

HP recommends Windows.



DecisionSpace® Desktop performance studies on HP Z Workstations

Configuration tips for performance

Introduction

The intent of this document is to provide information that will aid in selection of HP Workstation configurations for running DecisionSpace® Desktop from Halliburton/Landmark Software and Services. A performance study was completed with some applications in the R5000.8.1 DecisionSpace® Desktop suite. We first summarize the new technologies found in HP Workstations. Next we show relative performance results from detailed DecisionSpace® Desktop workloads that take advantage of the new technologies in HP workstations. Finally, we recommend configurations of the new HP Z1, HP Z220, HP Z420, HP Z620, HP Z820 workstations, including considerations for running the entire solution at ultimate performance.

What type of application is the DecisionSpace® Desktop workspace?

The DecisionSpace® Desktop workspace comprises a vast suite of tools that geophysicists, geologists, earth modelers and well planners rely on to collaborate, evaluate and develop assets. Because the workflows involved may have very large datasets or require intensive visualization, the applications may be very demanding of workstation resources. As is evident by the performance improvements shown below, many DecisionSpace® Desktops applications are nicely optimized to exploit the latest technology performance advancements, thus allowing customers to realize more value from their workstation deployments.

How do the new HP workstations provide an ultimate experience for demanding workflow?

Compute performance is improved over previous-generation Intel® processor-based workstations. The new HP Z420, HP Z620 and HP Z820 workstations utilize the Intel® Xeon® processors E5 Sandy Bridge family with the Intel C602 chipset. The HP Z1 workstation utilizes the Intel Xeon processor E3 family and the Intel PCH C206 chipset. The HP Z220 workstations utilize the Intel Xeon processor E3v2 family or Intel Core™ i7 processor or Intel Pentium® processor and Intel PCH C216 chipset.

Memory bandwidth and latency is improved. Memory speeds have been increased from 1333Mhz to 1600Mhz. The HP Z620 and HP Z820 have Dual QPI links in parallel with up to 8GT/s to improve bandwidth across dual-processor NUMA nodes. Memory design is improved with either 2 or 4 channels per processor, with each channel enabling additional memory accesses per cycle, resulting in additional bandwidth.

- HP Z1 and HP Z220 supports unbuffered DIMMS and non-ECC unbuffered DIMMS
 - 4 DIMM sockets, 2 channels, 2 DIMMs per channel
- HP Z420 supports unbuffered DIMMs (UDIMM)
 - 8 DIMM sockets, 4 channels, 2 DIMMs per channel
- HP Z620 supports unbuffered DIMMS (UDIMM) and registered DIMMS (RDIMM)
 - 12 DIMM sockets, 4 channels
 - 2 DIMMs per channel – CPU0 – 8 sockets
 - 1 DIMM per channel – CPU1 – 4 sockets

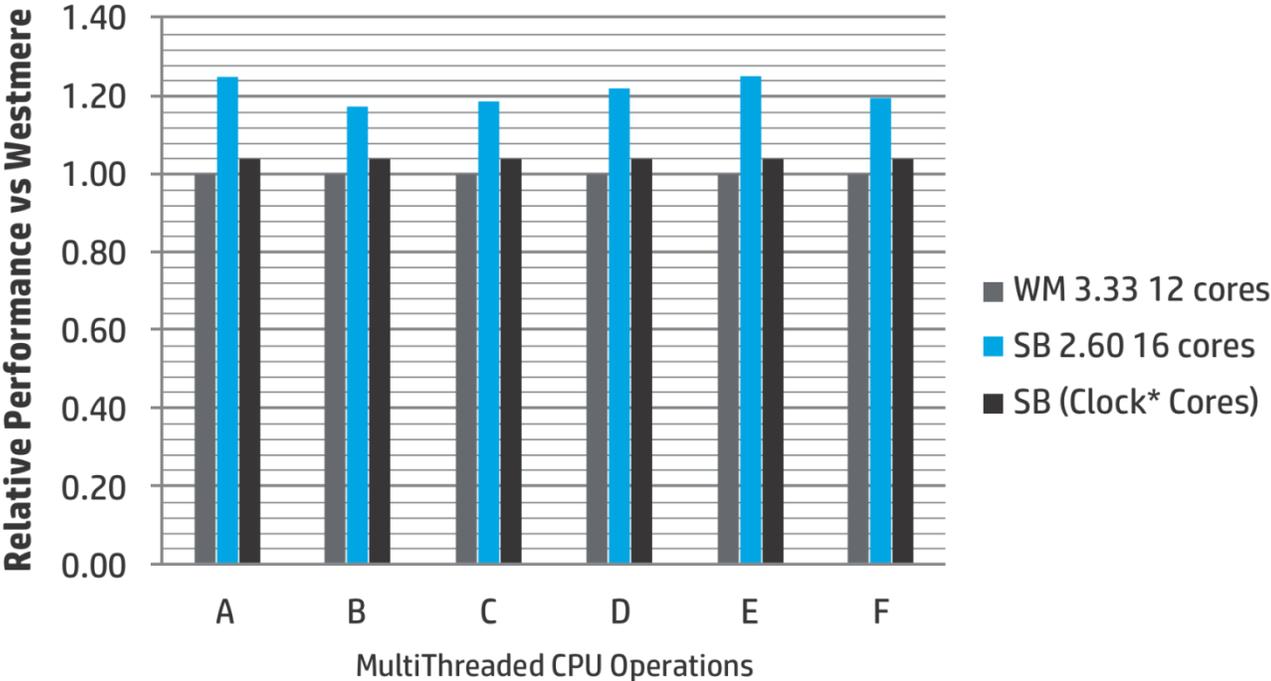
- HP Z820 supports unbuffered DIMMs (UDIMM), registered DIMMS (RDIMM) and load-reduced DIMMS 1333Mhz (LRDIMM)
 - Mixing UDIMM/RDIMM/LRDIMM is not permitted
 - 16 DIMM sockets, 4 channels
 - 2 DIMMS per channel – CPU0 – 8 sockets
 - 2 DIMMS per channel – CPU1 – 8 sockets

