Tutorial 2 – VPCs and Persisting Virtual Machine Images

Disclaimer: Subject to updates as corrections are found
Version 0.20

The purpose of this tutorial is to build on tutorial #1 to introduce the use of the Virtual Private Clouds (VPCs) for creating groups of instances within subnetworks, and also to describe how to create and managing virtual machine images in Amazon to support use of EC2 for TCSS 562 projects.

Once creating and launching a virtual machine, the software stack can be customized, and an new image made to save the configuration for replication. A base image with a software stack can be replicated to support **horizontal scaling** of VM instances.

For this tutorial we follow "scenario 2", which is a VPC with Public and Private Subnets (NAT)

http://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Scenario2.html

This is in contrast to "scenario 1", which is a VPC with a Single Public Subnet.
The issue with scenario 1, is that ALL VMs must have public IPs to have internet access to make simple package updates and do things such as "ping google.com".
Using scenario 2, ALL VMs will have internet access using NAT, which is what is typically used for Virtual Box VM's.

A load balancer such as haproxy or nginx can be installed on a VM or Amazon's Load Balancer can be used directly to route traffic across multiple VMs.

Complete the tutorial using the US-EAST-1A Virginia Region.

1. Create an Elastic IP Address for your NAT Gateway

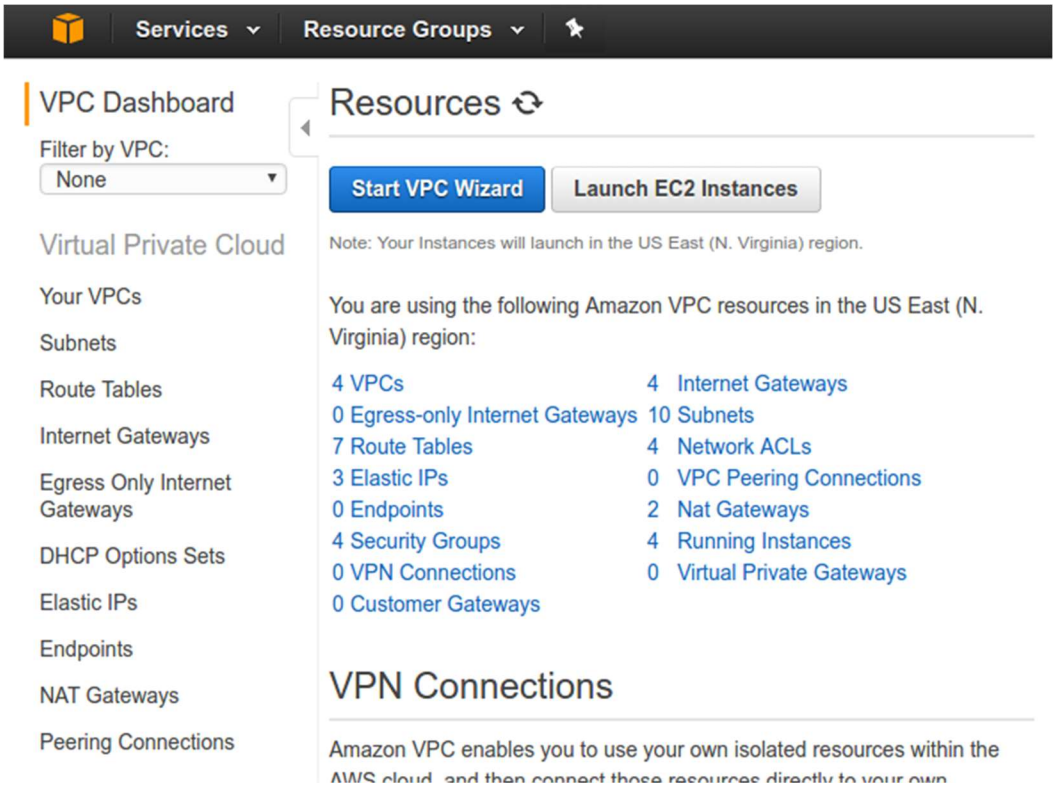
Let's begin by creating a VPC.
Before creating a VPC, let's create an elastic IP address. This is a public IP address which will be used to route traffic to and from your instances, and the internet. The elastic IP will be associated with a "NAT gateway".

