



Data Center & Cloud Computing



FS S5800-48F4S Switch 1/10GE Ethernet Performance Validation

White Paper
May, 2014

Overview

The FS S5800-48F4S Switch is a high-performance, high-density, low-latency 1 and 10 Gigabit Ethernet switch facing next generation Metro, Data Center and Enterprise Ethernet network. This compact 1RU 1- and 10-Gbps switch provides line-rate Layer 2 and 3 switching. It runs the FSOS Software operating system, providing customers with features and capabilities that are widely deployed worldwide.

To fully validate the FS S5800-48F4S performance, rigorous testing was performed. IETF RFC 2544 is widely accepted in the industry as standard benchmarking methodologies to evaluate switch performance by measuring throughput, back to back, forwarding latency and frame loss at various conditions. Spirent TestCenter RFC 2544 was used in the tests.

The IETF RFC 2544 Benchmarking Methodology

The RFC 2544 standard, established by the Internet Engineering Task Force (IETF) standards body, is the de facto methodology that outlines the tests required to measure and prove performance criteria for carrier Ethernet networks. The standard provides an out-of-service benchmarking methodology to evaluate the performance of network devices using throughput, back-to-back, frame loss and latency tests, with each test validating a specific part of an SLA. The methodology defines the frame size, test duration and number of test iterations. Once completed, these tests will provide performance metrics of the Ethernet network under test. Specific tests are:

- Back to Back
- Frame Loss
- Throughput
- Latency

Back to Back Test

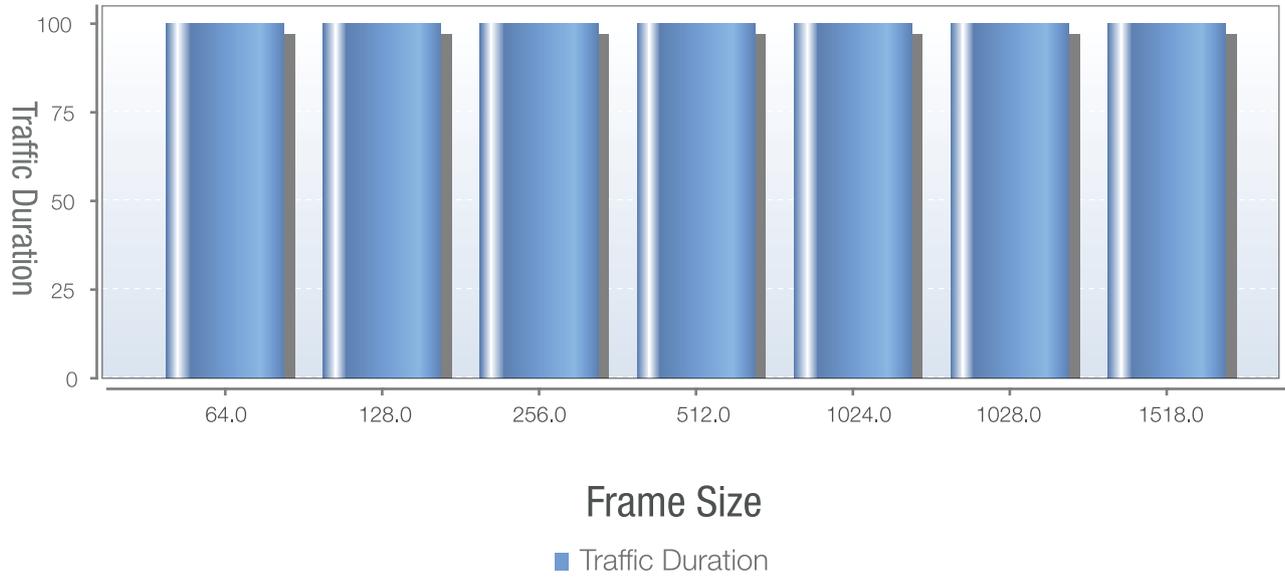
Overview

The back-to-back test (also known as burstability or burst test) assesses the buffering capability of a switch. It measures the maximum number of frames received at full line rate before a frame is lost. In carrier Ethernet networks, this measurement is quite useful as it validates the excess information rate (EIR).

Test Objective

The objective of the Back to Back test is to determine the node buffer capacity by sending bursts of traffic at the highest theoretical rate, and then measuring the longest burst where no packets are dropped.

