BSC (HONS) IN COMPUTING SCIENCE

CLOUD INFRASTRUCTURE QUOTATION AND DEPLOYMENT REPORT

CLOUD PLATFORM DEVELOPMENT (B8IS124_2425_TMD1)

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Introduction

I have been tasked with evaluating and comparing cloud infrastructure options for a startup's web application that focus on high availability, fault tolerance across multiple regions and zones, load balancing and support. This report analyses and compares the three biggest cloud providers: Amazon Web Services, Google Cloud Platform and Microsoft Azure using their official pricing calculator provided in the attached files.

Startup Requirements

- Run 24x7, serving at least 10,000 users per day.
- Be fault-tolerant across multiple availability zones and regions.
- Use at least 3 instances for both frontend and backend systems.
- Ensure network load balancing between web instances.
- Use VM instances with a minimum of 2 vCPUs and 8GB RAM.
- Provide at least 250GB storage per instance.
- Include production-grade support.

Pricing table and cost comparison

The following table shows the estimated monthly costs for each provider, based on the official quotes. All prices are in USD and they are subject to changes.

Component	**AWS**	**Azure**	**Google Cloud (GCP)**
Compute (VMs)	$678.76	$831.43	$678.13
Storage (VM Disks)	Included	Included	$246.00
Load Balancing	$176.66	$119.50	$109.98
IP Addresses	$43.80	Included	$128.46
Data Transfer	$81.92	$71.68	$121.19
Support	$100.64	$100.00	$100.00
Total (approx.)	**$1,107.01**	**$1,122.61**	**$1,137.76**

All prices are based on 3-year reserved/commitment pricing for compute resources, it can save up to 50% on the monthly price.

Amazon Web Services (AWS)

AWS delivers a highly customizable infrastructure with a vast pool of services and pricing options. The instance chosen is a t3.large EC2 that counts with 2vCPUS, 8GB RAM and 250GB SSD delivering enough performance for the web application using a three-year reserved plan for cost optimisation being deployed 6 per region. AWS offers multiple load balancing solutions for Application, Network and Gateway for precise configuration spread between North America and Europe. Public IPv4 addresses are provided for all instances and their business support plan ensures 24/7 technical assistance when needed.

Microsoft Azure

Azure offers an integrated, user-friendly platform. The offered instance is called D2 v3 and it has 2 vCPUs, 8 GB RAM and 50 GB of temporary storage, it was necessary to add managed disks of SSD 256GB for each instance enabled zone-redundant storage that copies data synchronously across three Azure availability zones in the primary region, also instances are spread between North America and Europe ensuring a higher availability in case of disasters. There is no cost for basic Load Balancer, for our application we selected 2 cross-region load balancers which have a cost, one for each region using the standard tier and the same tier for business support 24/7.

Google Cloud Platform (GCP)

GCP emphasizes transparency and modularity in prices and services. The estimate includes six VM instances per region using N4 series standard counting with 2 vCPUS, 8GB RAM, 50GB Boot disk with 250GB Hyperdisk balanced attached to each instance and deployed in different regions. GCP offers a Cloud Load Balancer supporting cross-region, the enhanced support plan is designed for production workloads.

Comparison Table

Component	AWS	Microsoft Azure	Google Cloud Platform (GCP)
VM Instances	6 × t3.large (2 vCPU, 8GB RAM)	6 × D2 v3 (2 vCPU, 8GB RAM, Temp Disk 50GB)	6 × n4-standard-2 (2 vCPU, 8GB RAM, Boot Disk 50 GB)
Storage	250GB EBS Cold SSD/instance	250GB Managed Disk/instance	250GB Boot Disk/instance (SSD)
Regions	North America, Europe	North America, Europe	North America, Europe
Load Balancer	Application/Network/ Gateway LB	Cross-region Load Balancer	Cloud Load Balancer (cross-region)
IP Addresses	6 public per region	6 public per region	6 static per region
Data Transfer	1TB/month inter-region	1TB/month inter-region	1TB/month inter-region
Support	Business Support (24/7)	Standard Support (24/7)	Enhanced Support (24/7)
OS	Linux	Linux	Linux

Conclusion

All three providers meet the technical and operational requirements for globally available web applications, price is not a concern since there is not much difference between them. The final choice for this would be depending on team expertise and training costs, if this is not a factor for the web application, we can consider Azure since it has a better user experience, requires less expertise, and it would take less time to set-up everything. If you are looking for higher scalability AWS would be the answer since AWS has more services available.

