Atrium Field Trial

Phase 1 - Test Report

NOV 2016

This test report is an evaluation of readiness of Open Flow based BGP peering router (Project Atrium) for the upcoming service provider field trial.

Atrium is one of the Open Source SDN efforts supported by the Open Networking Foundation. The test report is based on independent testing conducted by Criterion Network Labs and is first in a series of a test reports that captures the readiness of the open source routers, controllers and vendor switches participating in the field trial.

Criteron Network Labs, one of the ONF approved Open Flow interoperability test labs undertakes independent testing, interoperability and certifications for network operators and product vendors in the SDN/NFV domain.

The Atrium BGP peering router is one of the use case requirements from SIFY, an ICT solution provider and an SDN/NFV Alliance member of Criterion Network Labs.

SIFY plans to underake field trial tests for an Open Flow based BGP peering router based on Atrium distribution in Q1 2017. The core field trial requirements of the customer are independently validated at CNLabs. The solution will additionally undergo formal acceptance testing at SIFY before field trial deployment.

Write to cnlabs@criterionnetworklabs.com for additional questions and clarifications related to the test report.

INTRODUCTION

Project Atrium is one of the Open Source SDN projects from Open Networking Foundation. The goal of the project is to provide integrated SDN solutions for network operator use-cases while achieving interoperability across multiple switch products. Atrium distributions include concepts like Flow Objectives that allow for interoperability across different implementations of Open Flow switch pipelines.

Atrium distributions are open source, integration tested and prequalified for near production quality. Since 2015, it has been demonstrated at various forums including the SDN world congress and more recently at Open SDN India.

Atrium 16/A is the most recent distribution of Atrium for the service provider solutions. Along with the routing application, the distribution includes support of flow objectives interoperability module for ONOS and Open Daylight controllers.

The SDN BGP router implementation uses Quagga for control plane learning, a BGP speaker application on the SDN controller and implement flow objectives to program Open Flow capable switches.

Additional details on Open Flow based BGP peering router is available at https://github.com/onfsdn/atrium-docs/wiki.

SCOPE AND OBJECTIVE

The objective of the test effort is to ensure that the participating vendors and open source components meet all the core requirements identified for the field trail. The requirements are validated in a phased manner prior to acceptance testing at the customer site.

Gaps identified during each phase of testing are shared with the participants and the Atrium project team atrium_eng@groups.opensourcesdn.org. Requirement gaps must be resolved by field trial participants to be included in the next phase of test efforts. SIFY, the field trial customer might add additional requirements to be met based on the results of each phase of testing,

Phase 1:

- Validate core functional requirements
- Baseline tests and characterization
- SDN control plane learning/programming

Phase 2:

- IPv6 and MPLS support
- Data plane characterization
- Additional control plane requirements
- System level tests

Phase 3:

- Full test report with member switches

- Phase 3 test report will be disclosed publicly only if the vendors provides explicit consent to share the results

PARTICIPANTS

SIFY is one of the largest integrated ICT Solutions and Services companies in India, offering end-to-end solutions.

The comprehensive range of products from SIFY are delivered over a common telecom data network infrastructure and reach more than 1300 cities and towns in India. SIFY's telecom network connects 38 Data Centers across India including SIFY's 6 Tier III Data Centers across the cities of Chennai, Mumbai, Delhi and Bengaluru.

As part of their next generation network transformation initiatives, SIFY has been evaluating virtual provider edge gateways based on Open SDN solutions. The field trial of the Open Flow based Internet Gateway router is the first step of a phased field trial at SIFY towards achieving this end goal.

The current list of participants in the field trail include switches from Extreme Networks, Noviflow and SDN controllers from ONOS, Open Daylight and Open MUL.

