

# Bridge Functions Consortium

**Hardware Rate Limiting  
Feature Verification Test Suite**  
*Version 0.1*



*Last Updated: 2005-09-05*

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## **MODIFICATION RECORD**

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0.1	2005-09-05	Curtis Knittle Curtis Simonson	Initial Draft

## **ACKNOWLEDGEMENTS**

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Curtis Knittle  
Curtis Simonson

Harmonic, Inc.  
UNH InterOperability Lab

## **INTRODUCTION**

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. This suite of tests has been developed to help implementers evaluate the functionality of their Hardware Rate Limiting capable products.

*“Hardware rate limiting enables providers to pinpoint bandwidth control and provision bandwidth dynamically. Although rate limiting can sometimes place a very heavy burden on a router's central processor, thereby reducing system performance, some manufacturers offer rate-enabled line cards to ensure that the system's performance is not degraded.”<sup>1</sup>*

This test suite has been designed based on the set of common accepted practices that pertain to Hardware Rate Limiting. The test suite is designed to help determine whether or not the DUT will behave in accordance with the industry standard practice during normal operation.

These tests are not designed as performance tests. The relative performance of Hardware Rate Limiting capable devices (e.g. rate granularity, burst handling, etc.) is beyond the scope of this document.

These tests are not designed as conformance tests. Rather, they provide one method to isolate problems within a Hardware Rate Limiting capable device that may affect interoperability. Successful completion of all tests contained in this suite does not guarantee that the tested device will operate with other Hardware Rate Limiting 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 Hardware Rate Limiting capable environments.

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<sup>1</sup> “Dynamic Provisioning: the New Mantra - Technology Information”, Andrew Feldman, Telecommunications Magazine Online – [www.telecommagazine.com](http://www.telecommagazine.com)

## **REFERENCES**

The following documents are referenced in this text:

- |                         |  |
|-------------------------|--|
| [IEEE Std 802.1D™-2004] | IEEE Computer Society LAN/MAN Standards Committee, “Media Access Control (MAC) Bridges”  |
| [IEEE Std 802.1Q™-2003] | IEEE Computer Society LAN/MAN Standards Committee, “Virtual Bridged Local Area Networks” |

## **DEFINITION OF TERMS**

### **Abbreviations and Acronyms:**

DUT	Device Under Test
DUT.TS	Port on the DUT connected to Test Station (ex. DUT.TS1 refers to the Port on the DUT connected to Test Station 1)
MTU	Maximum Transmission Unit
TS	Test Station (ex. TS1 refers to Test Station 1)

### **Definitions:**

Device Under Test	The Bridge on which the Rate.ver test suite is being conducted.
Test Station	A tool that supports the analysis and generation of test traffic, i.e. MAC frames.
Frame	A unit of data transmission on an IEEE 802 LAN MAC that conveys a PDU between MAC Service users. There are three types of frame; untagged, VLAN-tagged, and priority-tagged.
Jumbo Frame	An Ethernet frame containing a data size greater than 1500-bytes.
Untagged frame	An untagged frame is a frame that does not contain a tag header immediately following the Source MAC Address field of the frame [...].
Virtual Bridged Local Area Network (LAN)	A Bridged LAN in which the existence of one or more VLAN-aware Bridges allows the definition, creation, and maintenance of VLANs.
Virtual Local Area Network (VLAN)	A subset of the active topology of a Bridged Local Area Network. Associated with each VLAN is a VLAN Identifier (VID).
VLAN-aware	A property of Bridges or end stations that recognize and support VLAN-tagged frames.
VLAN-tagged frame	A tagged frame whose tag header carries both VLAN identification and priority information.
VLAN-unaware	A property of Bridges or end stations that do not recognize VLAN-tagged frames.

## **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 Rate.Ver.1.2 refers to the second test of the first test group in the Hardware Rate Limiting Feature Verification test 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

Port Admin Status	Enabled (all ports)
Ageing Time	300 seconds
Bridge Spanning Tree Admin Status	Disabled
PVID	1 (all ports)
VLAN Membership	1 – untagged (all ports)
Port Frame Priority	0
QoS/CoS Bridge Admin Status	Enabled
QoS/CoS Bridge Mode	Strict
Priority-to-Transmission Queue Mapping	DUT Default
DUT's Bridge Filtering Database (Content Addressable Memory)	No entries*
Rate Limiting Bridge Admin Status	Enabled
Rate Limiting Port Status	Enabled
Rate Limiting Port Value	100% (full line rate)

\*This excludes reserved multicast MAC addresses.

### Example Priority-to-Queue Mapping (four egress queues)

Priority Value	Egress Queue
0	0
1	0
2	1
3	1
4	2
5	2
6	3
7	3

## **GROUP 1: Egress Hardware Rate Limiting**

### **Scope**

To examine the DUT's Egress (transmission) Hardware Rate Limiting functionality.

