TEST REPORT

Tolly.

#223131

July 2023

Commissioned by

Dell, Inc.

Dell PowerEdge R760 Rack Server & Emulex LPe36002 Host Bus Adapter

Dell R760 and 64GFC Combine to Accelerate Oracle Analytics Workloads

EXECUTIVE SUMMARY

New generation technology can be expected to improve performance. There are times, however, when multiple technology advances can combine to provide an outsized advantage. Such is the case when the Dell PowerEdge R760 Rack Server is combined with the Broadcom Emulex LPe36002 64G Fibre Channel Host Bus Adapter

Dell commissioned Tolly to benchmark the analytics workload performance of the Broadcom Emulex LPe36002 64G Fibre Channel dual-port host bus adapter (HBA) running in the Dell PowerEdge R760 Rack Server. Specifically, this report will focus on illustrating two points: 1) Improved database analytic performance due to the increased input/output (I/O) throughput of 64GFC, 2) Increased application performance when paired with PCIe 4.0/5.0 and the dual-port 64GFC HBA.

Tests showed that the new R760 Intel Eagle Stream-based platform's increased CPU power and PCIe 5.0 bus work in conjunction with the Broadcom 64GFC dual-port adapter to deliver line rate, 64G throughput that cannot be matched by earlier generation technology. See Figure 1.

THE BOTTOM LINE

Dell PowerEdge R760 & Emulex LPe36002 64G HBA benefits over older generation 16/32GFC PCIe 3.0 HBAs:

1. R760 with 64GFC HBA can achieve 4x the database analytics throughput of the16GFC HBA and 2x the throughput of the 32GFC HBA
2. 42% improvement in complex database ad hoc query processing time when running the dual-port 64GFC HBA on the PCIe 5.0-based R760 server compared to the older generation R740 server

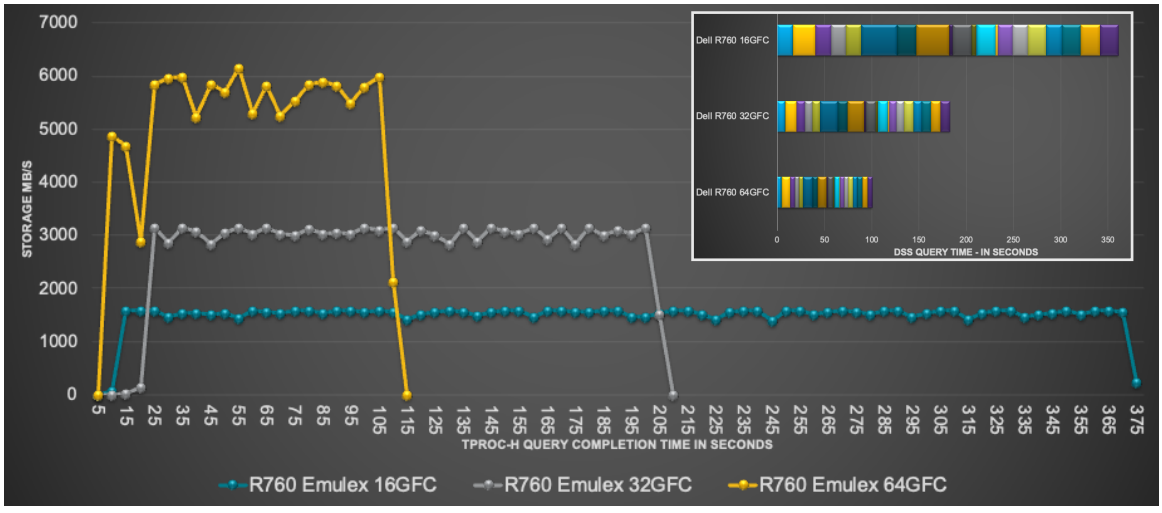
Dell R760 & Emulex LPe36002 64G HBA Oracle Database 19c

I/O Throughput & Transaction Improvement: Dell PowerEdge R760 with 64GFC vs 16/32GFC

(as reported by HammerDB TPROC-H and Linux iostat)

Graphs shows overlayed results for the database test run using the same server outfitted for each run with 64/32/16GFC HBAs.

Main chart graphs throughput showing 64GFC achieving the highest throughput. Inset chart illustrates transaction time showing 64GFC with the fastest completion.



Source: Tolly, June 2023

Figure 1

Overview

The goal of these tests, as noted, was to illustrate, simply, that deploying a Dell PowerEdge R760 Rack Server with the Emulex 64G Fibre Channel HBA can improve database analytic performance by providing double and quadruple the I/O throughput of the two prior generation HBAs respectively. Similarly, the tests were used to illustrate the key role of the newer-generation PCIe 5.0 server bus and PCIe 4.0 dual-port 64GFC HBA in increasing server I/O throughput.

All benchmarking was done using the open source TPROC-H analytics workload of HammerDB.[1] The tests were run using the Oracle 19c database environment but the results are generally applicable to any database or other input/output intensive workload.

