Immersion Day

VPC/EC2 Hands-On Lab

Getting Started with Virtual Private Cloud

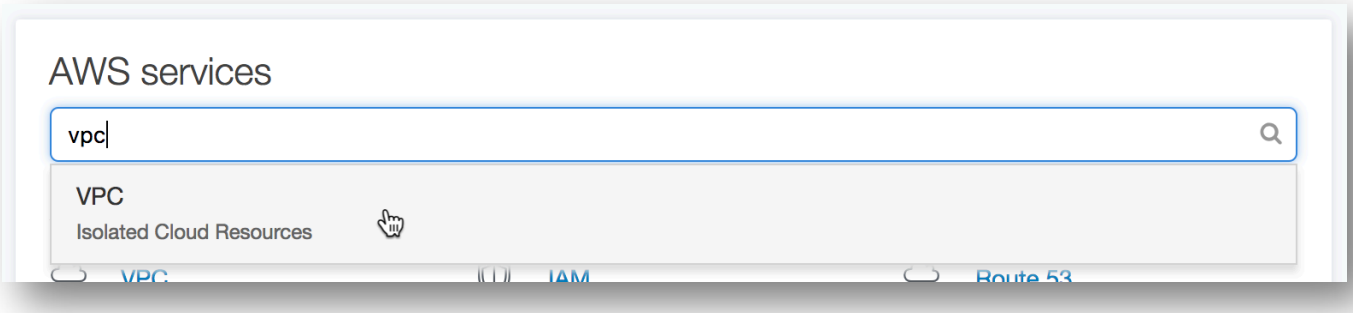
Virtual Private Cloud (VPC) Overview

Amazon Virtual Private Cloud (Amazon VPC) lets you provision a logically isolated section of the AWS Cloud where you can launch AWS resources in a virtual network that you define. You have complete control over your virtual networking environment, including selection of your own IP address range, creation of subnets, and configuration of route tables and network gateways. You can use both IPv4 and IPv6 in your VPC for secure and easy access to resources and applications.

In this lab, you will learn how to set up a VPC with public and private subnets. You will also learn about AWS networking concepts such as Elastic IPs, NAT Gateways, and Flow Logs.

Navigate to the VPC Dashboard

To get started, let's take a look at the VPC Dashboard.



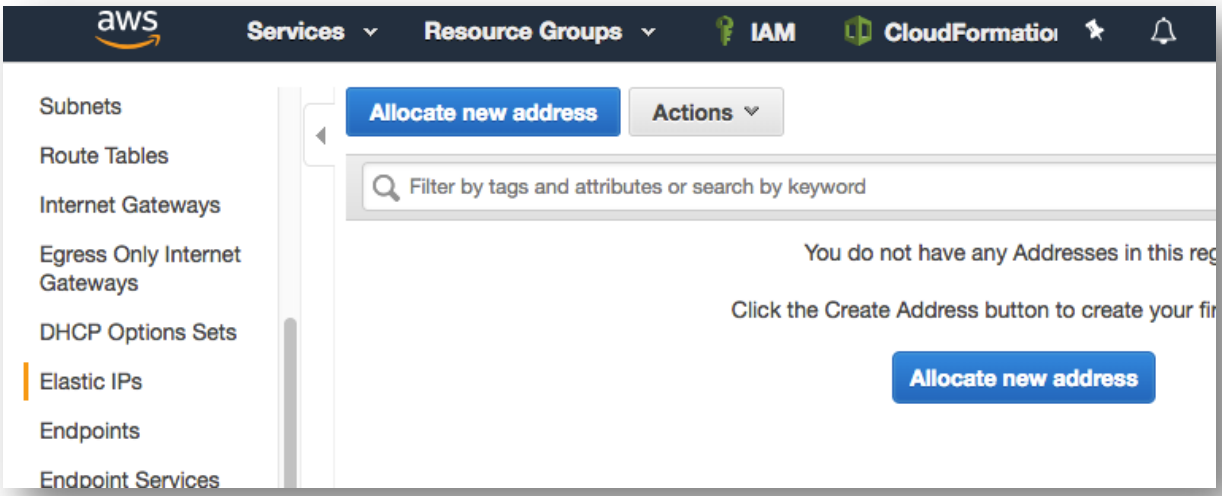
In every region, a **default VPC** has already been created for you. So, even if you haven't created anything in your account yet, you will see some VPC resources already there.

In this lab, we will be using the **VPC Wizard** to create a VPC with private and public subnets pre-configured. Once you're more familiar with AWS networking, you can create VPCs and subnets without the Wizard to create custom networking configurations.

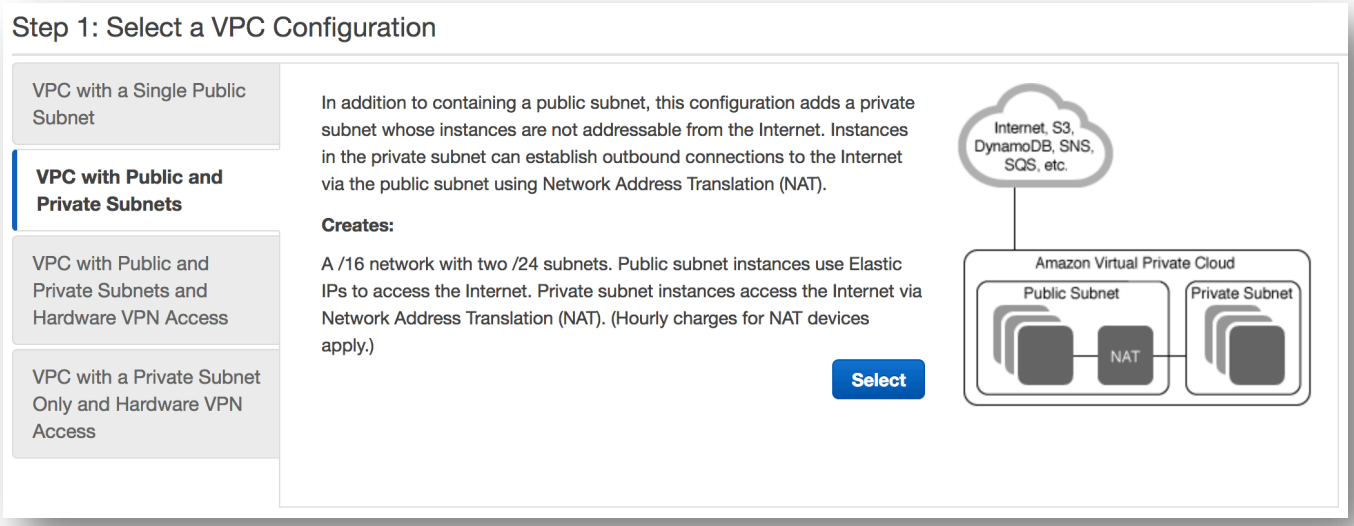
Continuing past this point will incur a very small charge in your account. The Elastic IP (EIP) and NAT Gateway (NGW) are both resources which are not eligible for the Free Tier.

During the VPC wizard set up, you will need to specify an **Elastic IP Address (EIP)**. An Elastic IP is a static public IPv4 address that you can attach to AWS resources, such as EC2 instances and NAT Gateways. Elastic IPs are required for NAT Gateways.

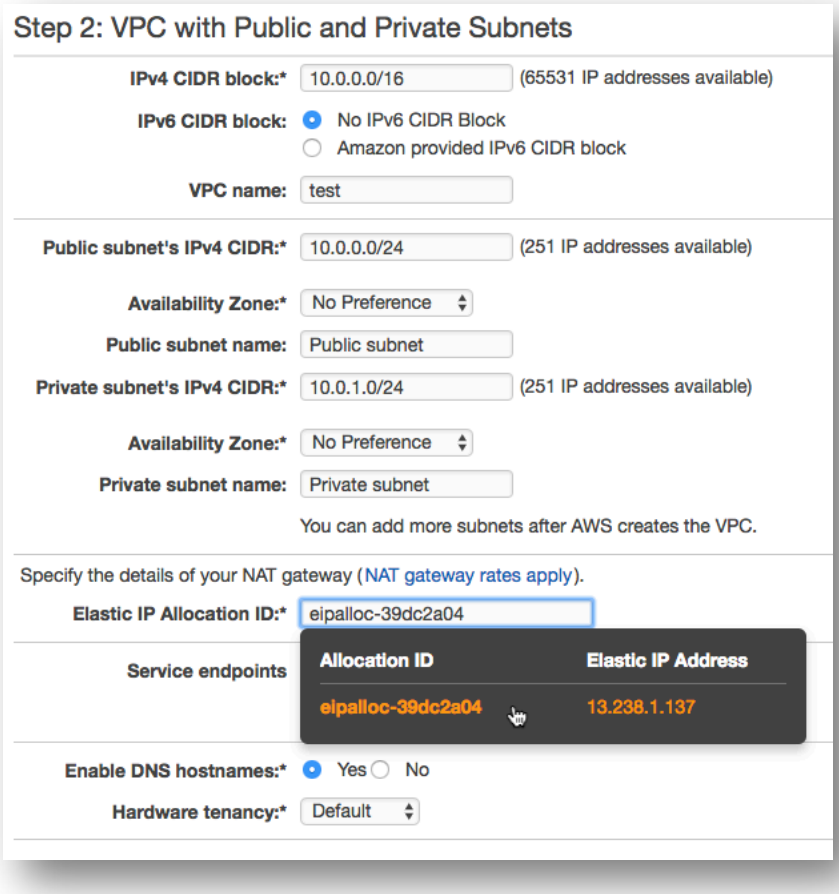
To create one, go to **Elastic IPs** in the sidebar, and press **Allocate new address**, **Allocate**, **Close.**



Now click on **VPC Dashboard** in the top left corner to go back to the main VPC page.
Click on **Launch VPC Wizard** to start the VPC Wizard and select '**VPC with Public and Private Subnets'**.



