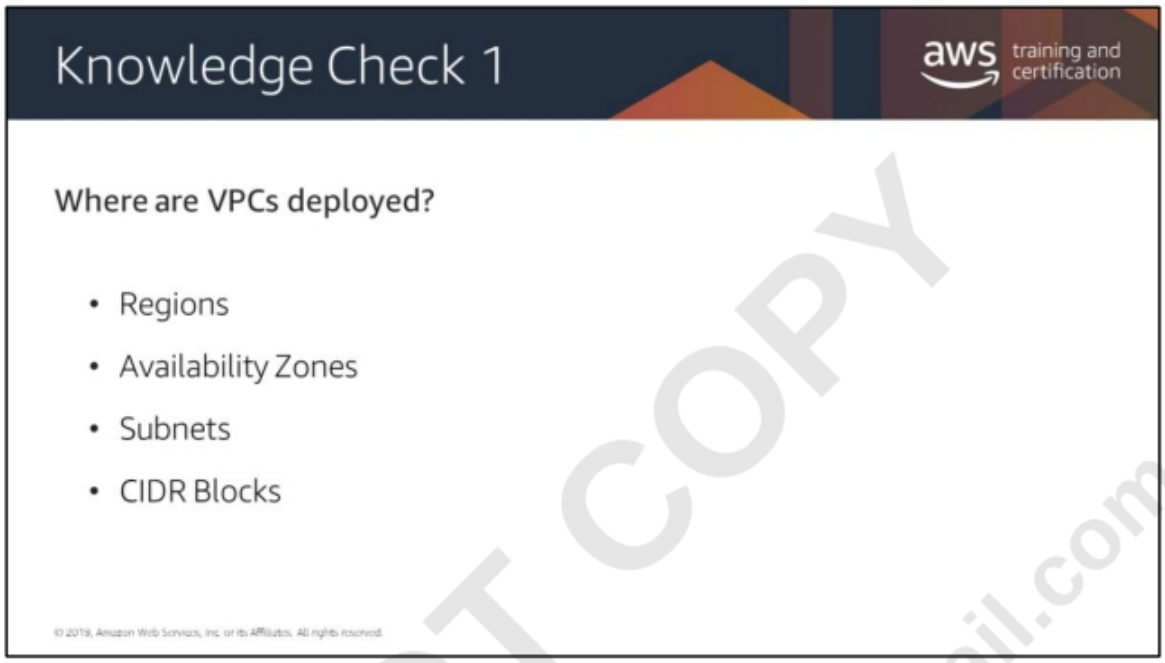
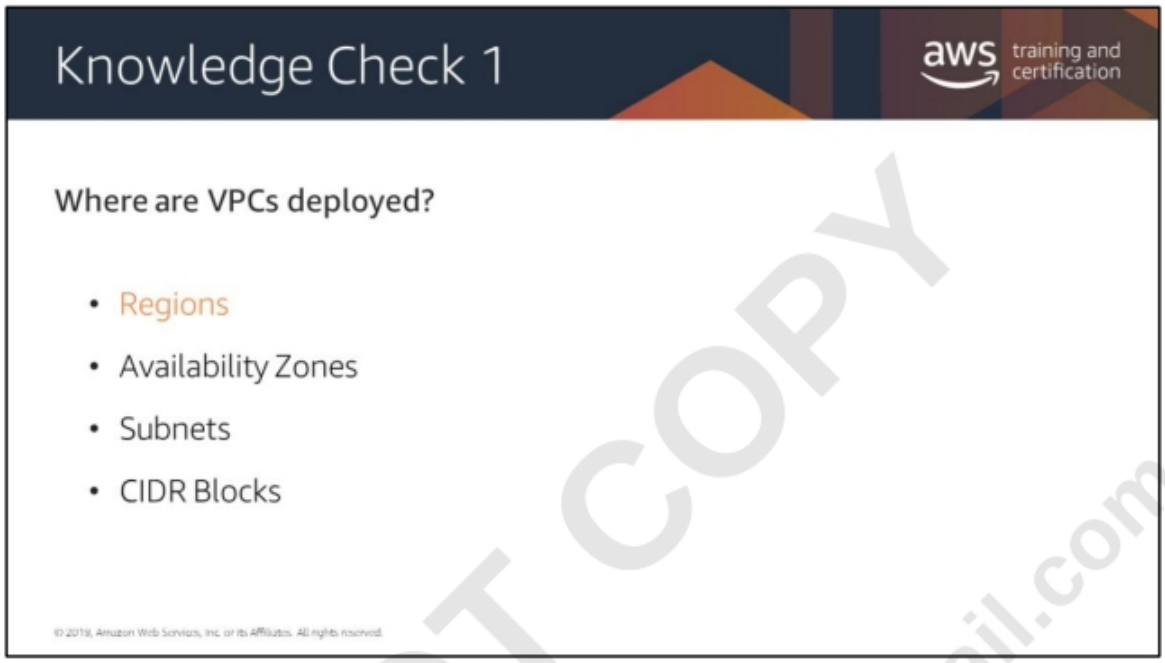
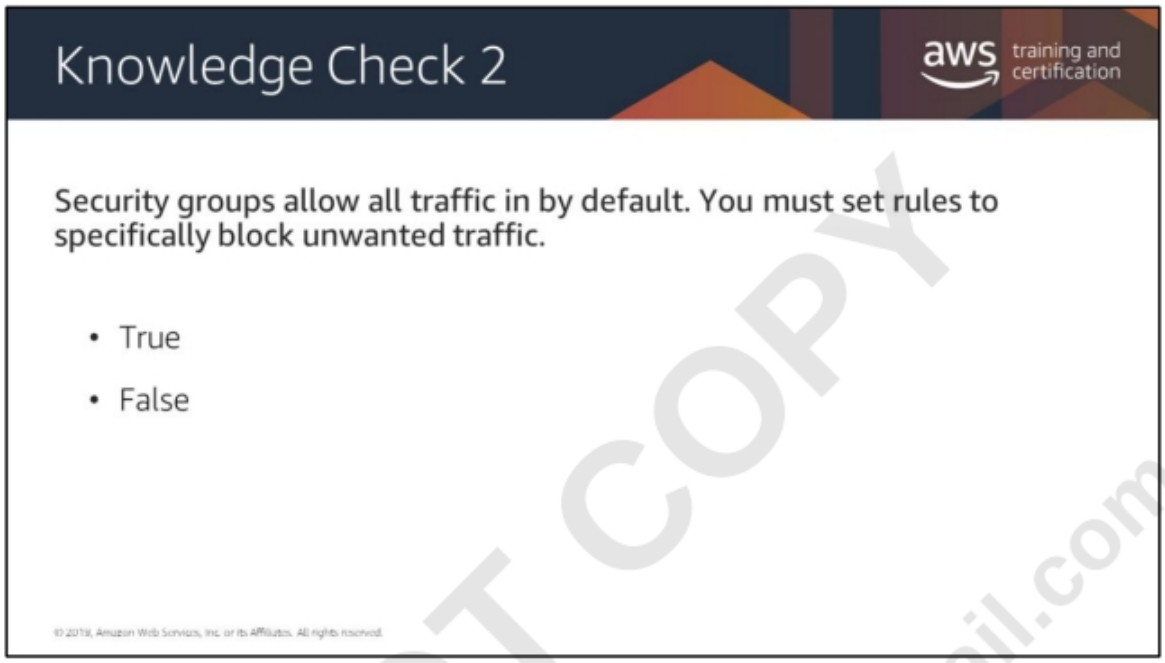
