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University of New Hampshire
InterOperability Laboratory

PON TESTING SERVICE

PON Integrator Test Plan

1.0

TECHNICAL DOCUMENT

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INTRODUCTION

Overview

The University of New Hampshire's InterOperability Laboratory (UNH-IOL) is an institution designed to improve the interoperability of standards based products by providing an environment where a product can be tested against other implementations of a standard.

Note that successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other compliant devices. However, combined with satisfactory operation in the UNH-IOL's interoperability test bed, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most environments.

Organization of Tests

The tests contained in this document are organized to simplify the identification of information related to a test and to facilitate the actual testing process. Each test contains an identification that describes the test and provides cross-reference information. The discussion section covers background information and specifies why the test is to be performed. Tests are grouped in order to reduce setup time in the lab environment. Each test contains the following information:

Test Number

The Test Number associated with each test follows a simple grouping structure. Listed first is the Test Group Number followed by the test's number within the group. This allows for the addition of future tests to the appropriate groups of the test suite without requiring the renumbering of the subsequent tests.

Purpose

The purpose is a brief statement outlining what the test attempts to achieve. The test is written at the functional level. The section may also cover the assumptions made in the design or implementation of the test, as well as known limitations. Other items specific to the test are covered here.

Test Configuration & Setup

The setup section describes the initial configuration of the test environment. Small changes in the configuration may be included in the test procedure.

Procedure

The procedure section of the test description contains the systematic instructions for carrying out the test. It provides a cookbook approach to testing and may be interspersed with observable results.

Metrics (pass / fail criteria)

This section lists the specific observables that can be examined by the tester in order to verify that the DUT is operating properly. When multiple values for an observable are possible, this section provides a short discussion on how to interpret them. The determination of a pass or fail outcome for a particular test is often based on the successful (or unsuccessful) detection of a certain observable.

TABLE OF CONTENTS

TEST SETUP & CONFIGURATION

This section provides general information about test setups, configurations, and other information that may be common across the test plan. Individual test cases may include additional information, changed, or diagrams, as required for the specific test case.

Physical Test Setup

Figure 1 below shows the basic physical layer test setup used throughout this test plan. The setup may include one or more ONU devices, while the figure shows only 2 devices for clarity.

Fiber connections are each labeled as using either A' or A, where the "prime" indicates the connection between the OLT and optical splitter, while none prime case references the connection from the optical splitter to the ONU. Fiber connection A corresponds to ONU1, connection B for ONU2, and so on.

Unless otherwise specified in the specific test case, all connections are 3m in physical length. In this case, each optical connection from the OLT (e.g. A') shall include an additional optical attenuator of 10 dB. For test cases specifying a fiber length greater than 3m, the additional optical attenuator shall be removed or moved into the 3m path.

The Optical Splitter shall be a 1:8, unless otherwise specified within a specific test case. The test report shall include the specific model of the optical and its optical insertion loss.

