National University of Sciences and Technology (NUST)
School of Electrical Engineering and Computer Science

# Department of Computing

## SE-315: Cloud Computing

### Lab 04: Set Up Network and HTTP Load Balancers

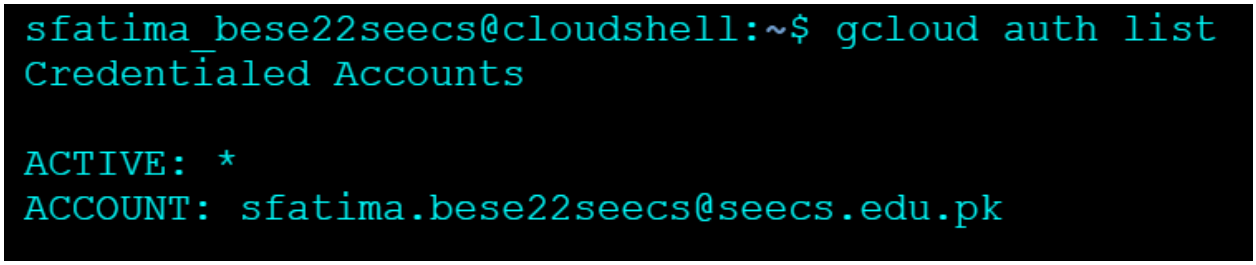
**CLO1: Explain the core concepts of the cloud computing paradigm**

**Date: 2.10.23**

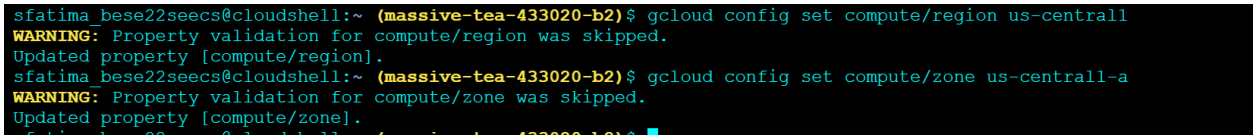
# Lab 04: Set Up Network and HTTP Load Balancers

## Lab Task

1. Go through the link 1 given above (under helping material: https://www.cloudskillsboost.google/focuses/12007?parent=catalog) which will take you to the 'Set Up Network and HTTP Load Balancers' page. You have to start the lab and perform the tasks given below. Make sure to take screenshots of each task as you will need to add them in the solution section given below.

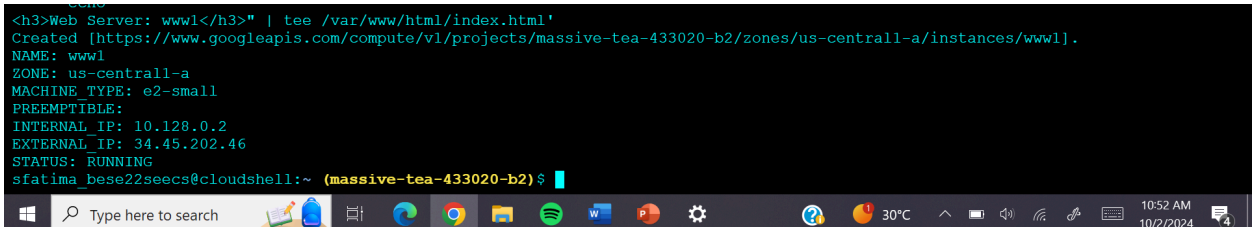



### a. Set the default region and zone for all resources




### b. Create multiple web server instances

**Create a virtual machine www1 in your default zone using the following code:**




**Create a virtual machine www2 in your default zone:**

```
Created [https://www.googleapis.c
NAME: www2
ZONE: us-central1-a
MACHINE_TYPE: e2-small
PREEMPTIBLE:
INTERNAL_IP: 10.128.0.3
EXTERNAL_IP: 34.122.10.64
STATUS: RUNNING
```

,

**Create a virtual machine www3 in your default zone.**

```
Created [https://www.googleapi
NAME: www3
ZONE: us-central1-a
MACHINE_TYPE: e2-small
PREEMPTIBLE:
INTERNAL_IP: 10.128.0.4
EXTERNAL_IP: 34.171.240.4
STATUS: RUNNING
```

