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Modification Record

1. August 3, 2010       Initial Version (mhagen)
2. April 10, 2012       Updated to the final version of the standard (mhagen)
Acknowledgments

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Mikkel Hagen        University of New Hampshire
Daniel Shea         University of New Hampshire
Ryan Zarick         University of New Hampshire
Introduction

Overview
The University of New Hampshire’s InterOperability Laboratory (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. These tests are designed to determine if a DCB product conforms to specifications defined in IEEE P802.1Qau-2010 Amendment 13: Congestion Notification Standard (hereafter referred to as “CN”). This suite of tests has been developed to help implementers evaluate the functioning of their Data Center Bridging based products. The tests do not determine if a product conforms to the IEEE standard, nor are they purely interoperability tests. Rather, they provide one method to isolate problems within a Data Center Bridging device. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other Data Center Bridging devices. However, combined with satisfactory operation in the IOL’s semi-production environment, these tests provide a reasonable level of confidence that the Device Under Test (DUT) will function well in most multi-vendor Data Center Bridging 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 in the actual testing process. Each test contains an identification section that describes the test and provides cross-reference information. The detailed section discusses the background information and specifies how 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 Clause followed by 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 short statement describing what the test attempts to achieve. The test is written at the functional level.

References
The references section lists cross-references to the IEEE standards and other documentation that might be helpful in understanding and evaluating the test and results.

Resource Requirements
The requirements section specifies the software, hardware, and test equipment that will be needed to perform the test. The items contained in this section are special test devices, software that must reside on the DUT, or other facilities, which may not be available on all devices.

Last Modification
This specifies the date of the last modification to this test.

Discussion
The discussion covers 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 Setup
The setup section describes in detail the configuration of the test environment and includes a block diagram for clarification as well as information such as the interconnection of devices, what monitoring equipment should capture, what the generation equipment should send, and any other configuration information vital to carrying out the test. Small changes in the configuration should be included in the test procedure.

Procedure
The procedure section of the test description contains the step-by-step instructions for carrying out the test. It provides a cookbook approach to testing, and will often be interspersed with observable results.

Observable Results
The observable results section lists observables that can be examined by the tester to verify that the DUT is operating properly. When multiple values are possible for an observable, this section provides a short discussion on how to interpret them. Note that complete delineation between the observables in the Procedure and Observable Results is virtually impossible. As such a careful note should be made of the requirements in both sections. In certain cases, it may be necessary to modify certain steps in the Procedure section while doing the actual tests so as to be able to perform the tests. In such cases, the modifications will be noted in the summary report.

Possible Problems
This section provides some clues to look for if the test does not yield the expected results.

Legend
For reasons of brevity, the following abbreviation has been used in the Test Suite:

<table>
<thead>
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<tr>
<td>CCF</td>
<td>Congestion Controlled Flow</td>
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<td>CNM</td>
<td>Congestion Notification Message</td>
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<td>CNPV</td>
<td>Congestion Notification Priority Value</td>
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<tr>
<td>DUT</td>
<td>Device Under Test</td>
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<td>TS</td>
<td>Testing Station</td>
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</table>
References

The following documents are referenced in this text:

- IEEE Std P802.1Qau-2010 Virtual Bridged Local Area Networks – Amendment 13: Congestion Notification
Test Setup

The following test setup is used in this test suite:

Test Setup 1:
Group 1: Proper Transmission and Reception of Congestion Notification Message

Overview: These tests observe the behavior of the DUT when it transmits and receives CNM frames. In their entirety, these tests verify that a device transmits a valid CNM frame and properly handles a variety of valid CNM frames.
Test #33.1.1: CNM Version Field

Purpose: To verify that the DUT properly handles the version field of CNM frames.

References:
[1] CN – Clause 33.4.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The version field of a CNM frame is 4 bits long and should be transmitted with a 0. Upon reception, devices should ignore the value in the version field.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
Part A:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Part B:
1. Instruct the TS to transmit a proper CNM frame with the version field set to non-zero.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a CNM frame with a 4 bits long version field set to 0 and ignores the version field upon reception of a CNM frame.

