Lab3
VPC deployment using Terraform

Contents

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Overview

1. This lab will take you through coding a multi-component cloud deployment into Google Cloud using Terraform. You will deploy a relatively simple VPC, but even this has several components that need either to exist already or be created as part of the deployment.
2. Elements required in this lab are the VPC itself, Subnets, Routing, NAT Service and Firewall Rules. This lab breaks the deployment into phases, each a separate task below, to demonstrate component interdependencies:

    Task 1: VPC with 2 subnets

    Task 2: Router and NAT service

    Task 3: Firewall Rules

    Task 4: GCE instances for testing

Objectives

In this lab, you will:

- Deploy a custom VPC
- In the us-central1 region, create a Public subnet using CIDR 10.0.1.0/24 and a Private subnet using CIDR 10.0.2.0/24
- Create a Router with a NAT service
- Create a GCE instance on the public subnet with an internal and external IP and one on the private subnet with just an internal IP.
- Restrict inbound traffic to the Public Subnet to only SSH traffic from any other source
- Restrict inbound traffic to the Private subnet, allowing any traffic from the Public subnet only
- Allow unrestricted outbound traffic
- Test the configuration by establishing a ssh session to the instance on the public subnet and then from it test communication to the instance on the private subnet.

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Teaching Points

1. This lab will take you through coding a multi-component cloud deployment into Google Cloud using Terraform. You will deploy a relatively simple VPC, but even this has several components that need either to exist already or be created as part of the deployment. Elements required in this lab are the VPC itself, Subnets, Routing Tables, Gateways and Firewall rules. This lab breaks the deployment into phases, each a separate task, to demonstrate component interdependencies.

Before you begin

1. Ensure you have completed Lab0 before attempting this lab.
2. In the IDE terminal pane, enter the following commands…

   cd ~/googlelabs/labs03

3. This shifts your current working directory to googlelabs/labs03. ***Ensure all commands are executed in this directory***
4. Close any open files and use the Explorer pane to navigate to and open the empty main.tf file in **googlelabs/lab03**

Solution

The solution to this lab can be found in **googlelabs/solutions/lab03**. Try to use this only as a last resort if you are struggling to complete the step-by-step processes

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Task 1. Create the basic VPC

References

https://registry.terraform.io/providers/hashicorp/google/6.17.0

https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_network

https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_subnetwork

Try it yourself

The aim of this task is to:

1. Create a VPC resource **google_compute_network.lab_vpc** named **lab-vpc**
2. On this VPC, create a subnet resource **google_compute_subnetwork.public_subnet** in **us-central1** named **public-subnet** using CIDR **10.0.1.0\24**
3. Create a second subnet resource **google_compute_subnetwork.private_subnet,** named **private-subnet** using CIDR **10.0.2.0\24**
4. If you feel comfortable doing so, then attempt to complete this task without referencing the step-by-step instructions below. You can verify your attempt by comparing your code with the Task 1 section of the solution code.
5. **Note:** Provider version 6.17.0 should be used throughout this lab.

Step by Step

1. Review Terraform Google Provider documentation: https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs
2. Click `Use Provider`
3. Copy the code block into main.tf. For convenience, the code is listed below…

```
terraform {
  required_providers {
    google = {
      source = "hashicorp/google"
```

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```
      version = "6.17.0"
    }
  }
}

provider "google" {
  # Configuration options
}
```

4. From within the documentation, we see that the provider configuration options typically include the project and region. Copy the sample code and overwrite the empty provider sub-block in main.tf…

```
provider "google" {
  project     = "<your project id here>"
  region      = "us-central1"
}
```

5. Update the project value to reflect your lab project id

6. Review the documentation for creating a VPC; https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_network

7. Copy the **Example Usage - Network Basic** sample code into main.tf

```
resource "google_compute_network" "vpc_network" {
  name = "vpc-network"
}
```

8. Change the resource block identifier from **vpc_network** to **lab_vpc** and the resource name from **vpc-network** to **lab-vpc**

9. We will only be creating selective subnets on the VPC and therefore need to toggle off the default behaviour which is to create a subnet in every region. Add the argument **auto_create_subnetworks** and set its value to **false**

10. Your modified resource block should now be...

