Experiments and Investigations for the Personal High Performance Computing (PHPC) built on top of the 64-bit processing and clustering systems

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Abstract

The motivation and objective for this paper is to demonstrate “Personal High Performance Computing (PHPC)”, which requires only a smaller number of computers, resources and space in the secure wireless home networking (WHN) environment. The PHPC is based on a cluster of the 64-bit AMD machines, which can achieve the following: (a) reducing CPU time by 10% - 50% for a single task; (b) minimizing the memory and hard-disk workload by 50%; (c) running 64-bit software applications successfully; (d) receiving up to 60% better performance in multi-tasking performance; (e) executing fast, robust and accurate calculations, visualization and server-side applications on 32-bit and 64-bit Windows and Linux; (f) ensuring a secure working environment (g) storing a massive amount of data (12 TB, or 12,000 GB) for database and server applications; and (h) successfully integrating with other emerging technologies such as LAN/wireless networks and entertainment systems.

1. Introduction

The 64-bit computing offers distinctive values for high performance computing, and this is strongly supported by the following four experimental results. Firstly, a 64-bit computer performs much better than a 32-bit computer in dynamic multimedia and calculations, where high CPU and memory utilizations are required. A 64-bit computer has up to a 50% better performance than a 32-bit computer in stress testing [1]. Secondly, the “dual-core” 64-bit computer, a computer that has the capabilities for 2 CPUs, which performs between 6% - 42% better than a single-core 64-bit computer in high performance computing. The percentage for improvements can be greatly enhanced, provided that a stable and operational 64-bit software is implemented, and this has better advantages than 32-bit clusters - being mobile, fast, robust and secure [2, 3]. Finally, the dual-core 64-bit computers can successfully integrate with the latest emerging technologies, which include 3-D visualization, .NET and Java Web Services, broadband/wireless networks and home entertainment systems. This paper also demonstrates that integrations can take place in the secure WHN environment.

2. Detailed Experiments

There are four sets of experiments justifying the added values by the 64-bit processing abilities. The relative

performance for a cluster of 64-bit computers was compared with a cluster of 32-bit computers.

2.1 Investigation of CPU time reduction

“CPU time” is a common term used in high performance computing, which refers to either the amount of time taken for a job to be completed, or the duration of time that a task requires [5]. In order to find out (a) as to what extent the 64-bit model reduces CPU time in comparison to a traditional 32-bit model and (b) the percentage for such CPU time reduction, whereby two sets of experiments, one on Java and one on .NET Web Service, were designed and carried out.

2.1.1 Test on Java Web Service

OMII_2.1.0 was used for this part of research. Three tests were carried out and the total time was recorded. The second set of CPU time experimentation is to record the CPU time required whilst running a single GUI-Cauchy job, and later on to record the CPU time required whilst running 100 GUI-Cauchy jobs. The results are summarized in the table below.

CPU time test	64-bit	32-bit
OMII Client to Server	20% quicker	20% slower
GUI-Cauchy (single)	10% quicker	10% slower
GUI-Cauchy (100 jobs)	30% quicker	30% slower

2.2.2 Test on .NET Web Service

The 64-bit .NET e-portal and e-Services were used for this test, which were configured to be 32-bit compatible on the client side and 32/64 bit compatible on the server side. The procedure included creating an account on the client and recording the time when the server replied back for a .NET job request. Another test was to write a simple .NET script that informed the client to run a job on the server and then recorded down the CPU time required. The tests were repeated three times for both experiments, for which the results were shown below.

CPU time test	64-bit	32-bit
Client-Server CPU Time	45% quicker	45% slower
CPU time to complete a task	50% quicker	50% slower

2.2 Executing fast, robust and accurate calculations, visualization and server-side applications on 32-bit and 64-bit Windows and Linux

Both the 32-bit and 64-bit models can offer robust and accurate calculations (C++ and Visual C++),

visualization (3-D modeling) and server-side applications (64-bit .NET Services and OMII) on 32-bit Windows and Linux. However, unlike the 64-bit cluster, the 32-bit cluster cannot run any robust and accurate calculations, visualization or server-side applications on 64-bit Windows and Linux. Hence, the 64-bit model performs approximately 50% better than the 32-bit model in this scenario.

2.3 Multi-tasking performance

This set of experiments are designed to (a) understand how well the 64-bit and 32-bit clusters can cope whilst simultaneously running several applications, which requires high CPU and memory consumption; and (b) compare the relative performance between these two models. In order to perform this scenario, two sets of test are carried out. The CPU and memory utilizations were recorded every second, and the final results were taken thrice and were based on the combined outcome from the “FreeRAM XP Pro”, “System Log”, “BySoft Free-RAM” and a .NET script. The 64-bit clusters completed all the tasks within 18 minutes. On the other hand, the 32-bit model could not complete the tasks within 25 minutes and at points, a system crash was encountered. To be equally fair, the comparison was taken up to 18 minutes and the better performance of the 64-bit model was up to 60%, as Figure 1 shown below.

Figure 1: 64-bit vs. 32-bit model: % in better

2.4 Integrating with emerging technologies such as broadband/wireless networks and home entertainment systems

There are two groups of emerging technologies under investigation. The first group is “wireless home networking”, which includes wireless network, mobile communication, mobile learning, broadband, and wireless security with 64-bit computing. The second group is “home entertainment systems” which include “VoIP, TV, DVD/movies, MP3/Hi-Fi and gaming”.

Figure 2: Simplified Architecture for wireless home networking

The network protocols for wireless home networking include Wi-Fi, Bluetooth, GPS and 3G, the four of which are the main bodies in the Wireless Local Area Network (WLAN) [4]. The details for implementations and demonstrations of Virtual Organizations are also discussed in that paper. In conclusion, Figure 2 is the architecture for all the system integrations.

3. Conclusion

This paper demonstrates that it is not necessary to build up such a large cluster for high-performance computing, but that a smaller cluster can achieve the equivalent standard provided by the correct ways for (a) reducing CPU time; (b) improving memory and hard-disk workloads; (c) improving multi-tasking performance and finally (d) executing fast, robust and accurate calculations, visualization and server-side applications on 32-bit and 64-bit Windows and Linux. Furthermore, this leads to the new research area: “Personal High Performance Computing” (PHPC), where the specifications, functionalities and integrations with other emerging technologies can be designed, developed and implemented based on individual needs and demands, including the integrations with the home entertainment systems and globally-distributed computing systems. The integrated Windows (x64 Cluster 2003) and Linux (16 different distributions) clusters have been implemented and the demonstration for PHPC will be discussed in details for another paper.

4. References

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- [5] The OMII Software and User Guide, which is accessible via the OMII website: <http://www.omii.ac.uk>.