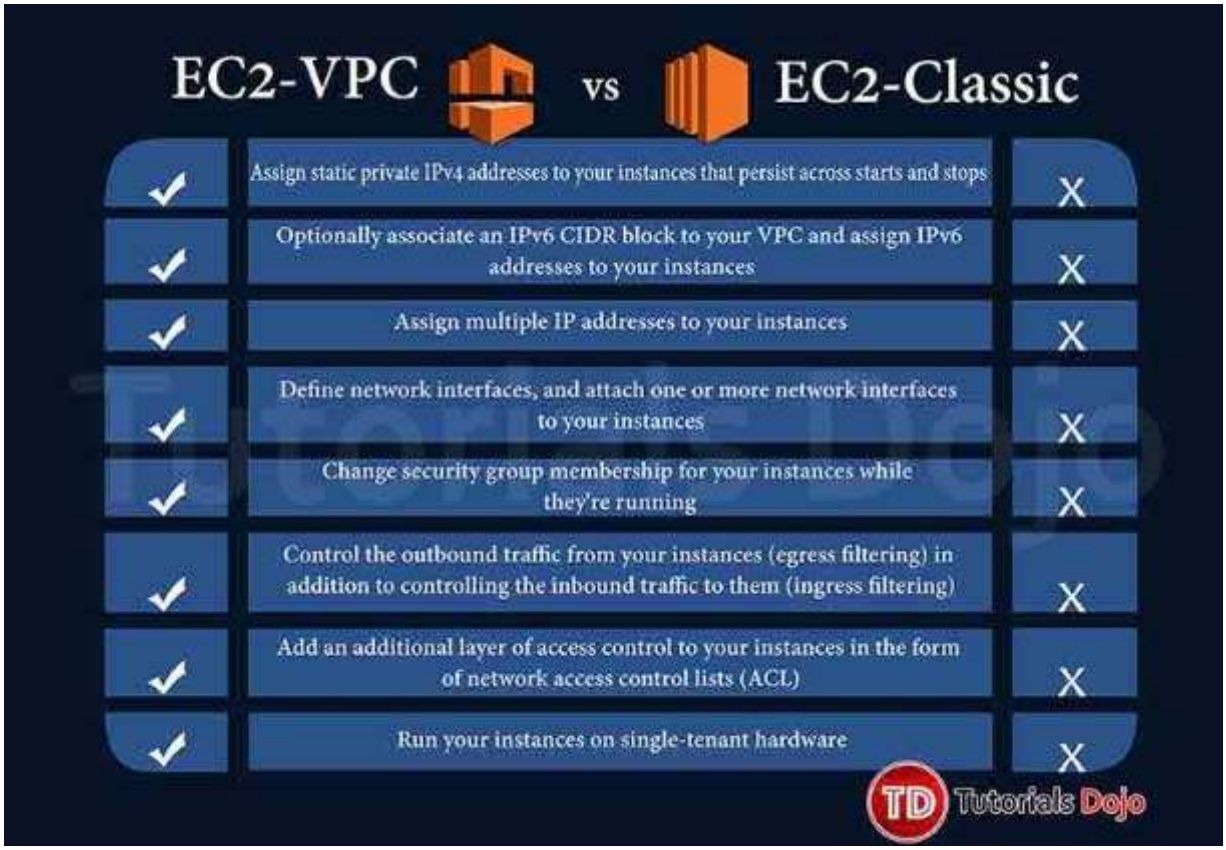
Amazon VPC

- Create a virtual network in the cloud dedicated to your AWS account where you can launch AWS resources
- Amazon VPC is the networking layer of Amazon EC2
- A VPC spans all the Availability Zones in the region. After creating a VPC, you can add one or more subnets in each Availability Zone.

Key Concepts

- A **virtual private cloud** (VPC) allows you to specify an IP address range for the VPC, add subnets, associate security groups, and configure route tables.
- A **subnet** is a range of IP addresses in your VPC. You can launch AWS resources into a specified subnet. Use a **public subnet** for resources that must be connected to the internet, and a **private subnet** for resources that won't be connected to the internet.
- To protect the AWS resources in each subnet, use **security groups** and **network access control lists (ACL)**.
- Expand your VPC by adding secondary IP ranges.