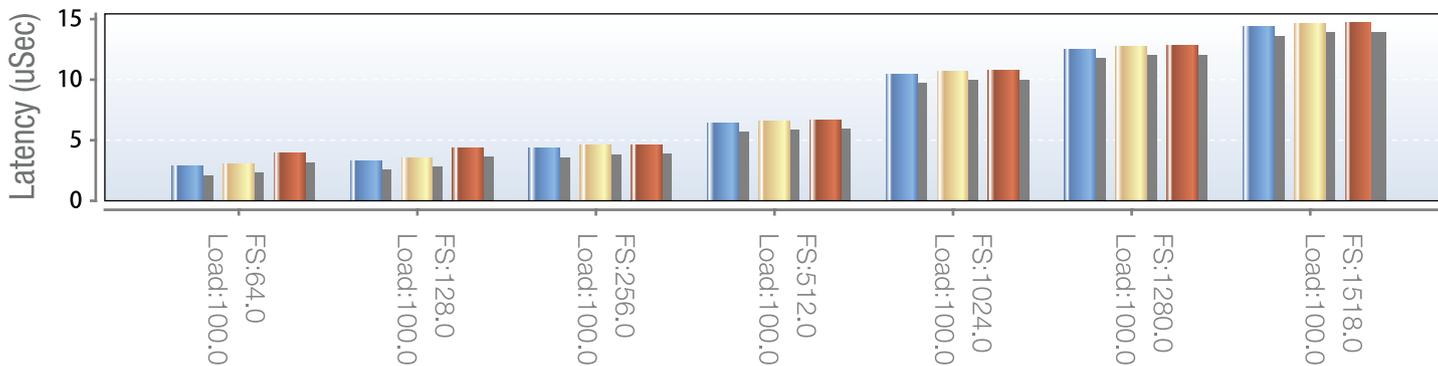
Back-to-Back Burst Duration per Frame Size



Duration is measured in SECONDS

Frame Size (bytes)	Back-to-Back Burst(frames)	Back-to-Back Time(sec)	Intended Load(%)	Average Frame Rate (fps)	Average Tx Frames	Average Rx Frames	Average Lost Frames
64	595238096	100	100	5952380.96	595238096	595238096	0
128	337837840	100	100	3378378.4	337837840	337837840	0
256	181159424	100	100	1811594.24	181159424	181159424	0
512	93984964	100	100	939849.64	93984964	93984964	0
1024	47892724	100	100	478927.24	47892724	47892724	0
1280	38461540	100	100	384615.4	38461540	38461540	0
1518	32509756	100	100	325097.56	32509756	32509756	0

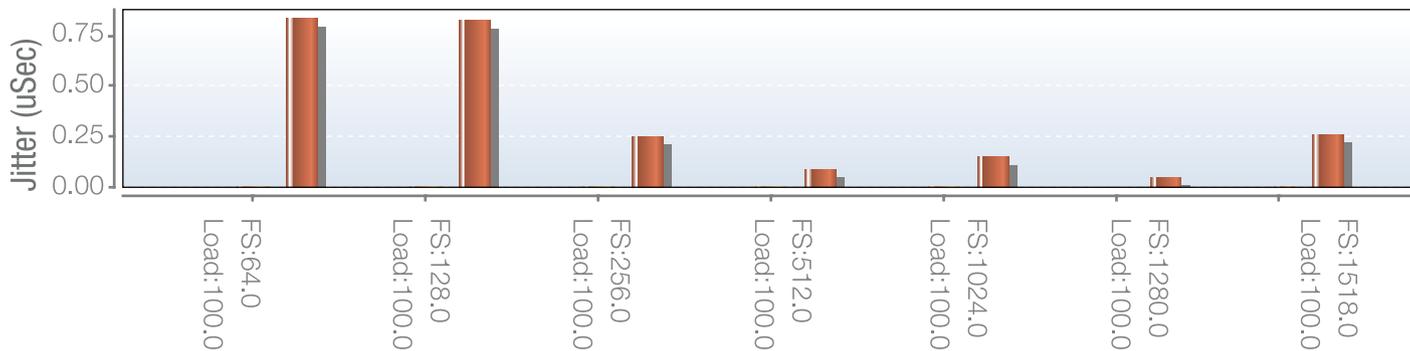
Latency by Frame Size and Load



Frame Size and Load (%)

■ Min Latency ■ Avg Latency ■ Max Latency

Jitter by Frame Size and Load



Frame Size and Load (%)

■ Min Jitter ■ Avg Jitter ■ Max Jitter

Summary Statistics by Trial

Trial	Frame Size (bytes)	Intended Load (%)	Offered Load (%)	Offered Load (fps)	Tx Frames	Rx Frames	Frame Lost	Burst Sizer	Duration (Sec)	Latency Min (uSec)	Avg Latency (uSec)	Max Latency (uSec)
1	64	100	100	5952380.96	595238096	595238096	0	595238096	100	2.84	3.077	3.92
1	128	100	100	3378378.4	337837840	337837840	0	337837840	100	3.3	3.547	4.39
1	256	100	100	1811594.24	181159424	181159424	0	181159424	100	4.36	4.59	4.64
1	512	100	100	939849.64	93984964	93984964	0	93984964	100	6.44	6.621	6.7
1	1024	100	100	478927.24	47892724	47892724	0	47892724	100	10.47	10.708	10.76
1	1280	100	100	384615.4	38461540	38461540	0	38461540	100	12.54	12.76	12.81
1	1518	100	100	325097.56	32509756	32509756	0	32509756	100	14.37	14.659	14.7