### **Overview**

Egress Hardware Rate Limiting is used to limit the egress (transmission) rate of a Bridge Port. Generally the egress rate limit is configured as a percent of total line rate, with a configuration specific granularity. Egress Hardware Rate Limiting may be deployed by Service Providers wishing to limit the download bandwidth of a particular subscriber.

This Group of Tests examines the DUT's Egress Hardware Rate Limiting functionality, including rate limit accuracy, configuration granularity and multiple frame types.

## **Rate.Ver.1.1: Egress Hardware Rate Limiting**

**Purpose:** To examine the DUT's Egress Hardware Rate Limiting functionality.

### **References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

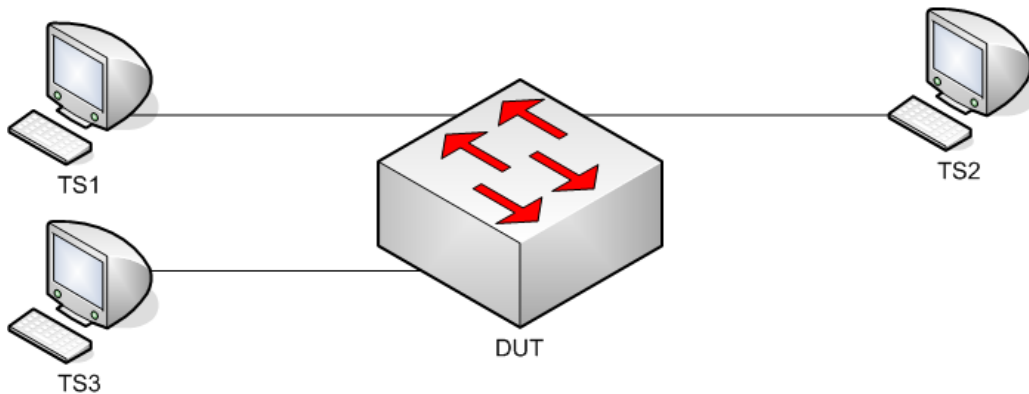
### **Resource Requirements:**

- 3 Test Stations

### **Discussion:**

Ethernet devices claiming "Egress Hardware Rate Limiting" capabilities indicate support for the configuration of egress (transmission) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's egress rate limiting accuracy and the effect of untagged and VLAN-tagged frames on the DUT's Egress Hardware Rate Limiting capabilities.

### **Test Layout:**



*Figure 1 – Egress Rate Limiting*

**Procedure:**

*Part A: Egress Hardware Rate Limiting Granularity and Range*

1. Ensure that the [default](#) values are configured on the DUT.
2. Record the DUT's Egress Hardware Rate Limiting granularity and range, as configurable through any/all configuration methods.

*Part B: Egress Hardware Rate Limiting Verification*

3. Ensure that the [default](#) values are configured on the DUT.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
5. Start capture on TS1, TS2 and TS3.
6. Wait until TS3 captures 1000 frames.
7. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
8. Set DUT.TS3's Egress Hardware Rate Limit to 75% line rate.
9. Repeat Steps 4 through 7.
10. Set DUT.TS3's Egress Hardware Rate Limit to 50% line rate.
11. Repeat Steps 4 through 7.
12. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
13. Repeat Steps 4 through 7.
14. Set DUT.TS3's Egress Hardware Rate Limit to 1% line rate.
15. Repeat Steps 4 through 7.

*Part C: Egress Hardware Rate Limiting Verification – VLAN tagged frames*

16. Ensure that the [default](#) values are configured on the DUT.
17. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
18. Set all DUT.TSs's PVID to 1.
19. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
20. Start capture on TS1, TS2 and TS3.
21. Wait until TS3 captures 1000 frames.
22. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
23. Set DUT.TS3's Egress Hardware Rate Limit to 75% line rate.
24. Repeat Steps 19 through 22.
25. Set DUT.TS3's Egress Hardware Rate Limit to 50% line rate.
26. Repeat Steps 19 through 22.
27. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
28. Repeat Steps 19 through 22.
29. Set DUT.TS3's Egress Hardware Rate Limit to 1% line rate.
30. Repeat Steps 19 through 22.

**Observable Results:**

- In Part A, during Step 2, record the DUT's Egress Hardware Rate Limiting granularity and range.
- In Part B, during Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture all frames transmitted by TS1.
- In Part B, during Step 9, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 75% of the bits transmitted by TS1.
- In Part B, during Step 11, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 50% of the bits transmitted by TS1.
- In Part B, during Step 13, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 25% of the bits transmitted by TS1.
- In Part B, during Step 15, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 1% of the bits transmitted by TS1.
- In Part C, during Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture all frames transmitted by TS1, tagged for VID 2.
- In Part C, during Step 24, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 75% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 26, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 50% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 28, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 25% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 30, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 1% of the bits transmitted by TS1, tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- This Test cannot be completed, if the DUT does not support Egress Hardware Rate Limiting. No further Egress Hardware Rate Limiting testing can be performed.
- In Part B, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.
- In Part C, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.