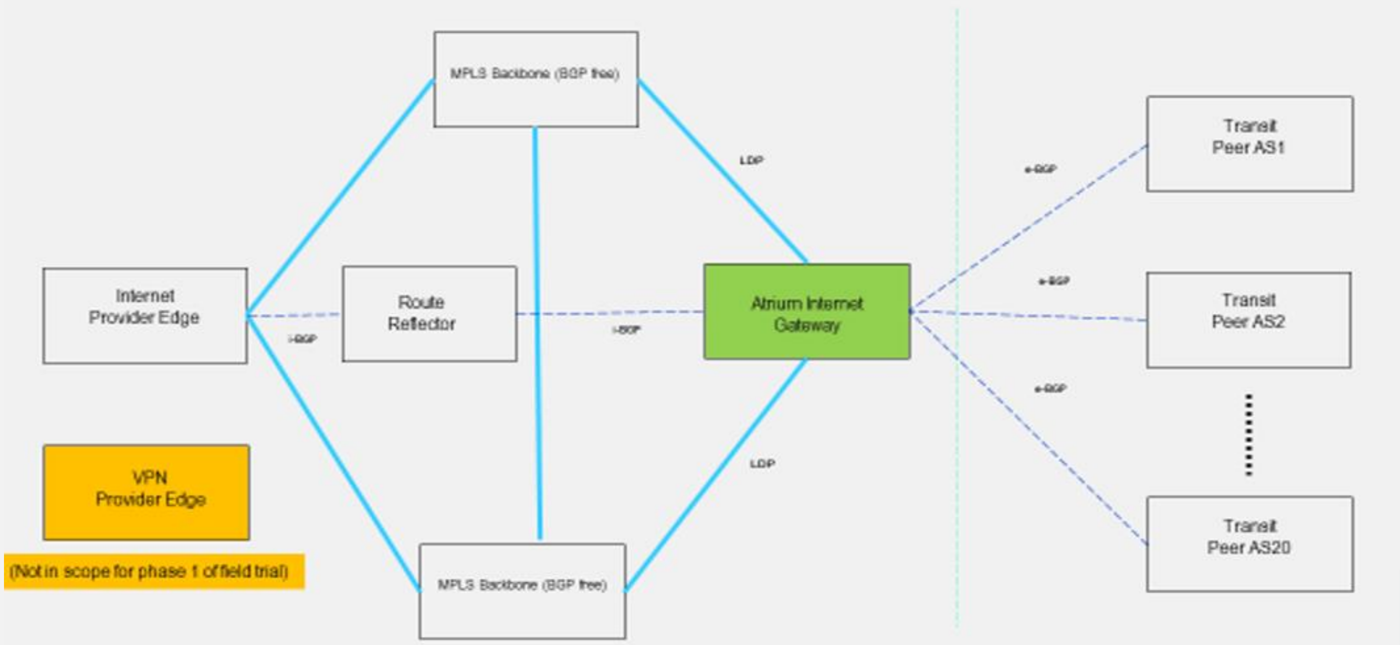
IXIA and Spirent provide traffic generation and network emulation capabilities for the test environment.

OPEN SOURCE SDN

CNLABS

DEPLOYMENT OVERVIEW

The test topology is a simple representation of SIFY's provider network. For the first phase of the field trial, SIFY is evaluating the implementation of the Open Flow based Internet Gateway router at the Tier-1 POP. The Atrium internet gateway provides internet connectivity to the enterprise customers connected to the Internet and VPN provider edge routers.