Theoretical Maximum Frame Rates

Media Type	Line Speed (Mbps)	64 Byte	128 Byte	256 Byte	512 Byte	1024 Byte	1280 Byte	1518 Byte
Ethernet	10	14,880	8,445	4,528	2,349	1,197	961	812
Ethernet	100	148,809	84,459	45,289	23,496	11,973	9,615	8,127
Gigabit Ethernet	1,000	1,488,095	844,594	452,898	234,962	119,731	96,153	81,274
10 Gigabit Ethernet	10,000	14,880,952	8,445,945	4,528,985	2,349,624	1,197,318	961,538	812,743
40 Gigabit Ethernet	40,000	59,523,809	33,783,783	18,115,942	9,398,496	4,789,272	3,846,153	3,250,975
100 Gigabit Ethernet	100,000	148,809,523	84,459,459	45,289,855	23,496,240	11,973,180	9,615,384	8,127,438
POS (OC-3)	155	288,000	145,116	72,840	36,491	18,263	14,613	12,323
POS (OC-12)	622	1,152,000	580,465	291,361	145,964	73,053	58,622	49,413
POS (OC-48)	2,448	4,608,000	2,321,860	1,165,447	583,859	292,214	233,817	197,182
POS (OC-192)	9,953	18,432,000	9,287,441	4,661,789	2,335,438	1,168,858	935,269	788,729
ATM (OC-3)	155	176,603	117,735	58,867	32,109	16,054	13,082	11,037
ATM (OC-12)	622	706,412	470,940	235,468	122,810	64,216	52,578	44,148

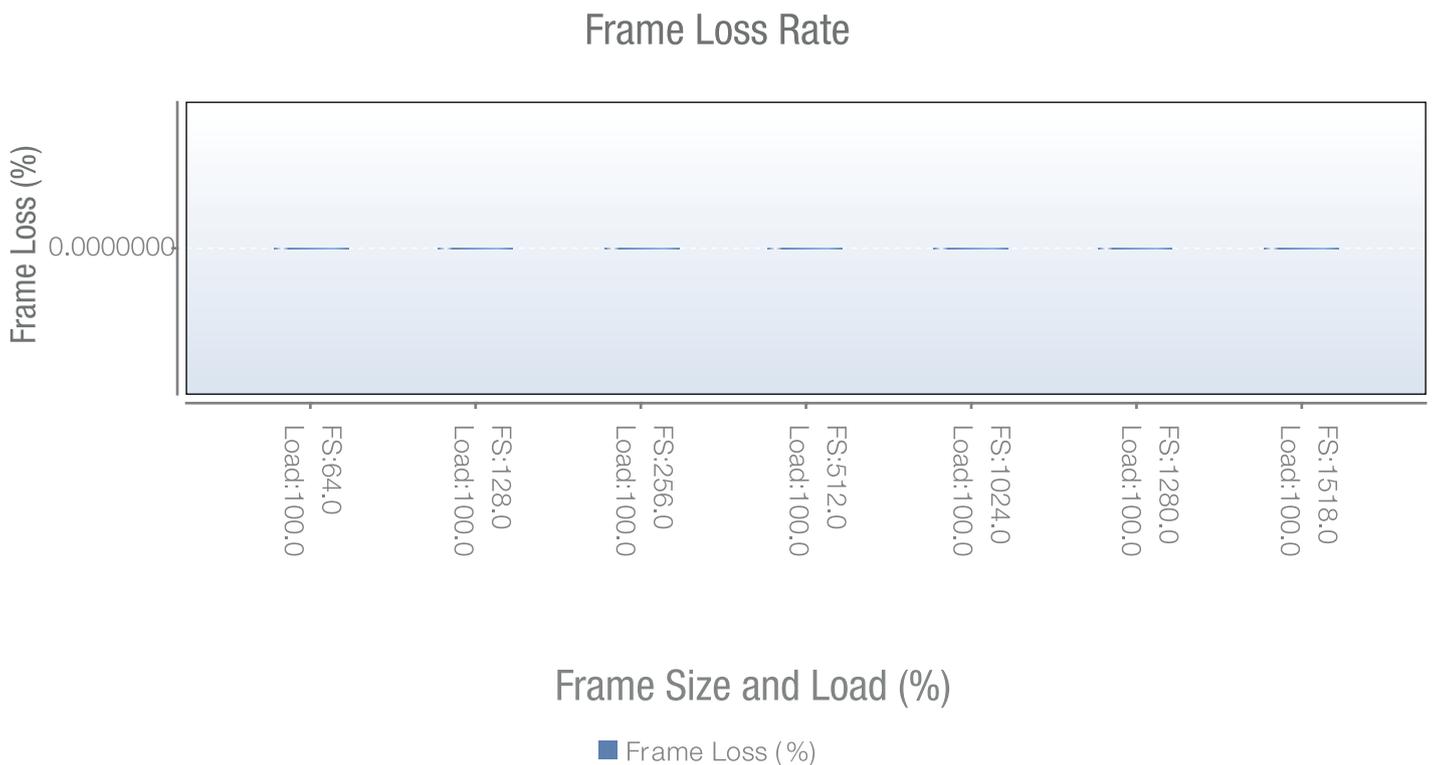
Frame Loss Test

Overview

The Frame Loss test determines how many frames the DUT loses at various frame size. The number of frames to transmit is specified along with the initial transmit rate, and the percentage decrease in the frame rate (the Granularity parameter) for each iteration.

