Bridge Functions Consortium

Spanning Tree
Interoperability Test Suite
Version 1.5

Last Updated: 2005-09-06

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MODIFICATION RECORD

Version	Date	Editor(s)	Comments
Beta	1999-08-01	Micah Abbot, Calvin Bascom, Benjamin Schultz, Robert Wolff.	Initial Version
1.0	1999-09-01	Micah Abbot, Calvin Bascom, Benjamin Schultz, Robert Wolff.	
1.1	1999-10-31	Micah Abbot, Calvin Bascom, Benjamin Schultz, Robert Wolff.	
1.2	2001-06-12	Brandon Barry, Tony Mwingira, Gerard Goubert.	
1.3	2004-09-30	Corey Hill	Format Update
1.4	2005-01-20	Tyler Marcotte	Format Update
1.5	2005-09-06	Curtis Simonson	Modified Test STP.io.1.1 Format Update

ACKNOWLEDGEMENTS

The University of New Hampshire would like to acknowledge the efforts of the following individuals in the development of this test suite.

Micah Abbot	University of New Hampshire
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Calvin Bascom	University of New Hampshire
Gerard Goubert	University of New Hampshire
Anthony Mwingira	University of New Hampshire
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Robert Wolff	University of New Hampshire
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INTRODUCTION

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. This suite of tests has been developed to help implementers evaluate the functionality of their Spanning Tree capable products.

The operation of Spanning Tree Protocol provides for the recovery of networks in the event of link failure. Spanning Tree Protocol also helps guard against the creation (either accidental or intentional) of data loops in the active topology.

This test suite has been designed based on the set of clauses described in IEEE Std. 802.1D™-1998 and IEEE Std. 802.1t™-2001 that pertain to Spanning Tree. The test suite is designed to help determine whether or not the DUT will behave in accordance with the standard during normal operation.

These tests do not determine whether the DUT conforms to clauses described in IEEE Std. 802.1D™-1998, nor are they designed as conformance tests. Rather, they provide one method to isolate problems within a Spanning Tree capable device that will affect interoperability. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other Spanning Tree capable devices. However, combined with satisfactory completion of interoperability testing, these tests provide a reasonable level of confidence that the DUT will function well in most Spanning Tree capable environments.

REFERENCES

The following documents are referenced in this text:

- IEEE Std. 802.1D™-1998
- IEEE Std. 802.1t™-2001

DEFINITION OF TERMS

Abbreviations and Acronyms:

BPDU	Bridge Protocol Data Unit
DUT	Device Under Test
FdB	Filtering Database
ID	Identifier
MAC	Media Access Control
STP	Spanning Tree Protocol
TS	A Test Station capable of transmitting and receiving arbitrary MAC frames
TCN	Topology Change Notification

TEST ORGANIZATION

This document organizes tests by group based on related test methodology or goals. Each group begins with a brief set of comments pertaining to all tests within that group. This is followed by a series of description blocks; each block describes a single test. The format of the description block is as follows:

Test Label: The test label and title comprise the first line of the test block. The test label is the concatenation of the short test suite name, group number, and the test number within the group, separated by periods. The test number is the group number and the test number, also separated by a period. So, test label STP.io.1.2 refers to the second test of the first test group in the STP Interoperability suite. The test number is 1.2.

Purpose: The Purpose is a short statement describing what the test attempts to achieve. It is usually phrased as a simple assertion of the feature or capability to be tested.

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

Resource Requirements: The Resource Requirements section specifies the software, hardware, and test equipment that will be needed to perform the test. The Discussion is a general discussion of the test and relevant section of the specification, including any assumptions made in the design or implementation of the test as well as known limitations.

Discussion: The Discussion is a general discussion of the test and relevant section of the specification, including any assumptions made in the design or implementation of the test as well as known limitations.

Test Layout: This diagram shows how the Test Systems, DUT, and any other Devices used should be connected for this test. Elements of the Procedure may change the Layout.

Procedure: This section of the test description contains the step-by-step instructions for carrying out the test. These steps include such things as enabling interfaces, disconnecting links between devices, and sending MAC frames from a Test Station. The test procedure also cues the tester to make observations, which are interpreted in accordance with the observable results given for that test part.

Observable Results: This section lists observable results that can be examined by the tester to verify that the DUT is operating properly. When multiple observable results are possible, this section provides a short discussion on how to interpret them. The determination of a PASS or FAIL for each test is usually based on how the behavior of the DUT compares to the results described in this section.

