



Immersion Day

VPC Hands-On Lab

Getting Started with Virtual Private Cloud

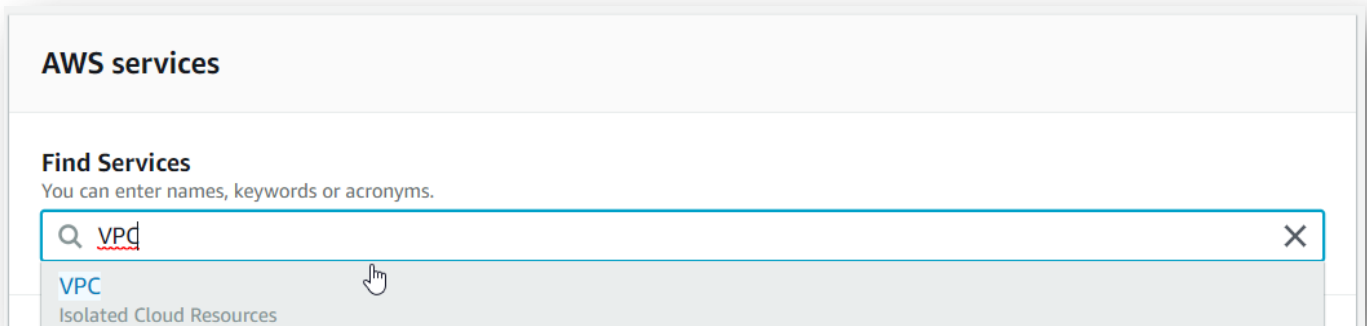
Virtual Private Cloud (VPC) Overview

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.

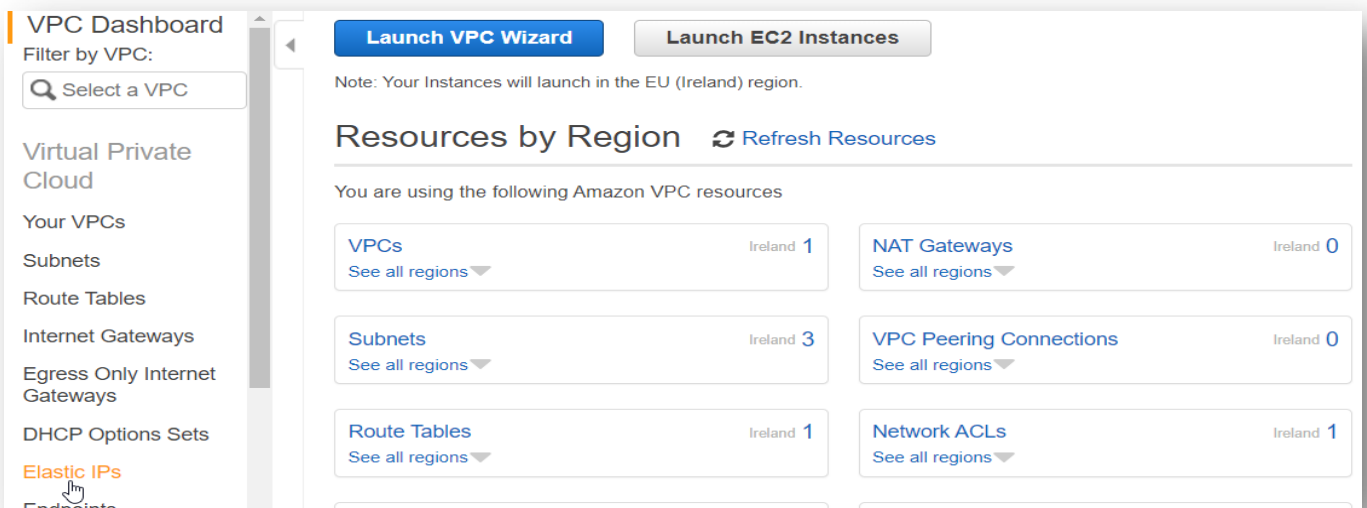
In this lab, you will learn how to set up a VPC with public and private subnets. You will also learn about AWS networking concepts such as Elastic IPs, NAT Gateways, and Flow Logs.

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.