This option will create a VPC with a /16 CIDR block and two subnets with /24 CIDR blocks which have 256 total IP addresses each. In each subnet, **AWS reserves 5 IP addresses**. In this case, that leaves you 251 IP addresses per subnet. Fill in the **VPC name** (I called my VPC "**test"**) and select your **Elastic IP Allocation ID** from the drop-down. For this lab, we will leave the rest of the default configuration as is.



This Elastic IP will be used to create a **Network Address Translation (NAT) gateway** for the private subnet. NAT gateway is a managed, highly scalable NAT service that gives your resources access to the internet but doesn't allow anyone on the internet access to your resources. NAT is helpful for when a resource needs to pull down updates from the internet but should not be publicly accessible.

Click on **Create VPC**. This step will take a couple minutes. Once your VPC has been created, click **OK**.

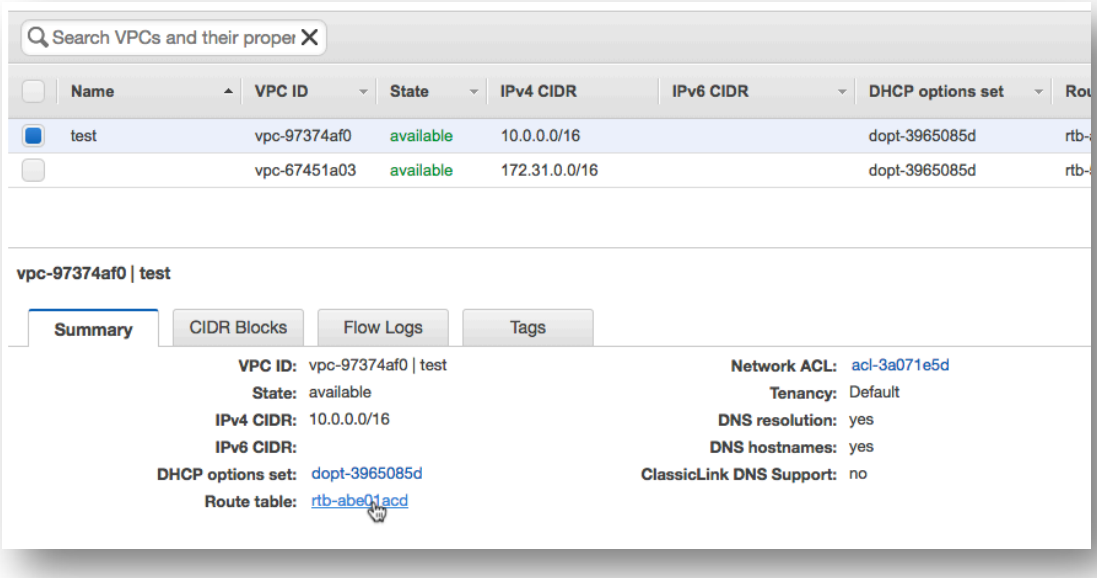
Wow! It only took you a few minutes to set up an entire virtual private network, including subnets for public and private resources, routing rules, and a scalable NAT service.

What the VPC Wizard Created

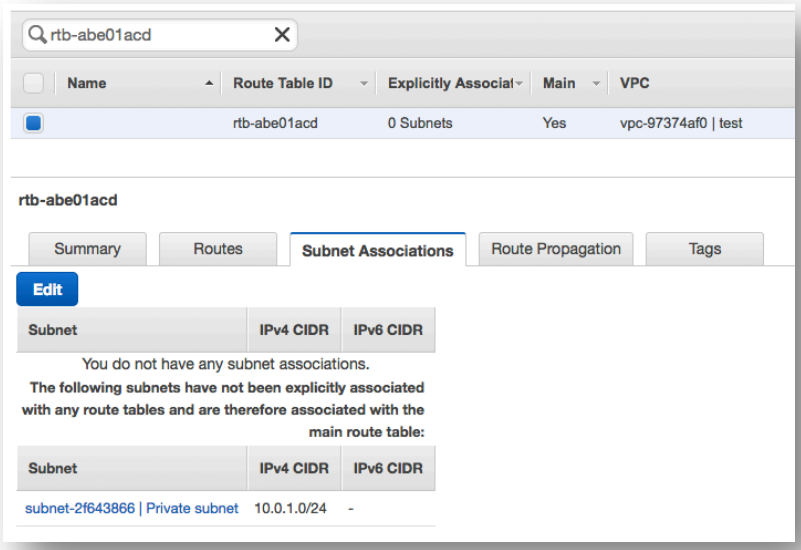
Let's walk through the VPC Console and explain each component that the wizard created.

From the last step, you should now be on the **Your VPCs** dashboard looking at all of your VPCs in this region. Select the VPC that you just created, and look at the **Summary** tab. If you can't see everything in the pane, you can pull the pane up by dragging on the pane's top line.

In the **Summary** tab in the left-hand column, you can see the **Main Route Table** for your VPC. Any subnets in the VPC that do not have a route table directly associated with it will use this route table by default. To explore this further, click on the **Route table link**.



You are now in the **Route Tables** dashboard, filtered on the main route table of the VPC you just created. That means that there should be only one route table shown. Select this route table and click on the **Subnet Associations** tab.



You can see that there are no **explicit subnet associations** on this route table. However, since this is the main route table for the VPC, there is one subnet implicitly associated. It's the **Private subnet** of the VPC.

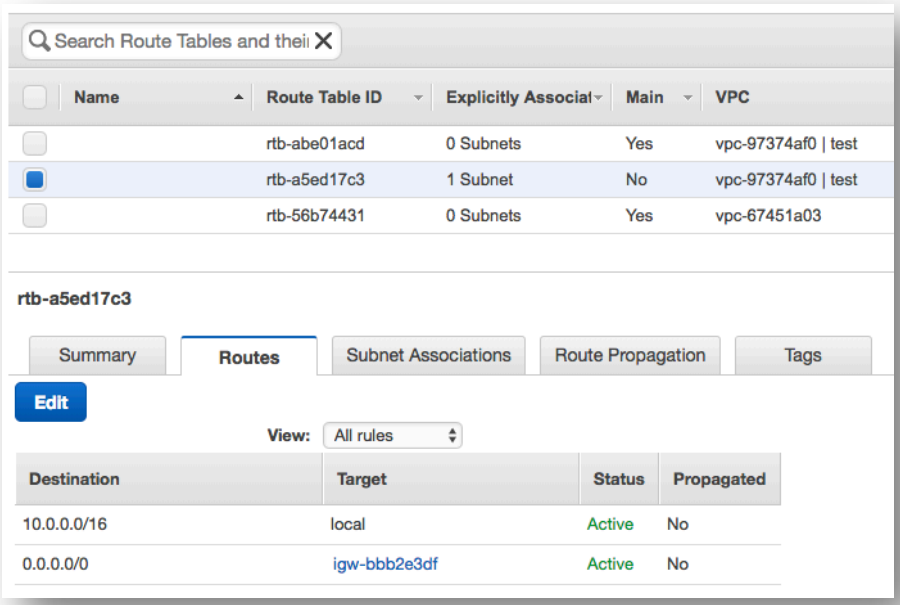
What makes a subnet public or private? We can find out by looking at the routes in this table.
Click on the **Routes** tab.

In the **Routes** tab, look at the **Target** column. You'll see one **local route** which every route table has. This ensures that resources within the VPC can talk to each other.

You will also see a route to the **NAT gateway** that the wizard created. Remember that a NAT gateway gives internet access to resources which are not publicly accessible. Because the resources in this subnet are not publicly accessible, this is considered a **private subnet**.

Now let's find out what makes a subnet public. First, get rid of the filter on this view. To do this, **click the X in the search bar**. You are now looking at all of the route tables in this region. Your dashboard should look something like the screenshot below.

Select the other route table in your VPC (check **VPC** column for name) which is not the main route table (check **Main** column for **No**). In the **Routes** tab, you'll see a route to an **Internet Gateway (IGW)**. IGWs are another managed and scalable service like the NAT Gateway except that it allows access from the internet to your resources in the VPC, making your resources publicly accessible.

