, INT, ...)
   Including P4-programmable S/W switches and test framework
   Exciting apps for network monitoring, analysis, diagnostics, and control

Join the mailing lists - [http://lists.p4.org](http://lists.p4.org)
Thank you!