EANTC Independent Test Report

Huawei WDM Compatibility Test

OptiXtrans E9600

Huawei OptiXtrans E9624 / Huawei OptiXtrans E9612

April 2021

Introduction

Huawei commissioned EANTC to validate functional, interoperability, and performance aspects of the Huawei wave-division multiplexing (WDM) solution with a specific focus on the Storage Area Network (SAN) use case scenarios. Two different types of chassis participated in the test: Huawei OptiXtrans E9612 and Huawei OptiXtrans E9624. We used two separate topologies to represent their structure difference. The Huawei OptiXtrans E9612 participated in a centralized topology. This architecture (also known as OTU architecture by Huawei) enabled the M12 chassis to add client side services to the WDM side. In particular, it provided a cross-connection function that can forward traffic in a all-cards in-one chassis mode.

The centralized architecture also enabled a combined setup, consisting of both chassis types. A logical unit was formed by them to introduce a tributary/line separated architecture. The Huawei OptiXtrans E9624 carried tributary/line boards to face client side services, and the Huawei OptiXtrans E9612 for WDM side. We conducted all tests in the Huawei lab in Cheng Du, Berlin, in January 2021.

Four board types under test participated in the test, acting facing client side services: Huawei M520SM, M210D (with the Huawei OptiXtrans E9612), T220 and T212 (with the Huawei OptiXtrans E9624).

An Optical Transponder Unit (OTU) board transforms client-side services into standard optical signals after performing mapping, convergence, and other procedures. The board also performs the reverse process. The Huawei M520SM, M210D are referred to the OTU boards.

A tributary board interworks with a line board to perform the functions of an OTU board. The combination of the tributary and line boards achieve more flexible and fine-grained grooming of electrical services and offer a higher bandwidth utilization by working with a cross-connect board. The Huawei T220, T212 worked as tributary boards. Huawei Optic Transmission Network (OTN) products series support the use of separate tributary and line boards.

Test Highlights
→ DCI interoperability with two Fibre Channel switches, including the combination of Brocade G620-G620, G620-6505, 300-300, Cisco MDS 9132T - 9132T, and Cisco MDS 9132T – 9148S
→ Compatibility certification with three types of Fibre Channel Physical Interface (FC-PI), including FC-PI-3, FC-PI-5, FC-PI-6[1]
→ Transparent multi-switch type forwarding between Brocade G620 – G620, Brocade G620 - 6505, Brocade 300 – 300, Cisco MDS 9132T – 9132T, and Cisco MDS 9132T – 9148S
→ Stability of overnight soak testing[2]
→ Capacity measurement to link speeds of 1G, 2G, 4G, 8G, 10G, 16G, 32G with 100 km long haul connections[2]
→ Protection of ISL trunking and long-haul link[2]

Table 1: Features of the Board Types

[1] FC-PIs specifications are defined by the T11 committee of the International Committee on Information Technology Standards (INCITS). INCITS is accredited by and operates under rules approved by the American National Standards Institute (ANSI). FC-PI-6 (ANSI INCITS 512-2015) defines the standard to support the link speeds of 32G, 16G, and 8G; FC-PI-5 (ANSI INCITS 479-2011) defines the standard to support the link speeds of 16G, 8G, and 4G; FC-PI-3 (ANSI/INCITS 460-2011) defines the standard to support the link speeds of 10G, 4G, 2G, and 1G.

[2] Cisco MDS 9132T – 9148S combination had been tested with 20KM long-haul at a speed of FC8G because of the buffer limitation of Cisco MDS 9148S, no availability or 24 hours test is performed.

The Huawei OptiXtrans E9612 is an optical-electrical WDM transmission device. Huawei OptiX OSN 9800 M12 is a product of the same brand. All devices provide the same implementation. It is the same relationship between Huawei OptiXtrans E9624 and OptiX OSN 9800 M24. It is designed for enterprise DCI use case scenarios — any situation where two redundant data centers are located in a region within a 100 kilometers distance.

The current report is part of a series of reports of the Huawei WDM tests between 2020 and 2021. On the timeline respectively, its reference to other reports[3] as below:

- Huawei OptiXtrans DC908 introduced WDM-based data center interconnection as test background
- Huawei OptiX OSN 1800 added different board types under test to support fine-grained bandwidth interfaces
- Huawei OptiX OSN 1800 V Pro added synchronized storage data by using quorum server to the test bed

The current report Huawei OptiXtrans E9600 added different chassis types to support OTU architecture and tributary/line separated architecture.

Device Under Test

Huawei explained that the OptiXtrans E9612 and OptiXtrans E9624 brought another outcome of the test series, has not changed its concept. It is designed for DCI, which can simplify deployment, ultra-wideband, and highly integrated data traffic. The four main boards of OptiXtrans E9612/OptiX OSN 9800 M12 and OptiXtrans E9624/OptiX OSN 9800 M24 vary at different speeds and services.

Executive Summary

We verified the interface-speed forwarding of the DUT on the FC port side and the long-distance forwarding between the two simulated data centers. We verified the forwarding performance when a quorum server synchronized data traffic between both emulated data centers.

We verified two types of DUT chassis:

- Huawei OptiXtrans E9612 with OTU architecture as defined by Huawei. The architecture added client side services directly to WDM side.
- Huawei OptiXtrans E9624 with tributary/line separated architecture. The client-side services are not encapsulated into WDM-side services (OTUk) and added to the line side using one board.

We verified the compatibility of its four board types Huawei M520SM, M210D, T220, and T212, to the FC-PI-6, FC-PI-3, and FC-PI-5 standards.

The test bed consisted of emulated data centers integrated with 3rd party Fibre Channel switches of different vendors represented by Brocade and Cisco, using hybrid switch pairs of Brocade G620 / Brocade G620, Brocade G620 / Brocade 6505, Brocade 300 / Brocade 300, Cisco MDS 9132T / Cisco MDS 9132T, and Cisco MDS 9132T / Cisco MDS 9148S respectively.

We verified the DUT's robustness by performing administrative activities on the DUT and connected equipment, as well as ISL trunking and protection against long-haul link failure. We also put DUT under continuous load for 24 hours in a soak test environment to make sure it would support uninterrupted service. The system remained stable without any restart or service interruption, zero packet loss, and low latency, as expected.

Finally, we measured the latency introduced by the DUT. It matched the expectations based on switching delay and physical distance.

[3] https://eantc.de/test_reports.html

Figure 1: Huawei OptiXtrans E9612/
OptiX OSN 9800 M12

Figure 2: Huawei OptiXtrans E9624/
OptiX OSN 9800 M24

Figure 3: Huawei M520SM

Figure 4: Huawei M210D

Figure 5: Huawei T212

Figure 6: Huawei T220

Test Bed Description

Huawei installed SUSE Enterprise Linux 12.4 in a bare metal mode on both hosts. We used vdbench, which was already installed at Huawei labs by Huawei engineers, for generating FC traffic. The host has 2x Intel® Xeon® E5-2658 v4 @2.30GHz CPUs, 8x 16G DDR4 memory, 1x Huawei IN300 (2x FC32G) port FC Host Bus Adapter (HBA), 1x QLogic QLE2562-HUA-SP FC HBA and 1x SAS 800G SSD. We used all the CPU, FC adapter ports, and 16G memory for our test. The quorum server supported the data integrity of the storage cluster located in both data centers. It recognized one of the Huawei OceanStor 5000 V3 as preferred storage and another one as non-preferred storage. The quorum server's strategy was to keep the preferred storage in a working state when a link or storage failure is detected. One note for the M210D board, it needed a Dispersion Compensation Module (DCM) for the long haul protection to work properly when the long-haul distance is 100KM, and the FC speed is 10G. It is because of the TSFP+ we tested with. The optical module we test is "Optical module XFP|SFP+ Transceiver, TSFP+, Extended C Band, 9.95~11.3Gbps with CDR,-1dBm, 3dBm, -16dBm, LC, 40KM". DCM is needed when the transmission distance is greater than 40km of the optical module specification. The optical module's dispersion adjustment takes time in the service reconstruction when switching to the standby channel. And the switching performance may not be able to guarantee as less than 50ms when the transmission distance is more than 40km, and there is no DCM.

