



# HP DL380 Gen8 and HP LE PCIe Accelerator 25 TB/45 TB Data Warehouse Fast Track RA

Based on Microsoft SQL Server 2014 Data Warehouse Fast Track RA

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This document is for individuals (business intelligent architects, database administrators, report developers, and IT directors) involved in decision making who are looking for guidance when designing enterprise business intelligence applications.

## Executive summary

The Microsoft® SQL Server Data Warehouse Fast Track Reference Architecture (RA) is designed to eliminate the complexity of properly sizing hardware, which helps reduce unnecessary scale-out of storage and servers. The sizing techniques used in SQL Server Data Warehouse Fast Track will properly size servers, based on I/O and CPU consumption. This consumption-based approach ensures your data warehouse can fully take advantage of your hardware investment. Using HP PCIe LE Workload Accelerators to host the 28 TB and 45 TB warehouses, solution I/O throughput performance exceeds 5 Gbps with more than 1400 queries/hr/TB.

## Why choose HP | SanDisk solutions?

Together, HP and SanDisk dedicated hundreds of hours of testing to engineer the SQL Server Data Warehouse Fast Track solutions to ensure maximum reliability and performance. These series of tests pushed the HP DL380 Gen8 Server and HP PCI express (PCIe) LE Workload Accelerator to their peak performance without any hardware failures. The reliability and performance experienced during testing is what can be expected in production environments.

## About the HP ProLiant DL380 Gen8 Server

What is your server bottleneck—storage, processing, and expansion? No matter the bottleneck, the HP ProLiant DL380p Gen8 Server series can help. It sets the data center standard for 2U, two-socket rack servers with the latest in serviceability, enhanced configuration flexibility, customer-inspired innovation, and unmatched performance.

The HP ProLiant DL380p Gen8 Server offers the perfect solution for the dynamic compute requirements of growing small businesses, as well as demanding data centers.

## What's new?

- Eliminate infrastructure complexity with HP OneView 1.10, now available on all HP ProLiant DL Gen8 servers.
- Increase performance by up to 35 percent<sup>1</sup> at the same or lower power levels with the new Intel® Xeon® E5-2600 v2 processors.
- Graphics processing unit (GPU) support is provided in primary and secondary risers to accelerate compute and enable large-data processing for a wide array of applications.
- New HP Common Slot Power Supplies provide up to 96 percent server power efficiency, and new infrastructure power efficiencies are achieved with 277 VAC and 380 VDC input voltages.
- HP SmartMemory enables up to 16.6 percent better memory performance.<sup>1</sup>
- Up to 4X workload performance<sup>2</sup> with HP SmartCache, a controller-based caching solution that caches hot data onto lower-latency SSDs.<sup>3</sup>

<sup>1</sup> Performance results per Intel® testing, August 2013

<sup>2</sup> HP SmartMemory at 1,866 MHz @2 DPC vs. 1,600 MHz @2 DPC, June 2013

<sup>3</sup> Performance and configuration as outlined in white paper TC1211951, February 2013

## Features

- Improved capacity and performance on compute and storage.
- Intel Xeon processor E5-2600 v2 product family offering increased performance, and improved security and efficiency; ideal for demanding workloads.
- HP SmartMemory, with speeds up to 1,866 MHz. This prevents data loss and downtime with enhanced error handling, while improving workload performance and power efficiency.
- GPU compute support to maximize performance.
- HP SmartCache, a controller-based caching solution. This caches hot data onto lower latency SSDs providing up to 4X workload performance.<sup>3</sup>

[hp.com/us/en/products/proliant-servers/product-detail.html?oid=5177957](http://hp.com/us/en/products/proliant-servers/product-detail.html?oid=5177957)

## New data warehouse features in SQL Server 2014

Microsoft added clustered column store indexes (CCI) in SQL Server 2014, which are designed to decrease query response times and deliver deeper levels of data compression. CCI eliminates the need to build summary tables, thus further reducing extract/transform/load run times.

- CCI is optimized for query performance. These solutions deliver an order-of-magnitude of 7X better query performance when using CCI. CCI accomplishes this by using a columnar format to compress the data by 10X or more, processing a set of rows in batches, and reading only the columns that are referenced in the query.
- CCI is updateable allowing concurrent insert—both bulk import and trickle insert—of new data while query workload is running. This reduces the data latency from the time data is born to when it is available for querying.

