TECHNICAL REPORT

TR-273
Testing of Bonded, Multi-Pair xDSL Systems

Issue: 1 Corrigendum 1
Issue Date: September 2014

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Issue History

Issue Number	Approval Date	Publication Date	Issue Editor	Changes
1	21 August 2012	10 September 2012	Arlynn Wilson, ADTRAN	Original
1 Corrigendum 1	8 September 2014	24 September 2014	Lincoln Lavoie, UNH InterOperability Lab	Corrections

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Executive Summary

This document contains corrections to TR-273 Issue 1 that are critical to the proper implementation of testing based on the technical report. These corrections include updates to the test procedures and test metrics. No new tests or test procedures have been included in this corrigenda document.

1 Purpose and Scope

This document contains corrections to TR-273 Issue 1.

The following sections within TR-273 are altered:

- Section 4.2:
  - Text to describe the derivation of the acceptable number of packets lost due to other interconnections within the system under test.
- Section 4.3:
  - Addition of new text to describe the acceptable number of lost frames due to other interconnections within the system under test.
- Section 4.3:
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.
- Section 4.4:
  - Correct test procedure to clearly indicate low rate traffic must flow in the direction not being tested and low rate traffic must be transmitted at less than 100 frames per second.
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.
- Section 4.5:
  - Correct frame sizes used during testing to align with Section 4.2.
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.
- Section 4.6:
  - Correct frame sizes used during testing to align with Section 4.2.
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.
- Section 4.7:
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.
- Section 4.8:
  - Corrected the maximum number of frames that can be dropped during each 2 minute test interval.

Corrections and changes are shown within this document using Track Changes (change bars / colored text) against the original TR-273 Issue 1 content.

2 Changes to TR-273 Issue 1

The following changes SHALL be made to TR-273 Issue 1, as shown bellow using Track Changes (colored text).

2.1 Changes to Section 4.2

Insert the following paragraph after all other text contained in Section 4.2.

Figure 1 describes the typical test setup, including the DSLAM and CPE with multiple DSL connections (the bonded link), the Traffic Generator / Analyzer, and its two connections to the DSLAM and CPE. The two connections to/from the traffic generator/analyzer are likely Gigabit Ethernet, but are not limited to a specific type or technology.

These two connections however, are subject to an operational bit error ratio, as defined within the appropriate standard. This bit error ratio, while likely very low, will allow for some number of bits to be received in error. If a Gigabit Ethernet connection is assumed, the operational bit error ratio defined in the standard is 10^{-9}. Assuming the test transmits approximately 3,000,000,000 bits over the link, up to 7 bits might be received in error while the Gigabit Ethernet link is operating within its defined parameters with a confidence of 95%. Assuming a single bit error per received Ethernet frame (worst case), this would suggest 7 Ethernet frames could be lost without violating the standardized bit error ratio requirement.

For this reason, each test defined within this document allows for a small loss of Ethernet frames and has been simplified to an average limit of 7 frames per test interval.

2.2 Changes to Section 4.3

The purpose of the test defined in Table 1 is to verify that the basic aggregation function (i.e., assembly and reassembly of cells/fragments) is performed successfully.
This test is executed for downstream and upstream simultaneously (i.e., with downstream and upstream traffic).

Table 1. Testing procedure for nominal bonding operation

Test Configuration	(1) The test setup SHALL be as shown in Figure 1. (2) Set up the loop simulators or real cable to a very short loop length (back to back). (3) Set up the traffic generator to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Set up the traffic generator to send IMIX in both directions at the required frame rate (using either Equation 5 or Equation 6). (5) Allow traffic to run for at least 10 seconds. (6) Run traffic test for at least 10 minutes. Record the upstream and downstream frame loss and throughput frame rate as frames per second. (7) Verify that no CVs occurred over the test period, if CVs occurred then repeat MOP(6)

	once.
Expected Result	The test is passed if not more than 7 frames are lost~~no frame loss occurs~~ over one test period, otherwise the test is declared failed.

2.3 Changes to Section 4.4

The purpose of the test defined in Table 2 is to verify the unidirectional error free frame rate for several frame length configurations.

This test is executed separately for downstream and upstream (i.e., with either downstream traffic or upstream traffic passing at the required frame rate). The aggregation functions SHALL be enabled for both upstream and downstream, simultaneously. During unidirectional testing a low rate payload, not greater than 100 frames per second, shall be generated in the opposite direction of using the random IMIX frame length ~~arbitrary mix~~ to ensure proper MAC learning behavior in the equipment.