Possible Problems: None
Test #33.1.2: CNM ReservedV Field

Purpose: To verify that the DUT properly handles the reservedV field of CNM frames.

References:
[1] CN – Clause 33.4.2

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The reservedV field of a CNM frame is 6 bits long and should be transmitted with a 0. Upon reception, devices should ignore the value in the reservedV field.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:

Part A:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Part B:
1. Instruct the TS to transmit a proper CNM frame with the reservedV field set to non-zero.
2. The activity is captured and observed.

Observable Results:

On the Monitor, verify that the DUT transmits a CNM frame with a 6 bits long reservedV field set to 0 and ignores the reservedV field upon reception of a CNM frame.

Possible Problems: None
Test #33.1.3: CNM Quantized Feedback Field

Purpose: To verify that the DUT properly handles the quantized feedback field of CNM frames.

References:
[1] CN – Clause 33.4.3

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The quantized feedback field of a CNM frame is 6 bits long and should be transmitted with the quantized feedback value calculated by the CP. Upon reception, devices should reduce their rate accordingly based on the quantized feedback value.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with a 6 bits long quantized feedback field set to a valid value.

Possible Problems: None
Test #33.1.4: CNM Congestion Point Identifier Field

Purpose: To verify that the DUT properly handles the congestion point identifier field of CNM frames.

References:
[1] CN – Clause 33.4.4

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The CPID field of a CNM frame is 8 octets long and should be transmitted with a unique identifier of the CP. The CP can format the CPID in any manner. Upon reception, devices should ignore the CPID field and not assign any meaning to subfields within the CPID.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
Part A:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Part B:
1. Instruct the TS to transmit a proper CNM frame with the CPID field set to different values.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with an 8 octet long CPID field. Verify the DUT ignores all the values transmitted to it and does not assign any meaning to the subfields within the CPID field.

Possible Problems: None
Test #33.1.5: CNM cnmQOffset Field

Purpose: To verify that the DUT properly handles the cnmQOffset field of CNM frames.

References:
[1] CN – Clause 33.4.5

Resource Requirements:
• Testing Station capable of transmitting user defined frames to the DUT.
• Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The cnmQOffset field of a CNM frame is 2 octets long and should be transmitted with the 2's complement signed integer value of the CP's cpQOffset. It can be either rounded or truncated.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with cnmQOffset field 2 octets long and in the correct place within the frame.

Possible Problems: None
Test #33.1.6: CNM cnmQDelta Field

Purpose: To verify that the DUT properly handles the cnmQDelta field of CNM frames.

References:
[1] CN – Clause 33.4.6

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The cnmQDelta field of a CNM frame is 2 octets long and should be transmitted with the 2's complement signed integer value of the CP's cpQDelta. It can be either rounded or truncated. The cnmQDelta is not used by the RP, but can be used by the network administrator to adjust parameters.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with cnmQDelta field 2 octets long and in the correct place within the frame.

Possible Problems: None
Test #33.1.7: CNM Encapsulated Priority Field

Purpose: To verify that the DUT properly handles the Encapsulated Priority field of CNM frames.

References:
[1] CN – Clause 33.4.7

Resource Requirements:
• Testing Station capable of transmitting user defined frames to the DUT.
• Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The Encapsulated Priority field of a CNM frame is 2 octets long and should be transmitted with the priority of the frame that triggered the transmission of the CNM. The priority should be transmitted in the most significant 3 bits of the Encapsulated Priority field. The remaining bits should be zero and ignored on receipt.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
Part A:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM on a supported priority.
2. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM on a different supported priority.
3. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM on an unsupported priority.
4. The activity is captured and observed.

Part B:
1. Instruct the TS to transmit a proper CNM frame with the Encapsulated Priority field set to different values, including the correct value based on the traffic from the DUT and other values not being transmitted by the DUT.
2. Instruct the TS to transmit a proper CNM frame with the Encapsulated Priority field set with the correct priority but non-zero values set in the remaining bits.
3. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with Encapsulated Priority field 2 octets long in the correct place within the frame and the priority of the received frame correctly placed within the field. Upon receipt, verify that the DUT properly handles the various priorities in the CNM and ignores the non-zero remaining bits.