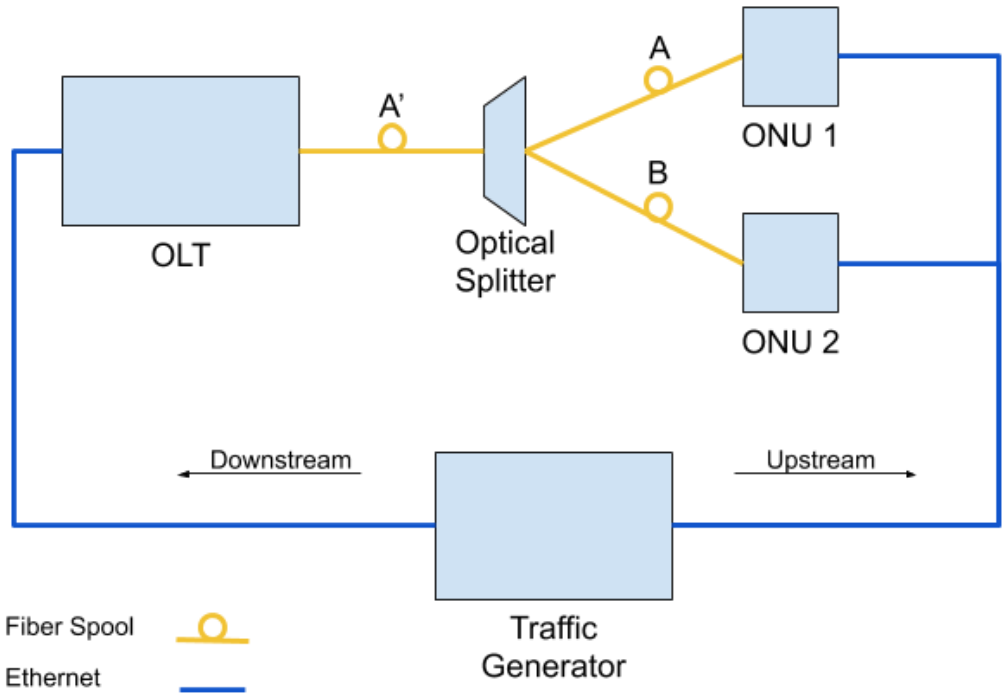

Figure 1: Basic Physical Layer Test Setup

REFERENCES

The following references are of relevance to this Test Plan:

Document	Title	Source	Year
[1] TR-255 Issue 1	GPON Interoperability Test Plan	Broadband Forum	2013

1. ONU Provisioning and Management Tests

1.1 ONU Provisioning According to Serial Number

Compliance with this test requires the following test to be performed according to [1]: *6.8.1 ONU provisioning according to serial number test case.*

1.2 ONU Provisioning According to the Registration-ID

Compliance with this test requires the following test to be performed according to [1]: *6.8.2 ONU provisioning according to the registration-ID test case.*

1.3 Remote Reboot & Troubleshooting

Purpose:

The purpose of this test is to ensure the OLT is able to instruct the ONU to perform a full reboot and the ONU responds to the instruction properly.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Only one ONU is required for this test.

Procedure:

1. Once the ONU is fully ranged and active on the PON, verify the OLT reports the operational status of the ONU as “up.”
2. Configure the OLT to reboot (forced if necessary), the ONU.
3. Observe the ONU to verify it appears to reboot (i.e. LEDs shut off, or the ONU debug console reports a reboot). If possible, verify the ONU process is a “cold boot” (full reload of its operating system.
    a. Note: This may only be possible on ONU devices that support additional local debug access.
4. While the ONU appears to be rebooting, verify the OLT lists the ONU operational status as “down.”
5. Allow the ONU to complete its reboot process.
6. Verify the OLT reports the ONU operational status as “up.”

Metrics (pass/fail criteria):

1. The ONU must correctly respond to the reboot requests and perform a full reboot.
2. The OLT must correctly report the ONU operational status as “down” during the reboot.
3. The OLT must correctly report the ONU operational status as “up” following the completion of the reboot.
4. (optional) The ONU performed a full “cold boot” reloading its operating system.

1.4 ONU Dying Gasp & Power Cycle

Purpose:

This test verifies the behavior of the ONU after multiple reboot events caused by loss of power. Power is removed from and restored to the ONU, while the ONU is under a traffic load. The OLT should report the ONU power failure. This process is repeated multiple times as part of a stress test of the ONU device.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Only one ONU is required for this test. A remote controlled power strip may be used to automate the power cycle of the ONU.

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1.
2. Power on the ONU.
3. Provision the ONU within the OLT, assigning the next available ONU ID.
4. Configure the ONU for a basic 1 Gbps symmetric data service.
5. Configure the Ethernet traffic generator to transmit 1500 byte Ethernet frames upstream and downstream at 950 Mbps.
6. Verify the Ethernet frames are being received at the expected rate, and dropped frame counters are not increasing.
7. While the traffic is running, remove power from the ONU.
8. Verify the OLT lists a loss of power event for the ONU (i.e. it received dying gasp notification).
9. Reapply power to the ONU.
10. Wait 60 seconds.
11. Verify the OLT reports the ONU as active.
12. Verify the Ethernet frames are being received at the expected rate, and dropped frame counters are not increasing.
13. Repeat steps #7 through #12 for a total of 10 power cycle events.

Metrics (pass/fail criteria):

1. At step #6, the ONU must pass the Ethernet frames at the expected rate, without dropping frames.
2. At step #8, the OLT must list a loss of power event / status for the ONU.
3. At step #11, the OLT must report the ONU as active / operationally up.
4. At step #12, the ONU must pass the Ethernet frames at the expected rate, without dropping frames.

