Benchmarking and Compliance Methodology for White Rabbit Switches

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Introduction

This document describes the methodology for testing White Rabbit Switches. Part of the tests follows the RFC 2544 and 2889, others are specific for Whiter Rabbit or specific protocols. In turn the methodology is divided in Benchmarking and Compliance Test.

The goal of this test methodology is threefold:

- Benchmark the White Rabbit switch
- Ascertain the compliance of the protocols implemented in the WR Switch
- Ascertain the WR protocol compliance of others manufacturers

1 Benchmarking Tests

To asses the performance of the WR Switch regarding:

1.1 Throughput

RFC 2544 Section 26.1

To determine the throughput.

Test Parameters

Duration:	> 60 secs
Length of Frames:	Recommended Ethernet frame sizes
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Frame Rate:	100 % of the theoretical maximum.
Trials:	10 for every frame length and CoS
Burst size:	?

Test Output

Frames Length	Theoretical Max Rate	Throughput
64	....	...
...	....	....
1518	....	...

1.2 Frame Latency

RFC 2544 Section 26.2

To determine the latency of a frame traversing the DUT.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Trials:	10 for every frame length and CoS
Burst size:	?

Test Output

Frames Length	Frame Rate	Latency	CoS
A	....	N	7
...	....	....	...
A	....	N	1

1.3 Broadcast and 7th CoS Frame Forwarding and Latency

To determine the throughput and latency of the DUT when forwarding 7th CoS and broadcast traffic a.k.a "High Priority Traffic".

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Trials:	10 for every frame length and CoS
Load per port:	? (%)
Burst size:	?

Test Output

Frames Length	Load	Throughput	Latency
64	....	...	...
...	....	...	...
1518	....	...	...

* Throughput, maximum load with no frame loss * Average latency.

1.4 Frame Loss Rate

RFC 2544 Section 26.3

To determine the frame loss rate of the DUT over various loads, frame lengths and CoS.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Frame Rate:	100 % of the theoretical maximum.
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Trials:	10 for every frame length and CoS
Burst size:	?

Test Output

Frame Rate	Frame Loss Rate	Frame Length
...	....	64
...	....	....
..	....	1518

1.5 Back-to-Back frames

RFC 2544 Section 26.3

To determine the largest burst of frames with minimum interframe gap (back-to-back frames) the DUT can handle with zero loss.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Back-to-back value:	from min - max ?
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Trials:	10 for every frame length and CoS
Burst size:	?

Test Output

Frame Length	Frame Rate	Recovery Time
64	....	....
...	....	....
1518	....	....

1.6 System recovery

RFC 2544 Section 26.4

To characterize the speed at which a DUT recovers from an overload condition.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Traffic Direction:	bi, uni-directional, input-output and vice versa.
Trials:	10 for every frame length and CoS

Test Output

Frame Length	Frame Rate	Recovery Time
64	....	....
...	....	....
1518	....	....

1.7 Fully Meshed

RFC 2889 Section 5.1

To determine the throughput, frame loss and forwarding rates of the DUT offered fully meshed traffic.

Test Parameters

Duration:	30 secs
Length of Frames:	Recommended Ethernet frame sizes
Load per port:	? (%)
Trials:	5 for every frame length and CoS
Burst size:	from 1 to 1000 frames

Output

- Forwarding rate for each frame legnth, load and CoS
- Throughput for each frame size with no frame loss.
- Flood count

1.8 Partially Meshed

1.8.1 One to Many/Many to One

RFC 2889 Section 5.2

To determine the throughput when transmitting from one-to-many ports or from many-to-one port. To measure the capability to switch frames without frame loss and determine the ability to utilize a port when switching traffic from multiple ports.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Duration:	30 secs
Traffic Direction:	one port to many ports, many ports to one port.
Load per port:	? (%)
Trials:	5 for every frame length and CoS
Burst size:	from 1 to 1000 frames

Test Output

- Forwarding rate for each frame size, for each load and CoS.
- Flood count

1.8.2 Multiple Devices

RFC 2889 Section 5.3

To determine the throughput, frame loss and forwarding rates of two WR Switches connected in Back-Bone Configuration.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Duration:	30 secs
Traffic Direction:	one port to many ports, many ports to one port.
Load per port:	? (%)
Trials:	5 for every frame length and CoS
Burst size:	from 1 to 1000 frames

Test Output

- Forwarding rate for each frame size, for each load and CoS.
- Flood count

1.8.3 Unidirectional Traffic

RFC 2889 Section 5.3

To determine the throughput of the DUT when multiple streams of one-way traffic using half of the ports on the DUT are sending frames to the other half of the ports.