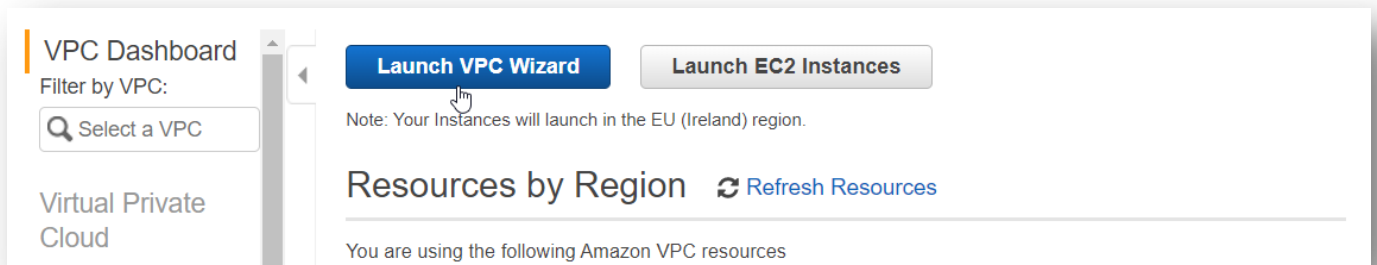
Continuing past this point will incur a very small charge in your account. The NAT Gateway (NGW) is a resource which are not eligible for the Free Tier.

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.

Press **Allocate new address**, choose **Amazon pool** and click on **Allocate** and then **Close**. Your Elastic IP will now be listed on console.

Now click on **VPC Dashboard** in the top left corner to go back to the main VPC page and click on **Launch VPC Wizard** to start the VPC Wizard



Select '**VPC with Public and Private Subnets**'.

Step 1: Select a VPC Configuration

VPC with a Single Public Subnet

VPC with Public and Private Subnets

VPC with Public and Private Subnets and Hardware VPN Access

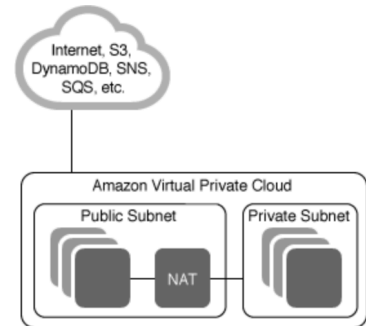
VPC with a Private Subnet Only and Hardware VPN Access

In addition to containing a public subnet, this configuration adds a private subnet whose instances are not addressable from the Internet. Instances in the private subnet can establish outbound connections to the Internet via the public subnet using Network Address Translation (NAT).

Creates:

A /16 network with two /24 subnets. Public subnet instances use Elastic IPs to access the Internet. Private subnet instances access the Internet via Network Address Translation (NAT). (Hourly charges for NAT devices apply.)

Select



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** (show as **"test"** here) 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.

Step 2: VPC with Public and Private Subnets

IPv4 CIDR block: 10.0.0.0/16 (65531 IP addresses available)

IPv6 CIDR block: ☒ No IPv6 CIDR Block
☐ Amazon provided IPv6 CIDR block

VPC name: test

Public subnet's IPv4 CIDR: 10.0.0.0/24 (251 IP addresses available)

Availability Zone: No Preference

Public subnet name: Public subnet

Private subnet's IPv4 CIDR: 10.0.1.0/24 (251 IP addresses available)

Availability Zone: No Preference

Private subnet name: Private subnet

You can add more subnets after AWS creates the VPC.

Specify the details of your NAT gateway (NAT gateway rates apply).

Elastic IP Allocation ID: eipalloc-39dc2a04

Allocation ID	Elastic IP Address
eipalloc-39dc2a04	13.238.1.137

Service endpoints

Enable DNS hostnames: ☒ Yes ☐ No

Hardware tenancy: Default

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**.

VPC Successfully Created

Your VPC has been successfully created.

You can launch instances into the subnets of your VPC. For more information, see [Launching an Instance into Your Subnet](#).

