Berk-Tek Leviton Technologies' Connectivity Performance with Arista Network's Universal 40G QSFP Transceivers

Berk-Tek Leviton Technologies recently evaluated 40 Gb/s Ethernet transmission performance using its OM3, OM4, and OM4+ components and Arista Network 40G Universal transceivers. Various channel configurations were tested, with single mode and multimode optical cables (Gigalite™-10LB, Gigalite-10XB Micro Data Center Plenum) and multi-fiber cassettes (HDX MTP-LC). All the tests were performed under full network load conditions with 40 Gb/s Ethernet frames that were transmitted to achieve a minimum bit error ratio of 10^{-12}. The results indicate that the Berk-Tek Leviton Technologies cabling and connectivity — in conjunction with Arista's Universal (UNIV) transceivers — meet the IEEE bit error ratio targets and exceed their distance specifications.

Introduction

With the increase in data center bandwidth requirements, migration to 40 GbE for switch to switch connections — and in a few cases server to switch connections — is in higher demand. Arista Networks, a leader in high-density network switches, believes that a 2-fiber LC cable solution with a QSFP form factor is attractive and has developed a 40GbE optical transceiver with LC connectors, which enables seamless migration from 10G to 40G by eliminating the need to modify existing fiber infrastructure. Arista's solution is a 40 GbE QSFP transceiver called Universal, which is based on IEEE defined 40GBASE-LR4 specifications and operates in the 1310 nm band. The name indicates that the device can work over both Multimode and Single mode fiber. As shown in **Figure 1**, each fiber carries four 10 Gb/s CWDM channels (1270, 1290, 1310 and 1330 nm) with an aggregated capacity of 40 Gb/s each direction.

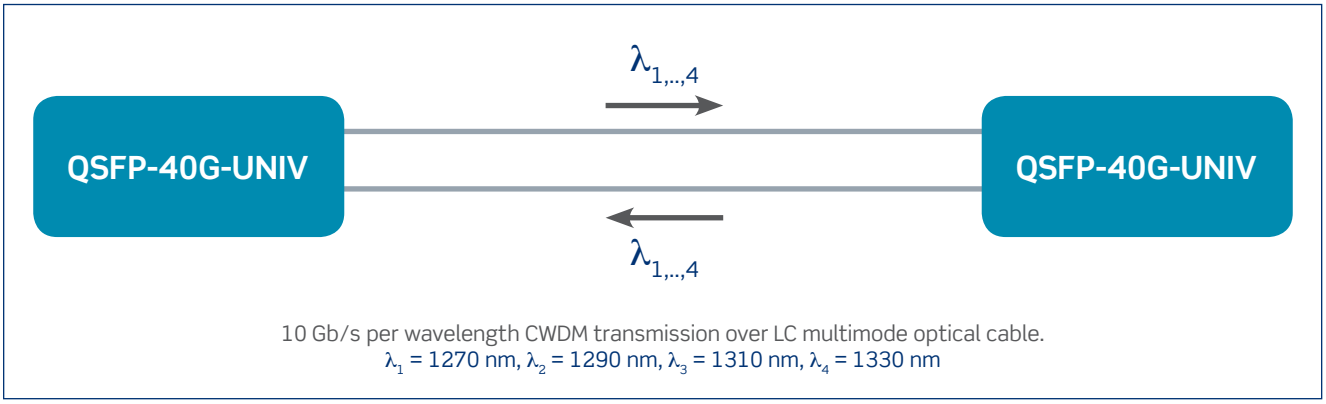

Figure 1: Schematic of CWDM communication over optical channel using Arista's 40GbE Universal transceiver.

The reader should be aware that Arista's UNIV transceiver is based on IEEE 40GBASE-LR4 specifications. This means that the devices operate at optical wavelengths not specified by the OM3/OM4 standard, and a direct correlation between fiber bandwidth (typically specified at 850 nm) and performance cannot be assumed. Arista's achievable transmission distance specifications for the UNIV transceiver are summarized in **Table 1**.

Table 1: Arista Universal 40G Distance Specification for Different Fiber Types

FIBER TYPE	DISTANCE
OM3	150 m
OM4	150 m
OS2	500 m

In the Tek Center at Berk-Tek's Pennsylvania headquarters, several tests were performed under various channel configurations on OM3, OM4 and OM4+ multimode fiber components to understand the maximum reach and connection limitations.

