Stratum Project

Enabling era of next generation of SDN
Announcements

• Next-Generation SDN
  • A set of next generation interfaces
    • Leverages P4, P4Runtime, OpenConfig, gNMI, gNOI
  • Provides full lifecycle management & control
  • Successor for OpenFlow

• Stratum Project
  • New Open Source Project
  • Complete white box switch software solution
  • Supports next-generation SDN interfaces

• Business Benefits
  • Interchangeability of forwarding devices
  • Programmability of forwarding behaviors
  • Enables a new white-box ecosystem

STRATUM FOUNDING MEMBERS

Cloud Providers:
Google, Tencent

Telecom Operators:
China Unicom, NTT, Turk Telekom/Netsia

Networking Vendors:
Big Switch, Ruijie, VMware

White Box Vendors:
Delta, Edgecore, QCT

Silicon Vendors:
Barefoot, Broadcom, Cavium, Mellanox, Xilinx

Open Source Projects:
CORD, ONL, ONOS, OpenSwitch, OVS, SDKLT
ONF – An Operator Led Consortium with A Track Record of Impact

“Nearly 40% of all end-customers will have service provided by ... CORD by mid-2021”
Roz Roseboro
Heavy Reading

“70% of operators worldwide are planning to deploy CORD”
Michael Howard
IHS Markit

Stratum
• Open Source
• Not a PDF standard
• Supports all aspects of full lifecycle control and management
  • Going far beyond OpenFlow
• New Ecosystem
  • Enabling a vibrant market of white box solutions
SDN Architecture: As Proposed Ten Years Ago

Open Interface(s)

Routing

TE

Mobility

Network Map Abstraction

Separation of Control & Data Plane

Network OS

Packet Forwarding

OpenFlow interface/protocol to Forwarding Pipeline

Programmable Basestation
What have we learned? How can we improve on OpenFlow?

**OpenFlow**

- Addressed 1 of the 4 major areas needed for complete ‘software defined’ management & control
  - OpenFlow only provides pipeline control
  - Pipeline definition is typically in silicon vendor specs
  - Config & operations not addressed

- Used traditional standards process
  - Not ‘software defined’
  - Very long innovation cycle

- Operators found challenges:
  - Proved to be non-deterministic
    - Specifies Match, not Actions
  - Each data plane has differences
  - Hard to deploy latest switching silicon innovations

**Packets**

**Pipeline Definition**
- OpenFlow TTPs relatively static, ambiguous, and specified in a protocol spec

**Pipeline Control**
- OpenFlow Fixed standard, breaking “Software Defined” principles

**Configuration**
- Not Specified
  - SNMP, Netconf & CLI used

**Operations**
- Not Specified
  - No good available options
Next-Generation SDN Interfaces

Next-Generation SDN
Complete set of next-generation interfaces for comprehensive full lifecycle control and automated network management.

Pipeline ‘Contract’ Definition
Expressed in P4 Language (or possibly another language)
On compatible systems can be updated at runtime.

Northbound
Embedded System

Pipeline Control
P4Runtime
Configuration
gNMI with OpenConfig
Operations
gNOI

Packets
programmable pipeline
match action steps

Complete set of next-generation interfaces for comprehensive full lifecycle control and automated network management.
**P4Runtime – works with programmable and fixed pipelines**

### Programmable Pipeline

- **P4Runtime** enables interface to be generated from P4 program
- Controller can work with a variety of data planes without modification
- **P4Runtime Agent** compiles the P4 program
- **P4Runtime Table Management** provides the application interface

### Fixed Pipeline

1. **P4Runtime** is of value even if the data plane is not programmable
2. **P4** can be used to unambiguously describe any pipeline

### Diagram

**Programmable data plane pipeline**

**Fixed-function data plane pipeline**

**Table:**

<table>
<thead>
<tr>
<th>match</th>
<th>actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packet</td>
<td>Packet</td>
</tr>
</tbody>
</table>
Next-Generation SDN Interfaces

- **P4 (for pipeline definition)**
  - Defines the logical pipeline behavior that is silicon-, pipeline-, and pkt header-agnostic
  - Defines ‘contract’ between NOS and data plane

- **P4Runtime (for pipeline control)**
  - Message payloads derived from P4 program defining the pipeline
  - Allows for run time changes to the contract on systems with programmable silicon

- **gNMI using OpenConfig models (for configuration)**
  - Manage configuration (with persistence across reboots)
  - Stream telemetry