```
resource "google_compute_network" "lab_vpc" {
  name = "lab-vpc"
  auto_create_subnetworks = false
```

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```
}
```

11. We now need to add 2 subnets to this VPC. Review the documentation for sample code on the **google_compute_subnetwork** resource

    https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_subnetwork

12. We need 2 subnets, so the simplest option is to create 2 copies of this resource block. What if we wanted many more though ? We will discuss more efficient options in a later lab. For now, though, copy the first example code block into main.tf.

```
resource "google_compute_subnetwork" "network-with-private-secondary-ip-ranges" {
 name = "test-subnetwork"
 ip_cidr_range = "10.2.0.0/16"
 region      = "us-central1"
 network     = google_compute_network.custom-test.id
 secondary_ip_range {
  range_name    = "tf-test-secondary-range-update1"
  ip_cidr_range = "192.168.10.0/24"
 }
}
```

13. Change the resource block identifier from **network-with-private-secondary-ip-ranges** to **public_subnet**

14. Change the resource name from **test-subnetwork** to **public-subnet**,

15. Change the cidr block from **10.2.0.0/16** to **10.0.1.0/24**

16. Change the network argument value from **google_compute_network.custom-test.id** to **google_compute_network.lab_vpc.id**

    This references the vpc you defined earlier and is an example of implicit dependency. Terraform will know to create the vpc before attempting to create this subnet on it.

17. Finally, delete the secondary_ip_range sub-block.

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18. The modified block should now be as follows..

```
resource "google_compute_subnetwork" "public_subnet" {
 name = "public-subnet"
 ip_cidr_range = "10.0.1.0/24"
 region      = "us-central1"
 network = google_compute_network.lab_vpc.id
}
```

19. Duplicate this resource block

20. Change the resource block identifier from **public_subnet** to **private_subnet**

21. Change the resource name from **public-subnet** to **private-subnet**

22. Change the cidr block from **10.0.1.0/24** to **10.0.2.0/24**

23. The modified block should now be as follows..

```
resource "google_compute_subnetwork" "private_subnet" {
 name = "private-subnet"
 ip_cidr_range = "10.0.2.0/24"
 region      = "us-central1"
 network = google_compute_network.lab_vpc.id
}
```

24. Save main.tf and run **terraform init**

25. Run **terraform plan** Note any errors and fix if appropriate. Refer to the Task 1 block in the solution code if necessary

26. Run **terraform apply**, entering **yes** when prompted. 3 resources should be added.

27. Run **terraform state list** and verify the following resources exist..

```
PS C:\googlelabs\solutions\lab03> terraform state list
google_compute_network.lab_vpc
google_compute_subnetwork.private_subnet
google_compute_subnetwork.public_subnet
PS C:\googlelabs\solutions\lab03>
```

28. Switch to the Console

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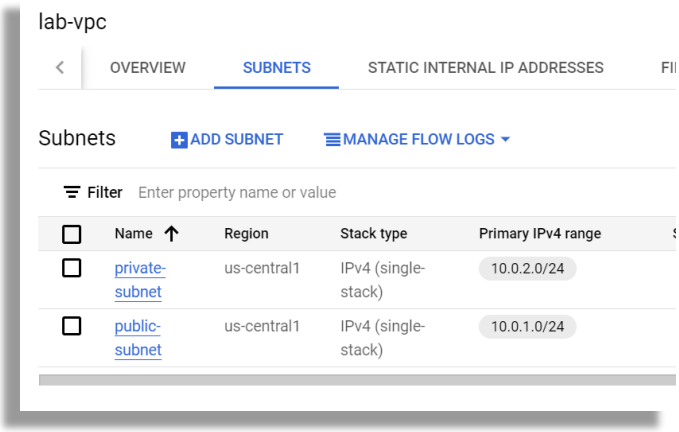
29. Use the Search bar to search for **VPC networks**

30. Verify you see **lab-vpc**, the VPC we have just deployed

31. Select l**ab-vpc** and verify you see the 2 subnets we have just deployed.



Task 2. Provision a Cloud Router and NAT Service

References

https://registry.terraform.io/providers/hashicorp/google/latest/docs/resources/compute_router_nat

Try it yourself

1. If you feel comfortable doing so, then attempt to complete this task without referencing the step-by-step instructions below. You can verify your attempt by comparing your code with the Task 2 block in the solution code

2. **Important.** If you attempted the previous task yourself, then your code, whilst hopefully achieving the objectives specified, may vary slightly from the solution provided at the end of this lab. You are encouraged to continue attempting each task without precise guidance if you feel comfortable doing so. An alternative approach is to 'reset' your code at the start of each task to align it with the solution code prior to moving forward.