The TPROC-H workload measures how long it takes to run a series of 22 different types of decision support queries. This type of workload is "read only" with no database updates taking place. The Linux iostat utility was used to measure storage I/O throughput.

Test Background & Results

64GFC vs 16/32GFC

This test was run three times with the only variable being the link speed between the server's FC HBA and the switch.

Figure 1 (main and inset), on the previous page, summarizes all three tests using two metrics: storage I/O throughput and query execution time as reported by the HammerDB database benchmark. What is important to note are the relative results across the three scenarios. The 16GFC HBA is clearly a bottleneck (blue dots) taking the longest to complete and delivering the lowest throughput. (Note: multiple colors in the inset bar chart represent the different transaction types used in the TPROC-H benchmark.)

Performance is improved, roughly by 2x, when the HBA is configured for 32GFC (gray dots) but, as will be seen, 32GFC still presented a transaction bottleneck.

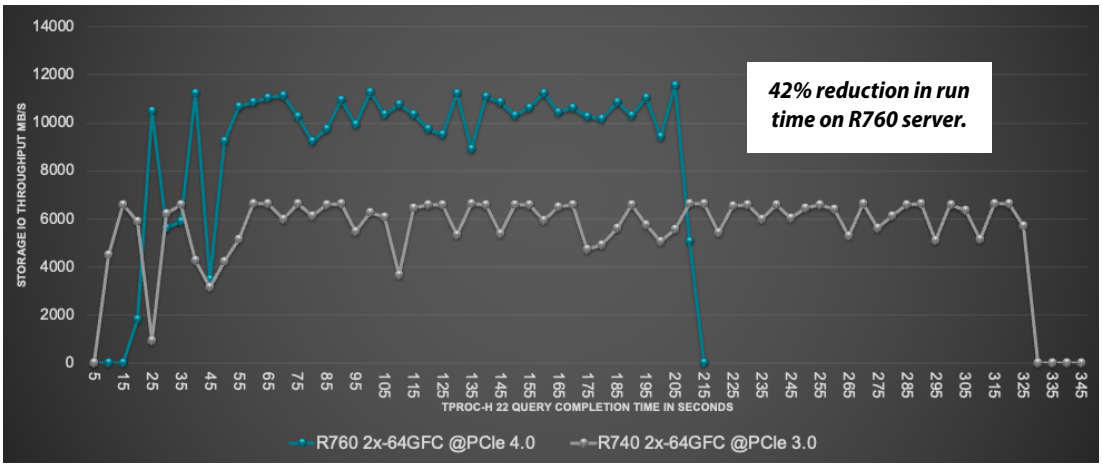
When run using the 64GFC the database storage IO throughput is the

Dell R760 & Emulex LPe36002 64G PCIe 4.0 HBA Performance Improvements
Dell PowerEdge R760 (PCIe 5.0) vs Dell PowerEdge R740 (PCIe 3.0) Servers
(as reported by HammerDB TPROC-H and Linux iostat)

Graph shows overlayed results for the database test run using the same 2-port 64GFC, PCIe 4.0 HBA on two different generation servers.

Gray dots show that the 64GFC transaction throughput is limited by the PCIe 3.0 bus architecture of the older generation R740.

Blue dots showing transaction time reduced by 425% when deployed in the R760 with PCIe 5.0 bus architecture.



Source: Tolly, June 2023

Figure 2

[1] https://www.hammerdb.com/docs/ch11.html

highest and the query execution time is the shortest. Again, performance is improved roughly by a factor of two over the 32GFC results.

64GFC Dual-Port HBA Performance

The Emulex LPe36002 64GFC HBA is a PCIe 4.0 interface card and is the recommended HBA for the Dell R760 server. The card's total performance capacity is restricted by the bandwidth limitations of older generation servers that utilize PCIe 3.0.

As in the prior test, the TPROC-H benchmark was run on an Oracle 19c database multiple times using the same card but in servers that implement two different PCIe generation architectures.

Figure 2, on the previous page, illustrates the how the same dual-port 64GFC HBA delivers dramatically higher throughput and shorter database query times when deployed in a current generation server that implements PCIe 5.0 bus architecture.

Taking the same dual-port 64GFC HBA and deploying it in a PCIe 5.0 R760 server improved transaction time by 42% simply by removing the limitations imposed by the maximum bandwidth of the R740 PCIe 3.0 bus.

Test Setup & Methodology

The HBA under test used current production drivers that are publicly available. Default settings were used. Details of the test environment and systems under test are found in Tables 1-6. Figure 3 shows a composite test environment.

Server systems were all VMware ESXi 8 hosts running ESXi-8.0U1-21495797. Storage volumes mapped to each VM were configured as thick provisioned, eagerly zeroed. PVSCSI controller was used.