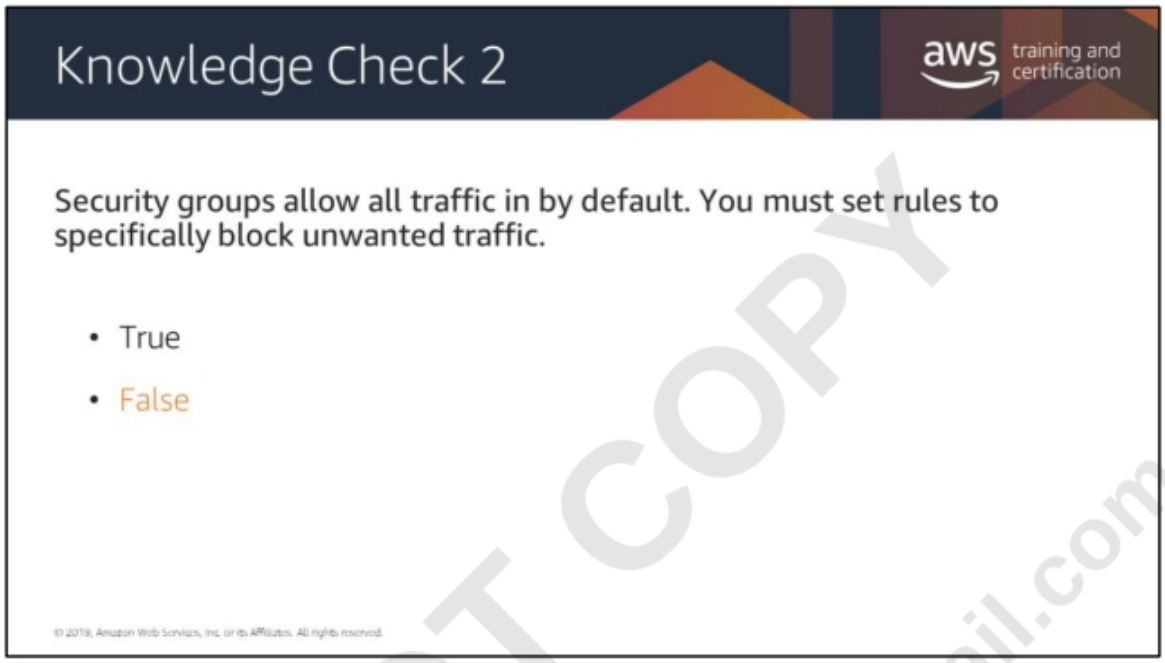
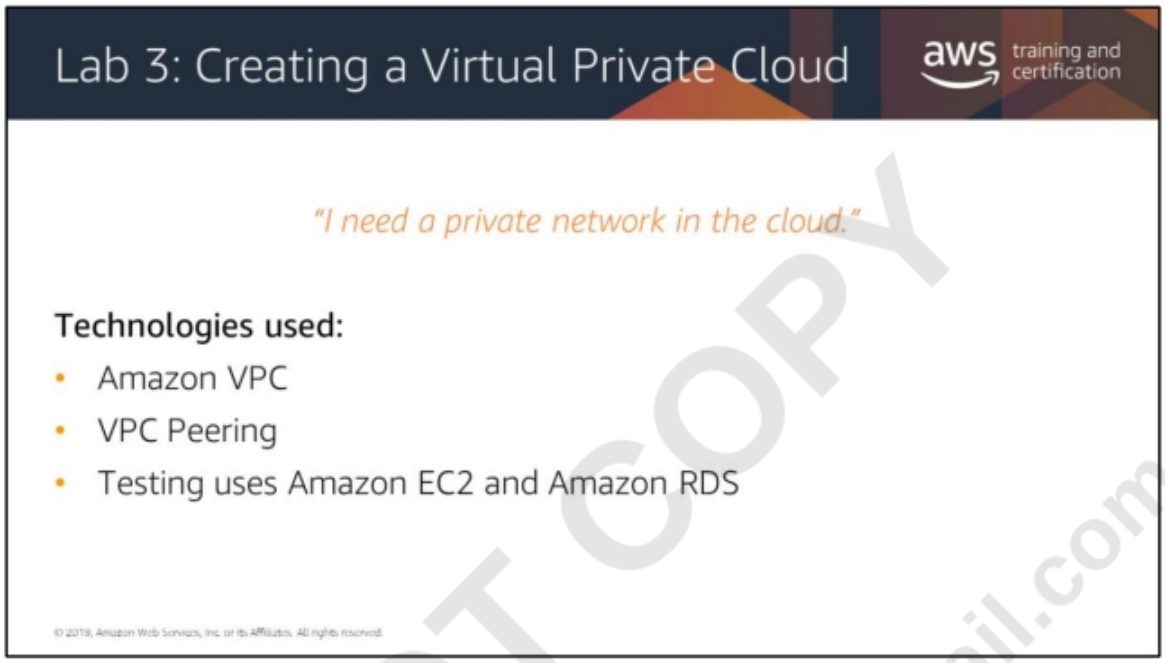