## **Rate.Ver.1.2: Egress Hardware Rate Limiting Granularity Verification**

**Purpose:** To examine the DUT's Egress Hardware Rate Limiting configuration granularity.

**References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

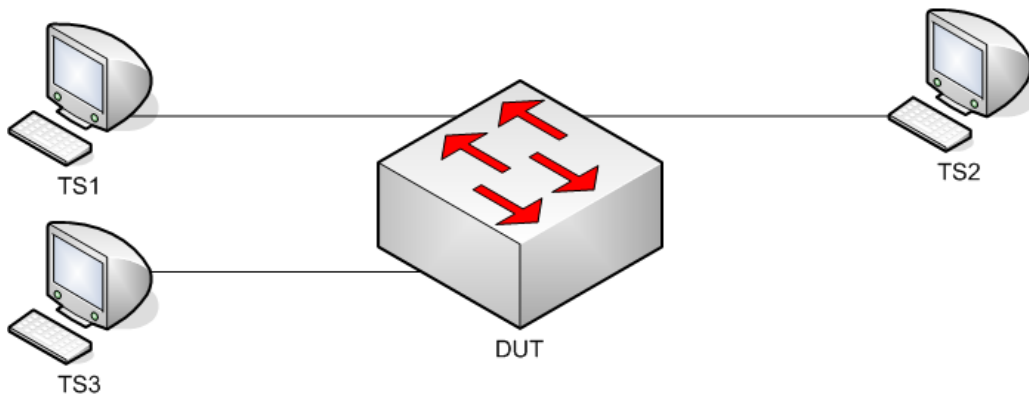
**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming “Egress Hardware Rate Limiting” capabilities indicate support for the configuration of egress (transmission) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's egress rate limit configuration granularity, with both untagged and VLAN-tagged frames.

**Test Layout:**



*Figure 2 – Egress Hardware Rate Limiting Granularity Verification*

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InterOperability Laboratory*

**Procedure:**

*Part A: Egress Hardware Rate Limiting Granularity Verification*

1. Ensure that the [default](#) values are configured on the DUT.
2. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
3. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where  $X = 64$  to  $Y$ , in increments of 1.  
\*\*\* $Y = DUT's\ Maximum\ Frame\ Size$ \*\*\*
4. Start capture on TS1, TS2 and TS3.
5. Wait until TS3 captures 1000 frames.
6. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
7. Set DUT.TS3's Egress Hardware Rate Limit to 26% line rate.
8. Repeat Steps 3 through 6.
9. Set DUT.TS3's Egress Hardware Rate Limit to 27% line rate.
10. Repeat Steps 3 through 6.

*Part B: Egress Hardware Rate Limiting Granularity Verification – VLAN tagged frames*

11. Ensure that the [default](#) values are configured on the DUT.
12. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
13. Set all DUT.TSs's PVID to 1.
14. Set DUT.TS3's Egress Hardware Rate Limit to 50% line rate.
15. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where  $X = 64$  to  $Y$ , in increments of 1.  
\*\*\* $Y = DUT's\ Maximum\ Frame\ Size$ \*\*\*
16. Start capture on TS1, TS2 and TS3.
17. Wait until TS3 captures 1000 frames.
18. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
19. Set DUT.TS3's Egress Hardware Rate Limit to 49% line rate.
20. Repeat Steps 15 through 18.
21. Set DUT.TS3's Egress Hardware Rate Limit to 48% line rate.
22. Repeat Steps 15 through 18.

**Observable Results:**

- In Part A, during Step 5, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 25% of the bits transmitted by TS1.
- In Part A, during Step 8, repetition of Step 5, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 26% of the bits transmitted by TS1.
- In Part A, during Step 10, repetition of Step 5, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 27% of the bits transmitted by TS1.
- In Part B, during Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 50% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 20, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 49% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 22, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture all frames transmitted by TS1. TS3 must capture 48% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- In Part A, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.
- In Part B, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.

### **Rate.Ver.1.3: Egress Rate Limiting and Frame Queuing**

**Purpose:** To examine the DUT's Egress Rate Limiting and frame queuing mechanisms.

**References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

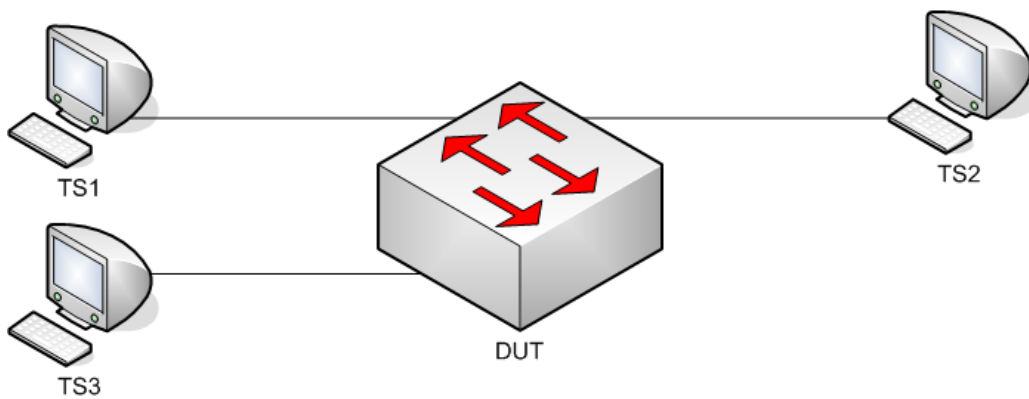
**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming "Hardware Egress Rate Limiting" capabilities indicate support for the configuration of egress (transmission) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's rate limiting and frame queuing mechanisms, with both untagged and VLAN-tagged frames.

