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SYSTEM	**HIGH PERFORMANCE COMPUTING FACILITIES**
TITLE	**CONFIGURATION TESTING AND PERFORMANCE EVALUATION OF NEW WORKSTATIONS**

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SUMMARY

As part of setting up a new workstation facility at Computer Centre twenty four numbers of high-end workstations have been procured. It is important to test the hardware configuration for finding out any mismatch with the required specification or malfunction. The evaluation of performance using benchmark tools is also help us in ensuring the functionality of the system. This internal report briefly explains about the high-end workstations configuration testing and the evaluation of the performance using benchmark tools.

Configuration testing and performance evaluation of new workstations

1. Introduction

The Engineers from various groups of IGCAR require High-end graphics workstations for their 3D modeling, pre-processing and post-processing analysis. They use applications like ANSYS, ABAQUS and COMSOL etc. High-end graphics workstations are most suited for running this high-end application software. These workstations will help the Engineers / Scientists of IGCAR to work with as front end machines for developing and running graphics intensive applications. As part of setting up a new workstation facility at Computer Centre twenty four numbers of high-end workstations have been procured. It is important to test the hardware configuration for finding out any mismatch with the required specification or malfunction. The evaluation of performance using benchmark tools is also help us in ensuring the functionality of the system. This internal report briefly explains about the high-end workstations configuration testing and the evaluation of the performance using benchmark tools.

2. Detailed specification of the workstation

The make and model number of twenty four numbers of Intel Xeon based High-end workstations is Dell Precision 7920 and the detailed specification of each workstation is shown in table 1.

S.No	Item	Specification
1	Processors	2 Nos Intel Xeon Gold 6136 3.0 GHz ,3.7 GHz Turbo, 12C, 10.4GT/s 3UPI, 24.75Mcache, HT(150W) DDR4-2666Mhz
2	Memory	128 GB (8 x 16 GB) 2666 MHz DDR4 RDIMM ECC 24 DIMM Slots (12 DIMMs per CPU)
3	Chipset	Intel C621
4	Motherboard	Dell
5	Hard Disk Drives	1 No. X m.2 512GB PCIe NVMe Class 40 Solid State Drive (SSD) x16 Card (bootable) 6 Nos x 2.5" 1.2 TB 10K SAS 12Gbps Hard Drive
6	Storage Controller	Mega RAID SAS 9460-16i 12Gb/s PCIe SATA/SAS HW RAID Controller (4GB Cache) Hardware RAID 0.1.5.10
7	Video/Graphics	NVIDIAQuadroP5000 16GB, 4DP, DL-DVID. Video card would support 4k Display and required accessories would be supplied along with the card. It would have Display port / DVI interfaces
8	Network Interface	2x 1Gbps Gigabit network controller ports
9	I/O Slots	All slots PCIe Gen 3: (2) PCIe x16, (2) additional x16 slots with 2nd CPU; (1) PCIe x8 open ended, (1) x16 wired as x4, (1) x16 wired as x1

10	Ports / Interfaces	Front -2 - USB 3.1 Gen1 TypeA, 2 - USB 3.1 Type C 1-Universal Audio Jack, Up to 4 x 4 PCIe slots in PCIe enabled chassis for M.2 and U.2 (future) PCIe SSDs, Internal - 1 - USB 2.0, 1-2 x5 USB 2.0 header (requires 3rd party splitter cable to support 2 x USB 2.0 type A ports), 8 - SATA @6Gb/s plus 1 SATA for optical, Rear - 6 - USB 3.1 Gen1 Type A, 1 - Serial, 2 - RJ45 Network, 1- Audio Line out, 1 - Audio Line in / Microphone
11	Optical Drive	8x DVD-/+RW 9.5mm Optical Disk Drive
12	Power Supply	1400 W 90% Efficient, EPEAT Gold, 80 Plus Gold Power supply, Input Voltage range100-240 VAC power at frequency of 50Hz / 60 Hz
13	Monitor	1 No x Dell UltraSharp 27 4K Monitor - U2718Q: Aspect Ratio (native) : 16:9 and panel type IPS, Viewing Angle (h/v) : 178/178 Resolution : 3840 x 2160 pixels or higher, Video Input Support: 1 x DP (ver. 1.2), 1 x mDP (ver. 1.2), 1 x HDMI (ver. 2.0) , 1 x USB 3.0 port - Upstream 4x USB 3.0 ports, including 2 x USB 3.0, BC1.2 charging capability at 2A (max), Color Support: Color Gamut (typical): 99% sRGB 1.07 billion colors
14	Keyboard & Mouse	Dell Wired Keyboard KB216 Black and Dell Wired Mouse MS116 Black
15	Supported Operating Systems	Windows 7, 8.x, 10 pro and Red Hat Enterprise Linux 7.x Workstation
16	Operating System	Windows 10 Professional for workstations 64bit (4 cores Plus) The OS loaded on SSD hard disk with Downloaded media

Table 1: Detailed specification of the high-end workstation

3. Configuration testing

The first step is checking the configuration of the workstation against the required specification (given in table 1). The specifications of the workstation like processor, RAM, HDD, graphics card, network adapter and other PCI slots are verified and cross checked. The configuration of the workstations is tested using different ways.

