Cloud Systems (H/M) – Lab 2 – Virtual Machines

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The primary goal of this lab is to gain practical experience with system virtualization to host and run virtual machines. With this, the lab builds towards the first assessed exercise.

You can either work with Google's commercial cloud (Alternative A below) or with QEMU, a free open-source hypervisor, on your personal computer (Alternative B below). If you decide to use CGP, please **only** use the educational voucher credits or other free credits (see Appendix A).

As before, we suggest using your own computer, as you need privileged access. We also highly recommend working in small groups (of 2-4 students), which might allow you to jointly cover Alternatives A and B.

If you have not found your team yet, have a look at the Teaming Up Forum on Moodle and/or see Lauritz and James at the beginning of the second lab session.

1. Alternative A: Google Compute Platform

1.1 Prerequisites

To use Google Compute Platform (GCP), you need a GCP account and free credits, as well as, ideally, the GCP tools installed on your machine (or another way to remotely connect to your VMs). See "Appendix A" for further guidance.

1.2 Practice Task: Set up a Virtual Machine

Study the documentation of the Google Cloud SDK and learn how to set up and use the command line tools.

Configure your Google Cloud SDK so that it can access your GCP account, i.e. commands like the following should work: `gcloud compute instances list`.

Practice task: Write a script that prepares and starts a virtual machine on GCP.

You can first manually experiment with the `gcloud` command and make notes, before finally combining the commands into a script.

When you connect to your VM using the `gcloud` command for the first time, Compute Engine creates an SSH key for you.

The script should

1. Launch an instance with the following parameters
    a. Machine type: n2d-standard-2
    b. Image: "Ubuntu 24.04 LTS"
    c. Tag: "cloud-systems"
2. Resize the VM disk volume size to 100 GB
3. Suspend the VM instance

After writing the script, test it: delete all running VM instances, run the script, and check that the result is as expected.

Be mindful of where you store this script, if it contains your private information (such as your access or secret key).

2. Alternative B: QEMU on Your Linux Machine

2.1 Prerequisites

Using Linux natively is recommended for this task, so that you can later make use of hardware-supported virtualization using KVM. However, QEMU also works on Mac OS and Windows (with other underlying hypervisors that might make use of hardware support) – and it should even be possible to use it in a Linux VM on a Windows host (though likely not with hardware support).

2.2 Install QEMU and Set Up a Virtual Machine

Install QEMU – with the KVM kernel module, if you are using Linux.

Study the QEMU documentation on how to work with disk images.

Create or obtain a VM image in the qcow2 format with Ubuntu 24.04 installed. You can either manually install Ubuntu, or download an Ubuntu cloud image. When working with a cloud image, you have to configure cloud-init (see, for example, this guide and these examples).

The guest OS needs to be able to access the internet and you need SSH access into the guest to exchange files and run commands. You are welcome to use QEMU manually or use a management tool such as Libvirt.

Give your VMs access to multiple CPU cores and ensure sufficient memory.

Practice task: Find a way to copy the `forksum.c` file (from Lab 1) into your Ubuntu VM (perhaps using the scp tool, which allows you to copy files over a ssh connection). Once it is in the VM, compile and run it as before.

3. Open-Ended Task Towards AE1: Virtual Machine Benchmarking

Once you have set up a new virtual machine and it is running, connect to it and benchmark its performance, e.g. sysbench to measure CPU performance or fio to measure disk speeds (as introduced in the previous lab sheet).

Look, for example, at different resources, e.g. compare different GCP virtual machine types/sizes (Alternative A) or native vs. virtualized execution on your host machine side-by-side (Alternative B), perhaps also with and without hardware support, if possible with your setup.

Note that if you are running a VM on GCP, it runs on a Google server and will likely share this with other customers' VMs, which might be a source of interference. However, you will not know much about this, neither what nor where exactly the server is[1], nor how resources are shared. Similarly, if you run a VM on your local machine using QEMU, there might be interference with other applications that you are running at the same time on your computer as well as simply the

[1] A principle referred to as "Location Independence" in the NIST definition of Cloud Computing.

host operating system (seeing you are using a type 2 hypervisor/emulator). Does this show through when you measure the VM performance repeatedly or for a longer time? Is the performance of the same GCP VM instance type and size exactly the same across regions? Can you actively influence the performance of a VM running on your machine using QEMU by deliberately stressing your computer's resources at the same time?

Take notes of your findings and, as much as possible, automate your benchmarking process by creating a benchmarking script, so that you can efficiently build on this for Assessed Exercise 1.

Appendix A – Google Cloud Platform

Every student of CS(H/M) receives a coupon worth $**50 of free credits for Google's cloud**. At the same time, the overall coupons are limited to accommodate the students of this course, so please do not pass on this sheet or the following link.

Visit this link to **retrieve your credit coupon**: https://vector.my.salesforce-sites.com/GCPEDU?cid=%2FxfgI9yL04r6WVTaHRPlkvOzMolothDXfDTrwsaLn%2BNhOuONNrF4XsDJ9SXRWI7L/. Fill out the form with your @student.glasgow.ac.uk email address. You will get an email to your email addresses with your individual coupon code and instructions on how to redeem the coupon.

You need a Google account to use GCP[2]. Use an existing one or create a new one.

You can optionally check if you are also eligible for additional free credits for new customers at https://cloud.google.com/free/.

Although you have a coupon for free GCP credits, you might run out of credits. Please,

- **keep an eye on your credits (go to "Billing" or "Billing Account Management" for your account and "Credits" to see how many credits are remaining for Cloud Systems; consider that it might take some time for recently spent credits to show through)**
- **always remember to shut down your VMs when you do not use them.**
- **do not spend all Google Cloud Credits on this lab. You will need them also for other labs and the exercises.**

[2] Note, however, that you can also work with QEMU (see Alternative B above) if you prefer not to have an account with Google for using their commercial public cloud.