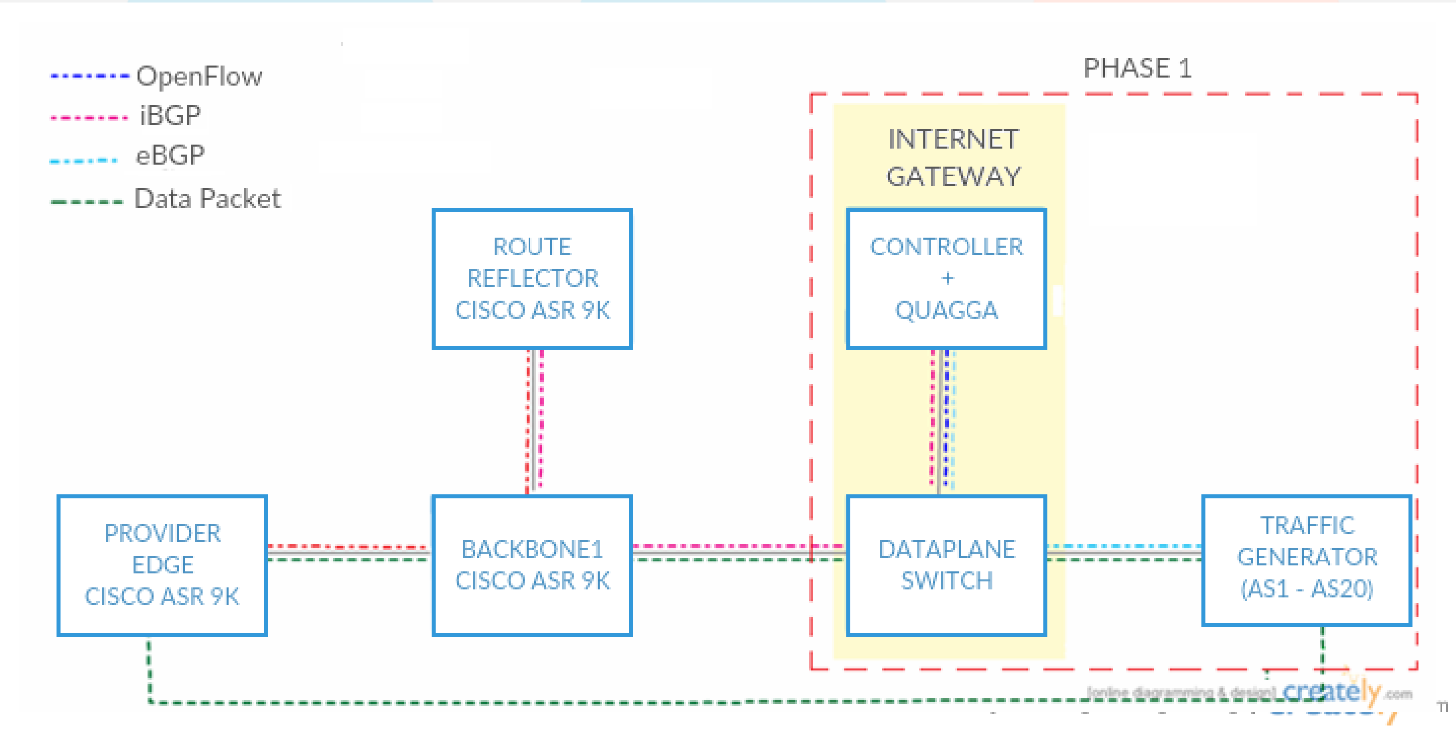


- Each Tier-1 POP has 1 Internet Gateway Router and 1 Route Reflector to provide internet connectivity for several internet provider edge routers connected to the MPLS backbone
- Each Internet Gateway Router is required to peer with
    - Up-to 20 transit peers using eBGP
    - 1 route reflector using iBGP
    - 2 MPLS neighbors using LDP
- Full internet feed and default route (IPv4 + IPv6) is received from transit partners. Internet routes are reflected to all Internet edge routers through Route Reflectors
- Route reflectors handle control plane traffic only. Best path routing decision is done by RR using traditional BGP algorithm
- The Internet Gateway and Provider Edge devices are required to handle full RIB and FIB

TEST CONFIGURATION

Phase 1 test efforts is focused on functional testing and baseline characterization of the control plane. Vendor switches are not included in this phase of testing and OVS (version 2.3.1) is used instead as the Open Flow Switch. Cisco ASR 9000s are used as the provide edge and route reflectors and additionally to emulate backbone network. However, as noted above this phase of testing does not focus on all aspects of the final test configuration.