3.1 Configuration testing using Windows Admin tools

Computer Management is a collection of Windows administrative tool used to monitor and manage the devices attached to the computer.

- ***Device Manager***: to view the hardware devices installed in the computer. This gives information about most the system devices, ports and PCI slots. Screen shot is attached in figure 1.

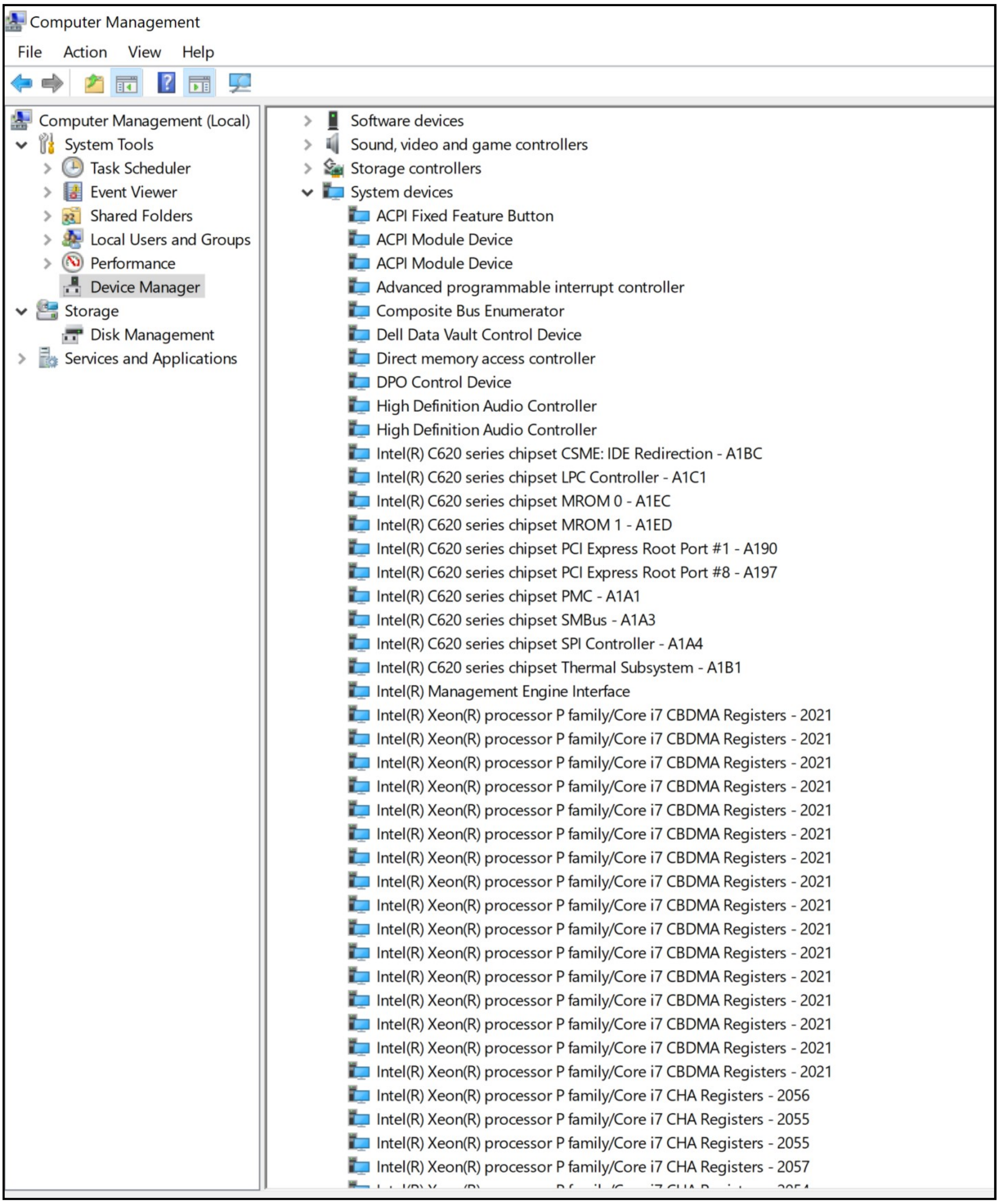

Figure 1: system configuration details using computer management

3.2 Configuration testing using DirectX Diagnostic Tool

This tool displays the machine's important hardware details which are shown in figure 2. They are grouped under four categories.