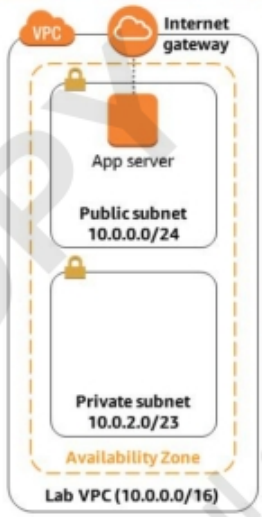
Lab 3: Creating a Virtual Private Cloud

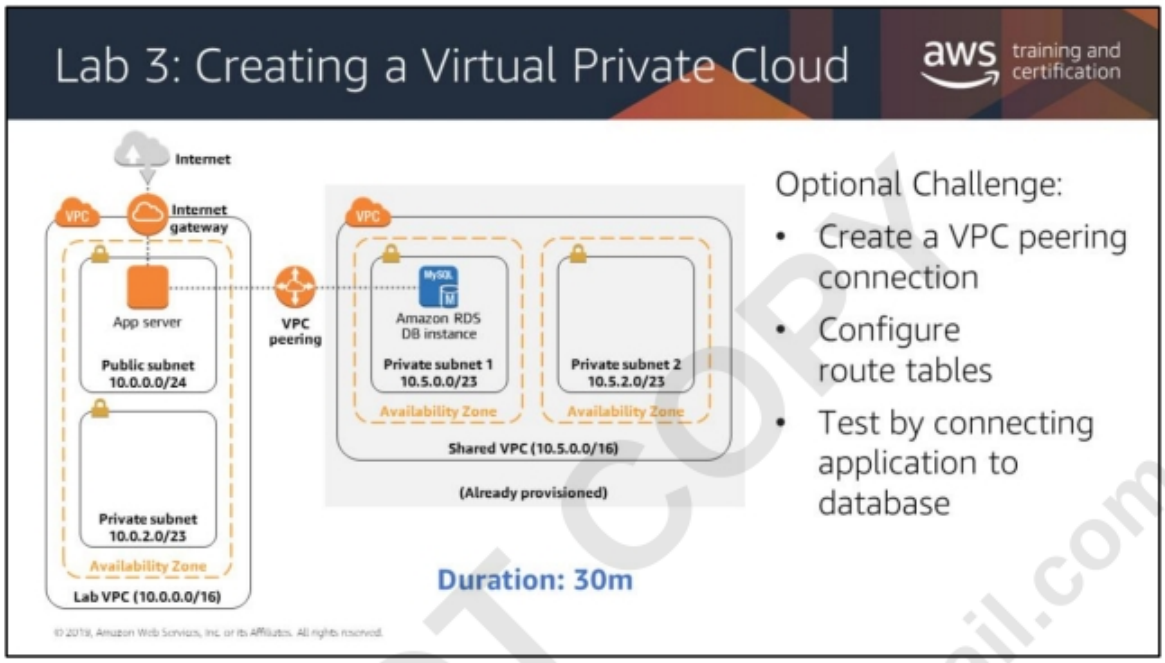
aws training and certification

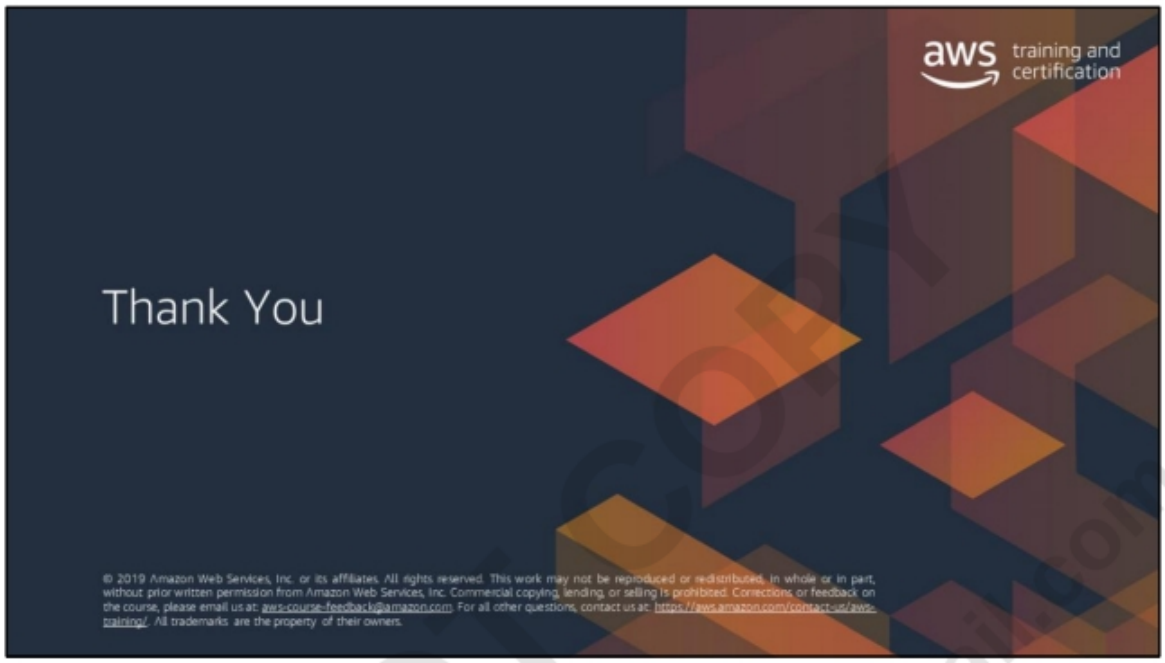
You will create a VPC with:

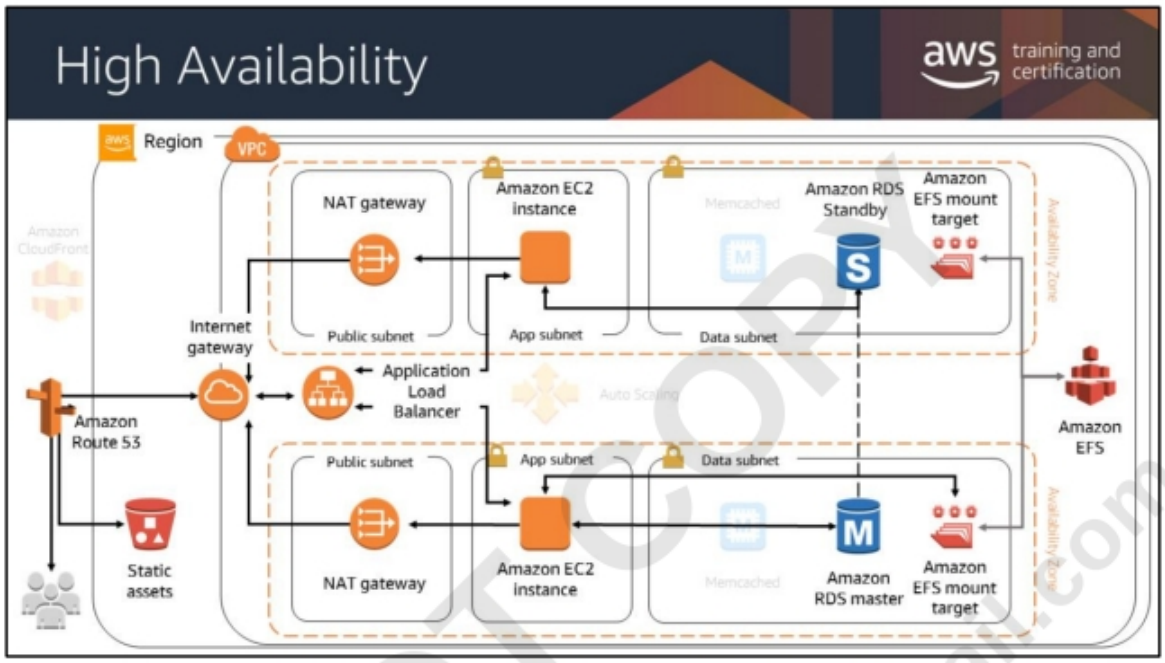
- An internet gateway
- A public subnet
- A private subnet
- Route tables for each subnet

Then test the public subnet by launching an app server and connecting to it.

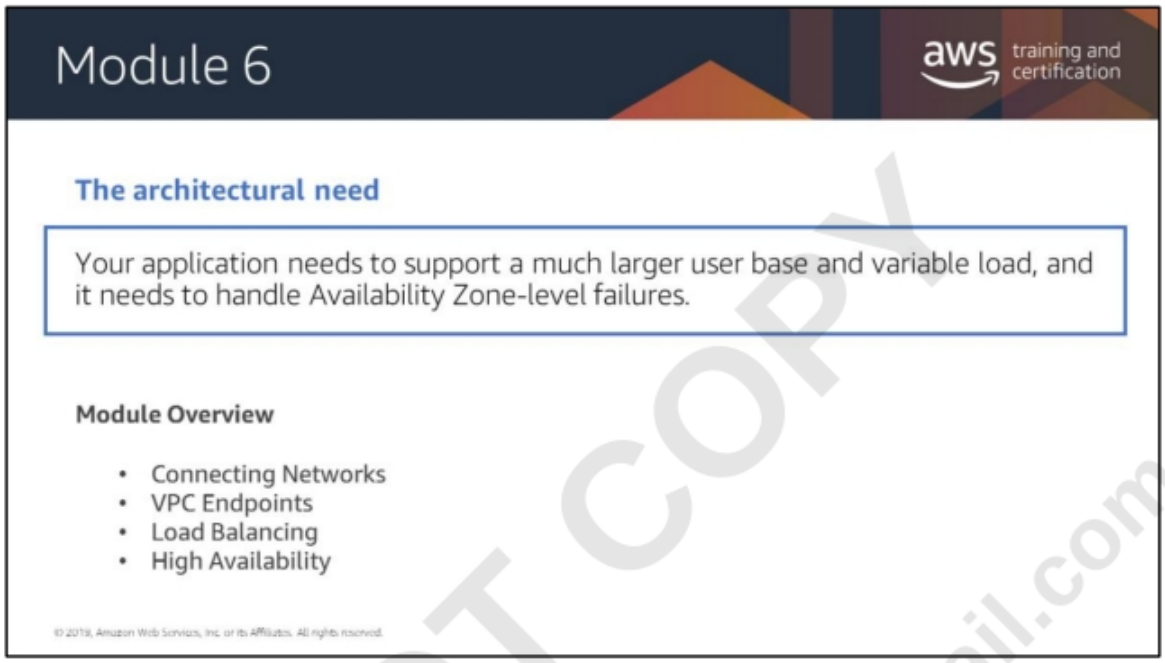








By the end of class, you will be able to understand all of the components of this architectural diagram. You will also be able to construct your own architectural solutions that are just as large and robust.