From the EC2 Dashboard, select "Elastic Ips":

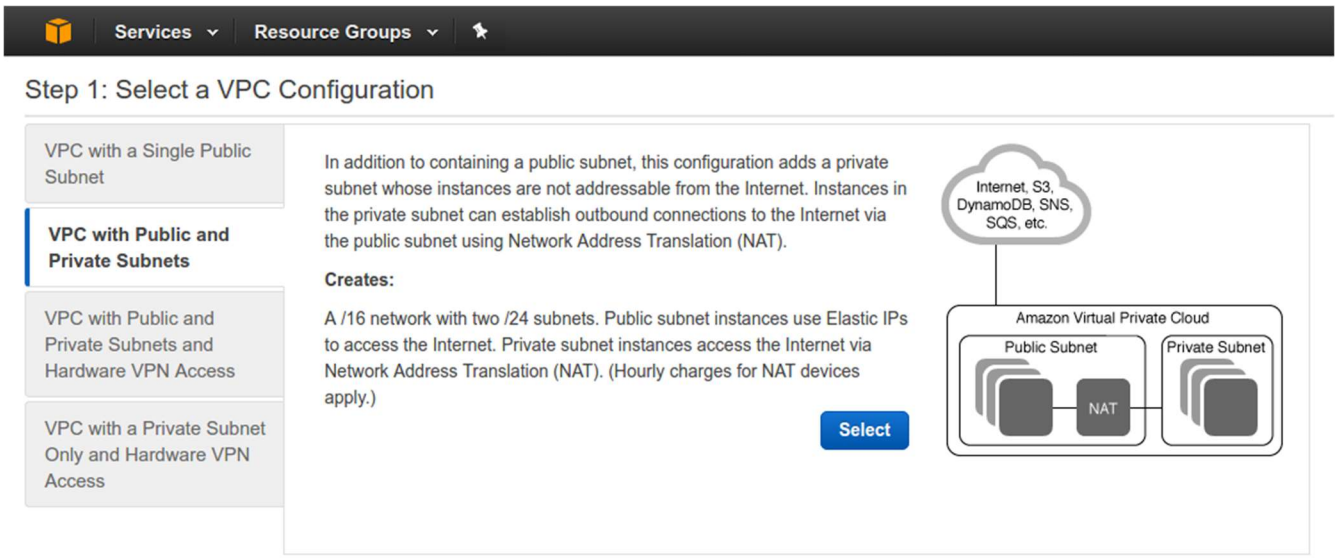
And click the button to “Allocate new address”.
Select “Allocate”

2. **Create your VPC using the VPC Wizard**

From the list of services, select “VPC”. The “VPC Dashboard” should appear.