- ***"System"*** tab represents the information about hardware details (processor, RAM) with BIOS version
- ***"Display"*** tab shows important information which pertains to the display device/s that are attached to the machine. This information includes the name of the video card, its manufacturer, the currently set resolution
- ***"Sound"*** tab displays information about your computer's audio device, its manufacturer and the drivers that are currently installed for it
- ***"Input"*** tab displays information about the input devices such as mouse keyboard and others input devices that are attached to the computer

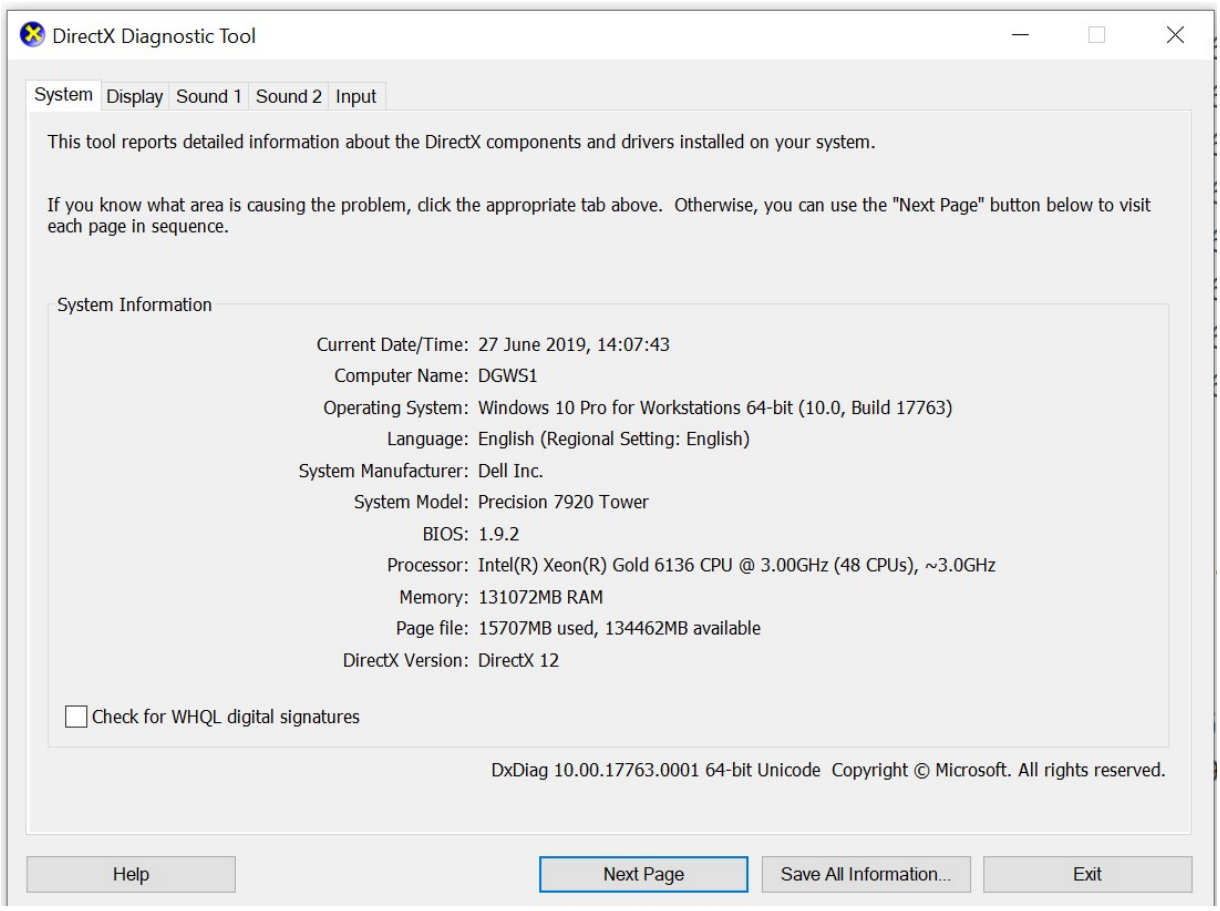

Figure 2: system configuration details using directX diagnostic tool

3.3 Configuration testing using SiSoftware Sandra

It is a robust package provides diagnostic tools for checking the system configuration. The information about the CPU, GPGPU, chipset, video adapter (GPU), ports, printers, sound card, memory, network, Windows internals like .NET and Java also listed using this tool. Figure 3 depicts the configuration details of the workstation using SiSoftware sandra tool.