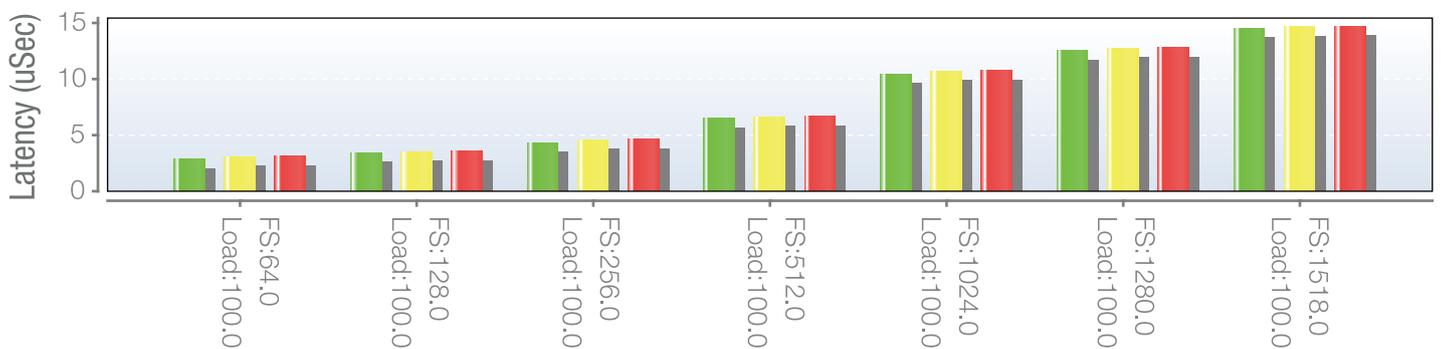
Test Objective

The objective of the frame loss test is to determine the frame loss ratio throughout the entire range of input data rates and frame sizes.



Frame Size (bytes)	Load(%)	Total Tx Frames	Total Rx Frames	Total Frames Lost	Frame Loss(%)
64	100	357142860	357142860	0	0
128	100	202702704	202702704	0	0
256	100	108695656	108695656	0	0
512	100	56390980	56390980	0	0
1024	100	28735636	28735636	0	0
1280	100	23076924	23076924	0	0
1518	100	19505852	19505852	0	0

Latency by Frame Size and Load



Frame Size and Load (%)

■ Min Latency ■ Avg Latency ■ Max Latency

Jitter by Frame Size and Load



Frame Size and Load (%)

■ Min Jitter ■ Avg Jitter ■ Max Jitter

Frame Size (bytes)	Load (%)	Frame Loss(%)	Min Latency (uSec)	Avg Latency (uSec)	Max Latency (uSec)	Min Jitter (uSec)	Avg Jitter (uSec)	Max Jitter (uSec)
64	100	0	2.87	3.088	3.11	0	0.005	0.14
128	100	0	3.34	3.546	3.57	0	0.003	0.09
256	100	0	4.32	4.588	4.64	0	0.005	0.26
512	100	0	6.49	6.619	6.66	0	0.004	0.1
1024	100	0	10.47	10.713	10.75	0	0.005	0.25
1280	100	0	12.52	12.763	12.8	0	0.001	0.05
1518	100	0	14.55	14.659	14.7	0	0.003	0.07

Frame Loss by Trial

Trial	Frame Size (bytes)	Load (%)	Tx Frames	Rx Frames	Frames Lost	Frame Loss (%)
1	64	100	357142860	357142860	0	0
1	128	100	202702704	202702704	0	0
1	256	100	108695656	108695656	0	0
1	512	100	56390980	56390980	0	0
1	1024	100	28735636	28735636	0	0
1	1280	100	23076924	23076924	0	0
1	1518	100	19505852	19505852	0	0