The control plane applications (Quagga + SDN controller) are hosted on a general-purpose rack server. All servers in the test-bed have identical hardware configuration and use Intel® Xeon® CPU E5620, 2.4 GHz quad core processors with dual CPUs. The next phase of test efforts will use the actual server hardware configuration recommended by the customer.



To ensure identical test conditions, all controller distributions are hosted on virtualized environments. VMWare (ESXi 5.5.0) with a base Linux distribution of Ubuntu 14.04 is used in the test configuration.

Quagga 0.99.24.1 and 0.99.22.1 with SDN controllers ONOS (1.5.0) and OpenMul (5.10.20) respectively, provide the control plane function. IXIA and Spirent emulate route updates from the internet peers.

As captured at the outset, the focus of phase 1 testing is to validate

- If SDN controllers and routing application meet the core functional requirements
- Characterize route learning and flow programming time using Quagga router for various traffic profiles
- Control plane learning and programming times with SDN controllers using Open Virtual Switch

TEST SUMMARY AND ANALYSIS

Core requirements

The purpose of this test section is to identify if the Quagga router and all evaluated SDN controllers meet the core functional and scale requirements for the field trial and to identify gaps in the control plane requirements. Given that the focus is on validating control plane functionality, all the testing is conducted using OVS 2.3.1 as the Open Flow forwarding plane.

SDN Controller Name	ONOS	OpenMul	ODL
SDN Controller Version	1.5.0	5.10.20	—
Quagga Router Version	0.99.24.1	0.99.22.1	—
Support for IPv4			Not Tested
Support for IPv6	Fail	Fail	Not Tested
Support for i-BGP and e-BGP			Not Tested
GTSM and MD5 authentication			Not Tested
BGP route policies			Not Tested
Support for 4 Byte ASN			Not Tested
BGP flow spec (optional)	Not Supported	Not Supported	Not Tested
Route dampening (optional)			Not Tested
Must support LDP processing	Phase 2	Phase 2	Not Tested
Peer with 20 transit peer routers each advertising 30K routes			Not Tested
Learn and program 450K routes from one transit peer			Not Tested
Learn and program 600,000 IPv4 routers and 30,000 IPv6 routes	Fail	Fail	Not Tested

Quagga with all tested SDN controllers met most of the core requirements. However, support for IPv6 was not available on both the controllers at the time of testing. The support for missing features is being developed by the member communities and will be included in the scope of Phase 2 testing as the features are made available. Tests were not conducted using the Open Daylight Controller as part of the first phase of testing due to resource constraints.

Detailed test methodologies are available at https://github.com/onfsdn/atrium-docs/wiki/Atrium-Field-Trial

Baseline Characterization Tests

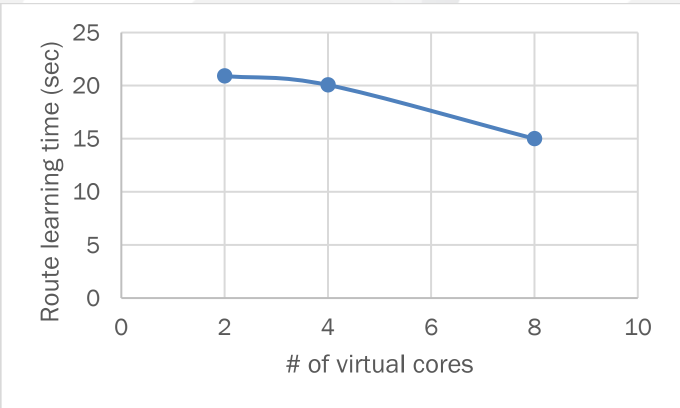
This purpose of this test section is to baseline the characteristics of the control plane and finalize the test methodology that will be applied for future phases of testing. All tests in this section are conducted using Quagga as the router that with integrated control and forwarding plane and with no SDN controller using the identified hardware configuration.

