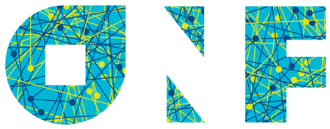

OPEN NETWORKING FOUNDATION

SDN Interoperability Event Technical Issues Report AppFest 2015

Testing-Interop Working Group

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Open Networking Foundation
2275 E. Bayshore Road, Suite 103, Palo Alto, CA 94303
www.opennetworking.org

1 Introduction

ONF organized the first SDN Application Interoperability event, (the seventh in a series of interoperability events) at Ericsson, Santa Clara from May 18th – May 22nd 2015. Around 60 participants from various vendors and communities participated. Products from 7 switch vendors, 9 controllers and 4 test tool vendors took part in the event. For the first time, non ONF member companies also participated.

While the objective of the prior interoperability events was primarily to uncover potential incompatibilities in Open Flow implementations across SDN switch and controllers, the ONF interoperability event of 2015 was heavily focused on exposing issues encountered while running SDN applications across different controller and switch platforms. Each SDN controller vendor exercised up to three application use cases scenarios on a multi-vendor switch fabric.

With the Open Flow 1.3 specification in the final review phase, test tool vendors used the opportunity to validate the latest versions of the conformance test suites as part of the event. Test tools implementing Switch and Controller benchmarking suites were also part of the event and the inputs will be reflected in the benchmarking methodologies that are currently under development.

This document summarizes the list of major issues uncovered as part of the plug fest with observations/recommendations. The purpose of this document is to increase awareness among SDN application developers, controller, switch and test tool vendors so that steps can be taken to avoid their recurrence in the future deployments. Learnings from the event will also lead to publishing of best practices documents for specific areas that would benefit.

As with the previous plug fest events, vendor names are not explicitly referred to as part of this report to protect the confidentiality of participants.

2 Test format

Identifying issues with application interoperability was the key focus. Uncovering Open Flow 1.3 protocol interoperability issues between switches and controllers was a secondary objective.

Open Flow 1.3 or higher was the southbound protocol of choice for the switches in the interoperability test-bed. Participants were required to pre-validate applications with supported controllers using at-least one identified switch prior to the event.

- Two test-beds for Application Interoperability testing
- Seven sandboxes for conformance and benchmarking tests
- Scheduled test slots for application testing (scheduling is done by each controller vendor); no prior scheduling for conformance and scale test pods

- Bring up tests – Identify basic implementation issues across controllers and switches (Basic testing - channel setup, discovery, flow programming)
- Validate application functionality on multi-vendor switch test-bed (based on a published test plan for each application)
- Test suites for controller and switch benchmarking (based on benchmarking test plans under development)
- Conformance test suites implementing the approved Open Flow 1.3 test specification

3 Issue Summary

A high level summary of the issues and observations from the App Fest 2015 Interoperability event is captured below.

- Several issues identified were related to the fact that applications and controllers were not aware of the different open flow switch pipelines. Among others, this predominantly manifested as interoperability problems in topology discovery and flow programming scenarios.
- Switch implementation issues with multiple actions / instructions
- Some issues were due to incorrect implementation / bugs on the switches and controllers, but as in the case of Fall 2014 plug fest event many of these were not basic interoperability issues
- Error reporting of switches was better (improvement from previous plug fests)
- Test tools had performance issues with multi table tests; some observations while validating the conformance test suites led to updating the test specification
- Since many applications were tightly integrated in the controller, it was not possible to test the controller with multiple applications

The next section captures in detail the interoperability issues found during the AppFest event. Application, switch, controller and test tool vendors should watch out for these interoperability issues as they proceed with their product development efforts and have means of handling these issues gracefully should these scenarios occur in the field.

4 Interoperability Issues

This section lists all the issues reported at the ONF App Fest 2015 event. The device field identifies the component that contributed the most to the interoperability issue. Impact level is an indicator of the severity should the interoperability scenario be uncovered in a real world deployment. Details provide more information on why the issue was uncovered and might contain additional recommendations.

No default pre-configured table: Device: Switch: Impact: 3

Where a switch may not have pre-configured table defined by default, it relies on the controller to send multipart table feature request to configure switch table. In these cases, if an attempt is made to program a flow before sending a multipart table feature message, the switch will return an error indicating that the "Table does not exist".

Details: It is recommended that switches with flexible table implementations have default table capabilities advertised on boot up. Controllers should have implementations to address cases where switches do not have a default pipeline configured.

Table configuration: Device: Application: Impact: 3

Some switches expected flow table features to be explicitly configured, in particular which fields are to be matched on and whether the fields can be wild carded. The application was not aware of this information and the switch had to be setup manually.

Details: Switch tables might require configuration by the application or controller for exercising intended functionality.

Flow programming on non-table 0 switch implementation: Device: Switch Impact: 2

While several switches support capabilities from table 0, one of the switches started from table 100. So the controller had to be specifically programmed to push flow to table id 100 before pushing the flow. With different table id from different switch vendors, some mechanism is required to ensure interop of controller with various switch vendors.

Details: Controllers should support TTP or some other method to negotiate data paths to understand the switch capabilities beforehand. Where applications do not have a need to directly write into switch tables, mechanisms like App TTPs could be used to achieve abstraction.

Controller limitation where table 0 read-only: Device: Controller: Impact: 4

Some controllers disconnected the control channel from switches that had implemented table 0 as read only, because they were not able to modify the entries

Details: This issue is similar to the above problem where table 0 does not support modifications of flows and supports just a GOTO table action. Controllers must be equipped to handle this scenario where table 0 might be read only.

Application flow prog. for non-table 0 devices: **Device: Application: Impact: 3**
For switches that expected flow rules to be writeable into flow table 100 and not table 0, the applications did not detect this correct flow table had to be specified manually.