**Test Layout:**



*Figure 3 – Egress Hardware Rate Limiting and Frame Queuing*



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InterOperability Laboratory*

**Procedure:**

*Part A: Egress Hardware Rate Limiting and Frame Queuing*

1. Ensure that the [default](#) values are configured on the DUT.
2. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
3. Transmit, from TS3, one Src22 frame.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
5. Continuously transmit, from TS2, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
6. Start capture on TS1, TS2 and TS3.
7. Wait until TS3 captures 1000 frames.
8. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
9. Set DUT.TS3's Egress Hardware Rate Limit to 75% line rate.
10. Repeat Steps 3 through 8.

*Part B: Egress Hardware Rate Limiting and Frame Queuing – VLAN tagged frames*

11. Ensure that the [default](#) values are configured on the DUT.
12. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
13. Set all DUT.TSs's PVID to 1.
14. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
15. Transmit, from TS3, one Src22\_Tag2 frame.
16. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
17. Continuously transmit, from TS2, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
18. Start capture on TS1, TS2 and TS3.
19. Wait until TS3 captures 1000 frames.
20. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
21. Set DUT.TS3's Hardware Egress Rate Limit to 75% line rate.
22. Repeat Steps 15 through 20.

**Observable Results:**

- In Part A, during Step 7, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture 12.5% of the bits transmitted by TS1. TS3 must capture 12.5% of the bits transmitted by TS2. TS3 must capture 25% of the total bits transmitted by TS1 and TS2. TS3 must capture an evenly distributed sample of frames from TS1 and TS2.
- In Part A, during Step 10, repetition of Step 7, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture 37.5% of the bits transmitted by TS1. TS3 must capture 37.5% of the bits transmitted by TS2. TS3 must capture 75% of the bits transmitted by TS1 and TS2. TS3 must capture an evenly distributed sample of frames from TS1 and TS2.
- In Part B, during Step 19, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture 12.5% of the bits transmitted by TS1. TS3 must capture 12.5% of the bits transmitted by TS2. TS3 must capture 25% of the total bits transmitted by TS1 and TS2. TS3 must capture an evenly distributed sample of frames from TS1 and TS2, tagged for VID 2.
- In Part B, during Step 22, repetition of Step 19, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture 37.5% of the bits transmitted by TS1. TS3 must capture 37.5% of the bits transmitted by TS2. TS3 must capture 75% of the bits transmitted by TS1 and TS2. TS3 must capture an evenly distributed sample of frames from TS1 and TS2, tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- In Part A, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.
- In Part B, this Test must be modified, if the DUT does not support the specified Egress Hardware Rate Limit values.

## **GROUP 2: Ingress Hardware Rate Limiting**

### **Scope**

To examine the DUT's Ingress (reception) Hardware Rate Limiting functionality.

### **Overview**

Ingress Hardware Rate Limiting is used to limit the ingress (reception) rate of a Bridge Port. Generally the ingress rate limit is configured as a percent of total line rate, with a configuration specific granularity. Ingress Hardware Rate Limiting may be deployed by Service Providers wishing to limit the upload bandwidth of a particular subscriber.

This Group of Tests examines the DUT's Ingress Hardware Rate Limiting functionality, including rate limit accuracy, configuration granularity and multiple frame types.