Possible Problems: This section contains a description of known issues with the test procedure, which may affect test results in certain situations.

TEST SETUP

Default Settings: DUT

Topology Change Acknowledgement Flag	**False**
Topology Change Flag	**False**
Root ID Priority	**0x8000 (32,768)**
Root ID MAC address	**Worse than the Bridge MAC address of the DUT**
Root Path Cost	**0x00000000 (0)**
Bridge ID Priority	**0x8000 (32,768)**
Bridge ID MAC address	**Equal to Root Bridge MAC address**
Port ID	**0x8 + port number [Port 1 would be 0x8001]**
Message Age	**0x0000 (0)**
Max Age	**0x1400 (20 seconds)**
Hello Time	**0x0200 (2 seconds)**
Forward Delay	**0x0F00 (15 seconds)**

Default Values for DUT Settings:

Unless otherwise stated, the DUT shall be configured as follows before every Part of every Test. Elements of Test Procedure may cause these settings to change. This is expected. These setting simply help ensure that the DUT is in a known state prior to running each Part of each test.

- The Spanning Tree Protocol shall be enabled on the DUT and each Port used for testing.
- The DUT shall be connected to the specified number of Test Stations and Bridge Partners.
- Ports on the DUT that are connected to Test Stations and Bridge Partners shall be members of the Untagged Set for the Default VLAN. These Ports shall not be members of any other VLAN. The PVID for these Ports shall be that of the Default VLAN.
- All Ports on the DUT connected to Test Stations and Bridge Partners shall be in the Forwarding Port State.
- The DUT shall consider itself to be the Root Bridge.
- The Topology Change and Topology Change Acknowledgement Flags shall not be set in Configuration BPDUs transmitted by the DUT.
- Bridge Forward Delay, Bridge Max Age, and Bridge Hello Time shall be set to their recommended default values (Bridge Forward Delay = 15 seconds, Bridge Max Age = 20 seconds, Bridge Hello Time = 2 seconds.)
- It may be that Ports used for testing operate at different speeds. In order to simplify the testing process, select one of the speeds (whichever is most common), and set the Path Cost for each Port used for testing to the recommended default value for Ports operating at that speed. That is, if 3 Ports used for testing operate at 100Mb/s, and 1 operates at 1000Mb/s, set the Path Cost of all 4 Ports to 200,000 (the recommended path cost for 100Mb/s).
- The ageing time for the filtering database(s) shall be set to the recommended default value (300 seconds).

GROUP 1: Basic Interoperability

Scope

To ensure a reasonable level of confidence that the DUT will function well in most Spanning Tree capable environments.

Overview

These tests have been designed to test the Interoperability of the Device Under Test with other Spanning Tree Capable devices.

STP.io.1.1: Link Failure

Purpose: To ensure that the device under test (DUT) can properly reconfigure the Spanning Tree in the event of link failure on one of its Ports.

References:

- IEEE Std. 802.1D-2003: sub-clause 8.1, 8.3.1, 8.6.11

Resource Requirements:

- 2 Test Stations Testing Stations capable of transmitting and receiving arbitrary MAC frames.
- 1 Spanning Tree capable Bridge Partner.

Discussion:

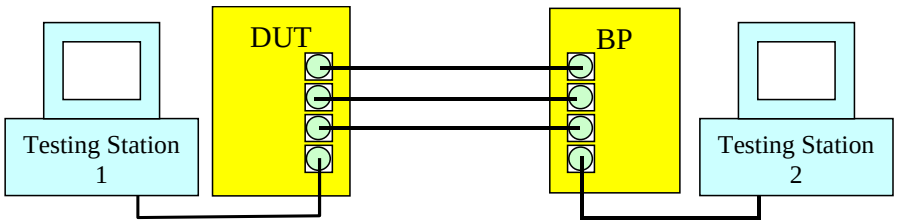
This test verifies that the DUT can properly reconfigure the Spanning Tree when a link between the DUT and a Spanning Tree capable Bridge is broken. This tests both a Port in the Forwarding State and Ports in the Blocking State on the DUT, as well as Basic Spanning Tree Interoperability. Disconnecting the Blocking Ports should have no effect on network traffic. Disconnecting the Forwarding Port should eventually put a Blocking Port into the Forwarding State.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure..