3. To do this now:

    a. Destroy any currently deployed resources
    b. Clear the contents of your current main.tf file

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c. Copy the Task 1 block from the solution main.tf into your main.tf
d. Update the project id with your project id and deploy the resources

4. The aim of this task is to:
    a. Create a Cloud Router resource google_compute_router.lab_router named lab-router and associate it with google_compute_network.lab_vpc
    b. Create a router nat resource google_compute_router_nat.lab_nat named lab-nat, associate it with google_compute_network.lab_vpc and google_compute_subnetwork.private_subnet

Step by Step

1. Review the Terraform Registry documentation regarding the creation of a Google Cloud resources **google_compute_router** and **google_compute_router_nat** at https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_router_nat

2. Copy the code examples relating to **google_compute_router** and **google_compute_router_nat** from **Example Usage - Router NAT Basic**, into main.tf

3. Change the identifier of the resource block **google_compute_router** from **router** to **lab_router**

4. Change the name of the **google_compute_router** resource from **my-router** to **lab-router**

5. Change the **google_compute_router** region from **google_compute_subnetwork.subnet.region** to **google_compute_subnetwork.private_subnet.region**

   This references the private subnet you defined earlier and is another example of implicit dependency. Terraform will know the subnet has to exist before attempting to create this router in the same region

6. Change the **google_compute_router** network from **google_compute_network.net.id** to **google_compute_network.lab_vpc.id**

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7. Delete the **bgp** sub-block

8. Change the name of the resource block **google_compute_router_nat** from **nat** to **lab-nat**

9. Change the **google_compute_router_nat** name from **my-router-nat** to **lab-nat**

10. Change the **google_compute_router_nat** router from **google_compute_router.router.name** to **google_compute_router.lab_router.name**

11. Change the google_compute_router_nat region from **google_compute_router.router.region** to **google_compute_router.lab_router.region**

12. Change the source_subnetwork_ip_ranges_to_nat from **ALL_SUBNETWORKS_ALL_IP_RANGES** to **LIST_OF_SUBNETWORKS**

13. Delete the **log_config sub-block** and replace it with the code below to apply use of the nat gateway to the private subnet...

```
subnetwork {
   name = google_compute_subnetwork.private-subnet.id
   source_ip_ranges_to_nat = ["ALL_IP_RANGES"]
 }
```

14. Confirm the modified blocks are as shown below...

```
resource "google_compute_router" "lab_router" {
  name = "lab-router"
 network = google_compute_network.lab_vpc.id
}

resource "google_compute_router_nat" "lab_nat" {
 name = "lab-nat"
 router = google_compute_router.lab_router.name
 region = google_compute_router.lab_router.region
 nat_ip_allocate_option = "AUTO_ONLY"
 source_subnetwork_ip_ranges_to_nat = "LIST_OF_SUBNETWORKS"
```

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```
  subnetwork {
    name = google_compute_subnetwork.private_subnet.id
    source_ip_ranges_to_nat = ["ALL_IP_RANGES"]
  }
}
```

15. Run **terraform plan.** Note any errors and fix if appropriate. Refer to the Task 2 section of the solution code if necessary.

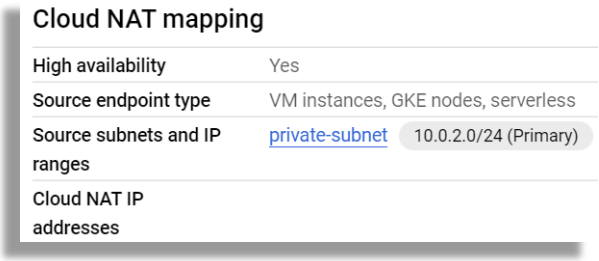
16. Finally, run **terraform apply**, entering **yes** when prompted. 2 additional resources are created.

17. Run **terraform state list** and verify the following resources should now exist..