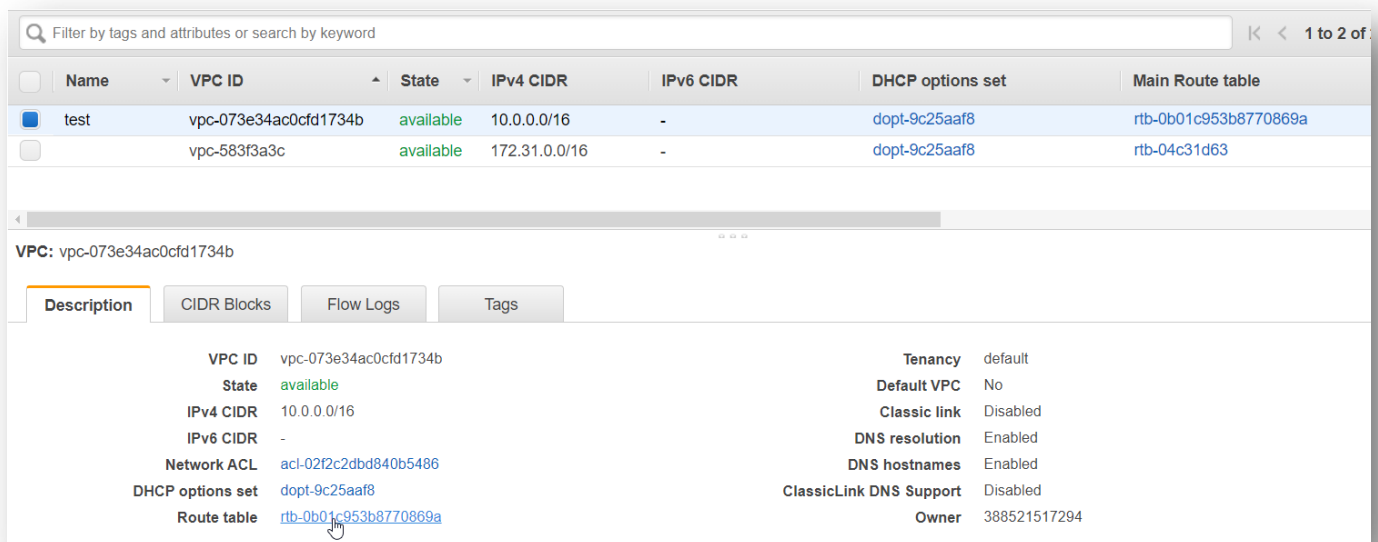
Wow! It only took you a few minutes to set up an entire virtual private network, including subnets for public and private resources, route tables, and a scalable NAT service.

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 **Description** 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 **Description** tab, 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**.



The screenshot shows the AWS VPC console interface. At the top, there is a search bar and a table listing VPCs. Below the table, the details for a selected VPC are shown in the 'Description' tab.

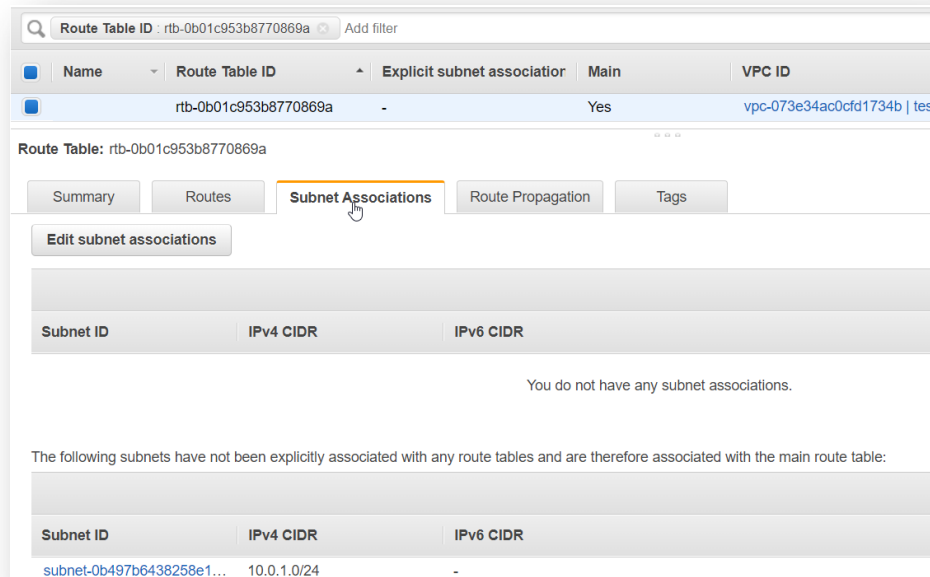
Name	VPC ID	State	IPv4 CIDR	IPv6 CIDR	DHCP options set	Main Route table
test	vpc-073e34ac0cfd1734b	available	10.0.0.0/16	-	dopt-9c25aaf8	rtb-0b01c953b8770869a
	vpc-583f3a3c	available	172.31.0.0/16	-	dopt-9c25aaf8	rtb-04c31d63