## **Rate.Ver.2.1: Ingress Rate Limiting**

**Purpose:** To examine the DUT's Ingress Hardware Rate Limiting functionality.

**References:**

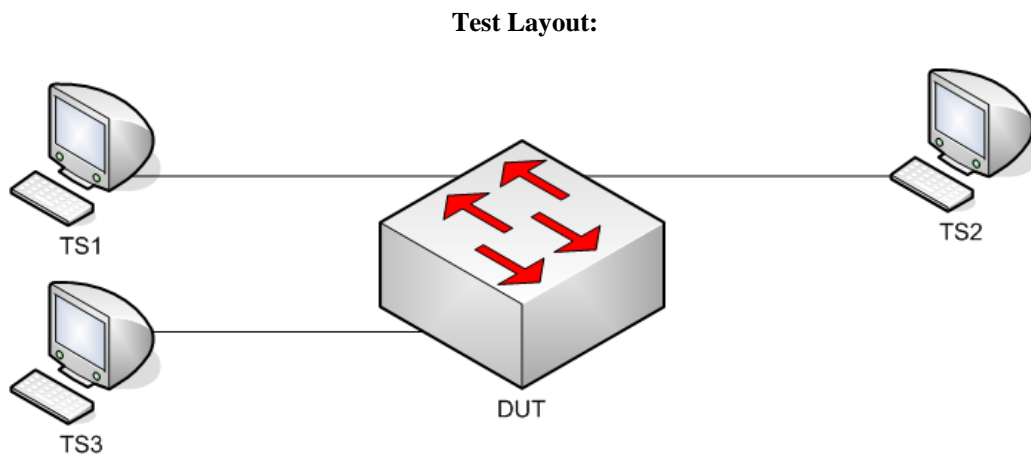
- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming "Ingress Hardware Rate Limiting" capabilities indicate support for the configuration of ingress (reception) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's ingress rate limiting accuracy and the effect of untagged and VLAN-tagged frames on the DUT's Ingress Hardware Rate Limiting capabilities.



*Figure 4 – Ingress Hardware Rate Limiting*

**Procedure:**

*Part A: Ingress Hardware Rate Limiting Granularity and Range*

1. Ensure that the [default](#) values are configured on the DUT.
2. Record the DUT's Ingress Hardware Rate Limiting granularity and range, as configurable through any/all configuration methods.

*Part B: Ingress Hardware Rate Limiting Verification*

3. Ensure that the [default](#) values are configured on the DUT.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
5. Start capture on TS1, TS2 and TS3.
6. Wait until TS3 captures 1000 frames.
7. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
8. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
9. Repeat Steps 4 through 7.
10. Set DUT.TS1's Ingress Hardware Rate Limit to 50% line rate.
11. Repeat Steps 4 through 7.
12. Set DUT.TS1's Ingress Hardware Rate Limit to 25% line rate.
13. Repeat Steps 4 through 7.
14. Set DUT.TS1's Ingress Hardware Rate Limit to 1% line rate.
15. Repeat Steps 4 through 7.

*Part C: Ingress Hardware Rate Limiting Verification – VLAN tagged frames*

16. Ensure that the [default](#) values are configured on the DUT.
17. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
18. Set all DUT.TSs's PVID to 1.
19. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
20. Start capture on TS1, TS2 and TS3.
21. Wait until TS3 captures 1000 frames.
22. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
23. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
24. Repeat Steps 19 through 22.
25. Set DUT.TS1's Ingress Hardware Rate Limit to 50% line rate.
26. Repeat Steps 19 through 22.
27. Set DUT.TS1's Ingress Hardware Rate Limit to 25% line rate.
28. Repeat Steps 19 through 22.
29. Set DUT.TS1's Ingress Hardware Rate Limit to 1% line rate.
30. Repeat Steps 19 through 22.

**Observable Results:**

- In Part A, during Step 2, record the DUT's Ingress Hardware Rate Limiting granularity and range.
- In Part B, during Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture all frames transmitted by TS1.
- In Part B, during Step 9, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 75% of the bits transmitted by TS1.
- In Part B, during Step 11, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 50% of the bits transmitted by TS1.
- In Part B, during Step 13, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 25% of the bits transmitted by TS1.
- In Part B, during Step 15, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 1% of the bits transmitted by TS1.
- In Part C, during Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture all frames transmitted by TS1, tagged for VID 2.
- In Part C, during Step 24, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 75% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 26, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 50% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 28, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 25% of the bits transmitted by TS1, tagged for VID 2.
- In Part C, during Step 30, repetition of Step 21, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 1% of the bits transmitted by TS1, tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- This Test cannot be completed, if the DUT does not support Ingress Hardware Rate Limiting. No further Ingress Hardware Rate Limiting testing can be performed.
- In Part B, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.
- In Part C, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.

## **Rate.Ver.2.2: Ingress Hardware Rate Limiting Granularity Verification**

**Purpose:** To examine the DUT's Ingress Hardware Rate Limiting configuration granularity.

**References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

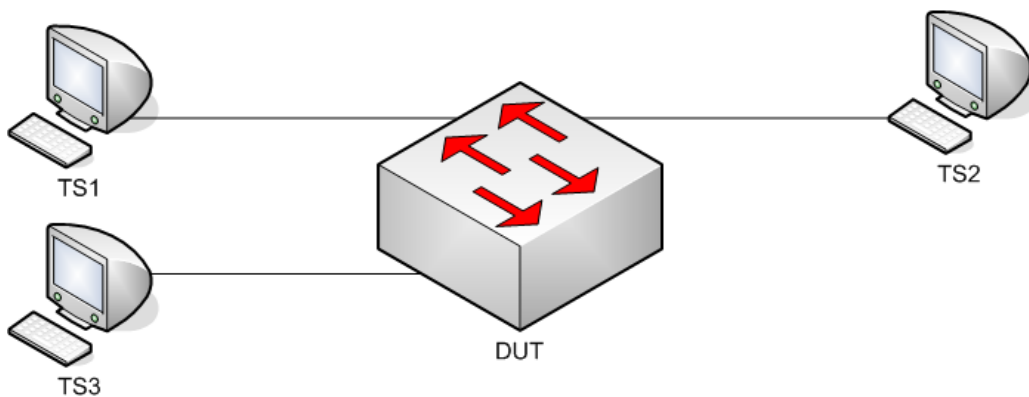
**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming “Ingress Hardware Rate Limiting” capabilities indicate support for the configuration of ingress (reception) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's ingress rate limit configuration granularity, with both untagged and VLAN-tagged frames.