Details: In addition to necessity of the controllers to be pipeline aware, applications that have a necessity to program flows directly to the switches directly need to be aware of the switch pipelines.

Topology discovery: **Device: Controller: Impact: 4**

For topology discovery, controller writes LLDP rules to table 0, whereas some switch tables start from table 100 causing issues with topology discovery. Controllers needs to support vendor specific rule pipelines (e.g. TTP)

Details: Controllers need to be aware of device pipeline before using mechanisms like LLDP for topology discovery.

Reliability of topology detection: **Device: Switch, Controller: Impact: 2**
Some restarts were needed for controller and switches to get the topology right. In some after reboot LLDP packets were forwarded out from wrong ports. State synchronization was incorrect between controller and some affected switches.

Details: Possible bugs

Incorrect topology discovery: **Device: Controller, Application: Impact: 2**
In some cases controller listed links to nodes that were not connected to controller. This caused problems during the tests, for example path computation in the application.

Details: Applications can be made more robust if they can additionally verify information from the controller.

Prerequisite for L2 match: **Device: Switch: Impact: 3**

Controller programed flows with L3 match with IP source and destination. Multiple switches reject flows with error message "prerequisite was not met". After a bug fix on the controller to include match of Ethernet type, flows could be successfully pushed to the switch.

Details: Bug on the controller where pre-requisite was not specified as part of the match request.

Multiple instructions: Device: Switch: Impact: 1

One of the applications for monitoring used two instructions in one flow to do monitoring. Some switches could not handle output actions and actions in the goto-table at the same time. Rules had to be changed to support particular vendor pipelines.

Details: Multiple unique instructions for a flow are supported by OpenFlow and mandatory instructions must be supported (section 5.9). Controller must be equipped to handle the scenarios.

Switch limitation with multiple actions: Device: Switch: Impact: 2

Some switches did not handle flow rules whose actions include both forwarding to a port and forwarding to the controller.

Details: Bug on the switch that was eventually fixed

Usage of max_entries: Device: Switch: Impact: 2

Max-entries should be read-only, but the switch is using this value in table_features to reconfigure the size of the table.

Details: Switch should not reconfigure the size of the table based on max_entries unless it is same as the value that was shared by the switch as part of a previous update to the controller.

Message length: Device: Switch, Controller: Impact: 3

The switch sent packet-in messages to the controller that the controller could not understand. (The total_len field was set to the total length of the OpenFlow packet-in message, as opposed to the length of the packet being forwarded.) As a result, the controller dropped the connection, even though the spec says that the controller should ignore malformed messages (section 5.3.2). The controller has since been fixed to deal with malformed messages properly; however the incompatibility still remains.

Details: The switch had a bug that reported the total_len field inaccurately. But in such cases, the controllers should handle malformed messages gracefully.

Error Messages: Device: Switch: Impact: Info

If a flow is rejected, switch should include proper error message code. Most switches returned the proper message code which made trouble shooting earlier.

Details: Error message implementation on switches has improved and is an improvement from previous plug fest events.

Packet_IN for ARP: Device: Switch: Impact: 4

Switch did not send packet-in to the controller even if the laptop connected to it sent out an ARP request. On the other hand, Packet-in for LLDP was successful.

Details: Switch bug

Test specification update: Device: Test tool: Impact: 4

An update was made to the test methodology for test case 100.60 in the Open Flow 1.3 test specification to accommodate testing for switches that do not support OFPPC_NO_FWD port configuration.

Length of Packet_IN message: Device: Test Tool: Impact: 3

Switch generates packet_in with miss_send_len due to reasons like invalid TTL. However if the reason is explicit output to controller action miss_sen_len is not applicable. The test tool expect the miss_send_len to be used for this case as well which caused the test case to fail. (Section 7.4.1 of test specification)

Details: Test tool bug

Scale->Multi table tests: Device: Test Tool: Impact: 3

Large multi-table pipelines caused performance issues when performing multi-table tests.

Scale->Flow installation: Device: Test Tool: Impact: 4

Flow installation not flexible enough to handle unique multi-table pipelines.

5 AppFest 2015 Participants

- SDN applications – BlueCat, Ericsson, Decimus Capital Markets, GaTech, Infoblox, Institute for Information Industry, Kemp, Luxoft, NEC, Network Protector
- Switch vendors - Allied Telesis, Ericsson, HP, Infoblox, NoviFlow, Tallac Networks
- Controllers - Ericsson / OpenDaylight, Hewlett Packard, Inocybe, Infoblox, NEC
- Test tools – INCNTRE, IXIA, Luxoft, Spirent

6 References

- ONF Interoperability Test Reports – Mar-12 / Oct-12 / Jun-13 / May-14 / Nov-14
- Open Flow 1.3 Specification - https://www.opennetworking.org/images/stories/downloads/sdn-resources/onf-specifications/openflow/openflow-switch-v1.3.4.pdf
- Open Flow Single Table Conformance Specification - https://www.opennetworking.org/images/stories/downloads/working-groups/OpenFlow1.3.4TestSpecification-Basic.pdf
- TTP 1.0 - https://www.opennetworking.org/images/stories/downloads/sdn-resources/onf-specifications/openflow/OpenFlow%20Table%20Type%20Patterns%20v1.0.pdf
- https://www.opennetworking.org/images/stories/downloads/sdn-resources/technical-reports/TR_Multiple_Flow_Tables_and_TTPs.pdf

7 Revision History

Version	Date	Notes
0.1	Aug 5th 2015	Initial version – Kumar Jayaprakash, CNLabs
0.2	Mar 13th 2016	Updated list of AppFest participants