DPDK

Programmable Networks @ Multi-Terabit Scale

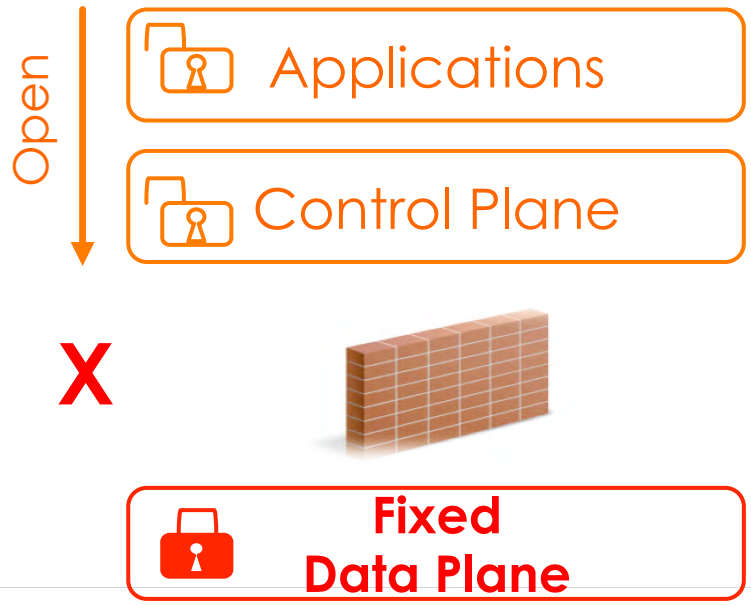
Prem Jonnalagadda, Barefoot Networks

DPDK US Summit - San Jose - 2016

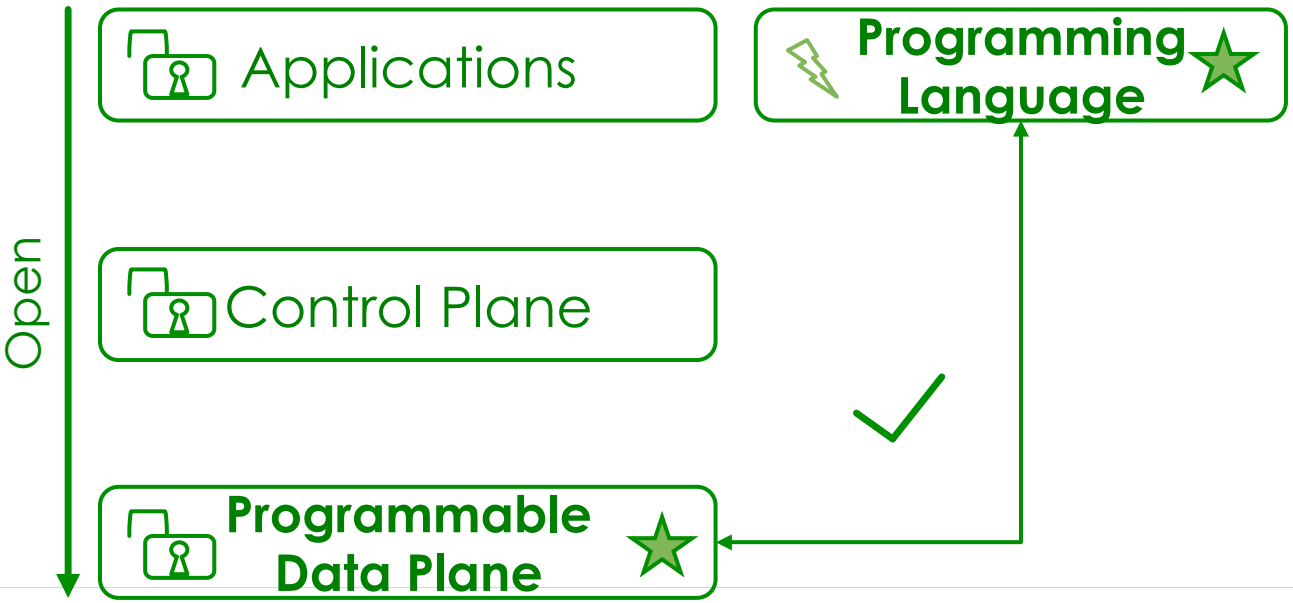
Today, how can we ...

