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To What Extend Does Windows Virtual Memory Affect the Performance of Containerized Applications

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1 Background

Virtual Memory (VM) is a feature of modern operating systems like Windows. It swaps out the inactive memory pages to the external storage when the physical memory is low. This allows the system to carry some heavier workloads without having to extend the actual memory size.

However, because of the huge performance gap [1,2] between modern SSDs and modern high-frequency memories, swapping brings noticeable performance impact. This gap is particularly larger in devices using HDDs.

1.1 Containers Increase Memory Pressure

Containerization technologies like Docker creates isolated runtimes for applications to ensure the environment is always correctly configured, while in another aspect, this usually means that containerized applications require more memories to run.

2 Introduction

In the paper I will discuss the performance impact of Windows VM on containerized applications in two aspects:

- Physical memory is (nearly) full and swapping happens frequently,
- Physical memory is sufficient and swapping happends occasionally.

In each of the two aspects, I will:

- Measure the performance of memory-intensive applications like Redis inside Docker containers,
- Measure the performance of disk-intensive apps inside containers, and
- Measure my own program that runs simple but quantitative tasks, inside a container.

2.1 Method of Measurement

For the same application running on different memory conditions, I will first measure the time it takes to complete the task by writing a program that calls their main functions (for example, "`SET ...`" for Redis and "`INSERT INTO ...`" for databases). The CPU usage will also be take into consideration.

Then, as expected, there will be a performance difference between the two conditions. Some applications may be more sensitive to VM than others, that is, they may have a larger performance drop than others. I will try to analyze the reason behind this.

References

[1] V. Mironov, I. Chernykh, I. Kulikov, A. Moskovsky, E. Epifanovsky, and A. Kudryavtsev. Performance evaluation of the intel optane dc memory with scientific benchmarks. In *2019 IEEE/ACM Workshop on Memory Centric High Performance Computing (MCHPC)*, pages 1–6, 2019.

[2] P. Saxena and P. Kumar. Performance evaluation of hdd and ssd on 10gige, ipoib & rdma-ib with hadoop cluster performance benchmarking system. In *2014 5th International Conference - Confluence The Next Generation Information Technology Summit (Confluence)*, pages 30–35, 2014.