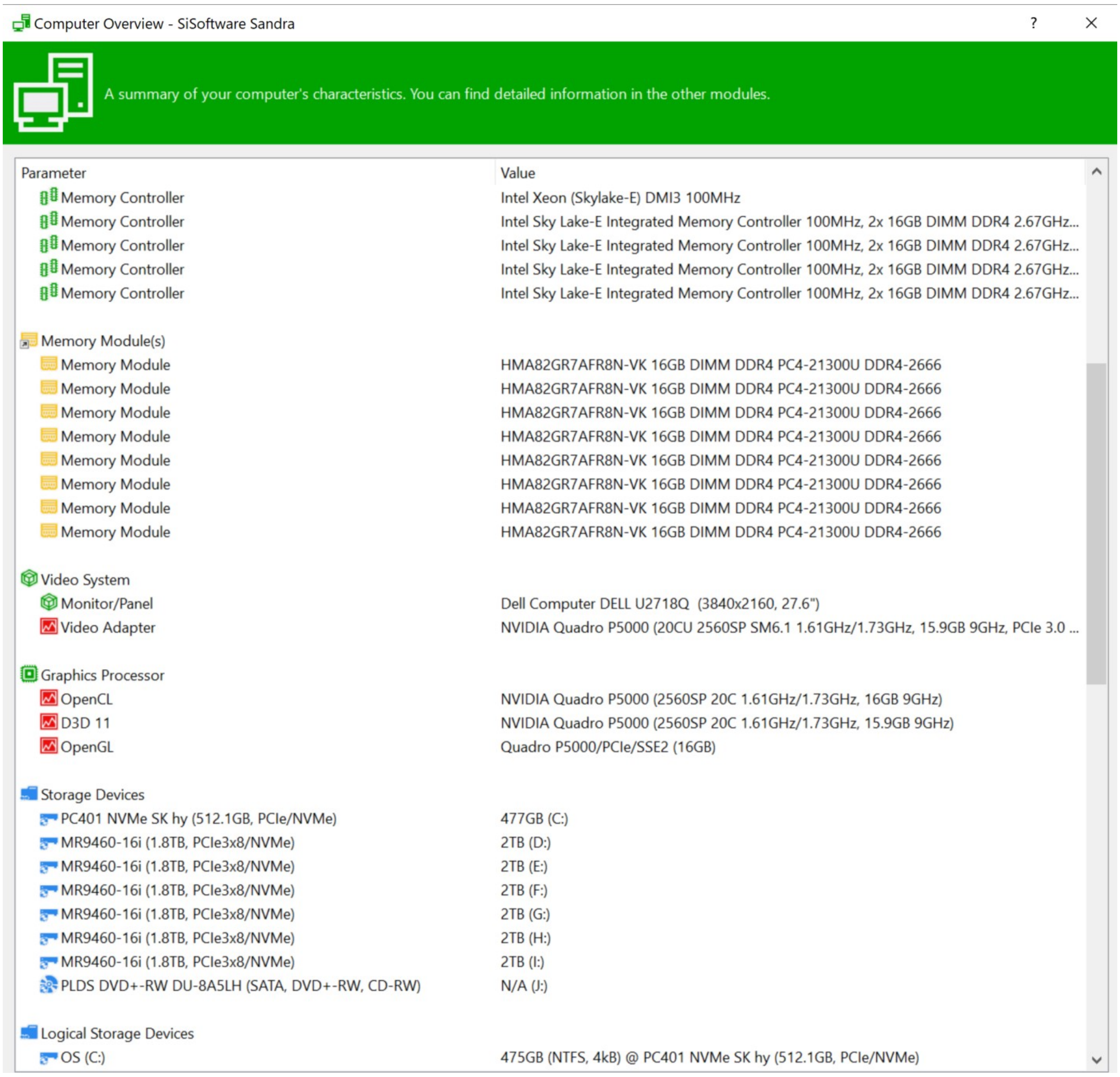

Figure 3: system configuration details using SiSoftware Sandra tool

4. Performance evaluation of workstation using Benchmark tools

Benchmark is a software tool which gives a well-defined overview of the internal components of the computing system. The performance of important resources such as processor, hard drive, RAM, GPU are obtained from the benchmark results. For evaluating the performance of the new workstations third party benchmark tools are used and made run in all the workstations. The results are captured and tabulated to analyze the performance between the workstations. The benchmark tools used for performance evaluation of twenty four numbers of workstations are:

- PassMark PerformanceTest
- 3D Mark PerformanceTest
- PC mark PerformanceTest
- SPECWorkstation Benchmark

4.1. PassMark PerformanceTest

PassMark PerformanceTest is a fast, easy to use tool for PC speed testing and benchmarking. It allows objectively benchmarking a PC using a variety of different speed tests and comparing the results to other computers. Thirty two standard benchmark tests are available in PassMark PerformanceTest. They are further classified into five test suites as follows:

1. CPU tests: Mathematical operations, compression, encryption, physics
2. 2D graphics tests: Vectors, bitmaps, fonts, text, and GUI elements
3. 3D graphics tests: DirectX 9 to DirectX 12 in 4K resolution; DirectCompute & OpenCL
4. Disk tests: Reading, writing & seeking within disk files + IOPS
5. Memory tests: Memory access speeds and latency

Test results of passmark test are shown in Table 2. A graph is drawn as shown in Figure 4 to compare the performance between the workstations.