- Simplify and scale the data plane of a switch
- Create and own data plane Intellectual Property (IP)
- Get full visibility into the data plane
- Tailor the network to meet specific needs

Evolution of Open Networking



What networks need ...



"Control stops where Data Plane starts"

"Control & Ownership down to the wire"

Evolution of Programmable Hardware

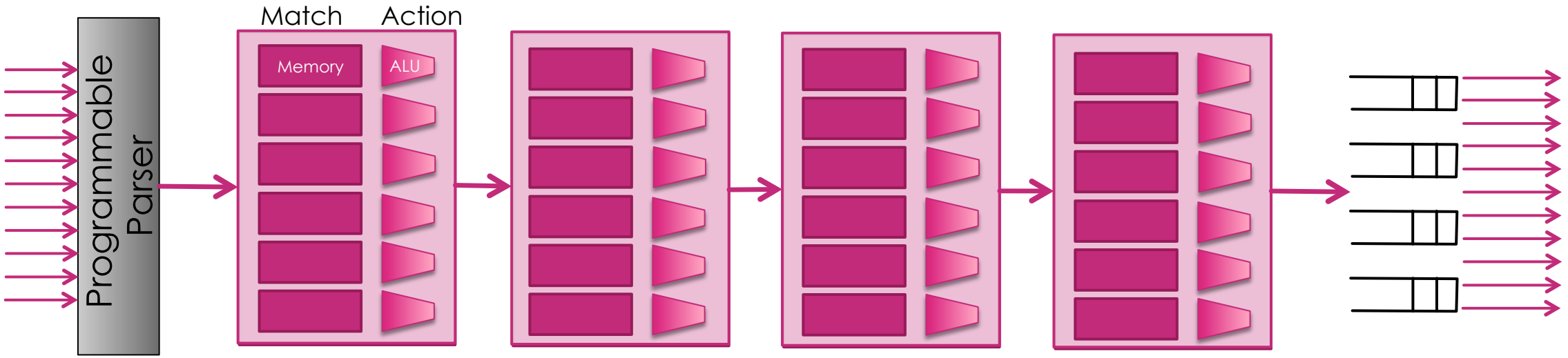
Compute	Graphics	Signal Processing	Networking
C/C++/...	**OpenGL/OpenCL/...**	**C++/Matlab/...**	**?**
Compiler	Compiler	Compiler	Compiler
			?

"Networking is late to the game!"

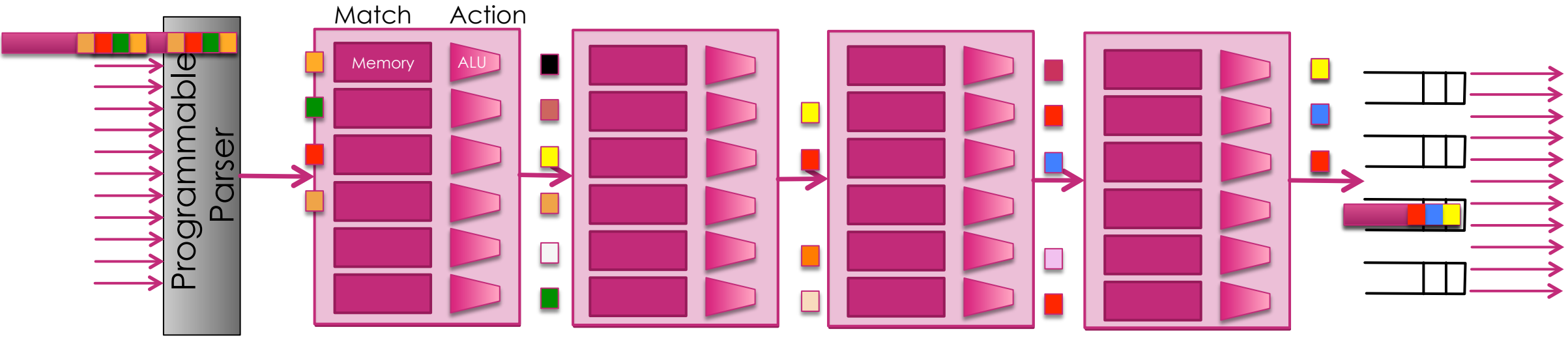
We need a couple of things ...