Table 2. Unidirectional testing procedure of bonding operation

Test Configuration	(1) The test setup SHALL be as shown in Figure 1. (2) Set up the loop simulators or real cable to a very short loop length (back to back). (3) Set up the traffic generator/analyzer to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Set up the traffic generator to send IMIX in ~~both~~ the downstream direction~~s~~ at the required frame rate (using either Equation 5 or Equation 6). Configure the traffic generator to send IMIX in the other direction at the low frame rate (not greater than 100 frames per second). (5) Allow traffic to run for at least 10 seconds. (6) Run traffic test for at least 2 minutes. Record the appropriate upstream or downstream frame loss and throughput frame rate as frames per second. (7) Verify that no CVs occur over the test period, if CVs occurred then rerun the test which had CVs during the traffic test, once. (8) Repeat MOP(6) & MOP(7) 4 times using fixed length frames of [64, 256, 1024, 1500] using one frame size at a time (frame probability = 1). (9) Repeat MOP(4) to MOP(8) in the upstream direction
Expected Result	The test is passed if not more than 7 frames are lost~~no frame loss occurs~~ over any 2 minutes test period without CVs. Otherwise the test is declared as failed.

2.4 Changes to Section 4.5

The purpose of the test defined in Table 3 is to verify the bidirectional error free frame rate for several frame length configurations.

Table 3. Bidirectional testing procedure of bonding operation

Test	(1) The test setup SHALL be as shown in Figure 1.

Configuration	(2) Set up the loop simulators or real cable to a very short loop length (back to back). (3) Set up the traffic generator to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Set up the traffic generator to send IMIX in both directions at the required frame rate (using either Equation 5 or Equation 6) (5) Allow traffic to run for at least 10 seconds. (6) Run traffic test for at least 2 minutes. Record the appropriate upstream or downstream frame loss and throughput frame rate as frames per second. (7) Verify that no CVs occur over the test period, if CVs occurred then rerun the test which had CVs during the traffic test, once. (8) Repeat MOP(6)& MOP(7) 4 times using fixed length frames of [64, ~~512~~256, 1024, 1500] using one frame size at a time (frame probability = 1) at the required frame rate (using either Equation 5 or Equation 6) in the downstream direction while sending the IMIX traffic determined in MOP(4) in the upstream direction. (9) Repeat MOP(6) 4 times using fixed length frames of [64, ~~512~~256, 1024, 1500] using one frame size at a time (frame probability = 1) at the required frame rate (using either Equation 5 or Equation 6) in the upstream direction while keeping the IMIX traffic determined in MOP(4) in the downstream direction.
Expected Result	The test is passed if for each of the 9 tests not more than 7 frames are lost~~no frame loss occurs~~ over any 2 minutes test period. Otherwise the test is declared as failed.

2.5 Changes to Section 4.6

The bonding standards provide the capability to bond together loops whose net rate differs by a factor of 4:1. The purpose of this test is to verify that the aggregation function can successfully bond multiple loops whose minimum versus maximum net data rates differ by a factor of 4. The testing configuration, method of procedure and expected results are outlined in Table 4.

Table 4. Test procedure for unequal net data rates

Test Configuration	(1) The test setup SHALL be as shown in Figure 1. (2) Set up the loop simulators or real cable to a very short loop length (back to back). (3) Set up the traffic generator to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Identify the line with the lowest downstream actual net data rate, and record the rate as min_N. Reconfigure one line with a fixed net data rate equal to 25% of min_N, rounded up to the next 8kbit/s. Reconfigure the other N-1 lines with a fixed net data rate equal to min_N. Reinitalize the lines ensuring that the lowest actual net data rate of the lines is between 25% and 26% of the highest actual net data rate of the lines. (5) Let the lines retrain and wait until the bonding group is up, then wait 60 seconds. (6) Set up the traffic generator to send IMIX in the both directions at the required frame

	rate (using either Equation 5 or Equation 6). (7) Record the upstream and downstream frame loss and frame rate as frames per second. The test SHALL be run for 2 minutes. Verify that no CVs occurred over the test period, if CVs occurred then rerun the test, once. (8) Repeat MOP(7) 4 times using fixed length frames of [64, ~~512~~256, 1024, 1500] bytes using one frame size at a time (frame probability = 1) at the required frame rate (using either Equation 5 or Equation 6) in the downstream direction while sending the IMIX traffic determined in MOP(6) in the upstream direction. (9) Repeat MOP(2) to to MOP(8) in the other direction
Expected Result	The test is passed if (for each of the 5 downstream tests and for each of the 5 upstream tests) not more than 7 frames are lost ~~no frame loss occurs~~ over the 2 minutes test period. Otherwise the test is declared as failed.