Test Methology

Several channel configurations were implemented for testing the performance of UNIV transceivers as shown in **Figure 2**. The total number of connectors[1], the channel length and fiber types are indicated in **Table 2**. To test a single trunk, the transceivers were connected to the12-fiber MDP trunk using a 30 m LC-LC patch cord and MPO-LC module panel on each side of the link as shown in **Figure 2(a)**. For this test case depicted as **Channel A**, the trunk lengths varied from 90 m to 140 m depending on the fiber type. Similarly, for testing multiple concatenated trunks, patch cords ranging from 2 to 5 meters were used to make the connections between the transceivers and module panels. The trunks were concatenated using module panels and LC-LC patch cords, as depicted in **Figure 2 (b) &(c)**. These configurations represent a typical scenario in data centers, where traffic from different sectors is routed either to a certain area of the data center or to the main switch fabric.

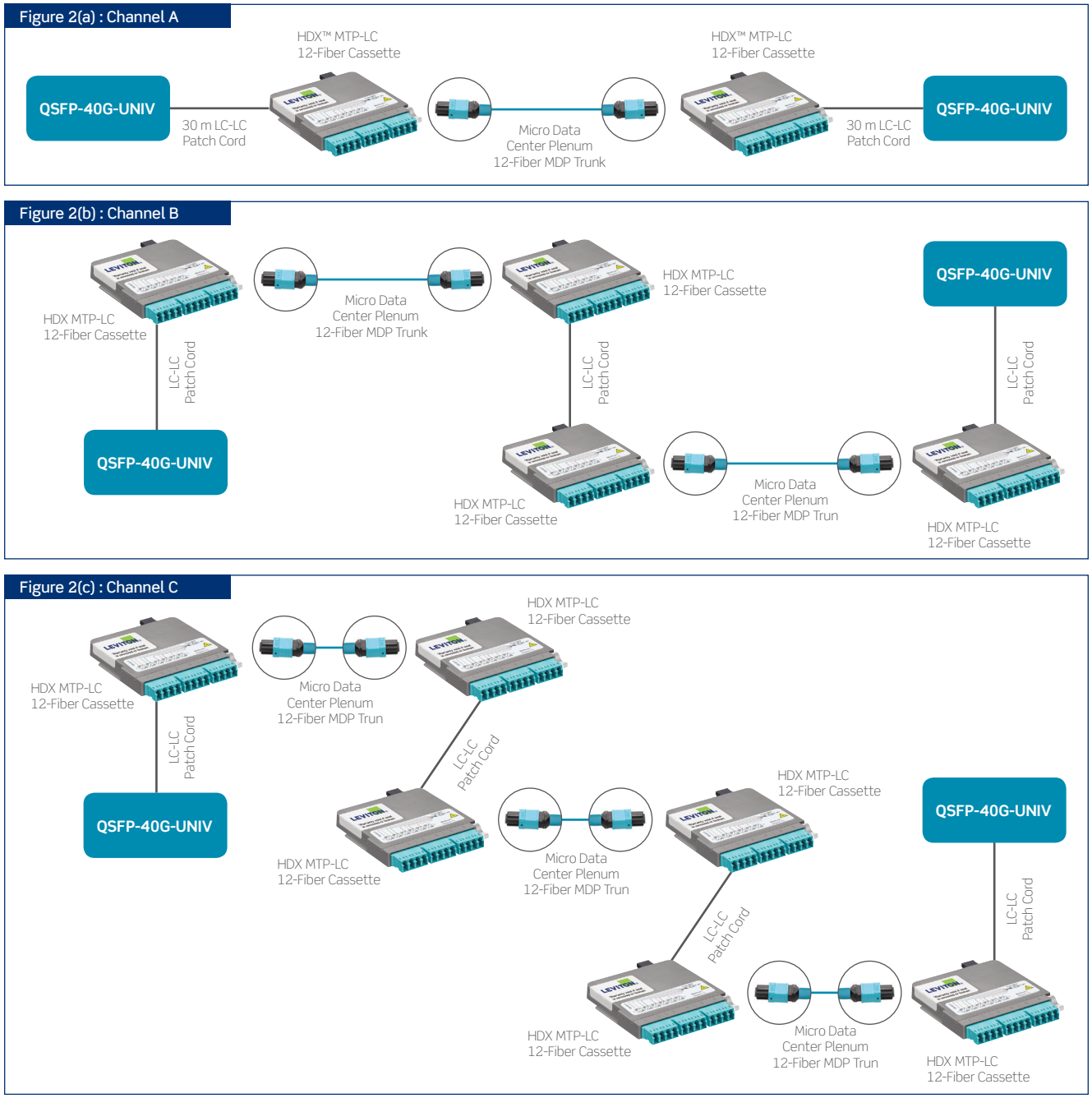

Figure 2: Schematic of test configurations for evaluating Arista's UNIV transceiver performance. Channel A is for testing a single trunk whereas Channels B and C are to test concatenated trunks with increased number of connectors.