1.5 OLT PON Restart & Reboot

Purpose:

The purpose of this test is to verify the ONU is able to return to an operational state, following a PON restart (OLT admin status change to PON port) and a reboot of the OLT.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Only one ONU is required for this test.

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1.
2. Power on the ONU.
3. Provision the ONU within the OLT, assigning the next available ONU ID.
4. Configure the ONU for a basic 250 Mbps symmetric data service.
5. Configure the Ethernet traffic generator to transmit 1500 byte Ethernet frames upstream and downstream at 200 Mbps.
6. Verify the Ethernet frames are being received at the expected rate, and dropped frame counters are not increasing.
7. While the traffic is running, set the OLT PON port to “admin down.”
8. Wait 30 seconds.
9. Set the OLT PON port to “admin up.”
10. Wait 30 seconds.
11. Verify the OLT reports the ONU as active.
12. Verify the Ethernet frames are being received at the expected rate, and dropped frame counters are not increasing.
13. While the traffic is running, use the configuration/management interface to reboot the OLT.
14. Wait for the OLT to fully reboot.
15. Verify the OLT reports the ONU as active.
16. Verify the Ethernet frames are being received at the expected rate, and dropped frame counters are not increasing.

Metrics (pass/fail criteria):

1. At step #6, the ONU must pass the Ethernet frames at the expected rate, without dropping frames.
2. At step #11, the OLT must report the ONU as active / operationally up.
3. At step #12, the ONU must pass the Ethernet frames at the expected rate, without dropping frames.
4. At step #15, the OLT must report the ONU as active / operationally up.

5. At step #16, the ONU must pass the Ethernet frames at the expected rate, without dropping frames.

1.6 Emergency Stop

Purpose:

The purpose of this test is to verify the ONU properly responds to the “Emergency Stop” messages, where the ONU must enter the O7 State, and disable its upstream laser / transmission. This test requires the use of an in-line optical power monitor.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. An in-line optical power meter is required between the OLT and the ONU to measure the transmit power of the ONU. Only one ONU is required for this test.

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1.
2. Ensure that the OLT has no provisioning for the ONU under test.
3. Power on the ONU.
4. Wait until the OLT reports the ONU as discovered.
5. Confirm that the in-line power meter shows significant transmit power from the ONU.
6. Configure the OLT to place the ONU into the emergency stop (O7) state.
7. Confirm that the in-line power meter shows no significant transmit power from the ONU.
8. Configure the OLT to remove the ONU from the emergency stop (O7) state.
9. Confirm that the in-line power meter shows significant transmit power from the ONU.
10. Provision the ONU within the OLT, assigning the next available ONU ID.
11. Verify that the OLT reports the ONU as activated and operational.
12. Confirm that the in-line power meter shows significant transmit power from the ONU.
13. Configure the OLT to place the ONU into the emergency stop (O7) state.
14. Confirm that the in-line power meter shows no significant transmit power from the ONU.
15. Configure the OLT to remove the ONU from the emergency stop (O7) state.
16. Verify that the OLT reports the ONU as activated and operational.
17. Confirm that the in-line power meter shows significant transmit power from the ONU.

Metrics (pass/fail criteria):

1. At step #5, the in-line power meter must report significant transmit power from the ONU.
2. At step #7, the in-line power meter must report no significant transmit power from the ONU.
3. At step #9, the in-line power meter must report significant transmit power from the ONU.
4. At step #11, the OLT must report the ONU as active / operationally up.
5. At step #12, the in-line power meter must report significant transmit power from the ONU.
6. At step #14, the in-line power meter must report no significant transmit power from the ONU.

7. At step #16, the OLT must report the ONU as active / operationally up.
8. At step #17, the in-line power meter must report significant transmit power from the ONU.

1.7 Overnight Stability Test

Purpose:

The purpose of this test is to verify the ONU can maintain stability with the OLT for an extended period of time.

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1.
2. Configure the OLT to activate and range the ONU onto the PON.
3. Verify that the OLT lists the ONU as activated.
4. Configure the Ethernet traffic generator to transmit 1500 byte Ethernet frames upstream and downstream at 250 Mbps for 12 hours.
5. Record the total number of frames transmitted and received in each direction.
6. Verify that the OLT lists the ONU as activated.