The measurements in this section will be used to measure key test parameters, finalize test methodologies and to assess the performance impact when an SDN controller with an Open Flow switch is added to the test environment.

The baseline characterization tests will be repeated any time the underlying hardware configuration is changed.

Case 1: Route learning time vs processor cores allotted to virtual machine

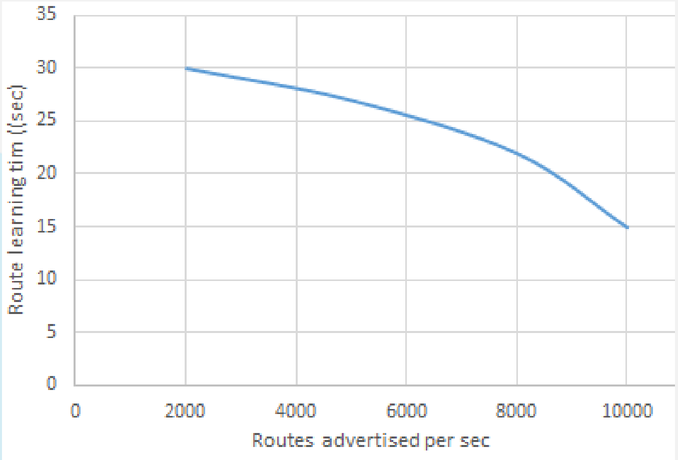
Test profile - 600K routes, 20 eBGP peers, 30K routes/peer, non-overlapping route updates with 10000 route updates/sec, 2-8 virtual cores



It was observed that that the performance is optimal when 6 virtual cores are allocated to the virtual machine that hosts Quagga. Given that in a Quagga + SDN Controller test scenario the same hardware resources will need to be shared by both the router and controller, it was decided to allocate <u>8 virtual cores for control plane VM</u> in the test-bed.

Case 2: Route learning time vs number of route updates for each BGP peer

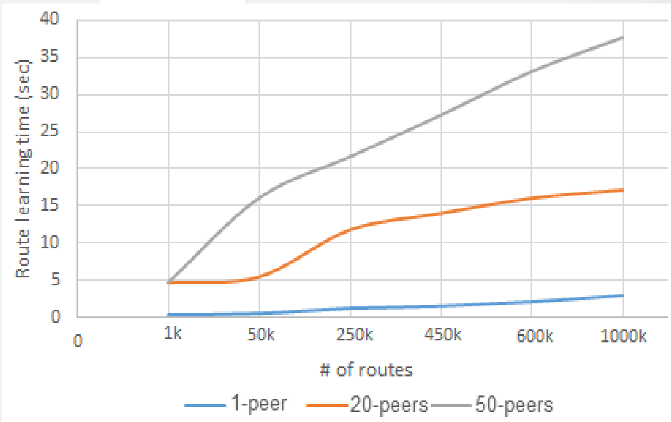
Test profile - 600K routes, 20 eBGP peers, 30K routes/peer, non-overlapping route updates, 8 virtual cores allocated to the control plane VM, 2000-10000 route updates/sec



As the number of simultaneous route updates per peer is increased, the route learning times are faster. Based on the observation, the <u>number of route updates per second is set to 10000</u> for all further testing.