## About the SQL Server Data Warehouse Fast Track Reference Architecture

The SQL Server Data Warehouse Fast Track Reference Architecture provides a scalable framework centered on balancing I/O to achieve maximum performance from SMP-based servers. SQL Server Data Warehouse Fast Track eliminates the complexity of sizing servers with data warehouses by providing a set of data consumption rates that properly balances performance between the disk subsystem, CPU, and memory.

This architecture is based on the HP ProLiant DL380 Gen8 Server and HP PCIe LE Workload Accelerator PX600-2600/PX600-5200 storage controllers. These configurations are optimized for data warehouse (scan I/O) workloads and are rated by Microsoft for up to 45 TB of compressed data. For more information on SQL Server Data Warehouse Fast Track visit: [microsoft.com/en-us/server-cloud/data-warehouse-fast-track.aspx](http://microsoft.com/en-us/server-cloud/data-warehouse-fast-track.aspx).

## Data Warehouse Fast Track Reference Architecture configurations

### Storage configuration

#### Storage layout for 28 TB certification

| Slot number | Device                   | Capacity | Mount point | Allocation | Notes |
|-------------|--------------------------|----------|-------------|------------|-------|
| 1           | HP PCIe LE WA PX600-2600 | 2.6 TB   | IOM01       | Data files | JBOD  |
| 2           | HP PCIe LE WA PX600-2600 | 2.6 TB   | IOM02       | Data files | JBOD  |
| 4           | HP PCIe LE WA PX600-2600 | 2.6 TB   | IOM03       | Data files | JBOD  |
| 5           | HP PCIe LE WA PX600-2600 | 2.6 TB   | IOM04       | Data files | JBOD  |
| 3, 6        | Empty                    |          |             |            |       |

#### Storage layout for 45 TB certification

| Slot number | Device                   | Capacity | Mount point | Allocation | Notes |
|-------------|--------------------------|----------|-------------|------------|-------|
| 1           | HP PCIe LE WA PX600-5200 | 5.2 TB   | IOM01       | Data files | JBOD  |
| 2           | HP PCIe LE WA PX600-5200 | 5.2 TB   | IOM02       | Data files | JBOD  |
| 4           | HP PCIe LE WA PX600-5200 | 5.2 TB   | IOM03       | Data files | JBOD  |
| 5           | HP PCIe LE WA PX600-5200 | 5.2 TB   | IOM04       | Data files | JBOD  |
| 3, 6        | Empty                    |          |             |            |       |

An SAS controller was used for the database transaction log in both configurations, with 8 x 15K spindles in RAID 10.

### Power override



Enabling the power override setting on the HP PCIe LE Workload Accelerator product line is required to achieve the performance results below. A server reboot is required for the setting to be active and persist. For instructions on enabling the power override, see the “HP PCIe LE Workload Accelerator User Guide” for instructions.

Example:



```
fio-config -p FIO_EXTERNAL_POWER_OVERRIDE <device serial number>:<power (milliwatts)>
fio-config -p FIO_EXTERNAL_POWER_OVERRIDE 1234Z5678:40000, 9876Z-5432:40000
```