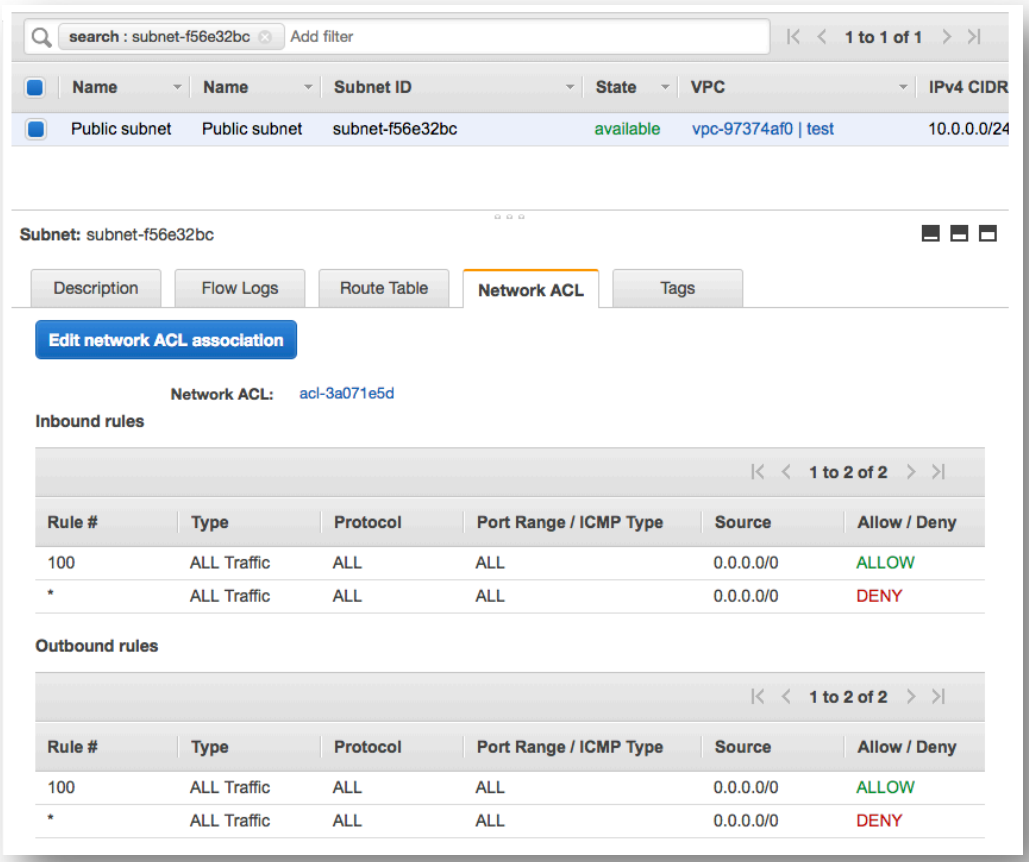


There is a reason why this route table is not the main route table. It is best practice for your VPC's main route table to not have a route to an IGW so that subnets are private by default and only public if specified.

Go to the **Subnet Associations** tab and confirm that it is the **Public subnet** which is associated with this route table. Click on the **Public subnet link**.

Look at the **Description** tab. You'll notice a **Network Access Control List (Network ACL)** link. NACLs are virtual stateless firewalls at the subnet layer. This wizard used the **default NACL** (created automatically with the VPC) for both subnets. Similar to the main route table, the default NACL is implicitly associated with all subnets in a VPC unless another NACL is directly associated with that subnet.

Go to the **Network ACL** tab to look at the default NACL rules. Rules are evaluated in order from lowest to highest. If the traffic doesn't match any rules, the * rule is applied, and the traffic is denied. Default NACLs allow all inbound and outbound traffic, as shown below, unless customized.



Allowing all traffic in and out of your subnets is not a good security posture. However, it is possible to achieve good security with this default NACL by leveraging **Security Groups** as well.

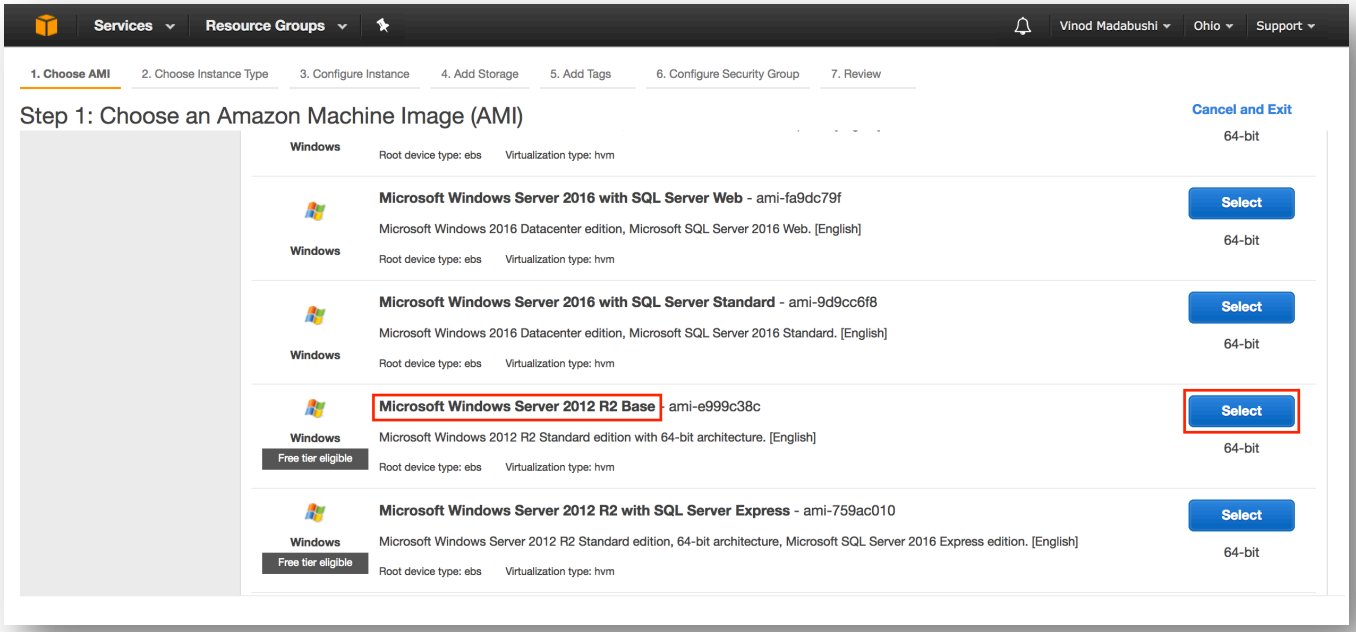
Security Groups are virtual stateful firewalls at the resource (EC2 instance) level. It is best practice to implement necessary firewall rules with Security Groups first and only adding rules to NACLs as necessary. For instance, you can explicitly deny traffic from specific IPs with NACLs but not with Security Groups. We will explore Security Groups more in the next section.

We have now gone through the bread and butter of AWS networking. You should now understand how routing works in a VPC, what makes a subnet public or private, and how to secure your resources at the subnet and resource levels.

Create a Public EC2 Instance

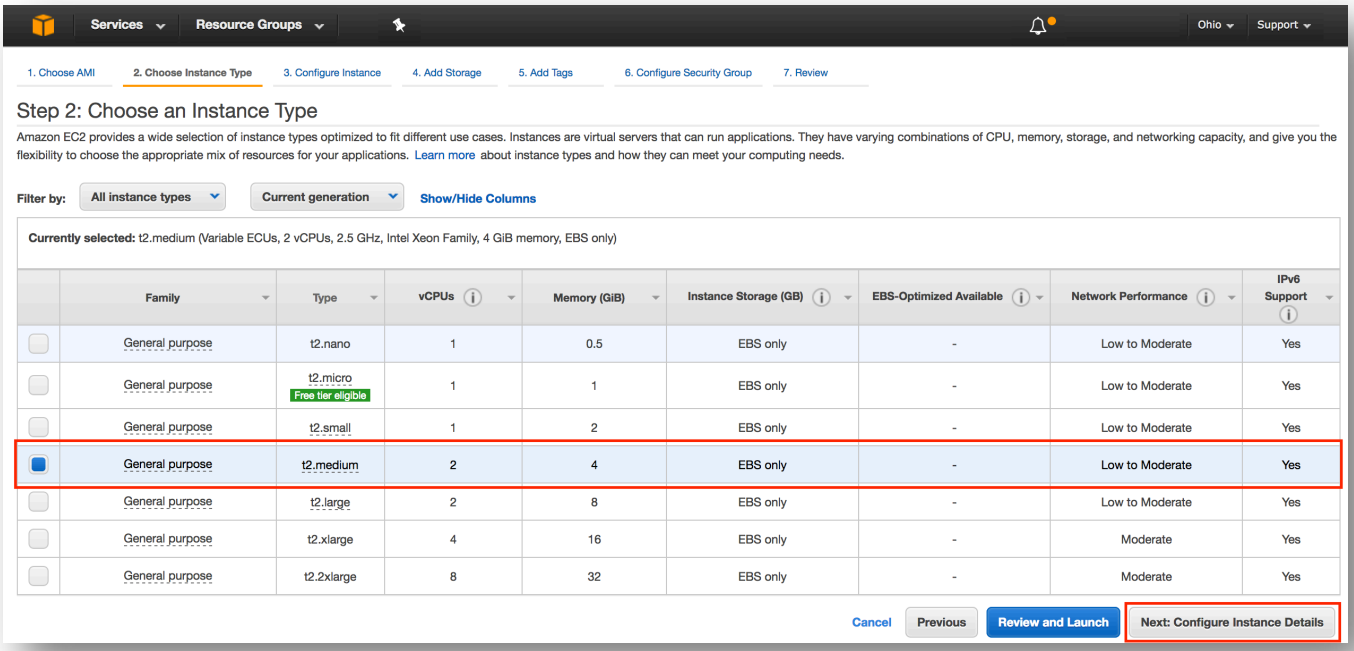
In this section, you will spin up an EC2 instance in the Public subnet of your VPC.
To get started, go to the **Services** drop down menu in the top left corner and go to the **EC2 dashboard**.

