Interactive Programming for Dynamic Network Probes — A Use Case for POF Data Plane

Haoyu Song, Huawei Technologies
Service Provider’s Pain Point

Lack of real-time and full visibility of network states, so the service provider’s capability of effective and efficient network monitoring and optimization is limited.
Control Loop in SDN

What data to collect — observability
• For routing
• For traffic engineering
• For security
• For health monitoring, trouble shooting & fault diagnosis

What changes to make — controllability
• FIB
• ACL
• Other configurations, e.g., TM
• Refined ways to collect data
• New packet processing functions
Ideal & Reality

Ultimate Visibility: Any time, any where

• Limited available mechanisms
• Limited data plane resource
• Unpredictable data needs
• Limited control-data bandwidth

Ultimate Programmability: Any time, any thing

• Only changes on flow entry and some preset configurations are real time
• Behavior programming is either impossible or incurs long latency
How to close the gap

- Cover every possible function at design time
- Reprogram the data plane when change is needed
- Support real time interactive data plane programming
Open Programmable Data Plane

Decouple

- Hide heterogeneity
- Application reuse

Box w/ fixed function ASIC

Gen 1

Config. time Programming

- Custom application
- One size fits all

Box with programmable Chip

Gen 2

Runtime Interactive Programming

- Real time & on demand
- Interactive & stateful

Box with programmable Chip

Gen 2+
Protocol Oblivious Forwarding

Abstract IR

High Level Language

Compile

Runtime

Apps

static → dynamic

Standard OF-based Configuration & Runtime interface

Programmable Chips/Devices

in Ports → Table → Action → out Ports

match key parameter pointer
dynamically loaded entry dynamically loaded entry

dynamically loaded entry dynamically loaded entry

custom action
dynamically shared resource

2012
OpenFlow 1.3 release

2013
POF project kickoff
POF debut @ SDN Summit
POF paper published @ SIGCOMM
POF PoC demo @ ONS

2014
OCP Networking kickoff
POF paper published @ ONF

2015
ONF PIF WG founded
Join P4 consortium
POF WAN field trial
demo P4 on POF @ P4 Workshop

2016
POF App Demo @ ONS

2012

2013

2014

2015

2016

POF FIS
What POF Promises

**Flexibility**
- Match-action pipeline
- Match on anything
- Customized Function

**Agility**
- Software-based deployment
- Runtime interactive reprogramming

**Low Cost**
- Same device, multiple purpose
- Upgrade on software only
- Open ecosystem
Dynamic Data Analytics on POF

- big data analytics
- dynamic transactional query
- present
- compile
- analyze
- disseminate
- collect
- configure

POF-based Networks

Data Analytics App
- SDN Controller (e.g., ONOS, ODL)
- Config. (e.g., P4)
- Runtime (control & reconfig.)

POF Interface
- Interactive Programmable Device (POF-enabled)
Dynamic Network Probes

- In-band stateful processing — control-data plane bandwidth efficiency
- Dynamic resource allocation — data plane resource efficiency
- Prototyped on NP-based NE40E platform
- Live demo in Huawei’s ONS booth
Applications Using the Probes

**QoE**
- Flow jitter, latency measurement
- Packet drop rate
- Application analysis

**Security**
- DDoS detection
- Deep packet inspection
- Stateful flow monitor

**Customer Care**
- Customer statistics
- Flow tracing
- Root cause analysis

**Optimization**
- Load estimation
- Traffic matrix calculation
- Elephant flow identification
Challenges

• Interactive Programming Language & Compiler
  • Deployment safety guarantee
  • Parallel task orchestration
  • High level data analytics primitives

• Chip Architecture
  • Flexible pipeline
  • Hitless in-service update
Summary

• POF is the most advanced open programmable data plane technology
  • Support interactive programming – agile & flexible data plane
  • Build on top of POF, dynamic probe provides unprecedented network visibility
    • Mine value form network data in real time – killer application addressing key customer pain point
Thank you