VPC: vpc-073e34ac0cfd1734b

Tabs: Description | CIDR Blocks | Flow Logs | Tags

VPC ID	vpc-073e34ac0cfd1734b	Tenancy	default
State	available	Default VPC	No
IPv4 CIDR	10.0.0.0/16	Classic link	Disabled
IPv6 CIDR	-	DNS resolution	Enabled
Network ACL	acl-02f2c2dbd840b5486	DNS hostnames	Enabled
DHCP options set	dopt-9c25aaf8	ClassicLink DNS Support	Disabled
Route table	rtb-0b01c953b8770869a	Owner	388521517294

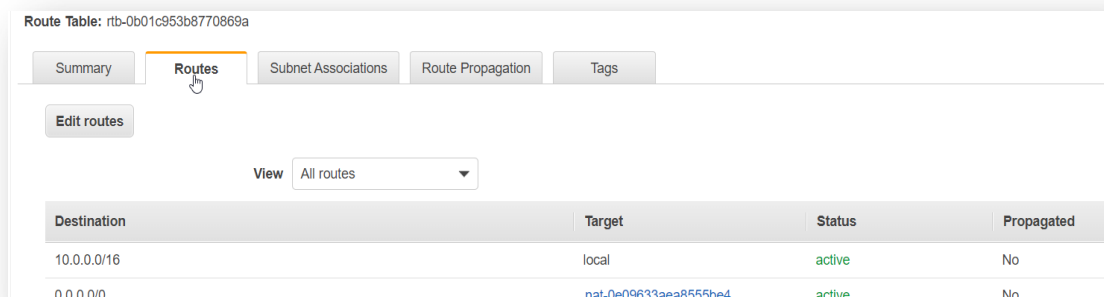
You are now in the **Route Tables** dashboard, filtered on the main route table of the VPC you just created. That means that there should be only one route table shown. Select this route table and click on the **Subnet Associations** tab.



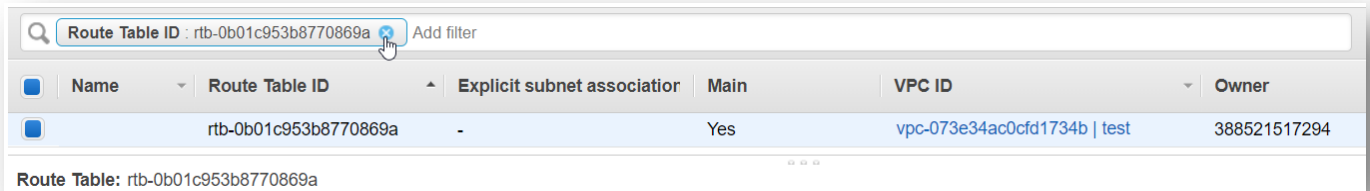
You can see that there are no **explicit subnet associations** on this route table. However, since this is the main route table for the VPC, there is one subnet implicitly associated. It's the **Private subnet** of the VPC. What makes a subnet public or private? We can find out by looking at the routes 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. This route cannot be modified.