1. Select Launch Instance, and then in the **Quick Start** section select the first Windows Server 2012 R2 Base AMI and click **Select.**

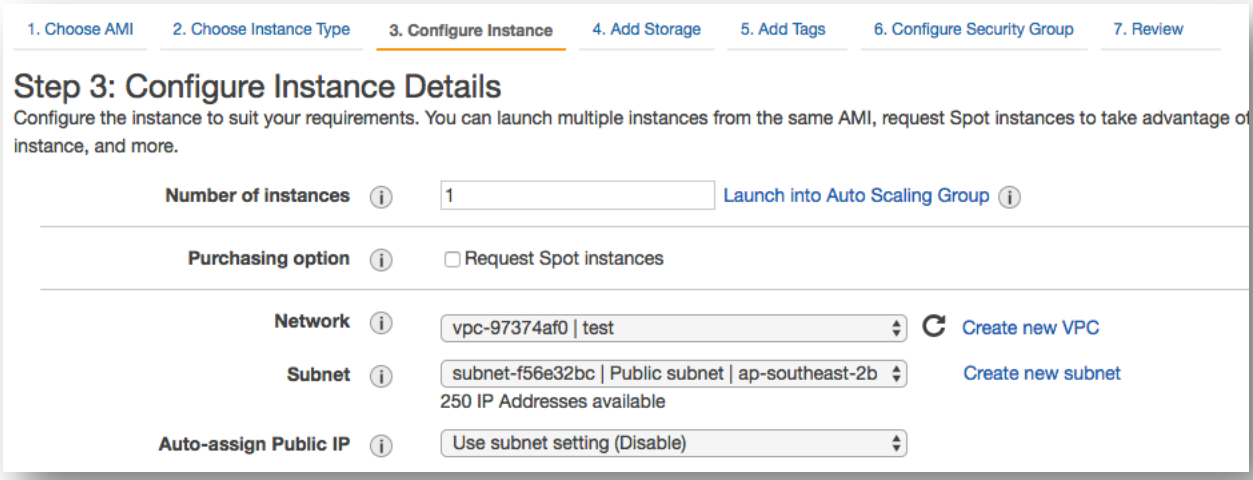


2. In the Choose Instance Type tab, select the **t2.medium** instance size and click **Next: Configure Instance Details**

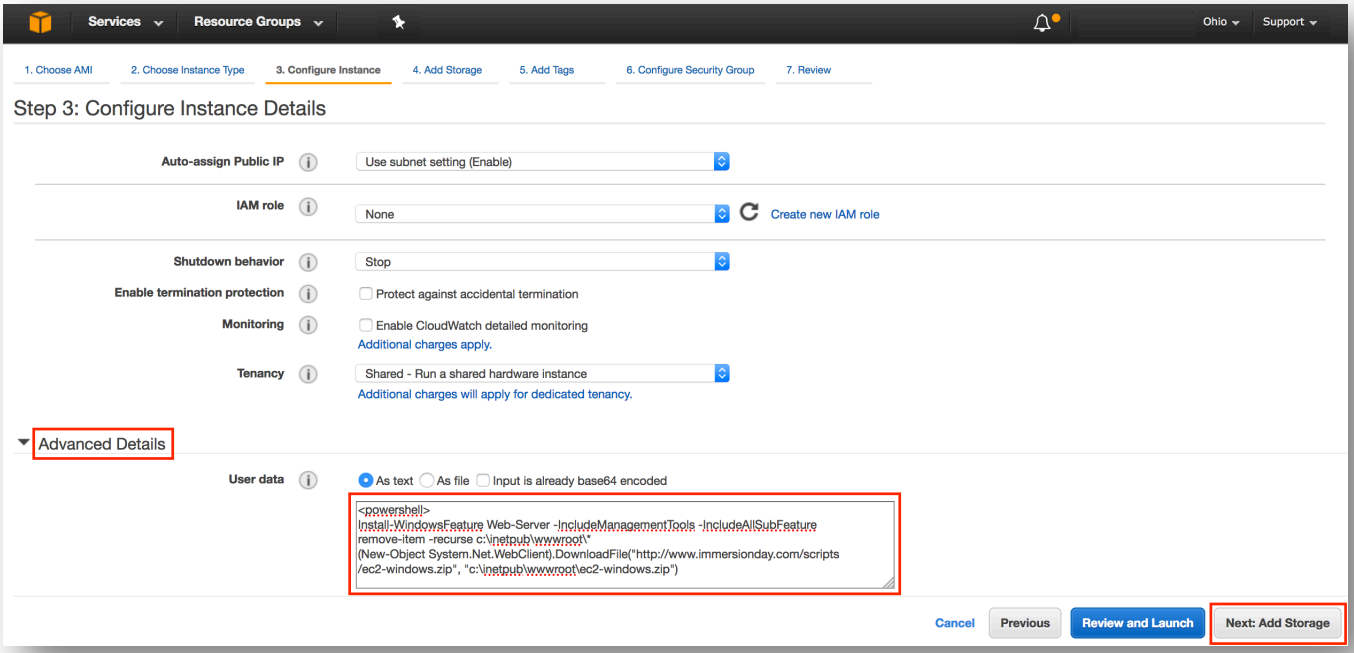
If it isn't labeled "Free Tier Eligible", you may incur a charge!



3. On this page, you decide which network and subnet this resource will be put into. Change the **Network** field to the VPC that you just created and change the **Subnet** field to the **Public subnet**. Leave the other default settings as is. Click **Next**.



1. On the **Configure Instance Details** page, expand the **Advanced Details** section, copy/paste the script at https://bit.ly/2QFxEKw into the User Data field (this PowerShell script will install/start IIS and deploy a simple web page) and click **Next: Add Storage**:

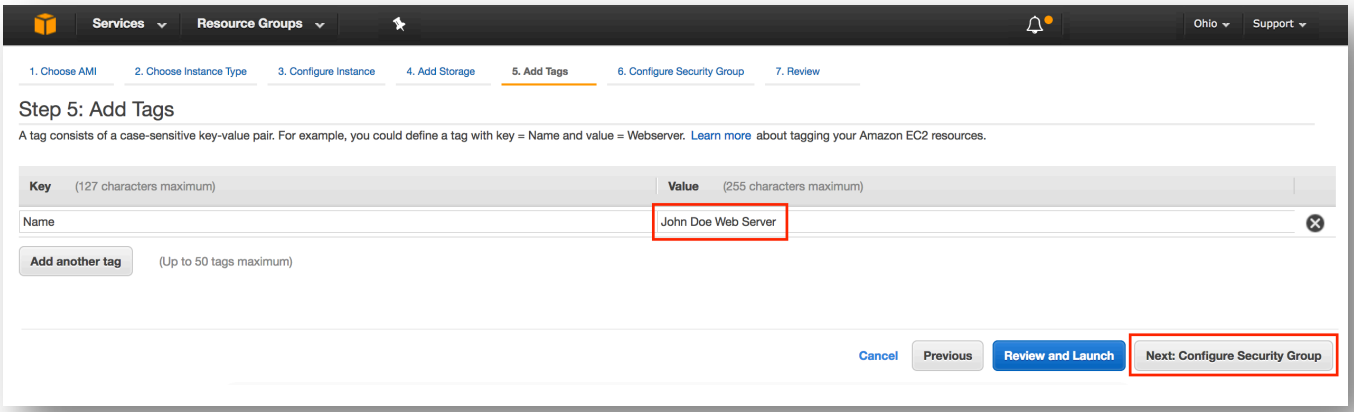


For further information on User Data please refer to the documentation at - http://docs.aws.amazon.com/AWSEC2/latest/WindowsGuide/ec2-instance-metadata.html.

On the **Step 4: Add Storage** screen, Click **Next: Add Tags** to accept the default Storage Device Configuration and move to the Step 5: Add Tags screen.

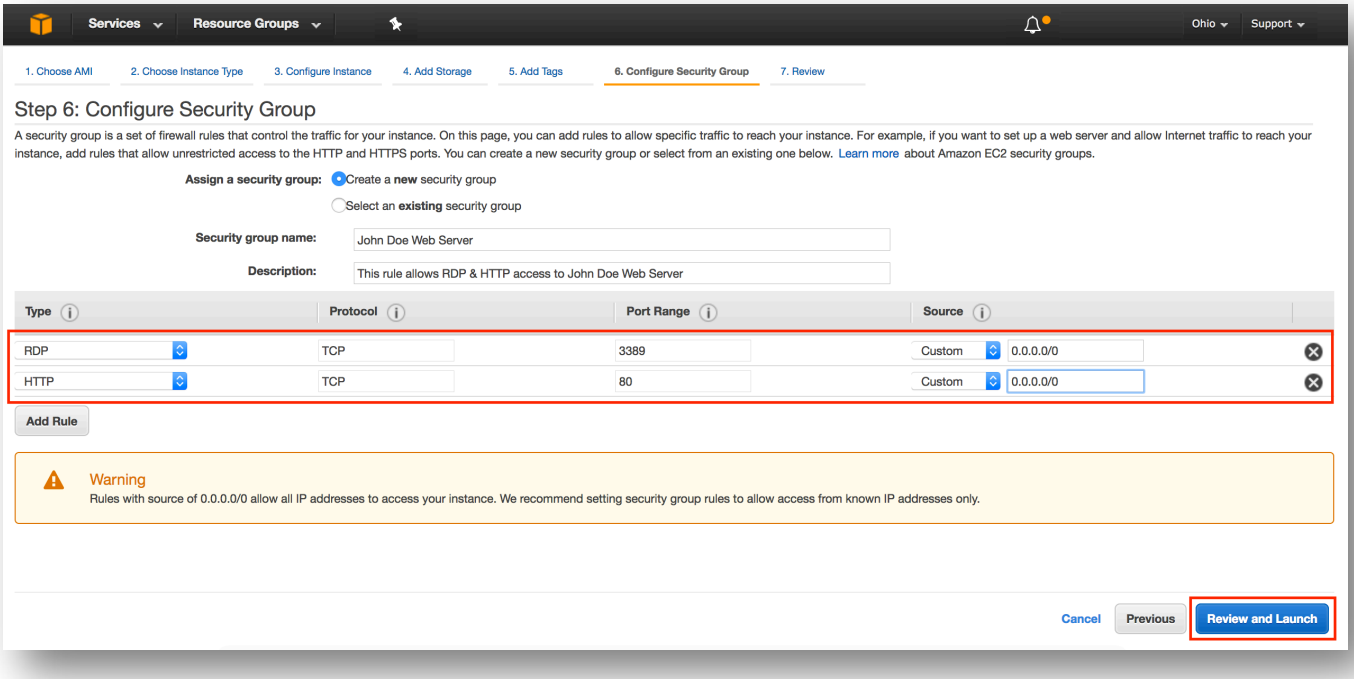
Next, choose a “friendly name” for your instance. This name, more correctly known as a tag, will appear in the console once the instance launches. It makes it easy to keep track of running machines in a complex environment. Name yours according to this format: “[Your Name] Web Server”.