[1] The total number of connections does not include the connections made to and from the QSFP modules. These losses are included in the transceiver power budget.

Table 2: List of all Test Cases and Their Corresponding Lengths and Number of Connectors

TEST CONFIGURATION	TRUNK LENGTH(S)	TOTAL LENGTH	NUMBER OF LC CONNECTIONS	NUMBER OF MPO CONNECTIONS
A	OM3 : 90 m	150 m	2	2
	OM4 : 90 m	150 m	2	2
	OM4+ : 140 m	200 m	2	2
B	OM3 : 90, 45 m	150 m	4	4
	OM4 : 90, 45 m	150 m	4	4
	OM4+ : 140, 50 m	200 m	4	4
	OS2 : 243, 243 m	501 m	4	4
C	OM3 : 90, 20, 20 m	150 m	6	6
	OM4 : 90, 20, 20 m	150 m	6	6
	OM4+ : 100, 50, 25 m	200 m	6	6

Once the channels were set-up, channel insertion loss and return loss measurements were taken using the JDSU MAP 2000 optical measurement equipment. The 40GbE traffic was generated using the IXIA IP tester and was transmitted over the channel under test in both directions. To record a bit error rate (BER) of 10^{-12}, more than 10^{12} bits were transmitted and the total bits lost was measured, resulting in a BER value. The following section describes the results in detail.

Table 3: Test Configurations and Their Respective Bit Error Ratio Values

TEST CONFIGURATION	CHANNEL PROPERTIES			BIT ERROR RATIO
	FIBER TYPE	TOTAL LENGTH	NUMBER OF CONNECTORS	
A	OM3	150 m	4	$<1e10^{-13}$
	OM4	150 m	4	$<1e10^{-13}$
	OM4+	200 m	4	$<1e10^{-13}$
	OM4+	310 m	4	$<1e10^{-13}$
B	OM3	150 m	8	$<1e10^{-13}$
	OM4	150 m	8	$<1e10^{-13}$
	OM4+	200 m	8	0.12
	OS2	501 m	8	$<1e10^{-13}$
	OS2	1498 m	>12	$<1e10^{-13}$
C	OM3	150 m	12	$<1e10^{-13}$
	OM4	150 m	12	$<1e10^{-13}$
	OM4+	200 m	12	$9.8e10^{-3}$

Results

The data transmission results using both the transceivers and the insertion loss of the corresponding channels are summarized in table 3. The BER was measured after counting the total number of errors recorded and the path loss was measured at both 850 nm and 1310 nm. The rows marked in red indicate the channel configurations that did not meet the UNIV's BER requirement of 10-12.

For the Arista's UNIV transceiver, error free transmission over channels of 150 meters for OM3 and up to 310 meters of OM4+ with four connectors was achieved using the **Channel A** configuration. The UNIV also achieved error-free 150 meter transmission with twelve connections in the link. These results indicate that the Berk-Tek Leviton components exceed both the distance and channel loss specification by Arista. Berk-Tek Leviton Technologies' components result in twice the distance on OM4+ compared to the Arista specification for OM4.

On the other hand, using a singlemode fiber, 500 meters of transmission over the **Channel B** configuration with eight connections was free of errors. To understand the performance limits of UNIV on singlemode channel, the total channel length was increased to 1498 meters by looping back into other fibers on the 12-fiber MDP trunk, and error-free transmission was achieved. It should be noted that in this case, the total number of connections was greater than 12.

Conclusion

Extensive tests were performed on Berk-Tek Leviton Technologies' channel configurations using Arista's UNIV 40G transceiver. The results indicate superior-error free transmission performance for all the test cases for distances specified by Arista over Berk-Tek Leviton Technologies optical components.

The Arista UNIV transceiver resulted in error-free transmission for OM3 and OM4 at 150 meters, OM4+ at 310 meters, and singlemode fiber channels at 500 meters, exceeding the manufacturer's specification. A record distance of nearly 1,500 meters was achieved over singlemode fiber with more than eight connections. Under stress conditions with more than eight connectors and distance greater than the specified 150 meters over OM3/OM4, the link resulted in errors. However, the channels meet or exceed the Arista's maximum distance specifications in single trunk and 2-trunk configurations with up to eight optical connections.