EC2-VPC vs EC2-Classic

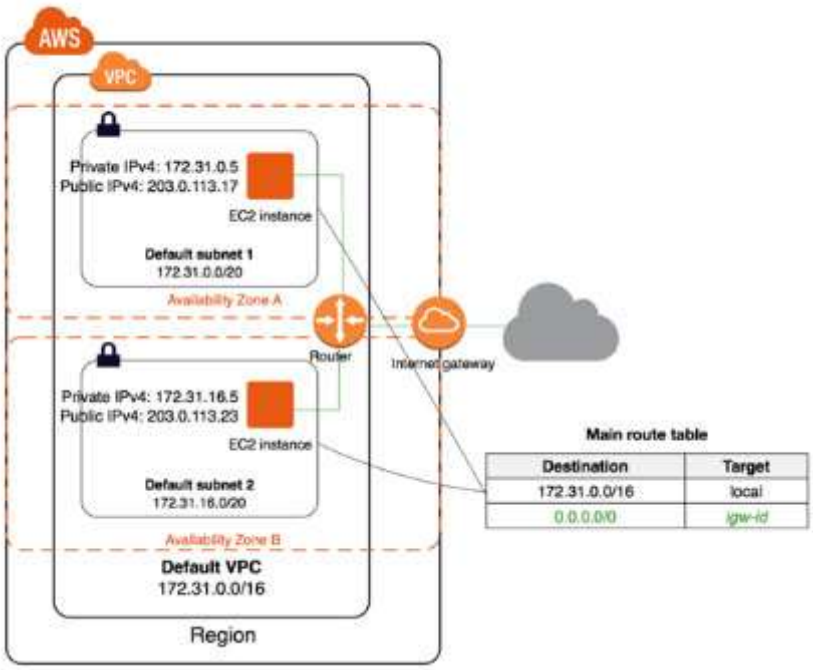


Default vs Non-Default VPC

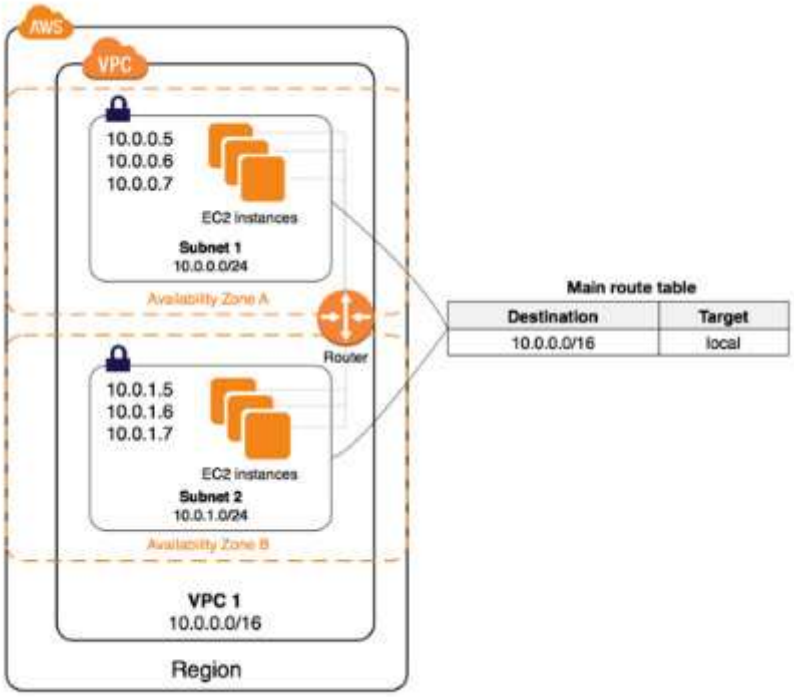
Default	Non-Default VPC
If your account supports the EC2-VPC platform only, it comes with a default VPC that has a default subnet in each Availability Zone.	You can create your own non-default VPC, and configure it as you need. Subnets that you create in your non-default VPC and additional subnets that you create in your default VPC are called non-default subnets.
Your default VPC includes an internet gateway, which allows your instances to communicate with the internet, and each default subnet is a public subnet.	Instances can communicate with each other, but can't access the internet. You can enable internet access for an instance launched into a non-default subnet by attaching an internet gateway and associating an Elastic IP address with the instance.
Each instance that you launch into a default subnet has a private IPv4 address and a public IPv4 address.	By default, each instance that you launch into a non-default subnet has a private IPv4 address, but no public IPv4 address, unless you specifically assign one at launch, or you modify the subnet's public IP address attribute.
To allow an instance in your VPC to initiate outbound connections to the internet but prevent unsolicited inbound connections from the internet, you can use a network address translation (NAT) device for IPv4 traffic.	To allow an instance in your VPC to initiate outbound connections to the internet but prevent unsolicited inbound connections from the internet, you can use a network address translation (NAT) device for IPv4 traffic.
You can optionally associate an Amazon-provided IPv6 CIDR block with your VPC and assign IPv6 addresses to your instances. IPv6 traffic is separate from IPv4 traffic; your route tables must include separate routes for IPv6 traffic.	You can optionally associate an Amazon-provided IPv6 CIDR block with your VPC and assign IPv6 addresses to your instances. IPv6 traffic is separate from IPv4 traffic; your route tables must include separate routes for IPv6 traffic.