By default, instances that you launch into an Amazon VPC can't communicate with your own (remote) network. You can enable access to your remote network from your VPC by attaching a virtual private gateway (VGW) to the VPC, creating a custom route table, updating your security group rules, and creating an AWS-managed VPN connection.

Although the term *VPN connection* is a general term, in the Amazon VPC documentation, it refers to the connection between your VPC and your own network. AWS supports internet protocol security (IPsec) VPN connections.

A VGW is the VPN concentrator on the Amazon side of the VPN connection. You create a VGW and attach it to the VPC from which you want to create the VPN connection.

When you create a VGW, you can specify the private Autonomous System Number (ASN) for the Amazon side of the gateway. If you don't specify an ASN, the VGW is created with the default ASN (64512). You cannot change the ASN after you've created the VGW.

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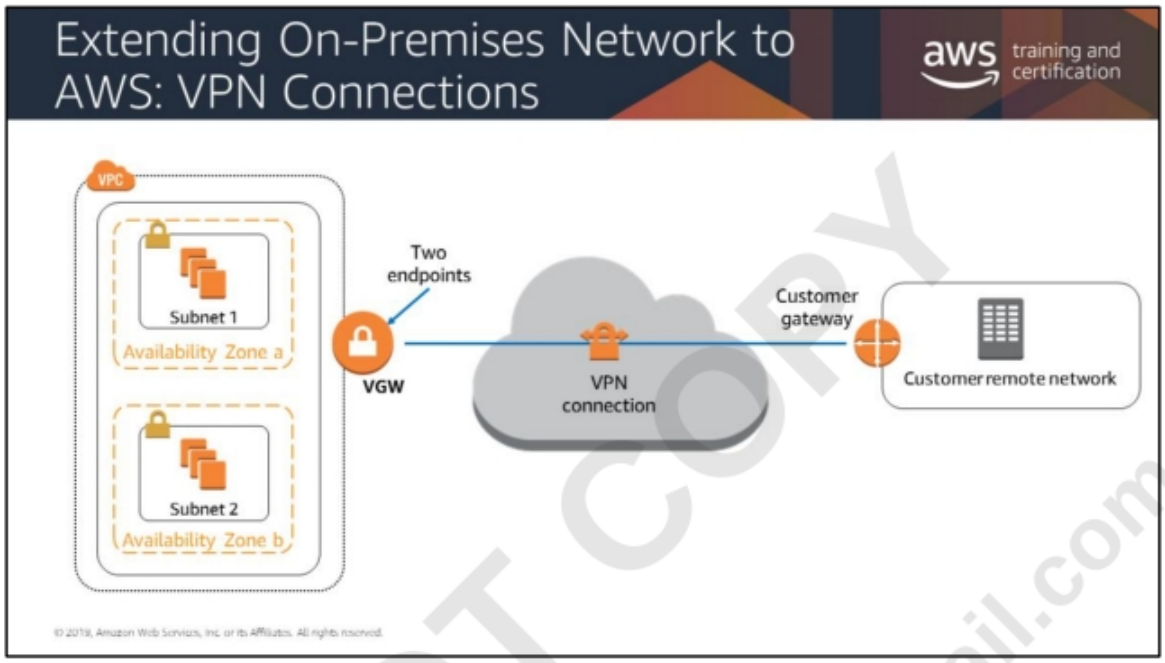
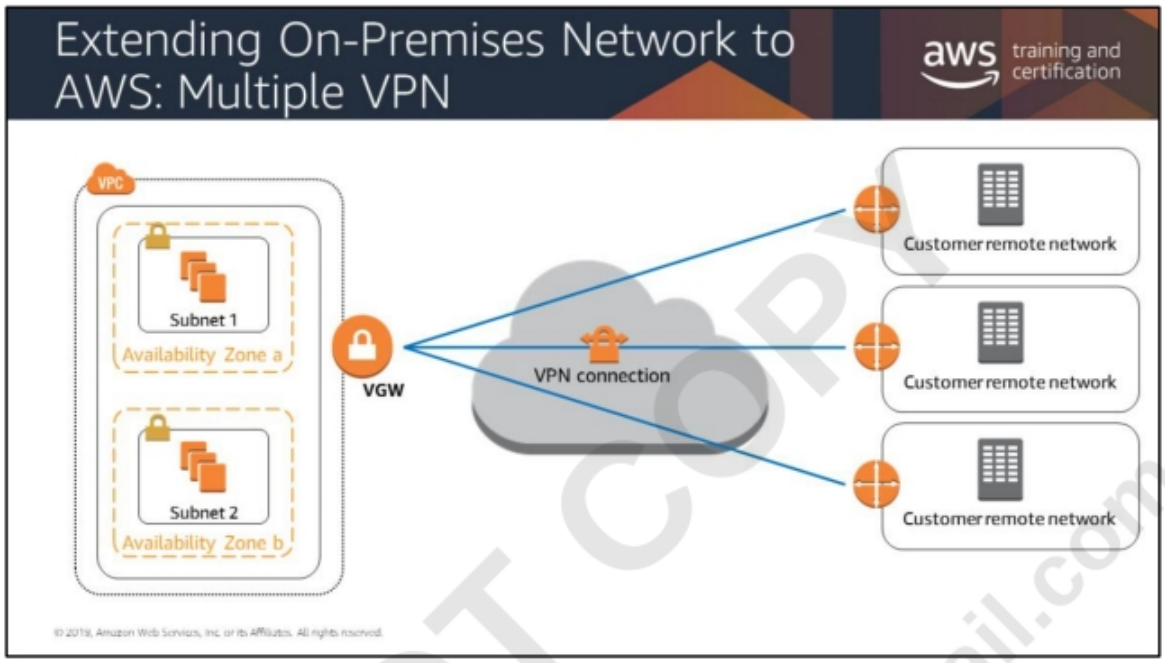
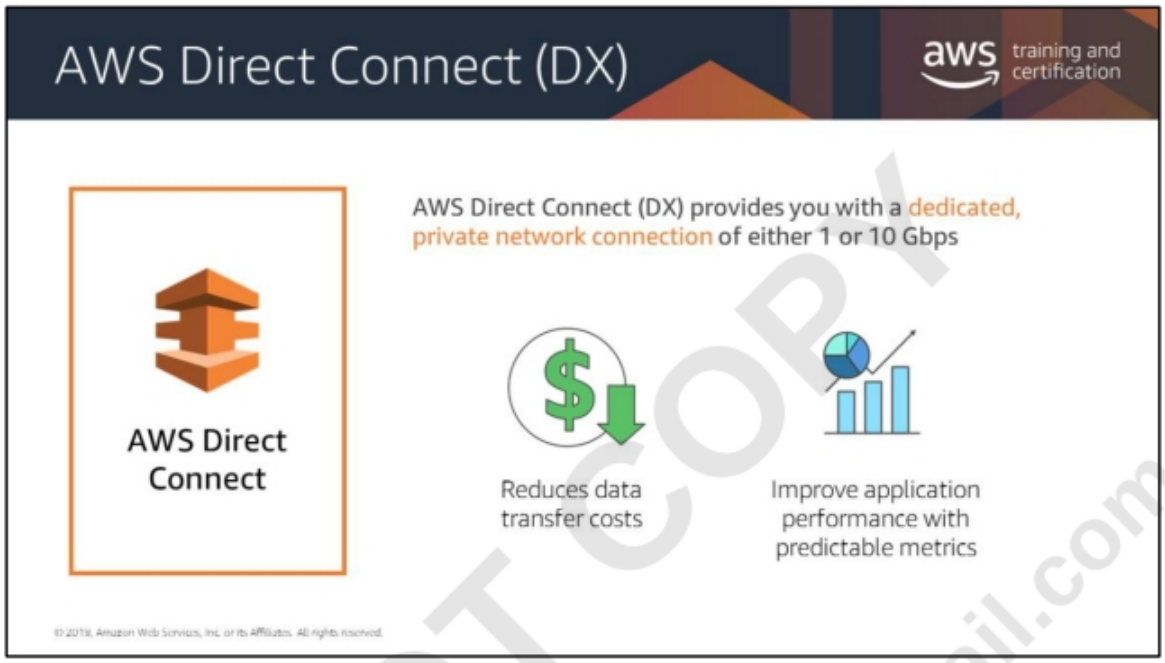


One solution is to use a VPN connection between your VPC's virtual gateway and your data center. With an AWS hardware VPN, you given two VPN endpoints to provide basic, automatic failover. For more information about creating an AWS hardware VPN, see http://docs.aws.amazon.com/AmazonVPC/latest/UserGuide/VPC_VPN.html.