Theoretical Maximum Frame Rates

Media Type	Line Speed (Mbps)	64 Byte	128 Byte	256 Byte	512 Byte	1024 Byte	1280 Byte	1518 Byte
Ethernet	10	14,880	8,445	4,528	2,349	1,197	961	812
Ethernet	100	148,809	84,459	45,289	23,496	11,973	9,615	8,127
Gigabit Ethernet	1,000	1,488,095	844,594	452,898	234,962	119,731	96,153	81,274
10 Gigabit Ethernet	10,000	14,880,952	8,445,945	4,528,985	2,349,624	1,197,318	961,538	812,743
40 Gigabit Ethernet	40,000	59,523,809	33,783,783	18,115,942	9,398,496	4,789,272	3,846,153	3,250,975
100 Gigabit Ethernet	100,000	148,809,523	84,459,459	45,289,855	23,496,240	11,973,180	9,615,384	8,127,438
POS (OC-3)	155	288,000	145,116	72,840	36,491	18,263	14,613	12,323
POS (OC-12)	622	1,152,000	580,465	291,361	145,964	73,053	58,622	49,413
POS (OC-48)	2,448	4,608,000	2,321,860	1,165,447	583,859	292,214	233,817	197,182
POS (OC-192)	9,953	18,432,000	9,287,441	4,661,789	2,335,438	1,168,858	935,269	788,729
ATM (OC-3)	155	176,603	117,735	58,867	32,109	16,054	13,082	11,037
ATM (OC-12)	622	706,412	470,940	235,468	122,810	64,216	52,578	44,148

Throughput Test

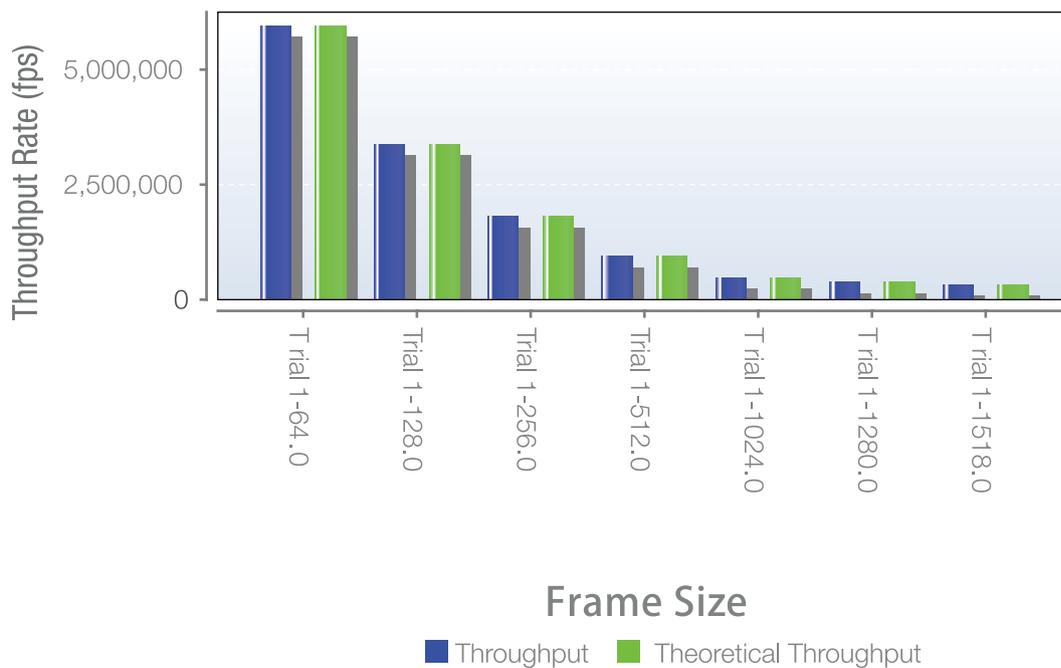
Overview

The throughput test determines how well suited a device is to applications in which minimal frame loss is critical. With each trial of the throughput test, test frames are sent at a specific frame rate and the number of frames forwarded by the DUT is counted. If there is any frame loss, the rate is decreased; otherwise, the rate is increased. The trials are repeated until the maximum rate is found at which there is no frame loss.

Test Objective

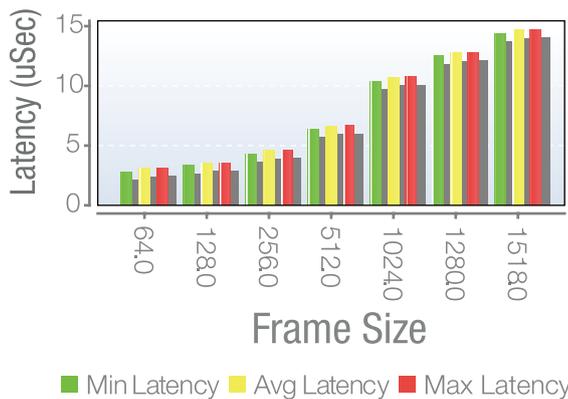
The objective of the throughput test is to determine the throughput of the DUT. Throughput is defined as the maximum rate at which none of the offered frames are dropped by the device.