Test Setup:

Connect the DUT to the Bridge Partner with three links as shown in Figure 1 below. Enable Spanning Tree on both devices. Connect Testing Station 1 to the DUT and Testing Station 2 to the Bridge Partner. The operations of multiple Testing Stations can be implemented with just one multi-port Testing Station, but are shown as separate devices for simplicity.

Test Layout:



Procedure:

Part A: Disconnect the Blocking Port

1. Ensure that the default values are configured on the DUT.
2. Allow time for configuration of the Spanning Tree.
3. Set the Testing Stations to capture arbitrary MAC frames.
4. Pass unicast, multicast, and broadcast frames between the Testing Stations.
5. While passing frames, disconnect a Blocking Port on the DUT.
6. Repeat Steps 3-5, disconnecting the remaining Blocking Port on the DUT.

Part B: Disconnect the Forwarding Port

1. Ensure that the default values are configured on the DUT.
2. Ensure the DUT is not the Root Bridge.
3. Allow time for configuration of the Spanning Tree.
4. Set the Testing Stations to capture arbitrary MAC frames.
5. Pass unicast, multicast, and broadcast frames between the Testing Stations.
6. While passing frames, disconnect the Forwarding Port on the DUT.
7. Record frames received by the Testing Stations for a period greater than twice the Bridge Forward Delay value of the Bridge Partner.
8. Reconnect the previously disconnected link.
9. Record frames received by the Testing Stations for a period greater than twice the Bridge Forward Delay value of the Bridge Partner.

Observable Results:

- In Part a, there should be no interruption in network traffic (none of the frames should be lost). None of the frames should be duplicated or misordered.
- In Part b, once the Spanning Tree reconfigures, frames should be exchanged between Testing Stations (no additional frames should be observed). None of the frames should be duplicated or misordered.

Possible Problems:

- None.

STP.io.1.2: Repeated Network

Purpose: To ensure that the device under test (DUT) can interoperate with another Spanning Tree Capable Bridge when the active topology contains a Repeater.

References:

- IEEE Std. 802.1D-2003: sub-clause 8.1, 8.3.1

Resource Requirements:

- 2 Test Stations Testing Stations capable of transmitting and receiving arbitrary MAC frames.
- 1 Spanning Tree capable Bridge Partner.
- 1 Repeater.

Discussion:

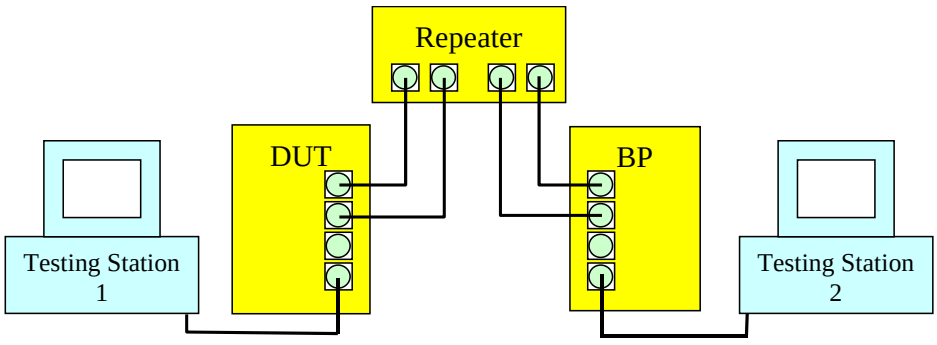
This test verifies that the DUT can properly exchange frames and develop a Spanning Tree topology when connected to another Spanning Tree capable Bridge. There are times when it is desirable to expand a network without adding a Bridge, so a Repeater is used to connect the DUT to the Bridge Partner. This tests the ability of the DUT and Bridge Partner to function in the presence of a Repeater, as well as Basic Spanning Tree Interoperability.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup:

Connect the DUT and Bridge Partner to a Repeater as shown in Figure 1 below. Enable Spanning Tree on both Bridges. Connect Testing Station 1 to the DUT, and Testing Station 2 to the Bridge Partner. The operations of multiple Testing Stations can be implemented with just one multi-port Testing Station, but are shown as separate devices for simplicity.

Test Layout:



Procedure:

Part A: Repeated Network

1. Ensure that the default values are configured on the DUT.
2. Allow time for configuration of the Spanning Tree.
3. Set the Testing Stations to capture arbitrary MAC frames.
4. Pass unicast, multicast, and broadcast frames between the Testing Stations.
5. Record frames received by the Testing Stations.
6. Repeat Steps 2-4 with the Bridge Partner as the Root Bridge.