Storage I/O performance is improved. The latest systems have increased number of Generation 2 PCI-Express lanes with closer connection to the CPU and Memory subsystem, and this will soon move to Generation 3 PCI-Express for even higher bandwidth. In addition, the IO controllers and storage device interfaces have doubled their bandwidths, now providing 6 Gb/s data rates on both SATA and SAS interfaces. Solid State Drives (SSDs) provide excellent random file-IO performance, and can be configured with RAID 0 stripe to exceed 1Tb volume size. Finally, several flavors of 10Ge NICs have been tested with the new HP workstations for customers needing high-bandwidth access to network storage.

Although Halliburton/Landmark Software and Services typically focus their qualifications on richly-configured Z4/6/8 class workstations, they also qualify high-end HP EliteBook mobile workstations for running their powerful DecisionSpace® Desktop suite. Both the HP Z1 and HP Z220 workstations can provide CPU and IO capabilities as good as those found in high-end mobile workstations.

What DecisionSpace® Desktop performance was measured on HP workstations?

1 – CPU performance via multi-threaded seismic attribute computations



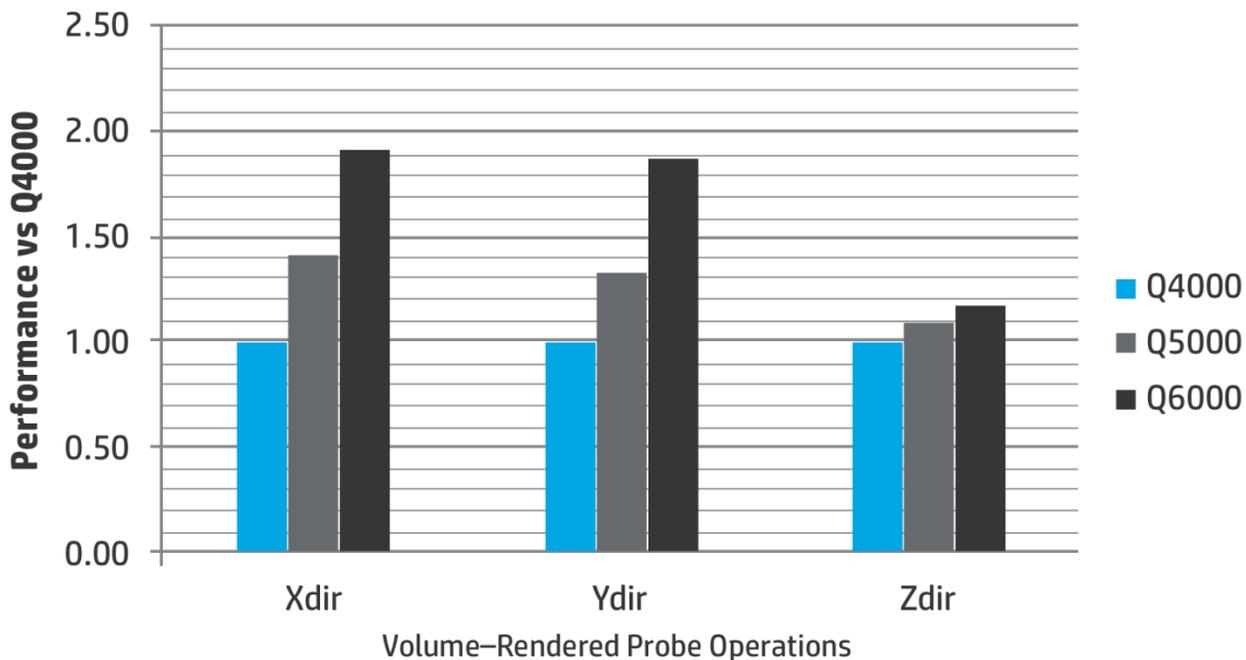
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In order to compare top-end processors in HP Z800 with high-end processors in HP Z820, we use GeoProbe® 5000.8.1 to launch the Seismic Attribute calculations outlined below. Both workstations are configured with >= 12G memory with all memory channels populated in a balanced, optimal fashion. Both are configured with Win7x64sp1 operating system, and NVIDIA® Quadro® 6000 graphics. Each test starts with a synthetic 4G Amplitude seismic volume, and the following six attribute calculations operations are done on the entire volume:

- A. Semblance, default settings (12 samples, 9 traces)
- B. Multiple, default settings (InstAmp, Freq, Phase)
- C. Instant Amplitude, default settings
- D. Salt Detect, default settings
- E. Phase, default settings
- F. Frequency, default settings

When reading the results above, the GREY color bar represents Intel® (Westmere) 3.33GHz X5680, BLUE represents Intel (SandyBridge) 2.60GHz E5-2670, and BLACK represents a theoretical comparison between the two processors based solely on cores and clock-rate. In this theoretical comparison, we expect HP Z820 E5-2670 to be 4% faster than HP Z800 X5680 **assuming** perfect CPU scaling. It is a testimony to Landmark's efficient coding and compilation that their codes scale better than 4% using the new Intel SandyBridge processors.

2 – Graphics performance via volumetric box probe roaming measurements



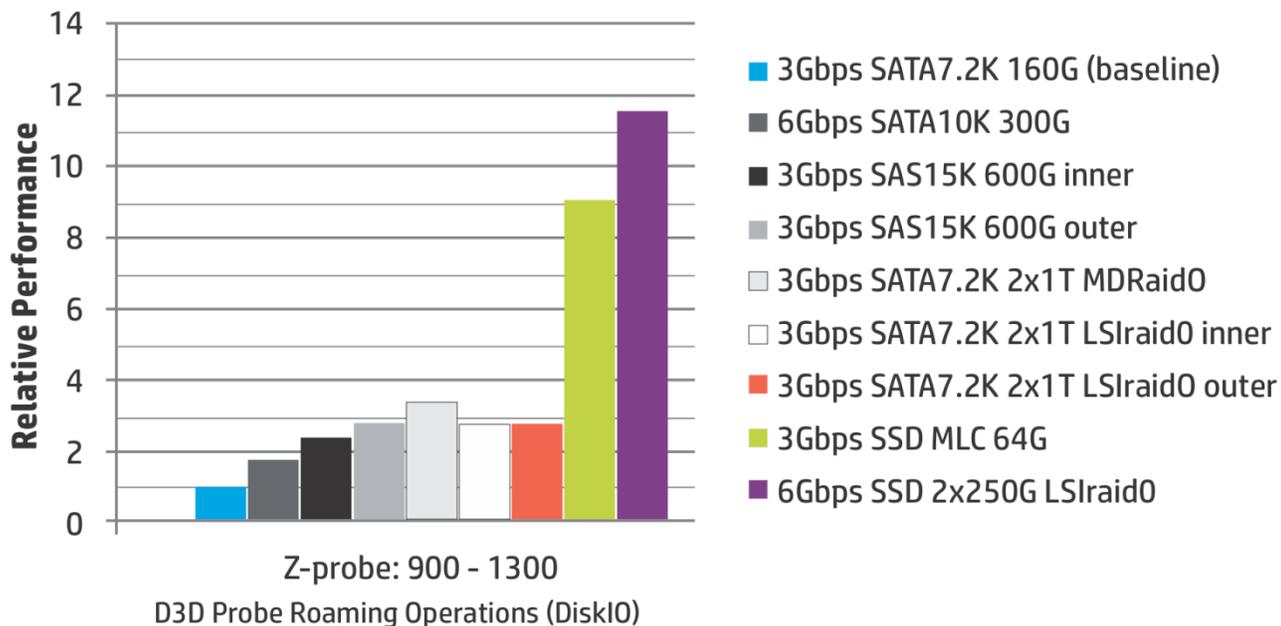
To compare top-end graphics cards, we time how long it takes to roam (play) a volume-rendered box probe, repeating the same operations on NVIDIA Quadro 4000, 5000, and 6000 graphics cards. The cards, each with their latest respective Video BIOS, are physically swapped into the same system to ensure that the graphics card is the only variable that changes. These measurements are taken using GeoProbe® 5000.8.1 running on a HP Z820 with Win7x64sp1, using 296.70 graphics driver. The state restore loads the same synthetic 4G Amplitude seismic volume which was used in the previous CPU performance section. This volume has the following characteristics: (X) 3735 slices, range 283 – 34; (Y) 2520 slices, range 5 – 172; (Z) 480 slices, range 1834 – 876.