- Programmable Switch Architecture (PISA™)
  - Giving end-users a programmable target for their data plane
- 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

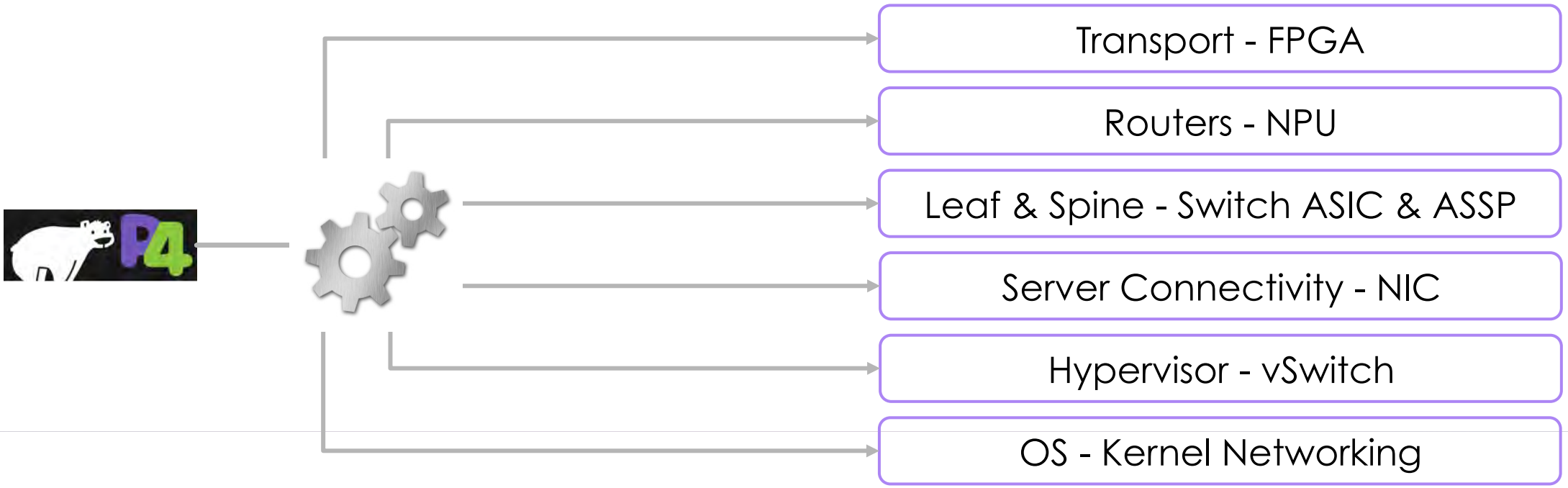


P4™
Programming Protocol-Independent Packet Processors

- High-level programming language
- Networking domain specific
- Protocol/Target Independent
- Growing adoption and ecosystem

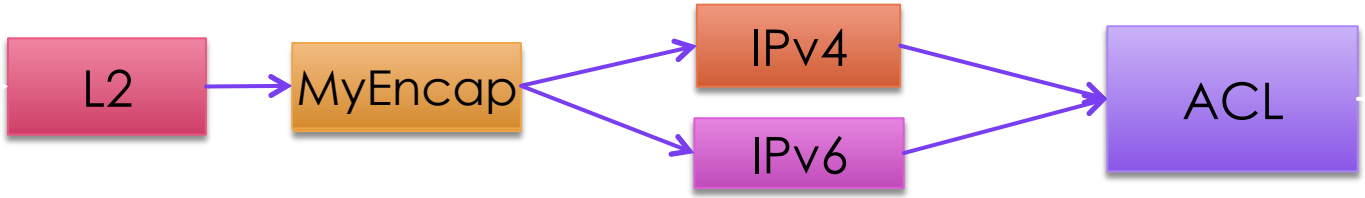

```
/*********************************************/
/* Router MAC lookup                         */
/*********************************************/
action rmac_hit() {
     modify_field(l3_metadata.rmac_hit, TRUE);
}

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;
}
```