Observable Results:

- All frames should be properly exchanged between the Testing Stations. None of the frames should be duplicated or misordered.

Possible Problems:

- Transmitting data between the Testing Stations at high rates of speed could result in packet loss due to collisions.

STP.io.1.3: Maximum Hello Time

Purpose: To ensure that the device under test (DUT) can properly reconfigure Spanning Tree when the Root Bridge uses the maximum allowed value for Bridge Hello Time.

References:

- IEEE Std. 802.1D-2003: sub-clause 8.1, 8.3.1, 8.5.3.6, 8.5.4.1
- IEEE Std. 802.1D-2003: Figure 8-3

Resource Requirements:

- 3 Test Stations capable of transmitting and receiving arbitrary MAC frames.
- 2 Spanning Tree capable Bridge Partners

Discussion:

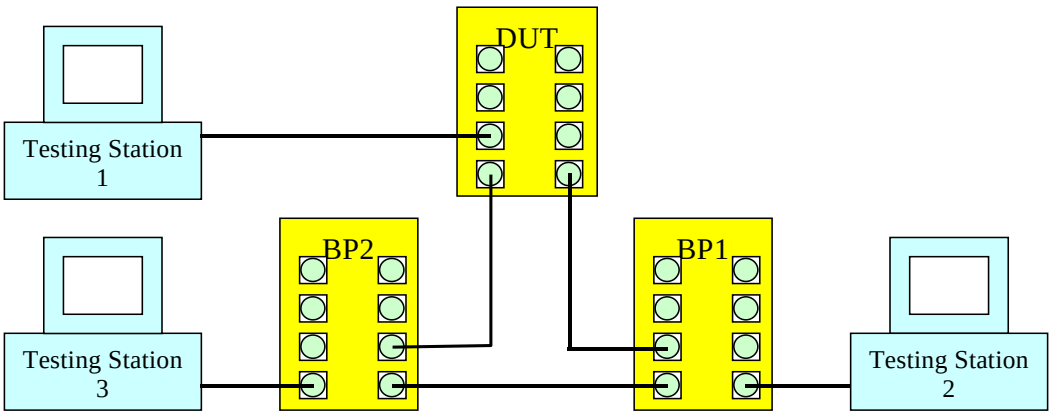
This test verifies that the DUT can properly reconfigure the Spanning Tree when Bridge Hello Time on the Root Bridge is set to the maximum allowed value. If the Spanning Tree Algorithm is properly implemented, connecting 3 Bridges with redundant links should not result in the formation of transient data loops, even when the Root Bridge uses the maximum allowed value for Bridge Hello Time. This tests the Forward Delay Timer and the Hello Timer, as well as Extended Spanning Tree Interoperability.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup:

Connect the DUT to 2 Bridge Partners as shown in Figure 1 below. Enable Spanning Tree on all devices. Connect a Testing Station to each Bridge Partner for a total of 3 Testing Stations. The operations of multiple Testing Stations can be implemented with just one multi-port Testing Station, but are shown as separate devices for simplicity.

Test Layout:



Procedure:

Part A: Maximum Hello Time

1. Ensure that the default values are configured on the DUT.
2. Ensure Bridge Partner 1 is the Root Bridge.
3. Set Bridge Hello Time on the Root Bridge to the maximum allowed value. Properly adjust the values of Bridge Max Age and Bridge Forward Delay on the Root Bridge to accommodate the new Bridge Hello Time value.
4. Allow time for configuration of the Spanning Tree.
5. Set the Testing Stations to capture arbitrary MAC frames.
6. Just after the Root Bridge transmits a Configuration BPDU, connect the DUT to the Root Bridge with an additional link.
7. Before the Root Bridge transmits another Configuration BPDU, pass unicast, multicast, and broadcast frames between Testing Stations.
8. Allow the Testing Stations to capture frames for more than ten seconds.
9. Record frames captured by the Testing Stations.
10. Allow time for the Spanning Tree to reconfigure.
11. Repeat Steps 4-9, using an additional link to connect the DUT to the Bridge Partner that is not the Root Bridge when repeating Step 5.
12. Repeat Steps 2-10 with Bridge Partner 2 as the Root Bridge.