Tutorials Dojo

A diagram of default VPC

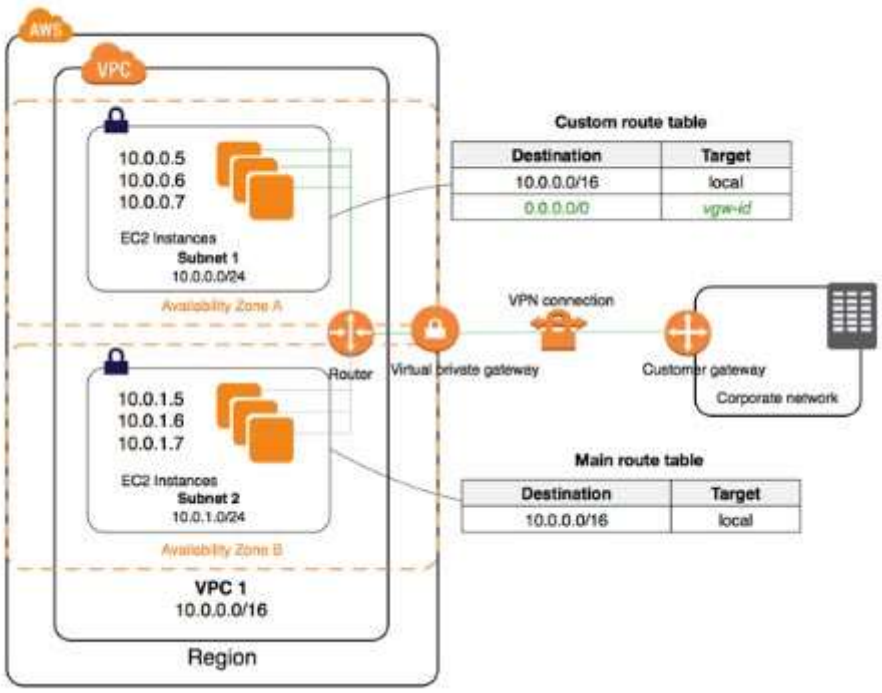


A diagram of non-default VPC



Accessing a Corporate or Home Network

- You can optionally connect your VPC to your own corporate data center using an **IPsec AWS managed VPN connection**, making the AWS Cloud an extension of your data center.
- A **VPN connection** consists of:
  - a **virtual private gateway** (which is the VPN concentrator on the Amazon side of the VPN connection) attached to your VPC.
  - a **customer gateway** (which is a physical device or software appliance on your side of the VPN connection) located in your data center.
  - A diagram of the connection



- **AWS PrivateLink** enables you to privately connect your VPC to supported AWS services, services hosted by other AWS accounts (VPC endpoint services), and supported AWS Marketplace partner services. You do not require an internet gateway, NAT device, public IP address, AWS Direct Connect connection, or VPN connection to communicate with the service. Traffic between your VPC and the service does not leave the Amazon network.
- You can create a **VPC peering connection** between your VPCs, or with a VPC in another AWS account, and enable routing of traffic between the VPCs using private IP addresses. You cannot create a VPC peering connection between VPCs that have overlapping CIDR blocks.
- Applications in an Amazon VPC can securely access AWS PrivateLink endpoints across VPC peering connections. The support of VPC peering by AWS PrivateLink makes it possible for customers to privately connect to a service even if that service's endpoint resides in a different Amazon VPC that is connected using VPC peering.
- AWS PrivateLink endpoints can now be accessed across both intra- and inter-region VPC peering connections.

VPC Use Case Scenarios

- VPC with a Single Public Subnet
- VPC with Public and Private Subnets (NAT)
- VPC with Public and Private Subnets and AWS Managed VPN Access
- VPC with a Private Subnet Only and AWS Managed VPN Access

Subnets

- When you create a VPC, you must specify a range of IPv4 addresses for the VPC in the form of a Classless Inter-Domain Routing (CIDR) block (example: 10.0.0.0/16). This is the **primary CIDR block** for your VPC.
- You can add one or more subnets in each Availability Zone of your VPC's region.
- You specify the CIDR block for a subnet, which is a subset of the VPC CIDR block.
- A CIDR block must not overlap with any existing CIDR block that's associated with the VPC.
- Types of Subnets
    - Public Subnet – has an internet gateway
    - Private Subnet – doesn't have an internet gateway
    - VPN-only Subnet – has a virtual private gateway instead
- IPv4 CIDR block size should be between a /16 netmask (65,536 IP addresses) and /28 netmask (16 IP addresses).
- The **first four IP addresses and the last IP address in each subnet CIDR block** are **NOT available** for you to use, and cannot be assigned to an instance.
- You cannot increase or decrease the size of an existing CIDR block.
- When you associate a CIDR block with your VPC, a route is automatically added to your VPC route tables to enable routing within the VPC (the destination is the CIDR block and the target is *local*).
- You have a limit on the number of CIDR blocks you can associate with a VPC and the number of routes you can add to a route table.
- The following rules apply when you add IPv4 CIDR blocks to a VPC that's part of a **VPC peering connection**:

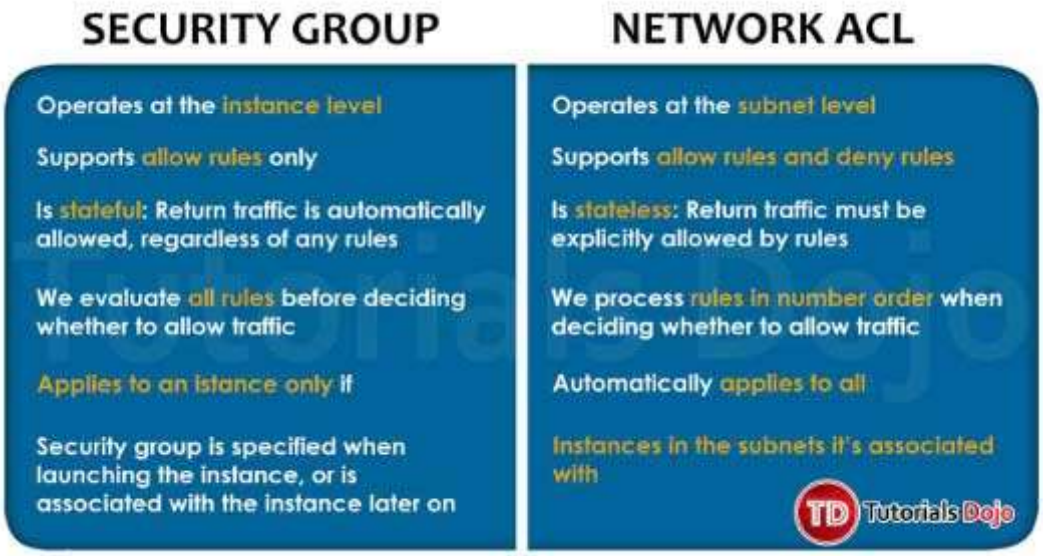
    - If the VPC peering connection is active, you can add CIDR blocks to a VPC provided they do not overlap with a CIDR block of the peer VPC.
    - If the VPC peering connection is pending-acceptance, the owner of the requester VPC cannot add any CIDR block to the VPC. Either the owner of the accepter VPC must accept the peering connection, or the owner of the requester VPC must delete the VPC peering connection request, add the CIDR block, and then request a new VPC peering connection.
    - If the VPC peering connection is pending-acceptance, the owner of the accepter VPC can add CIDR blocks to the VPC. If a secondary CIDR block overlaps with a CIDR block of the requester VPC, the VPC peering connection request fails and cannot be accepted.
- If you're using AWS Direct Connect to connect to multiple VPCs through a direct connect gateway, the VPCs that are associated with the direct connect gateway must not have overlapping CIDR blocks.
- The CIDR block is ready for you to use when it's in the *associated* state.
- You can disassociate a CIDR block that you've associated with your VPC; however, you cannot disassociate the primary CIDR block.

Subnet Routing

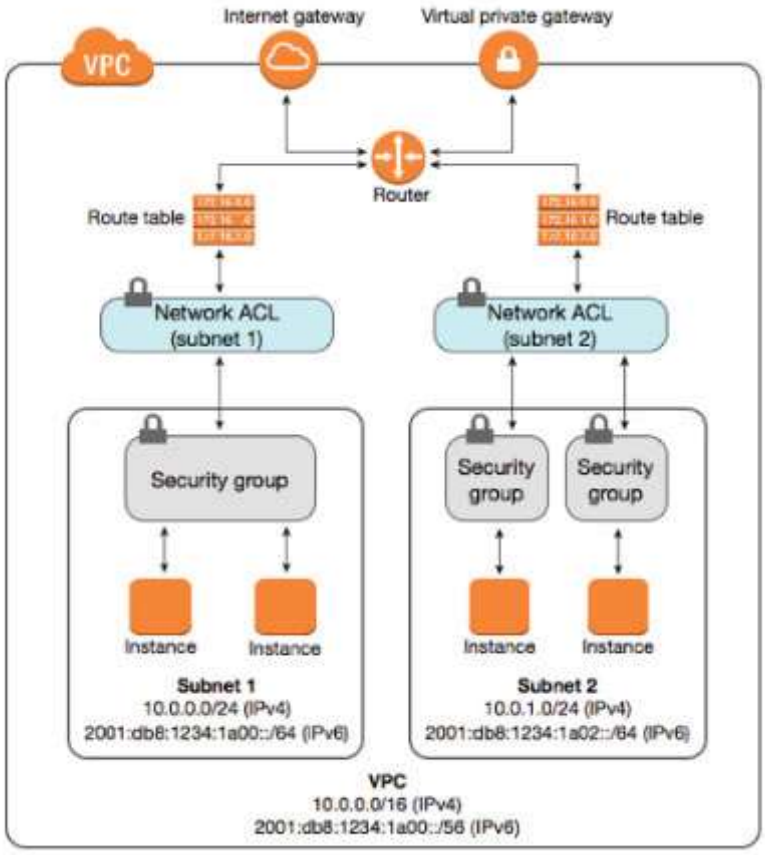
- Each subnet must be associated with a **route table**, which specifies the allowed routes for **outbound traffic** leaving the subnet.
- Every subnet that you create is automatically associated with the main route table for the VPC.
- You can change the association, and you can change the contents of the main route table.
- You can allow an instance in your VPC to initiate outbound connections to the internet over IPv4 but prevent unsolicited inbound connections from the internet using a **NAT gateway or NAT instance**.
- To initiate outbound-only communication to the internet over IPv6, you can use an egress-only internet gateway.