**Create a firewall rule to allow external traffic to the VM instances:**

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute firewall-rules create www-firewall-network-lb \
    --target-tags network-lb-tag \
    --allow tcp:80
Creating firewall...working..Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/firewalls/www-firewall-network-lb].
Creating firewall...done.
NAME: www-firewall-network-lb
NETWORK: default
DIRECTION: INGRESS
PRIORITY: 1000
```

**list your instances. You'll see their IP addresses in the EXTERNAL_IP column:**

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute instances list
NAME: www1
ZONE: us-central1-a
MACHINE_TYPE: e2-small
PREEMPTIBLE:
INTERNAL_IP: 10.128.0.2
EXTERNAL_IP: 34.45.202.46
STATUS: RUNNING

NAME: www2
ZONE: us-central1-a
MACHINE_TYPE: e2-small
PREEMPTIBLE:
INTERNAL_IP: 10.128.0.3
EXTERNAL_IP: 34.122.10.64
STATUS: RUNNING

NAME: www3
ZONE: us-central1-a
MACHINE_TYPE: e2-small
PREEMPTIBLE:
INTERNAL_IP: 10.128.0.4
EXTERNAL_IP: 34.171.240.4
```

Verify that each instance is running with `curl`, replacing **[IP_ADDRESS]** with the IP address for each of your VMs:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ curl http://34.45.202.46

<h3>Web Server: www1</h3>
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ curl http://34.122.10.64

<h3>Web Server: www2</h3>
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ curl http://34.171.240.4

<h3>Web Server: www3</h3>
```

### c. Configure the load balancing service

**1. Create a Static External IP Address for the Load Balancer:**

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute addresses create network-lb-ip-1 \
  --region us-central1
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/regions/us-central1/addresses/network-lb-ip-1].
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```

### 2. Add a Legacy HTTP Health Check Resource:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute http-health-checks create basic-check
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/httpHealthChecks/basic-check].
NAME: basic-check
HOST:
PORT: 80
REQUEST_PATH: /
```

### 3. Create a Target Pool in the Same Region as Your Instances:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute target-pools create www-pool \
  --region us-central1 --http-health-check basic-check
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/regions/us-central1/targetPools/www-pool].
NAME: www-pool
REGION: us-central1
SESSION_AFFINITY: NONE
BACKUP:
HEALTH_CHECKS: basic-check
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```



### 4. Add the Instances to the Target Pool:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute target-pools add-instances www-pool \
    --instances www1,www2,www3
Updated [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/regions/us-central1/targetPools/www-pool].
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```



### 5. Add a Forwarding Rule:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute forwarding-rules create www-rule \
  --region us-central1 \
  --ports 80 \
  --address network-lb-ip-1 \
  --target-pool www-pool
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/regions/us-central1/forwardingRules/www-rule].
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```



## d. Sending traffic to your instances

### 1. View the External IP Address of the www-rule Forwarding Rule:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute forwarding-rules describe www-rule --region us-central1
IPAddress: 35.188.191.10
IPProtocol: TCP
creationTimestamp: '2024-10-02T02:07:42.183-07:00'
description: ''
fingerprint: iFnqqMb7-f8=
id: '8188925009177129905'
kind: compute#forwardingRule
labelFingerprint: 42WmSpB8rSM=
loadBalancingScheme: EXTERNAL
name: www-rule
networkTier: PREMIUM
portRange: 80-80
```

### 2. Store the External IP Address in a Variable:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ IPADDRESS=$(gcloud compute forwarding-rules describe www-rule --region u
s-central1 --format="json" | jq -r .IPAddress)
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```

### 3. Show the External IP Address:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ echo $IPADDRESS
35.188.191.10
```

### 4. Use curl to Send Traffic to the External IP Address:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ while true; do curl -m1 $IPADDRESS; done
<h3>Web Server: www3</h3>
<h3>Web Server: www2</h3>
<h3>Web Server: www3</h3>
<h3>Web Server: www3</h3>
<h3>Web Server: www3</h3>
```

## e. Create an HTTP load balancer

### 1. Create the Load Balancer Template:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute instance-templates create lb-backend-template \
   --region=us-central1 \
   --network=default \
   --subnet=default \
   --tags=allow-health-check \
   --machine-type=e2-medium \
   --image-family=debian-11 \
   --image-project=debian-cloud \
   --metadata=startup-script='#!/bin/bash
     apt-get update
     apt-get install apache2 -y
     a2ensite default-ssl
     a2enmod ssl
     vm_hostname="$(curl -H "Metadata-Flavor:Google" \
     http://169.254.169.254/computeMetadata/v1/instance/name)"
     echo "Page served from: $vm_hostname" | \
     tee /var/www/html/index.html
     systemctl restart apache2'
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/instanceTemplates/lb-backend-template].
NAME: lb-backend-template
MACHINE_TYPE: e2-medium
```

### 2. Create a Managed Instance Group:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute instance-groups managed create lb-backend-group \
   --template=lb-backend-template --size=2 --zone=us-central1-a
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/zones/us-central1-a/instanceGroupManagers/lb-backend
-group].
NAME: lb-backend-group
LOCATION: us-central1-a
SCOPE: zone
BASE_INSTANCE_NAME: lb-backend-group
SIZE: 0
TARGET_SIZE: 2
INSTANCE_TEMPLATE: lb-backend-template
AUTOSCALED: no
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```

