Bridge Functions Consortium

Quality/Class of Service
Conformance Test Suite
Version 0.3

Last Updated: 2005-09-23

Bridge Functions Consortium
University of New Hampshire
InterOperability Laboratory
www.iol.unh.edu

121 Technology Drive, Suite 2
Durham, NH 03824
Phone: (603) 862-0090
Fax: (603) 862-4181

TABLE OF CONTENTS

MODIFICATION RECORD

Version	Date	Editor(s)	Comments
0.1	2005-08-24	Curtis Knittle Curtis Simonson	Initial draft
0.2	2005-09-06	Chester Balut Curtis Knittle Curtis Simonson	Added Group 2
0.3	2005-09-23	Curtis Simonson	Split Tests QoS.op.1.3 to QoS.op.1.3 and QoS.op.1.4 Split Tests QoS.op.2.3 to QoS.op.2.3 and QoS.op.2.4 Minor Test Suite modifications

ACKNOWLEDGEMENTS

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

Chester Balut	UNH InterOperability Lab
Curtis Knittle	Harmonic, Inc.
Curtis Simonson	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 Quality/Class of Service capable products.

IEEE Std 802.1Q™-rev-d4 states:

> *"The MAC Service includes priority as a Quality of Service parameter. MA_UNITDATA.request primitives with a high priority may be given precedence over other request primitives made at the same station, or at other stations attached to the same LAN, and can give rise to earlier MA_UNITDATA.indication primitives. The MAC Sublayer maps the requested priority onto the priorities supported by the individual MAC method. The requested priority may be conveyed to the destination station. The transmission delay experienced by a frame in a Bridge can be managed by associating a priority with the frame."*

This Test Suite has been designed based on the set of requirements that pertain to IEEE Std 802.1Q VLAN Quality of Service. 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 are not designed as performance tests. The relative performance of IEEE Std 802.1Q™-rev-d4 capable devices (e.g. Transit and Queuing Delays, Bridge Throughput, Bridge Latency, etc.) is beyond the scope of this document.

These Tests do not determine whether the DUT conforms to IEEE Std 802.1Q™-rev-d4, nor are they designed as interoperability tests. Rather, they provide one method to isolate problems within an IEEE Std 802.1Q™-rev-d4 capable device that will affect interoperability. Successful completion of all Tests contained in this suite does not guarantee that the DUT will interoperate with other IEEE Std 802.1Q™-rev-d4 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 IEEE Std 802.1Q™-rev-d4 capable environments.

REFERENCES

The following documents are referenced in this text:

[IEEE Std 802.1Q™-rev-d4] IEEE Computer Society LAN/MAN Standards Committee, "Virtual Bridged Local Area Networks – Revision, Draft 4.0"

[IEEE Std 802.1Q™-2003] IEEE Computer Society LAN/MAN Standards Committee, "Virtual Bridged Local Area Networks"

[IEEE Std 802.1p™-1998] IEEE Computer Society LAN/MAN Standards Committee, "Port-Based Network Access Control"

[IEEE Std 802.1Q™-1998] IEEE Computer Society LAN/MAN Standards Committee, "Virtual Bridged Local Area Networks"

DEFINITION OF TERMS

Abbreviations and Acronyms

CoS	Class of Service
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)
IEEE	Institute of Electrical and Electronics Engineers
PVID	Port VLAN ID
QoS	Quality of Service (a.k.a Class of Service)
TS	Test Station (ex. TS1 refers to Test Station 1)
WRR	Weighted Round Robin

Definition of Terms

Device Under Test	The Bridge on which the QoS.op 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.
Strict Priority Queuing	A transmission queuing mechanism that forwards frames up to 100% line rate of the transmission link by selecting the highest priority frames in the transmission queue, and drops all other frames of lower priority.
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.
Weighted Round Robin Queuing	A transmission queuing mechanism that forwards frames up to 100% line rate of the transmission link by selecting a percentage of higher and lower priority frames in the transmission queue, where more higher priority frames are selected than lower priority frames, and drops all other frames of lower priority.

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 QoS.op.1.2 refers to the second test of the first test group in the QoS Operation 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*

**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: Frame Queue Verification – Strict Priority

Scope

To examine the DUT's Layer 2 quality of service and frame queuing behavior, when configured with Strict Priority Queuing mechanisms.

Overview

On point-to-point Ethernet links a certain Link Speed is established via Auto-Negotiation; the receivers on each end of the link indicate that they can receive at full line-rate as negotiated. IEEE Std 802.1Q™ Bridges process incoming frames upon reception and a determine which Port, or set of Ports, the frame must be transmitted out of. The Bridge places the frame in the egress queue on the transmitting Port(s). During the frame processing that occurs upon reception, each frame is associated with a priority value. If the transmitting Port(s) support one egress queue, all frames are place in the egress queue, regardless of priority, unless the egress queue is full. When the egress queue is full it does not accept frames. If the transmitting Port(s) support more than one egress queue, the frame priority value is used to determine which egress queue the frame is place in. In this case

Tagged frames carry an explicit priority value encoded in the 3-bit priority field of the IEEE Std 802.1Q™ VLAN-tag. Untagged frames do not carry a priority value; Bridges assign a priority value to received untagged frames according to the priority value configured in management on the receiving Port. Bridges may also support the ability to modify the priority value of incoming VLAN-tagged frames.

This group of Tests focuses on the frame contents and configuration aspects that may have an effect on the DUT"s Layer 2 quality of service and frame queuing behavior. The DUT"s behavior is observed while configured with Strict Priority Queuing mechanisms.

The Strict Priority Queuing transmission mechanism selects frames from the Bridge Port's egress queue(s) and forwards them to the physical layer for immediate transmission. Strict Priority Queuing will always select the oldest frame from the highest priority populated egress queue. No lower priority frames will be transmitted before all the highest priority frames are transmitted.

Tests in this group assume the DUT implements four queues, and has a default priority-to-queue mapping as specified in the Example Priority-to-Queue Mapping table. If the DUT does not support this default configured priority-to-queue mapping, then some Test Procedures must be modified accordingly.