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Dell PowerEdge R760 & Emulex LPe36002 HBA

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64GFC Oracle Analytics Performance

Tested June 2023

Each VM was assigned 100GB of memory and 40 vCPUs. Each VM was running RHEL 8.8.

Details of the HammerDB tests are found in the "Overview" section above.

For the 16/32/64GFC comparisons the server's HBA-to-switch connection was configured to each of the link speeds as required by each test scenario.

For the PCIe generation comparison test, the R760 and R740 were not matched with respect to CPU and memory but as the test focused on I/O, the differences were acceptable.

Consolidated Test Bed Topology: 64/32/16GFC & PCIe 5.0/PCIe 3.0 Tests

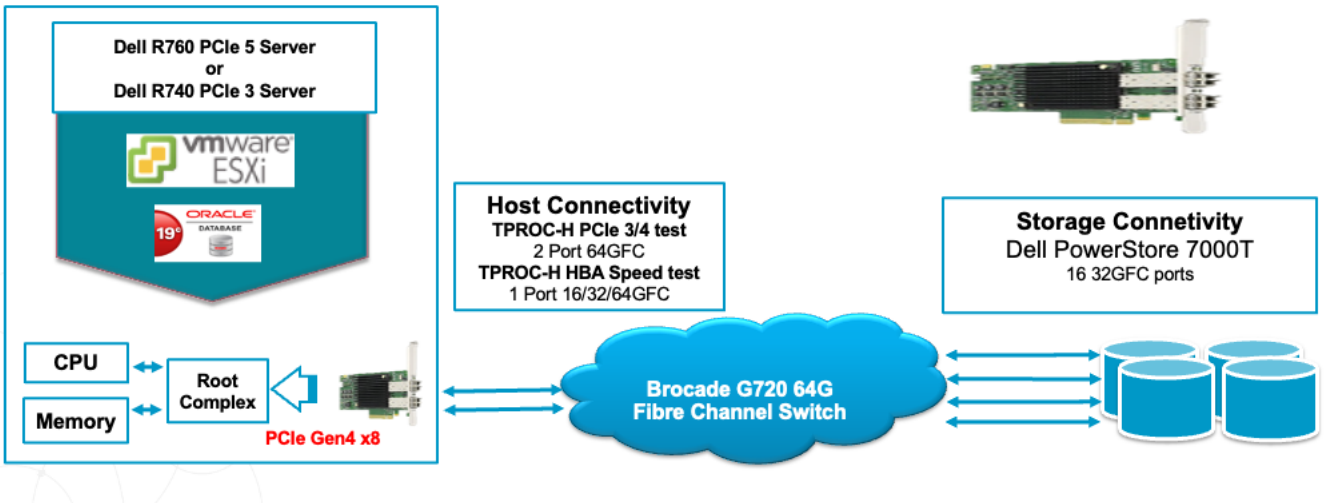

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Figure 3

Test Configuration Summary

64G HBA Under Test

Vendor	Product Name	Bus Architecture	Firmware	Driver
Broadcom	Emulex LPe36002	PCIe 4.0	14.2.455.15	14.2.560.8

Table 1

R760 Server Configuration

Vendor/System	Dell PowerEdge R760
CPU	2 socket Intel(R) Xeon(R) Platinum 8468 @ 2.1 GHz
Number of CPUs	96
Memory (RAM)	512 GB
OS	Red Hat Ent. Linux 8.8 (RHEL8)

Table 2

R740 Server Configuration

Vendor/System	Dell PowerEdge R740
CPU	2 socket Intel(R) Xeon(R) Gold 6146 @ 3.2 GHz
Number of CPUs	24
Memory (RAM)	128GB
OS	Red Hat Ent. Linux 8.8 (RHEL8)

Table 3

Database Test Tool

Vendor	Open Source
Application	HammerDB 4.7
TPROC-H settings	Degree of parallelism = 80 Scale factor = 100 Virtual users = 1

Table 4

Storage Configuration

Vendor/Device	Dell PowerStore 7000T v3.2.0.1
Ports	16 x 32G FC
Volumes	9 x NVMe: 1x 200 GB and 8x 1 TB
Performance Policy	High
Namespace/LUN	8 x 32G Target ports per Namespace
Network Fabric	Brocade G720 64G FC Switch v9.1.1

Table 5

Oracle Database Configuration

Database	Oracle Database 19c (19.3)
Storage Type	ASM Disk group external redundancy, 8 Namespaces for data
Dataset Size	150GB
Database Settings	SGA = 34000 MB PGA = 4000 MB Block size = 8 KB

Table 6

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Broadcom Emulex LPe36002

The Broadcom Emulex LPe36000-series Gen 7 Fibre Channel HBAs are designed for demanding mission-critical workloads and emerging applications. The family of adapters features Silicon Root of Trust security, designed to thwart firmware attacks aimed at enterprises and governments.

Gen 7 64G provides seamless backward compatibility to 32G and 16G networks.

Dell sells the LPe36002 64G HBA for the same price as the 32G model.

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