Cluster Catastronomy - Ryzen HPC Development

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Abstract. *This project, supported by the "Instituto Professor João Margon Vaz," aims to develop a High-Performance Computer, inspired by the renowned "Pegasus IV Project" from University of Science and Technology of Missouri. Our primary objective is to provide computational resources for students and educators engaged in analytical and simulation-based research. Our targets are students from underprivileged backgrounds, who often lack access to greater computing power for complex simulation. Utilizing AMD Ryzen processors, unlike Pegasus's Intel architecture, this pioneering "Cluster Catastronomy," is diskless assembled and have many technology upgrades compared to S&T HPC.*

1. Introduction

This work will describe an under-development High-Performance Computer (HPC), by the Universidade Federal de Goiás (UFCat). The computer was built with collected information about the needs carried by potential users, mainly teachers and students from co-related departments in the academy. All the hardware was donated by "Instituto Professor João Margon Vaz".

The Cluster Catastronomy in development is currently on its final stage, which includes a user-friendly platform for job submission, a file management system for external data gathering, a personal A.I chatbot to assist and support the users, and a suitable refrigeration equipment to maintain the temperature. Also, the reports and benchmarks for the testing stages will be included in the final version of the completion paper.

Part of an "Extension program" called "Catastronomy", this project is a collaboration between the Department of Computer Science, Institute of Physics, and "Instituto Professor João Margon Vaz". The goal is to apply cutting-edge technology while building an equivalent to the University of Science and Technology of Missouri. Beyond replicating Pegasus IV technology, we've adopted the latest Ryzen CPU series for the "Catastronomy Cluster." This choice adapts renowned computational methodologies to the Brazilian context and also aims for advanced software and hardware architecture techniques.

2. Implementation scenario and Justification

In today's technology-driven era, computing plays an inseparable role in our daily lives. Science has also evolved inextricably linked to computing, ushering in significant 21st-century advancements. We daily encounter technology through text editors, calculators, electronic communication, automation, management systems, and more. Scientific research relies heavily on technology, including computational physics, where simulations precede real-world applications.

Decades of research have enabled precise simulations of materials, natural phenomena, and fluid dynamics, even in other fields like medicine, engineering, etc. Historically, computational physics was the first scientific use of modern computers, aligning with both physics and computer science (LANDAU, R. H.; PÁEZ, M. J.; BORDEIANU, C. C. 2015).

The "Cluster Catastronomy" was made upon resources donated by “Instituto Professor João Margon Vaz”. The resources had to be used for hardware acquisition which led us to take advantage of the evolutionary difference available at the time. Unlike the based project, we used up to date AMD processors, SSD disk for Master’s O.S and GPUs for OpenMPI management. Adding to that, it uses a diskless assembly concept for slave nodes, with network distributed booting images to enable the initialization and integration (MERCIER, M. 2019). Employing minimalist concepts, few files are added to the emulated kernel, containing only basic drivers and strictly important files for initialization.

3. Theoretical Foundation

3.1. Socioeconomic and Scientific Impact

The “Associação Nacional dos Dirigentes das Instituições Federais de Ensino Superior” (Andifes) and Universidade Federal da Integração Latino-Americana (UNILA) indicates in its latest study that 70.2% of students in federal universities come from low-income families. According to Meissner, F; Yi, A; Alexander, M; Fey, A; Kirschestein, T; Orologopoulos, N (2021), the component crisis leaded to the largest price increase of the decade for chipsets used in electronic devices. We estimate that computers can cost up to four times a family's income, creating a significant barrier for researchers and forcing them to abandon their projects or perhaps not even try to work on them.

3.2. Regular application and Evolutionary Changes

As pointed by E, Alfianto; A, Sa’diyah; F, Rusydi; I, Puspitasari (2022), the application for Clustering Computing at 21s century is not surprising, as the characteristics of this technology provide significant autonomy in terms of performance and cost-effectiveness. All major institutions and companies around the world employ this model to some extent. The recovering of second-hand hardware and researches in Parallel Computing stimulate this practice. One of the motivations for the development of parallel programs is to accelerate scientific applications as those require a significant of computing capacity and time (LIMA, J. V. F; SCHEPKE, C; LUCCA, N. 2021).4. Development

This work is a collection of data gathered during the entire building process, which means that some details must been kept from public until the final release of the paper.

4. Development

4.1. Technological Evolutions

We do not know why the Pegasus projects used Intel architecture, but we do know that the Pegasus IV benefited by the newest technology available at the time it was built. We chose AMD and also included some implementation not so easily available by the time S&T assembled their computer, such as SSDs, DDR4 RAM, RX6700 XT GPU.

We included newest software versions or even different ones for compatibility and performance purposes. This includes the addiction of AMD packs that are freeware like AOCC, instead of using “Intel Parallel Studio XE for Linux” as Pegasus IV did.

Lima, J. V. F; Schepke, C; Lucca, N. (2021), mentions the importace of it because the compilers combined with the right Message Passing Interfaces (MPI), grant a solid organization of the tasks to be parallelized. Using AOCC have the benefit of being completely freeware and the difficulty for adequation of the acquired S&T source code. The task queue manager that Pegasus used was "Maui Schedule" which is not maintained anymore, so we kept using only the newest version of the Torque Software.

4.2. User-friendly environment

The scientific computation is also known for its complexity, having codes written from scratch. The researchers usually lack extensive knowledge about the nature of the computing environment. As it can be seen at the main Pegasus IV page, the developers recognized that they were Physicists that needed a powerful computer but did not knew how to build one of such extent. That information may be the reason for a few problems found on their project, even so amazingly developed nevertheless.

Like Seskir, Z. C; Umbrello, S; Coenen, C; Vermaas, P. E. (2023), we believe that the science should be democratized and the Cluster Catastronomy carry this ideal. Some of our researchers are even High-School students so, we created a robust “User Area” with tools to help users edit and post their codes/scripts. The user area is a webpage within their personal space capable to verify the undergoing jobs. This environment was mainly created to solve the difficulties experienced on Institutional Networks, which prevent any external access. The known “eduroam” network available at UFCat does not accept any form of direct external connection to the Cluster Catastronomy so we had to buy a hosting subscription, creating instructions to be executed by the cluster in order to track for job scripts in an external FTP folder.

5. Final Considerations

We have embraced the latest Ryzen CPU, adapting renowned computational methodologies to the Brazilian context. Furthermore, the project takes into account the socioeconomic realities in the country. With the ongoing semiconductor crisis causing a significant increase in the prices of chipsets used in electronic devices, it's evident that students in need of computers for their research face many challenges. This, in turn, hampers the progress of analytical-simulation research within the university and the country.

The adoption of Ryzen processors and the implementation of advanced hardware components represent significant advancements in the Cluster Catastronomy. We have

focused on using freeware and open-source resources, like AOCC and newer versions of software to enhance performance. Additionally, the choice of the Torque software for task queue management, as well as the development of a user-friendly environment demonstrates a forward-looking approach to meet the needs of diverse users, including those with limited computational expertise.

This project remains one of the most ambitious and intriguing initiatives undertaken by our researches. While significant challenges and upgrades still lie ahead, we are preparing the Open Beta Test Phase at the beginning of the following year. The Catastronomy Cluster stands as a testament to the university's commitment to advancing technology, research, and education, and we look forward to the opportunities it will bring to researchers and students.

7. References

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