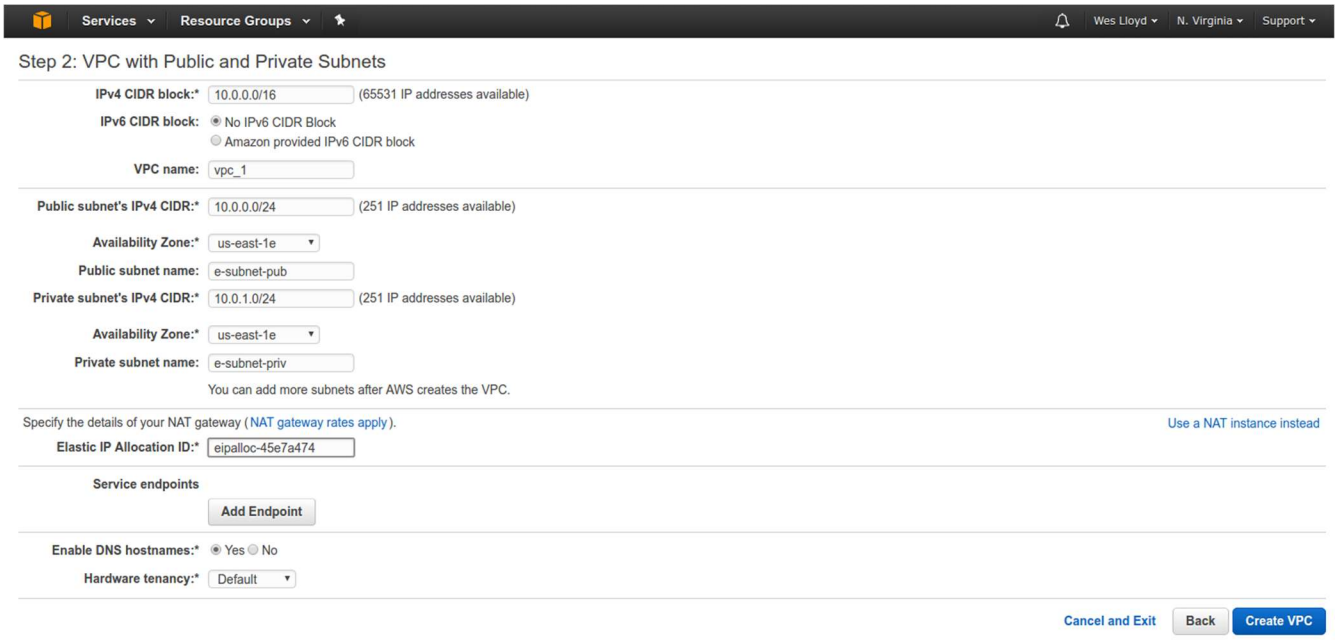


Click “Start VPC Wizard”.
Then select the second tab, “VPC with Public and Private Subnets”



Next configure your “VPC with Public and Private Subnets”

This VPC provides network isolation. An Internet Gateway provides internet access, and the NAT gateway supports translation of internal IP addresses to external IP addresses to route traffic over the internet.



Using the wizard, keep defaults and specify the following:

VPC name: vpc_1

Under Public subnet…
Availability Zone: us-east-1e
Public subnet name: e-subnet-pub

Under Private subnet…
Availability Zone: us-east-1e
Private subnet name: e-subnet-priv

For the NAT gateway
Elastic IP Allocation ID: select the elastic IP address you previously allocated

Then press the “Create VPC” button to create your VPC.

This wizard automatically creates:

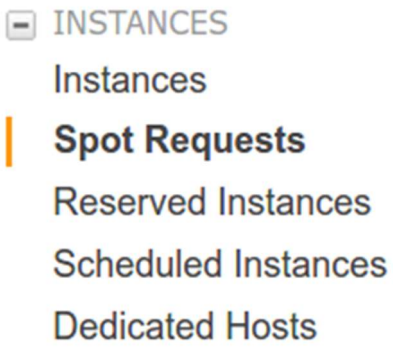
Your VPC
Your Public and Private Subnets
An Internet Gateway
A DHCP Option Set, which provide the Domain Name Server functionality
A NAT Gateway

Once your VPC has been created, go to “VPC” under Services, and inspect all of the artifacts that have been created.