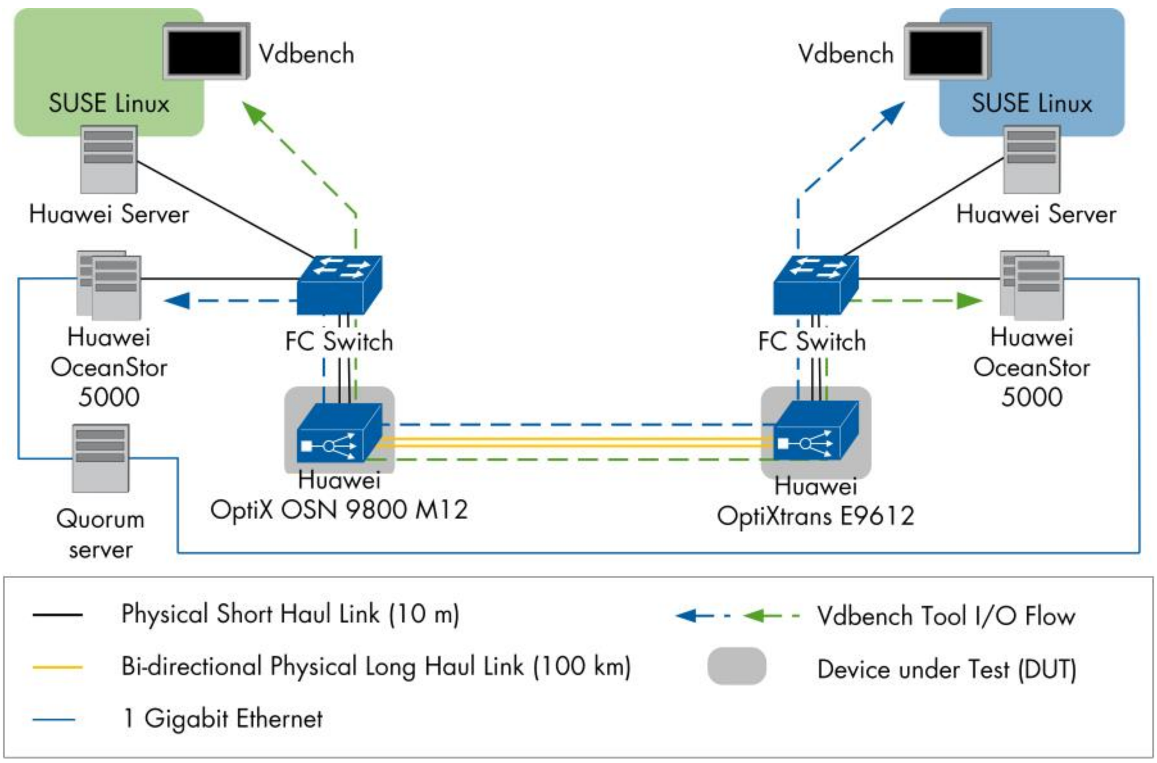


Figure 7: Logical Test Topology (Huawei OptiXtrans E9612 as All-in-one Chassis)

Chassis under Test	Board	Description
Huawei OptiXtrans E9612	Huawei M520SM	Service board under test
	Huawei M210D	Service board under test
	DWSS20	Optical function
	DAP	
	OLP	

Table 2: Huawei OptiXtrans E9612 Chassis Setup

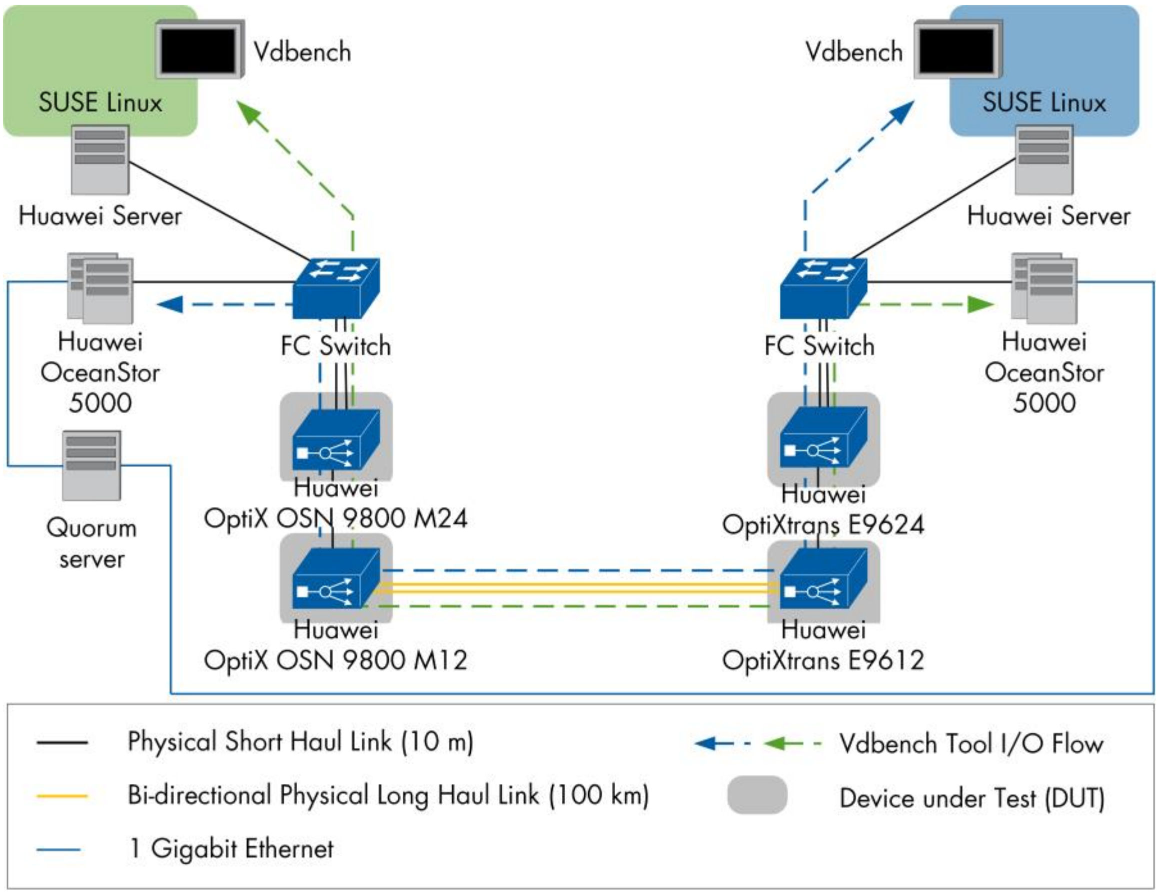


Figure 8: Logical Test Topology (Huawei OptiX 9800M24 with Tributary Boards)

Chassis under Test	Board	Description
Huawei OptiXtrans E9624	T220	Service board under test (tributary board)
	T212	Service board under test (tributary board)
	N402	Line board
Huawei OptiXtrans E9612	DWSS20	Optical function
	DAP	
	OLP	

Table 3: Combined Chassis Setup

Compatibility Test Combinations

Setup	FC Switch 1	FC Switch 2	Optical Transceiver (at E-port)
1	Brocade G620-1	Brocade G620-2	FC-PI-6
			FC-PI-3
2	Brocade G620-1	Brocade 6505[4]	FC-PI-5
3	Cisco MDS 9132T-1	Cisco MDS 9132T-2[5]	FC-PI-6
4	Brocade 300-1	Brocade 300 - 2	FC-PI-3
5	Cisco MDS 9132T-1	Cisco MDS 9148S - 2[6]	FC-PI-5

Table 4: FC Switch Combinations

Optical Transceiver	Huawei Board
FC-PI-6	M520SM, T220
FC-PI-5	M520SM, M210D, T220, T212
FC-PI-3	M520SM, M210D, T220, T212

Table 5: Optical Transceivers between FC Switch and DUT

Product Type	Product Name	Software Version
Devices Under Test WDM Equipment	OptiXtrans E9612/OptiX OSN 9800 M12	V100R019C10
	OptiXtrans E9624/OptiX OSN 9800 M24	
	M520SM (facing E-ports towards FC-switch)	
	M210D (facing E-ports towards FC-switch)	
	T220 (facing E-ports towards FC-switch)	
	T212 (facing E-ports towards FC-switch)	
	N402	
	DWSS20	
	OLP	
Dispersion Compensation Module	Huawei code 45060013 DCM(B)-C-G.652	N/A
Device Management Tools	iMaster NCE	V100R019C00

Table 6: Devices Under Test - Hardware and Software

[4] Brocade 6505 does not support FC-PI-6 and FC-PI-3

[5] Cisco MDS 9132T does not support FC-PI-3

[6] Cisco MDS 9148S only supports FC-PI-5

Product Type	Product Name	Software Version
Physical Server	Huawei RH2288H V3	iBMC: 2.94 BIOS: 3.87
Operating System	SUSE Linux Enterprise Server 12 SP4	Release: 12.4 Kernal: Linux 4.12.14-94.41-default
FC traffic simulation software	Vdbench	v50406
FC traffic generator	Viavi MTS5800-100G	BERT 28.0.1
SAN Storage	Huawei OceanStor 5000 V3[7]	V300R002C10
Quorum server	Quorum server	V300R002C10
FC Switch	Brocade G620	FOS v8.2.1b
	Brocade 6505	FOS v8.2.1a
	Brocade 300	FOS v7.4.1f
	Cisco MDS 9132T	NX-OS 8.4
	Cisco MDS 9148S	NX-OS 6.2

Table 7: Test Environment

[7] 24 Non-Volatile Memory Express (NVMe) solid-state disk (SSD) disks that provided up to 5.8 GB/s (Gigabytes per second) Input/Output

Capacity Testing

We measured the maximum FC-interface forwarding of the DUT using 1, 2, 4, 8, 10, 16, and 32 GBytes/s block traffic generated respectively between emulated data centers that have 100km away from each other. Cisco MDS 9148S had only been tested at a speed of FC8G with a 20km long-haul due to the buffer limitation. The following tables show the throughput.