The view, as stored in the state, is rotated ~30 degrees around vertical (Y) and ~20 degrees around horizontal (X) so that three faces of the semi-transparent probe are always clearly visible. The timed probe roaming operations are as follows:

- Xdir : full extent in Y and Z, 38 in X, right to left
- Ydir : full extent in X and Z, 27 in Y, back to front
- Zdir: full extent in X and Y, 240 in Z, Z top to bottom

Note that Landmark uses advanced multi-threaded techniques for their visualization operations to deliver optimal interactivity for their customers' visualization tasks. This characterization does not account for all of the other optimizations Landmark has put in place for visualizing wells, horizons, faults, geobodies, and other surface and subsurface structure representations. So, for example, NVIDIA® Quadro® 6000 versus 4000 may show even greater benefit when visualizing some customer's detailed, complex structures. Also note that Landmark has made their powerful visualization capabilities available across their DecisionSpace® Desktop suite.

3 – Multi-threaded disk IO Measurements



Depending on the use case, large datasets may need to be stored locally. In this case, we measure how DecisionSpace® Desktop stresses the IO subsystem when reading seismic data from disk using Landmark's D3D data volume format. Using GeoProbe® 5000.8.1, we pull data simultaneously from three ~13G D3D volumes; their combined size exceeds our physical memory size and we always pull new data so that file system caching to memory is not a factor. The D3D volumes are generated from our original synthetic 4Gbyte Amplitude volume by applying Semblance and Frequency attribute calculations to generate two new volumes, then converting all three to D3D format volumes. For these comparisons, the OS disk stays the same and we vary which disk contains the project with the D3D volumes. All non-OS disks are built using the same MBR DOS partitioning tools, and the same EXT3 mke2fs command options. We do this on RHEL5.8 because we can obtain consistent disk IO measurements by easily purging file system cache between tests. (With this workload, Win7 with NTFS seemed to incur significant overhead; since we could do the comparisons easily with RHEL5.8, we did not investigate further to understand if this was a side-effect of NTFS inefficiencies, or some Win7 feature like SuperFetch getting in the way.)

The hardware configuration consists of HP Z820, NVIDIA® Quadro® 4000 with 296.70 driver, and all disks are attached to onboard LSI controller (6Gb/sec links possible, either SAS or SATA). From a common state file, we load all three D3D volumes and populate each volume with an X-, Y-, and Z-plane probe, all at one end of the volume's respective axis. We then use Probe Control to start

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playing all X-planes, then all Y-planes, then all Z-planes -- all nine planes are moving simultaneously through all three D3D volumes. We then measure the time it takes for the 3rd Z-plane to move from position 900 to 1300. Landmark uses advanced multi-threaded techniques to fetch all planes, so many CPU cores are busy reading and formatting data for display.

As seen in the chart above, there is a very large improvement going from 3Gb/sec SATA HDD to SSDs – this is expected because the reads are very random, and SSDs excel significantly over HDDs when handling random reads and writes.

HP Workstation recommendations for running R5000 OpenWorks® and DecisionSpace® Desktop

Interpreters frequently make simultaneous use of multiple applications to complete their tasks. Multi-core CPUs provide limited benefit in this situation because the number of truly simultaneous operations is limited. However, Landmark has made many aspects of their DecisionSpace® Desktop suite multi-threaded, so those applications will benefit from processor core availability. The primary user interface is dominated by a single thread but easily spawns other threads when there is work to do. As the threading model of DecisionSpace® Desktop is relatively ubiquitous, and interpretation workflows and operations from different disciplines blend easily within DecisionSpace®, multi-core benefits best correlate to dataset size, rather than specific kinds of interpretation workflows. A small number of cores may suffice if your projects easily fit within 16GB, and your use of shared memory for multiple 3D seismic volumes is limited.

