OPEN POSSIBILITIES.

PINS – P4 Integrated Network Stack
PINS – P4 Integrated Network Stack

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Reshma Sudarshan, Intel
SDN

- Google - a major user of SDN in Data Center [1]
  - Simpler Traffic Engineering [2]
  - Easier Debugging - Network State visible to controller [3]
  - Control Plane runs on Dedicated Fast Servers
- SDN & Remote Controller Adoption growing
- Focus: Help SDN go mainstream

[1]: Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google’s Datacenter Network
[2]: B4: Experience with a Globally-Deployed Software Defined WAN
[3]: Orion: Google’s Software-Defined Networking Control Plane
SONiC

- Vendor Agnostic (thanks to SAI and common platform API)
- Decoupled Software from Hardware
- Enabling rapid innovation
- Vibrant Ecosystem
- Open Source

Can we extend SONiC to provide an incremental, opt-in path to SDN?
- Focus on customer problems & business opportunities
- Build confidence in new infrastructure as we go

OPEN POSSIBILITIES.
P4 Programs

sai/routing.p4

```p4
@p4runtime_role(P4RUNTIME_ROLE_ROUTING)
@id(ROUTING_IPV4_TABLE_ID)
table ipv4_table {
  key = {
    local_metadata.vrf_id : exact @id(1) @name("vrf_id")
    @refers_to(vrf_table, vrf_id);
    headers.ipv4.dst_addr : lpm @format(IPV4_ADDRESS) @id(2)
    @name("ipv4_dst");
  }
  actions = {
    @proto_id(1) drop;
    @proto_id(2) set_nexthop_id;
    @proto_id(3) set_wcmp_group_id;
  }
  const default_action = drop;
  size = ROUTING_IPV4_TABLE_MINIMUM_GUARANTEED_SIZE;
}
```

Control Plane
Contract

Test & Verification Plan

Hardware Layout
(for programmable targets)

P4 compiler
Solution: PINS

- P4 used to model the SAI pipeline
- SDN protocol: P4Runtime
  - Standard, open, silicon-independent
  - Enables runtime-control of data plane objects
- Management protocols: OpenConfig
  - Standard, open, widely used
  - Already used in SONiC

<table>
<thead>
<tr>
<th>P4Runtime</th>
<th>OpenConfig-gNMI</th>
</tr>
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<tbody>
<tr>
<td>SDN forwarding control</td>
<td>configuration and telemetry interface</td>
</tr>
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</table>

SONiC

Vendor SAI / SDK

Switch ASIC / Or Behavioral Model

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Architecture
Integration - ASIC Programming

APPL_DB

1) "ROUTE_TABLE:10.0.0.0/31"
   1) "nexthop"
   2) "0.0.0.0"
   3) "ifname"
   4) "Ethernet0"

... 

32) "ROUTE_TABLE:10.0.0.62/31"
   1) "nexthop"
   2) "0.0.0.0"
   3) "ifname"
   4) "Ethernet124"

33) "ROUTE_TABLE:172.16.0.0/16@Vrf5"
   1) "nexthop_group"
   2) "group5"

34) "ROUTE_TABLE:192.168.0.0/24@Vrf8"
   1) "nexthop"
   2) "192.168.0.1"
   3) "ifname"
   4) "Ethernet8"

Existing SONiC Applications

SDN Controller

P4Runtime

All writes to same tables

Try once, Return status

Fire and forget, Retry on failure

Switching ASIC

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PINS Architecture

(Docker container)

Existing module

New module

Existing Path (black)

New Path (dotted blue)

New Path (green)
P4Runtime App

- New Docker container
- Writes controller intent to APPL_DB

Features
- Arbitration
- Readback support
- P4Info Upgrades
P4 Orchagent

- New orchagent in SWSS
  - Parses APPL_DB entries,
  - Maintains objects, refcounts
  - Translates intent to ASIC_DB
- Handles ordering dependencies
- Supports response path
Example: Installing a route

**SDN Controller**

1. **RPC: Write**
   - **type:** INSERT
   - **ipv4_table_entry**
     - **match**
       - vrf_id: "vrf-8"
       - ipv4_dst: "192.168.0.0/24"
     - **action:** set_nexthop_id
     - nexthop_id: "s1"

2. **P4RT: FIXED_IPV4_TABLE:**
   - "match/vrf_id": "vrf-8",
     - "match/ipv4_dst": "192.168.0.0/24"
   - "action" = "set_nexthop_id"
   - "param/nexthop_id" = "s1"

3. **ASIC_STATE:SAI_OBJECT_TYPE_ROUTE_ENTRY:**
   - "dest": "192.168.0.0/24",
     - "switch_id": "oid:0x21000000000000",
     - "vr": "oid:0x3000000000008"
   - "SAI_ROUTE_ENTRY_ATTR_NEXT_HOP_ID" = "oid:0x500000000097b"
Packet I/O
Integration - Packet I/O

- SDN Controller
  - P4Runtime
  - P4Runtime App

- genetlink driver
  - psample
  - genl_packet

- send_to_ingress
- Ethernet0
- ... EthernetN

- Vendor ASIC Kernel Module
  - Switching ASIC
  - Packets over CPU port
  - Packets on this netdev are sent to ingress pipeline from the CPU port

- Existing SONiC Applications
  - Existing SONiC Applications
  - P4Runtime App
  - P4Runtime

- Networking
  - user space
  - kernel space

- Open Possibilities
Demo
Use Case: L3 Routing & WCMP

Use a converged view of the fabric topology to:

- Compute the global routing table
- Assign optimal weights for balanced traffic

Demo: L3 Routing & WCMP

ONF Booth Location
Roadmap
## SONiC Release Roadmap

<table>
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<tr>
<th>SONiC Release</th>
<th>202111 - MVP</th>
<th>202206</th>
<th>Future</th>
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<tbody>
<tr>
<td>Release Date</td>
<td>Nov. 30, 2021</td>
<td>June 30, 2022</td>
<td>2022+</td>
</tr>
</tbody>
</table>
| **Features**  | ● P4Runtime Application  
                ● SAI P4 Program  
                    ○ L3 Admit / VRF  
                    ○ IPv4 / IPv6 Routing  
                    ○ WCMP Next Hop Groups  
                    ○ Configurable ACLs  
                ● Packet I/O  
                ● P4Orch with Response Path  
                ● Integration with ONOS  
                ● Internal System Testing  
                ● SAI P4 Extension Path (delayed)  | ● SAI P4 Program  
                ○ Hash configuration  
                ○ L2 FDB / VLAN  
                ○ SVI  
                ● Critical State  
                ● Open System Test Framework  
                ○ Test Cases  | ● Response Path in other Orchs  
                ● SAI P4 Program  
                    ○ VxLAN  
                    ○ Other tunnels  
                ● gNOI support |
Community – PINS Working Group

- Working group formed in 2019
- Multiple Use Cases (Data center, 5G, ...)

PINS “MVP” is part of the SONiC.202111
Call to Action

- Try out PINS in the SONiC.202111 release!
- Join the SONiC PINS Subgroup
- Comment on and contribute to PINS high-level designs (HLDs)
- Help us build the next set of features for upcoming releases
  - PINS “MVP” Pull Requests
  - SONiC repos: sonic-pins, sonic-swss, sonic-swss-common, sonic-buildimage
  - Active development in the ONF PINS Working Group repos
Thank you!