You can also create a VPN connection to your remote network by using an Amazon EC2 instance in your VPC that's running a software VPN appliance. AWS does not provide or maintain software VPN appliances; however, you can choose from a range of products provided by partners and open source communities on the AWS Marketplace.



In AWS, VGW also supports and encourages multiple customer gateway connections so that customers can implement redundancy and failover on their side of the VPN connection, as shown on this slide. Both dynamic and static routing options are provided, which gives customers flexibility in their routing configuration. Dynamic routing uses BGP peering to exchange routing information between AWS and these remote endpoints. Dynamic routing also allows customers to specify routing priorities, policies, and weights (metrics) in their BGP advertisements and to influence the network path between their networks and AWS.



AWS Direct Connect (DX) is a unique solution to go beyond simple connectivity over the internet and, instead, get access with scale, speed, and consistency to the AWS network for these important applications. DX does not involve the internet; instead, it uses dedicated, private network connections between your on-premises solutions and AWS.

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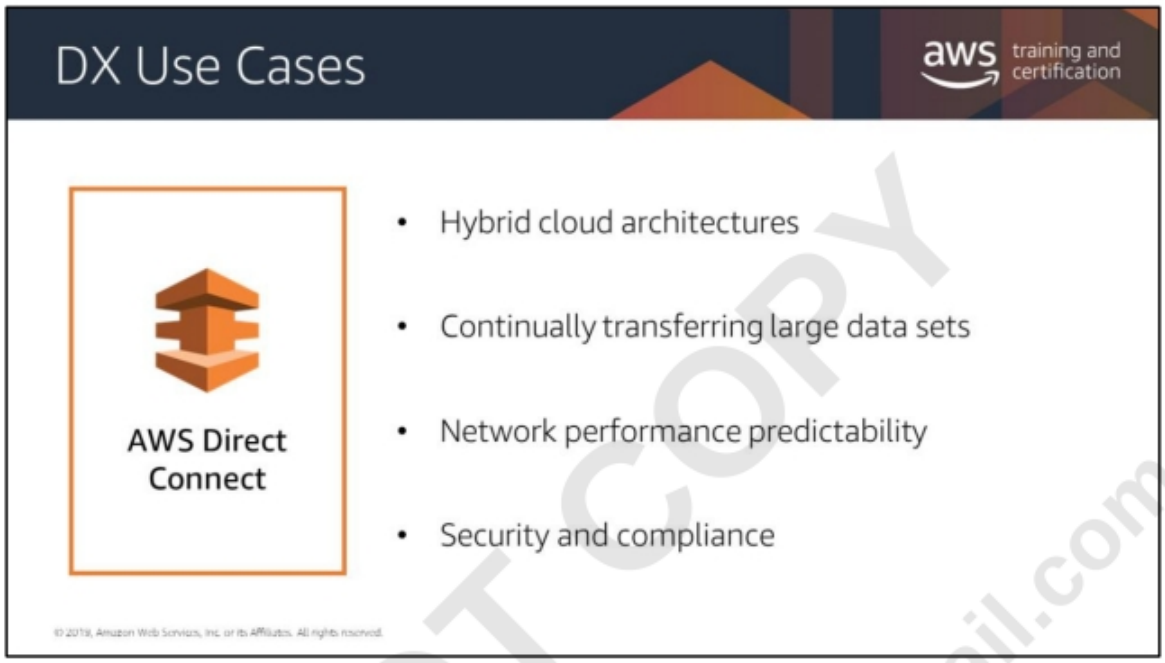

Service Benefits

DX is useful for several scenarios, some of which are described below.

Transferring Large Data Sets

Consider an HPC application that operates on large data sets that must be transferred between your data center and the AWS Cloud. For such applications, connecting to the AWS Cloud using DX is a good solution:

network transfers will not compete for internet bandwidth at your data center or office location.

The high bandwidth link reduces the potential for network congestion and degraded application performance.

Reduced Network Transfer Costs

By using DX to transfer large data sets, you can limit the internet bandwidth used by your application. By doing so, you can reduce network fees that you pay to your internet service provider (ISP) and avoid having to pay for increased internet bandwidth commitments or new contracts.

In addition, all data transferred over DX is charged at the reduced DX data transfer rate rather than internet data transfer rates, which can greatly reduce your network costs.

Improved Application Performance

Applications that require predictable network performance can also benefit from DX. Examples include applications that operate on real-time data feeds, such as audio or video streams. In such cases, a dedicated network connection can provide more consistent network performance than standard internet connectivity.

Security and Compliance

Enterprise security or regulatory policies sometimes require applications hosted on the AWS Cloud to be accessed through private network circuits only. DX is a natural solution to this requirement because traffic between your data center and your application flows through the dedicated private network connection.

Hybrid Cloud Architectures

Applications that require access to existing data center equipment that you own can also benefit from DX. The next section discusses this use case and illustrates different scenarios that can be supported by DX.

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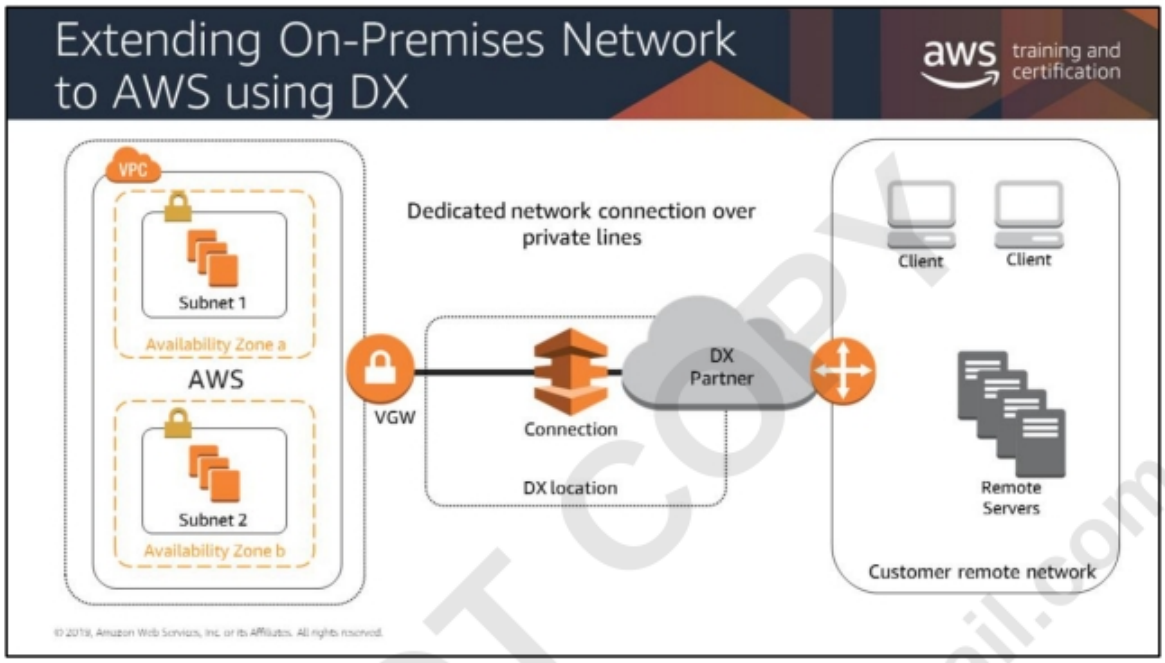

Benefits:

- More predictable network performance
- Reduced bandwidth costs
- 1- or 10-Gbps provisioned connections
- Supports BGP peering and routing policies

We have partnered closely with Equinix, Coresite, Eircom, TelecityGroup, and Terramark to create global DX access to every AWS Region in the world. In a few of our locations, particularly in LA, NYC, and London, we have extended the capability of the service to provide access to additional IT hot spots.