Google Cloud

Environment Setup

We must download and Google SDK from the official website - Guide can be found at https://cloud.google.com/sdk/docs/install

In my case I am running Fedora 41 in my laptop, we must add the following repository running this command:

```
sudo tee -a /etc/yum.repos.d/google-cloud-sdk.repo << EOM
[google-cloud-cli]
name=Google Cloud CLI
baseurl=https://packages.cloud.google.com/yum/repos/cloud-sdk-el9-x86_64
enabled=1
gpgcheck=1
repo_gpgcheck=0
gpgkey=https://packages.cloud.google.com/yum/doc/rpm-package-key.gpg
EOM
```

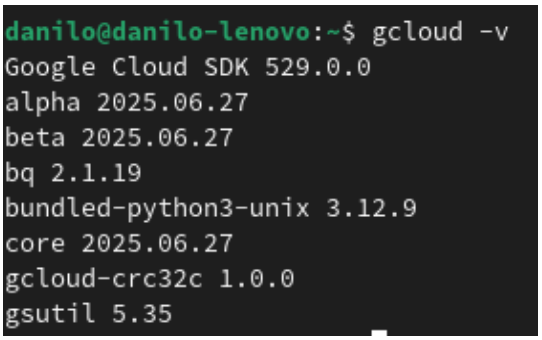
After the command is executed, we need install **libxcrypt-compat.x86_64**

```
sudo dnf install libxcrypt-compat.x86_64
```

And finally we are able to install Google SDK and set-up

```
sudo dnf install google-cloud-cli
```

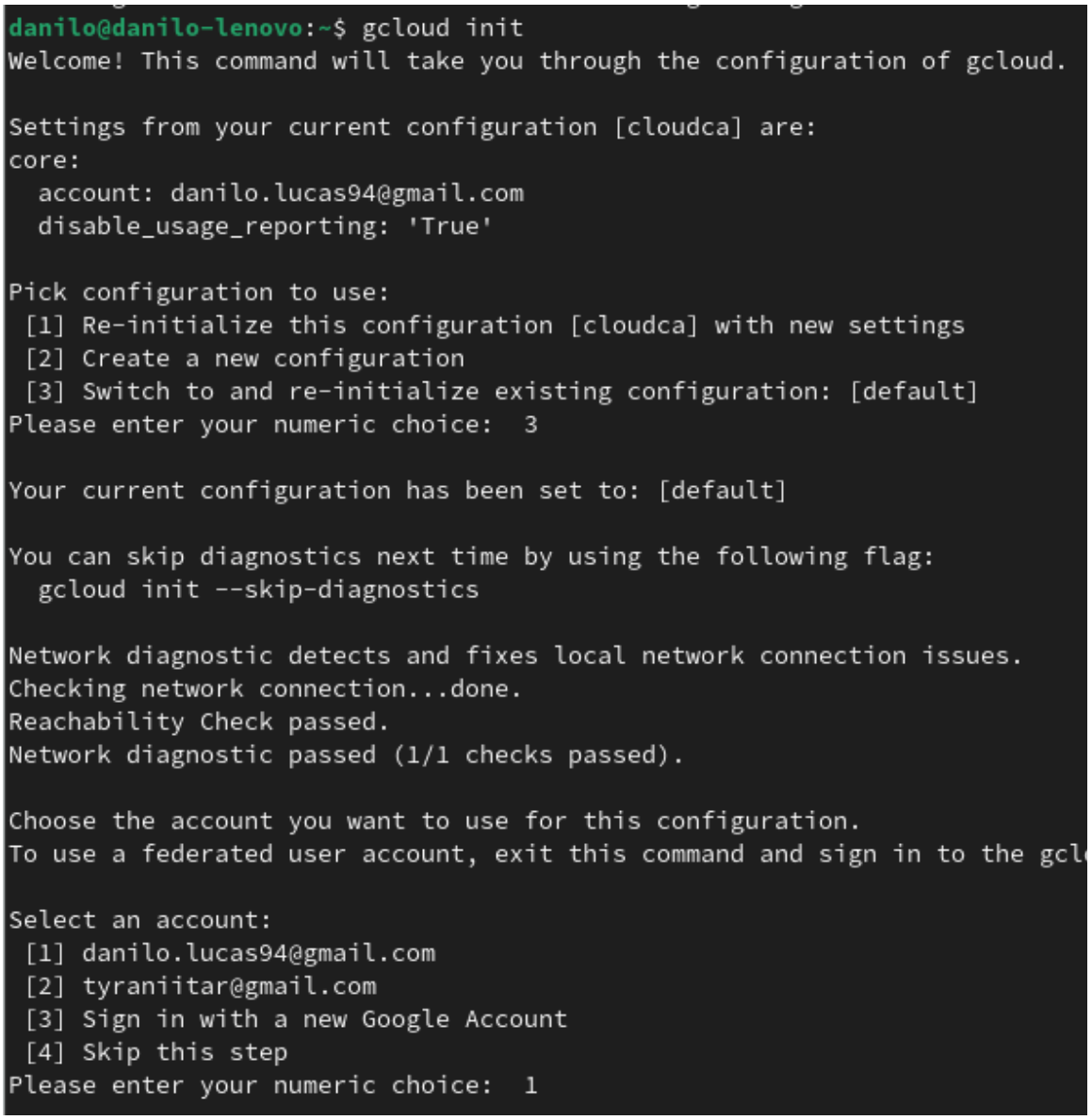
After installation is completed, we are able to check if everything is up typing gcloud -v in our console