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 at the top of the page.**

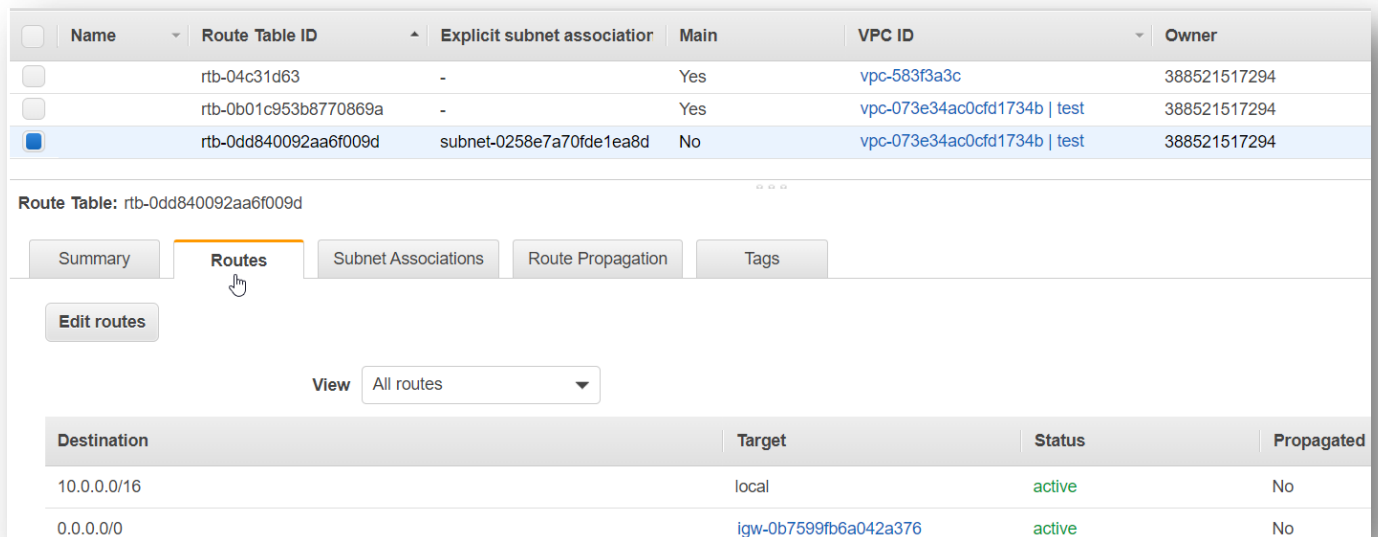


<input type="checkbox"/>	Name	Route Table ID	Explicit subnet association	Main	VPC ID	Owner
<input type="checkbox"/>		rtb-0b01c953b8770869a	-	Yes	vpc-073e34ac0cfd1734b test	388521517294

Route Table: rtb-0b01c953b8770869a

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 ID** column for name with "test") 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.



<input type="checkbox"/>	Name	Route Table ID	Explicit subnet association	Main	VPC ID	Owner
<input type="checkbox"/>		rtb-04c31d63	-	Yes	vpc-583f3a3c	388521517294
<input type="checkbox"/>		rtb-0b01c953b8770869a	-	Yes	vpc-073e34ac0cfd1734b test	388521517294
<input checked="" type="checkbox"/>		rtb-0dd840092aa6f009d	subnet-0258e7a70fde1ea8d	No	vpc-073e34ac0cfd1734b test	388521517294

Route Table: rtb-0dd840092aa6f009d

Summary Routes Subnet Associations Route Propagation Tags

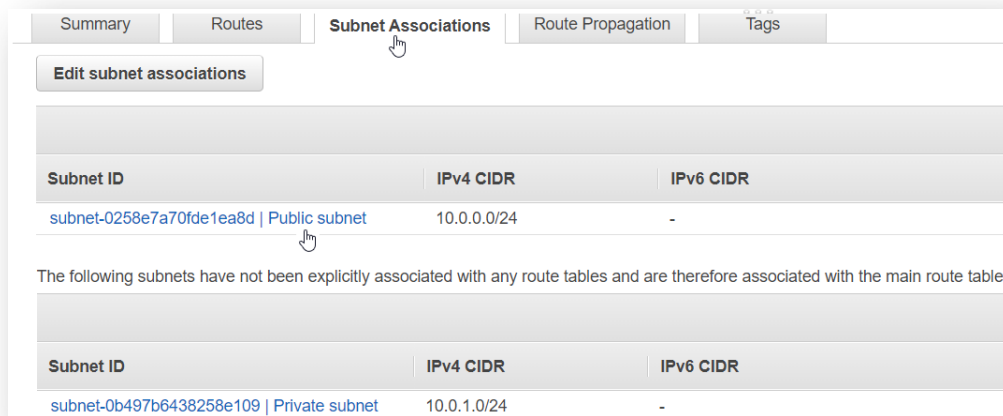
Edit routes

View All routes

Destination	Target	Status	Propagated
10.0.0.0/16	local	active	No
0.0.0.0/0	igw-0b7599fb6a042a376	active	No

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**.