Observable Results:

- All frames should be successfully exchanged between the Testing Stations. None of the frames should be duplicated or misordered.

Possible Problems:

- Some Bridge Partners may not allow the configuration of Bridge Hello Time. This test cannot be completed with these devices as the Root Bridge.
- If a sufficiently high frame rate is used while transmitting data between the Testing Stations, and a data loop forms, Configuration BPDUs may not be received (at which point the Spanning Tree Protocol is no longer capable of restoring a simply and fully connected active topology).

STP.io.1.4: Network Initialization

Purpose: To ensure the device under test (DUT) can properly execute the Spanning Tree Algorithm when the network is (re)initialized.

References:

- IEEE Std. 802.1D-2003: sub-clause 8.1, 8.3.1, 8.8.1

Resource Requirements:

- 4 Test Stations capable of transmitting and receiving arbitrary MAC frames.
- 3 Spanning Tree capable Bridge Partners.

Discussion:

This test verifies that the DUT does not behave in a manner inconsistent with the requirements of the Spanning Tree
Algorithm, even when the network is (re)initialized. While such an event will result in a temporary inability to receive or forward arbitrary MAC frames, it should not result in either the formation of transient data loops or the duplication and misordering of frames. This tests Extended Spanning Tree Interoperability. A full mesh test setup is used for added thoroughness.

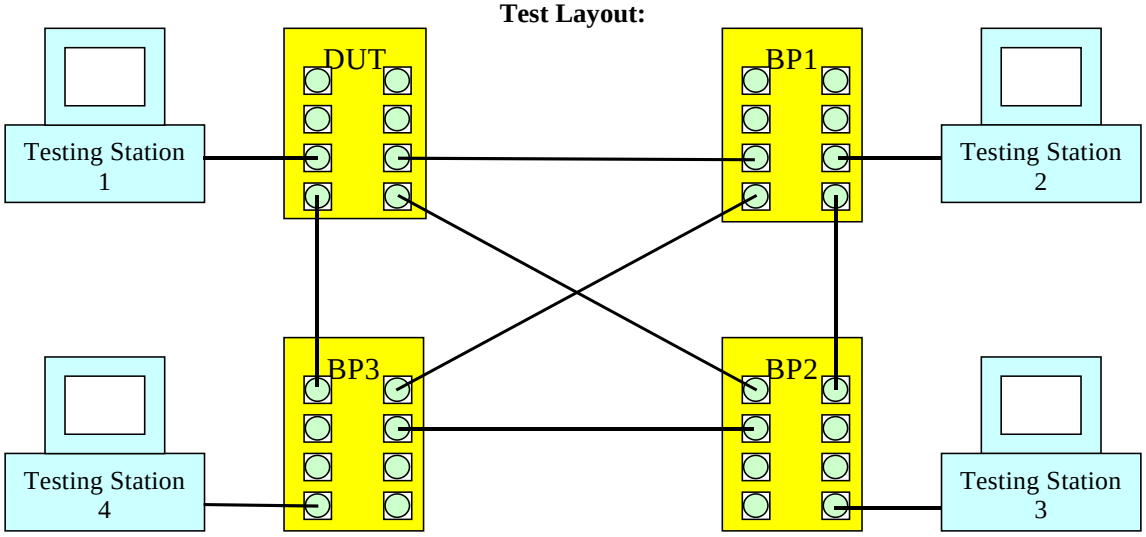
It should also be noted that the time needed for a device to initialize varies. Consequently, when power is restored to the test setup, it is important to allow time for all devices to initialize. Once all devices are initialized, allow additional time for configuration of the Spanning Tree.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup:

Connect the DUT to 3 Bridge Partners as shown in Figure 1 below. Enable Spanning Tree on all devices. Connect a Testing Station to each Bridge Partner for a total of 4 Testing Stations. The operations of multiple Testing Stations can be implemented with just one multi-port Testing Station, but are shown as separate devices for simplicity.

Test Layout:



Procedure:

Part A: Network Initialization

1. Ensure that the default values are configured on the DUT.
2. Set the Testing Stations to capture arbitrary MAC frames.
3. Pass unicast, multicast, and broadcast frames between the Testing Stations.
4. While passing frames, disconnect all power to the DUT and Bridge Partners.
5. Restore power to the DUT and Bridge Partners.
6. Allow time for initialization of the devices.
7. Allow time for configuration of the Spanning Tree.
8. Record frames captured by the Testing Stations.
9. Configure Bridge Partner 1 to be the Root Bridge, and repeat Steps 2-8.
10. Configure Bridge Partner 2 to be the Root Bridge, and repeat Steps 2-8.
11. Configure Bridge Partner 3 to be the Root Bridge, and repeat Steps 2-8.