## 3. Create the Firewall Rule:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute firewall-rules create fw-allow-health-check \
  --network=default \
  --action=allow \
  --direction=ingress \
  --source-ranges=130.211.0.0/22,35.191.0.0/16 \
  --target-tags=allow-health-check \
  --rules=tcp:80
Creating firewall...working..Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/firewalls/fw-all
ow-health-check].
Creating firewall...done.
NAME: fw-allow-health-check
NETWORK: default
DIRECTION: INGRESS
PRIORITY: 1000
ALLOW: tcp:80
DENY:
DISABLED: False
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```


## 4. Create a Global Static External IP Address:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute addresses create lb-ipv4-1 \
  --ip-version=IPV4 \
  --global
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/addresses/lb-ipv4-1].
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```

## 5. Get the Reserved IPv4 Address:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute addresses describe lb-ipv4-1 \
  --format="get(address)" \
  --global
34.120.106.117
```

## 6. Create a Health Check:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute health-checks create http http-basic-check \
  --port 80
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/healthChecks/http-basic-check].
NAME: http-basic-check
PROTOCOL: HTTP
```

## 7. Create the Backend Service:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute backend-services create web-backend-service \
  --protocol=HTTP \
  --port-name=http \
  --health-checks=http-basic-check \
  --global
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/backendServices/web-backend-service].
NAME: web-backend-service
BACKENDS:
PROTOCOL: HTTP
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```

### 8. Add the Instance Group to the Backend Service:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute backend-services add-backend web-backend-service \
  --instance-group=lb-backend-group \
  --instance-group-zone=us-central1-a \
  --global
Updated [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/backendServices/web-backend-service].
```

### 9. Create a URL Map:

```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute url-maps create web-map-http \
    --default-service web-backend-service
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/urlMaps/web-map-http].
NAME: web-map-http
DEFAULT_SERVICE: backendServices/web-backend-service
```

### 10. Create a Target HTTP Proxy:

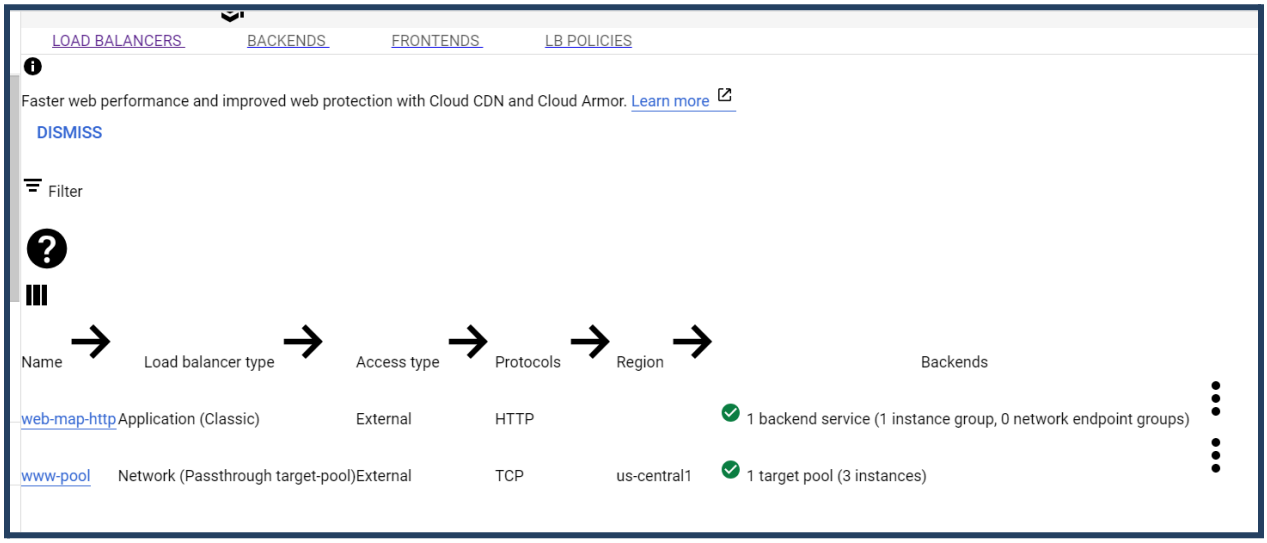
```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute target-http-proxies create http-lb-proxy \
    --url-map web-map-http
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/targetHttpProxies/http-lb-proxy].
NAME: http-lb-proxy
URL_MAP: web-map-http
```

### 11. Create a Global Forwarding Rule:

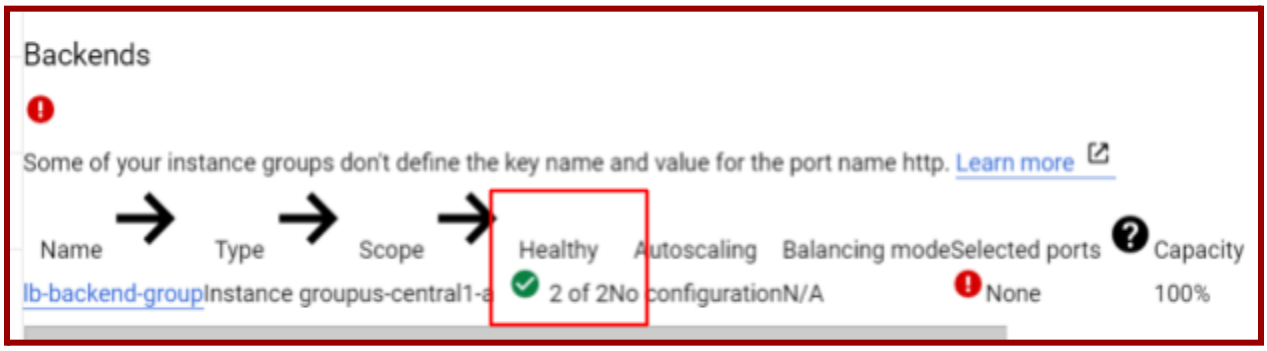
```
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$ gcloud compute forwarding-rules create http-content-rule \
   --address=lb-ipv4-1 \
   --global \
   --target-http-proxy=http-lb-proxy \
   --ports=80
Created [https://www.googleapis.com/compute/v1/projects/massive-tea-433020-b2/global/forwardingRules/http-content-rule].
sfatima_bese22seecs@cloudshell:~ (massive-tea-433020-b2)$
```


## f. Testing traffic sent to your instances

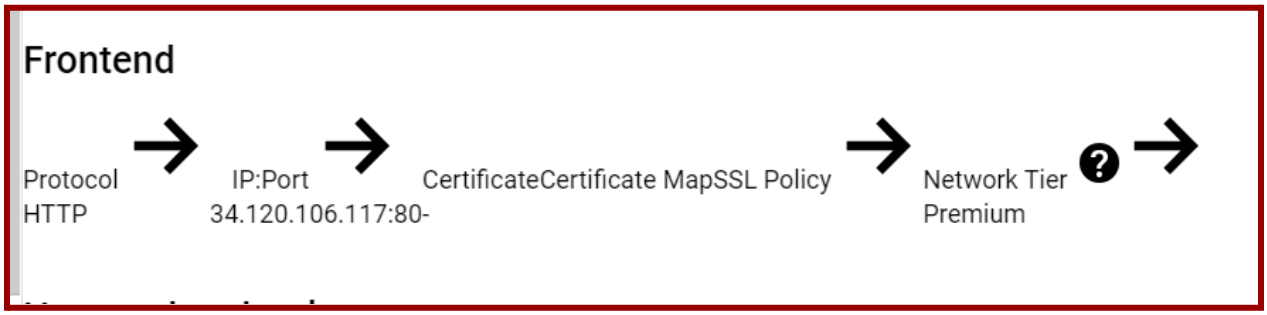
### Checking the load balancers:



**Checking Backend Health**




**Identifying IP addresses:**

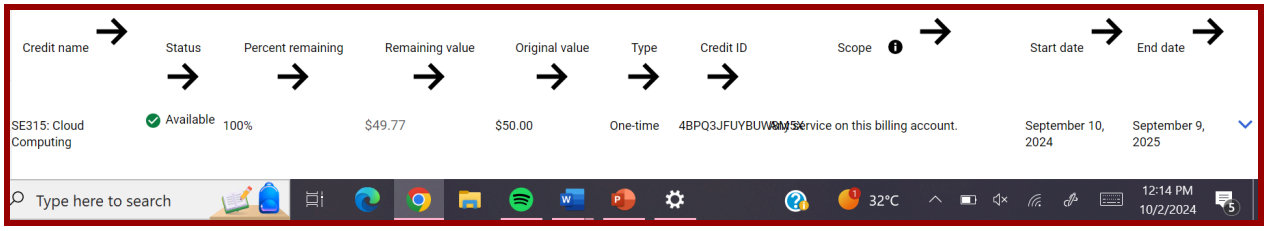



**Accessing the IP Address from browser:**

**following is the output rendered:**

**Remaining credits summary:**

**$49.77 credits remain.**

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**—the end—**