Design and Implementation of an OpenFlow Hardware Abstraction Layer

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Motivation

• SDN is reshaping network infrastructure
  – From campus networks to data centers to global-scale network infrastructures to distributed cloud computing
  – Rethinking network control and operation
  – Assumption: An OpenFlow-based control plane will become common in the future
• But, a range of existing provider domains are not OpenFlow-ready
  – Support deployment beyond Ethernet-like networks
  – Shield implementation from velocity and scope of protocol specification changes
  – Consider real-world hardware platforms such as DOCSIS and DWDM
  – Transform (legacy) network elements into OpenFlow-capable devices
ALIEN Hardware Abstraction Layer

• Modular system and software architecture
  – Designed for a large array of devices
    • Programmable platforms (NetFPGA, traditional NPU, multicore CPUs with hardware network enhancements, standard CPUs with software network enhancements)
    • Lightpath devices (DWDM ROADM)
    • Point to multi-point access networks (DOCSIS, GEPON)
  – Decoupling of hardware-specific control and management logic from the network node abstraction
  – Software reusability
• Support multiple OpenFlow versions
• Hide device complexity, technology- and vendor-specific features from the control plane logic
HAL Functional Schematic

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HAL Components and Interfaces

• Cross-Hardware Platform Layer
  – OpenFlow Endpoint
  – OpenFlow Pipeline
  – Virtualization Agent

• Hardware Specific Layer
  – Discovery
  – Orchestration
  – Translation

• Abstract Forwarding API (AFA)

• Hardware Pipeline API (HPA)

• NETCONF/OF-CONFIG
HAL Implementation

HAL based on ROFL/xDPd

Abstract Forwarding API

OpenFlow Endpoint

OpenFlow Pipeline

Cross-Hardware Platform Layer

Hardware Pipeline API

Programmable Platforms

Hardware Driver

EZappliance NP-3

Net FPGA

Dell Split Data Plane

ATCA with Octeon

DOCSIS

Closed-box Platforms

Hardware Driver

Hardware Driver

Hardware Driver

Hardware Driver

Hardware Driver

ADVA DWDM

GEPON

OpenFlow Protocol
HAL in Action

• FIA Athens 2014
  – Video-on-demand in OpenFlow networks
  – Distributed and version-agnostic OpenFlow slicing mechanism
  – Integration of legacy DOCSIS access network under OpenFlow control

• TERENA Networking Conference 2014

• EWSDN 2014 (upcoming)
Conclusion

- OpenFlow support is lacking in production environments where most of the forwarding devices are based on either closed platforms or legacy hardware which is incompatible with the protocol.
- The ALIEN HAL addresses this gap:
  - Software architecture and implementation which aims to complement conventional hardware platforms.
  - Viable, experimentally-tested approach.
  - Platform for development and deployment of OpenFlow on network elements that do not support the protocol out-of-the-box.
- Decoupling of hardware-specific control and management logic from the OpenFlow node abstraction logic.
- Current work: Introduce HAL devices to the OFELIA pan-European SDN experimental facility.
Further Reading

- **Software**
  - Revised OpenFlow Library ([ROFL](http://rofl.org))
  - eXtensible OpenFlow datapath daemon ([xDPd](http://xdpd.org))
  - xDPd-Virtualization plugin ([git](https://gitrepo.org))
  - eXtensible Control Path daemon ([xCpD](http://xcpd.org))

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