- **gNOI (for operations)**
  - Autonomous actions for debugging and operating a production network
  - Device reboots, key management, BERT & ping testing

All running over gRPC, which has many advantages:
- Built on HTTP/2 for a high speed, bi-directional streaming, multiplexing, security
- Uses ProtoBuf, supporting many more languages and optimized for low latency
Benefits of a Centralized NOS

- Centralized NOS gets a complete and up to date view of all:
  - Forward state
  - Configuration state
  - Connectivity and end-to-end flow state
  - Performance status

- With a global view, one can build a tool chain to do:
  - Network Verification
  - Network Debugging
  - Change Management – verifying a change won’t break anything
  - Lifecycle Management – bring-up, apply config, upgrades, rollbacks, etc.

- Intent-based networking then becomes possible:
  - Operators define policy
  - Proposed changes are calculated
    - Automatically generate flow table and configuration change
  - Before applying, verify how changes would affect the network
  - Apply changes, with ability to perform automated rollback
  - Verify changes are having desired affect
Stratum: Open Source Thin Switch Implementation

- Open Source streamlined implementation for a thin switch
- Implements next-gen SDN interfaces northbound to NOS
- Supports full lifecycle necessary for control and management
  - Configuration
  - Control
  - Operations
  - Optional pipeline programmability
- NOS could be external or embedded in the same switch
Stratum Goals

• Primary Goal - Interoperability
  • ‘Contract’ between the Network OS and data plane so behavior is deterministic
    • ‘Contract’ in code (unlike a PDF standard), eliminating ambiguity
    • Automated verification of the ‘contract’, to make it easy to deploy latest technologies
  • Complete set of interfaces for full lifecycle control and management

• Secondary Goal - Full pipeline programmability
  • Make it possible to create highly optimized custom ‘Contracts’
  • Each operator can specify in detail what they require
Stratum Benefit for Vendors

Next-Generation SDN Enables Silicon and Box Vendors to Bring More Value to Network Operators with Reduced Time-to-Market and Reduced R&D
Stratum Timeline

• Incubation – 2018
  • Project Members have full access to code
  • Others can join with FTE resource commitment

• Open Phase – Expected Early 2019
  • Open Sourced
    • Apache 2.0 license
  • Expecting a Complete Ecosystem when Released:
    • Multiple interoperable solutions (including support on some legacy systems)
    • Variety of silicon options
    • Selection of white box suppliers ready with shippable product

Google has stated they plan to take Stratum into production at scale in 2018
Realizing Full Potential of Software Defined 

**Software Defined**

- Definition of Forwarding Pipeline
- Control of Forwarding Pipeline
- Dynamic Configuration of Network Devices
- Operation of Network Devices

**Enable Network Operators To**

- Define unambiguous ‘contract’ between NOS and data plane
- On compatible systems, enables runtime customization of forwarding behavior ‘contract’
- Reduce overhead to insert a new device into network (simplifying upgrade cycles)
- Enable a new market for white box systems with choice of silicon

**Net Result**

A Network Infrastructure supporting:

- Greater Velocity of Innovation
- Greater Reliability and Availability
- Much lower CapEx and OpEx
Backup
Understanding Landscape of Open Switching & Routing Projects

- **Control & Management**
  - FRR (replacing Quagga) – Routing protocols
  - ONOS – External Network OS (SDN Controller)
  - ODL – Centralized configurator for traditional networking devices

- **Data Plane**
  - ONL
    - **Stratum**

- **Forwarding Toolkits (Silicon APIs)**
  - SAI
  - SDKLT – New Broadcom project

- **Traditional - Tightly Coupled Solutions**
  - dNOS – Management and routing protocols
  - SONiC – Management & Routing, using SAI

Control & Mgmt

Data Plane

Forwarding Toolkits

Tightly Coupled Solutions

Traditional Devices package everything together

Control & Data plane are separated in SDN solutions
Stratum Components

Remote or Local Network OS (NOS)

P4Runtime   gNMI   gNOI

Switch Interface

Table Manager   Node Manager   Chassis Manager

Silicon Abstraction Managers
  e.g. ACL, L2, L3, Packet I/O, Tunnel

Platform Manager

Silicon SDK (API)   Platform API

Silicon Drivers   Platform Drivers

Switching Silicon   Peripheral(s)

Shared (HW agnostic)
Silicon specific
Platform specific
Silicon and Platform specific

user

kernel

hardware
Thank You