## SQL Server Data Warehouse Fast Track Reference Architecture results

### 28 TB certification

|   |   |   |   |                                     |                            |
|---|---|---|---|-------------------------------------|----------------------------|
| DWFT Certification #2014-003  | HP ProLiant DL380 Gen8 with HP PCIe LE Workload Accelerator 28TB reference architecture for Microsoft SQL Server 2014 Data Warehouse Fast Track |   | Report Date 9/3/2014                            |                                     |                            |
| DWFT Rev. 5.4   |   |   |   |                                     |                            |
| <b>System Provider</b>  | <b>System Name</b>  | <b>Processor Type</b>                         | <b>Memory</b>                                   |                                     |                            |
|    | HP DL380 G8   | Intel Xeon E5-2697v2<br>2.7 GHz (12/24/48)    | 768 GB  |                                     |                            |
| <b>Operating System</b>   |   | <b>SQL Server Edition</b>                     |   |                                     |                            |
| Windows Server 2012 R2  |   | SQL Server 2014 Enterprise Edition            |   |                                     |                            |
| <b>Storage Provider</b>   | <b>Storage Information</b>  |   |   |                                     |                            |
|    | 4 x 2.6TB HP PCIe LE Workload Accelerator for data and tempdb<br>2 x 300GB HDD for OS (RAID 1)<br>8 x 15K 300GB HDD for log (RAID 10)           |   |   |                                     |                            |
| <b>Primary Metrics</b>  |   |   |   |                                     |                            |
| Rated User Data Capacity <sup>1</sup><br>(TB)   | Row Store Relative Throughput <sup>2</sup>  | Column Store Relative Throughput <sup>3</sup> | Maximum User Data Capacity <sup>1</sup><br>(TB) |                                     |                            |
| 28  | 170   | 218   | 32  |                                     |                            |
| <b>Row Store</b>  |   |   |   |                                     |                            |
| Relative Throughput <sup>2</sup>  | Measured Throughput<br>(Queries/Hr/TB)  | Measured Scan Rate Physical<br>(MB/Sec)       | Measured Scan Rate Logical<br>(MB/Sec)          | Measured I/O Throughput<br>(MB/Sec) | Measured CPU (Avg.)<br>(%) |
| 170   | 202   | 4,508   | 5,500   | 5,004                               | 96                         |
| <b>Column Store</b>   |   |   |   |                                     |                            |
| Relative Throughput <sup>2</sup>  | Measured Throughput<br>(Queries/Hr/TB)  | Measured Scan Rate Physical<br>(MB/Sec)       | Measured Scan Rate Logical<br>(MB/Sec)          | Measured I/O Throughput<br>(MB/Sec) | Measured CPU (Avg.)<br>(%) |
| 218   | 1,414   | 1,389   | N/A   | N/A                                 | 98                         |
| <p>The reference configuration is a 2 socket system rated for 25TB using the FTDW V4 methodology</p> <p><sup>1</sup> Assumes a data compression ratio of 5:1</p> <p><sup>2</sup> Percent ratio of the throughput to the row store throughput of the reference configuration.</p> <p><sup>3</sup> Percent ratio of the throughput to the column store throughput of the reference configuration.</p> <p>* Reported metrics are based on the qualification configuration which specifies database size and SQL Server memory.</p> |   |   |   |                                     |                            |

## 45 TB certification

|   |   |   |   |                                     |                            |
|---|---|---|---|-------------------------------------|----------------------------|
| DWFT Certification #2014-003  | HP ProLiant DL380 Gen8 with HP PCIe LE Workload Accelerator 45TB reference architecture for Microsoft SQL Server 2014 Data Warehouse Fast Track |   |   | Report Date 9/3/2014                |                            |
| DWFT Rev. 5.4   |   |   |   |                                     |                            |
| <b>System Provider</b>  | <b>System Name</b>  | <b>Processor Type</b>                         | <b>Memory</b>                                   |                                     |                            |
|    | HP DL380 G8   | Intel Xeon E5-2697v2 2.7 GHz (12/24/48)       | 768 GB  |                                     |                            |
| <b>Operating System</b>   |   | <b>SQL Server Edition</b>                     |   |                                     |                            |
| Windows Server 2012 R2  |   | SQL Server 2014 Enterprise Edition            |   |                                     |                            |
| <b>Storage Provider</b>   | <b>Storage Information</b>  |   |   |                                     |                            |
|    | 4 x 5.2TB HP PCIe LE Workload Accelerator for data and tempdb<br>2 x 300GB HDD for OS (RAID 1)<br>8 x 15K 300GB HDD for log (RAID 10)           |   |   |                                     |                            |
| <b>Primary Metrics</b>  |   |   |   |                                     |                            |
| Rated User Data Capacity <sup>1</sup><br>(TB)   | Row Store Relative Throughput <sup>2</sup>  | Column Store Relative Throughput <sup>3</sup> | Maximum User Data Capacity <sup>1</sup><br>(TB) |                                     |                            |
| 45  | 161   | 227   | 72  |                                     |                            |
| <b>Row Store</b>  |   |   |   |                                     |                            |
| Relative Throughput <sup>2</sup>  | Measured Throughput<br>(Queries/Hr/TB)  | Measured Scan Rate Physical<br>(MB/Sec)       | Measured Scan Rate Logical<br>(MB/Sec)          | Measured I/O Throughput<br>(MB/Sec) | Measured CPU (Avg.)<br>(%) |
| 161   | 198   | 4,220   | 5,240   | 4,730                               | 97                         |
| <b>Column Store</b>   |   |   |   |                                     |                            |
| Relative Throughput <sup>2</sup>  | Measured Throughput<br>(Queries/Hr/TB)  | Measured Scan Rate Physical<br>(MB/Sec)       | Measured Scan Rate Logical<br>(MB/Sec)          | Measured I/O Throughput<br>(MB/Sec) | Measured CPU (Avg.)<br>(%) |
| 227   | 1,476   | 1,443   | N/A   | N/A                                 | 99                         |
| <p>The reference configuration is a 2 socket system rated for 25TB using the FTDW V4 methodology</p> <p><sup>1</sup> Assumes a data compression ratio of 5:1</p> <p><sup>2</sup> Percent ratio of the throughput to the row store throughput of the reference configuration.</p> <p><sup>3</sup> Percent ratio of the throughput to the column store throughput of the reference configuration.</p> <p>* Reported metrics are based on the qualification configuration which specifies database size and SQL Server memory.</p> |   |   |   |                                     |                            |