Then click **Next: Configure Security Group**.

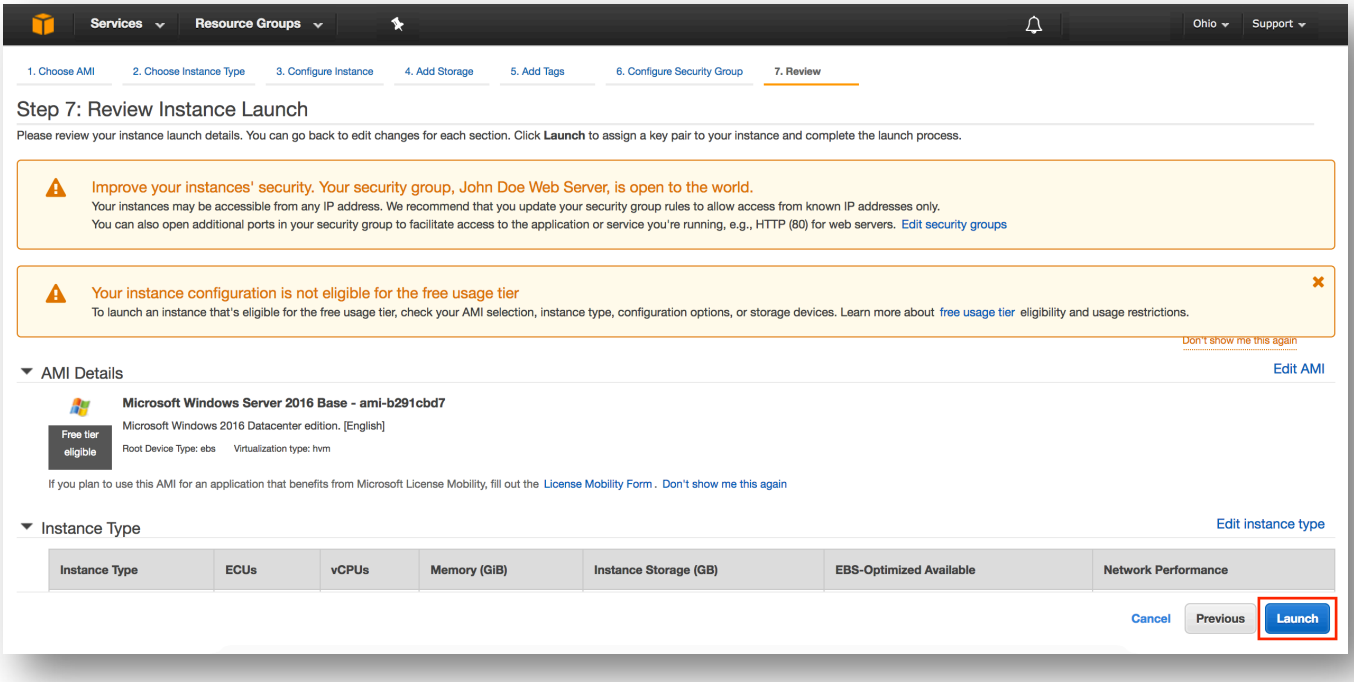


For further information on Tags please refer to the documentation at - http://docs.aws.amazon.com/AWSEC2/latest/UserGuide/Using_Tags.html.

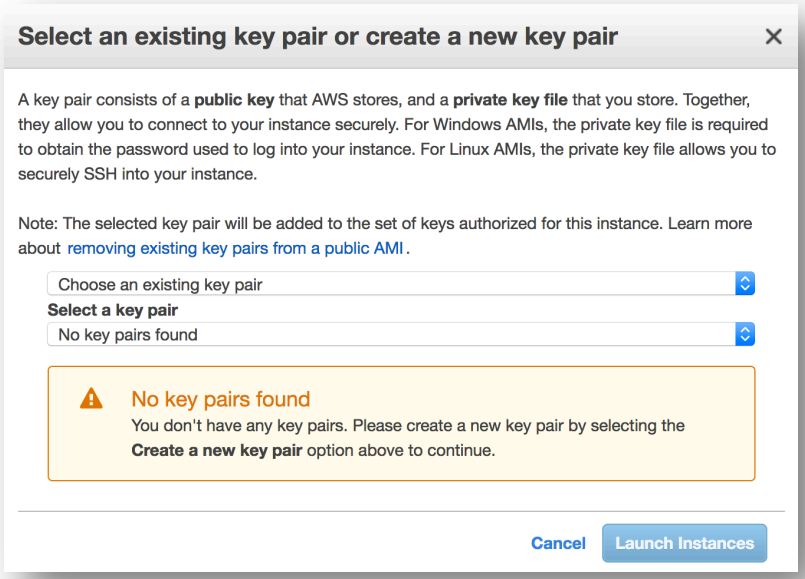
2. You will be prompted to create a new security group, which will be your firewall rules. On the assumption that we are building out a Web server, name this security group according to this format "[Your Name] Web Server", and open ports 3389 and 80. Click the **Review and Launch** button after configuring the security group.



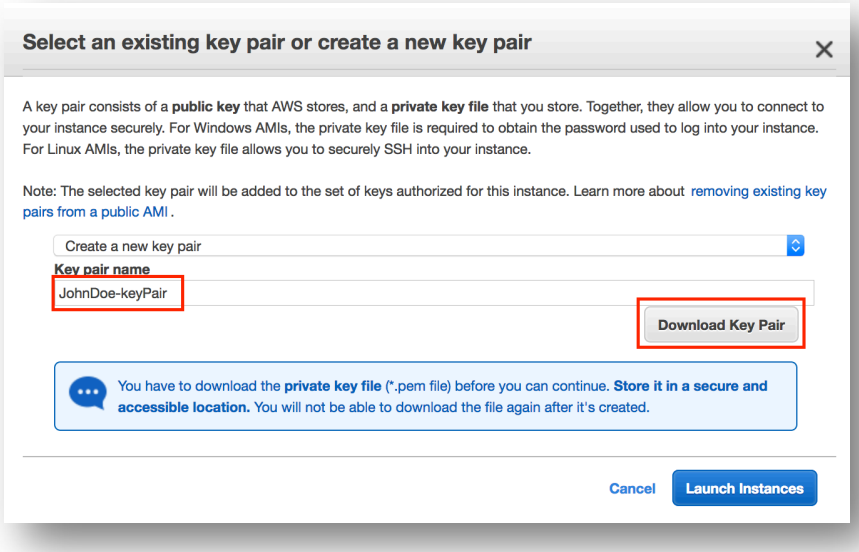
3. Review your choices, and then click **Launch**. *Note the two warning boxes at the top of the page, these are to warn you about possible configuration issues. In this lab we are creating a Windows server that has RDP access that is "open to the world" this is something that you wouldn't normally do.*



4. Now you need to create a public/private keypair. When this instance launches, you will connect to it via Remote Desktop using the credentials for "administrator". For Windows instances, EC2 automatically generates a password and encrypts with your public key. To decrypt the encrypted password, you will use your private key. Let's create a new public/private keypair.



5. Enter a name for the key pair using the following format: [YourName]-KeyPair and click **Download Key Pair**.

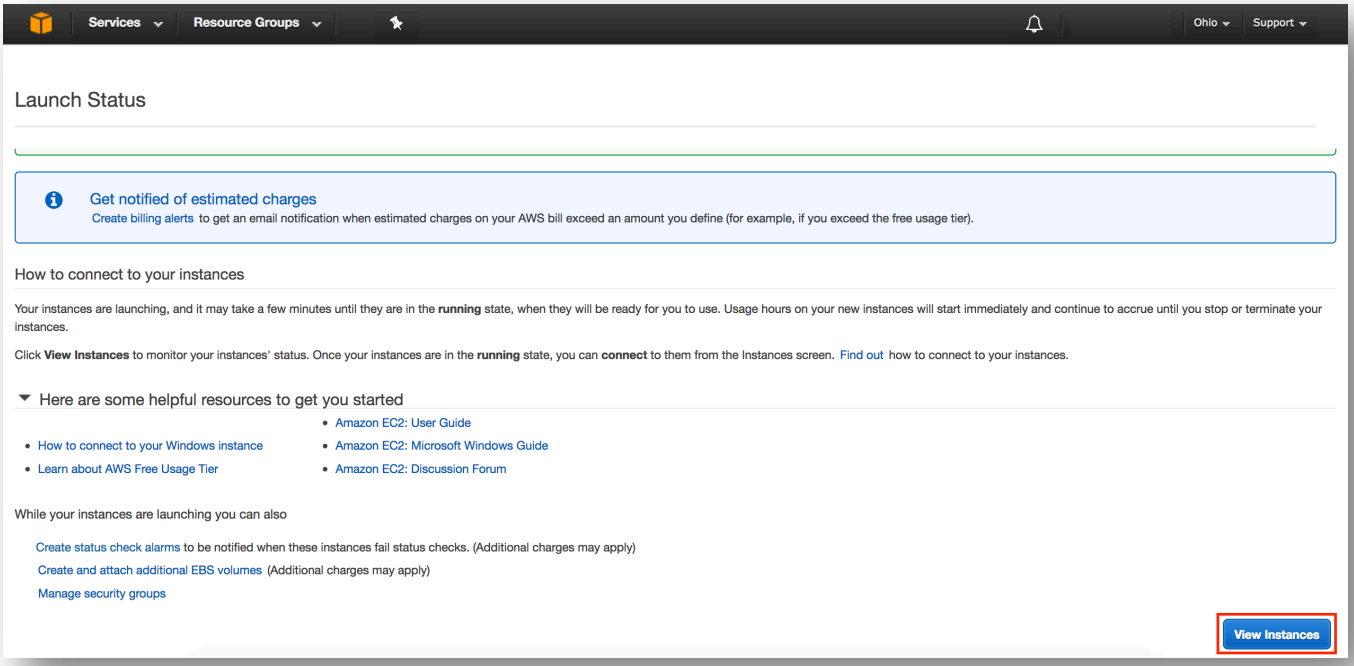


6. Your browser will download the private portion of the key pair to your PC. It will have a name like *JohnDoe-KeyPair.pem*. Note the location of this file because you will need it later to decrypt the administrator password.