The screenshot shows the 'Subnet Associations' tab in the AWS Management Console. It features a table with columns for Subnet ID, IPv4 CIDR, and IPv6 CIDR. The first row shows 'subnet-0258e7a70fde1ea8d' with a link to 'Public subnet', '10.0.0.0/24', and '-'. Below this, a message states: 'The following subnets have not been explicitly associated with any route tables and are therefore associated with the main route table:'. A second table row shows 'subnet-0b497b6438258e109' with a link to 'Private subnet', '10.0.1.0/24', and '-'.

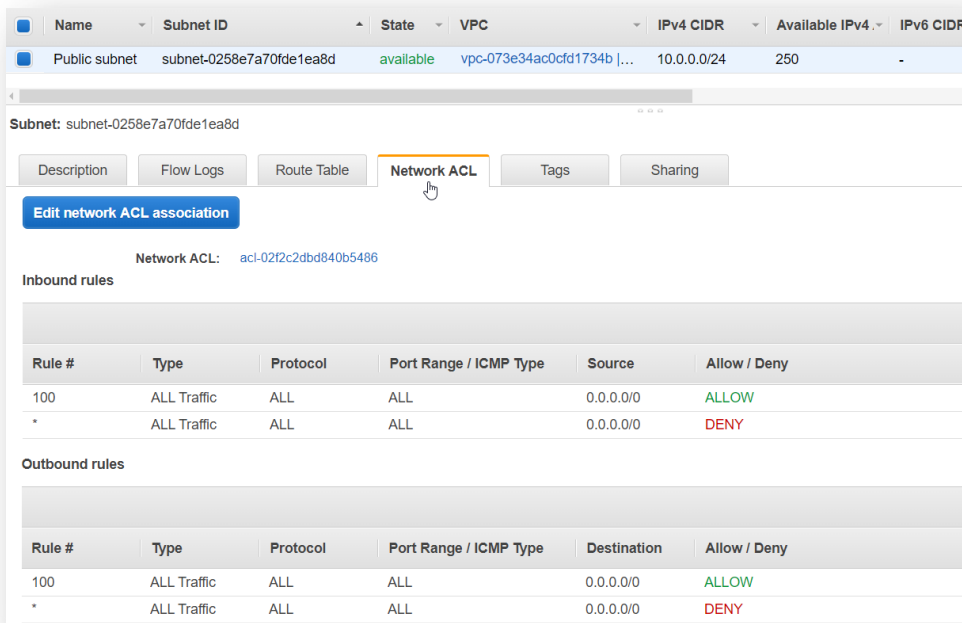
Subnet ID	IPv4 CIDR	IPv6 CIDR
subnet-0258e7a70fde1ea8d Public subnet	10.0.0.0/24	-

The following subnets have not been explicitly associated with any route tables and are therefore associated with the main route table:

Subnet ID	IPv4 CIDR	IPv6 CIDR
subnet-0b497b6438258e109 Private subnet	10.0.1.0/24	-

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 best practice. However, it is possible to achieve better security with this default NACL by also leveraging **Security Groups**.


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 basics of AWS VPC networking. You should now understand how routing works within 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 Amazon Linux 2 AMI for 64-bit (x86) architecture and click **Select**. Note that the ami-xxxxxxxxx label and specific versions of the installed package may be different than in the image below



Amazon Linux
 Free tier eligible

Amazon Linux 2 AMI (HVM), SSD Volume Type - ami-0b69ea66ff7391e80 (64-bit x86) / ami-09c61c4850b7465cb (64-bit Arm)

Select

☒ 64-bit (x86)
☐ 64-bit (Arm)

Amazon Linux 2 comes with five years support. It provides Linux kernel 4.14 tuned for optimal performance on Amazon EC2, systemd 219, GCC 7.3, Glibc 2.26, Binutils 2.29.1, and the latest software packages through extras.