We performed a capacity test for each of the board under test, with all three setups, respectively. Each traffic stream carried bi-directional traffic. The performance test results met our expectations for Input/ Output operations per second (maximum 99,856 IOPs at the reading size of 32KB), Input/Output response time (less than 10 milliseconds in most cases), and block bandwidth (maximum 3.12 GB/s, or Gigabytes per second).

Setup	Speed Type	Expected Throughput (MB/s)[8]	Measured Bi-directional Throughput	Verdict
1. Brocade G620 pair	FC400	400	390	Pass
			390	
	FC800	800	780	Pass
			781	
	FC-1200	1200	1172	Pass
			1171	
	FC1600	1600	1565	Pass
			1565	
	FC3200	3200	3087	Pass
			3089	
2. Brocade G620/6505 pair	FC1600	1600	1562	Pass
			1531	
3. Cisco MDS 9132T pair	FC800	800	779	Pass
			779	
	FC1600	1600	1559	Pass
			1559	
	FC3200	3200	3117	Pass
			3118	
4. Brocade 300 pair	FC100	100	96	Pass
			96	
	FC200	200	193	Pass
			194	
5. Cisco MDS 9132T/9148S	FC800	800	779	Pass
			779	

Table 8: M520SM Interface Throughput

Setup	Speed Type	Expected Throughput (MB/s)[8]	Measured Bi-directional Throughput	Verdict
1. Brocade G620 pair	FC400	400	390	Pass
			389	
	FC800	800	781	Pass
			781	
	FC-1200	1200	1168	Pass
			1171	
3. Cisco MDS 9132T pair	FC800	800	779	Pass
			779	
4. Brocade 300 pair	FC100	100	96	Pass
			96	
	FC200	200	194	Pass
			193	
5. Cisco MDS 9132T/9148S	FC800	800	779	Pass
			779	

Table 9: M210D Interface Throughput

Setup	Speed Type	Expected Throughput (MB/s)[8]	Measured Bi-directional Throughput	Verdict
1. Brocade G620 pair	FC3200	3200	3087	Pass
			3090	
2. Cisco MDS 9132T pair	FC3200	3200	3115	Pass
			3118	

Table 10: T220 Interface Throughput

Figure 9 is a screenshot from one of the Huawei OceanStor 5000 V3. It shows the reading speed from Host B to storage A of with the combination M520SM and Cisco MDS 9132T.

Setup	Speed Type	Expected Throughput	Measured Bi-	Verdict
1. Brocade G620 pair	FC400	400	390	Pass
			391	
	FC800	800	781	Pass
			781	
	FC-1200	1200	1171	Pass
			1171	
	FC1600	1600	1565	Pass
			1565	
2. Brocade G620/6505 pair	FC1600	1600	1562	Pass
			1530	
3. Cisco MDS 9132T pair	FC800	800	779	Pass
			779	
	FC1600	1600	1559	Pass
			1559	
4. Brocade 300 pair	FC100	100	96	Pass
			96	
	FC200	200	193	Pass
			193	
5. Cisco MDS 9132T/9148S	FC800	800	779	Pass
			779	

Table 11: T220 T212 Interface Throughput

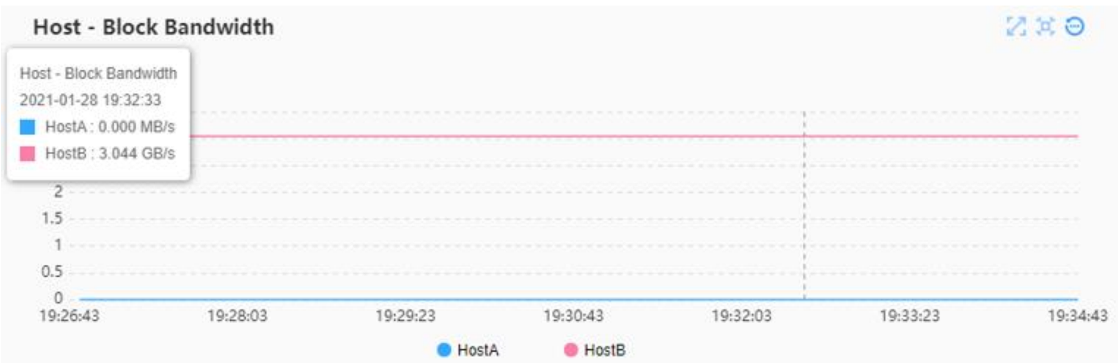


Figure 9: Interface Throughput of FC32G, M520SM, Cisco MDS 9132T - 9132T

[8] The expected throughput is based on the layer 2 payload; we used a ratio of 97% of the link speed. The ratio is based on the formula: 2,048 bytes payload size / 2,112 bytes maximum frame size * 100%, which excludes overhead from the throughput consisting of Start Of Frame (SOF), Cyclic Redundancy Check (CRC), and End of Frame (EOF). For example, 3.104 GB/s = 97% * 3.2 GB/s link speed.

Latency Test

We measured with the Viavi MTS5800-100G tester the WDM system's latency value. In this setup, we connected both DUTs back to back with the measurement tool (see figure), which provides latency value in microseconds' precision. We removed all data center devices from the test bed and remained only both WDM devices running the FC services between the traffic generators.

We generated FC traffic from all ports at different FC speeds consisting of 1G, 2G, 4G, 8G, 10G, 16G, and 32G. The test tool supported the latency measurement on the same port. Therefore, we designed the Rx and Tx like below. Using an optical splitter, we split the Rx and Tx at the traffic generator port into two separate fibers and connect them to the two WDM devices like in the figure.

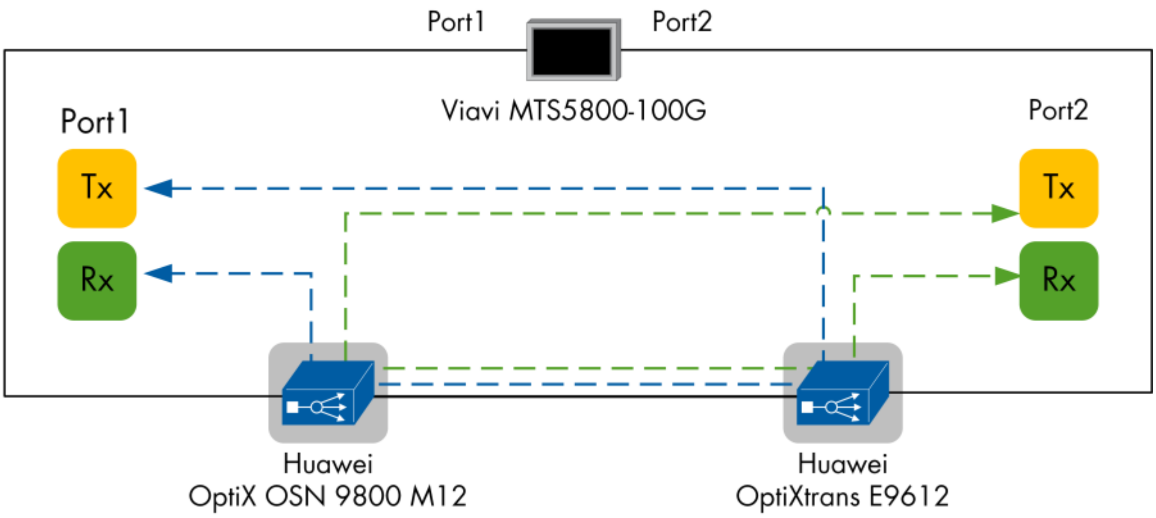


Figure 10: Latency Test Topology (Huawei OptiXtrans E9612 as All-in-one Chassis)