**Test Layout:**



*Figure 5 – Ingress Hardware Rate Limiting Granularity Verification*

*The University of New Hampshire  
InterOperability Laboratory*

**Procedure:**

*Part A: Ingress Hardware Rate Limiting Granularity Verification*

1. Ensure that the [default](#) values are configured on the DUT.
2. Set DUT.TS1's Ingress Hardware Rate Limit to 25% line rate.
3. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where  $X = 64$  to  $Y$ , in increments of 1.  
\*\*\* $Y = \text{DUT's Maximum Frame Size}$ \*\*\*
4. Start capture on TS1, TS2 and TS3.
5. Wait until TS3 captures 1000 frames.
6. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
7. Set DUT.TS1's Ingress Hardware Rate Limit to 26% line rate.
8. Repeat Steps 3 through 6.
9. Set DUT.TS1's Ingress Hardware Rate Limit to 27% line rate.
10. Repeat Steps 3 through 6.

*Part B: Ingress Hardware Rate Limiting Granularity Verification – VLAN tagged frames*

11. Ensure that the [default](#) values are configured on the DUT.
12. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
13. Set all DUT.TSs's PVID to 1.
14. Set DUT.TS1's Ingress Hardware Rate Limit to 50% line rate.
15. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where  $X = 64$  to  $Y$ , in increments of 1.  
\*\*\* $Y = \text{DUT's Maximum Frame Size}$ \*\*\*
16. Start capture on TS1, TS2 and TS3.
17. Wait until TS3 captures 1000 frames.
18. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
19. Set DUT.TS1's Ingress Hardware Rate Limit to 49% line rate.
20. Repeat Steps 15 through 18.
21. Set DUT.TS1's Ingress Hardware Rate Limit to 48% line rate.
22. Repeat Steps 15 through 18.

**Observable Results:**

- In Part A, during Step 5, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 25% of the bits transmitted by TS1.
- In Part A, during Step 8, repetition of Step 5, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 26% of the bits transmitted by TS1.
- In Part A, during Step 10, repetition of Step 5, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 27% of the bits transmitted by TS1.
- In Part B, during Step 17, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 50% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 20, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 49% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 22, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 and TS3 must capture 48% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- In Part A, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.
- In Part B, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.



### **Rate.Ver.2.3: Ingress Hardware Rate Limiting and Frame Queuing**

**Purpose:** To examine the DUT's Ingress Hardware Rate Limiting and frame queuing mechanisms.

**References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

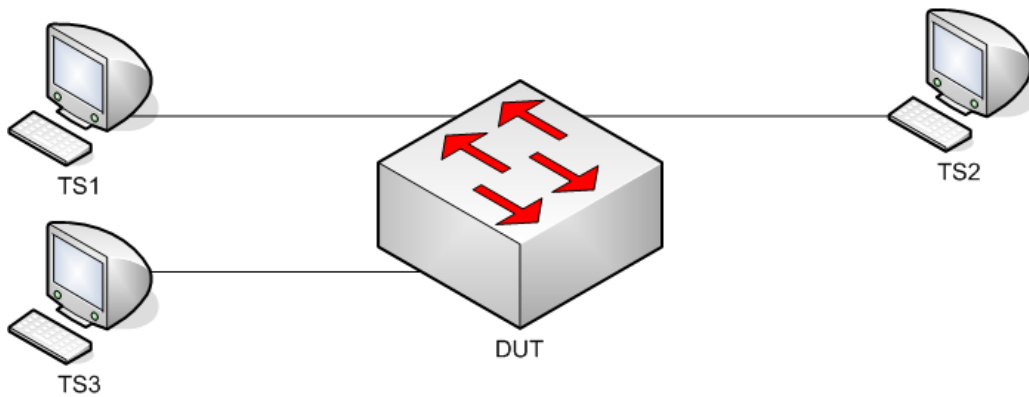
**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming “Ingress Hardware Rate Limiting” capabilities indicate support for the configuration of ingress (reception) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's ingress rate limiting and frame queuing mechanisms, with both untagged and VLAN-tagged frames.