Observable Results:

- After power is restored to the DUT and Bridge Partners, and once the Spanning Tree has been configured, all frames should be successfully exchanged between the Testing Stations. None of the frames should be duplicated or misordered.

Possible Problems:

- Some of the captured frames may contain errors, because frames are being transmitted when power to the test setup is disconnected.

STP.io.1.5: Topology Change

Purpose: To ensure that the device under test (DUT) can properly reconfigure Spanning Tree in the event of a Topology Change.

References:

- IEEE Std. 802.1D-2003: sub-clause 8.1, 8.3.1, 8.6.14

Resource Requirements:

- 4 Test Stations capable of transmitting and receiving arbitrary MAC frames.
- 3 Spanning Tree capable Bridge Partners.

Discussion:

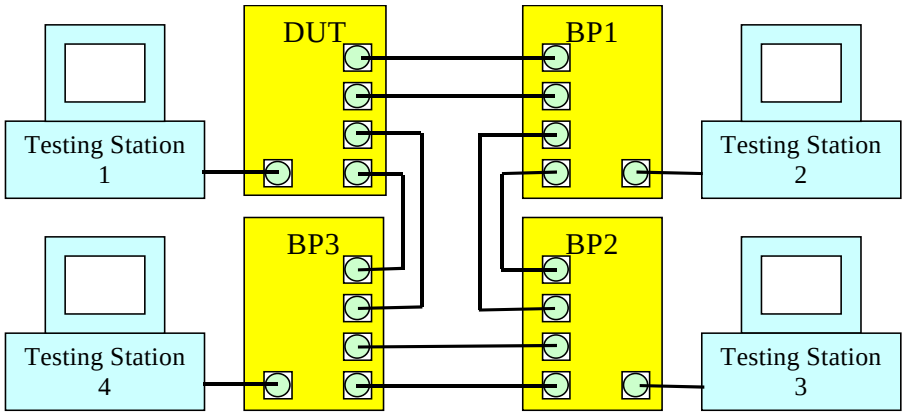
This test verifies that the DUT can properly reconfigure Spanning Tree in the event of a Topology Change. Each Bridge will need to select the proper Port State for each of its Ports during the Topology Changes that take place. This tests Extended Spanning Tree Interoperability.

Please note that this test is an interoperability test. Therefore, failure against any one device does not necessarily indicate nonconformance. Rather, it indicates that the two devices are unable to work "properly" together and that further work should be done to isolate the cause of the failure.

Test Setup:

Connect the DUT to 3 Bridge Partners as shown in Figure 1 below. Enable Spanning Tree on all devices. Connect a Testing Station to each Bridge Partner for a total of 4 Testing Stations. The operations of multiple Testing Stations can be implemented with just one multi-port Testing Station, but are shown as separate devices for simplicity.

Test Layout:



Procedure:

Part A: Topology Change

1. Ensure that the default values are configured on the DUT.
2. Set the Testing Stations to capture arbitrary MAC frames.
3. Pass unicast, multicast, and broadcast frames between the Testing Stations.
4. Configure Bridge Partner 1 such that it has the highest priority Bridge Identifier. This should result in a Topology Change.
5. Allow time for configuration of the Spanning Tree.
6. Record frames received by the Testing Stations.
7. Repeat Steps 2-6, selecting Bridge Partner 2 in Step 4.
8. Repeat Steps 2-6, selecting Bridge Partner 3 in Step 4.
9. Repeat Steps 2-6, selecting the DUT in Step 4.

Observable Results:

- Before and after each Topology Change, once the Spanning Tree has been configured, all frames should be successfully exchanged between the Testing Stations. Testing Stations may not receive frames during a Topology Change, as Ports that were in a Blocking State must transition into the Forwarding State.
- None of the frames should be duplicated or misordered.
- After each Topology Change, once the Spanning Tree has been configured, the Root Identifier contained in Configuration BPDUs captured by the Testing Stations should be equal to the Bridge Identifier of the Bridge used in Step 4.

Possible Problems:

- None.