Measurements of Light VMs

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Problem Statement and Motivation

As almost all cloud applications run in the virtual environment and many IT infrastructures run in the cloud or on-premise virtualization environment, it is important to understand key aspects of virtualization. While many virtualization environments have been proposed and are in use, traditional VMs are too heavyweight and do not scale well. On the other hand, containers that are on the other end of the scale is lightweight but do not provide good isolation, hence potentially not as secure.

The aim of the work is to provide a variety of performance measurements of benchmarks run on the different types of virtualization in the spectrum: traditional VM, light VM, and containers. We will select widely used infrastructures for each of the choices in the spectrum and provide a thorough evaluation of the measurements to assess the strengths and weaknesses of each virtualization technique.

Challenge

There are a number of challenges in conducting this project:

- Understanding each infrastructure and handling various issues during installation and configuration
- Developing environments to make precise measurements of different components: system call latency, memory access performance, CPU performance, I/O performance
- Evaluation of the contributing factors to the aforementioned components/overhead
- Developing and porting microbenchmarks and real applications for the evaluation

To overcome the above problems, we will partly refer to documentations available online and also refer to the gVisor benchmark tools. Furthermore, to handle the difficulties in porting real applications, we will utilize our experience from the ongoing research projects.

Approach

We will first select a number of virtualization infrastructures in the spectrum:

- Traditional VM: VirtualBox
- Light VM: Amazon Firecracker, Kata Container
- Container: Docker

All of these different virtualization infrastructures are open-source, and we will install these and set up the development environment on local machines whose detailed specifications are provided below:

CPU	DRAM	GPU	SSD (SATA)	Motherboard
i7-6700	32 GB	TITAN Xp	Crucial 256GB	GIGABYTE Z170XP-SLI-CF

We will use the following microbenchmarks and a real application to measure the performance of each VM:

- We will be using the gVisor benchmark tools: https://gvisor.dev/docs/architecture_guide/performance/
- We will be using PageRank on Spark and TPC-H/TPC-DS workloads on SparkSQL for real application workloads

Finally, we will measure the scalability of each system by varying the number of VMs within a single machine.

Timeline and Milestone

- 1st Stage: Setting up the environment and running part of the microbenchmark (2 weeks)
- 2nd Stage: Making measurements for the microbenchmarks (1.5 weeks)
- 3rd Stage: Setting up the real application and running them (1.5 weeks)
- 4th Stage: Evaluation of the results and preparation of final presentation and report (2 weeks)

Environment Requirements

VirtualBox

- OS: Ubuntu Xenial 16.04 (LTS)
- Version: 6.1.2

Amazon Firecracker

- OS: Ubuntu Xenial 16.04 (LTS)
- Version: 0.20.0

Kata Container

- OS: Ubuntu Xenial 16.04 (LTS)
- Version: 1.9.4

Docker

- OS: Ubuntu Xenial 16.04 (LTS)
- Version: 17.12.1-ce