7. Now click the **Launch Instances** button to launch your Windows web server.

8. The next screen will confirm that your instance is now launching. Click the **View Instances** button.

Once your instance has launched, you will see the “[Your Name] Web Server” instance as well as the Availability Zone the instance is in and its publicly routable DNS name.



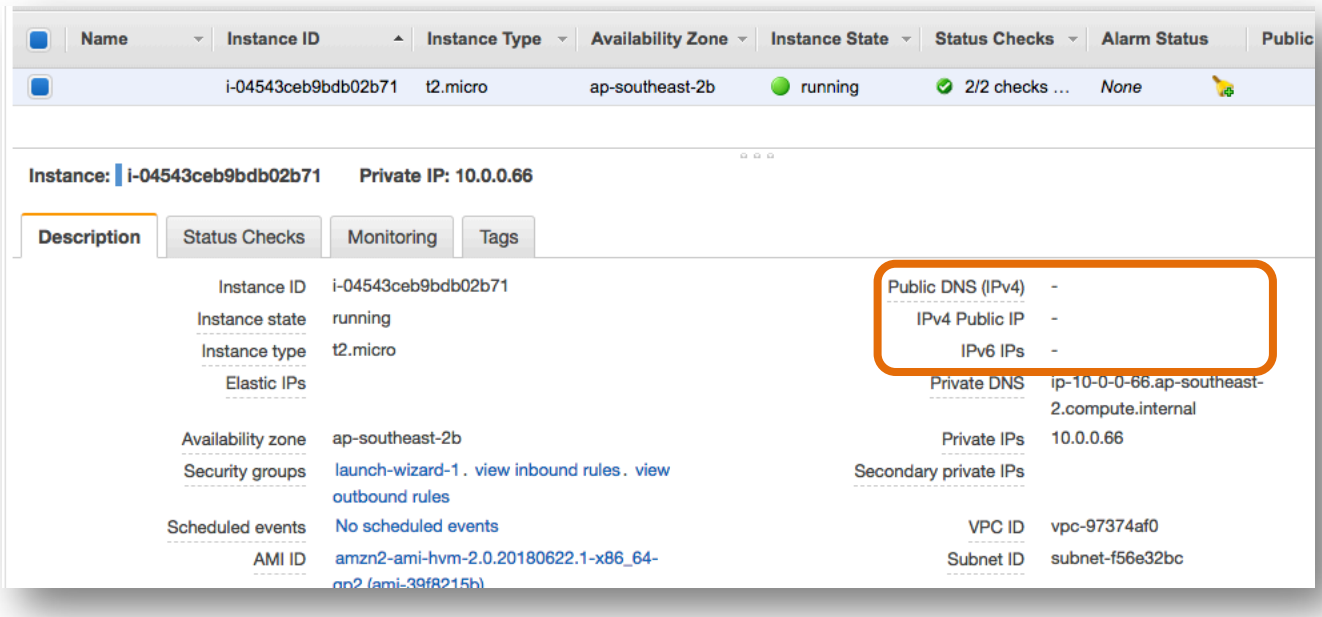
Congratulations! You have just launched a virtual server in your private network.

Test Access to Public Instance

In this section, you will ping the EC2 instance that you just created and learn more about security groups along the way.

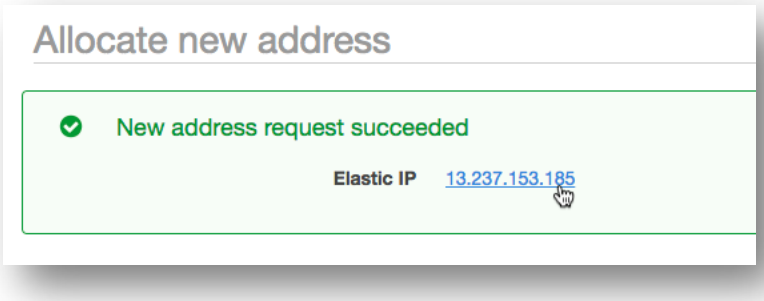
You should be on the EC2 **Instances dashboard** from the last section, looking at all of the EC2 instances in this region. If you just finished the last section, your EC2 instance might still be spinning up. You can tell by looking at the **Instance State** and **Status Checks** columns. If you see **pending** state and/or status **Initializing**, the instance is not ready yet.

While you're waiting for your instance to be ready, select the instance to look at the **Description** tab. At the top of the right-hand column, there is the information that we need to access the instance – the IP addresses and DNS records associated with the instance. However, you can see that this instance doesn't have a public IP or DNS yet. We will need at least one of these to ping this instance via the internet.



To fix this, we are going to attach an **Elastic IP** to the EC2 instance. First, copy the **Instance ID** of this EC2 instance by hovering your mouse to the right of the Instance ID line in the **Description** tab, and clicking on the **Copy to clipboard** icon that appears.

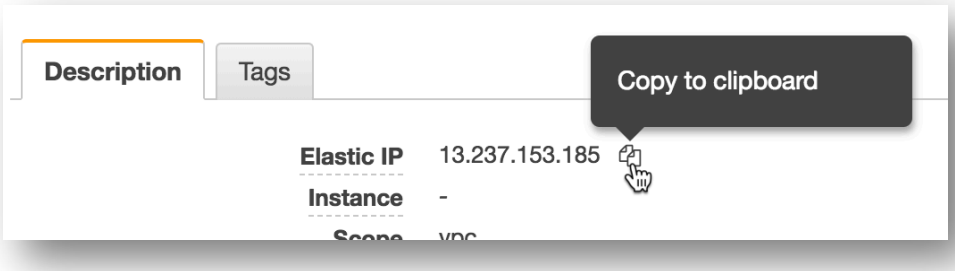
Next, click on **Elastic IPs** in the sidebar (under the **Network & Security** section). Create a new Elastic IP as before, except this time, **do not** click on the **Close** button. Instead, you will: **Allocate new address, Allocate**, and then click on the **Elastic IP** link in the **New address request succeeded** box.



Now you are back on the **Elastic IPs** dashboard. Go to the **Actions** dropdown and select **Associate address**. Paste the Instance ID that you copied previously into the **Instance** box and click on **Associate**, then **Close**.

Now that an Elastic IP is attached to the EC2 instance, we should be able to ping the instance over the internet. It now has a public IP address from the Elastic IP, and it's in the public subnet which has a route to an IGW.

In the **Description** tab, copy the Elastic IP address.



To ping the instance, you need to open your CLI. On Windows, open the **Command Prompt**. On Mac, open the **Terminal**. Type **ping,** then a **space**, then **paste the Elastic IP** from above and click **enter**.

If the instance is reachable, we expect to see lines appearing such as

```
64 bytes from 13.237.153.185: icmp_seq=0 ttl=238 time=169.294 ms
```

However, you will see request timeouts instead. You will see lines that say something similar to

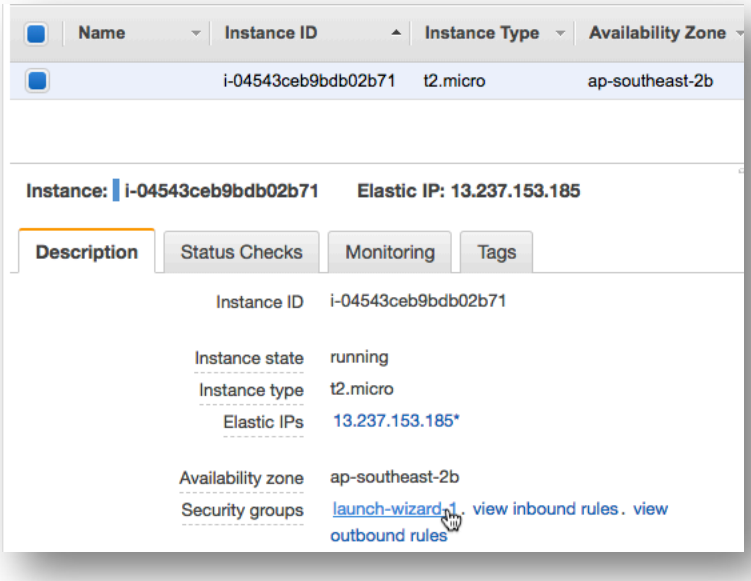
```
Request timed out.
```

Why aren't we able to reach this instance?

You can confirm that the instance is in the public subnet and check the route table associated with that subnet to make sure there is a route to the IGW.

Next, let's check our virtual firewall configurations. As you remember, we left the NACL of the public subnet as is, which allows all traffic by default. So, let's check the security group associated with this instance.