Root device type: ebs Virtualization type: hvm ENA Enabled: Yes

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



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

- 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. Choose AMI 2. Choose Instance Type **3. Configure Instance** 4. Add Storage 5. Add Tags 6. Configure Security Group 7. Review

Step 3: Configure Instance Details

Configure the instance to suit your requirements. You can launch multiple instances from the same AMI, request Spot instances to take advantage of the lower pricing,

Number of instances ⓘ 1 [Launch into Auto Scaling Group ⓘ](#)

Purchasing option ⓘ ☐ Request Spot instances

Network ⓘ vpc-073e34ac0cfd1734b | test [Create new VPC](#)

Subnet ⓘ subnet-0258e7a70fde1ea8d | Public subnet | eu-wes [Create new subnet](#)

250 IP Addresses available

Auto-assign Public IP ⓘ Use subnet setting (Disable)

- For this lab, you can accept the default values in the remaining steps, so finish creating this instance by clicking on **Review and Launch**. You will see a warning that your security group is open to the world. You can ignore this warning and select **Launch**.
- In the pop-up window, select **Proceed without a key pair** from the drop-down and check the **acknowledgement** box. For this lab, you will not need to SSH into this instance. Click **Launch Instances** and then **View Instances**.

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.

Instance: **i-0791e3eb3ab4e7587** Private IP: 10.0.0.33

Description | Status Checks | Monitoring | Tags

Copy to clipboard

Instance ID	i-0791e3eb3ab4e7587
Instance state	running
Instance type	t2.micro
Elastic IPs	
Availability zone	eu-west-1b
Security groups	launch-wizard-1 , view inbound rules , view outbound rules
Scheduled events	No scheduled events
AMI ID	amzn2-ami-hvm-2.0.20190823.1-x86_64-gp2 (ami-0ce71448843cb18a1)

Public DNS (IPv4) -

IPv4 Public IP -

IPv6 IPs -

Private DNS ip-10-0-0-33.eu-west-1.compute.internal

Private IPs 10.0.0.33

Secondary private IPs

VPC ID [vpc-073e34ac0cfd1734b \(test\)](#)

Subnet ID [subnet-0258e7a70fde1ea8d \(Public subnet\)](#)

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. From the **Action** menu select **Associate Elastic IP 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 **Summary** tab, copy the Elastic IP address.

To ping the instance, you need to open your command line interface (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

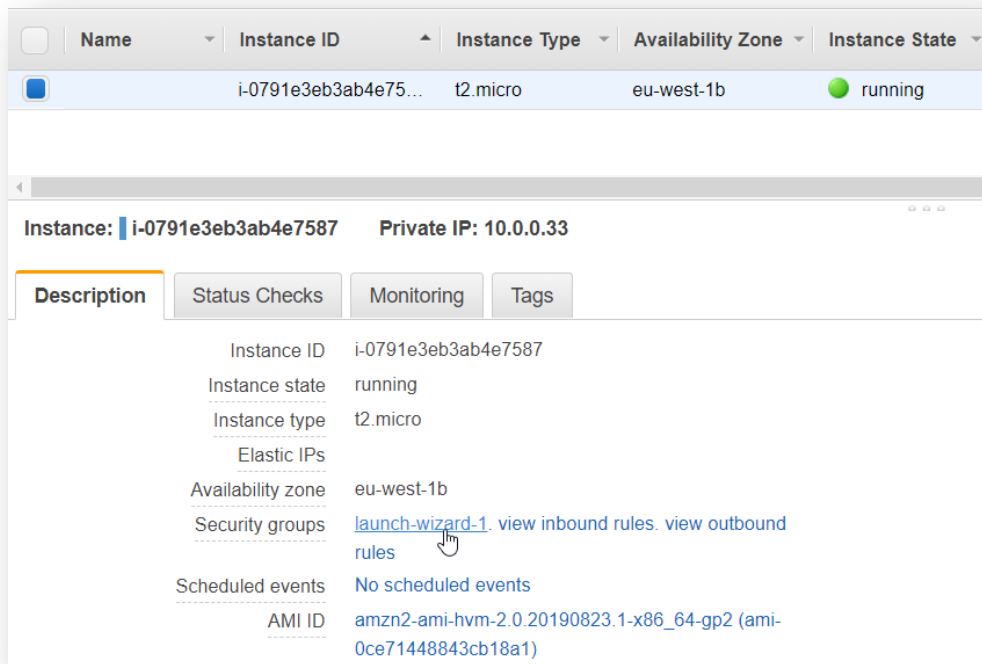
```
Request timed out.
```

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 networking configuration. 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**.