2.6 Changes to Section 4.7

The purpose of the test defined in Table 5. Power cycle CPE test is to verify that a bonding group retrains and traffic is picked up again after a CPE power cycle.

Table 5. Power cycle CPE test

Test Configuration	(1) The test setup SHALL be as shown in Figure 1. (2) Set up the loop simulators or real cable to a very small loop length (back to back). (3) Set up the traffic generator to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Set up the traffic generator to send IMIX in the both directions at the required frame rate (using either Equation 5 or Equation 6). (5) Record the upstream and downstream frame rate as frames per second. (6) Wait 2 minutes. (7) Switch off the CPE's power supply. The traffic generator continues to generate traffic. (8) Wait 20 seconds (9) Switch on the CPE's power supply (10) Let the lines retrain and wait until the bonding group is up, then wait 60 seconds. (11) The traffic measurement (frame loss/frame rate) SHALL be run for 2 minutes. (12) Verify that no CVs occurred over the 2 minutes test period, if CVs occurred then rerun the test, once.
Expected Result	The test is passed ~~is~~ if not more than 7 frames are lost~~no frame loss occurs~~ over any 2 minutes test period. Otherwise the test is declared failed.

2.7 Changes to Section 4.8

The test defined in Table 6 verifies a removal of a single bonded line out of a bonded group and a restoral to the bonded group without degradation of traffic, frame rate and minimal CVs.

Table 6. Test procedure for removal and restoral of a single bonded line to a bonded group

Test Configuration	(1) The test setup SHALL be as shown in Figure 1. (2) Set up the loop simulators or real cable to a very short loop length (back to back). (3) Set up the traffic generator to send Ethernet frames in both directions.
Method of Procedure	(1) Configure the bonded group and place all N lines into the group. (2) Configure the DSLAM to the profile line configuration allowing maximum net data rates in both directions on all N loops. (3) Let the lines train and wait until the bonding group is up, then wait 60 seconds. (4) Set up the traffic generator to send IMIX in the both directions at the required frame rate (using either Equation 5or Equation 6). (5) Record the upstream and downstream frame rate as frames per second. The test SHALL be run for 2 minutes. (6) Verify that no CVs occurred over the 2 minutes test period. If CVs occurred then rerun the test, once. (7) Remove line #1 by physically disconnecting the wire pair at either end of the line. (8) Allow for 60 seconds to stabilize the loops and aggregation functions (9) Verify that the DSLAM reports that line #1 has left the bonded group. (10) Set the frame rate of both the upstream and downstream direction to the required frame rate (using either Equation 5 or Equation 6, with the actual net data rate of line #1 being zero). (11) Record the upstream and downstream frame rate as frames per second. The test SHALL be run for 2 minutes. (12) Verify that no CVs occurred over the 2 minutes test period. If CVs occurred then rerun the test, once. (13) Restore line#1. (14) Let the line train, then allow for 60 seconds to stabilize the loops and aggregation functions. (15) Verify that the DSLAM reports that line #1 has joined the bonded group. (16) Set the frame rate of both the upstream and downstream direction to the required frame rate (using either Equation 5 or Equation 6). (17) Record the upstream and downstream frame rate as frames per second. The test SHALL be run for 2 minutes. (18) Verify that no CVs occurred over the 2 minutes test period. If CVs occurred then rerun the test, once. (19) Repeat steps 7 to 18 (removal/restoral) for the remaining lines #2 to #N until all lines have been removed and restored to the bonding group.
Expected Result	The test is passed if for all lines not more than 7 frames are lost~~no frame loss occurs~~ over the 2 minutes test period before removal, over the 2 minutes test period during disconnect, and over the 2 minutes test period after restoral. Otherwise the test is declared failed.

End of Broadband Forum Technical Report TR-273