*****This Group of Tests cannot be completed if the DUT does not support Strict Priority Queuing*****

QoS.op.1.1: Queue Verification – VLAN-Tagged Frames – Strict Priority

Purpose: To verify the default number of queues, priority-to-queue mapping and transmission mechanism on the DUT, while configured for Strict Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Tagged frames contain an explicit integer priority value. The Bridge, upon frame reception, determines which Port(s) to transmit the frame out of and uses the conveyed priority value to determine which egress queue the frame is placed in on the transmitting Port(s). A common industry practice allows users to configure a Bridge's priority-to-queue mapping. For example, a device supporting four egress queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses tagged frames to determine the DUT's default number of queues, priority-to-queue mapping and transmission mechanisms while configured for Strict Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

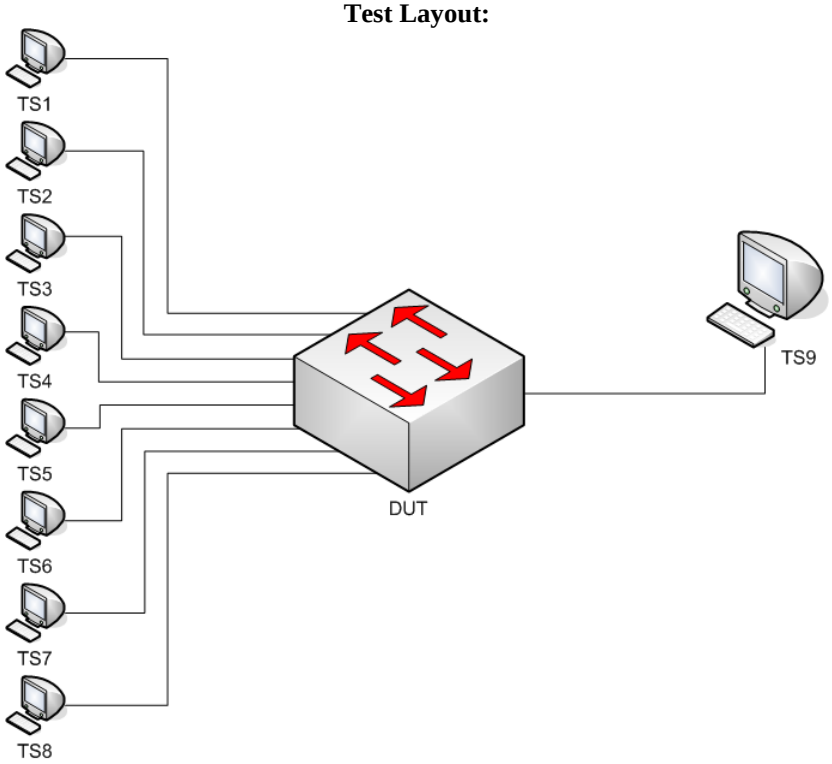

Figure 1 – Queue Verification – VLAN-Tagged Frames – Strict Priority

******Links connecting all TSs to the DUT must be configured to the same line speed (ex. 100 Mbps)******

Procedure:

Part A: Tagged Ingress Frames → Tagged Egress Frames – No Port Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set all DUT.TSs's VLAN membership to VID 2, tagged.
3. Transmit, from TS9, one Src22_Tag2 frame.
4. Continuously transmit, from TS1, Dest22_Pri0_Tag2 frames, at 100% line rate.
5. Start capture on TS9.
6. Wait until TS9 captures 5000 frames.
7. Stop capture on TS9 and observe the capture frames (if any).
8. Continuously transmit, from TS2, Dest22_Pri1_Tag2 frames, at 100% line rate.
9. Start capture on TS9.
10. Wait until TS9 captures 5000 frames.
11. Stop capture on TS9 and observe the capture frames (if any).
12. Continuously transmit, from TS3, Dest22_Pri2_Tag2 frames, at 100% line rate.
13. Start capture on TS9.
14. Wait until TS9 captures 5000 frames.
15. Stop capture on TS9 and observe the capture frames (if any).
16. Continuously transmit, from TS4, Dest22_Pri3_Tag2 frames, at 100% line rate.
17. Start capture on TS9.
18. Wait until TS9 captures 5000 frames.
19. Stop capture on TS9 and observe the capture frames (if any).
20. Continuously transmit, from TS5, Dest22_Pri4_Tag2 frames, at 100% line rate.
21. Start capture on TS9.
22. Wait until TS9 captures 5000 frames.
23. Stop capture on TS9 and observe the capture frames (if any).
24. Continuously transmit, from TS6, Dest22_Pri5_Tag2 frames, at 100% line rate.
25. Start capture on TS9.
26. Wait until TS9 captures 5000 frames.
27. Stop capture on TS9 and observe the capture frames (if any).
28. Continuously transmit, from TS7, Dest22_Pri6_Tag2 frames, at 100% line rate.
29. Start capture on TS9.
30. Wait until TS9 captures 5000 frames.
31. Stop capture on TS9 and observe the capture frames (if any).
32. Continuously transmit, from TS8, Dest22_Pri7_Tag2 frames, at 100% line rate.
33. Start capture on TS9.
34. Wait until TS9 captures 5000 frames.
35. Stop capture on TS2 and observe the capture frames (if any).
36. Set DUT's priority-to-queue mapping different than the DUT's default priority-to-queue mapping.
37. Repeat Steps 3 through 35.

Observable Results:

- In Part A, during Steps 6, 10, 14, 18, 22, 26, 30, 34, record the captured frames' VLAN-tag priority value. This information indicates the priority-to-queue mapping configured on DUT.
- In Part A, during Step 37, the repetition of Steps 6, 10, 14, 18, 22, 26, 30, 34, record the captured frames' VLAN-tag priority value. Ensure that this information indicates the modified priority-to-queue mapping.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.1.2: Frame Queuing – Untagged Frames – Strict Priority

Purpose: To examine the DUT's untagged frame queuing and ingress priority association behavior while configured for Strict Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Untagged frames do not contain a priority value. A Bridge, upon frame reception, determines which Port(s) to transmit the frame out of. The Bridge assigns a priority value to all incoming tagged frames equal to the Port Frame Priority value configured on the receiving Port. The priority value assigned to the frame is then used to determine which transmission queue the frame is placed in on the transmitting Port(s). VLAN-tagged frames transmitted by a Bridge must contain the proper priority value, equal to either the explicitly or the internally assigned frame priority values. Common industry practices allow users to configure a Bridge to assign a specific priority value to incoming untagged frames and modify the priority value included in VLAN-tagged frames, as well as modify the Bridge's priority-to-queue mapping. For example, a Port may associate all incoming untagged frame a priority value equal to 5 and a device supporting four queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses untagged frames to examine the DUT's behavior when receiving frames on multiple Ports with an equal priority value and the ability of the DUT to assign priority values to incoming untagged frames. This Test also determines the DUT's default priority-to-queue mapping while configured for Strict Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

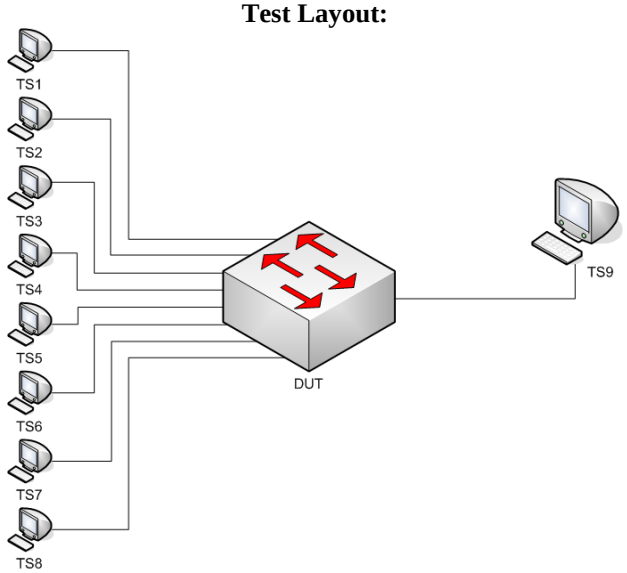

Figure 2 – Frame Queuing – Untagged Frames – Strict Priority

******Links connecting all TSs to the DUT must be configured to the same line speed (ex. 100 Mbps)******

Procedure:

Part A: Untagged Ingress Frames – Zero Priority

1. Ensure that the default values are configured on the DUT.
2. Transmit, from TS9, one Src22 frame.
3. Continuously transmit, from TS1, Dest22 frames, at 100% line rate.
4. Continuously transmit, from TS2, Dest22 frames, at 100% line rate.
5. Continuously transmit, from TS3, Dest22 frames, at 100% line rate.
6. Continuously transmit, from TS4, Dest22 frames, at 100% line rate.
7. Continuously transmit, from TS5, Dest22 frames, at 100% line rate.
8. Continuously transmit, from TS6, Dest22 frames, at 100% line rate.
9. Continuously transmit, from TS7, Dest22 frames, at 100% line rate.
10. Continuously transmit, from TS8, Dest22 frames, at 100% line rate.
11. Start capture on TS9.
12. Wait until TS9 captures 5000 frames.
13. Stop capture on TS2 and observe the capture frames (if any).
14. Set all DUT.TS9s's VLAN membership to VID 1, tagged.
15. Repeat Steps 2 through 13.

Part B: Untagged Ingress Frames – Non-Zero Port Priority Modification

16. Ensure that the default values are configured on the DUT.
17. Set DUT.TS1 through DUT.TS8's Port Frame Priority to 0 through 7, respectively.
18. Transmit, from TS9, one Src22 frame.
19. Continuously transmit, from TS1, Dest22 frames, at 100% line rate.
20. Continuously transmit, from TS2, Dest22 frames, at 100% line rate.
21. Start capture on TS9.
22. Wait until TS9 captures 5000 frames.
23. Stop capture on TS9 and observe the capture frames (if any).
24. Continuously transmit, from TS3, Dest22 frames, at 100% line rate.
25. Continuously transmit, from TS4, Dest22 frames, at 100% line rate.
26. Start capture on TS9.
27. Wait until TS9 captures 5000 frames.
28. Stop capture on TS9 and observe the capture frames (if any).
29. Continuously transmit, from TS5, Dest22 frames, at 100% line rate.
30. Continuously transmit, from TS6, Dest22 frames, at 100% line rate.
31. Start capture on TS9.
32. Wait until TS9 captures 5000 frames.
33. Stop capture on TS9 and observe the capture frames (if any).
34. Continuously transmit, from TS7, Dest22 frames, at 100% line rate.
35. Continuously transmit, from TS8, Dest22 frames, at 100% line rate.
36. Start capture on TS9.
37. Wait until TS9 captures 5000 frames.
38. Stop capture on TS9 and observe the capture frames (if any).
39. Set all DUT.TS9s's VLAN membership to VID 1, tagged.
40. Repeat Steps 18 through 38.

Observable Results:

- In Part A, during Step 12, TS9 must capture an evenly distributed sample of frames from TS1 through TS8. During Step 15, repetition of Step 12, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, tagged for VID 1. Record the VLAN-tag priority value contained in the captured frames.
- In Part B, during Steps 22, 27, 32, 37, record the source MAC addresses of frames captured by TS9. During Step 40, repetition of Steps 22, 27, 32, 37, TS9 must capture frames containing a priority value and tagged for VID 1. Record the VLAN-tag priority value contained in the frames captured by TS9. This information indicates priority-to-queue mapping configured on DUT.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- In Part B, the Test Procedure must be modified if the DUT supports a default priority-to-queue mapping other than Example Priority-to-Queue Mapping.
- In Part B, this Test cannot be completed, if the DUT does not support the ability to configure the Port Frame Priority value.
- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.1.3: Frame Queuing – Null-VID VLAN-Tagged Frames – Strict Priority

Purpose: To examine the DUT's tagged frame queuing behavior for null-VID, non-null-Priority, VLAN-tagged frames, while configured for Strict Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6, 8.4.4
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

IEEE Std 802.1Q sub-clause 8.4.4 indicates that VLAN-tagged frames are not required to contain a VID value. VLAN-tagged frames may contain a priority value and a zero VID value, referred to as priority-tagged frames. A Bridge, upon priority-tagged frame reception, determines which Port(s) to transmit the frame out of and uses the conveyed priority value to determine which transmission queue the frame is placed in on the transmitting Port(s). VLAN-tagged frames transmitted by a Bridge must contain the proper priority value, equal to either the explicit frame priority value. A common industry practice allows users to configure a Bridge's priority-to-queue mapping. For example, a device supporting four queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses priority-tagged frames to examine the DUT's frame queuing mechanism. This Test also determines the DUT's default priority-to-queue mapping for priority-tagged frames, while configured for Strict Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

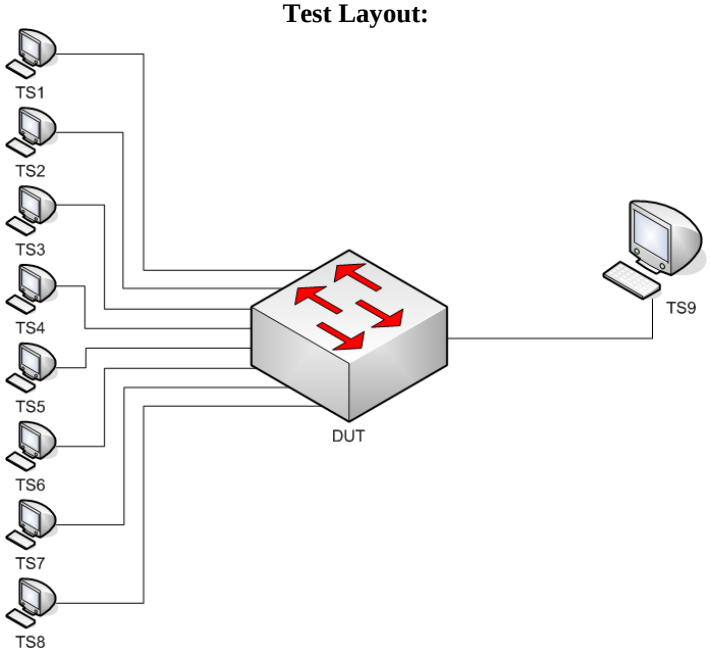

Figure 3 – Frame Queuing – Null-VID VLAN-Tagged Frames – Strict Priority

******Links connecting all TSs to the DUT must be configured to the same line speed******

Procedure:

Part A: Untagged Frames → Tagged Frames – No Port Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set DUT.TS9's VLAN membership to VID 2, tagged.
3. Transmit, from TS9, one Src22_Tag2 frame.
4. Continuously transmit, from TS1, Dest22_Pri0 frames, at 100% line rate.
5. Continuously transmit, from TS2, Dest22_Pri1 frames, at 100% line rate.
6. Start capture on TS9.
7. Wait until TS9 captures 5000 frames.
8. Stop capture on TS2 and observe the capture frames (if any).
9. Continuously transmit, from TS3, Dest22_Pri2 frames, at 100% line rate.
10. Continuously transmit, from TS4, Dest22_Pri3 frames, at 100% line rate.
11. Start capture on TS9.
12. Wait until TS9 captures 5000 frames.
13. Stop capture on TS2 and observe the capture frames (if any).
14. Continuously transmit, from TS5, Dest22_Pri4 frames, at 100% line rate.
15. Continuously transmit, from TS6, Dest22_Pri5 frames, at 100% line rate.
16. Start capture on TS9.
17. Wait until TS9 captures 5000 frames.
18. Stop capture on TS2 and observe the capture frames (if any).
19. Continuously transmit, from TS7, Dest22_Pri6 frames, at 100% line rate.
20. Continuously transmit, from TS8, Dest22_Pri7 frames, at 100% line rate.
21. Start capture on TS9.
22. Wait until TS9 captures 5000 frames.
23. Stop capture on TS2 and observe the capture frames (if any).

Observable Results:

- In Part A, during Steps 7, 12, 17, and 22, TS9 must capture frames containing a priority value and tagged for VID 2. Record the VLAN-tag priority value contained in the frames captured by TS9. This information indicates priority-to-queue mapping configured on DUT.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- In Part A, the Test Procedure must be modified if the DUT supports a default priority-to-queue mapping other than Example Priority-to-Queue Mapping.
- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.1.4: VLAN-tagged Frame Priority Modification – Strict Priority

Purpose: To examine the DUT's VLAN-tag priority value modification functionality while configured for Strict Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Tagged Frames convey a priority encoded in the first three bits of the VLAN tag. Along with assigning received frames a priority value, using the priority value conveyed in the frame, or modifying the priority value, the Bridge also determines which Ports to transmit the frame out of. The frame's priority value is then used to determine which transmission queue the frame is placed in on the transmitting Port(s). A common industry practice is to provide the users the ability to configure a device to assign a specific priority value to all incoming frames on a Port. A device can also be configured to modify the priority value included in VLAN-tagged frames. This Test examines the DUT's behavior while configured for Strict Priority Queuing.

Test Layout:

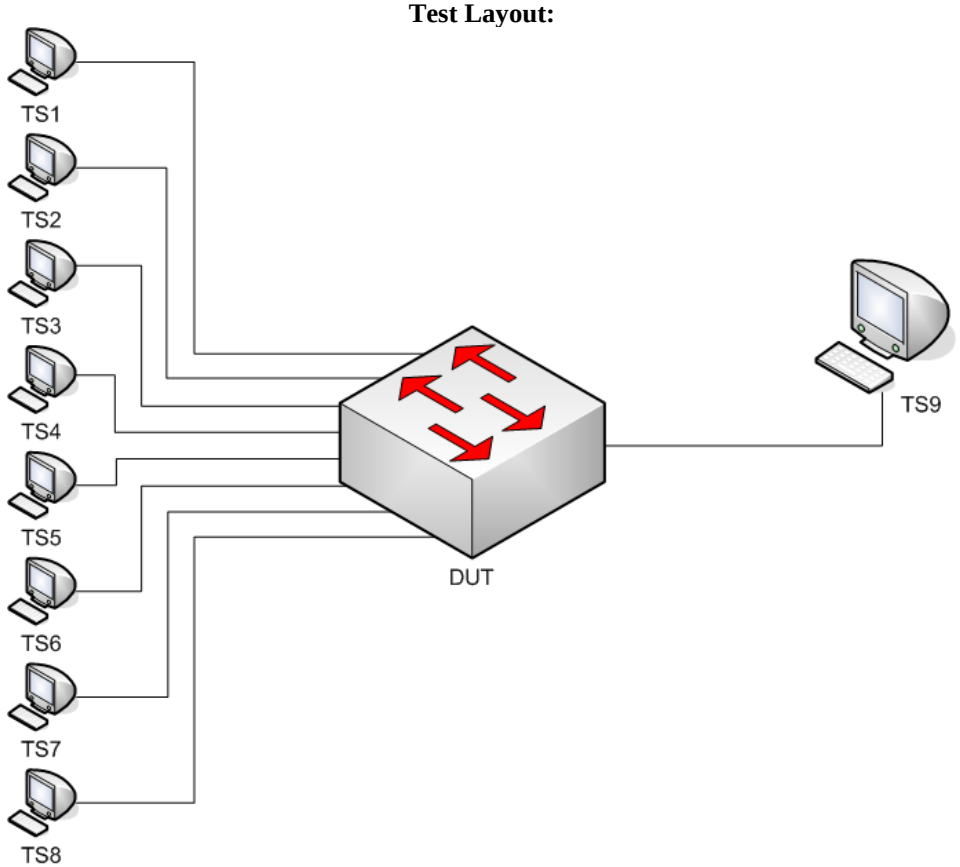

Figure 4 – VLAN-tagged Frame Priority Modification – Strict Priority

******Links connecting all TSs to the DUT must be configured to the same line speed******

Procedure:

Part A: Tagged Frames → Tagged Frames – VLAN-tagged Frame Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set all DUT.TSs's VLAN membership to VID 2, tagged.
3. Set all DUT.TSs's Port Frame Priority Modification to 0.
   Note – This setting must modify the VLAN-tag priority values of incoming frames.
4. Transmit, from TS9, one Src22_Tag2 frame.
5. Continuously transmit, from TS1, Dest22_Pri0_Tag2 frames, at 100% line rate.
6. Continuously transmit, from TS2, Dest22_ Pri1_Tag2 frames, at 100% line rate.
7. Continuously transmit, from TS3, Dest22_ Pri2_Tag2 frames, at 100% line rate.
8. Continuously transmit, from TS4, Dest22_ Pri3_Tag2 frames, at 100% line rate.
9. Continuously transmit, from TS5, Dest22_ Pri4_Tag2 frames, at 100% line rate.
10. Continuously transmit, from TS6, Dest22_ Pri5_Tag2 frames, at 100% line rate.
11. Continuously transmit, from TS7, Dest22_ Pri6_Tag2 frames, at 100% line rate.
12. Continuously transmit, from TS8, Dest22_ Pri7_Tag2 frames, at 100% line rate.
13. Start capture on TS9.
14. Wait until TS9 captures 5000 frames.
15. Stop capture on TS2 and observe the capture frames (if any).
16. Set all DUT.TSs's Port Priorty Modification to 4.
17. Repeat Steps 4 through 15.
18. Set all DUT.TSs's Port Priorty Modification to 7.
19. Repeat Steps 4 through 15.