```
PS C:\googlelabs\solutions\lab03> terraform state list
google_compute_network.lab_vpc
google_compute_router.lab_router
google_compute_router_nat.lab_nat
google_compute_subnetwork.private_subnet
google_compute_subnetwork.public_subnet
```

18. Switch to the Console

19. Search for **Cloud NAT** and verify the existence of the new NAT Gateway and Cloud Router. Drill into the nat gateway to verify that the gateway will provide **Cloud NAT mapping** to the private-subnet only.



20. As well as network connectivity, we must also consider firewall rules, needed to permit inbound and outbound traffic flows. Every VPC has default rules that deny all inbound traffic and allow all outbound traffic.

21. In Task 3 you will enhance your code to include appropriate firewall rules to your VPC.

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Task 3. Provision Routing tables and Firewall Rules

References:

https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_firewall

Try it yourself

1. If you feel comfortable doing so, then attempt to complete this task without referencing the step-by-step instructions below. You can verify your attempt by comparing your code with the Task 3 section of the solution code at the end of this document.

2. **Important** If you attempted a previous task yourself, then your code, whilst hopefully achieving the objectives specified, may vary slightly from the solution provided at the end of this lab. You are encouraged to continue attempting each task without precise guidance if you feel comfortable doing so. An alternative approach is to 'reset' your code at the start of each task to align it with the solution code, prior to moving forward.

3. To do this now:
    a. Destroy any currently deployed resources
    b. Clear the contents of your current main.tf file
    c. Copy the Task 1 and Task 2 blocks from the solution main.tf into your main.tf
    d. Update the project id with your project id and deploy the resources

4. The aim of this task is to:

    a. Create a Firewall Rule **lab-private-fw-rule** that will be applied to instances on the private subnet, with a rule that allows unrestricted inbound traffic from **public-subnet** instances. Note: In production we would only open selective ports between the public and private subnets.

    b. Use source tag **pub-subnet-vm** and target tag **priv-subnet-vm** as these will be used by instances on the public and private subnets, respectively.

    c. Create a second Firewall Rule **lab-public-fw-rule** that will be applied to instances on the public subnet, with a rule that allow TCP port 22

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inbound traffic from any source IP. Note: In production we would be more selective regarding source ranges.

d. Use target tag **pub-subnet-vm** as this will be used by instances on the public subnets.

Step by Step

1. Review the Terraform Registry documentation regarding the creation of a Google Cloud Firewall Rule resource **google_compute_firewall** https://registry.terraform.io/providers/hashicorp/google/6.17.0/docs/resources/compute_firewall

2. Copy the Example Usage - Firewall Basic code block into main.tf (do not copy the google_compute_network resource block as we have already defined our network)…

```
resource "google_compute_firewall" "default" {
 name    = "test-firewall"
 network = google_compute_network.default.name

 allow {
  protocol = "icmp"
 }
 allow {
  protocol = "tcp"
  ports    = ["80", "8080", "1000-2000"]
 }
 source_tags = ["web"]
}
```

3. Change the resource block identifier to **lab_private_fw_rule**

4. Change the resource name to **lab-private-firewall**

5. Change the network value to **google_compute_network.lab_vpc.name**

6. Remove the **allow.icmp** sub-block

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7. Change the remaining **allow** sub-block to allow all protocols across all ports (delete the port argument)

8. Add a **source_tag** argument with a list including **pub-subnet-vm**

9. Add a **target_tag** argument with a list including **priv_subnet_vm**

10. The modified block should now be as shown below…

```
resource "google_compute_firewall" "lab_private_fw_rule" {
 name    = "lab-private-firewall"
 network = google_compute_network.lab_vpc.name

 allow {
  protocol = "all"
 }
 source_tags = ["pub-subnet-vm"]
 target_tags = ["priv-subnet-vm"]
}
```

11. Duplicate the entire **google_compute_firewall** resource block and paste a copy into the end of **main.tf**

12. Change the new resource block identifier to **lab_public_fw_rule**

13. Change the resource name to **lab_public_firewall**

14. Change the protocol argument value from **all** to **tcp** and add a port argument with list value of **"22"**

15. Replace the **source_tags** argument with a **source_ranges** argument containing **"0.0.0.0/0"**

16. Change the target_tags from **priv-subnet-vm** to **pub-subnet-vm**.

17. The modified block should now be as shown below…