4.2. 3D Mark PerformanceTest

3D Mark benchmark program mainly focuses on graphics performance of the high-end workstation. The scores of the two different modules of 3D mark are listed in Table 3 and respective graphs are shown in Figure 5 and Figure 6.

4.3 PC mark PerformanceTest

PC Mark is a performance test program that provides organizations with a complete assessment of the system performance with respect to office work tasks. This covers a wide range of activities from everyday productivity tasks to demanding work with digital media content. The results of the PC mark are shown in Table 4. Figure 7 depicts the comparison chart of workstation scores.

Workstation Name	PassMark Test					
	CPU Mark	2D Mark	3D Mark	Memory Mark	Disk Mark	Total
DGWS-1	30882.5	782.1	11199.7	2709	18075.5	6338
DGWS-2	30978.6	777.8	11423.1	2679.4	18856	6538
DGWS-3	30896.7	763.2	11326.4	2691.5	18312.9	6468
DGWS-4	31023	775	11791	2756	19353	6598
DGWS-5	30755	776	11980	2728	18537	6524
DGWS-6	31020	766	11328	2730	18251	6100
DGWS-7	31044	781.9	12309	2728	18060	6460
DGWS-8	30908.3	778.5	10942.4	2678	17935.5	6460
DGWS-9	31030.4	778.8	11419.1	2708.9	19491.1	6573.4
DGWS-10	30620.9	781.4	11009.1	2677	17994.7	6344.6
DGWS-11	30404	777.3	11420	2725.1	17841.9	6537.8
DGWS-12	30574.9	791.4	11882.4	2775.4	18470.1	6659.3
DGWS-13	30921	774	11811	2735	18774	6569
DGWS-14	31000	770	11636	2698	18394	6516
DGWS-15	30860	785	11247	2717	18475	6584
DGWS-16	30744	769	11256	2687	18908	6497
DGWS-17	31041	767	11174	2728	19695	6531
DGWS-18	31027	780	11302	2757	19000	6602
DGWS-19	30930	761	11900	2677	17974	6750
DGWS-20	31058	769	11677	2720	18760	6533
DGWS-21	30967	781	11450	2683	19108	6147
DGWS-22	30970.2	779.4	11218.9	2703.3	18123.5	6544.6
DGWS-23	31010.7	787	11904.3	2758.2	19717	6658.2
DGWS-24	31072.3	769.7	11202	2703.5	18633.7	6511.1

Table 2: Results of PassMark PerformanceTest

Workstation Name	3D Mark (Time Spy)			3D Mark (Fire strike)			
	Graphics Score	CPU score	Total	Graphics Score	Physics Score	Combined Score	Total
DGWS-1	6787	6559	6751	19087	14055	8092	16045
DGWS-2	6828	6768	6818	19250	14303	8847	16460
DGWS-3	6800	6849	6807	19073	14364	8828	16368
DGWS-4	6800	6662	6778	18913	14120	8713	16192
DGWS-5	6797	6694	6781	19284	14233	8573	16367
DGWS-6	6741	6836	6755	19270	14086	8654	16359
DGWS-7	6736	6683	6727	19117	14291	9023	16444
DGWS-8	6729	6951	6761	19138	14390	8643	16344
DGWS-9	6778	6764	6775	19211	14341	8608	16362
DGWS-10	6733	6642	6733	19195	16630	8770	16808
DGWS-11	6788	6759	6792	19120	14149	6752	15470
DGWS-12	6783	6653	6763	19015	14071	8979	16329
DGWS-13	6794	6778	6791	19257	14217	8900	16465
DGWS-14	6801	6890	6801	19160	14157	8602	16296
DGWS-15	6754	6804	6761	19075	14306	8914	16387
DGWS-16	6747	6570	6719	19131	14308	8969	16437
DGWS-17	6815	6832	6817	19330	14219	8885	16500
DGWS-18	6805	6806	6805	19171	14170	8897	16407
DGWS-19	6757	6829	6767	19173	14029	8841	16361
DGWS-20	6792	6576	6758	19191	14229	8900	16431
DGWS-21	6784	6623	6759	16406	14142	8999	16406
DGWS-22	6794	6771	6790	19320	14121	9003	16515
DGWS-23	6773	6692	6760	19135	14145	9024	16425
DGWS-24	6848	6819	6843	19366	14204	9103	16592