Observable Results:

- In Part A, during Step 14, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 0.
- In Part A, during Step 17, the repetition of Step 14, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 4.
- In Part A, during Step 19, the repetition of Step 14, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 7.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- In Part A, the Test cannot be completed, if the DUT does not support modification of incoming VLAN-tag priority values.
- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

GROUP 2: Frame Queue Verification – Weighted Round Robin Priority

Scope

To examine the DUT's Layer 2 quality of service and frame queuing behavior, when configured with Weighted Round Robin Priority Queuing mechanisms.

Overview

On point-to-point Ethernet links a certain Link Speed is established via Auto-Negotiation; the receivers on each end of the link indicate that they can receive at full line-rate as negotiated. IEEE Std 802.1Q™ Bridges process incoming frames upon reception and a determine which Port, or set of Ports, the frame must be transmitted out of. The Bridge places the frame in the transmission queue on the transmitting Port(s). During the frame processing that occurs upon reception, each frame is associated with a priority value. If the transmitting Port(s) support one transmission queue, all frames are place in the queue, regardless of priority. If the transmitting Port(s) support more than one transmission queue, the frame priority value is used to determine which transmission queue the frame is place in.

Tagged frames carry an explicit priority value encoded in the 3-bit priority field of the IEEE Std 802.1Q™ VLAN-tag. Untagged frames do not carry a priority value; Bridges assign a priority value to received untagged frames according to the priority value configured in management on the receiving Port. Bridges may also support the ability to modify the priority value of incoming VLAN-tagged frames.

This group of Tests focuses on the frame contents and configuration aspects that may have an effect on the DUT"s Layer 2 quality of service and frame queuing behavior. The DUT"s behavior is observed while configured with Weighted Round Robin Priority Queuing mechanisms.

The Weighted Round Robin Priority Queuing transmission mechanism selects frames from the Bridge Port's egress queue(s) and forwards them to the physical layer for immediate transmission. Weighted Round Robin Priority Queuing selects frames from egress queues based on a "weighted", predetermined, percentage. For instance, a Bridge may be configured with a 67% weight for priority 7, %15 for priority 6, 7% for priority 5, 4% for priority 4, 3% for priority 3, 2% for priority 2 and 1% for priority 1, and 1% for priority 0%. When selecting from egress queues, the oldest frame from the in the queue is always transmitted first.

Tests in this group assume the DUT implements four queues, and has a default priority-to-queue mapping as specified in the Example Priority-to-Queue Mapping table. If the DUT does not support this default configured priority-to-queue mapping, then some Test Procedures must be modified accordingly.

*****This Group of Tests cannot be completed if the DUT does not support Weighted Round Robin Priority Queuing*****

QoS.op.2.1: Queue Verification – VLAN-Tagged Frames – Weighted Round Robin Priority

Purpose: To verify the default number of egress queues, priority-to-queue mapping and transmission mechanism on the DUT, while configured for Weighted Round Robin Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Tagged frames contain an explicit integer priority value. The Bridge, upon frame reception, determines which Port(s) to transmit the frame out of and uses the conveyed priority value to determine which egress queue the frame is placed in on the transmitting Port(s). A common industry practice allows users to configure a Bridge's priority-to-queue mapping. For example, a device supporting four egress queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses tagged frames to determine the DUT's default number of egress queues, priority-to-queue mapping and transmission mechanism while configured for Weighted Round Robin Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

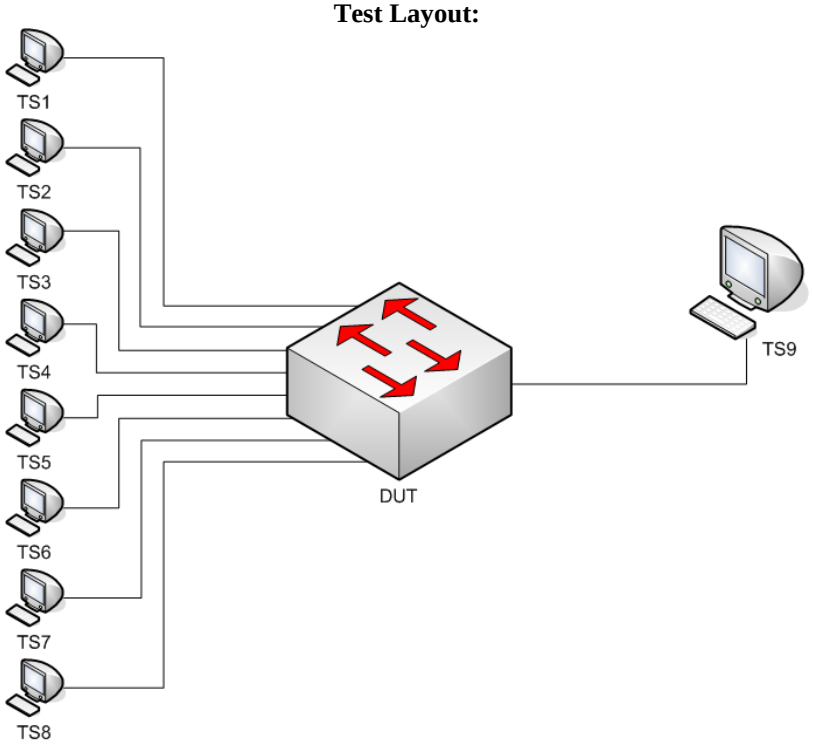

Figure 5 – Queue Verification – VLAN-Tagged Frames – Weighted Round Robin Priority

******Links connecting all TSs to the DUT must be configured to the same line speed (ex. 100 Mbps)******

Procedure:

Part A: Tagged Ingress Frames → Tagged Egress Frames – No Port Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set all DUT.TSs's VLAN membership to VID 2, tagged.
3. Set DUT's QoS/CoS Bridge Mode to Weighted Round Robin.
4. Transmit, from TS9, one Src22_Tag2 frame.
5. Continuously transmit, from TS1, Dest22_Pri0_Tag2 frames, at 100% line rate.
6. Start capture on TS9.
7. Wait until TS9 captures 5000 frames.
8. Stop capture on TS9 and observe the capture frames (if any).
9. Continuously transmit, from TS2, Dest22_Pri1_Tag2 frames, at 100% line rate.
10. Start capture on TS9.
11. Wait until TS9 captures 5000 frames.
12. Stop capture on TS9 and observe the capture frames (if any).
13. Continuously transmit, from TS3, Dest22_Pri2_Tag2 frames, at 100% line rate.
14. Start capture on TS9.
15. Wait until TS9 captures 5000 frames.
16. Stop capture on TS9 and observe the capture frames (if any).
17. Continuously transmit, from TS4, Dest22_Pri3_Tag2 frames, at 100% line rate.
18. Start capture on TS9.
19. Wait until TS9 captures 5000 frames.
20. Stop capture on TS9 and observe the capture frames (if any).
21. Continuously transmit, from TS5, Dest22_Pri4_Tag2 frames, at 100% line rate.
22. Start capture on TS9.
23. Wait until TS9 captures 5000 frames.
24. Stop capture on TS9 and observe the capture frames (if any).
25. Continuously transmit, from TS6, Dest22_Pri5_Tag2 frames, at 100% line rate.
26. Start capture on TS9.
27. Wait until TS9 captures 5000 frames.
28. Stop capture on TS9 and observe the capture frames (if any).
29. Continuously transmit, from TS7, Dest22_Pri6_Tag2 frames, at 100% line rate.
30. Start capture on TS9.
31. Wait until TS9 captures 5000 frames.
32. Stop capture on TS9 and observe the capture frames (if any).
33. Continuously transmit, from TS8, Dest22_Pri7_Tag2 frames, at 100% line rate.
34. Start capture on TS9.
35. Wait until TS9 captures 5000 frames.
36. Stop capture on TS2 and observe the capture frames (if any).
37. Set DUT's priority-to-queue mapping different than the DUT's default priority-to-queue mapping.
38. Repeat Steps 4 through 36.

Observable Results:

- In Part A, during Steps 7, 11, 15, 19, 23, 27, 31, 35, record the captured frames' VLAN-tag priority value and the number of frames captured for each VLAN-tag priority value. This information indicates the priority-to-queue mapping and Weighted Round Robin weights configured on DUT.
- In Part A, during Step 38, the repetition of Steps 7, 11, 15, 19, 23, 27, 31, 35, record the captured frames' VLAN-tag priority value and the number of frames captured for each VLAN-tag priority value. Ensure that this information indicates the modified priority-to-queue mapping and a Weighted Round Robin queuing mechanism.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.2.2: Frame Queuing – Untagged Frames – Weighted Round Robin Priority

Purpose: To examine the DUT's untagged frame queuing and ingress priority association behavior while configured for Weighted Round Robin Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Untagged frames do not convey a priority value. A Bridge, upon frame reception, determines which Port(s) to transmit the frame out of. The Bridge assigns a priority value to all incoming untagged frames equal to the Port Frame Priority value configured on the receiving Port. The priority value assigned to the frame is then used to determine which transmission queue the frame is placed in on the transmitting Port(s). VLAN-tagged frames transmitted by a Bridge must contain the proper priority value, equal to either the explicitly or internally assigned priority values for the frame. Common industry practices allow users to configure a Bridge to assign a specific priority value to incoming untagged frames and modify the priority value included in VLAN-tagged frames, as well as modify the Bridge's priority-to-queue mapping. For example, a Port may assign all incoming untagged frame a priority value equal to 5 and a device supporting four queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses untagged frames to examine the DUT's behavior when receiving frames on multiple Ports with an equal priority value and the ability of the DUT to assign priority values to incoming untagged frames. This Test also determines the DUT's default priority-to-queue mapping while configured for Weighted Round Robin Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

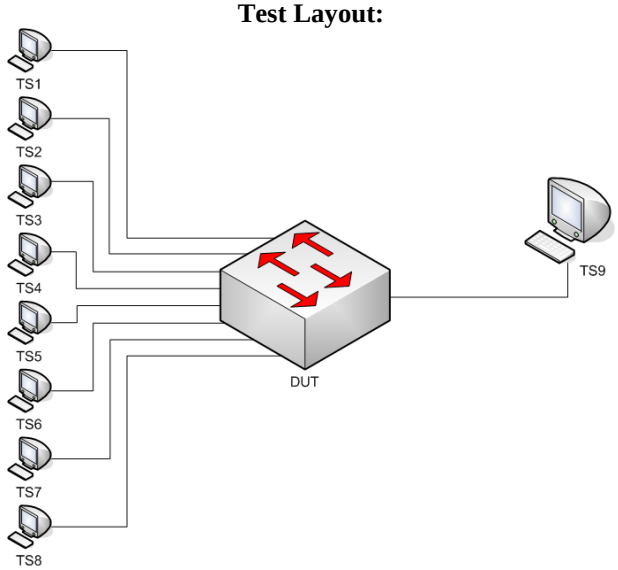

Figure 6 – Frame Queuing – Untagged Frames – Weighted Round Robin Priority

******Links connecting all TSs to the DUT must be configured to the same line speed (ex. 100 Mbps)******

Procedure:

Part A: Untagged Ingress Frames – Zero Priority

1. Ensure that the default values are configured on the DUT.
2. Set DUT's QoS/CoS Bridge Mode to Weighted Round Robin.
3. Transmit, from TS9, one Src22 frame.
4. Continuously transmit, from TS1, Dest22 frames, at 100% line rate.
5. Continuously transmit, from TS2, Dest22 frames, at 100% line rate.
6. Continuously transmit, from TS3, Dest22 frames, at 100% line rate.
7. Continuously transmit, from TS4, Dest22 frames, at 100% line rate.
8. Continuously transmit, from TS5, Dest22 frames, at 100% line rate.
9. Continuously transmit, from TS6, Dest22 frames, at 100% line rate.
10. Continuously transmit, from TS7, Dest22 frames, at 100% line rate.
11. Continuously transmit, from TS8, Dest22 frames, at 100% line rate.
12. Start capture on TS9.
13. Wait until TS9 captures 5000 frames.
14. Stop capture on TS2 and observe the capture frames (if any).
15. Transmit, from TS9, one Src22 frame.
16. Set all DUT.TS9's VLAN membership to VID 1, tagged.
17. Repeat Steps 4 through 14.

Part B: Untagged Ingress Frames – Non-Zero Port Priority Modification

18. Ensure that the default values are configured on the DUT.
19. Set DUT.TS1 through DUT.TS8's Port Frame Priority to 0 through 7, respectively.
20. Set DUT's QoS/CoS Bridge Mode to Weighted Round Robin.
21. Transmit, from TS9, one Src22 frame.
22. Continuously transmit, from TS1, Dest22 frames, at 100% line rate.
23. Continuously transmit, from TS2, Dest22 frames, at 100% line rate.
24. Start capture on TS9.
25. Wait until TS9 captures 5000 frames.
26. Stop capture on TS9 and observe the capture frames (if any).
27. Continuously transmit, from TS3, Dest22 frames, at 100% line rate.
28. Continuously transmit, from TS4, Dest22 frames, at 100% line rate.
29. Start capture on TS9.
30. Wait until TS9 captures 5000 frames.
31. Stop capture on TS9 and observe the capture frames (if any).
32. Continuously transmit, from TS5, Dest22 frames, at 100% line rate.
33. Continuously transmit, from TS6, Dest22 frames, at 100% line rate.
34. Start capture on TS9.
35. Wait until TS9 captures 5000 frames.
36. Stop capture on TS9 and observe the capture frames (if any).
37. Continuously transmit, from TS7, Dest22 frames, at 100% line rate.
38. Continuously transmit, from TS8, Dest22 frames, at 100% line rate.
39. Start capture on TS9.
40. Wait until TS9 captures 5000 frames.
41. Stop capture on TS9 and observe the capture frames (if any).
42. Transmit, from TS9, one Src22 frame.
43. Set all DUT.TS9's VLAN membership to VID 1, tagged.
44. Repeat Steps 22 through 41.