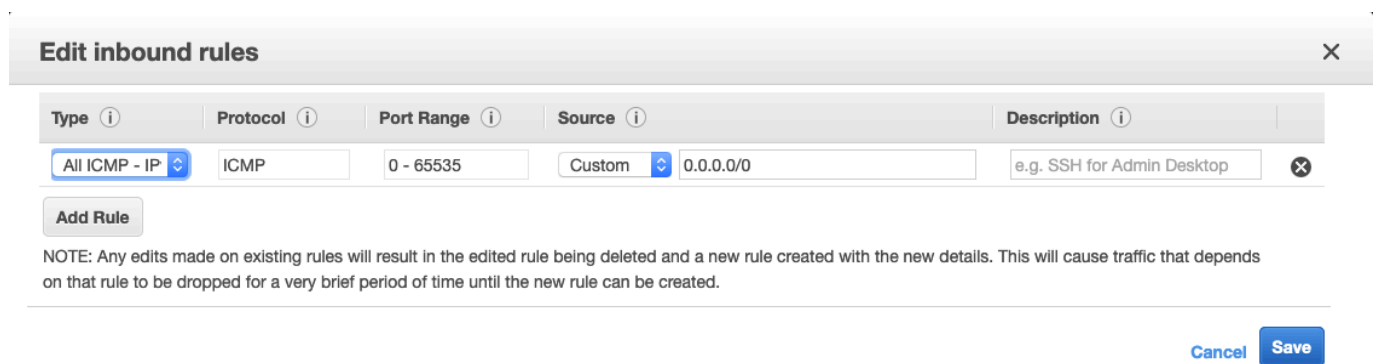


You are now in the **Security Groups** dashboard. Click on **Actions** and then **Edit Inbound rules**.

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. One of these default settings created this security group, which allows all inbound access on SSH port 22.

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

Click on **SSH** to open the drop-down and change it to **All ICMP - IPv4**. Click **Save**.

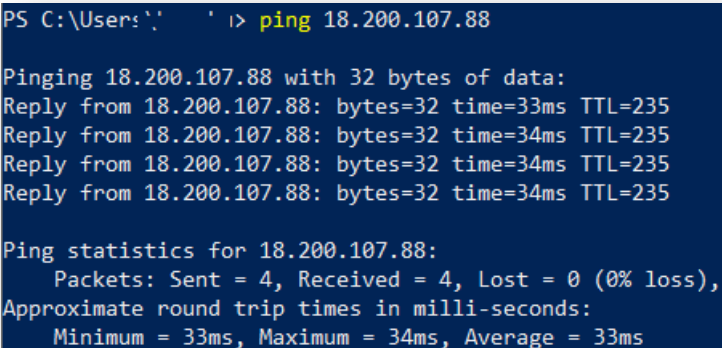


Since security groups are stateful, you don't need to edit the outbound rules. The security group will

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.

Note some VPN software may block ping. If you are still unable to ping, try disconnecting your VPN.

A screenshot of a Windows Command Prompt window with a dark blue background and white text. The prompt shows the command 'ping 18.200.107.88' being executed. The output displays four successful replies from 18.200.107.88, each with 32 bytes of data, response times between 33ms and 34ms, and a TTL of 235. Below the replies, the ping statistics are shown: 4 packets sent, 4 received, 0% loss, and average round trip times of 33ms minimum, 34ms maximum, and 33ms average.

```
PS C:\Users\'' ' ' > ping 18.200.107.88

Pinging 18.200.107.88 with 32 bytes of data:
Reply from 18.200.107.88: bytes=32 time=33ms TTL=235
Reply from 18.200.107.88: bytes=32 time=34ms TTL=235
Reply from 18.200.107.88: bytes=32 time=34ms TTL=235
Reply from 18.200.107.88: bytes=32 time=34ms TTL=235

Ping statistics for 18.200.107.88:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 33ms, Maximum = 34ms, Average = 33ms
```

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

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 as 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