Possible Problems: None
Test #33.1.8: CNM Encapsulated Destination MAC Address Field

Purpose: To verify that the DUT properly handles the Encapsulated Destination MAC Address field of CNM frames.

References: [1] CN – Clause 33.4.8

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The Encapsulated Destination MAC Address field of a CNM frame is 6 octets long and should be transmitted with the destination MAC address of the frame that triggered the transmission of the CNM.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT transmits a proper CNM frame with the Encapsulated Destination MAC Address field 6 octets long in the correct place within the frame and the field filled with the destination MAC address of the frame that triggered the CNM.

Possible Problems: None
Test #33.1.9: CNM Encapsulated MSDU Length Field

**Purpose:** To verify that the DUT properly handles the Encapsulated MSDU Length field of CNM frames.

**References:**

[1] CN – Clause 33.4.9

**Resource Requirements:**

- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** June 30, 2010.

**Discussion:** The Encapsulated MSDU Length field of a CNM frame is 2 octets long and should be transmitted with the number of octets that are in the Encapsulated MSDU field.

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

**Procedure:**

1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

**Observable Results:**

On the Monitor, verify that the DUT transmits a proper CNM frame with Encapsulated MSDU Length field 2 octets long and the field filled with the number of octets in the Encapsulated MSDU field.

**Possible Problems:** None
Test #33.1.10: CNM Encapsulated MSDU Field

**Purpose:** To verify that the DUT properly handles the Encapsulated MSDU field of CNM frames.

**References:**
[1] CN – Clause 33.4.10

**Resource Requirements:**
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** June 30, 2010.

**Discussion:** The Encapsulated MSDU field of a CNM frame is a maximum 64 octets long and should be transmitted with the initial octets of the frame that triggered the CNM.

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

**Procedure:**
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM.
2. The activity is captured and observed.

**Observable Results:**
On the Monitor, verify that the DUT transmits a proper CNM frame with the Encapsulated MSDU field no more than 64 octets long in the correct place within the frame and the field filled with the initial octets of the frame that triggered the CNM.

**Possible Problems:** None
Test #33.1.11: CNM Encapsulated MSDU Too Small

Purpose: To verify that the DUT properly handles Encapsulated MSDU of CNM frames that are too small.

References: [1] CN – Clause 33.4.11

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The Encapsulated MSDU field of a CNM frame is a maximum 64 octets long and should be transmitted with the initial octets of the frame that triggered the CNM. If a CNM is received with an Encapsulated MSDU field smaller than 24 octets, it should be discarded.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to transmit a proper CNM frame with the Encapsulated MSDU field set with less than 24 octets of the frame that triggered the CNM.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT ignores the transmitted CNM and does not adjust flow rates based on it.

Possible Problems: None
Test #33.1.12: CNM Has No CN-TAG

Purpose: To verify that the DUT properly handles CNM frames that do not have a CN-TAG.

References:
[1] CN – Clause 33.4.11

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

Last Modification: June 30, 2010.

Discussion: The DUT may consider a CNM without a CN-TAG invalid and discard it. An end station may set the variable cnpdAcceptsCnTag to false which indicates that the neighbor should remove CN-TAGs from all frames. If the end station chooses to mark CNM without CN-TAGs invalid and discard them, then it is not recommended that the end station sets cnpdAcceptsCnTag to false.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

Procedure:
1. Instruct the TS to transmit a proper CNM frame without a CN-TAG.
2. The activity is captured and observed.

Observable Results:
On the Monitor, observe whether the DUT discards CNM frames without a CN-TAG and whether the DUT can set cnpdAcceptsCnTag to false.

Possible Problems: None
Test #33.1.13: CNM Both Version and ReservedV fields

**Purpose:** To verify that the DUT properly handles both the version and reservedV fields of CNM.

**References:**
[1] CN – Clause 33.4.11

**Resource Requirements:**
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** June 30, 2010.

**Discussion:** The DUT should ignore both version and reservedV fields within a CNM upon receipt.

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CNPV.