3. **Launch an EBS-backed Amazon EC2 Ubuntu 16.04 instance in your public subnet**

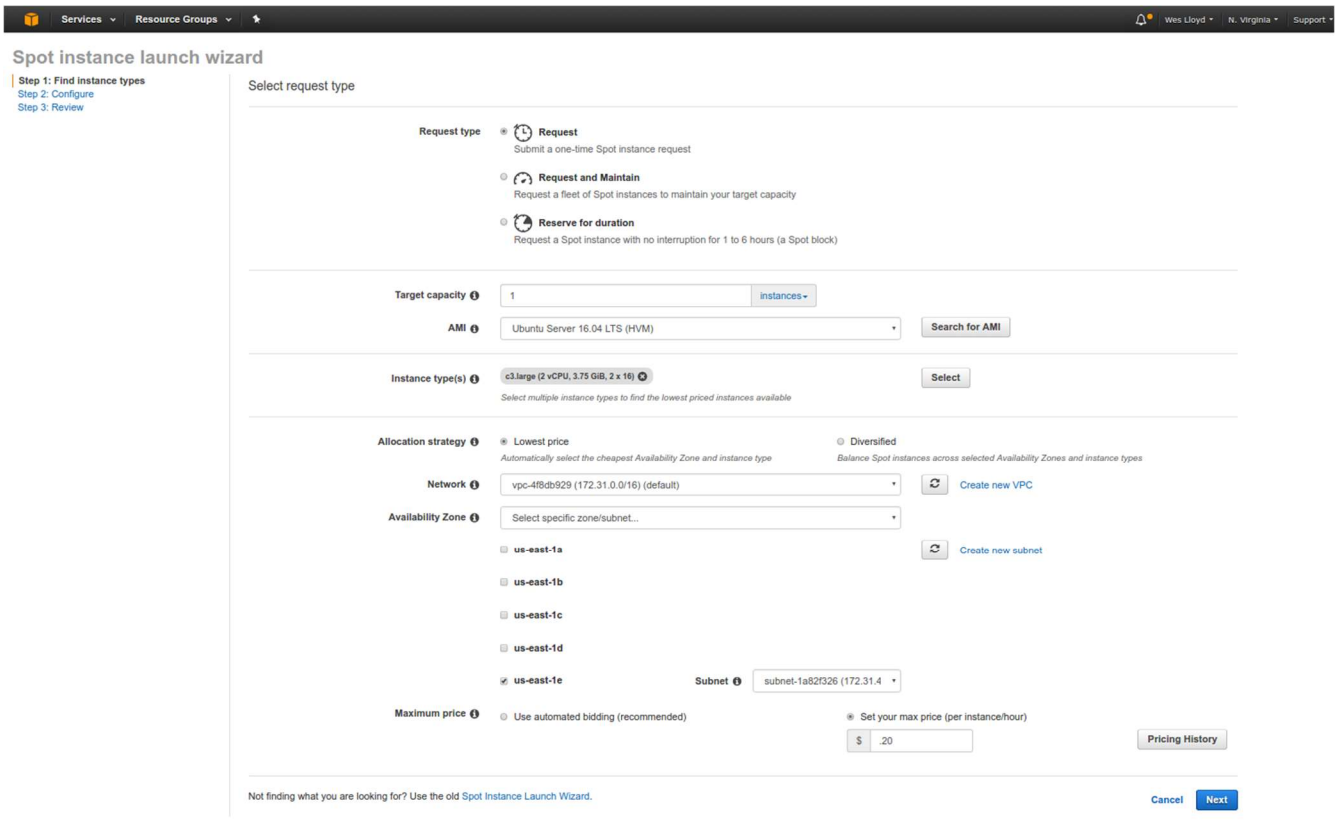
Next we will launch a VM into the public subnet of your newly created VPC.

From the EC2 Dashboard, click on the “Spot Requests” option on the left-hand menu:



Next, Select the “Request Spot Instances” button:

As in the screenshot, configure the spot request as follows.



If the parameter is not specified, keep the default value.

Request type: * Request (one-time)

Target capacity: 1

AMI: (select from the dropdown) Ubuntu Server 16.04 LTS (HVM)

Instance type: c3.large

Network: For the network, select **“vpc_1”**

This is the VPC we created with the wizard.

Next for the Availability Zone, choose “Select specific zone/subnet…”

Select, “us-east-1e”

For the subnet, select your “e_subnet_pub”.