Observable Results:

- In Part A, during Step 13, TS9 must capture an evenly distributed sample of frames from TS1 through TS8. During Step 17, repetition of Step 13, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, tagged for VID 1. Record the VLAN-tag priority value contained in the captured frames.
- In Part B, during Steps 25, 30, 35, 40, record the source MAC addresses of frames captured by TS9. During Step 44, repetition of Steps 25, 30, 35, 40, TS9 must capture frames containing a priority value and tagged for VID 1. Record the VLAN-tag priority value contained in the frames captured by TS9. Ensure that this information indicates the modified priority-to-queue mapping and a Weighted Round Robin queuing mechanism.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- In Part B, this Test cannot be completed, if the DUT does not support the ability to configure the Port Frame Priority value.
- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.2.3: Frame Queuing – Null-VID VLAN-Tagged Frames – Weighted Round Robin Priority

Purpose: To examine the DUT's tagged frame queuing behavior for null-VID, non-null-Priority, VLAN-tagged frames, while configured for Weighted Round Robin Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6, 8.4.4
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

IEEE Std 802.1Q sub-clause 8.4.4 indicates that VLAN-tagged frames are not required to contain a VID value. VLAN-tagged frames may contain a priority value and a zero VID value, referred to as priority-tagged frames. A Bridge, upon priority-tagged frame reception, determines which Port(s) to transmit the frame out of and uses the conveyed priority value to determine which transmission queue the frame is placed in on the transmitting Port(s). VLAN-tagged frames transmitted by a Bridge must contain the proper priority value, equal to either the explicit frame priority value. A common industry practice allows users to configure a Bridge's priority-to-queue mapping. For example, a device supporting four queues may map priorities 0 and 1 (lowest priorities) to queue 0 (lowest priority queue), priorities 2 and 3 to queue 1, priorities 4 and 5 to queue 2 and priorities 6 and 7 (highest priorities) to queue 3 (highest priority queue) (see Example Priority-to-Queue Mapping table).

This Test uses priority-tagged frames to examine the DUT's frame queuing mechanism. This Test also determines the DUT's default priority-to-queue mapping for priority-tagged frames, while configured for Weighted Round Robin Priority Queuing. If the DUT does not support a default priority-to-queue mapping equal to Example Priority-to-Queue Mapping, this information will be used to modify Test Procedures for further Tests.

Test Layout:

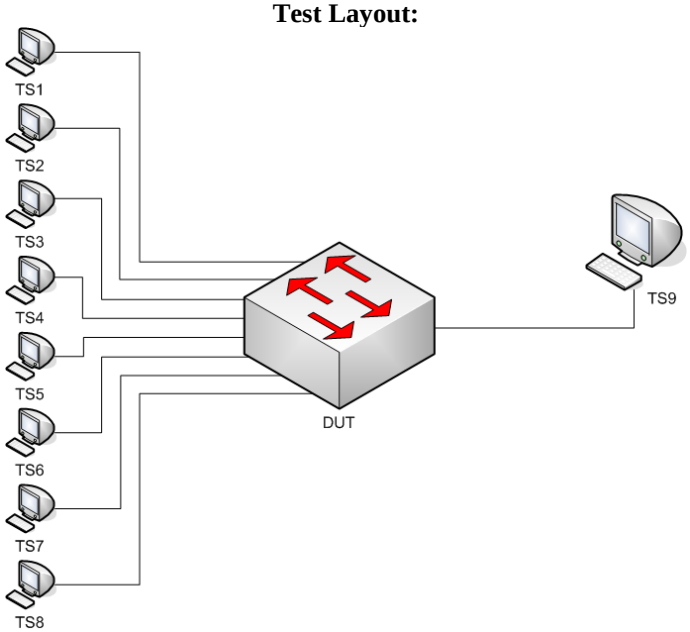

Figure 7 – Frame Queuing – Null-VID VLAN-tagged Frames – Untagged Frames

******Links connecting all TSs to the DUT must be configured to the same line speed******

Procedure:

Part A: Untagged Frames → Tagged Frames – No Port Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set DUT.TS9's VLAN membership to VID 2, tagged.
3. Set DUT's QoS/CoS Bridge Mode to Weighted Round Robin.
4. Transmit, from TS9, one Src22_Tag2 frame.
5. Continuously transmit, from TS1, Dest22_Pri0 frames, at 100% line rate.
6. Continuously transmit, from TS2, Dest22_Pri1 frames, at 100% line rate.
7. Start capture on TS9.
8. Wait until TS9 captures 5000 frames.
9. Stop capture on TS2 and observe the capture frames (if any).
10. Continuously transmit, from TS3, Dest22_Pri2 frames, at 100% line rate.
11. Continuously transmit, from TS4, Dest22_Pri3 frames, at 100% line rate.
12. Start capture on TS9.
13. Wait until TS9 captures 5000 frames.
14. Stop capture on TS2 and observe the capture frames (if any).
15. Continuously transmit, from TS5, Dest22_Pri4 frames, at 100% line rate.
16. Continuously transmit, from TS6, Dest22_Pri5 frames, at 100% line rate.
17. Start capture on TS9.
18. Wait until TS9 captures 5000 frames.
19. Stop capture on TS2 and observe the capture frames (if any).
20. Continuously transmit, from TS7, Dest22_Pri6 frames, at 100% line rate.
21. Continuously transmit, from TS8, Dest22_Pri7 frames, at 100% line rate.
22. Start capture on TS9.
23. Wait until TS9 captures 5000 frames.
24. Stop capture on TS2 and observe the capture frames (if any).

Observable Results:

- In Part A, during Steps 8, 13, 18, and 23, TS9 must capture frames containing a priority value and tagged for VID 2. Record the VLAN-tag priority value contained in the frames captured by TS9. This information indicates priority-to-queue mapping and priority queuing mechanism configured on DUT.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

QoS.op.2.4: Frame Priority Modification – Weighted Round Robin Priority

Purpose: To examine the DUT's VLAN-tag priority value modification functionality while configured for Weighted Round Robin Priority Queuing.