Test Parameters

Length of Frames:	Recommended Ethernet frame sizes
Duration:	30 secs
Trials:	5 for every frame length and CoS

Test Output

- Forwarding rate for each frame size, for each load and CoS.
- Flood count

1.8.4 Maximum Forward Rate

RFC 2889 Section 5.4

To determine the throughput of the DUT when multiple streams of one-way traffic using half of the ports on the DUT are sending frames to the other half of the ports.

Length of Frames:	Recommended Ethernet frame sizes
Duration:	30 secs
Load per port:	? (%)
Trials:	5 for every frame length and CoS
Burst size:	from 1 to 1000 frames

1.8.5 RTU Capacity

RFC 2889 Section 5.5

To determine the address caching capacity of the WR Switch.

Test Parameters

RTU Age time:	?
Address learning rate :	?
Trials:	5 for every frame length and CoS

Test Output

- RTU address caching capacity
- Flood count

1.8.6 Learning Rate

RFC 2889 Section 5.6

To determine the rate of address learning of the White Rabbit Switch.

Test Parameters

RTU Age time:	?
Address learning rate :	?
Trials:	5 for every frame length and CoS

Test Output

- RTU address learning rate using search algorithm.
- Flood count

1.9 (Multiple) Rapid Spanning Tree Protocol

NOTE: Part of the tests can be done using a WR Test Switch connected to DUT, who receives from the Test Switch BPDUs and at same point gives up simulating a failure. By doing this we can simulate the failure of port with a designate role.

1.9.1 Time of coverage

To determine the time of coverage of RSTP in the network when:

- new switch added to the network
- change of topology
- failure of a root, designated, alternate and buckup port.

Test Parameters

BPDU frames rate:	?
BPDU missing time :	?
Port Role:	?
Type of traffic:	"High Priority" or not

Test Output

- Time of convergence for the different roles of a designate port.
- Number of lost frames

1.9.2 Switch-over for "High Priority" Traffic

to determine the time of Switch-over in case of port failure. Ref "High Priority Traffic in RSTP" in the document "White Rabbit and Robustness".

1.10 White Rabbit PTP (WRPTP)

NOTE: Measurements are done by comparing the PPS output signal of a switch which is chosen a Timing Master (reference source of time) and PPS outputs of the other switches in the network.

1.10.1 Synchronization Quality of a Static Network

To determine the quality of the synchronization (accuracy, precision and stability) in a static network (no changes to the network configuration and no switching between redundant devices) under varying traffic load and varying external conditions.

Test Parameters

Duration:	24h
Temperature range:	0-30 Celsius degrees
Temperature change rate:	1 Celsius degrees per minute
Number of Timing Masters:	1
Traffic load	variable (0-100%)
Number of cascaded switches	0-4

Test Output

- Accuracy
- Precision
- Stability

1.10.2 Reliability of Network Synchronization

To determine the quality of the synchronization (accuracy,precision and stability) in a network which is subject to changes due to:

- network re-configuration : adding/removing redundant switches and connections (fiber/copper cables),
- failure of redundant elements (connections, master ports, switches): switch-overload,
- failure of non-redundant elements: hold-over.

Test Parameters

Duration:	24h
Temperature range:	0-30 Celsius degrees
Temperature change rate:	1 Celsius degrees per minute
Number of Timing Masters:	1 and more
Traffic load	variable (0-100%)
Number of cascaded switches	0-4

Test Output

- Accuracy
- Precision
- Stability

2 Compliance Tests

2.1 Standards

2.1.1 RSTP / MSTP

TBD

2.1.2 VLAN

TBD

2.1.3 PTP/WRPTP

TBD

2.1.4 Sync Ethernet ??

TBD

2.2 RFC 2889

2.2.0.1 Congestion Control Flow Control

TBD

2.2.0.2 Frame Filtering

TBD

Terminology

Recommended Ethernet Frames Sizes: The RFC recommends for the tests frame sizes of: 64, 128, 256, 512, 1024,1280 and 1518 bytes

DUT: Device Under Test

Back-to-Back: Fixed length frames presented at a rate where the minimum legal separation for a given medium between frames over a short to medium period of time, starting from an idle state. (RFC 1242)

Latency: For store and forward devices: The time interval starting when the last bit of the input frame reaches the input port and ending when the first bit of the output frame is seen on the output port. For bit forwarding devices: The time interval starting when the end of the first bit of the input frame reaches the input port and ending when the start of the first bit of the output frame is seen on the output port. (RFC 1242)

Throughput: The maximum rate at which none of the offered frames are dropped by the device. (RFC 1242)

Accuracy: Mean offset between the source of time (Timing Master) and the DUT.

Precision: Standard deviation of the offset between the source of time (Timing Master) and the DUT.

Stability:

PPS: Pulse per Second.

Bibliography

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- RFC2285
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