Limitation:
May require additional telecom and hosting provider relationships or new network circuits to be provisioned.
DX makes it easy to establish a dedicated network connection from on-premises to Amazon VPC. Using DX, customers can establish private connectivity between AWS and their data center, office, or colocation environment. This private connection can reduce network costs, increase bandwidth throughput, and provide a more consistent network experience than internet-based connections can.

DX lets customers establish 1-Gbps or 10-Gbps dedicated network connections (or multiple connections) between AWS networks and one of the DX locations, and uses industry standard VLANs to access Amazon EC2 instances running within a VPC using private IP addresses. Customers may choose from an ecosystem of WAN service providers for integrating their DX endpoint in an DX location with their remote networks.

For a list of current AWS DX locations, see http://aws.amazon.com/directconnect/details/

For information on using AWS Direct Connect for high resiliency for critical workloads, see https://aws.amazon.com/directconnect/resiliency-recommendation/

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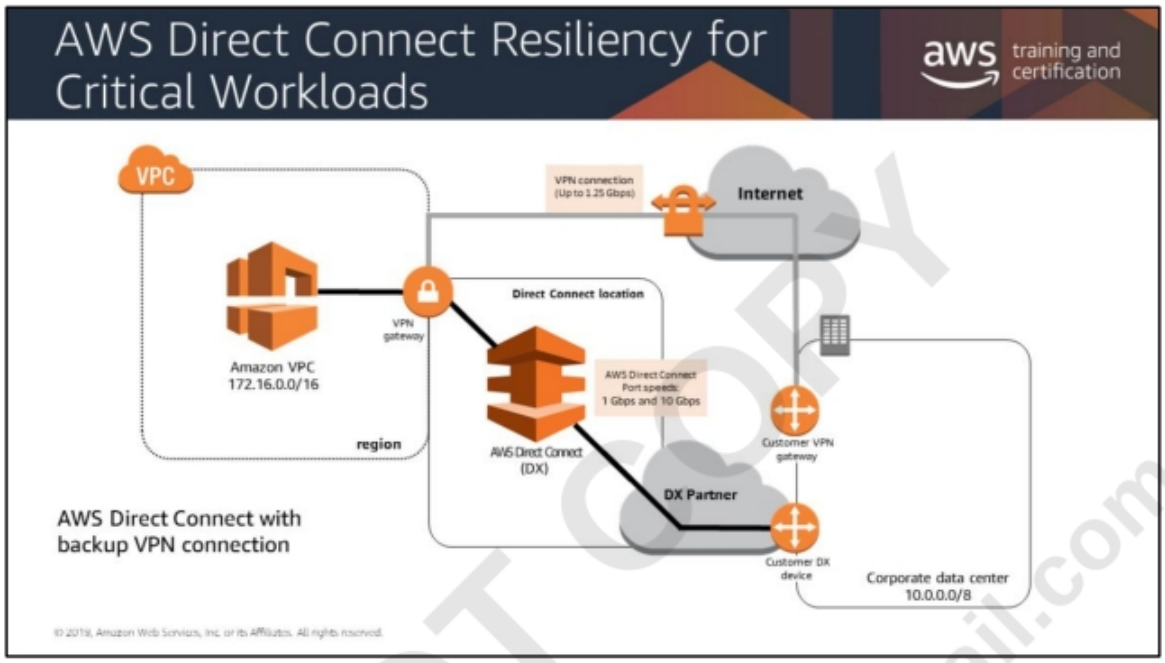

AWS customers can benefit of one or more AWS Direct Connect (DX) connections for their primary connectivity to AWS, coupled with a lower-cost backup connection. To achieve this objective, you can establish DX connections with a VPN backup, as depicted in the diagram above.

The configuration in this example consists of two dynamically routed connections, one using DX and the other using a VPN connection from two different customer devices. AWS provides example router configurations to assist in establishing both DX and dynamically routed VPN connections. By default, AWS will always prefer to send traffic over your DX connection, so no additional AWS-specific configuration is required to define primary and backup connections. However, customers should configure DX and VPN-specific internal-route propagation to ensure internal systems select the appropriate paths. The Multiple Data Center HA Network Connectivity Solution Brief has more details on route manipulation options for this scenario; however, the default configuration is typically sufficient for most customers connecting to AWS from a single data center.

AWS Direct Connect supports these port speeds over single-mode fiber: 1 Gbps: 1000BASE-LX (1310nm) and 10 Gbps: 10GBASE-LR (1310nm).

It is important to understand that AWS Managed VPN supports up to 1.25 Gbps throughput per VPN tunnel and does not support Equal Cost Multi Path (ECMP) for egress data path in the case of multiple AWS Managed VPN tunnels terminating on the same VGW.

This approach allows you to choose the primary network path and network provider for your AWS traffic, with the option of using a different provider for a backup VPN connection. Choose network providers and AWS Direct Connect locations that align with your organization's risk tolerance, financial expectations, and data-center connectivity policies. For example, if you are concerned about the risk associated with an individual network-provider outage, consider different network providers for AWS Direct Connect and Internet connectivity. However, because this design relies on a single customer location to provide connectivity to AWS, any location-specific disruption (e.g., loss of power or cable cut outside the facility) can still affect network connectivity to AWS, despite leveraging redundant network providers. Additionally, make sure to monitor AWS Direct Connect utilization to ensure that a VPN connection will be a sufficient backup to support your application's latency and bandwidth requirements.