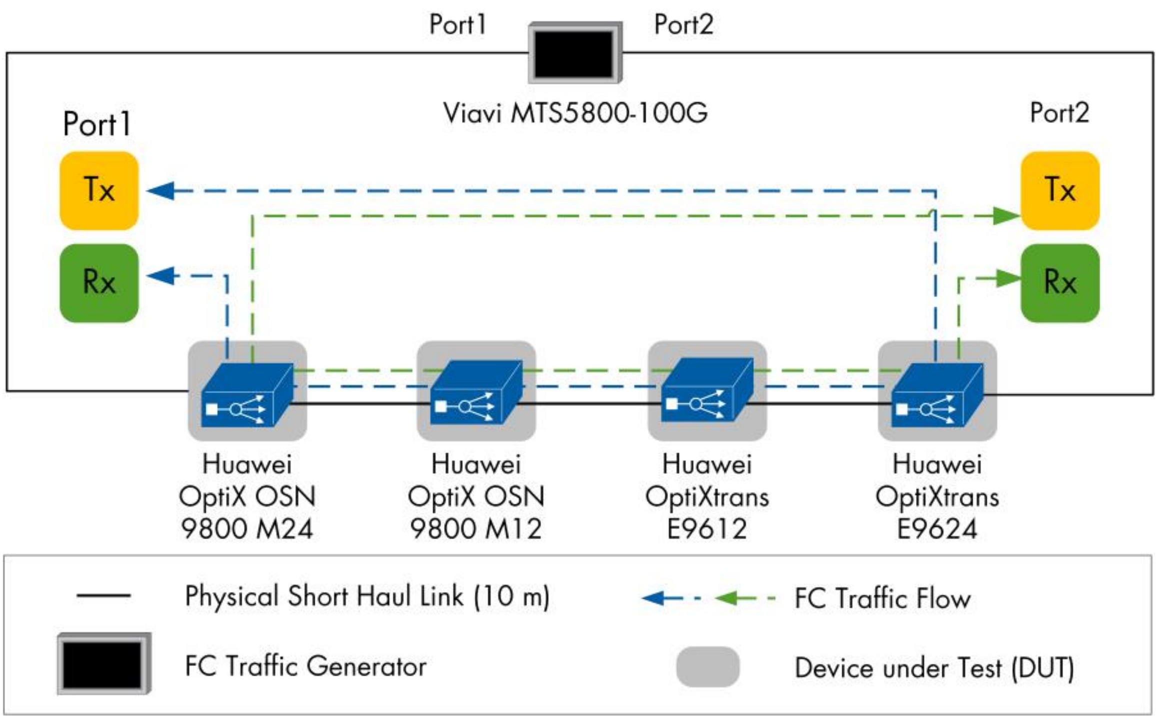
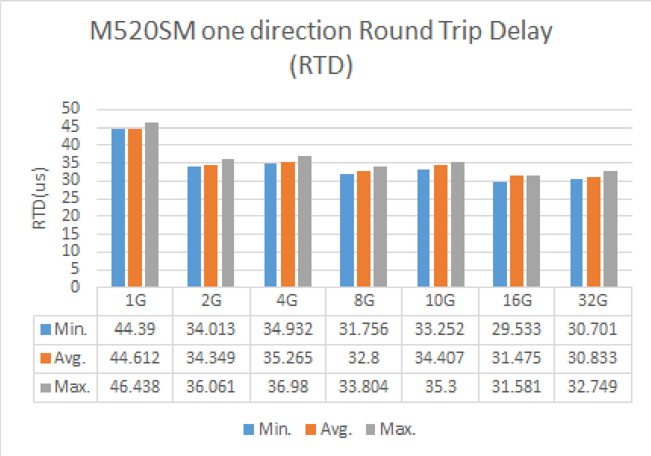
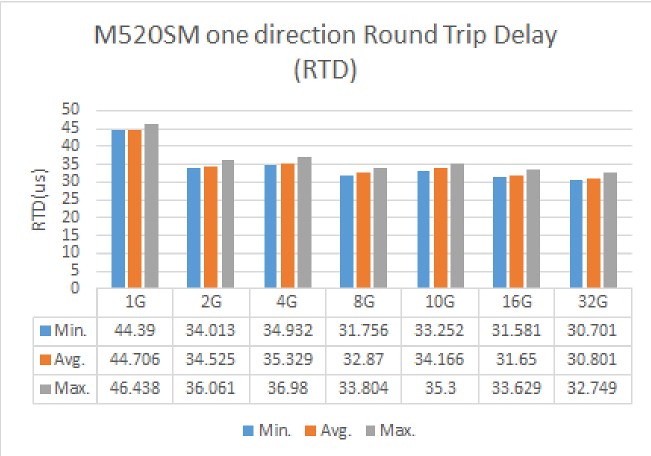


Figure 11: Latency Test Topology (Huawei OptiXtrans E9624 with Tributary/Line Boards)

On the M520SM board, the maximum latency we measured is under 47μs in all speeds. The figure below shows the direction from DUT1 to DUT2 and the reverse direction. The maximum latency was identical in both directions as expected.

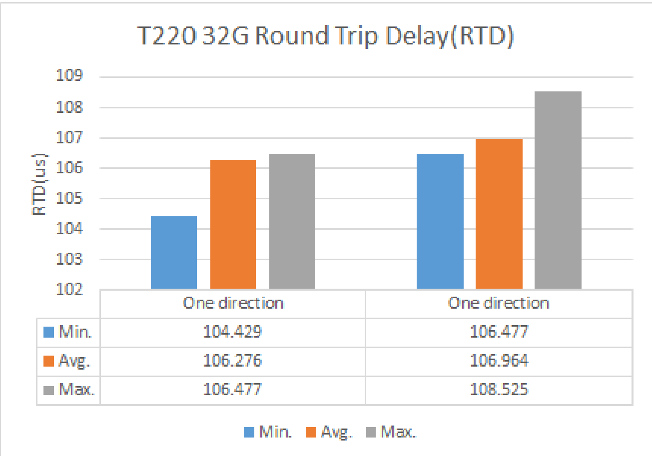


	1G	2G	4G	8G	10G	16G	32G
Min.	44.39	34.013	34.932	31.756	33.252	29.533	30.701
Avg.	44.612	34.349	35.265	32.8	34.407	31.475	30.833
Max.	46.438	36.061	36.98	33.804	35.3	31.581	32.749



	1G	2G	4G	8G	10G	16G	32G
Min.	44.39	34.013	34.932	31.756	33.252	31.581	30.701
Avg.	44.706	34.525	35.329	32.87	34.166	31.65	30.801
Max.	46.438	36.061	36.98	33.804	35.3	33.629	32.749

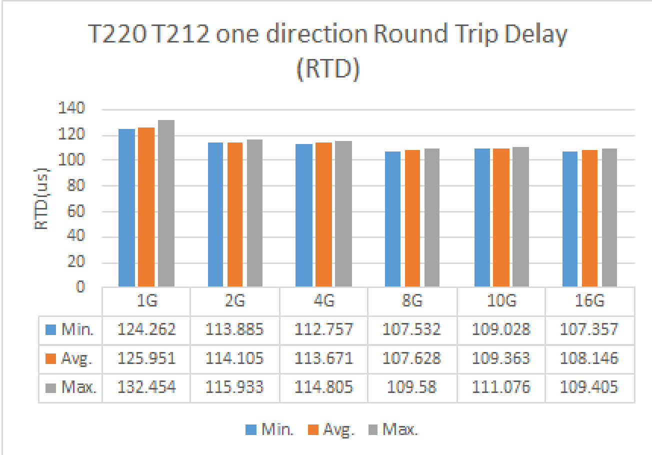
Figure 12: Latency Results of M520SM (DUT1 to DUT2, DUT2 to DUT1)



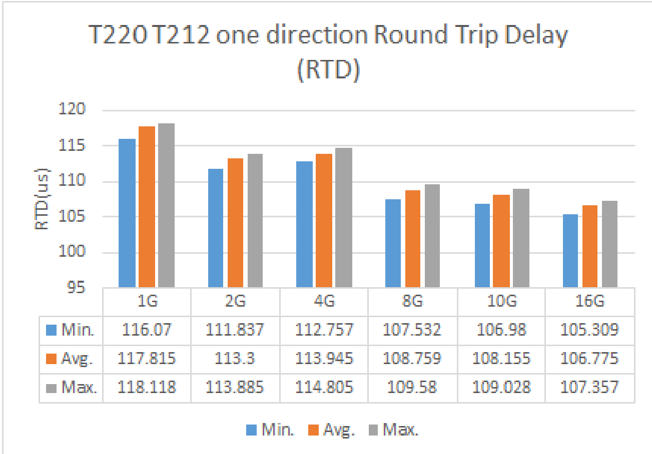
	One direction	One direction
Min.	104.429	106.477
Avg.	106.276	106.964
Max.	106.477	108.525

Figure 13: Latency Results of T220

On the T220 board, we measured the latency on the FC32G, and it was below 109 μs. We performed all speeds from FC1G to FC16G with a pair of T220 and T212 to keep identical with our capacity and function test. On the T220-T212 board combination, the maximum latency we measured is all under 133μs at all speeds. The detail values are shown in figure 14 below.



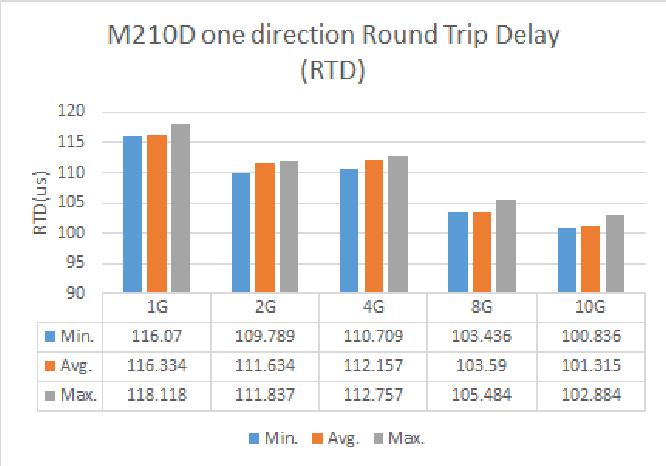
	1G	2G	4G	8G	10G	16G
Min.	124.262	113.885	112.757	107.532	109.028	107.357
Avg.	125.951	114.105	113.671	107.628	109.363	108.146
Max.	132.454	115.933	114.805	109.58	111.076	109.405



	1G	2G	4G	8G	10G	16G
Min.	116.07	111.837	112.757	107.532	106.98	105.309
Avg.	117.815	113.3	113.945	108.759	108.155	106.775
Max.	118.118	113.885	114.805	109.58	109.028	107.357

Figure 14: Latency Results of T220 and T212

On the M210D board, the maximum latency we measured is all under 119μs at all speeds. The detail values are shown in figure 15 below.



