**CLC - I/O System Design Tool and MIPS Assembly**

Alec Utzerath and Angel Velazquez

Grand Canyon University

CST-307

Professor Ricardo Citro

October 11st, 2023

**Introduction/Purpose**

The following project assignment aims to assess and compare the cost and performance of various Input/Output (I/O) systems, shedding light on essential factors that determine the efficiency of these systems. In an era marked by ever-increasing data demands and rapid technological advancements, understanding the pivotal role of I/O systems is crucial. This assignment encompasses two distinct sections. The first part delves into performance evaluation, focusing on identifying the determinants of system performance, pinpointing potential bottlenecks, and proposing modifications to enhance Input/Output Operations Per Second (IOPS). The second part shifts the focus to cost analysis, emphasizing the economic implications of different configurations and exploring opportunities to balance costs between varying disk capacities. Ultimately, this project delves into the intersection of technology, economics, and performance, addressing not only theoretical considerations but also their real-world applicability, providing valuable insights into the multifaceted nature of I/O systems.

**Execution**

The execution of this project will unfold through a systematic and well-structured approach designed to ensure accuracy, efficiency, and a comprehensive understanding of comparative cost and performance in I/O systems. The project will start with an analysis of the default input settings maintaining16 resource utilizations at 100%. This initial phase will provide the baseline data and insights necessary to answer fundamental questions regarding system performance bottlenecks and resource utilization. The subsequent stage will involve meticulous examination and experimentation to identify the key factors that influence the efficiency of the I/O systems under evaluation. Performance enhancement measures will be proposed, and their feasibility will be explored, addressing both theoretical and practical aspects. In parallel, a thorough cost analysis will be conducted, with a focus on understanding the economic implications of different system configurations. The project will conclude by reconciling the dual aspects of cost and performance to provide a holistic view of I/O system management, offering practical insights and solutions to the challenges of optimizing these systems in real-world scenarios. Through a structured and analytical approach, this project aims to provide valuable knowledge and recommendations to inform decision-making in the ever-evolving landscape of I/O technology.

Image 1: Default Maxiumum IOPS Settings

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*List all the links that decided performance of the system. What is the bottleneck in the current system?*

Performance can be influenced by several links within an I/O system. Some of the key links that may decide the performance include:

* CPU
* Main Memory
* I/O bus link
* SCSI Buses

The bottleneck in the current system is the disks followed by the SCSI buses. I determined this by looking for the link with the lowest bandwidth or the slowest component. If all resource utilizations are at 100%, it means that all the links are operating at maximum capacity, and the system's overall performance is limited by the slowest link.

*What can lead to the I/O bus performance to be the bottleneck of the system?*

High data transfer rates are one reason the I/O bus can bottleneck. This happens if the devices connected to the I/O bus require high data transfer rates, and the bus cannot handle the data rate effectively. Shared resources are another reason the I/O bus could bottleneck. f multiple devices share the same I/O bus and contend for bandwidth simultaneously, it can limit the overall performance.

*Make necessary change(s) to the system to increase the performance (IOPS). List all the change(s) made and all other possible changes. Give performance measures in each if possible. Also mention if the method is feasible.*

Image 2: Increased Performance Model

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These are the settings for increasing the perfromance on all of the differen portions such as CPU, main momory, I/O bus, SCSI buses, disks. To even out the and increase the disk space so it isn’t the bottle neck of the system the user can lower the “Average seek time” and increase the “Disk transfer rate”. In the model above the average seek time is 1ms and the disk capactity went up to 2100 GB. This is increased the 100% utilization performance to 6702.5. Increase memory: Adding more RAM can reduce the reliance on storage and improve performance. Measure IOPS with varying memory sizes to find the optimal configuration. It should be noted that when the performance of the system is increase the cost of the materials go up as well.

*What units cost the most in this system?*

In the Default settings the CPU cost has the highest cost at a value of 20000 dollars. The CPU being the most complex of all the parts makes sense that the CPU costs the most money to increase performance. Assuming max utilization the CPU costs $44700. The cost of the IOPs is 15 to 8 dollars for the 80 to 40GB disks respectively. With 3072 IOPS for the 80 GB disk and 6144 for the 40 GB system the total cost can be calculated using the price per IOP above.

80GB disk: total cost of IOPS is $46,080

40GB disk: total cost of IOPS is $49,152

Image 3: Cost of organization in the system

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*What can be done to make the system cost same for both 80GB and 40GB disks? Can it be done?*

Balancing CPU, memory, I/O and SCSI buses, and disks for 80GB and 40GB systems involves careful component selection. Opt for a mid-range CPU, right-sized RAM, and cost-effective buses, aligning performance with budgets. Choose 40GB disks that balance cost and performance while considering bulk purchases. Leverage virtualization and storage efficiency and monitor performance for optimal resource allocation. Cost parity depends on specific needs and hardware options, requiring a thorough cost-benefit analysis.The following image is an example when the 40 GB and the 80 GB system are close in value. It is possible to get the system cost for both the 40 and 80 GB system the same but will cause specific performance differences between them. In the image below the cost of the 80 GB disk system is 51000 and the cost of the 40 GB disk system is 51500.

Image 4: Cost similar for the 40 and 80 GB system

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**Conclsuion**

In conclusion, this project has highlighted the significance of careful and balanced component selection in achieving cost-efficiency while meeting performance requirements. By strategically aligning the CPU, memory, I/O and SCSI buses, and disk configurations, we have demonstrated the potential to create systems with varying storage capacities that share the same overall cost. This approach not only optimizes resource allocation but also underscores the importance of continuous monitoring and performance benchmarking to ensure that systems operate efficiently. In practice, cost parity between different storage options can be attainable with thoughtful planning and analysis, allowing us to make more informed decisions in system design and optimization.