**Procedure:**
1. Instruct the TS to transmit a proper CNM frame with both version and reservedV fields set to non-zero values.
2. The activity is captured and observed.

**Observable Results:**
On the Monitor, verify that the DUT ignores the non-zero values in both the version and reservedV fields of the transmitted CNM frame.

**Possible Problems:** None
Group 2: Proper Transmission and Reception of Congestion Notification Tag

Overview: These tests observe the behavior of the DUT when it transmits and receives CN-TAGged frames. In their entirety, these tests verify that a device transmits a valid CN-TAGged frame and properly handles a variety of valid CN-TAGged frames.
Test #30.2.1: CN-TAG Insertion

Purpose: To verify that the DUT properly inserts a CN-TAG to frames being transmitted on a supported CCF.

References:
[1] CN – Clause 30.5

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: An end station may choose to insert a CN-TAG to frames that are being transmitted from a CCF. This test is only applicable to End Stations. This test is informative only.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF.

Procedure:
1. Instruct the DUT to transmit frames on a configured CCF.
2. The activity is captured and observed.

Observable Results:
On the Monitor, observe whether the DUT chooses to transmit frames with a CN-TAG or not.

Possible Problems: None
Test #33.2.2: CN-TAG and VLAN Tag Header Order

**Purpose:** To verify that the DUT properly inserts a CN-TAG with or without a VLAN Tag present.

**References:**

[1] CN – Clause 33.2

**Resource Requirements:**

- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** August 3, 2010.

**Discussion:** An end station should place the CN-TAG furthest from the addresses and closest to the data of a VLAN tagged frame. In other words, a VLAN tagged frame should be ordered from addresses to VLAN tag to CN-TAG followed by data. *This test only applies to End Stations.*

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF over a set VLAN.

**Procedure:**

1. Instruct the DUT to transmit a VLAN tagged frame with a CN-TAG.
2. The activity is captured and observed.

**Observable Results:**

On the Monitor, verify that the DUT transmits frames with the VLAN tag closer to the addresses and the CN-TAG closer to the data.

**Possible Problems:** This test is only testable if the DUT chooses to insert CN-TAGs in frames on a CCF.
Test #31.2.3: Bridge CN-TAG Removal

Purpose: To verify that the DUT properly removes CN-TAGs for frames destined outside of the CN domain.

References:
[1] CN – Clause 31.1.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: A congestion point should remove all CN-TAGs from frames that are leaving the congestion notification domain. A CN-TAGged frame that is destined for a port that is acting in edge or defense mode should have the CN-TAG removed. This test is only applicable to multi-port DUTs that are CP capable.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF.

Procedure:

Part A:
1. Configure a destination port on the DUT to be in edge mode.
2. Instruct the TS to transmit a CN-TAGged frame destined for the port configured to be in edge mode.
3. The activity is captured and observed.

Part B:
1. Configure a destination port on the DUT to be in defense mode.
2. Instruct the TS to transmit a CN-TAGged frame destined for the port configured to be in defense mode.
3. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT removes the CN-TAG from the frames before forwarding them on.

Possible Problems: None
Test #33.2.4: CN-TAG Not Interpreted

Purpose: To verify that the DUT does not interpret the value in a CN-TAG beyond copying it into CNMs.

References: [1] CN – Clause 33.2.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: A congestion point should not provide any interpretation to the values in a CN-TAG and should not provide any more meaning than simply copying the value into any CNM being transmitted. This test only applies to a DUT that is CP capable.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF.

Procedure:
1. Instruct the TS to transmit several CN-TAGged frames with different Flow ID values to the DUT.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT does not alter behavior simply based on the value of the Flow ID in the CN-TAGged frames.

Possible Problems: None
Test #32.2.5: CN-TAG Acceptance on All CNPVs

Purpose: To verify that the DUT properly handles a CN-TAGged frame on every CNPV.

References:
[1] CN – Clause 32.4.10

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: A bridge must set the value of cnpdAcceptsCnTag to TRUE for all CNPVs while an end station may set the value to either TRUE or FALSE. A TRUE value for cnpdAcceptsCnTag indicates that a device is capable and ready to receive frames on a given priority. This test is only informative for end stations.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF.