Table 3: Results of 3D Mark PerformanceTest

Workstation Name	Essentials	Productivity	Digital Content	Total
DGWS-1	7818	5356	8025	4984
DGWS-2	7904	5691	8440	5191
DGWS-3	7824	5898	8415	5230
DGWS-4	8155	5776	8109	5201
DGWS-5	7881	5334	8036	4993
DGWS-6	8112	6290	8480	5422
DGWS-7	7797	5791	8058	5117
DGWS-8	7838	5807	8435	5210
DGWS-9	7894	5711	8461	5199
DGWS-10	8231	5957	8399	5333
DGWS-11	7898	6285	8453	5367
DGWS-12	7797	5748	8497	5196
DGWS-13	7979	6008	8412	5296
DGWS-14	8075	6350	8455	5426
DGWS-15	8015	5689	8343	5194
DGWS-16	7849	6327	7998	5269
DGWS-17	7906	5918	8058	5179
DGWS-18	8159	5755	8411	5259
DGWS-19	7937	6263	8497	5378
DGWS-20	8141	6314	8078	5348
DGWS-21	7811	5805	8052	5124
DGWS-22	7795	5733	8416	5175
DGWS-23	7967	5688	8422	5200
DGWS-24	8072	5987	8056	5234

Table 4: Results of PC Mark PerformanceTest

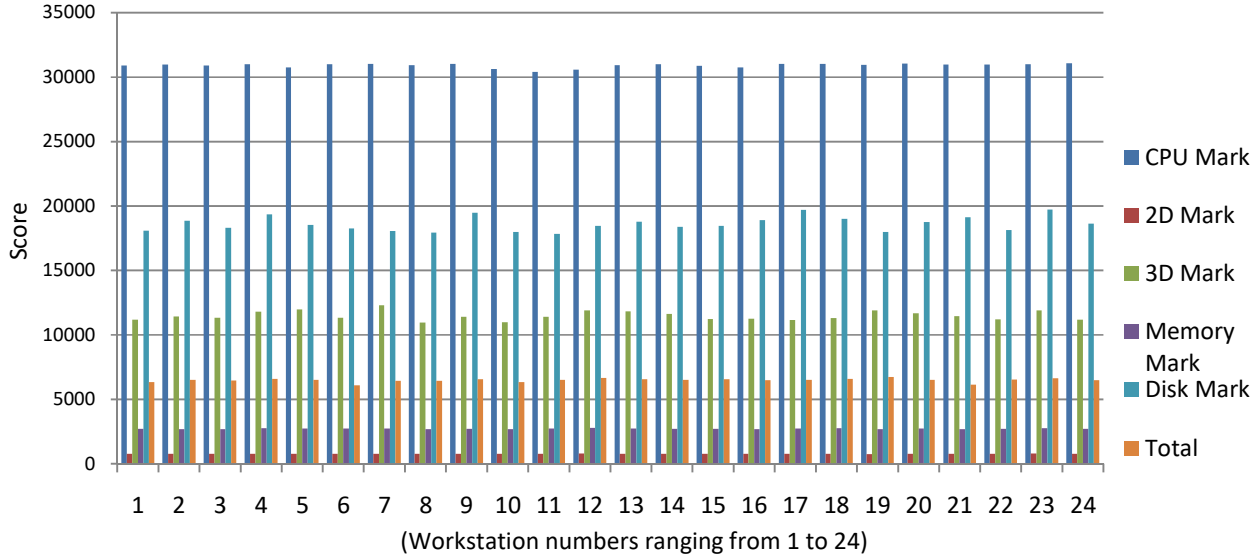

Figure 4: Results of PassMark PerformanceTest

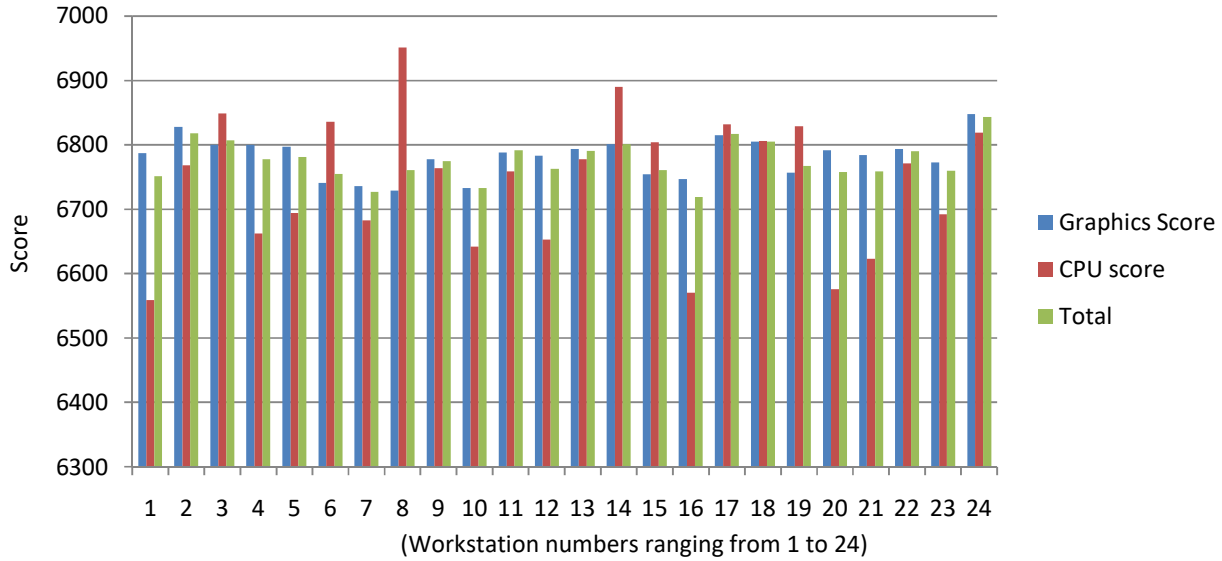

Figure 5: Results of 3DMark (Time spy) PerformanceTest

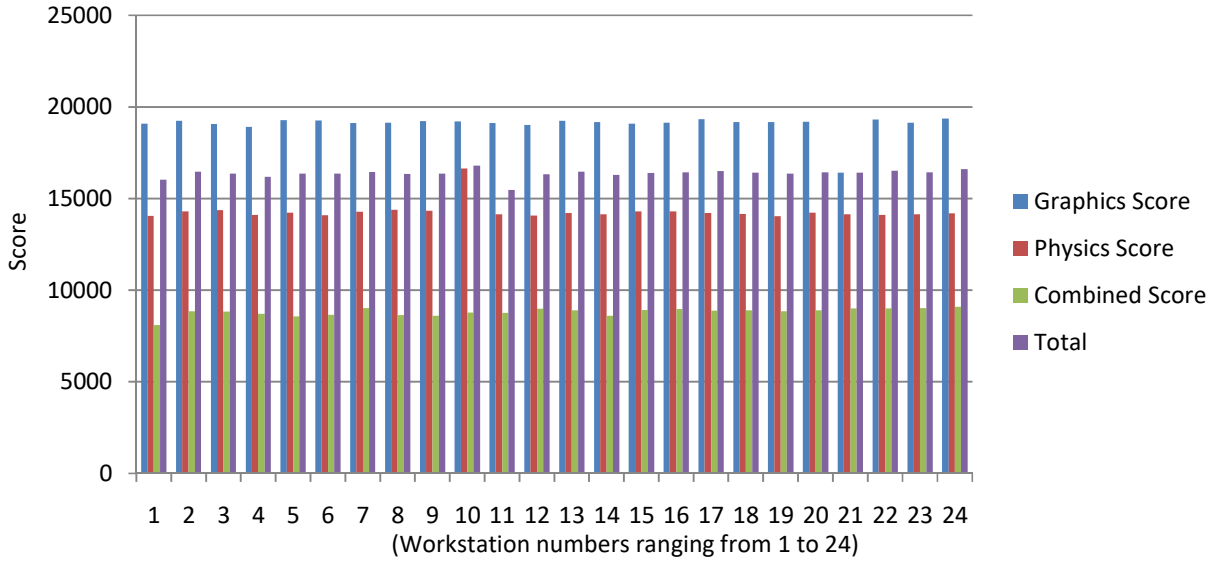

Figure 6: Results of 3DMark (Fire strike) PerformanceTest

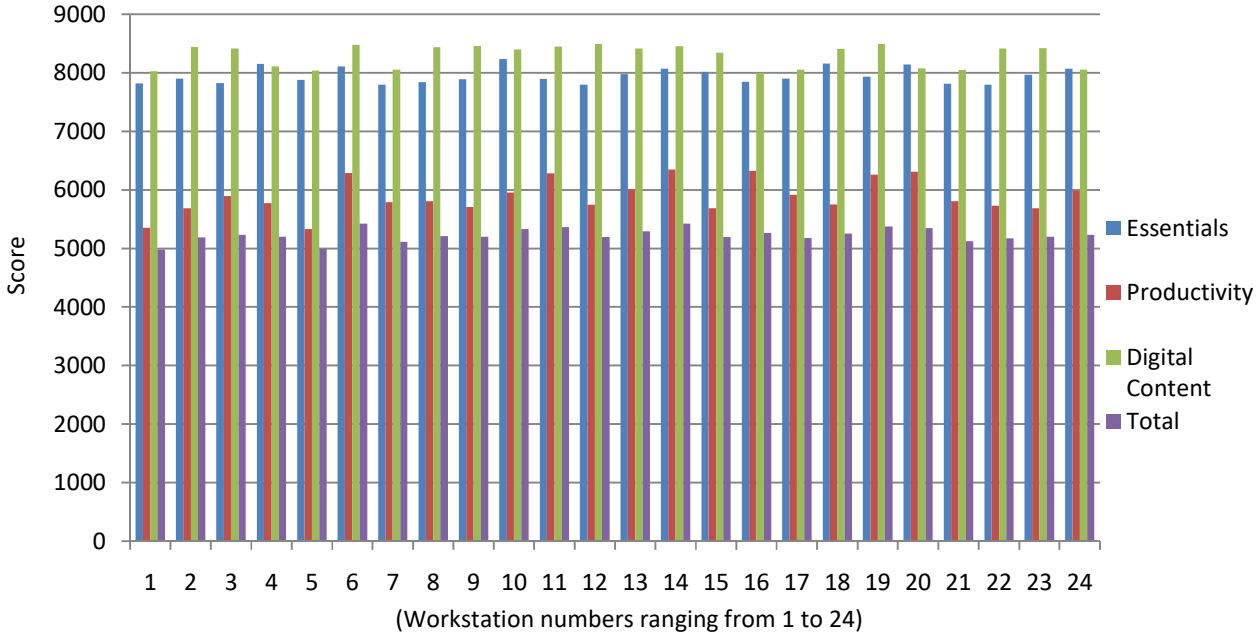

Figure 7: Results of PC Mark PerformanceTest

4.4 SPEC Workstation Benchmark

The SPEC workstation benchmark tests CPU, graphics, I/O and memory bandwidth based on real applications in the following categories: media and entertainment, financial services, product development, energy, life sciences, and general operations. Benchmark scores of the category and subsystem wise workloads for randomly selected workstation are shown in Table 5 and Table 6 respectively.