**Test Layout:**



*Figure 6 – Ingress Hardware Rate Limiting and Frame Queuing*

*The University of New Hampshire  
InterOperability Laboratory*

**Procedure:**

*Part A: Ingress Hardware Rate Limiting and Frame Queuing*

1. Ensure that the [default](#) values are configured on the DUT.
2. Set DUT.TS1's Ingress Hardware Rate Limit to 25% line rate.
3. Transmit, from TS3, one Src22 frame.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
5. Continuously transmit, from TS2, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
6. Start capture on TS1, TS2 and TS3.
7. Wait until TS3 captures 1000 frames.
8. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
9. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
10. Repeat Steps 3 through 8.

*Part B: Ingress Rate Limiting and Frame Queuing – VLAN tagged frames*

11. Ensure that the [default](#) values are configured on the DUT.
12. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
13. Set all DUT.TSs's PVID to 1.
14. Set DUT.TS1's Ingress Hardware Rate Limit to 25% line rate.
15. Transmit, from TS3, one Src22\_Tag2 frame.
16. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
17. Continuously transmit, from TS2, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
18. Start capture on TS1, TS2 and TS3.
19. Wait until TS3 captures 1000 frames.
20. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
21. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
22. Repeat Steps 15 through 20.

**Observable Results:**

- In Part A, during Step 7, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture a sample of frames from TS1 and TS2, such that TS3 captures more frames from TS2 than TS1.
- In Part A, during Step 10, repetition of Step 7, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture a sample of frames from TS1 and TS2, such that TS3 captures more frames from TS2 than TS1.
- In Part B, during Step 19, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture a sample of frames from TS1 and TS2, such that TS3 captures more frames from TS2 than TS1, tagged for VID 2.
- In Part B, during Step 22, repetition of Step 19, TS1 and TS2 must not capture any frames transmitted by TS1 or TS2. TS3 must capture a sample of frames from TS1 and TS2, such that TS3 captures more frames from TS2 than TS1, tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- In Part A, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.
- In Part B, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.

## **GROUP 3: Ingress/Egress Hardware Rate Limiting**

### **Scope**

To examine the DUT's Ingress and Egress (reception) Hardware Rate Limiting functionality simultaneously.

### **Overview**

Ingress Hardware Rate Limiting is used to limit the ingress (reception) rate of a Bridge Port. Egress Hardware Rate Limiting is used to limit the egress (transmission) rate of a Bridge Port. Generally the ingress and egress rate limits are configured as a percent of total line rate, with a configuration specific granularity.

This Group of Tests examines the DUT's Ingress and Egress Hardware Rate Limiting interaction, by configuring the DUT to simultaneously limit ingress and egress on separate Bridge Ports.

### **Rate.Ver.3.1: Ingress/Egress Rate Limiting**

**Purpose:** To examine the DUT's Ingress and Egress Hardware Rate Limiting functionality simultaneously.

**References:**

- IEEE Std 802.3-2002
- IEEE Std 802.1D-2004
- IEEE Std 802.1Q-2003

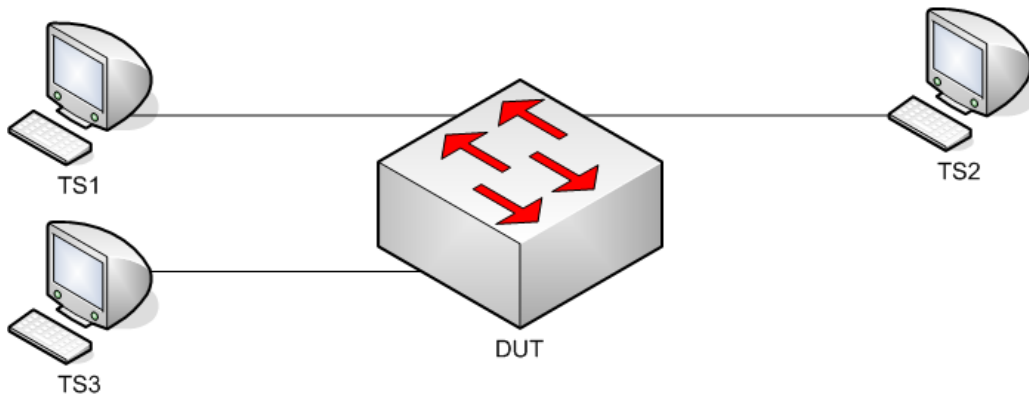
**Resource Requirements:**

- 3 Test Stations

**Discussion:**

Ethernet devices claiming "Ingress Hardware Rate Limiting" capabilities indicate support for the configuration of ingress (reception) rate limits on a particular Bridge Port, or set of Bridge Ports. Ethernet devices claiming "Egress Hardware Rate Limiting" capabilities indicate support for the configuration of egress (reception) rate limits on a particular Bridge Port, or set of Bridge Ports. This Test examines the DUT's egress rate limiting accuracy and the effect of untagged and VLAN-tagged frames on the DUT's Egress Hardware Rate Limiting capabilities.