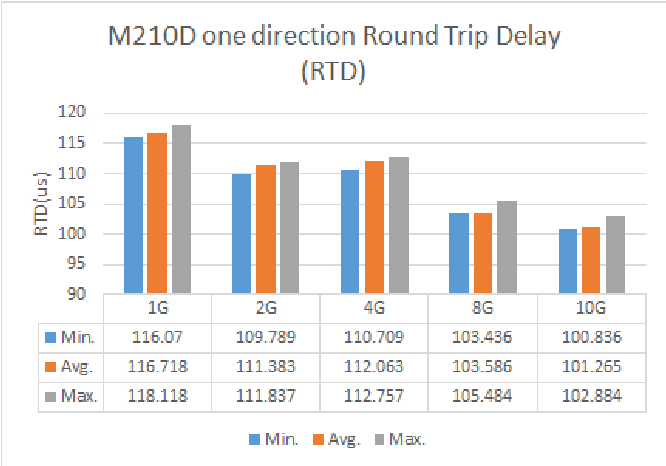


Figure 15: Latency Results of M210D

Availability Test

We verified that the DUT maintained stability when performing administrative activities on the DUT's hardware and the FC switch connected in the test environment. To verify the DUT's stability, we emulated a common set of failures of the DCI segment while the traffic was running under normal conditions.

These were a total of six types of emulated failures, as shown in the figure. In ISL trunking and long-haul link protection, we expected the DUT to provide traffic switching between primary and redundant links.

Especially with Quorum servers' participation, we expected that the active-active storage cluster to protect the traffic switching between storage devices.

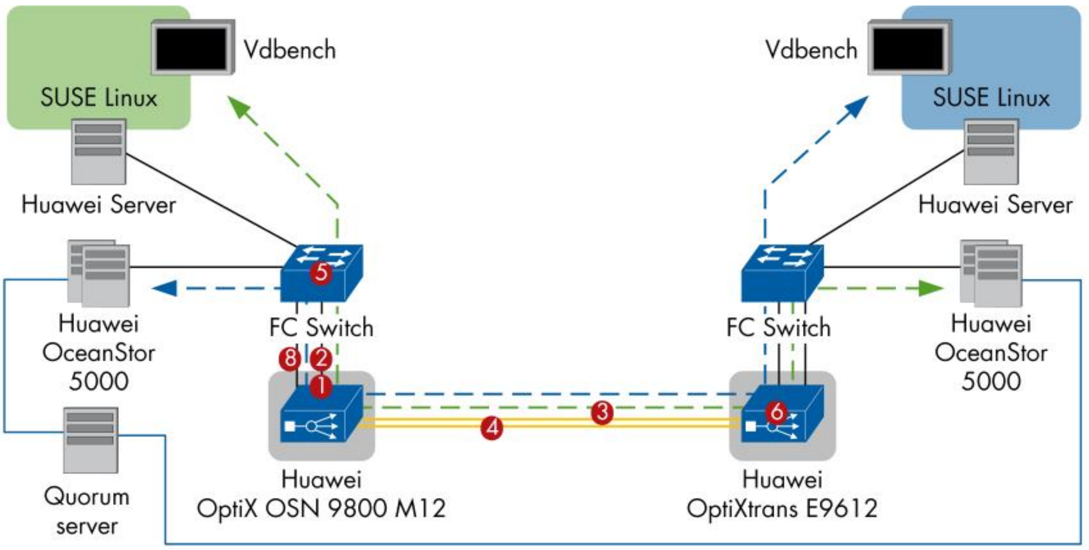


Figure 16: Emulated Failure in the Test Bed (Huawei OptiXtrans E9612 as All-in-one Chassis)

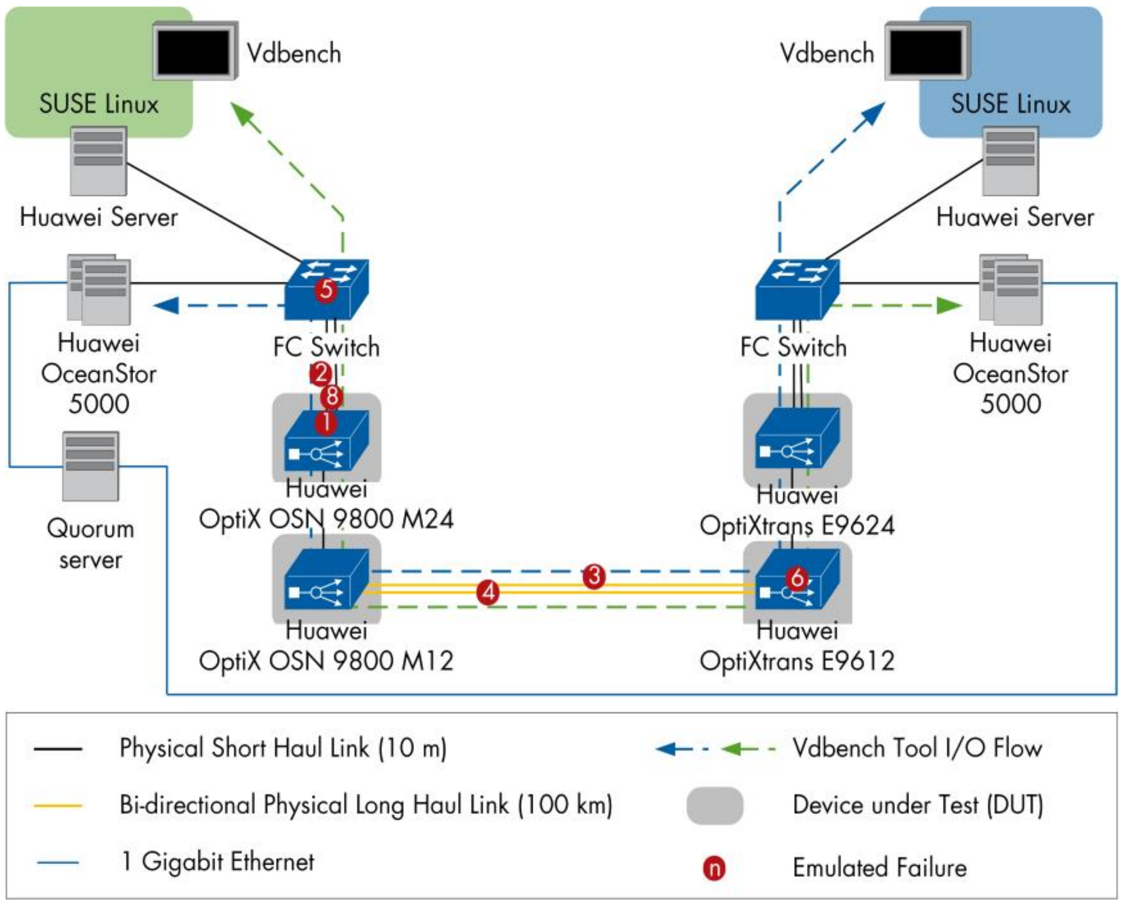


Figure 17: Emulated Failure in the Test Bed (Huawei OptiXtrans E9624 with Tributary/Line Boards)

Active-Active Storage Switch Over

Under failure types 1, 2, 3, and 6, the test results showed the same status of the traffic that has been switched over. The primary storage obtained the I/O access of the host in the same data center and continued I/O operation.

The secondary storage stopped receiving any I/O access from the remote datacenter, neither from the local data center. The former case was because these four types of failure could interrupt the whole DCI connection from different hardware locations (see figure below), thereby causing it to stop transmitting data between both data centers. The latter phenomenon was due to the design mechanism of quorum server as described below.

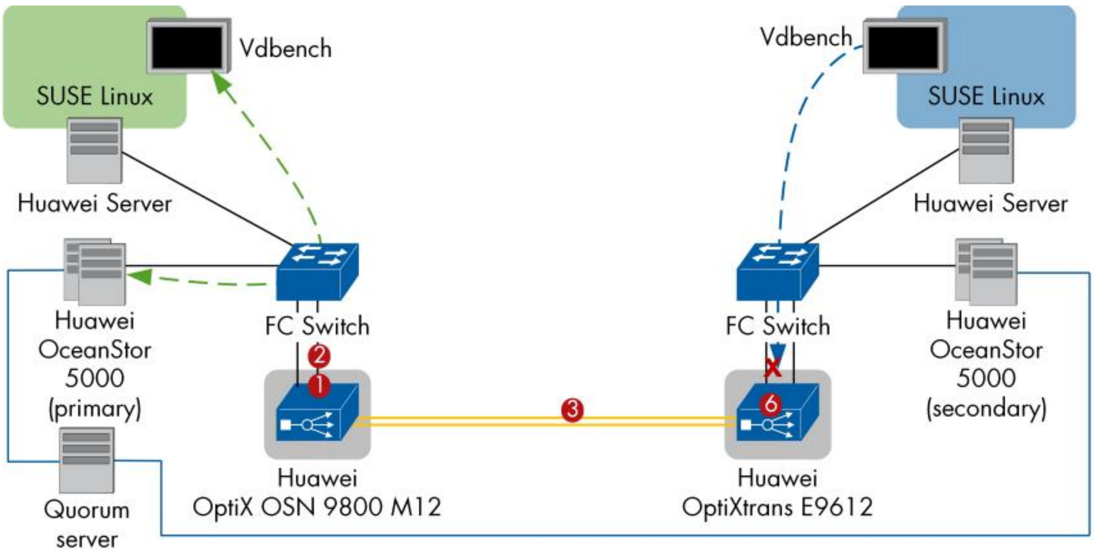


Figure 18: Traffic Status after the Switch Over for Failure Types 1, 2, 3 and 6 (Huawei OptiXtrans E9612 as All-in-one Chassis)