Check the pricing history (click the button)

Set your max price (per instance/hour)

Select a value at your discretion. At least 10 cents is recommended.

Click on the <Next> button

Now, the next screen is “Step 2 – Configure”.

EBS volumes:

Keep the capacity at 8GB.

Key pair name:

If this is the first time you’ve launched a VM, you’ll need to create a new keypair.
When generating a keypair, you’ll download the key file to your machine and use in place of a plaintext password to log into the cloud VM.

If using the Windows Putty client to access the VM, follow these instructions to convert the keypair for use:
http://www.cnx-software.com/2012/07/20/how-use-putty-with-an-ssh-private-key-generated-by-openssh/

If using Ubuntu/Linux, no conversion is required.

Security groups: default

Auto-assign IPv4 Public IP: Select “Enable” from the dropdown.
** We want to assign this VM a public IP. We will use it to access VMs in our VPC that only have private, internal Ips **

Next, click on the review button.

Check over everything, and then submit your spot request.

http://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Scenario1.html

4. **Log into your Amazon EC2 Spot Instance**

Once the spot request has been submitted, let’s check what is your IP address.
In your web browser, open Google search, and type in “What is my IP?”.

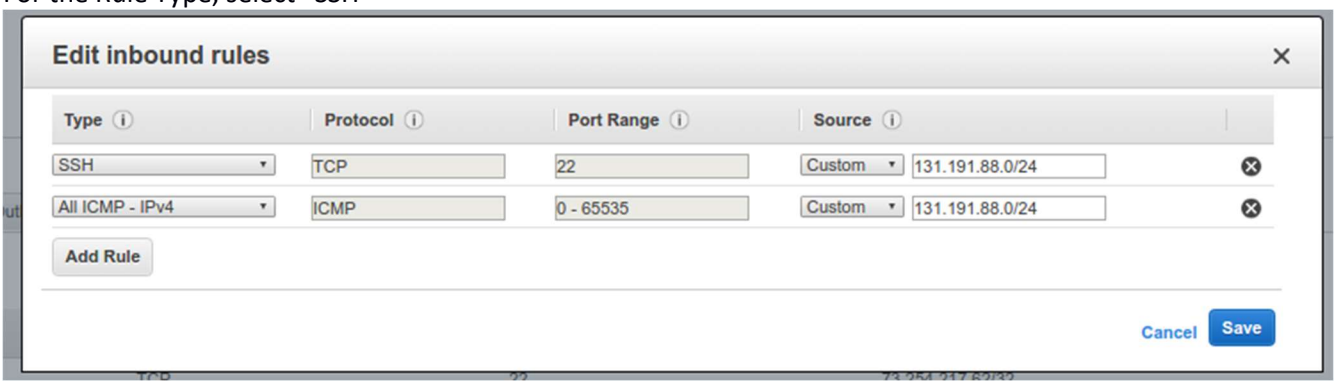
Your IP address should appear.
Note the first 3 numbers.
Let’s add SSH permission for your CIDR network block.

If your IP is for example 120.118.53.108, then your 24-bit CIDR block which would include all 255 addresses on the local subnet will be 120.118.53.0/24.

Go to EC2 – Instances, and select your instance once it appears.

In the instance description pane, find “Security Groups”.
Click on “default”…

This takes you into the Security Groups editor.
Click on the “Inbound” tab.
Click on “Edit”.
Click “Add Rule”
For the Rule Type, select “SSH”



For the Source, add your CIDR block, e.g. 120.118.53.0/24
Optionally, you can add the “All ICMP – IPv4” permission. This enables you to “ping” VM instances.

ADDITIONALLY, please two more rules, one for “HTTP” which is port 80,
and one “Custom TCP Rule”, select port 8080.

First Rule:
Select Type: HTTP
The port will default to 80.
And specify the Custom source, add your CIDR block for your inbound network, e.g. 120.118.53.0/24.

