DS:255 - System Virtualization
Project Details

This project aims to help evaluate the virtualization mechanisms used in three main stream virtualization technologies, Xen (https://www.xenproject.org/downloads/xen-archives/xen-project-410-series/xen-project-4100.html), KVM (https://www.linux-kvm.org/page/Main_Page) and Docker containers (https://docs.docker.com/). Make sure that you use the PVH mode in Xen and Qemu mode for KVM.

The students will be divided into group of two.

As part of this project each group is expected to install the assigned platform and create two VMs/containers each for Xen, KVM and Docker (based on the platform). The VMs and containers should have equal and same configuration, i.e. same number of CPU cores, same amount of memory, same CPU socket etc. They will also be sharing the same disk and network interface. Each VM/container for each platform will be pinned to independent CPU cores, i.e. the first KVM VM pinned to core 1 and the second one pinned to core 2 in a machine containing at least 4 cores (0, 1, 2 and 3).

It is mandatory that all the described experiments below, are to be conducted on the same system.

In each of the VMs/containers host the following benchmarks (assigned to your group) and execute to measure as stated below:

> 1. For each hypervisor technology report details of the system, hypervisor configuration and VM configuration information.

> 2. Stream benchmark:
> 　　　　Source: https://www.cs.virginia.edu/stream/FTP/Code/stream.c
> Notes: Please read the instructions carefully on setting up the benchmark in relation to your system's RAM and processor cache size. Set omp_get_num_threads to one and ensure that the data array size is sufficiently large to exceed the processor cache size of your virtualized system.

> Report Results:
> a. Case-study-I: Stream performance for your system in non-virtualization mode. This result will be treated as the native platform result.
> b. Case-study-II: Stream performance when executed inside one VM.
> c. Case-study-III: Stream performance when both VMs/containers execute the benchmark simultaneously.

> 3. Netperf benchmark:
> 　　　　Source: https://github.com/HewlettPackard/netperf
> Notes: Please read the instructions carefully on setting up the benchmark in relation to your system. Install the netserver on your system and the VMs/containers and execute netperf from a client on your network (a different machine) to measure the throughput as transactions per second for response size to vary from 1024, 4096, 16384 bytes.

> Report Results for TCP and UDP stream performance as below:

a. Case-study-I: netperf performance from a client on your local network when netserver is located on your system in non-virtualization mode. This result will be treated as the native platform result.
b. Case-study-II: netperf performance from a client on your local network when netserver is executing inside one VM.
c. Case-study-III: netperf performance from two different clients on your local network when netserver is executing inside both VMs/containers and the benchmark is executed simultaneously.

4. Sysbench benchmark:
        Source: https://github.com/akopytov/sysbench#sysbench
Notes: Please read the instructions carefully on setting up the benchmark in relation to your system. The total file size sould be considerabily larger than the system memory size to avoid caching of the file data inside memory. Use random read write mode to conduct the experiments.
Report Results:
a. Case-study-I: Sysbench fileio performance for your system in non-virtualization mode. This result will be treated as the native platform result.
b. Case-study-II: Sysbench fileio performance when executed inside one VM.
c. Case-study-III: Sysbench fileio performance when both VMs/containers execute the benchmark simultaneously.

5. Result analysis:
        Analyse the observed results using oprofile and perf to understand the impact of virtualization stack on the application performance.
        oprofile: https://oprofile.sourceforge.io/about/
        perf: https://perf.wiki.kernel.org/index.php/Main_Page

The project report should have the following mentioned:

1. Give a brief description of the benchmarks and what they aim to measure and evaluate in your opinion and how.
2. Configuration details of the system and the three case studies for each benchmark.
3. Report results for each of the case in the benchmarks and explain clearly why you see the results observed and what you conclude on the same using oprofile and perf
4. Discuss, if you perceive a bottleneck and how you believe, based on your course learning, the bottleneck can be resolved.