Throughput by Frame Size VS Theoretical Max

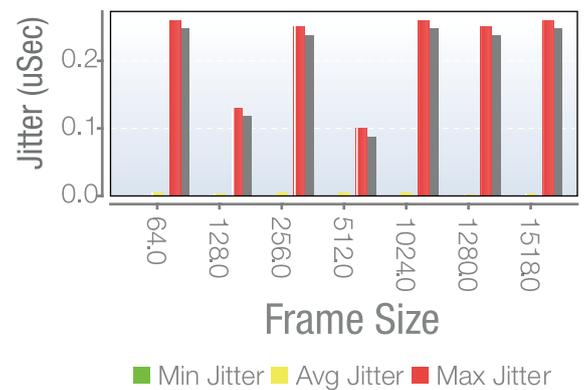


Total Trials	Number of Passed Trials	Frame Size (bytes)	Intended Load (%)	Offered Load (%)	Throughput (%)	Aggregated Throughput (fps)	Aggregated Theoretical Max (fps)	Aggregated Throughput (Mbps)	Aggregated Theoretical Max (Mbps)
1	1	64	100	100	100	5952381	5952380.952	4000	4000
1	1	128	100	100	100	3378378.4	3378378.378	4000	4000
1	1	256	100	100	100	1811594.267	1811594.203	4000	4000
1	1	512	100	100	100	939849.667	939849.624	4000	4000
1	1	1024	100	100	100	478927.267	478927.203	4000	4000
1	1	1280	100	100	100	384615.4	384615.385	4000	4000
1	1	1518	100	100	100	325097.533	325097.529	4000	4000

Latency by Frame Size at Throughput



Jitter by Frame Size at Throughput



Frame Size (bytes)	Intended Load (%)	Offered Load (%)	Min Frame Loss (%)	Min Latency (uSec)	Avg Latency (uSec)	Max Latency (uSec)	Min Jitter (uSec)	Avg Jitter (uSec)	Max Jitter (uSec)
64	100	100	0	2.77	3.083	3.11	0	0.005	0.26
128	100	100	0	3.35	3.546	3.57	0	0.003	0.13
256	100	100	0	4.3	4.587	4.61	0	0.005	0.25
512	100	100	0	6.39	6.621	6.66	0	0.004	0.1
1024	100	100	0	10.38	10.714	10.75	0	0.005	0.26
1280	100	100	0	12.5	12.761	12.8	0	0.001	0.25
1518	100	100	0	14.36	14.661	14.71	0	0.003	0.26

Throughput by Trial

Traffic Duration : 60 Seconds

Custom Frame Size(bytes) : {64 128 256 512 1024 1280 1518 }

Trial	Frame Size (bytes)	Result	Intended Load (%)	Offered Load (%)	Throughput (%)	Port Name	Throughput (fps)	Theoretical Max Throughput (fps)	Throughput (Mbps)	Theoretical Max Throughput (Mbps)	Frame Loss (%)	Max Latency Threshold Exceeded	Out of Sequence Threshold Exceeded
1	64	Passed	100	100	100		5952381	5952380.952	4000	4000	0	False	False
						Port //1/2	1488095.25	1488095.238	1000	1000			
						Port //1/1	1488095.25	1488095.238	1000	1000			
						Port //1/3	1488095.25	1488095.238	1000	1000			
						Port //1/4	1488095.25	1488095.238	1000	1000			
1	128	Passed	100	100	100		3378378.4	3378378.378	4000	4000	0	False	False
						Port //1/2	844594.6	844594.595	1000	1000			
						Port //1/1	844594.6	844594.595	1000	1000			
						Port //1/3	844594.6	844594.595	1000	1000			
						Port //1/4	844594.6	844594.595	1000	1000			
1	256	Passed	100	100	100		1811594.267	1811594.203	4000	4000	0	False	False
						Port //1/2	452898.567	452898.551	1000	1000			
						Port //1/1	452898.567	452898.551	1000	1000			
						Port //1/3	452898.567	452898.551	1000	1000			
						Port //1/4	452898.567	452898.551	1000	1000			
1	512	Passed	100	100	100		939849.667	939849.624	4000	4000	0	False	False
						Port //1/2	234962.417	234962.406	1000	1000			
						Port //1/1	234962.417	234962.406	1000	1000			
						Port //1/3	234962.417	234962.406	1000	1000			
						Port //1/4	234962.417	234962.406	1000	1000			
1	1024	Passed	100	100	100		478927.267	478927.203	4000	4000	0	False	False
						Port //1/2	119731.817	119731.801	1000	1000			
						Port //1/1	119731.817	119731.801	1000	1000			
						Port //1/3	119731.817	119731.801	1000	1000			
						Port //1/4	119731.817	119731.801	1000	1000			
1	1280	Passed	100	100	100		384615.4	384615.385	4000	4000	0	False	False
						Port //1/2	96153.85	96153.846	1000	1000			
						Port //1/1	96153.85	96153.846	1000	1000			
						Port //1/3	96153.85	96153.846	1000	1000			
						Port //1/4	96153.85	96153.846	1000	1000			
1	1280	Passed	100	100	100		325097.533	325097.529	4000	4000	0	False	False
						Port //1/2	81274.383	81274.382	1000	1000			
						Port //1/1	81274.383	81274.382	1000	1000			
						Port //1/3	81274.383	81274.382	1000	1000			
						Port //1/4	81274.383	81274.382	1000	1000			