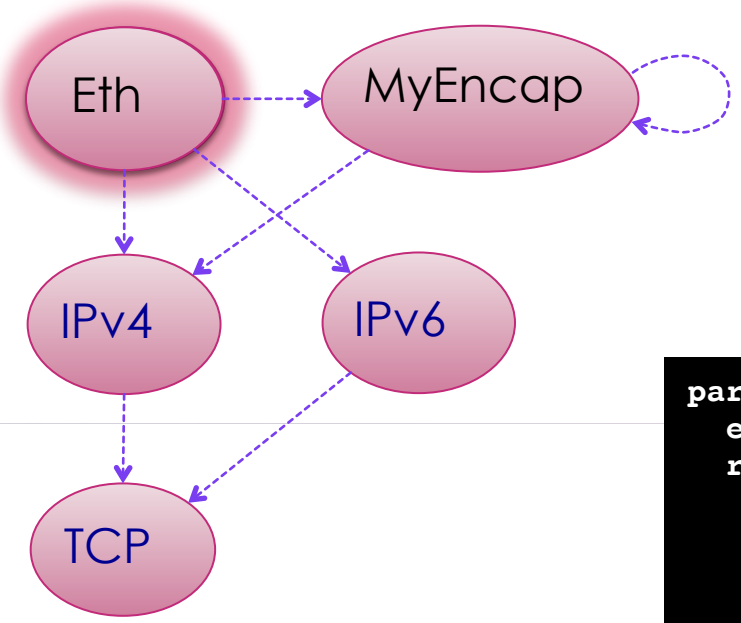
P4: Programming Language for Networking



"High-Level Programming Language for Programmable Networking across the Entire Network"

What does a P4 program look like?