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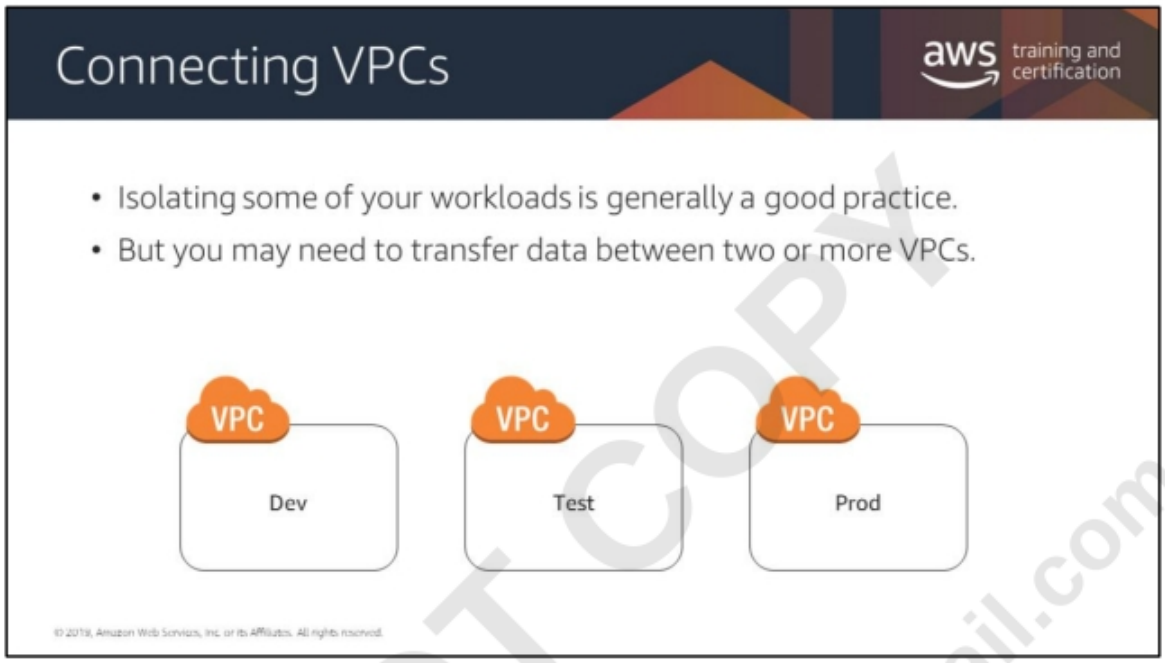
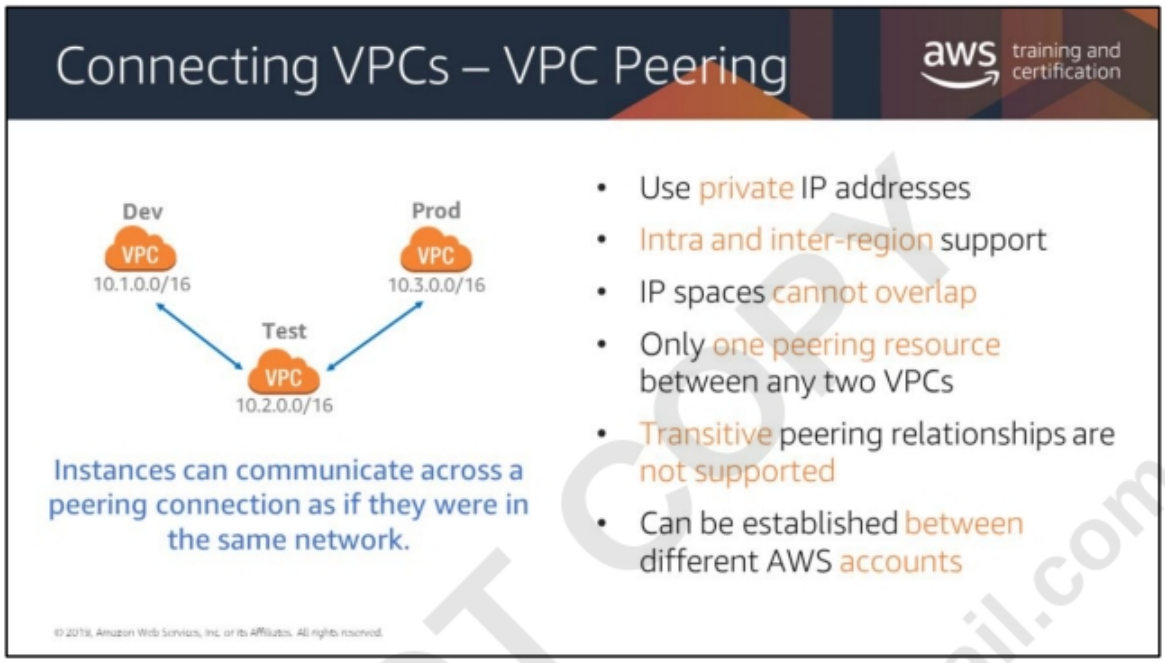


When your business or architecture becomes large enough, you will find the need to separate logical elements either for security or architectural needs, or just for simplicity's sake.



In the diagram, VPCs Dev and Test are peered, which does not mean that *Prod* can talk to Dev. By default, VPC peering does not allow Prod to connect to Dev unless they are *explicitly established as peers.* Therefore, you control which VPCs can talk to each other.

To establish a VPC peering connection, the owner of the requester VPC (or local VPC) sends a request to the owner of the peer VPC to create the VPC peering connection. The peer VPC can be owned by you or another AWS account, and cannot have a CIDR block that overlaps with the requester VPC's CIDR block. The owner of the peer VPC has to accept the VPC peering connection request to activate the VPC peering connection. To enable the flow of the traffic between the peer VPCs using private IP addresses, add a route to one or more of your VPC's route tables that points to the IP address range of the peer VPC. The owner of the peer VPC adds a route to one of their VPC's route tables that points to the IP address range of your VPC. You may also need to update the security group rules that are associated with your instance to ensure that traffic to and from the peer VPC is not restricted.

A VPC peering connection is a one-to-one relationship between two VPCs. You can create multiple VPC peering connections for each VPC that you own, but transitive peering relationships are not supported: you will not have any peering relationship with VPCs that your VPC is not directly peered with. You can create a VPC peering connection between your own VPCs, or with a VPC in another AWS account within a single region.

Amazon EC2 now allows peering relationships to be established between VPCs across different regions. Inter-region VPC peering allows VPC resources like Amazon EC2 instances, Amazon RDS databases, and Lambda functions running in different regions to communicate with each other using private IP addresses, without requiring gateways, VPN connections, or separate network appliances. Data transferred across inter-region VPC peering connections is charged at the standard inter-region data transfer rates.