Category	**SPECWorkstation score**
Media & Entertainment (Total)	**2.91**
Media & Entertainment(CPU)	4.02
Media & Entertainment (Graphics)	1.93
Media & Entertainment (Storage)	1.65
Product Development (Total)	**3.27**
Product Development (CPU)	4.2
Product Development (Graphics)	1.8
Product Development (Storage)	2.8
Life Sciences (Total)	**2.29**
Life Sciences (CPU)	5.48
Life Sciences (Graphics)	0.83
Life Sciences (Storage)	0.46
Energy (Total)	**2.36**
Energy (CPU)	2.32
Energy (Graphics)	2.79
Energy (storage)	2.17
General Operations (Total)	**2**
General Operations (CPU)	1.96
General Operations (Storage)	2.13
GPU Compute (GPU)	**2.39**

Table 5: SPEC Workstation Scores – Category wise

Subsystem	SPECWorkstation scores
CPU	**3.21**
7zip (2 subtests)	3.07
Blender (5 subtests)	2.15
CalculiX (1 subtests)	2.97
Convolution (1 subtests)	5.52
FFTW (3 subtests)	8.61
fsi (3 subtests)	5.22
handbrake (2 subtests)	3.07
Kirchhoff (1 subtests)	5.44
lammps (5 subtests)	5.71
LuxRender (1 subtests)	9.83
namd (3 subtests)	5.18
octave (2 subtests)	1.36
WPCcfd (1 subtests)	8.27
poisson (1 subtests)	1.55
python36 (3 subtests)	1.82
rodiniaLifeSci (4 subtests)	5.56
rodiniaCFD (1 subtests)	3.03
srmp (1 subtests)	0.17
Storage	**1.63**
WPCStorage (60 subtests)	1.63
Graphics	**1.76**