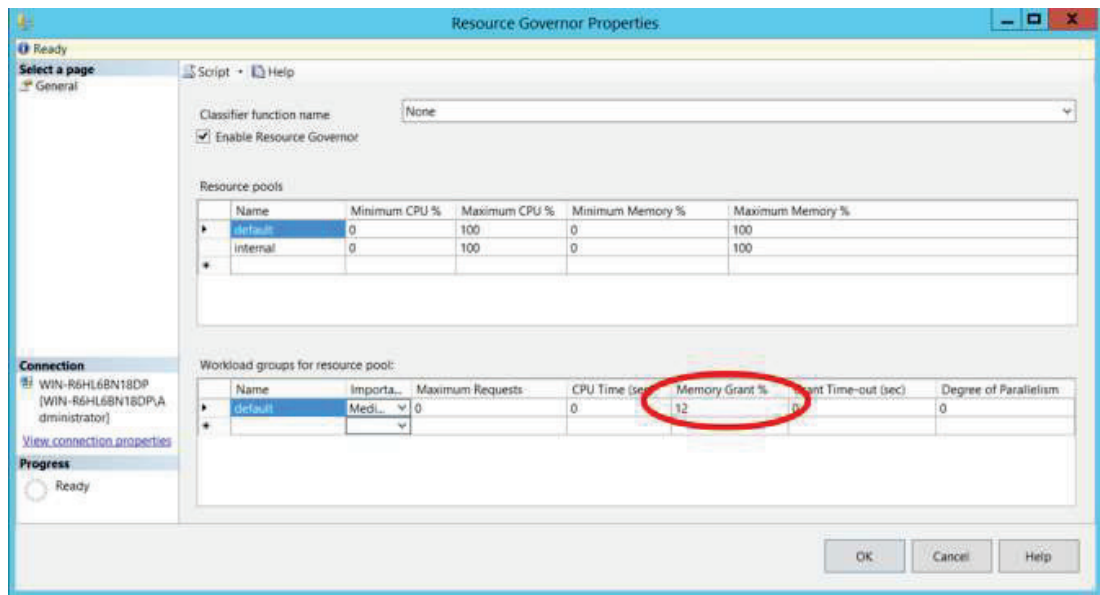
## Database configuration

| File group             | Number of data files                 |
|------------------------|--------------------------------------|
| FT_Demo_Base           | Four (one data file per data volume) |
| FT_Demo_stage_part_ci1 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci2 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci3 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci4 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci5 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci6 | Four (one data file per data volume) |
| FT_Demo_stage_part_ci7 | Four (one data file per data volume) |
| FT_Demo_LOG            | One (transaction log-on-log volume)  |

## TempDB configuration

Four TempDB files, 5 GB each, were stored on each data volume. In total, 24 TempDB data files were spread across six data mount points. The TempDB transaction log file was stored on the volume designated from log and staging files.