Subnet Security

- Security Groups — control inbound and outbound traffic for your instances
  - You can associate one or more (up to five) security groups to an instance in your VPC.
  - If you don't specify a security group, the instance automatically belongs to the default security group.
  - When you create a security group, it has no inbound rules. By default, it includes an outbound rule that allows all outbound traffic.
  - Security groups are associated with network interfaces.
- Network Access Control Lists — control inbound and outbound traffic for your subnets
  - Each subnet in your VPC must be associated with a network ACL. If none is associated, automatically associated with the default network ACL.
  - You can associate a network ACL with multiple subnets; however, a subnet can be associated with only one network ACL at a time.
  - A network ACL contains a numbered list of rules that is evaluated in order, starting with the lowest numbered rule, to determine whether traffic is allowed in or out of any subnet associated with the network ACL.
  - The default network ACL is configured to **allow all traffic to flow in and out** of the subnets to which it is associated.
- Flow logs — capture information about the IP traffic going to and from network interfaces in your VPC that is published to CloudWatch Logs.
- Amazon security groups and network ACLs don't filter traffic to or from link-local addresses or AWS-reserved IPv4 addresses. Flow logs do not capture IP traffic to or from these addresses.



- Diagram of security groups and NACLs in a VPC



VPC Networking Components

- Network Interfaces

- a virtual network interface that can include:
  - a primary private IPv4 address
  - one or more secondary private IPv4 addresses
  - one Elastic IP address per private IPv4 address
  - one public IPv4 address, which can be auto-assigned to the network interface for eth0 when you launch an instance
  - one or more IPv6 addresses
  - one or more security groups
  - a MAC address
  - a source/destination check flag
  - a description
- Network interfaces can be attached and detached from instances, however, you cannot detach a primary network interface.

◦ Route Tables

- contains a set of rules, called *routes*, that are used to determine where network traffic is directed.
- A subnet can only be associated with one route table at a time, but you can associate multiple subnets with the same route table.
- You cannot delete the main route table, but you can replace the main route table with a custom table that you've created.
- You must update the route table for any subnet that uses gateways or connections.
- Uses the most specific route in your route table that matches the traffic to determine how to route the traffic (longest prefix match).

◦ Internet Gateways

- Allows communication between instances in your VPC and the internet.
- Imposes no availability risks or bandwidth constraints on your network traffic.

- Provides a target in your VPC route tables for internet-routable traffic, and performs network address translation for instances that have been assigned public IPv4 addresses.
- The following table provides an overview of whether your VPC automatically comes with the components required for internet access over IPv4 or IPv6.
- To enable access to or from the Internet for instances in a VPC subnet, you must do the following:
    - Attach an Internet Gateway to your VPC
    - Ensure that your subnet's route table points to the Internet Gateway.
    - Ensure that instances in your subnet have a globally unique IP address (public IPv4 address, Elastic IP address, or IPv6 address).
    - Ensure that your network access control and security group rules allow the relevant traffic to flow to and from your instance