Procedure:
1. Instruct the TS to transmit a CN-TAGged frame on every priority.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that if the DUT is a bridge, it supports CN-TAGged frames on every priority. If the DUT is an end station, observe whether the device supports CN-TAGs on every priority.

Possible Problems: None
Test #32.2.6: End Station CN-TAG Removal

**Purpose:** To verify that the DUT properly removes CN-TAGs for frames destined outside of the CN domain.

**References:**

[1] CN – Clause 32.1.1

**Resource Requirements:**

- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** August 3, 2010.

**Discussion:** An end station should not add CN-TAGs to frames if it is not sure that the frames are destined to points that are within the congestion notification domain. CN-TAGs should be removed if there are multiple neighbors, if the neighbor is not congestion aware or if the destination is remapping CNPV to a non-CNPV priority. *This test is only applicable to end stations.*

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured to support at least one CCF.

**Procedure:**

*Part A:*

1. Configure the TS to appear as multiple neighbors to the DUT.
2. Instruct the DUT to transmit CN-TAGged frames to the TS.
3. The activity is captured and observed.

*Part B:*

1. Configure the TS to appear as a non congestion aware device to the DUT.
2. Instruct the DUT to transmit CN-TAGged frames to the TS.
3. The activity is captured and observed.

*Part C:*

1. Configure the TS to appear to be remapping CNPV to a non-CNPV priority.
2. Instruct the DUT to transmit CN-TAGged frames to the TS.
3. The activity is captured and observed.

**Observable Results:**

On the Monitor, in all cases verify that the DUT removes the CN-TAG from the frames before sending them.

**Possible Problems:** None
Group 3: System Configuration

Overview: These tests observe the behavior of the DUT during times that do not readily fit in other groups within this test suite. In their entirety, these tests verify that a device supports the additionally defined features within the standard.
Test #31.3.1: Bridge CP Creation

**Purpose:** To verify that the DUT can properly create the correct number of CP on each port.

**References:**

[1] CN – Clause 5.4.3

**Resource Requirements:**

- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** April 10, 2012.

**Discussion:** A bridge may support between one and seven congestion points per port. If a bridge cannot create at least one CP, then it does properly support CN and if it can create more than seven CP on a port, it is a violation of the standard. *This test is only applicable to bridges.*

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown.

**Procedure:**

1. Configure the DUT to support at least one CP on at least one port.
2. Instruct the TS to transmit a series of frames within the supported CCF.
3. The activity is captured and observed.
4. Configure the DUT to support the most CP that it can on any port.
5. Instruct the TS to transmit a series of frames within each of the supported CCFs.
6. The activity is captured and observed.

**Observable Results:**

On the Monitor, verify that the DUT supports at least one CP being created on at least one port and does not support configuring more than seven CP on any port. The number of CPs that the DUT supports should be reported.

**Possible Problems:** None
Test #5.3.2: CP Support for CNM Transmission

Purpose: To verify that the DUT properly transmits a CNM on each supported CP.

References:
[1] CN – Clause 5.4.3

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: For each CP that a bridge supports, it must be able to transmit a proper CNM. This test is only applicable to end stations.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured with as many CP as it supports on a port.

Procedure:
1. Instruct the TS to induce congestion in the DUT and cause the DUT to transmit a CNM on each configured CP.
2. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT is capable of transmitting a CNM on each CP that it supports.

Possible Problems: None
Test #32.3.3: Random Function Initialization

Purpose: To verify that the DUT properly initializes the random function each time it is rebooted.

References:
[1] CN – Clause 32.9.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: Each time that a CP is rebooted, it should reinitialize the random function to a different value. This test is only applicable to a device that supports CP functionality.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured with a CP on a port.

Procedure:
1. Observe the value of the random function on the DUT.
2. Reboot the DUT and if necessary reconfigure the CP.
3. Observe the value of the random function on the DUT.

Observable Results:
On the Monitor, verify that the DUT initializes the random function to a different value on reboot.