Now, we must run to configure our account and create a new project

```
gcloud init
```

Since I already had my Google Cloud setted-up, I will just re-initialize and create a new configuration



```
You are signed in as: [danilo.lucas94@gmail.com].

Pick cloud project to use:
 [1] dbs-real-state
 [2] gen-lang-client-0577238429
 [3] lostfound-454820
 [4] Enter a project ID
 [5] Create a new project
Please enter numeric choice or text value (must exactly match list item):  4

Enter project ID you would like to use:  dbscloudca
Project ID does not exist or is not active.
Do you want to continue (y/N)?  y

Your current project has been set to: [dbscloudca].

Not setting default zone/region (this feature makes it easier to use
[gcloud compute] by setting an appropriate default value for the
--zone and --region flag).
See https://cloud.google.com/compute/docs/gcloud-compute section on how to set
default compute region and zone manually. If you would like [gcloud init] to be
able to do this for you the next time you run it, make sure the
Compute Engine API is enabled for your project on the
https://console.developers.google.com/apis page.

The Google Cloud CLI is configured and ready to use!
```

Let’s create a new project and enable Compute and IAM APIs

gcloud projects create dbscloudca –set-as-default

```
danilo@danilo-lenovo:~$ gcloud projects create dbscloudca --set-as-default
Create in progress for [https://cloudresourcemanager.googleapis.com/v1/projects/dbscloudca].
Waiting for [operations/create_project.global.5345676730696686842] to finish...done.
Enabling service [cloudapis.googleapis.com] on project [dbscloudca]...
Operation "operations/acat.p2-505858927639-7d2075c8-2e58-4e88-bb06-e552d774db1f" finished successfully.
Updated property [core/project] to [dbscloudca].
```

Remember to select a billing account, you will not be able to proceed if you do not select one

```
danilo@danilo-lenovo:~$   gcloud services enable compute.googleapis.com iam.googleapis.com
ERROR: (gcloud.services.enable) FAILED_PRECONDITION: Billing account for project '50585892763
9' is not found. Billing must be enabled for activation of service(s) 'compute.googleapis.com
' to proceed.
Help Token: AeNz4PgIKLi-QaU4LcxT5cZlhbu_mQQdSCi2-OQ-vAKGQVOiH0OJmi5iZ28oiWsuGIHmQAFgcrXmXSVe-
NX58mBXGntUvzLzhM4wcWGcuvrpsU-A
- '@type': type.googleapis.com/google.rpc.PreconditionFailure
  violations:
  - subject: ?error_code=390001&project=505858927639&services=compute.googleapis.com
    type: googleapis.com/billing-enabled
- '@type': type.googleapis.com/google.rpc.ErrorInfo
  domain: serviceusage.googleapis.com/billing-enabled
  metadata:
    project: '505858927639'
    services: compute.googleapis.com
  reason: UREQ_PROJECT_BILLING_NOT_FOUND
```

gcloud services enable compute.googleapis.com iam.googleapis.com

```
danilo@danilo-lenovo:~$ gcloud services enable compute.googleapis.com iam.googleapis.com
Operation "operations/acf.p2-505858927639-726b2126-df99-4e81-9bc2-26f3eb82ba9b" finished successfully.
```