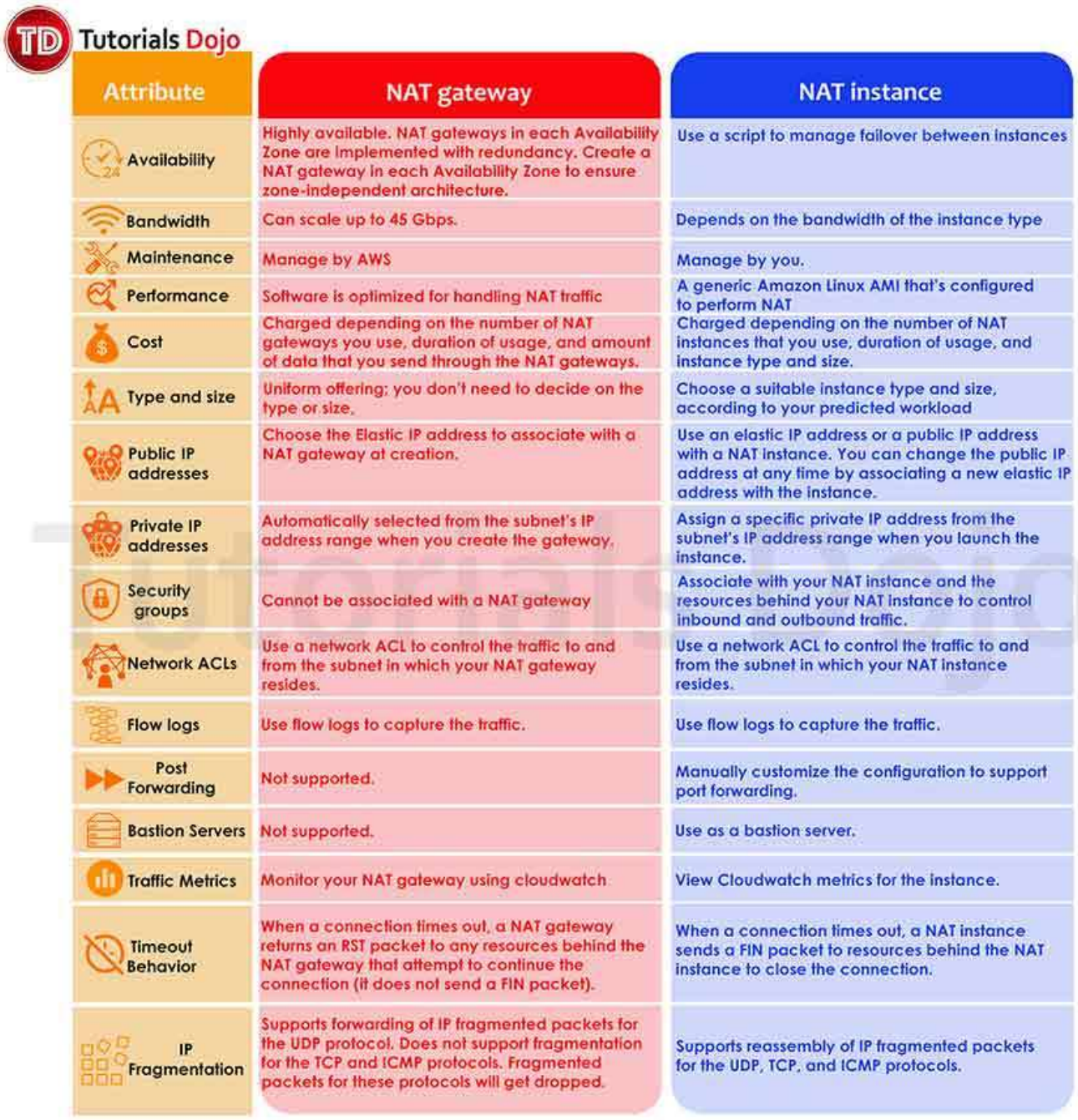
	Default VPC	**Non-default VPC**
Internet gateway	Yes	Yes, if you created the VPC using the first or second option in the VPC wizard. Otherwise, you must manually create and attach the internet gateway.
Route table with route to internet gateway for IPv4 traffic (0.0.0.0/0)	Yes	Yes, if you created the VPC using the first or second option in the VPC wizard. Otherwise, you must manually create the route table and add the route.
Route table with route to internet gateway for IPv6 traffic (::/0)	No	Yes, if you created the VPC using the first or second option in the VPC wizard, and if you specified the option to associate an IPv6 CIDR block with the VPC. Otherwise, you must manually create the route table and add the route.

Public IPv4 address automatically assigned to instance launched into subnet	Yes (default subnet)	No (non-default subnet)
IPv6 address automatically assigned to instance launched into subnet	No (default subnet)	No (non-default subnet)

- Egress-Only Internet Gateways
  - VPC component that allows outbound communication over IPv6 from instances in your VPC to the Internet, and prevents the Internet from initiating an IPv6 connection with your instances.
  - An egress-only Internet gateway is stateful.
  - You cannot associate a security group with an egress-only Internet gateway.
  - You can use a network ACL to control the traffic to and from the subnet for which the egress-only Internet gateway routes traffic.
- NAT
  - Enable instances in a private subnet to connect to the internet or other AWS services, but prevent the internet from initiating connections with the instances.
  - NAT Gateways
    - You must specify the **public subnet** in which the NAT gateway should reside.
    - You must specify an **Elastic IP address** to associate with the NAT gateway when you create it.
    - Each NAT gateway is created in a specific Availability Zone and implemented with redundancy in that zone.

- Deleting a NAT gateway disassociates its Elastic IP address, but does not release the address from your account.
- A NAT gateway supports the following protocols: TCP, UDP, and ICMP.
- You cannot associate a security group with a NAT gateway.
- A NAT gateway can support up to 55,000 simultaneous connections to each unique destination.
- A NAT gateway cannot send traffic over VPC endpoints, VPN connections, AWS Direct Connect, or VPC peering connections.