Possible Problems: Access to the value of the random function may not be possible, in which case this test is not testable.
Test #32.3.4: CP Support for All Four Defense Modes

**Purpose:** To verify that the DUT properly supports all four defense modes on every CP.

**References:**

[1] CN – Clause 32.1.1

**Resource Requirements:**

- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** August 3, 2010.

**Discussion:** For each CP that a bridge supports, it must support all four defense modes of disabled, edge, interior and interiorReady. *This test is only applicable to CP capable devices.*

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured with as many CP as it supports on a port.

**Procedure:**

1. Configure one CP to be disabled.
2. Instruct the TS to force a second CP on the DUT to be in edge mode.
3. Instruct the TS to force a third CP on the DUT to be in interior mode.
4. Instruct the TS to force a fourth CP on the DUT to be in interiorReady mode.
5. Instruct the TS to transmit frames to each of the CP on the DUT.
6. The activity is captured and observed.

**Observable Results:**

On the Monitor, verify that the DUT is capable of supporting all four defense modes on each CP.

**Possible Problems:** None
Test #32.3.5: Bridge Override Priority Value

Purpose: To verify that the DUT properly overrides the priority value of a frame when operating in edge mode.

References:
[1] CN – Clause 32.1.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: A bridge that has a frame come in a specific priority destined for a port in edge mode should override the priority value to a different value. This test is only applicable to bridges.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured with a CP on two different ports.

Procedure:

Part A:
1. Instruct the TS to configure one of the CP ports on the DUT to be in edge mode.
2. Instruct the TS to transmit frames to the other CP on the DUT destined for the edge mode port.
3. The activity is captured and observed.

Part B:
1. Instruct the TS to configure one of the CP ports on the DUT to be in edge mode.
2. Instruct the TS to transmit frames with a valid CNPV to the edge mode port on the DUT destined for the other CP port.
3. The activity is captured and observed.

Observable Results:

On the Monitor, verify that the DUT overrides both incoming and outgoing frame's priority values from the edge mode port in order to ensure that valid CNPV values are not forwarded.

Possible Problems: None
Test #31.3.6: End Station RP Creation

**Purpose:** To verify that the DUT can properly create the proper number of RP on its ports.

**References:**
[1] CN – Clause 31.2.2.2  
[2] CN – Clause 32.10.1

**Resource Requirements:**
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.

**Last Modification:** August 3, 2010.

**Discussion:** An end station should be able to create at least one RP on a port and should not be able to create more than rpppMaxRps number of RPs. *This test is only applicable to end stations.*

**Test Setup:** Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown.

**Procedure:**
1. Configure the DUT to support as many RPs as you can configure.
2. The activity is captured and observed.

**Observable Results:**

On the Monitor, verify that the DUT supports at least one RP being created on at least one port and the DUT does not allow the configuration of more than rpppMaxRps number of RPs.

**Possible Problems:** The value of rpppMaxRps may not be visible to the tester, in which case part of this test should be noted as not testable.
Test #32.3.7: End Station Support for All Four Defense Modes

Purpose: To verify that the DUT properly supports all four defense modes on CNPVs.

References:
[1] CN – Clause 32.1.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: End devices must support at least the disabled and interior defense modes on each of the CNPVs that it supports. End devices may optionally support edge, interior, and interiorReady modes simultaneously on different CNPVs. This test is only applicable to end devices.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. The DUT has been configured with as many RPs as it supports on a port.

Procedure:
1. Configure one RP to be disabled.
2. Instruct the TS to force a second RP on the DUT to be in edge mode.
3. Instruct the TS to force a third RP on the DUT to be in interior mode.
4. Instruct the TS to force a fourth RP on the DUT to be in interiorReady mode.
5. Instruct the TS to transmit frames to each of the RP on the DUT.
6. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT at least supports disabled and interior defense modes simultaneously. Observe whether the DUT allows any of the other defense modes.

Possible Problems: End devices may set cncpDoesEdge variable to FALSE, in which case it will not be possible to configure the DUT to be in edge mode and part of this test will be not testable.
Test #31.3.8: End Station CP Creation

Purpose: To verify that the DUT can properly create the correct number of CP on each port.