## SQL Server settings



## Resource Governor

The “Memory Grant %” value was set to 12 percent of the memory allocated for row store runs and 25 percent for column store runs. The settings were changed in the default resource pool.



## Maximum degree of parallelism

Maximum degree of parallelism was set to 24 for row store and 48 for column store. These values provided the best scan rates for the respective runs without pegging the processors at 100 percent utilization.

```

--for row store runs
EXEC sp_configure 'max degree of parallelism', 24
GO
RECONFIGURE WITH OVERRIDE
GO
--for column store runs
EXEC sp_configure 'max degree of parallelism', 48
GO
RECONFIGURE WITH OVERRIDE
GO
    
```

## Memory configuration

- SQL Server was allocated 90 percent of the server memory.
- The SQL Server service account was assigned the Lock Pages in Memory policy.

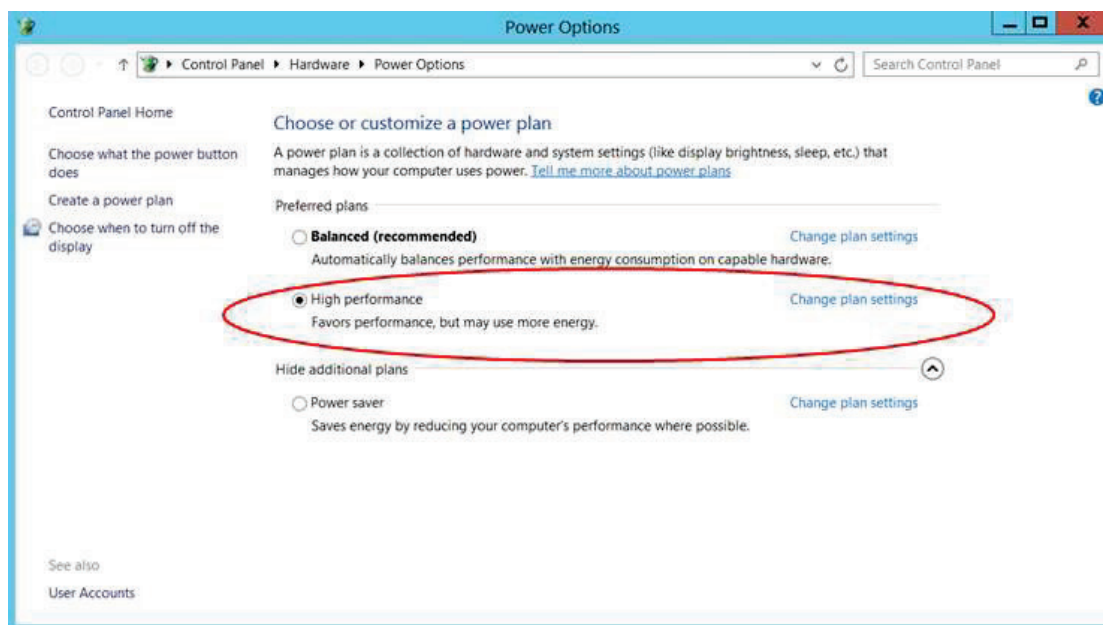
## Trace flags

Trace flag -T1117 was used to increase performance. This flag forces all data files in a file group to grow at once, which reduces “hot spots” of data pages. This ensures that all databases with more than one data file will grow properly across all the data mounts, which in turn ensures maximum physical I/O performance. Trace flag “-E” was omitted, as testing revealed a sharp increase in queue depth and latency, which decreases scan performance. Therefore trace flag “-E” is not recommended with this flash technology.

## Microsoft Windows Server 2012 R2 configuration

### Power settings

The high-performance plan was chosen to reduce CPU throttling.



### BIOS configuration

- Hyper-threading was enabled.
- System profile was set to high-performance mode.
- Fan offset was set to "increased cooling."