Metrics:

1. At step #2, the ONU must range onto the PON, with no errors or alarms reported by the OLT.
2. At step #3, the OLT must report the ONU as activated and operational.
3. At step #6, the OLT must report the ONU as activated and operational.
4. The number of dropped frames must not exceed 20 frames in either direction.

2. ONU Bring-Up Tests

2.1 ONU Bring-up for New ONU

Compliance with this test requires the following test to be performed according to [1]: *6.9.1 ONU Bring-up for New ONU.*

2.2 ONU Bring-up method for Old ONU

Compliance with this test requires the following test to be performed according to [1]: *6.9.2 ONU Bring-up method for Old ONU.*

2.3 ONU Bring-up method with encrypted OMCC

Compliance with this test requires the following test to be performed according to [1]: *6.9.3 ONU Bring-up method with encrypted OMCC.*

3. Basic High Speed Access Tests

3.1. N:1 Architecture

3.1.1 Untagged U-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.1.1 Untagged U-interface Test Case.*

3.1.2 Priority-tagged U-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.1.2 Priority-tagged U-interface Test Case.*

3.1.3 Q-tagged U-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.1.3 Q-tagged U-interface Test Case.*

3.1.4 User Isolation

Compliance with this test requires the following test to be performed according to [1]: *6.1.1.4 User Isolation Test Case.*

3.2. 1:1 Architecture

3.2.1 Untagged U-interface, Double Tagged V-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.2.2 Untagged U-interface, Double Tagged V-interface Test Case.*

3.2.2 Tagged U-interface, Double Tagged V-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.2.4 Tagged U-interface, Double Tagged V-interface Test Case.*

3.3. VLANs for Business Ethernet Services (VBES)

3.3.1 Double Tagged U-interface/V-interface

Compliance with this test requires the following test to be performed according to [1]: *6.1.3.5 Double Tagged U-interface, Double Tagged V-interface Test Case.*

3.3.2 Hairpin Turn for VBES at OLT

Compliance with this test requires the following test to be performed according to [1]: *6.1.3.6 Hairpin Turn for VBES at OLT Test Case.*

3.4 RFC 2544 Throughput & Latency Test

Purpose:

The purpose of this test is to measure the maximum throughput performance of the ONU dependent on the PON technology, for various Ethernet frame sizes.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Only one ONU is required for this test.

Table 2.8.1: Required frame sizes for RFC2544 test

Frame Size (bytes)
64
128
256
512
1024
1280
1500

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1.
2. Power on the ONU.
3. Provision the ONU within the OLT, assigning the next available ONU ID.
4. Verify the OLT reports the ONU as activated and operational.
5. Configure the ONU for a basic untagged 1 Gbps symmetric data service.
6. Configure the traffic generator for the first frame size in Table 2.8.1 below, at the maximum throughput of the PON technology.
7. Transmit Ethernet frames upstream and downstream at the configured rate for 60 seconds.
8. Record the number of frames transmitted and received for each direction (upstream & downstream).
9. If the number of received frames is less than the number of transmitted frames, reduce the transmit rate of that direction (upstream, downstream, or both) by 10 Mbps.
10. If the frame transmit rate for either direction was changed in step #9, repeat steps #7 through #9.

11. If the number of received frames is equal to the number of frames transmitted for both upstream and downstream, record the configured transmit rate for each direction as the Measured Throughput rate.
12. Record the average frame latency for each direction reported by the Ethernet traffic generator as the Measured Latency.
13. Repeat steps #5 through #11 for each frame size listed in Table 2.8.1 above.

Metrics (pass/fail criteria):

This section has no metrics and is intended to be informational only.