Second Rule:
Select Type: HTTP
Specify a custom port of 8080.
And specify the VPC’s CIDR address block, e.g. 10.0.0.0/16…

These security group assignments will now apply to all VMs we create within this VPC!

Now, navigate back to “Instances”, find your instance, and select it.
Note your instance’s “IPv4 Public IP”.

If you’ve configured the “All ICMP – IPv4” permission, try pinging your instance **from your laptop**… Use the windows, MAC, or Linux command line on your laptop...

```
$ ping 54.165.102.178
PING 54.165.102.178 (54.165.102.178) 56(84) bytes of data.
64 bytes from 54.165.102.178: icmp_seq=1 ttl=41 time=79.2 ms
```

```
64 bytes from 54.165.102.178: icmp_seq=2 ttl=41 time=71.7 ms
```

CTRL-C will exit.

Next, using your putty or ssh terminal client, and your keypair, SSH into the instance as follows. The first time you're connecting to a new IP, you may need to acknowledge the host's authenticity.

```
ssh -i <your_key_file_name> ubuntu@<the IPv4 Public IP>
```

Example Output:

```
$ssh -i <your_key_file_name> ubuntu@54.165.102.178
The authenticity of host '54.165.102.178 (54.165.102.178)' can't be established.
ECDSA key fingerprint is SHA256:35893chQunQ2eVt9O8X8jxyvJpYJbONdxOQjmi6U3OQ.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '54.165.102.178' (ECDSA) to the list of known hosts.
Welcome to Ubuntu 16.04.2 LTS (GNU/Linux 4.4.0-64-generic x86_64)

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

  Get cloud support with Ubuntu Advantage Cloud Guest:
    http://www.ubuntu.com/business/services/cloud

0 packages can be updated.
0 updates are security updates.



The programs included with the Ubuntu system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Ubuntu comes with ABSOLUTELY NO WARRANTY, to the extent permitted by
applicable law.

To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

ubuntu@ip-172-31-56-31:~$
```

5. Configure your instance

Let's first download the SSH keypair to your instance from your local machine.

If your using MAC or Linux, from the directory where the keypair is located, simply use secure copy:

```
scp -i <your key file> <your key file> ubuntu@<public IP of VM>:.
```

An example of this command looks like this:

```
scp -i mykey.pem mykey.pem ubuntu@34.206.59.188:.
```

Next, let's install some software:

```
sudo apt-get install haproxy
sudo apt-get install tomcat7
```

Next let's configure haproxy. We will move the original config file aside, and create a new one.

```
cd /etc/haproxy
sudo mv haproxy.cfg haproxy.cfg.bak
sudo nano haproxy.cfg
```

Copy the following contents:

```
global
    log 127.0.0.1 local0 notice
    maxconn 2000
    user haproxy
    group haproxy

defaults
    log     global
    mode    http
    option  httplog
    option  dontlognull
    retries 3
    option redispatch
    timeout connect  5000
    timeout client  10000
    timeout server  10000

frontend myserver
        bind proxy:80
        option http-server-close
```

```
        option forwardfor
        default_backend mytomcat


backend mytomcat
        mode http
        balance roundrobin
        server ubuntu1 localhost:8080 cookie A check inter 5000 rise 2 fall 5
```

Verify that the config file is correct:

```
haproxy -c -f /etc/haproxy/haproxy.cfg
```

If so, then restart (or start for the first time) haproxy:

```
sudo /etc/init.d/haproxy restart
```