Theoretical Maximum Frame Rates

Media Type	Line Speed (Mbps)	64 Byte	128 Byte	256 Byte	512 Byte	1024 Byte	1280 Byte	1518 Byte
Ethernet	10	14,880	8,445	4,528	2,349	1,197	961	812
Ethernet	100	148,809	84,459	45,289	23,496	11,973	9,615	8,127
Gigabit Ethernet	1,000	1,488,095	844,594	452,898	234,962	119,731	96,153	81,274
10 Gigabit Ethernet	10,000	14,880,952	8,445,945	4,528,985	2,349,624	1,197,318	961,538	812,743
40 Gigabit Ethernet	40,000	59,523,809	33,783,783	18,115,942	9,398,496	4,789,272	3,846,153	3,250,975
100 Gigabit Ethernet	100,000	148,809,523	84,459,459	45,289,855	23,496,240	11,973,180	9,615,384	8,127,438
POS (OC-3)	155	288,000	145,116	72,840	36,491	18,263	14,613	12,323
POS (OC-12)	622	1,152,000	580,465	291,361	145,964	73,053	58,622	49,413
POS (OC-48)	2,448	4,608,000	2,321,860	1,165,447	583,859	292,214	233,817	197,182
POS (OC-192)	9,953	18,432,000	9,287,441	4,661,789	2,335,438	1,168,858	935,269	788,729
ATM (OC-3)	155	176,603	117,735	58,867	32,109	16,054	13,082	11,037
ATM (OC-12)	622	706,412	470,940	235,468	122,810	64,216	52,578	44,148

Latency Test

Overview

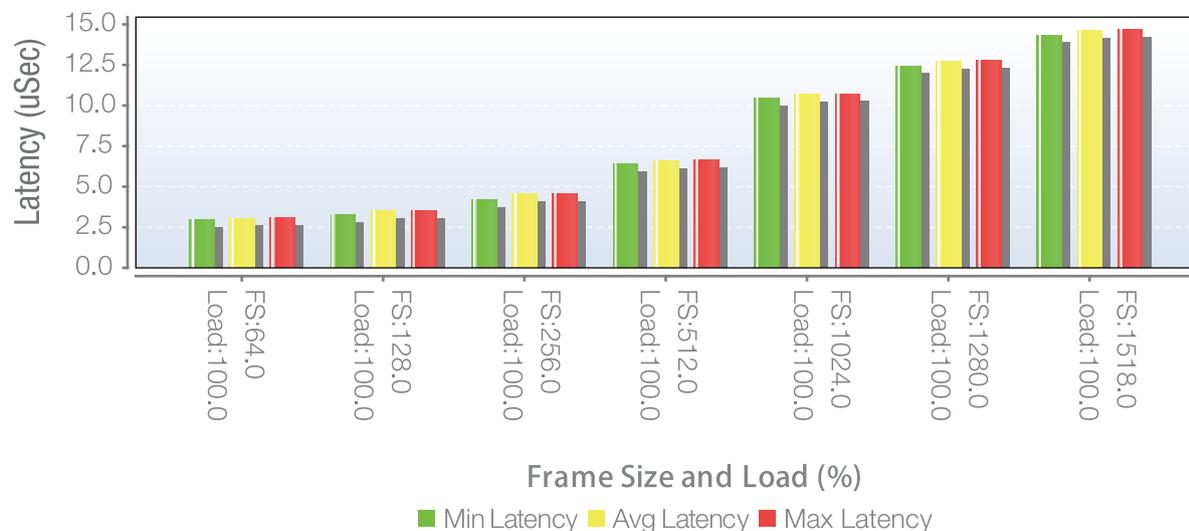
Latency is the amount of time it takes for the switch to move a packet from its incoming port to its outgoing port.

Essentially, the latency test measures how quickly a switch can forward a packet. The test uses the First In, First Out (FIFO) method, subtracting the time that the first bit exits the switch from the time that the first bit entered the switch.