**Test Layout:**



*Figure 7 – Ingress/Egress Hardware Rate Limiting*

*The University of New Hampshire  
InterOperability Laboratory*

**Procedure:**

*Part A: Ingress Hardware Rate Limiting Verification*

1. Ensure that the [default](#) values are configured on the DUT.
2. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
3. Set DUT.TS3's Egress Hardware Rate Limit to 50% line rate.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
5. Start capture on TS1, TS2 and TS3.
6. Wait until TS3 captures 1000 frames.
7. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
8. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
9. Repeat Steps 4 through 7.
10. Set DUT.TS1's Ingress Hardware Rate Limit to 50% line rate.
11. Repeat Steps 4 through 7.

*Part B: Ingress Hardware Rate Limiting Verification*

12. Ensure that the [default](#) values are configured on the DUT.
13. Set all DUT.TSs's VLAN membership to VID 2, tagged, and VID 1, untagged.
14. Set all DUT.TSs's PVID to 1.
15. Set DUT.TS1's Ingress Hardware Rate Limit to 75% line rate.
16. Set DUT.TS3's Egress Hardware Rate Limit to 50% line rate.
17. Continuously transmit, from TS1, Dest22\_Tag2 frames, at 100% line rate, where X = 64 to Y, in increments of 1.  
\*\*\*Y = DUT's Maximum Frame Size\*\*\*
18. Start capture on TS1, TS2 and TS3.
19. Wait until TS3 captures 1000 frames.
20. Stop capture on TS1, TS2 and TS3, and observe the captured frames (if any).
21. Set DUT.TS3's Egress Hardware Rate Limit to 25% line rate.
22. Repeat Steps 15 through 18.
23. Set DUT.TS1's Ingress Hardware Rate Limit to 50% line rate.
24. Repeat Steps 15 through 18.

**Observable Results:**

- In Part A, during Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture 75% of bits transmitted by TS1. TS3 must capture 50% of bits transmitted by TS1.
- In Part A, during Step 9, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture 75% of bits transmitted by TS1. TS3 must capture 25% of the bits transmitted by TS1.
- In Part A, during Step 11, repetition of Step 6, TS1 must not capture any frames transmitted by TS1. TS2 must capture 50% of bits transmitted by TS1. TS3 must capture 25% of the bits transmitted by TS1.
- In Part B, during Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture 75% of bits transmitted by TS1, tagged for VID 2. TS3 must capture 50% of bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 20, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture 75% of bits transmitted by TS1, tagged for VID 2. TS3 must capture 25% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- In Part B, during Step 22, repetition of Step 17, TS1 must not capture any frames transmitted by TS1. TS2 must capture 50% of bits transmitted by TS1, tagged for VID 2. TS3 must capture 25% of the bits transmitted by TS1. All frames captured by TS3, transmitted by TS1, must be tagged for VID 2.
- All frames received during this Test must contain a CRC value equal to the frame's original CRC value.

**Possible Problems:**

- This Test cannot be completed, if the DUT does not support Ingress and Egress Hardware Rate Limiting. No further Ingress/Egress Hardware Rate Limiting testing can be performed.
- In Part A, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.
- In Part B, this Test must be modified, if the DUT does not support the specified Ingress Hardware Rate Limit values.

## TEST FRAMES

<b>Src22</b>		
<b>Octet(s)</b>	<b>Description</b>	<b>Value (all numbers are hexadecimal)</b>
1 - 6	Destination MAC Address	FF FF FF FF FF FF
7 - 12	Source MAC Address	00 22 22 22 22 22
13 - 14	Type/Length	Pseudo-random Data Pattern
-	VLAN Tag Header	None
15 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

<b>Dest22</b>		
<b>Octet(s)</b>	<b>Description</b>	<b>Value (all numbers are hexadecimal)</b>
1 - 6	Destination MAC Address	00 22 22 22 22 22
7 - 12	Source MAC Address	<TS Source MAC>
13 - 14	Type/Length	Pseudo-random Data Pattern
-	VLAN Tag Header	None
15 - (X-4)	Data	Pseudo-random Data Pattern
(X-3) - X	Frame Check Sequence	Calculated at runtime

\*\*\*X = *Frame Size*\*\*\*

<b>Src22_Tag2</b>		
<b>Octet(s)</b>	<b>Description</b>	<b>Value (all numbers are hexadecimal)</b>
1 - 6	Destination MAC Address	FF FF FF FF FF FF
7 - 12	Source MAC Address	00 22 22 22 22 22
13 - 14	Type/Length	81 00
15 - 16	VLAN Tag Header	00 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

<b>Dest22_Tag2</b>		
<b>Octet(s)</b>	<b>Description</b>	<b>Value (all numbers are hexadecimal)</b>
1 - 6	Destination MAC Address	00 22 22 22 22 22
7 - 12	Source MAC Address	<TS Source MAC>
13 - 14	Type/Length	81 00
15 - 16	VLAN Tag Header	00 02
15 - (X-4)	Data	Pseudo-random Data Pattern
(X-3) - X	Frame Check Sequence	Calculated at runtime

\*\*\*X = *Frame Size*\*\*\*

All frames must contain a valid FCS.