Case 3: Route learning times vs number of peer routers vs number of routes

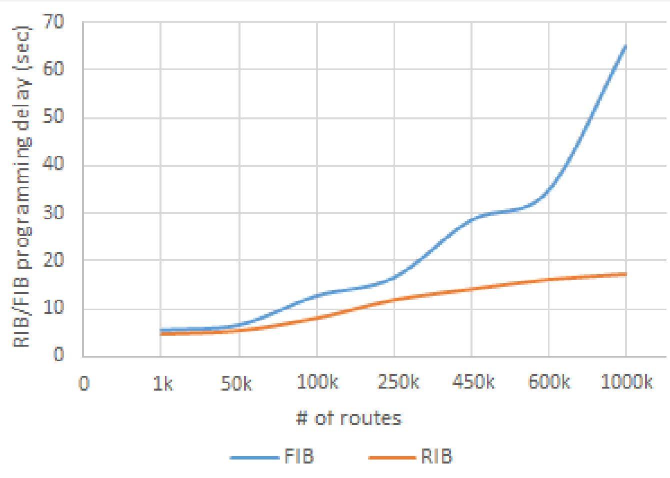
Test profile - 30K routes/peer, 10000 route updates/sec, non-overlapping routes, 8 virtual cores allocated to the control plane VM, 1K to 1M routes, 1 to 50 eBGP peers



For future tests, <u>20 eBGP peers with 600K routes</u> will be used as a baseline data for core measurements.

Case 4: Route learning vs route programming time using Quagga/Zebra and Linux kernel for forwarding

Test profile - 20 eBGP peers, 30K routes/peer, 10000 route updates/sec, non-overlapping routes, 8 virtual cores allocated to the control plane VM, 1K to 1M routes



The reference data above for route learning vs route programming times for a non-SDN router will be used to compare test results when identical configurations with SDN controllers are deployed.

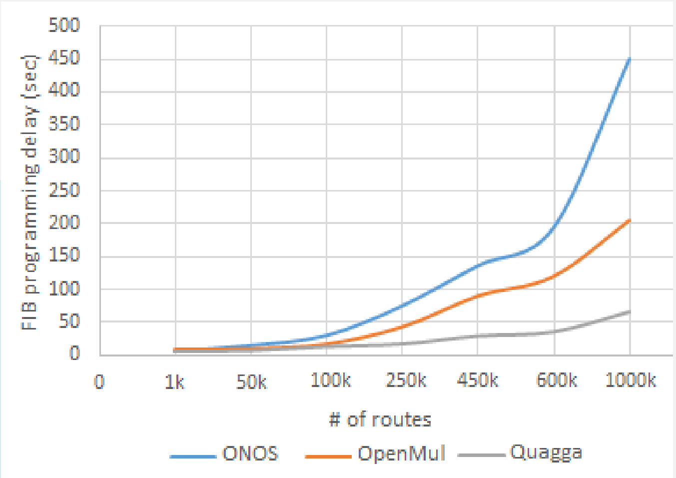
Flow programming time with SDN routers

This section characterizes difference in performance observed when SDN test controllers with an external Open Flow Switch is added to the baseline test configuration.

Test scenario: Route learning times vs route programming time using SDN controller and data plane

Test profile - 20 eBGP peers, 30K routes/peer, 10000 route updates/sec, non-overlapping routes, 8 virtual cores allocated to the control plane VM hosting both Quagga and SDN controller, 1K to 1M routes.

Flow programming times is observed on the OVS when the flows are installed and active on the Open Flow switch.



The table below captures the time taken to program the switch for the boundary conditions identified in the core requirements.

# of advertised routes	Route Learning time for ONOS (in sec)	Route Learning time for Open MUL (in sec)
600k Non-Overlapping Route Updates	194	120
600K with 30% Overlapping Route Updates	175	90

CONCLUSION

This concludes the first phase of the pre-testing efforts undertaken for the Atrium Field Trial. Other than identifying implementation gaps, the core focus of this test effort has been to characterize baseline performance on known hardware configurations and identify repeatable test methodologies that can be applied to future phases of testing.

The next phase of test efforts will validate support for IPv6 and MPLS routes - two key requirements that were not met due to non-availability of these features on the SDN controllers at the time of Phase-1 testing. The tests would also involve system level tests and additional characterization of the control and data planes. Additional test scenarios identified for the field trail based on feedback from SIFY will also be included in the test report.

Subscribe to atrium_eng@groups.opensourcesdn.org to participate or to get additional information on the progress of the field trial.