Creating a Web server using script

Now we are able to run our script to create VM that can be found at https://github.com/danilolucas94/DBS_CloudCA using the command SH, this script automatically create a new instance on GCloud, but before we must set a few variables to make it happen

```
danilo@danilo-lenovo:~/Google Drive/College/Cloud Computing$ sh vm-script.sh

*** Setting Variables for our VM  ***
Variables set

*** Setting Project ID on GCloud  ***
Updated property [core/project].

*** Reserving a static external IP  ***
Created [https://www.googleapis.com/compute/v1/projects/dbscloudca/regions/us-central1/addresses/ca-cloud-vm].

*** Creating VM  ***
Created [https://www.googleapis.com/compute/v1/projects/dbscloudca/zones/us-central1-c/instances/webserver-vm].
WARNING: Some requests generated warnings:
 - Disk size: '250 GB' is larger than image size: '10 GB'. You might need to resize the root repartition manually if the o
disk#resize_pd for details.

NAME          ZONE           MACHINE_TYPE   PREEMPTIBLE  INTERNAL_IP  EXTERNAL_IP     STATUS
webserver-vm  us-central1-c  e2-standard-2               10.128.0.6   104.198.38.210  RUNNING

Waiting for VM initialization...

*** Creating firewall rule to allow HTTP and SSH ***
Creating firewall...⠹Created [https://www.googleapis.com/compute/v1/projects/dbscloudca/global/firewalls/allow-http-ssh].
Creating firewall...done.
NAME            NETWORK  DIRECTION  PRIORITY  ALLOW          DENY  DISABLED
allow-http-ssh  default  INGRESS    1000      tcp:80,tcp:22        False

*** Connecting using SSH and install Apache and create Hello World file ***
Warning: Permanently added 'compute.3361074575208080676' (ED25519) to the list of known hosts.
Get:1 http://us-central1.gce.archive.ubuntu.com/ubuntu jammy InRelease [270 kB]
Get:2 http://us-central1.gce.archive.ubuntu.com/ubuntu jammy-updates InRelease [128 kB]
Get:3 http://us-central1.gce.archive.ubuntu.com/ubuntu jammy-backports InRelease [127 kB]
Get:4 http://security.ubuntu.com/ubuntu jammy-security InRelease [129 kB]
Get:5 http://us-central1.gce.archive.ubuntu.com/ubuntu jammy/main amd64 Packages [1395 kB]
Get:6 http://us-central1.gce.archive.ubuntu.com/ubuntu jammy/main Translation-en [510 kB]
```

In this screenshot your Firewall rules, internal IP and External IP is being shown

```
Enabling conf serve-cgi-bin.
Enabling site 000-default.
Created symlink /etc/systemd/system/multi-user.target.wants/apache2.service → /lib/systemd/system/apache2.service.
Created symlink /etc/systemd/system/multi-user.target.wants/apache-htcacheclean.service → /lib/systemd/system/apache-htcacheclean.service.
Processing triggers for libc-bin (2.35-0ubuntu3.10) ...

Running kernel seems to be up-to-date.

No services need to be restarted.

No containers need to be restarted.

No user sessions are running outdated binaries.

No VM guests are running outdated hypervisor (qemu) binaries on this host.
Hello World

*** Webserver updated and running ***
```

Our Webserver is updated and running, using a ping command we can see that we are getting a response from our webserver

```
danilo@danilo-lenovo:~/Google Drive/College/Cloud Computing$ ping 104.198.38.210
PING 104.198.38.210 (104.198.38.210) 56(84) bytes of data.
64 bytes from 104.198.38.210: icmp_seq=1 ttl=56 time=142 ms
64 bytes from 104.198.38.210: icmp_seq=2 ttl=56 time=143 ms
64 bytes from 104.198.38.210: icmp_seq=3 ttl=56 time=138 ms
64 bytes from 104.198.38.210: icmp_seq=4 ttl=56 time=137 ms
^C
--- 104.198.38.210 ping statistics ---
4 packets transmitted, 4 received, 0% packet loss, time 3001ms
rtt min/avg/max/mdev = 137.035/140.067/142.604/2.412 ms
```

Connect using SSH command or gcloud compute ssh

```
danilo@danilo-lenovo:~/Google Drive/College/Cloud Computing$ ssh 104.198.38.210
The authenticity of host '104.198.38.210 (104.198.38.210)' can't be established.
ED25519 key fingerprint is SHA256:RMQc8hGoN680AlU/mKQIc2ZmyiC11i6tyyQ63xSqQG8.
This key is not known by any other names.
Are you sure you want to continue connecting (yes/no/[fingerprint])? yes
Warning: Permanently added '104.198.38.210' (ED25519) to the list of known hosts.
Welcome to Ubuntu 22.04.5 LTS (GNU/Linux 6.8.0-1032-gcp x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro


This system has been minimized by removing packages and content that are
not required on a system that users do not log into.

To restore this content, you can run the 'unminimize' command.

Expanded Security Maintenance for Applications is not enabled.

0 updates can be applied immediately.

Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

New release '24.04.2 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

danilo@webserver-vm:~$
```

```
danilo@danilo-lenovo:~/Google Drive/College/Cloud Computing$ gcloud compute ssh webserver-vm
No zone specified. Using zone [us-central1-c] for instance: [webserver-vm].
Welcome to Ubuntu 22.04.5 LTS (GNU/Linux 6.8.0-1032-gcp x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/pro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Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status

New release '24.04.2 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

Last login: Sat Jul 12 13:04:40 2025 from 37.228.246.190
danilo@webserver-vm:~$
```

Using a browser we are able to see our site running and showing the message “Hello Word”