catia-05 (14 subtests)	1.64
creo-02 (16 subtests)	1.31
energy-02 (6 subtests)	2.79
maya-05 (10 subtests)	1.6
medical-02 (8 subtests)	0.83
snx-03 (10 subtests)	1.93
sw-04 (11 subtests)	1.29
3dsmax-06 (11 subtests)	2.33
showcase-02 (4 subtests)	3.52
GPU Compute - OpenCL	**2.39**
LuxRender (1 subtests)	2.27
caffe (3 subtests)	2.27
FAH (2 subtests)	2.66

Table 6: SPEC Workstation Score - Subsystem wise

Tests within the benchmark are scalable, solve large problems, support multiple architectures, and are freely available. The latest version of the benchmark, SPECWorkstation3, has more than 30 workloads containing nearly 140 tests. The workloads are divided by application categories that include media and entertainment (3D animation, rendering), product development (CAD/CAM/CAE), life sciences (medical, molecular), financial services, energy (oil and gas), general operations, and GPU compute. All the workloads are tested in the workstations.

5. Conclusion

Few popular benchmark tools, namely, PassMark PerformanceTest, 3D Mark, PC Mark and SPEC Workstation were installed and tested on workstations machines. From the results of various benchmark tests, it was observed that all the workstations are equally comparable in performance. This indicates that the critical resources of the workstations are healthy and functioning properly. These high-end workstations are capable of fulfilling the computational and graphical requirements of users.