### Summary

These solutions went through hundreds of hours of testing and engineering to provide the most optimal and reliable configuration for the HP and SanDisk SQL Server Data Warehouse Fast Track Reference Architecture. The HP DL380 Gen8 Server and HP LE PCIe Workload Accelerators delivered more than 5,000 MB per second of consistent database performance while providing exceptional reliability. Deploying the HP LE PCIe Workload Accelerator as the Fast Track storage simplifies storage configuration by reducing the importance of sequential I/O, as evangelized in previous Fast Track Data Warehouse Reference Architectures.

With a rated user capacity of 28 TB and 45 TB, these 2U configurations deliver the optimal mix of performance and data capacity, which reduces the need to scale your data warehouse. In fact, these solutions allow for massive database consolidation projects, allowing your organization to save on licensing costs as well.

These HP DL380p Gen8-based, Microsoft certified Data Warehouse Fast Track Reference Architectures with the HP LE PCIe Workload Accelerator delivers industry-leading, breakthrough performance with database read throughputs of more than 5000 MB per second, and the ability to host large data warehouses or a consolidation of data warehouses in a small footprint. Compared with previously released data warehouse solutions, these solutions combine all the benefits of the HP DL380p Gen8 Server with the HP LE PCIe Workload Accelerator built with the latest SanDisk-based ioMemory flash technology. The result is two Microsoft SQL Server 2014 Data Warehouse solutions with new levels performance densities and the flexibility to cost-effectively scale according to data warehouse needs.

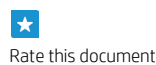
The results highlight how HP and SanDisk can deliver enterprise-level solutions that serve as the foundation for data warehouse or database consolidation projects.

## Bill of materials

| SKU                        | Description  | Quantity |
|----------------------------|--|----------|
| <b>28 TB configuration</b> |  |          |
| 653200-B21                 | HP ProLiant DL380p Gen8 8 SFF Configure-to-order Server                                  | 1        |
| 715224-L21                 | HP DL380p Gen8 Intel Xeon E5-2697 v2 (2.7 GHz/12-core/30 MB/130 W) FIO Processor Kit     | 2        |
| 708643-B21                 | HP 32 GB (1 x 32 GB) Quad Rank x 4 PC3-14900L (DDR3-1866) Load Reduced CAS-13 Memory Kit | 24       |
| 775670-B21                 | HP 2.6 TB HH/HL Light Endurance PCIe Workload Accelerator                                | 4        |
| 652611-B21                 | HP 300 GB 6G SAS 15K rpm SFF (2.5-inch) SC Enterprise three-year Warranty Hard Drive     | 8        |
| 684208-B21                 | HP Ethernet 1 Gb four-port 331 FLR FIO Adapter   | 1        |
| 656363-B21                 | HP 750 W Common Slot Platinum Plus Hot Plug Power Supply Kit                             | 2        |
| 663476-B21                 | HP 2U FIO Friction Rail Kit  | 1        |
| 755996-B21                 | Windows Server® 2012 R2 Standard Edition 2P Pre-Installed on ProLiant servers            |          |
| <b>55 TB configuration</b> |  |          |
| 653200-B21                 | HP ProLiant DL380p Gen8 8 SFF Configure-to-order Server                                  | 1        |
| 715224-L21                 | HP DL380p Gen8 Intel Xeon E5-2697 v2 (2.7 GHz/12-core/30 MB/130 W) FIO Processor Kit     | 2        |
| 708643-B21                 | HP (1 x 32 GB) Quad Rank x 4 PC3-14900L (DDR3-1866) Load Reduced CAS-13 Memory Kit       | 24       |
| 775672-B21                 | HP 5.2 TB FH/HL Light Endurance PCIe Workload Accelerator                                | 4        |
| 652611-B21                 | HP 6G SAS 15K rpm SFF (2.5-inch) SC Enterprise three-year Warranty Hard Drive            | 8        |
| 684208-B21                 | HP Ethernet four-port 331 FLR FIO Adapter  | 1        |
| 656363-B21                 | HP Common Slot Platinum Plus Hot Plug Power Supply Kit                                   | 2        |
| 663476-B21                 | HP 2U FIO Friction Rail Kit  | 1        |
| 755996-B21                 | Windows Server 2012 R2 Standard Edition 2P Pre-Installed on ProLiant servers             |          |

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