```
resource "google_compute_firewall" "lab_public_fw_rules" {
 name    = "lab-public-firewall"
 network = google_compute_network.lab_vpc.name

 allow {
  protocol = "tcp"
```

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```
    ports    = ["22"]
  }
  source_ranges =["0.0.0.0/0"]
  target_tags = ["pub-subnet-vm"]
}
```

18. Save main.tf
19. Run **terraform plan** Note any errors and fix if appropriate. Refer to Task 3 block in the solution code if necessary.
20. Run **terraform apply**, entering **yes** when prompted. 2 new resources are created.
21. Run **terraform state list** and verify the following resources should now exist..

```
PS C:\googlelabs\solutions\lab03> terraform state list
google_compute_firewall.lab_private_fw_rule
google_compute_firewall.lab_public_fw_rules
google_compute_network.lab_vpc
google_compute_router.lab_router
google_compute_router_nat.lab_nat
google_compute_subnetwork.private_subnet
google_compute_subnetwork.public_subnet
PS C:\googlelabs\solutions\lab03>
```

22. Switch to the Console
23. Navigate to the VPCs console, search for **Firewall**, and verify the existence of the new firewall rules..

☐	lab-private-firewall	Ingress	priv-subnet-vm	Tags: pub-subnet-vm	All
☐	lab-public-firewall	Ingress	pub-subnet-vm	IP ranges: 0.0.0.0/0	tcp:22

24. In Task 4 you will create GCE instances on each subnet to test the VPC network connectivity and Firewall rules.

Task 4. Create GCE Instances

1. **Important** If you attempted a previous task yourself, then your code, whilst hopefully achieving the objectives specified, may vary slightly from the solution provided at the end of this lab. You are encouraged to continue attempting each task without precise guidance if you feel comfortable doing so. An

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alternative approach is to 'reset' your code at the start of each task to align it with the solution code, prior to moving forward.

2. To do this now:
    a. Ensure you have destroyed any resources
    b. Clear the contents of your current main.tf file
    c. Scroll down to the Solution section at the end of this document and copy the Task1, 2 and 3 code blocks into main.tf
    d. Update the project id in the provider block and save main.tf

3. During this task you are required to:
    a. Create 2 EC2 Instances of size **e2-small** based on **debian-cloud/debian-11** public image
    b. Both instances should be in availability zone **us-central1-a**
    c. Name the first instance **PubVM**
    d. Place **PubVM** on subnet **Public-Subnet**
    e. Allocate **PubVM** a **dynamic** public IP address
    f. Name the second instance **PrivVM**
    g. Place **PrivVM** on subnet **Private-Subnet**
    h. Do not allocate a public IP address to **PrivVM**
    i. Tag each machine so it has the appropriate firewall rule applied.

4. Attempt this task without step-by-step guidance. Refer to the Task 4 code block in the solution code if needed.

5. Save and apply the now complete main.tf

6. Do not destroy the deployment as we will move onto testing next.

7. Use the boilerplate code below to achieve these objectives…

```
resource "google_compute_instance" "" {
name = ""
machine_type = ""
zone = ""
allow_stopping_for_update = true
tags = [""]
boot_disk {
initialize_params {
```

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```
image = ""
}
}
network_interface {
subnetwork =
access_config {
}
}
}
```

Task 5. Testing

1. Using the EC2 Dashboard, note the **private** IP address of PrivVM
2. Click on **SSH** against **PubVM** to connect using SSH-in-browser
3. Ping **PrivVM** from within the **PubVM** ssh session..

   ping -c 3 {private IP of PrivVM}
4. Pinging PrivVM from PubVM should succeed because there is a route from the public subnet to the private subnet and the firewall rules allow traffic from the public subnet to the private subnet.
5. Modify the **lab-private-fw-rules** firewall rule with an erroneous source tag entry, changing it from **pub-subnet-vm** to **pub-subnet-vm1**
6. Apply the change with **terraform apply**
7. Switch back to the ssh session and repeat the ping command.
8. This ping attempt should fail
9. Undo the change made to main.tf, resetting tag to **pub-subnet-vm**
10. Apply the change
11. Repeat the ping attempt
12. The pings should succeed.
13. Type **exit** to close the SSH session to PubVM

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Task 6. Destroy your deployment

1. Switch back to the IDE and run `**terraform destroy**` review the output and type `**yes**`

2. Switch to the Console and verify the deletion of your resources

****Congratulations, you have now completed this lab****

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