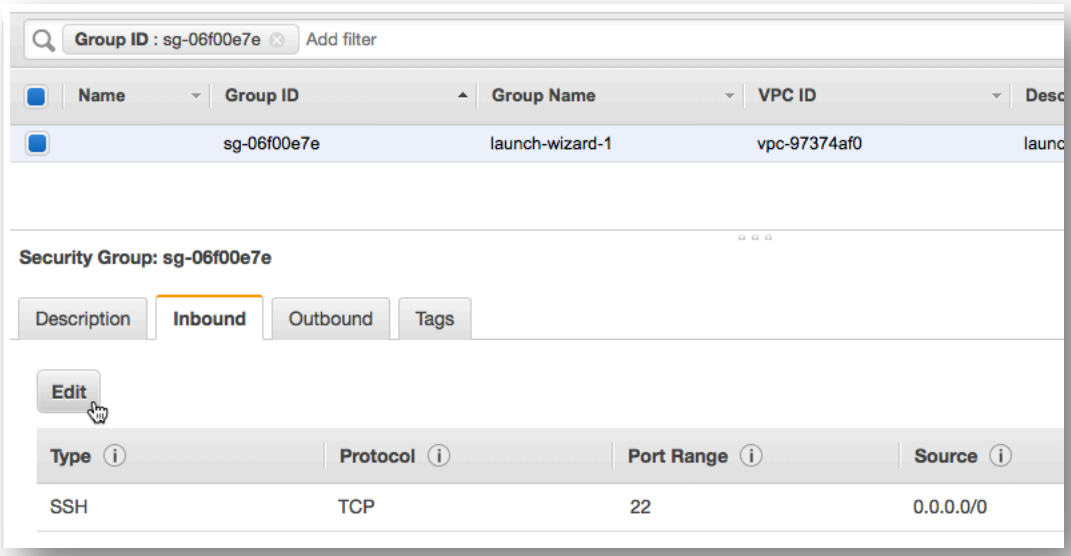
In the **EC2 dashboard**, go to the **Instances** section in the sidebar. Select the instance that you created and look at the **Description** tab. In the left column, click on the first **Security groups** link. It should be called something similar to **launch-wizard-1**.



You are now in the **Security Groups** dashboard. Go to the **Inbound** tab.

Remember when we were creating the EC2 instance we only specified the AMI, instance type, and VPC subnet. We left all the other default settings as is

Pings use **ICMP**, so we will need to change the security group rule to allow ICMP traffic. Click on the **Edit** button.



Click on **Add Rule** to open the drop-down and add **All ICMP - IPv4**. Click **Save**.

Since security groups are stateful, you don't need to edit the outbound rules. The security group will allow the instance to respond to the ping since it saw the ping arrive at the instance. This change will also take effect immediately, so we can try to ping the instance again right away.

Go back to your CLI and hit the **up arrow** and then **enter** to try and ping the instance again.

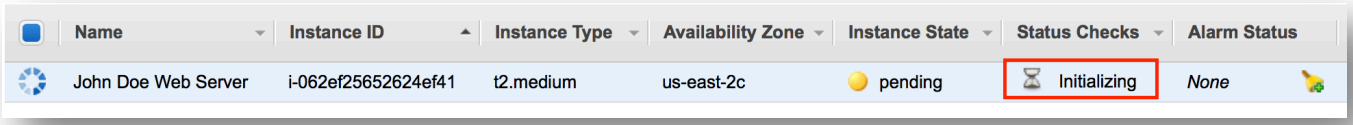
```
sh-3.2# ping 13.237.153.185
PING 13.237.153.185 (13.237.153.185): 56 data bytes
64 bytes from 13.237.153.185: icmp_seq=0 ttl=238 time=170.685 ms
64 bytes from 13.237.153.185: icmp_seq=1 ttl=238 time=171.408 ms
64 bytes from 13.237.153.185: icmp_seq=2 ttl=238 time=172.778 ms
64 bytes from 13.237.153.185: icmp_seq=3 ttl=238 time=171.531 ms
64 bytes from 13.237.153.185: icmp_seq=4 ttl=238 time=170.766 ms
64 bytes from 13.237.153.185: icmp_seq=5 ttl=238 time=170.729 ms
64 bytes from 13.237.153.185: icmp_seq=6 ttl=238 time=172.864 ms
64 bytes from 13.237.153.185: icmp_seq=7 ttl=238 time=173.407 ms
64 bytes from 13.237.153.185: icmp_seq=8 ttl=238 time=176.205 ms
64 bytes from 13.237.153.185: icmp_seq=9 ttl=238 time=173.657 ms
^C
--- 13.237.153.185 ping statistics ---
11 packets transmitted, 10 packets received, 9.1% packet loss
round-trip min/avg/max/stddev = 170.685/172.403/176.205/1.661 ms
```

Good job! You have successfully troubleshooted why an EC2 instance was unreachable and then accessed it over the internet.

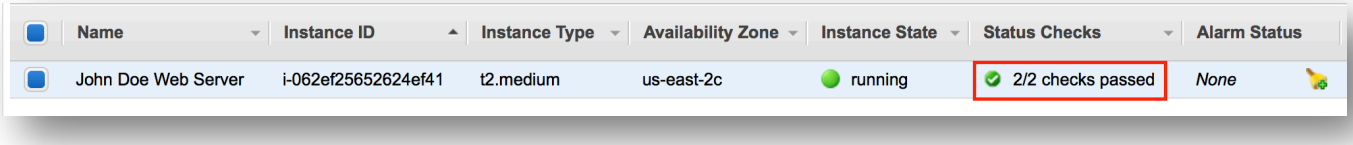
Browse the Web Server

Now you will browse to the Web Server site that was installed on the Instance using the PowerShell script defined in the **User Data** section during creation of the instance.

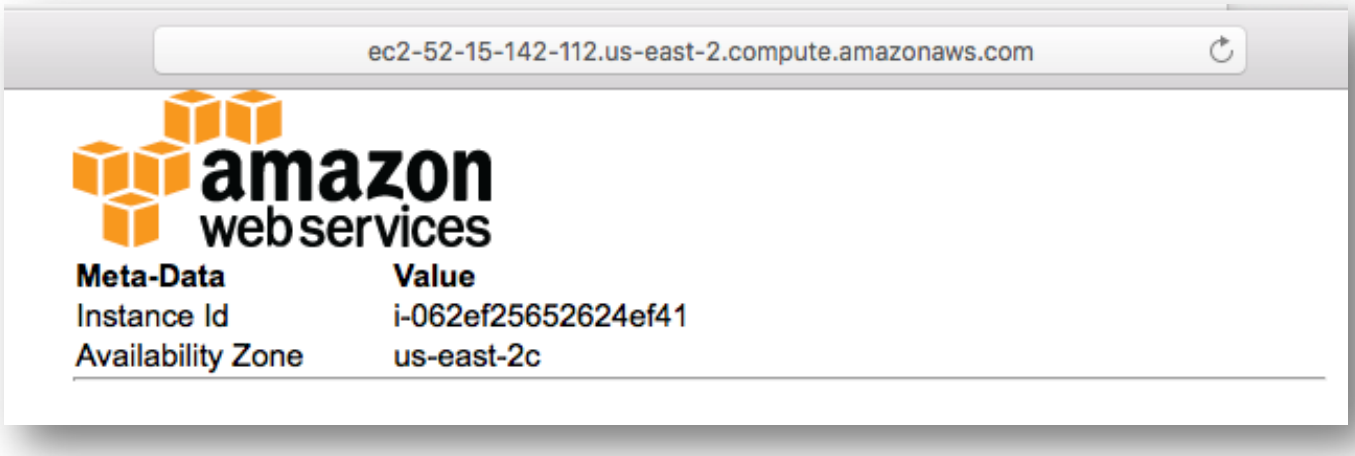
4. Wait for the instance to pass the Status Checks. For Windows instances, this could take up to 20 minutes.



When complete, you will see the Status Checks have passed.



5. Open a new browser tab and browse the Web Server by entering the EC2 instance's Public DNS name into the browser. The EC2 instance's Public DNS name can be found in the console by reviewing the "Public DNS" column. You should see a page that looks similar to this

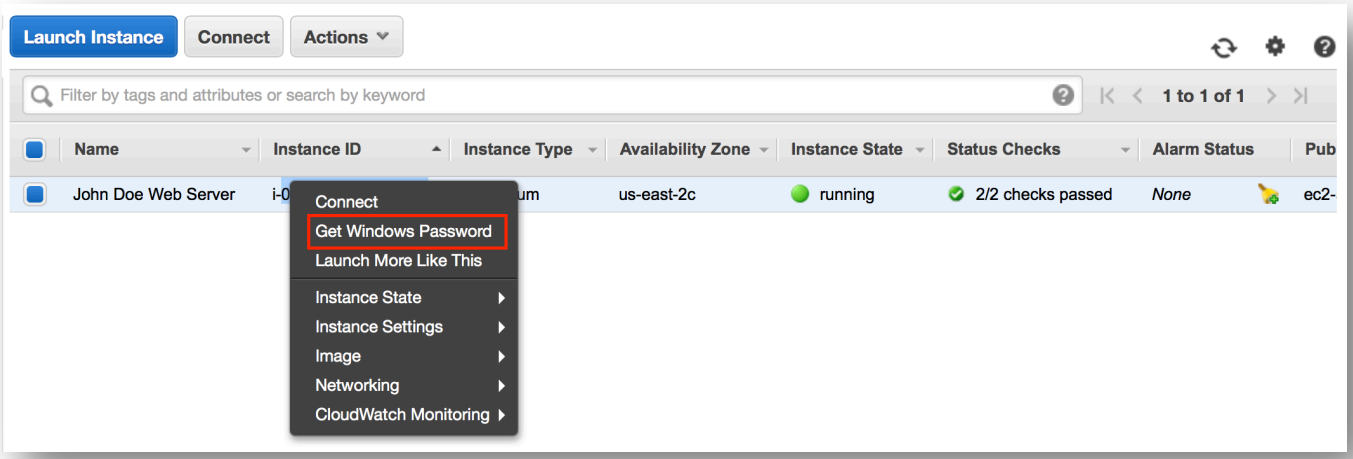


Great Job: You have built your first web server!