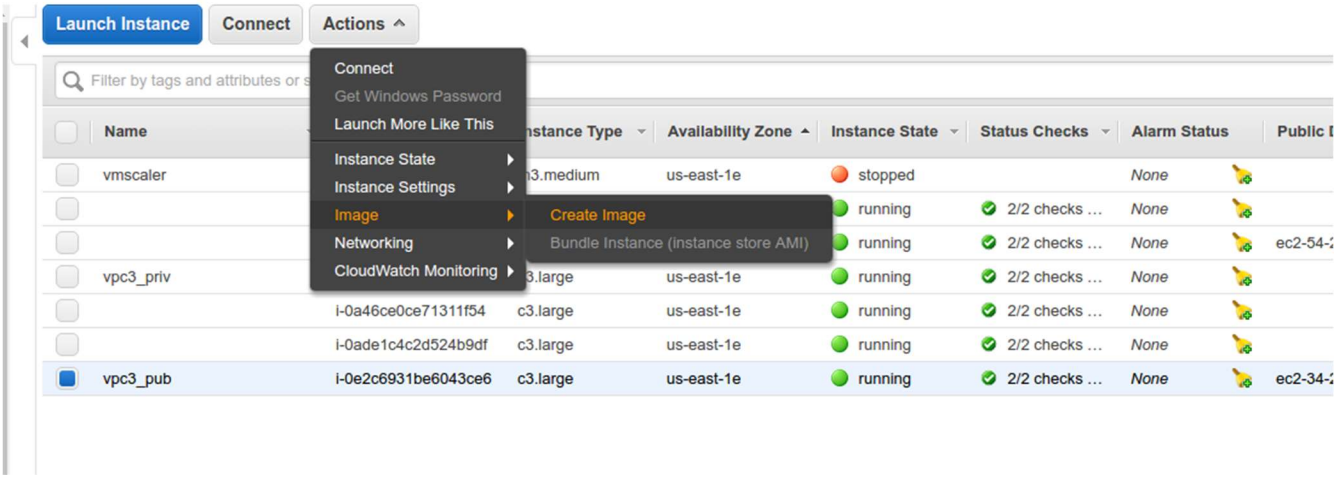
In your hosts file, add an entry which defines “proxy” to be the private IP of your VM:

```
sudo nano /etc/hosts
```

Add a line after localhost:
Replace 10.0.0.248 with your VM’s private IP
10.0.0.248 proxy

6. **Create an Amazon Machine Image (AMI) of your instance**

Now let’s create an image of your VM with the software installed:



In the “Create Image” dialog, provide:

Image name: worker_vm

Leave all other options as-is.

Click “Create Image”…

An image of your instance with your key, tomcat7, and haproxy is created after a few minutes.

Once the image has been created, check under “AMIs” for your “worker_vm”
The worker VM will have an “AMI ID”. This number, will be something like “ami-0a6ec428”. This is the unique identifier for your instance.

Note this ID.

7. **Launch spot instance worker VMs using your AMI on the private subnet within your VPC**

Now, navigate back to the Spot instance launch wizard.

We will now launch 2 c3.large instances of this newly create image.

From the spot instance launch wizard, in “Step 1: Find instance types”

Target capacity: 2
AMI: Under “Custom”, select “Search for AMI” and select your newly created AMI.

Instance type: c3.large

Network: vpc_1

Availability Zone: Select specific zone/subnet…
Select (X) us-east-1e

Subnet: select the “e-subnet-priv”

This will launch these new spot instances within your private subnet of your VPC.

Set price as before.

Click “Next” and go to “Step 2: Configure”

Be sure that your key pair is specified.
Otherwise, no other changes are required.

Click “Review” and go to “Step 3: Review”, and then launch the new instances.

8. **Configure the new instances**

After sometime, these two new instances will appear.

Using your keypair let's SSH into the first instance:

```
ssh -i <your_key_pair> ubuntu@10.0.1.xxx
```

While on the instance, note that we are able to ping www.google.com:

```
ping www.google.com
```

Does it work?
Network address translation has allowed our VM with a private IP access the internet.

On the instance, we will update the tomcat7 ROOT application index.html file

```
cd /var/lib/tomcat7/webapps/ROOT
sudo mv index.html index.old
```

Using nano, let's create a new index.html

```
sudo nano index.html
```

Paste the contents:

```
<html>
<body>
Hello from VM #1
</body>
</html>
```

Now, repeat these steps for the second instance, but this time, let's say "VM #2"

```
<html>
<body>
Hello from VM #2
</body>
</html>
```

9. **Configure haproxy on your public instance**

Now, let's log out of the second instance and update the /etc/haproxy/haproxy.cfg file.