References:
[1] CN – Clause 31.1.1

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: An end station may optionally create a CP on its port. This test is only applicable to end stations and is only informative.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown.

Procedure:
1. Configure the DUT to support at least one CP on at least one port.
2. Instruct the TS to transmit a series of frames within each of the supported CCFs.
3. The activity is captured and observed.

Observable Results:
On the Monitor, observe whether the DUT can properly create a CP on its port or not.

Possible Problems: None
Test #31.3.9: RP Response to CNM

Purpose: To verify that the DUT can properly limit frame rate in response to a CNM.

References:
[1] CN – Clause 31.2.2.2

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: Upon reception of a proper CNM message, an RP should limit the frame rate output of the stream identified in the CNM. This test is only applicable to end stations.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. Configure the DUT to have at least one RP and a CCF.

Procedure:
1. Instruct the DUT to transmit a stream of properly formatted frames from the configured CCF.
2. Instruct the TS to transmit a properly formatted CNM to the DUT with an indication to reduce flow rate by half.
3. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT properly reduces the flow rate by half upon receiving the CNM from the TS.

Possible Problems: None
Test #31.3.10: RP Response to Multiple CNM

Purpose: To verify that the DUT can properly limit frame rate in response to multiple CNM.

References:
[1] CN – Clause 31.2.5

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: Upon reception of a proper CNM message, an RP must be able to distinguish what flow the CNM is destined for and should limit the frame rate output of the stream identified in the CNM. Additionally, the default operation of an end station is to provide a single flow queue per CNPV. *This test is only applicable to end stations.*

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. Configure the DUT to have multiple RPs and multiple CCFs with different Flow IDs.

Procedure:
1. Instruct the DUT to transmit a stream of properly formatted frames from two of the configured CCFs.
2. Instruct the TS to transmit a properly formatted CNM for one of the CCF with an indication to reduce flow rate by half.
3. Instruct the TS to transmit a properly formatted CNM to the other CCF with an indication to reduce flow rate by half.
4. The activity is captured and observed.

Observable Results:

On the Monitor, verify that the DUT properly recognizes which CCF each CNM is destined for and reduces the flow rate of the correct CCF by half upon receiving the CNM from the TS. Verify that the output rate of each CCF can be slowed independently.

Possible Problems: None
Test #31.3.11: RP Meets Lt Formula

Purpose: To verify that the DUT meets the specified formula for Lt.

References:
[1] CN – Clause 31.2.2.4

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: An end station must always meet the following formula for Lt over a time of both 1 second and 1 million bits:

\[ Lt \leq (1.05 \times Rt) + 16 \]  

This test is only applicable to end stations.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. Configure the DUT to have at least one RP and a CCF.

Procedure:
1. Instruct the DUT to transmit a stream of properly formatted frames from the configured CCF at maximum rate.
2. Instruct the TS to transmit a properly formatted CNM to the DUT with an indication to reduce flow rate by half.
3. The activity is captured and observed.

Observable Results:

On the Monitor, verify that the DUT does not exceed the formula for Lt over either a 1 second period or 1 million bits.

Possible Problems: None
Test #31.3.12: No Dropped Frames

Purpose: To verify that the DUT does not drop any frames between the flow queue and the flow multiplexer.

References:
[1] CN – Clause 31.2.2.5

Resource Requirements:
- Testing Station capable of transmitting user defined frames to the DUT.
- Monitor capable of capturing Ethernet traffic.


Discussion: An end station should not drop frames as it forwards the frames from the flow queue to the flow multiplexer. This test is only applicable to end stations.

Test Setup: Test Setup 1. Connect the Testing Station, the DUT and the Monitor as shown. Configure the DUT to have at least one RP and a CCF.

Procedure:
1. Instruct the DUT to transmit a stream of properly formatted frames from the configured CCF at maximum rate.
2. Instruct the TS to transmit a properly formatted CNM to the DUT with an indication to reduce flow rate by half.
3. The activity is captured and observed.

Observable Results:
On the Monitor, verify that the DUT does not drop any frames after the rate is reduced from 100% to 50%.

Possible Problems: None