References:

- IEEE Std. 802.1Q-2003: sub-clauses 8.6
- IEEE Std. 802.1Q-2003: figure 8-9

Resource Requirements:

- 9 Test Stations

Discussion:

Tagged Frames convey a priority encoded in the first three bits of the VLAN tag. Along with assigning received frames a priority value, using the priority value conveyed in the frame, or modifying the priority value, the Bridge also determines which Ports to transmit the frame out of. The frame's priority value is then used to determine which transmission queue the frame is placed in on the transmitting Port(s). A common industry practice is to provide the users the ability to configure a device to assign a specific priority value to all incoming frames on a Port. A device can also be configured to modify the priority value included in VLAN-tagged frames. This Test examines the DUT's behavior while configured for Weighted Round Robin Priority Queuing.

Test Layout:

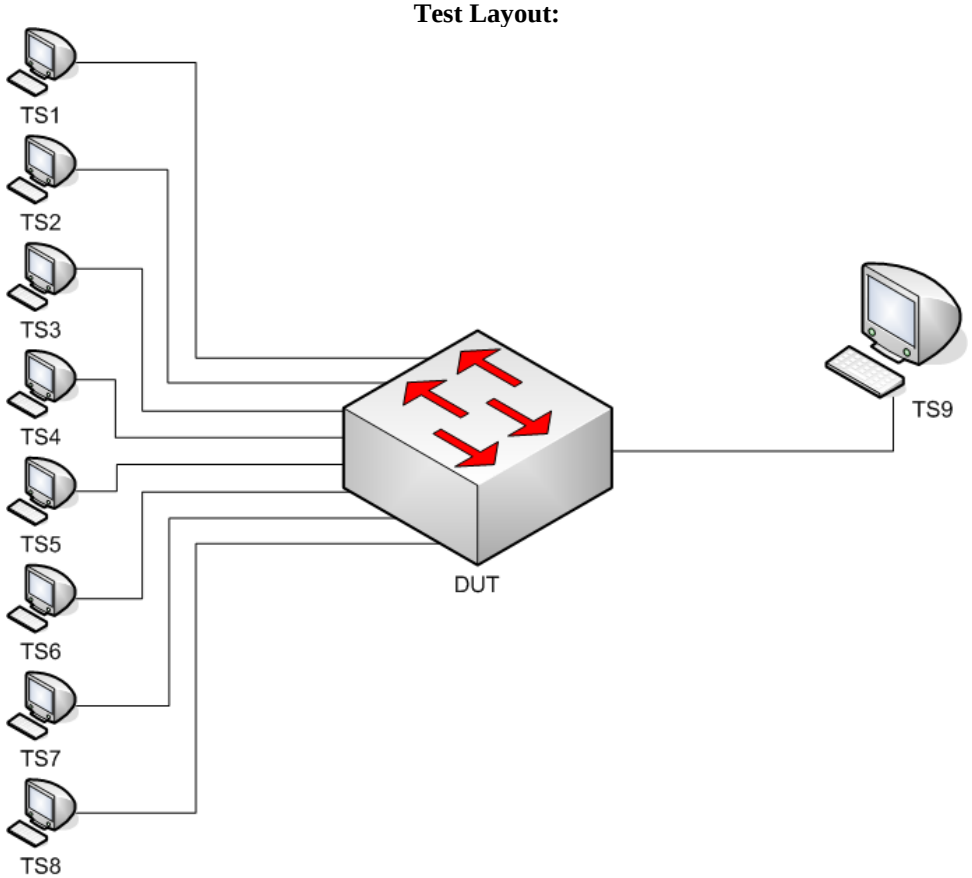

Figure 8 – Frame Priority Modification – Weighted Round Robin Priority

******Links connecting all TSs to the DUT must be configured to the same line speed******

Procedure:

Part A: Tagged Frames → Tagged Frames – Port Priority Modification

1. Ensure that the default values are configured on the DUT.
2. Set all DUT.TSs's VLAN membership to VID 2, tagged.
3. Set all DUT.TSs's Port Frame Priority Modification to 0.
   Note – This setting must modify the VLAN-tag priority values of incoming frames.
4. Set DUT's QoS/CoS Bridge Mode to Weighted Round Robin.
5. Transmit, from TS9, one Src22_Tag2 frame.
6. Continuously transmit, from TS1, Dest22_Pri0_Tag2 frames, at 100% line rate.
7. Continuously transmit, from TS2, Dest22_ Pri1_Tag2 frames, at 100% line rate.
8. Continuously transmit, from TS3, Dest22_ Pri2_Tag2 frames, at 100% line rate.
9. Continuously transmit, from TS4, Dest22_ Pri3_Tag2 frames, at 100% line rate.
10. Continuously transmit, from TS5, Dest22_ Pri4_Tag2 frames, at 100% line rate.
11. Continuously transmit, from TS6, Dest22_ Pri5_Tag2 frames, at 100% line rate.
12. Continuously transmit, from TS7, Dest22_ Pri6_Tag2 frames, at 100% line rate.
13. Continuously transmit, from TS8, Dest22_ Pri7_Tag2 frames, at 100% line rate.
14. Start capture on TS9.
15. Wait until TS9 captures 5000 frames.
16. Stop capture on TS2 and observe the capture frames (if any).
17. Set all DUT.TSs's Port Priorty Modification to 4.
18. Repeat Steps 5 through 16.
19. Set all DUT.TSs's Port Priorty Modification to 7.
20. Repeat Steps 5 through 16.

Observable Results:

- In Part A, during Step 15, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 0.
- In Part A, during Step 18, the repetition of Step 14, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 4.
- In Part A, during Step 20, the repetition of Step 14, TS9 must capture an evenly distributed sample of frames from TS1 through TS8, containing a VLAN-tag priority value equal to 7.
- All frames received during this Test must contain a valid CRC value.

Possible Problems:

- In Part A, the Test cannot be completed, if the DUT does not support modification of incoming VLAN-tag priority values.
- This Test cannot be completed, if the DUT does not support IEEE Std 802.1Q™.

TEST FRAMES

****<TS Source MAC> indicates frame contains TS Source MAC address unique to each TS****

Src22		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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

Dest22		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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 – 60	Data	Pseudo-random Data Pattern
61 – 64	Frame Check Sequence	Calculated at runtime

Src22_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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

Dest22_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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
17 – 60	Data	Pseudo-random Data Pattern
61 – 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri0		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri1		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	20 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	40 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri3		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	60 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri4		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	80 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri5		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	A0 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri6		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	C0 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri7		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	E0 00
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri0_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri1_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	20 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri2_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	40 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri3_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	60 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri4_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	80 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri5_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	A0 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri6_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	C0 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

Dest22_Pri7_Tag2		
Octet(s)	**Description**	**Value (all numbers are hexadecimal)**
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	E0 02
17 - 60	Data	Pseudo-random Data Pattern
61 - 64	Frame Check Sequence	Calculated at runtime

All frames must contain a valid FCS.