- Suggested workstation configurations include (“G” means GHz, “tb” means maximum GHz with TurboBoost):
 - HP Z1 with Windows 7 Professional 64-bit; Intel® Xeon® E3-1245 4-Core 3.3G/3.7tb, 16 GB memory, SSD boot, 2nd HDD 500Gb, Quadro 4000M
 - HP Z420 with Windows 7 Professional 64-bit; Intel® Xeon® E5-1660 6-Core 3.3G/3.9tb, 16 GB memory, SSD boot, 2nd HDD 1Tb, Quadro 5000
 - HP Z220 with Windows 7 Professional 64-bit; Intel® Xeon® E3-1280v2 4-Core 3.6G/4.0tb, 16 GB memory, SSD boot, 2nd HDD 1Tb, Quadro 2000
 - HP 8570w/8770w with Windows 7 Professional 64-bit; Intel® Core™ i7 4-Core, 16 GB memory, SSD boot, 500G 2nd HDD, Quadro K2000M/K4000M
- As project size and use of shared memory seismic grows, the highly multi-threaded operations in DecisionSpace® Desktop look for additional power. Within DecisionSpace®, even simple operations such as inspecting a graphic scene or loading data into the session (which can open multiple database connections), may use multiple threads to accelerate task completion. Computationally-heavy operations such as volume attribute calculations, multiple probe visualizations, simulations, seismic view rendering, and Dynamic Framework surface construction can scale with more powerful workstations. Some recommended workstation configurations for more intensive workflows are:
 - HP Z420 with Windows 7 Professional 64-bit; Intel® Xeon® E5-1650 6-core 3.2/3.8tb, 32 GB memory, SSD boot, 2nd HDD 1Tb, Quadro 4000
 - HP Z620 2x with Windows 7 Professional 64-bit; Intel® Xeon® E5-2643 4-core 3.3/3/5tb, 64 GB memory, SSD boot, 2nd HDD 1Tb, Quadro 5000
 - HP Z820 2x with Windows 7 Professional 64-bit; Intel® Xeon® E5-2680 8-core 2.7/3.5tb, 128 GB memory, SSD boot, 2nd HDD 1Tb, Quadro 6000
- Memory size is critical. For best performance, use the same size of memory on each channel, and the same total memory size on each CPU. A rule-of-thumb is to have memory size = Max Total Input Dataset Size (Gbytes) * 2.5 -- to hold the initial datasets, visualization data structures, new or imported modeling data, and any new refinements or filtered data created by the user as their workflow progresses. Add additional memory to account for workflows utilizing multiple applications.
- Landmark currently recommends Windows 7 64-bit Service Pack 1 or Red Hat® Enterprise Linux® version 5.8.
- Windows 7 and Red Hat® use physical memory for dynamic file system buffer cache when available. The buffer cache attempts to mitigate slower Disk I/O transactions; if the same portions of files are read repeatedly, significant performance improvement may be realized when the OS has physical memory available to cache these reads from storage.
- HP Z420, HP Z620 and HP Z820 chipset has 6 Gb/s and 3 Gb/s disk I/O ports. The 6 Gb/s I/O ports are recommended for 6 Gb/s devices. 3 Gb/s devices will negotiate 3 Gb/s protocol when plugged into 6 Gb/s ports
- 6 Gb/s SSD drive(s) for operating system and application data (cache).

OS and BIOS settings for running DecisionSpace® Desktop 5000.8.1

Operating System	Level	Control Panel/Power Options
Windows 7 Professional 64-bit ¹	Service Pack 1	High Performance
Red Hat® Enterprise Linux® 5 64-bit	Update 8	default

BIOS Setting	Default	Recommend
Power/OS Power Management/Runtime Power Management	Enable	Enable
Power/OS Power Management/Idle Power Savings	Extended	Normal
Power/OS Power Management/Turbo Mode	Enable	Enable
Advanced/Device Options/Hyper-Threading	Enable	Disable ²
Advanced/Bus Options/NUMA (HP Z620 and HP Z820 Dual processor)	Enable	Enable

¹ For Windows7 deployments, HP Performance Advisor can affect BIOS settings and help characterize any workflows as they are in progress – CPU, graphics, and memory usage. See hp.com/go/performanceadvisor

² If Hyper-Threading is enabled, a few multi-threaded calculations may realize a performance increase, and the rest of the solution should perform about the same.

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