Test Objective

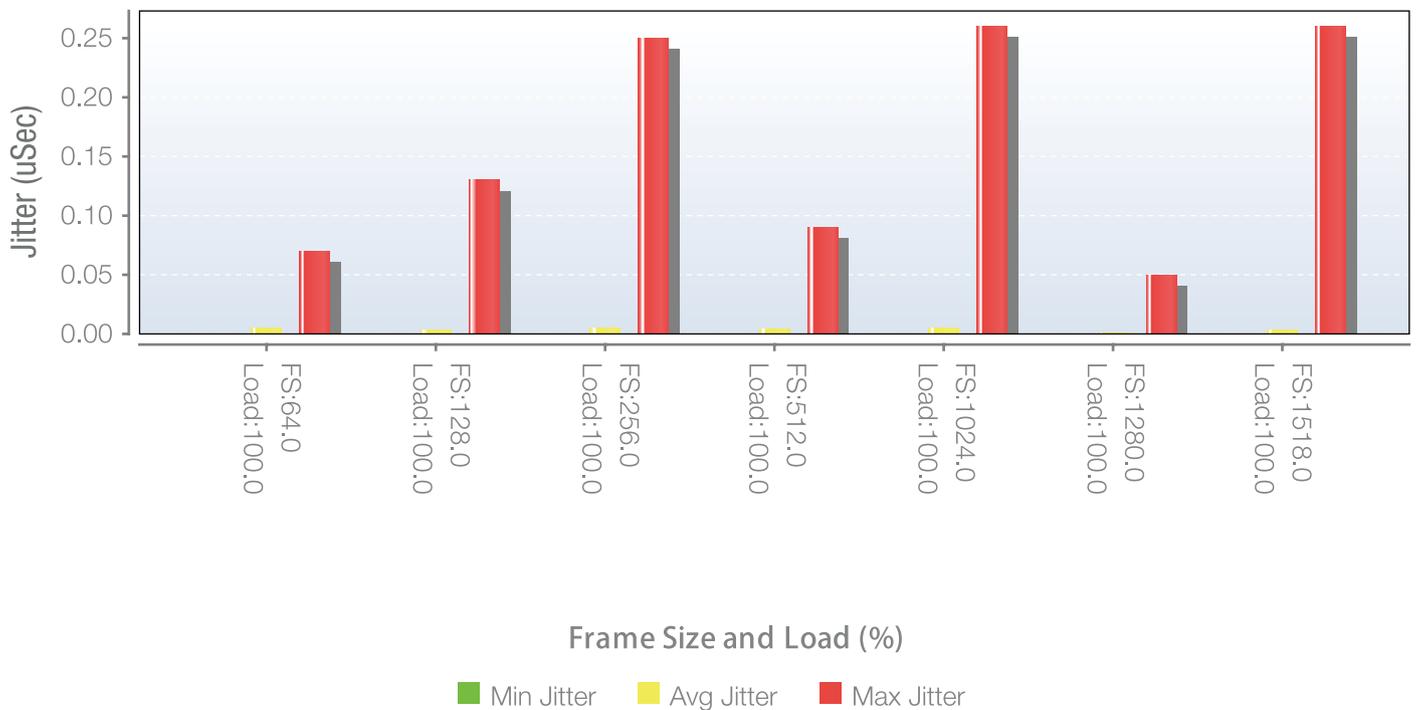
The objective of the latency test is to get the latency of the Frame in DUT when running at its maximum throughput.

Latency by Frame Size and Load



Frame Size (bytes)	Load (%)	Min Latency (uSec)	Avg Latency (uSec)	Max Latency (uSec)	LatencyType
64	100	2.98	3.088	3.11	FIFO
128	100	3.29	3.545	3.57	FIFO
256	100	4.24	4.587	4.61	FIFO
512	100	6.44	6.621	6.66	FIFO
1024	100	10.47	10.715	10.76	FIFO
1280	100	12.48	12.761	12.8	FIFO
1518	100	14.38	14.661	14.71	FIFO

Jitter by Frame Size and Load



Frame Size (bytes)	Load (%)	Frame Loss (%)	Min Jitter (uSec)	Avg Jitter (uSec)	Max Jitter (uSec)
64	100	0	0	0.005	0.07
128	100	0	0	0.003	0.13
256	100	0	0	0.005	0.25
512	100	0	0	0.004	0.09
1024	100	0	0	0.005	0.26
1280	100	0	0	0.001	0.05
1518	100	0	0	0.003	0.26

Latency by Load

Trial	Frame Size (bytes)	Load (%)	Min Latency (uSec)	Avg Latency (uSec)	Max Latency (uSec)	Min Jitter (uSec)	Avg Jitter (uSec)	Max Jitter (uSec)	TX Frames	Rx Frames
1	64	100	2.98	3.08775	3.11	0	0.005	0.07	357142860	357142860
1	128	100	3.29	3.5455	3.57	0	0.003	0.13	202702704	202702704
1	256	100	4.24	4.58725	4.61	0	0.005	0.25	108695656	108695656
1	512	100	6.44	6.62075	6.66	0	0.004	0.09	56390980	56390980
1	1024	100	10.47	10.7155	10.76	0	0.005	0.26	28735636	28735636
1	1280	100	12.48	12.76075	12.8	0	0.001	0.05	23076924	23076924
1	1518	100	14.38	14.66075	14.71	0	0.003	0.26	19505852	19505852

Theoretical Maximum Frame Rates

Media Type	Line Speed (Mbps)	64 Byte	128 Byte	256 Byte	512 Byte	1024 Byte	1280 Byte	1518 Byte
Ethernet	10	14,880	8,445	4,528	2,349	1,197	961	812
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