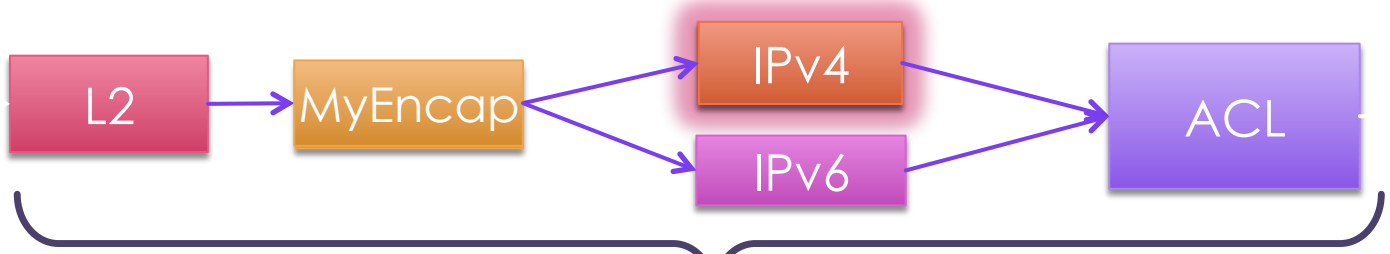



```
header_type ethernet_t {
     fields {
          dstAddr : 48;
          srcAddr : 48;
          etherType : 16;
     }
}
```

```
header_type my_encap_t {
     fields {
          foo : 12;
          bar : 8;
          baz : 4;
          qux : 4;
          next_protocol : 4;
     }
}
```

```
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?

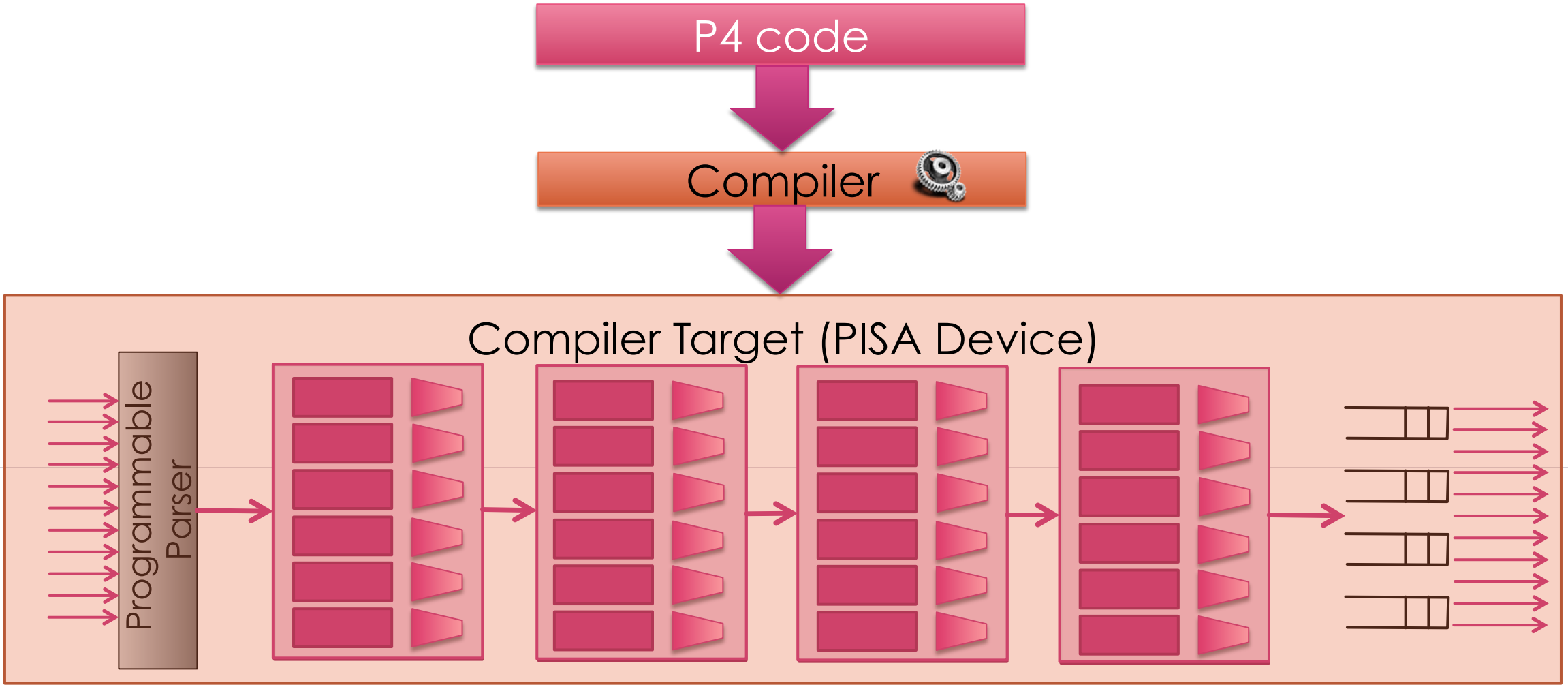



```
table ipv4_lpm
{
      reads {
         ipv4.dstAddr : lpm;
      }
      actions {
         set_next_hop;
         drop;
      }
}
```

```
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 (PISA Device)
Programmable Parser

Networking enters the game

DPDK

Compute

C/C++/...

Compiler

Graphics

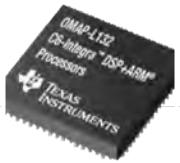
OpenCL/...

Compiler

DSP

C/Matlab/...

Compiler



Networking

P4.org

Compiler

Domain

Domain Specific Language

Compiler

Domain Specific Processor

Now we can ...

- Quickly implement new protocols
- Remove unnecessary complexity
- Flexibly assign table memory to features
- Create new diagnostics, telemetry, monitoring functions, etc.
- Compose forwarding behavior from libraries
- Specify forwarding behavior once; compile to many devices
- Keep your data plane IP from going to your competitors

P4 Language Consortium (P4.org)

- Independent CA non-profit
- Membership is FREE
- Open source
- Apache 2.0 CLA
- 46 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!

- Join P4.org - http://p4.org/join-us

- 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

Questions?

Prem Jonnalagadda

prem@barefootnetworks.com