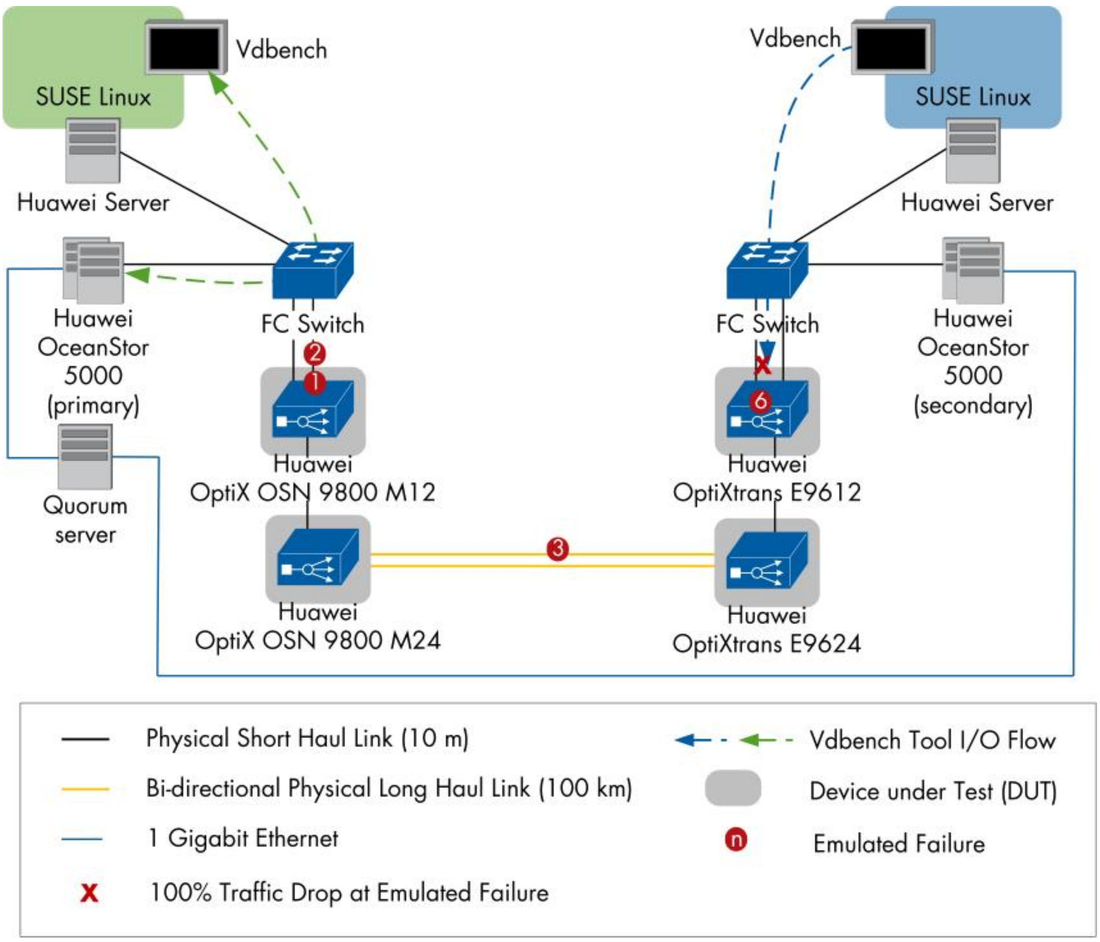


Figure 19: Traffic status after the switch over for failure types 1, 2, 3 and 6 (Huawei OptiXtrans E9624 with Tributary/Line Boards)

No. in Fig. 16 and 17	Test Case	Action	Service Interruption			Verdict
			Expected[9]	Observed (for primary storage)[10] All-in-one Chassis	Observed (for primary storage)[10] With Tributary Boards	
1	E-Port Disable/ Enable Test	Disable	10s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	Pass
		Enable	No impact	No impact	No impact	Pass
2	E-Port Cable Disconnect/ Reconnect Test	Disconnect	10s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	Pass
		Reconnect	No impact	No impact	No impact	Pass
3	Long Haul Network Failure without Redundancy	Disconnect	10s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	Pass
		Reconnect	No impact	No impact	No impact	Pass
6	DUT Reset Test	Shut down	10s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	A maximum of 8s service interruption time, including 6s drop to 0MB/s	Pass
		Turn on	No impact	No impact	No impact	Pass

Table 12: Out of Service Overview (Active-Active Storage Cluster Protection)

Huawei OceanStor 5000 V3 implements a technology called "HyperMetro" for synchronizing the states between preferred storage and non-preferred storage. Once the link between two storage systems went down, the HyperMetro pair changed to the "To be synchronized" state.

The Logic Unit Number (LUN) in the preferred storage continued providing service while the LUN in non-preferred storage stopped. During a link recovery, once the quiescing time (300 s) passed, we observed that the traffic switched back to baseline status between DC1 and DC2. We did not observe any impact as expected.

[9] The expected value included 5 s fault detection by the quorum server and 15 s from it to triggering an active-active switchover. Once the quorum server detected the fault, it triggers an active-active switchover, which lasts for 15 seconds (generally within 10 seconds in lab tests). After the switchover has been complete, the preferred storage took over services.

[10] We observed 6 s complete traffic drop to 0 MB/s during the switch over. The Huawei team configured the quorum server with a 5 s timer to detect the link heartbeat failure between the storage arrays. The link between storage arrays sent a heartbeat packet every second. After five consecutive heartbeat packets expired, the link was identified as disconnected. The 6 s complete traffic drop to 0 MB/s included the time from discovery to switchover at the quorum server.

FC Switch Reboot

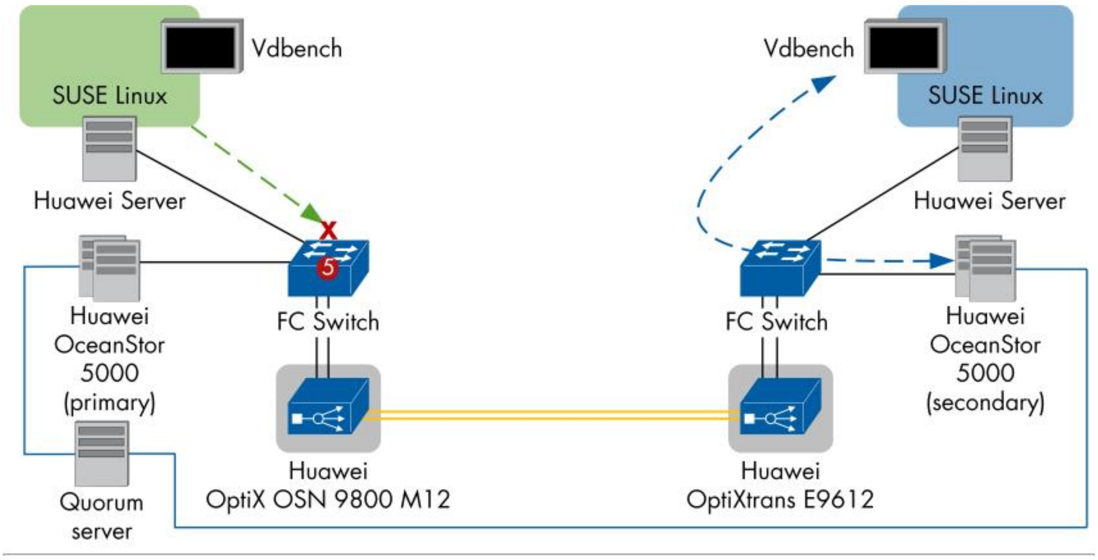


Figure 20: Traffic status during FC switch reboot
(Huawei OptiXtrans E9612 as All-in-one Chassis)