- NAT Instance vs NAT Gateways



Attribute	NAT gateway	NAT instance
Availability	Highly available. NAT gateways in each Availability Zone are implemented with redundancy. Create a NAT gateway in each Availability Zone to ensure zone-independent architecture.	Use a script to manage failover between instances
Bandwidth	Can scale up to 45 Gbps.	Depends on the bandwidth of the instance type
Maintenance	Manage by AWS	Manage by you.
Performance	Software is optimized for handling NAT traffic	A generic Amazon Linux AMI that's configured to perform NAT
Cost	Charged depending on the number of NAT gateways you use, duration of usage, and amount of data that you send through the NAT gateways.	Charged depending on the number of NAT instances that you use, duration of usage, and instance type and size.
Type and size	Uniform offering; you don't need to decide on the type or size.	Choose a suitable instance type and size, according to your predicted workload
Public IP addresses	Choose the Elastic IP address to associate with a NAT gateway at creation.	Use an elastic IP address or a public IP address with a NAT instance. You can change the public IP address at any time by associating a new elastic IP address with the instance.
Private IP addresses	Automatically selected from the subnet's IP address range when you create the gateway.	Assign a specific private IP address from the subnet's IP address range when you launch the instance.
Security groups	Cannot be associated with a NAT gateway	Associate with your NAT instance and the resources behind your NAT instance to control inbound and outbound traffic.
Network ACLs	Use a network ACL to control the traffic to and from the subnet in which your NAT gateway resides.	Use a network ACL to control the traffic to and from the subnet in which your NAT instance resides.
Flow logs	Use flow logs to capture the traffic.	Use flow logs to capture the traffic.
Post Forwarding	Not supported.	Manually customize the configuration to support port forwarding.
Bastion Servers	Not supported.	Use as a bastion server.
Traffic Metrics	Monitor your NAT gateway using cloudwatch	View Cloudwatch metrics for the instance.
Timeout Behavior	When a connection times out, a NAT gateway returns an RST packet to any resources behind the NAT gateway that attempt to continue the connection (it does not send a FIN packet).	When a connection times out, a NAT instance sends a FIN packet to resources behind the NAT instance to close the connection.
IP Fragmentation	Supports forwarding of IP fragmented packets for the UDP protocol. Does not support fragmentation for the TCP and ICMP protocols. Fragmented packets for these protocols will get dropped.	Supports reassembly of IP fragmented packets for the UDP, TCP, and ICMP protocols.

- DHCP Options Sets
    - **Dynamic Host Configuration Protocol (DHCP)** provides a standard for passing configuration information to hosts on a TCP/IP network.
    - You can assign your own domain name to your instances, and use up to four of your own DNS servers by specifying a special set of DHCP options to use with the VPC.
    - Creating a VPC automatically creates a set of DHCP options, which are domain-name-servers=AmazonProvidedDNS, and domain-name=domain-name-for-your-region, and associates them with the VPC.
    - After you create a set of DHCP options, you can't modify them. Create a new set and associate a different set of DHCP options with your VPC, or use no DHCP options at all.
- DNS
    - AWS provides instances launched in a default VPC with public and private DNS hostnames that correspond to the public IPv4 and private IPv4 addresses for the instance.
    - AWS provides instances launched in a non-default VPC with private DNS hostname and possibly a public DNS hostname, depending on the DNS attributes you specify for the VPC and if your instance has a public IPv4 address.
    - Set VPC attributes *enableDnsHostnames* and *enableDnsSupport* to true so that your instances receive a public DNS hostname and Amazon-provided DNS server can resolve Amazon-provided private DNS hostnames.
        - If you use custom DNS domain names defined in a private hosted zone in Route 53, the *enableDnsHostnames* and *enableDnsSupport* attributes must be set to true.
- VPC Peering

- A networking connection between two VPCs that enables you to route traffic between them privately. Instances in either VPC can communicate with each other as if they are within the same network.

- Elastic IP Addresses
    - A **static, public IPv4 address**.
    - You can associate an Elastic IP address with any instance or network interface for any VPC in your account.
    - You can mask the failure of an instance by rapidly remapping the address to another instance in your VPC.
    - Your Elastic IP addresses remain associated with your AWS account until you explicitly release them.
    - AWS imposes a small hourly charge when EIPs aren't associated with a running instance, or when they are associated with a stopped instance or an unattached network interface.
    - You're limited to five Elastic IP addresses.

- VPC Endpoints
    - Privately connect your VPC to supported AWS services and VPC endpoint services powered by PrivateLink without requiring an internet gateway, NAT device, VPN connection, or AWS Direct Connect connection.
    - Endpoints are virtual devices.
    - Two Types
        - **Interface Endpoints**
            - An elastic network interface with a private IP address that serves as an entry point for traffic destined to a supported service.
            - Can be accessed through AWS VPN connections or AWS Direct Connect connections, through intra-region VPC peering

connections from Nitro instances, and through inter-region VPC peering connections from any type of instance.
    - For each interface endpoint, you can choose only one subnet per Availability Zone. Endpoints are supported within the same region only.
    - Interface endpoints do not support the use of endpoint policies.
    - An interface endpoint supports IPv4 TCP traffic only.
- **Gateway Endpoints**
    - A gateway that is a target for a specified route in your route table, used for traffic destined to a supported AWS service.
    - You can create multiple endpoints in a single VPC, for example, to multiple services. You can also create multiple endpoints for a single service, and use different route tables to enforce different access policies from different subnets to the same service.
    - You can modify the endpoint policy that's attached to your endpoint, and add or remove the route tables that are used by the endpoint.
    - Endpoints are supported within the same region only. You cannot create an endpoint between a VPC and a service in a different region.
    - Endpoints support IPv4 traffic only.
    - You must enable DNS resolution in your VPC, or if you're using your own DNS server, ensure that DNS requests to the required service (such as S3) are resolved correctly to the IP addresses maintained by AWS.
- You can create your own application in your VPC and configure it as an AWS PrivateLink-powered service (referred to as an *endpoint service*). You

are the *service provider*, and the AWS principals that create connections to your service are *service consumers*.