4. Quality of Service Function Tests

4.1 Strict Priority Upstream Scheduling

Compliance with this test requires the following test to be performed according to [1]: *6.2.2.1 Strict priority upstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port).*

4.2 Strict Priority Downstream Scheduling

Compliance with this test requires the following test to be performed according to [1]: *6.2.2.5 Strict priority downstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port).*

4.3 Alarms synchronization

Compliance with this test requires the following test to be performed according to [1]: *6.10.1 Alarms synchronization.*

5. Software Download Tests

5.1 Software Download, Valid Image

Compliance with this test requires the following test to be performed according to [1]: *6.11.1 Software Download, Valid Image.*

5.2 Switch Active Software Instance

Compliance with this test requires the following test to be performed according to [1]: *6.11.3 Switch Active Software Instance.*

5.3 Switch Committed Software Instance

Compliance with this test requires the following test to be performed according to [1]: *6.11.4 Switch Committed Software Instance.*

6. PMD Layer Tests

6.1 Optical Range Tests

Purpose:

The purpose of this test is to verify the minimum and maximum optical reach of the ONU device, within the optical link budget for the transceiver types.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Only one ONU is required for this test. The optical connection between the splitter and the ONU (fiber A in Figure 1) shall be the length applicable to the optical transceiver combination listed in Table 2.1.1 below.

Table 2.1.1: Optical connection lengths for test 2.1

PON Type	OLT Transceiver Class	ONU Transceiver Class	Fiber Connection A length (km)
GPON	B+	B+	20
	B+	C+	20
	C+	B+	20
	C+	C+	20
XGS-PON	N1	N1	20

Procedure:

1. Connect the ONU / OLT to the ODN as shown in Figure 1. The fiber connection A shall be 3m.
2. Power on the ONU.
3. Wait for the OLT to report a discovered ONU and record the serial number reported by the OLT for the discovered ONU.
4. Provision the ONU within the OLT, assigning the next available ONU ID.
5. Power cycle the ONU.
6. Verify the ONU is able to reconnect to the OLT and the OLT lists the ONU as activated.
7. Configure the ONU for a basic 1 Gbps symmetric data service.
8. Record the number of upstream and downstream BIP errors for the provisioned ONU.
9. Configure the Ethernet traffic generator to transmit 1500 byte Ethernet frames upstream and downstream at 950 Mbps for 10 minutes.
10. Record the total number of frames transmitted and received in each direction.
11. Record the number of upstream and downstream BIP errors for the provisioned ONU.

12. Power off the ONU.
13. Change the fiber connection A to the applicable length from the table above, according to the optical transceivers provided in the OLT and ONU.
14. Repeat steps #2 through #9.

Metrics (pass/fail criteria):

1. At step #3, the OLT must report the ONU as a “new” or “detected” ONU, with a serial number that matches the serial number expected for the ONU.
2. At step #4, the OLT must report the ONU as activated and operational.
3. At step #6, the OLT must report the ONU as activated and operational.
4. The number of dropped frames must not exceed 20 frames in either direction.
5. The number of reported BIP errors must not exceed 100 during the test.

6.2 Differential Reach

Purpose:

The purpose of this test is to verify the ONU is able to operate without significant impact to other ONUs when the differential distance between two ONUs is close to the maximum supported distance for the PON.

Test Configuration & Setup:

This test uses the physical test setup shown in Figure 1. Two ONUs are required for this test. The optical connection between the splitter and the first ONU (fiber A in Figure 1) shall be 20km. The optical connection between the splitter and the second ONU (fiber B in Figure 1) shall be 3m.

Note: It may be necessary to reduce the value of the optical attenuator connected between the OLT and the splitter.

Procedure:

1. Connect the OLT and 2 ONUs to the ODN as shown in Figure 1, with the fiber lengths described above.
2. Configure the OLT to activate each ONU device.
3. Configure a basic data service on each ONU device.
4. Configure the Ethernet traffic generator to transmit 1500 byte frames upstream and downstream through each ONU at one of the following rates:
    a. GPON: 300 Mbps
    b. XGS-PON: 750 Mbps
        i. Note: The traffic transmission rate is intended to avoid congestion on the PON for upstream or downstream bandwidth.
5. Record the number of upstream and downstream BIP errors for each ONU.
6. Run the Ethernet traffic generator for 10 minutes.
7. Record the number of Ethernet frames transmitted and received through each ONU.
8. Record the number of upstream and downstream BIP errors for each ONU.

Metrics (pass/fail criteria):

1. At step #2, the OLT must report both ONUs as activated and operational.
2. The number of dropped frames must not exceed 20 frames for any traffic stream.
3. The number of reported BIP errors must not exceed 100 for each ONU during the test.