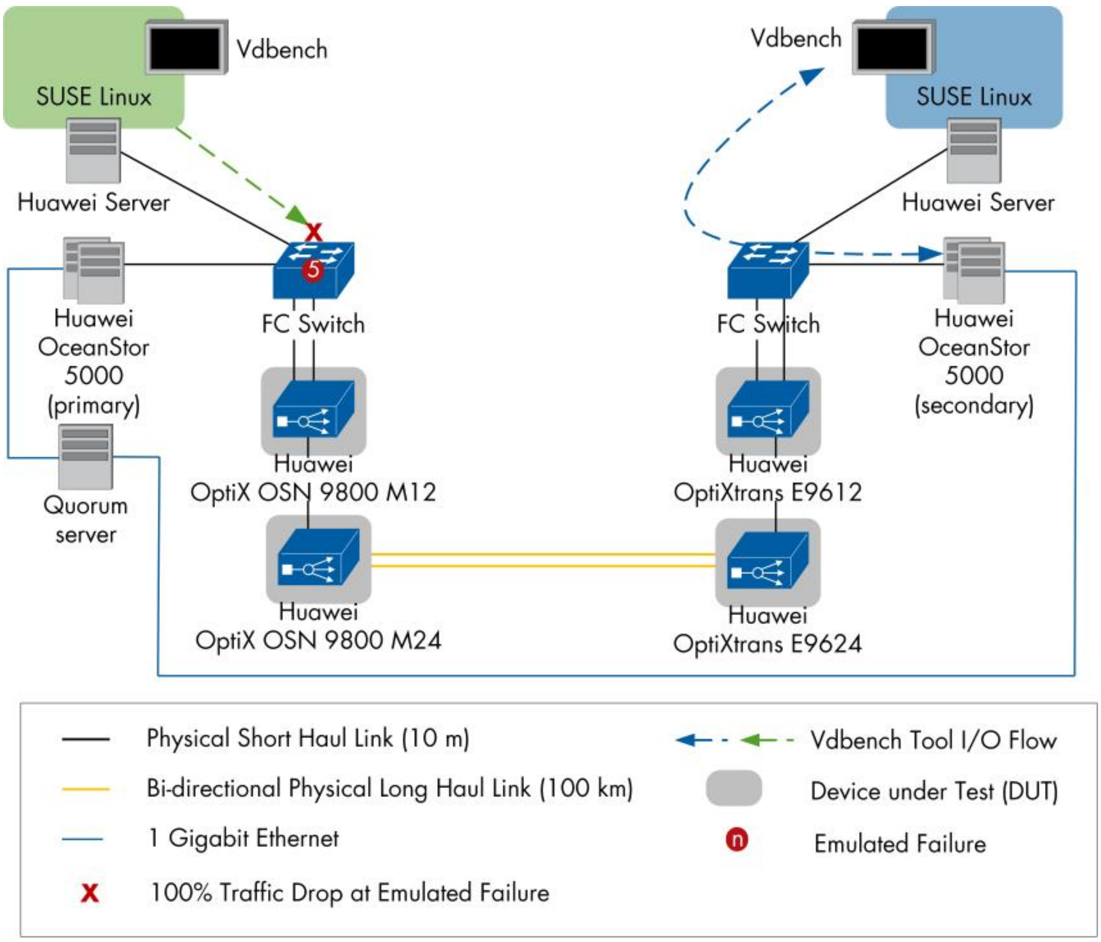


Figure 21: Traffic status during FC switch reboot
(Huawei OptiXtrans E9624 with Tributary/Line Boards)

Once the FC switch from one data center rebooted, the storage on the remote site where the FC switch was not touched obtained the host's I/O access and continues to perform I/O operations. In the data center where the FC switch rebooted, the storage stopped receiving any data from the FC switch until the FC switch was available again. Depending on the time taken by the FC switch to become available, we observed:

- The G620 pair rebooted less than 1 min. The FC service did not fully interrupt from the reboot site. The reboot site traffic was redirected to the non-reboot site and kept working, whereas the non-reboot site switched to access the local storage as well. There was 46s service interruption time (including a maximum of 43s drop to 0MB/s).
- The Brocade 300 and Cisco MDS 9132T FC SAN rebooted more than 1 min, where the link and the fabric were all down (status of out of service).

After the FC switch completed the reboot and the quiescing time (300 s) passed, we observed that the traffic switched back to the initial status between DC1 and DC2. We did not observe any impact as expected.

No. in Fig. 16 and	Test Case	Setup	Action	Service Interruption			Verdict
				Expected[11]	Observed (for primary storage)[12] All-in-one Chassis	Observed (for primary storage)[12] With Tributary Boards	
5	Switch Reboot Test	Brocade 300 pair / Cisco MDS 9132T pair	Shut down	15s	A maximum of 13s service interruption time on non-reboot site, including a maximum of 10s drop to 0MB/s	A maximum of 13s service interruption time on non-reboot site, including a maximum of 10s drop to 0MB/s	Pass
			Turn on	No impact	No impact	No impact	Pass
		Brocade G620 pair	Shut down	15s	A maximum of 12s service interruption time on non-reboot site, including a maximum of 10s drop to 0MB/s	A maximum of 12s service interruption time on non-reboot site, including a maximum of 10s drop to 0MB/s	Pass
			Turn on	No impact	No impact	No impact	Pass

Table 13: Out of Service Overview (Active-Active Storage Cluster Protection)

[11] The expected value included 5 s fault detection by the quorum server and 15 s from it to triggering an active-active switchover.

[12] The 11s drop to 0MB/s included 6s of switch over by the quorum server and the reboot time of the switch (during the reboot process, the link at the FC switch was interrupted from time to time)

Long Haul Link Protection

We measured the switch-over time for the system under test to switch traffic to the backup link when the primary long-haul link fails. While traffic was running, we disconnected the primary link from the long-haul connection between both WDM devices. We observed that the traffic was switched to the backup link. The following Table shows the switch-over time measured. No session drops appeared during this time.

When we reconnected the primary link previously disconnected, we did not observe any impact on the traffic. Then we disconnect the protect link again. The WDM switched back to the primary link again with the switch over time. The last step is to reconnect the protected link. We observed no impact on I/O flow traffic. We observed a maximum of 3s drop to 0MB/s in all Brocade FC switch pairs in all boards. The service interruption was less than 1 s with the Cisco FC switch pair with all boards.

No. in Fig. 16 and	Test Case	Setup	Action	Service Interruption		Verdict
				Expected[13]	Observed	
4	Long Haul Network Failure with Redundancy	Brocade 300 pair	Disconnect	6 s[14]	A maximum of 5s service interruption time, including 3s drop to 0MB/s (see figure "WDM link switch over with Brocade 300")	Pass
			Reconnect	No impact	No impact	Pass
		Brocade G620 pair	Disconnect	4 s	A maximum of 4s service interruption time, including 2s drop to 0MB/s	Pass
			Reconnect	No impact	No impact	Pass
		Brocade G620 6505 pair	Disconnect	4 s	A maximum of 3s service interruption time, including 1s drop to 0MB/s	Pass
			Reconnect	No impact	No impact	Pass
		Cisco MDS 9132T	Disconnect	4 s	<1s[15]	Pass
			Reconnect	No impact	No impact	Pass
8	ISL Trunking	Brocade G620	Disconnect	Drop 50%	Drop 50%	Pass
			Reconnect	Increase 100%	Increase 100%	Pass

Table 14: Out of Service Overview

[13] Includes the impact of end-to-end flow control (a total of four hops from the host to the storage through two FC switches). With credit recovery enabled on the FC switch, we calculated each hop for 1 second interruption, based on the hold off time of 500 ms (milliseconds that a frame could be buffered on a port without being overwritten) configured on the Brocade G620 (same as Cisco MDS 9132T) switch; added to that the impact of retransmission caused by the frame loss during the link failure, and vdbench accuracy of 1 sample per second.

[14] The expected value includes 4 s of impact by end-to-end flow control (see explanation as provided in * note), plus 2s of impact by edge hold off time (EHT) on F port. Note, the value is not provided by Brocade 300 manual, we calculated a double theoretical value of 250 ms for FC1G and FC2G (250 ms is the default EHT value of FC16G), so added 1 s per F port (based on 1 sample/sec based on vdbench).

[15] The smallest number of samples is one per second in vdbench

The Huawei M210D required the dispersion compensation module (DCM) to compensate for the fiber's dispersion accumulation when the transmission distance of the network is 100km.

Board Under Test	Switch Over Time (s)
M210D	A maximum of 4s service interruption (including a maximum of 2s drop to 0MB/s)
M520SM	A maximum of 5s service interruption (including a maximum of 3s drop to 0MB/s)
T220 T212	A maximum of 4s service interruption (including a maximum of 2s drop to 0MB/s)

Table 15: Switch Over Time Brocade 300 - 300

Board Under Test	Switch Over Time (s)
M210D	A maximum of 3s service interruption (including a maximum of 1s drop to 0MB/s)
M520SM	A maximum of 4s service interruption (including a maximum of 2s drop to 0MB/s)
T220 T212	A maximum of 3s service interruption (including a maximum of 1s drop to 0MB/s)

Table 16: Switch Over Time Brocade G620 - G620

Board Under Test	Switch Over Time (s)
M520SM	A maximum of 4s service interruption (including a maximum of 2s drop to 0MB/s)
T220 T212	A maximum of 3s service interruption (including a maximum of 1s drop to 0MB/s)

Table 17: Switch Over Time Brocade G620 - 6505

Board Under Test	Switch Over Time (s)
M210D	Less than 1 second
M520SM	Less than 1 second
T220 T212	Less than 1 second