- ClassicLink
  - Allows you to link an EC2-Classic instance to a VPC in your account, within the same region. This allows you to associate the VPC security groups with the EC2-Classic instance, enabling communication between your EC2-Classic instance and instances in your VPC using private IPv4 addresses.

VPN Connections

VPN connectivity option	Description
AWS managed VPN	You can create an IPsec VPN connection between your VPC and your remote network. On the AWS side of the VPN connection, a *virtual private gateway* provides two VPN endpoints (tunnels) for automatic failover. You configure your *customer gateway* on the remote side of the VPN connection.
AWS VPN CloudHub	If you have more than one remote network, you can create multiple AWS managed VPN connections via your virtual private gateway to enable communication between these networks.
Third party software VPN appliance	You can create a VPN connection to your remote network by using an Amazon EC2 instance in your VPC that's running a third party software VPN appliance. AWS does not provide or maintain third party software VPN appliances; however, you can choose from a range

	of products provided by partners and open source communities.
AWS Direct Connect	You can also use AWS Direct Connect to create a dedicated private connection from a remote network to your VPC. You can combine this connection with an AWS managed VPN connection to create an IPsec-encrypted connection.

- Specify a private Autonomous System Number (ASN) for the virtual private gateway. If you don't specify an ASN, the virtual private gateway is created with the default ASN (64512). You cannot change the ASN after you've created the virtual private gateway.
- When you create a VPN connection, you must:
  - Specify the type of routing that you plan to use (static or dynamic)
  - Update the route table for your subnet
- If your VPN device supports Border Gateway Protocol (BGP), specify **dynamic routing** when you configure your VPN connection. If your device does not support BGP, specify **static routing**.
- VPG uses path selection to determine how to route traffic to your remote network. Longest prefix match applies.
- Each VPN connection has two tunnels, with each tunnel using a unique virtual private gateway public IP address. It is important to configure both tunnels for redundancy.

Pricing

- Charged for VPN Connection-hour
- Charged for each "NAT Gateway-hour" that your NAT gateway is provisioned and available.
- Data processing charges apply for each Gigabyte processed through the NAT gateway regardless of the traffic's source or destination.

- You also incur standard AWS data transfer charges for all data transferred via the NAT gateway.
- Charges for unused or inactive Elastic IPs.

Limits

Resource	Default limit
VPCs per region	5
Subnets per VPC	200
IPv4 CIDR blocks per VPC	5
IPv6 CIDR blocks per VPC	1
Elastic IP addresses per region	5
Customer gateways per region	50
Internet gateways per region	5
NAT gateways per Availability Zone	5
Virtual private gateways per region	5
Network ACLs per VPC	200
Rules per network ACL	20
Network interfaces per instance	Varies by instance type
Network interfaces per region	350

Route tables per VPC	200
Routes per route table (non-propagated routes)	50
Security groups per VPC (per region)	500
Inbound or outbound rules per security group	60
Security groups per network interface	5
Gateway VPC endpoints per region	20
Interface VPC endpoints per VPC	20
VPN connections per region	50

Sources:

https://docs.aws.amazon.com/vpc/latest/userguide/what-is-amazon-vpc.html

https://aws.amazon.com/vpc/details/

https://aws.amazon.com/vpc/pricing/

https://aws.amazon.com/vpc/faqs/

***

AWS Certified Solutions Architect is consistently among the top paying IT certifications in the world, considering that Amazon Web Services is the leading cloud services platform with almost 50% market share! Earn over $150,000 per year with an AWS certification!

Subscribe to our newsletter for more helpful AWS training notes and blogs like this and answer as many AWS practice exams as you can. 🙂

Subscribe to our Newsletter

Sign up now and have the latest tech tutorials delivered straight to your mailbox.

PLUS: Upgrade your career by getting exclusive access to recent AWS exam passers' tips, freebies, promotions and lots more!

Your Name

Your Email Address

Sign Up Today!

I agree to have my personal information transfered to AWeber (more information)

TUTORIALS DOJO

info@tutorialsdojo.com

Monday - Sunday: 7:00 AM - 9:00 PM AEDT

ABN 35992104069

COURSES

*Premium Practice Test Courses

*Free Practice Test Samplers

GET SOCIAL