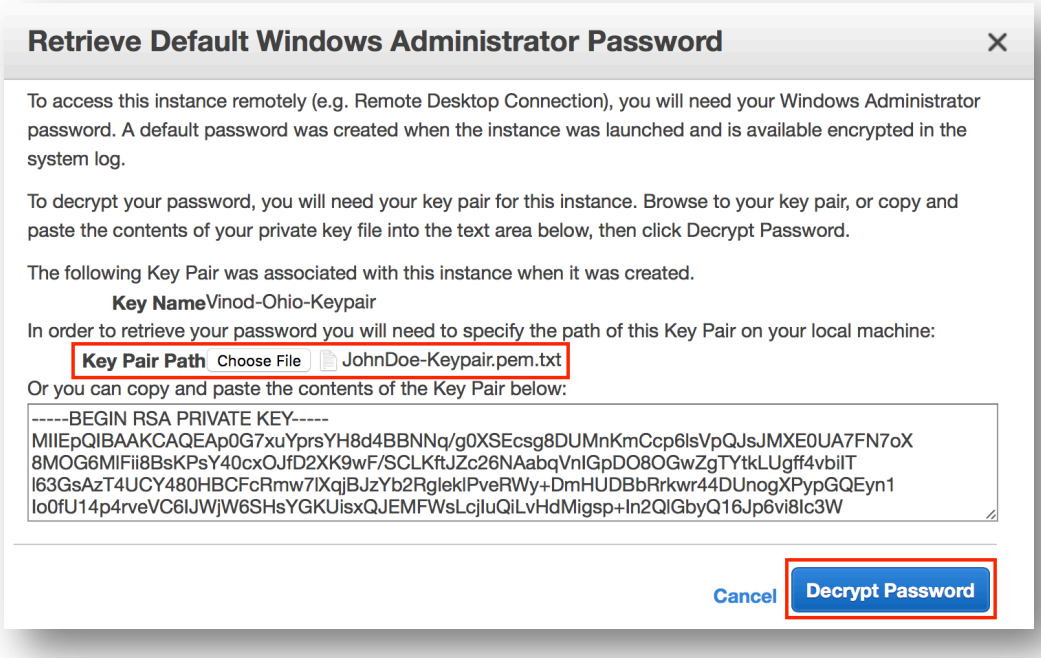
Connecting To Your Windows Instance

To connect to the Windows desktop, we will use a RDP client. If you're using a Windows PC, use the bundled Remote Desktop application. For Mac users, if you don't have a RDP client already installed, download Microsoft Remote Desktop.

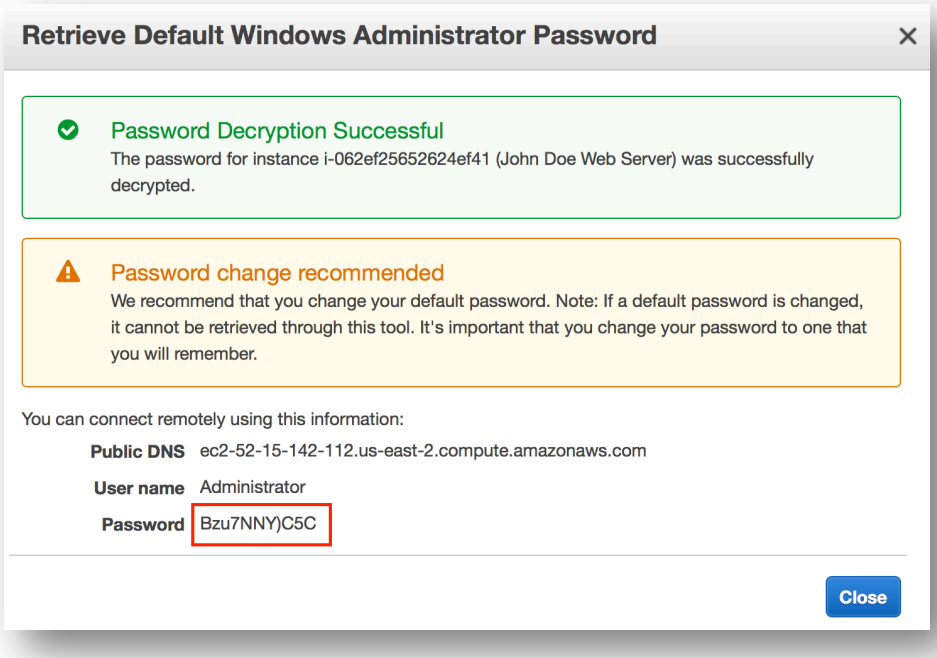
1. Retrieve the automatically generated, encrypted Windows password by right clicking your instance and selecting **Get Windows Password**.



2. On the next screen, click the Choose File button and select the private key file that was automatically downloaded earlier when you launched the instance. Then click **Decrypt Password** to obtain the Administrator password.

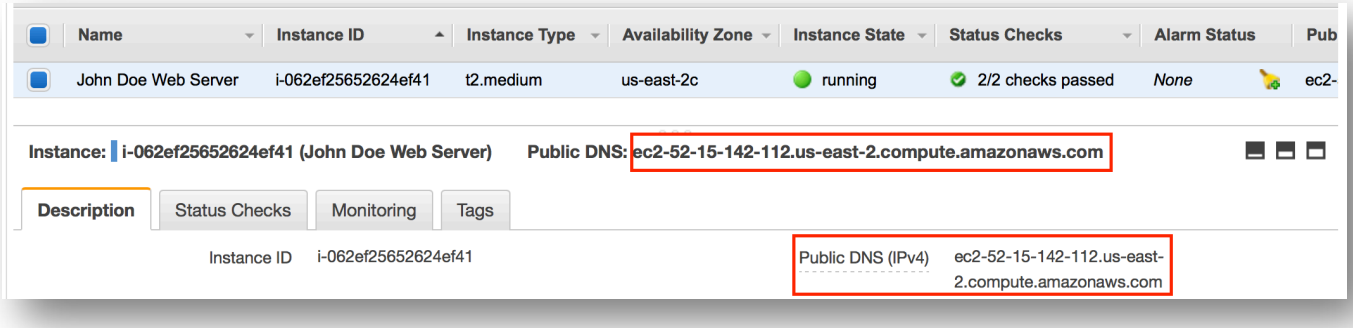


3. The decrypted Administrator password should look something like this:



Note that since only you have the private key, it's important to understand the automatically generated password can only be decrypted by you. So it's important to keep this key secure. Generally, the automatically generated password is changed by the customer after first login. If the automatically generated password is not changed and the private key is lost, there's no way to recover the password.

4. Start your RDP application and connect to the hostname of your instance. The hostname can be found in a couple of different places. For example, in the web console, you'll see hostname listed as the **Public DNS** of the instance.



5. In your RDP application, use **Administrator** as the username along with the decrypted password. Once connected, you will have access to the Windows desktop. At this point, feel

free to explore Windows. You should change the Administrator password to something friendlier or easy to remember (but still secure of course).

Test Access to Private Instance

Optionally, you can go through the same process in the last two sections in order to test access to a private EC2 instance. The only difference will be in the **Configure Instance Details** section, you will select the **Private subnet**. Also, if you don't want to go through attaching an Elastic IP, in the same section, you can select **Enable** under **Auto-assign Public IP**. Remember that this is not best practice for public facing resources, but in this case the instance will not be reachable anyways because the private subnet does not have an IGW route. We just want a public IP to try to access, and for this, the automatically assigned public IP is sufficient. Additionally, you will want to open up your security group from the beginning. That way, this private instance will be the same in every way to the public instance you just created except that it does not have a route to an IGW and thus cannot be accessed publicly.

Clean Up Lab Resources

If you want to clean up your account to get rid of everything we created during this lab, follow the instructions in this section. You can also leave your lab environment running if you want to test other AWS networking concepts.

First, you will need to terminate the EC2 instances that are running in the VPC. In the **EC2 dashboard**, select the public instance (as well as the private instance if you created one), go to the **Actions** dropdown, go to **Instance State**, and then **Terminate**. In the pop-up window, click on **Yes, Terminate.** You may need to wait a minute for the instances to finish shutting down. Watch the **Instance State** column and wait for the status to change from **shutting-down** to **terminated**.

Now we will delete the NAT gateway that the VPC wizard created. Go to the **Services** dropdown in the top left corner and select the **VPC dashboard**. Go to the **NAT Gateways** section in the sidebar. If there are multiple NAT Gateways, you can look at the VPC column to confirm which one belongs to your VPC. Select that NAT gateway and go to the **Actions** dropdown. Select **Delete NAT Gateway**. In the pop-up window, click on **Delete NAT Gateway** again. It may take a minute for the NAT gateway to delete. Wait for the status to change from **deleting** to **deleted** to make sure the VPC deletion will work.

Elastic IP addresses are completely free as long a they are attached to a resource. However, if the NAT gateway or EC2 instance they were attached to is terminated or deleted, the unattached EIP will incur a small monthly charge. To clean up, navigate to **Elastic IPs** on the sidebar, and **Release** each EIP you have allocated.

Now you can finally delete your VPC. Go to the **Your VPCs** section in the sidebar. Select your VPC, go the **Actions** dropdown, and choose **Delete VPC**. In the pop-up window, click **Yes, Delete**. This will take

a minute or so to complete.

Additional Resources

VPC Introduction:
https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Introduction.html
VPC Subnets: https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Subnets.html
VPC wizard configuration:
https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Scenario2.html
NAT Gateways: https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/vpc-nat-gateway.html
Elastic IPs: https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/vpc-eips.html
Security Groups and NACLs:
https://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_Security.html