Table 18: Switch Over Time Cisco MDS 9132T - 9132T

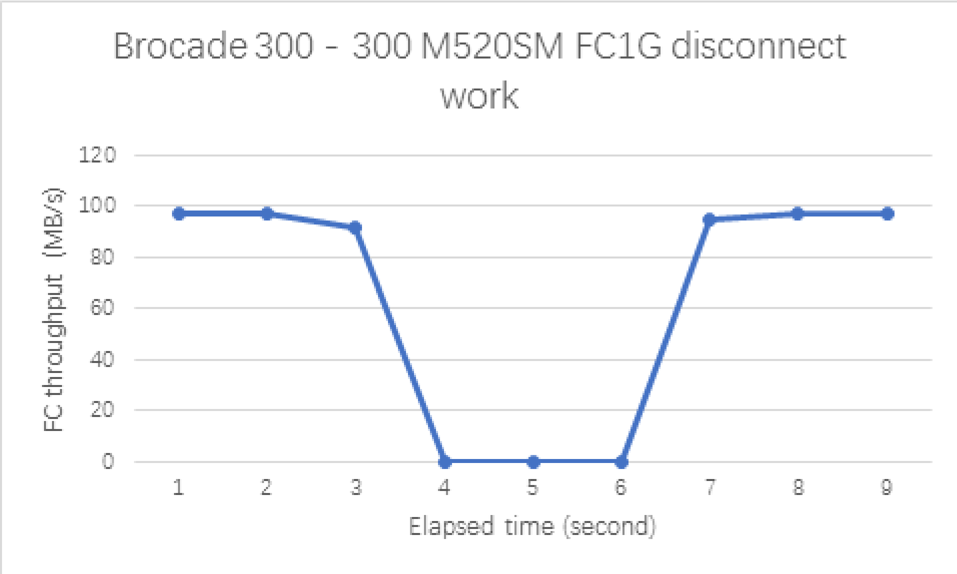


Figure 22: WDM Link Switch Over with Brocade 300

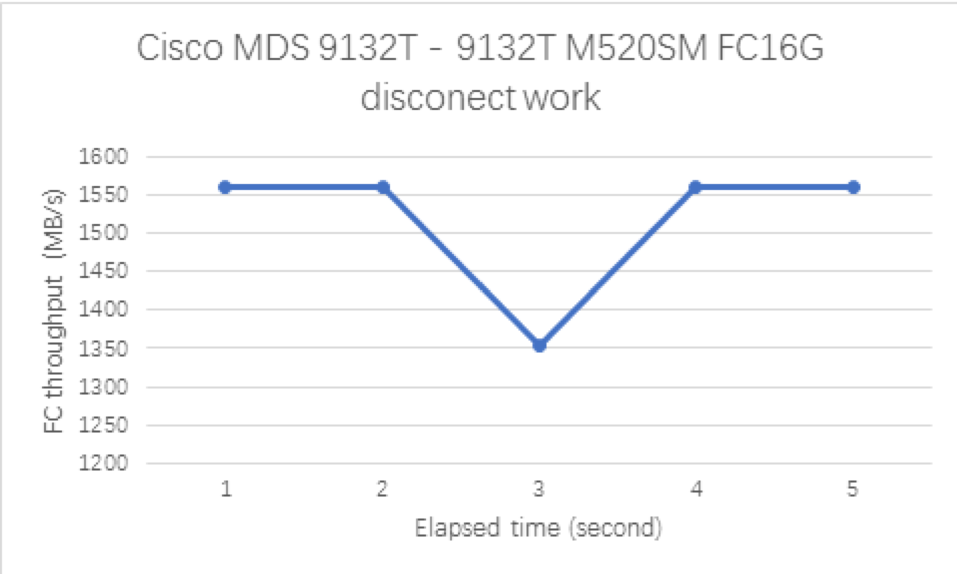


Figure 23: WDM Link Switch Over with Cisco MDS 9132T

Summary of Test Runs for All Failure Scenarios

With all three boards under test, the DUT demonstrated its ability to maintain stability while performing the above failure scenarios in each of the test setups.

We used the maximum load of the baseline traffic for each of the selected interfaces as measured in capacity tests and formed 78 combinations as listed in the tables below.

Board Under Test/ Test Scenario	E-port Interface used in Test Case			
	1	2	4	5
M210D	1G	2G	1G	2G
M520SM	1G	2G	1G	2G
T220 T212	1G	2G	1G	2G

Table 19: Setup 1 - Brocade 300 Pair

Board Under Test/	E-port Interface used in Test Case						
	1	2	3	4	5	6	8
M210D	8G	10G	8G	4G, 10G	8G	4G, 10G	
M520SM	8G, 16G	10G, 32G	8G, 32G	4G, 10G, 16G	8G, 16G	4G, 10G, 32G	16G, 32G
T220 T212	8G, 16G	10G	8G	4G, 10G,	8G, 16G	4G, 10G	
T220		32G	32G			32G	

Table 20: Setup 2 - Brocade G620 Pair

Board Under Test/ Test Scenario	E-port Interface used in Test Case			
	1	4	6	8
M520SM	16G	16G	16G	16G
T220 T212	16G	16G	16G	

Table 21: Setup 3 - Brocade G620 - 6505 Pair

Board Under Test/	E-port Interface used in Test Case					
	1	2	3	4	5	6
M210D		8G	8G			8G
M520SM	16G	8G, 32G	8G, 32G	16G	16G	8G, 32G
T220 T212	16G	8G	8G	16G	16G	8G
T220		32G	32G			32G

Table 22: Setup 4 - Cisco MDS 9132T Pair

Soak 24 Hours Test

We verified the WDM system's reliability in terms of performance consistency under long-period stress load conditions. We tested the Brocade G620 pair and Cisco MDS 9132T pair at the FC speed of 16G with the same topology as the capacity test. And the tested boards were M520SM, T220, and T212. The test tool Vdbench triggered the baseline traffic bidirectional for 24 hours. During that time, we monitored the system log of both hardware and software. We confirm that the system could transfer the data at a consistent rate and constant latency of 24 hours. As expected, the system under test remained stable; we did not observe any software crashes or hardware failures during the test duration.

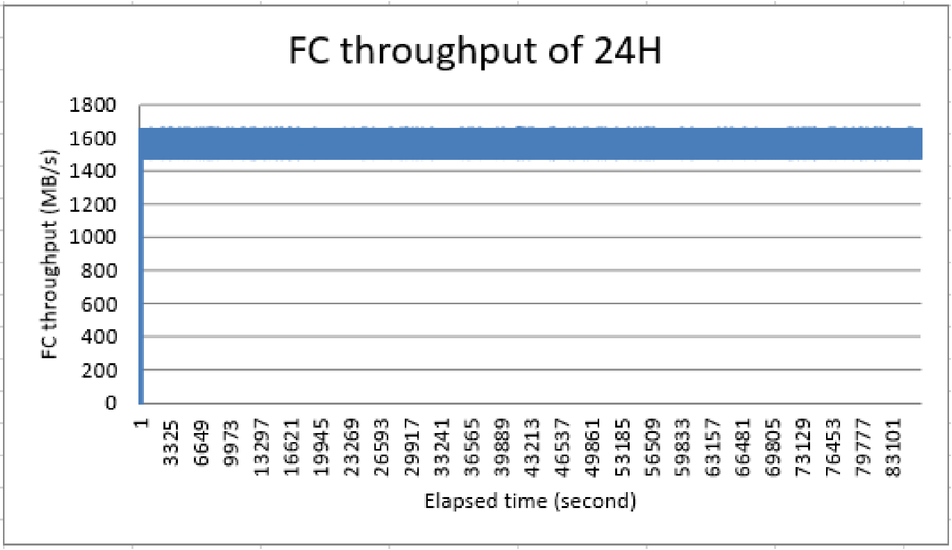


Figure 24: 24-hour Throughput of 32G

Conclusion

EANTC verified the interoperability of Huawei OptiXtrans E9612, Huawei OptiXtrans E9624 and third-party Fibre Channel switches from Brocade (G620, 6505, and 300) and Cisco (MDS 9132T and MDS 9148S). Multiple optical transceiver functions were certified in the E_port between these FC switches and the OptiXtrans E9612, OptiXtrans E9624, including FC-PI-6, FC-PI-5, and FC-PI-3. We validated forwarding speeds in FC 8G, 10G, 16G, and 32G scenarios. When forwarding traffic at any of these standardized speeds, the OptiXtrans E9612 and OptiXtrans E9624 did not exhibit any speed impact. The extended 24 hours soak testing confirmed stable operations of OptiXtrans E9612 and OptiXtrans E9624 without any traffic impact. We conducted a range of service availability tests to disable/ enable the port, disconnect/reconnect E_port fiber, disconnect/reconnect long haul, reboot FC switch, remove/re-install line card with both FC switch pairs, and remove/re-install ISL trunking fiber with Brocade G620. All tests documented in this report passed our verification.

Based on our test results, EANTC confirms that the OptiXtrans E9612 and OptiXtrans E9624 fulfills Huawei's claims to work in enterprise data center interconnection scenarios as an integrated, high-speed, and resiliency solution.

About EANTC

EANTC (European Advanced Networking Test Center) is internationally recognized as one of the world's leading independent test centers for telecommunication technologies. Based in Berlin, the company offers vendor-neutral consultancy and realistic, reproducible high-quality testing services since 1991. Customers include leading network equipment manufacturers, tier 1 service providers, large enterprises and governments worldwide. EANTC's Proof of Concept, acceptance tests and network audits cover established and next-generation fixed and mobile network technologies.

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