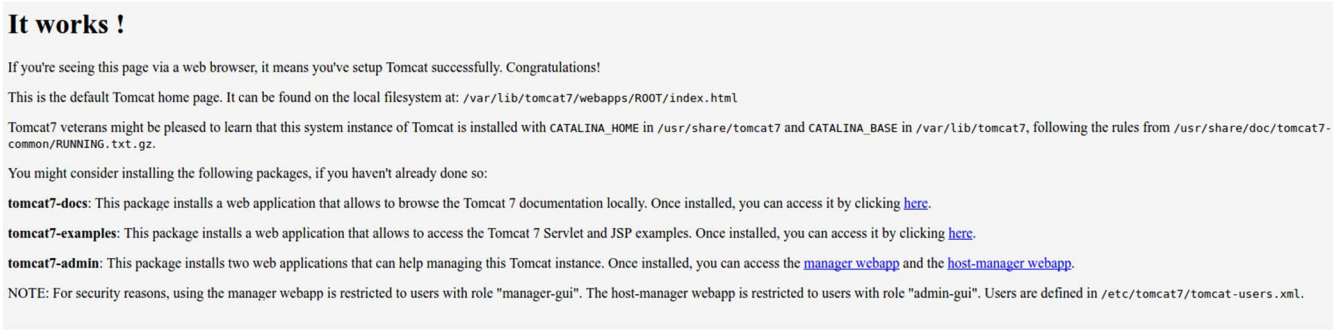
At the bottom of the file, under backend mytomcat, add the following two lines at the end. Revise the IP addresses to reflect the IP addresses your private IPs:

```
        server ubuntu1 10.0.1.69:8080 cookie A check inter 5000 rise 2 fall 5
        server ubuntu1 10.0.1.196:8080 cookie A check inter 5000 rise 2 fall 5
```

10. **Test your worker pool**

Now using a web browser, enter the public IP address of your first virtual machine.

If everything works correctly, you should see the tomcat welcome page:



It works !

If you're seeing this page via a web browser, it means you've setup Tomcat successfully. Congratulations!

This is the default Tomcat home page. It can be found on the local filesystem at: `/var/lib/tomcat7/webapps/ROOT/index.html`

Tomcat7 veterans might be pleased to learn that this system instance of Tomcat is installed with `CATALINA_HOME` in `/usr/share/tomcat7` and `CATALINA_BASE` in `/var/lib/tomcat7`, following the rules from `/usr/share/doc/tomcat7-common/RUNNING.txt.gz`.

You might consider installing the following packages, if you haven't already done so:

tomcat7-docs: This package installs a web application that allows to browse the Tomcat 7 documentation locally. Once installed, you can access it by clicking here.

tomcat7-examples: This package installs a web application that allows to access the Tomcat 7 Servlet and JSP examples. Once installed, you can access it by clicking here.

tomcat7-admin: This package installs two web applications that can help managing this Tomcat instance. Once installed, you can access the manager webapp and the host-manager webapp.

NOTE: For security reasons, using the manager webapp is restricted to users with role "manager-gui". The host-manager webapp is restricted to users with role "admin-gui". Users are defined in `/etc/tomcat7/tomcat-users.xml`.

When you refresh your browser, the content should alternate between the spalsh page and our two hellow world pages:

Hello from VM #1

Hello from VM #2

11. **Cleanup**

At the end of the tutorial, be sure to **TERMINATE** all EC2 instances, and **DELETE** all EBS volumes. Failing to do so, could result in loss of AWS credits or AWS charges to a credit card.

Additionally, use **must** delete your NAT gateway.
Once deleted, delete your Elastic IP address.

Failing to do so will result in charges.