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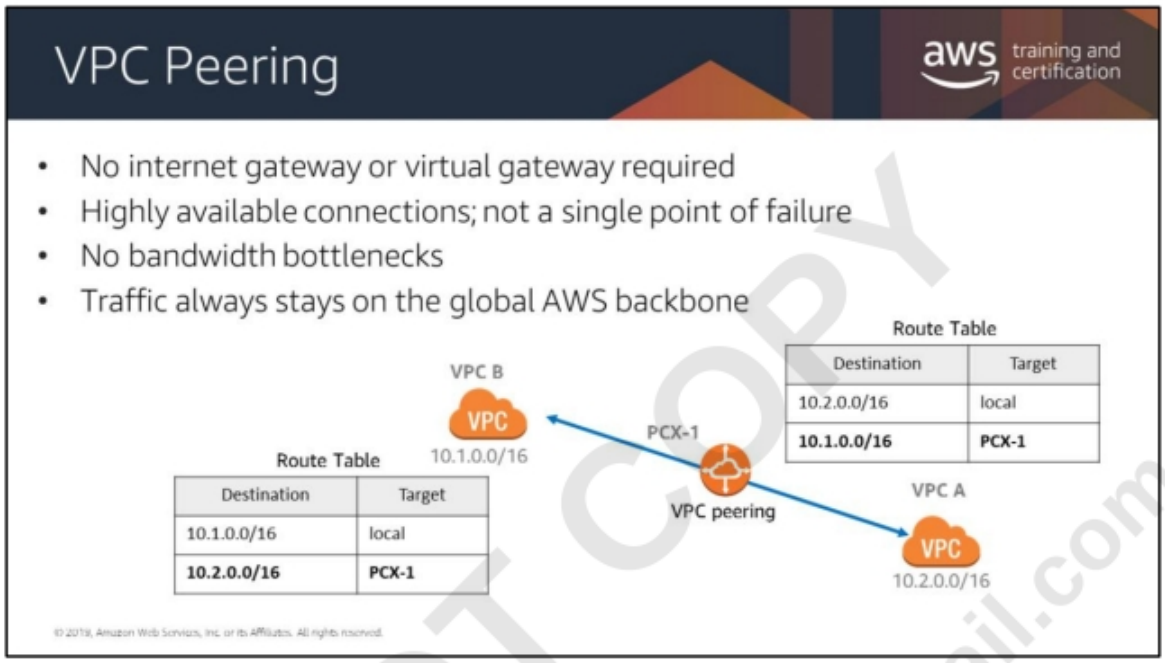
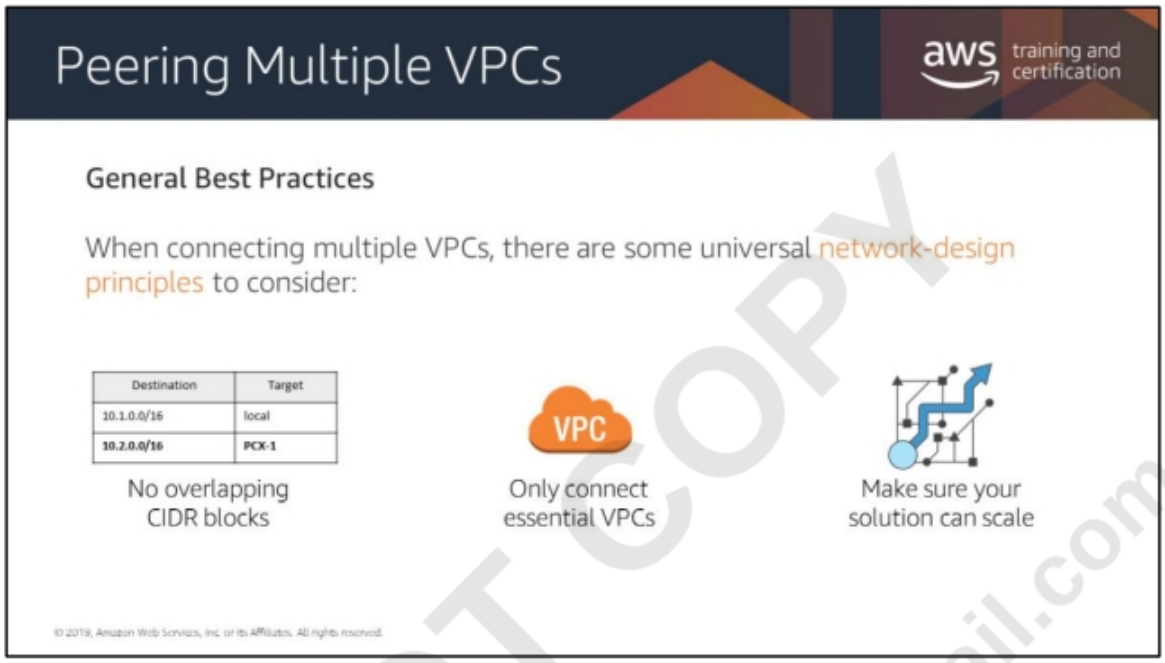


To create a VPC peering connection with another VPC, you need to be aware of the following limitations and rules:

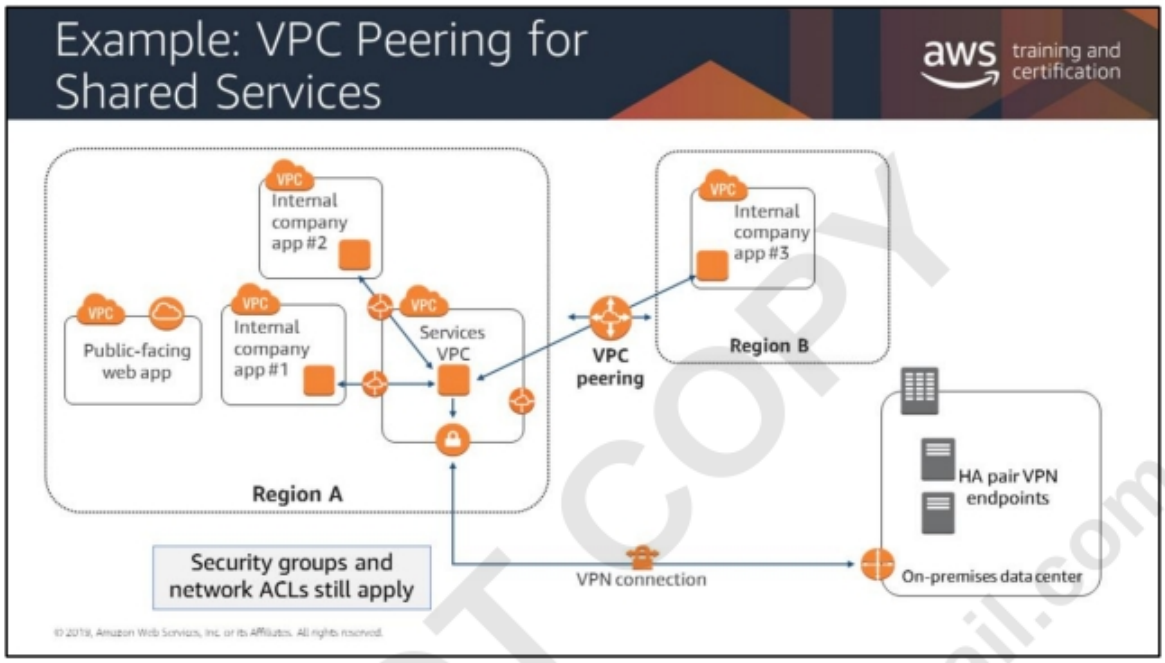
- There is a limit on the number of active and pending VPC peering connections that you can have per VPC.
- VPC peering does not support transitive peering relationships; in a VPC peering connection, your VPC will not have access to any other VPCs that the peer VPC may be peered with. This includes VPC peering connections that are established entirely within your own AWS account.
- You cannot have more than one VPC peering connection between the same two VPCs at the same time.
- The maximum transmission unit (MTU) across a VPC peering connection is 1500 bytes.
- A placement group can span peered VPCs; however, you will not get full-bisection bandwidth between instances in peered VPCs.
- Unicast reverse path forwarding in VPC peering connections is not supported.
- Private DNS values cannot be resolved between instances in peered VPCs.
- Traffic using inter-region VPC peering always stays on the global AWS backbone and never traverses the public internet, thereby reducing threat vectors, such as common exploits and DDoS attacks.

You can now reference security groups in a peered VPC in both inbound and outbound rules. This functionality is supported cross-account, so the two VPCs can be in different accounts. Support for security group references in a peered VPC simplifies configuration by controlling peering traffic via security group membership instead of CIDR ranges. You can reference security group from a peered VPC using the console, AWS CLI, and SDKs.



When connecting multiple VPCs in a single AWS Region, there are some universal network-design principles to consider:

- Ensure that your VPC network ranges (CIDR blocks) do not overlap.
- Make sure the solution you choose can scale according to your current and future VPC connectivity needs.
- Ensure that you implement a highly available (HA) design with no single point of failure.
- Consider your data-transfer needs, as this will affect the solution you choose. Some solutions may prove to be more expensive than others based on the amount of data transferred.
- Connect only those VPCs that really need to communicate with each other.



In this example, in order to deliver its responsibilities, the Corporate IT and Corporate Information Security groups provide a "Services VPC" that each department may peer with. This VPC contains connections to Active Directory, security scanning tools, monitoring/logging tools, and a variety of other capabilities. It also provides a proxy through which the department VPCs can access some on-premises resources.
VPC Peering:

- 1 to 1 Peer = company app isolation from other apps in other VPCs, but this could always facilitate TEMP connect b/t dev/qa and prod, TRANSFER data, tear down.
- Security groups and network ACLs still apply.

Note that a VPC peering connection with a VPC in a different region is present. Amazon EC2 now allows peering relationships to be established between VPCs across different AWS Regions. Inter-region VPC peering allows VPC resources like EC2 instances, Amazon RDS, and Lambda functions that run in different AWS Regions to communicate with each other using private IP addresses, without requiring gateways, VPN connections or separate physical hardware.

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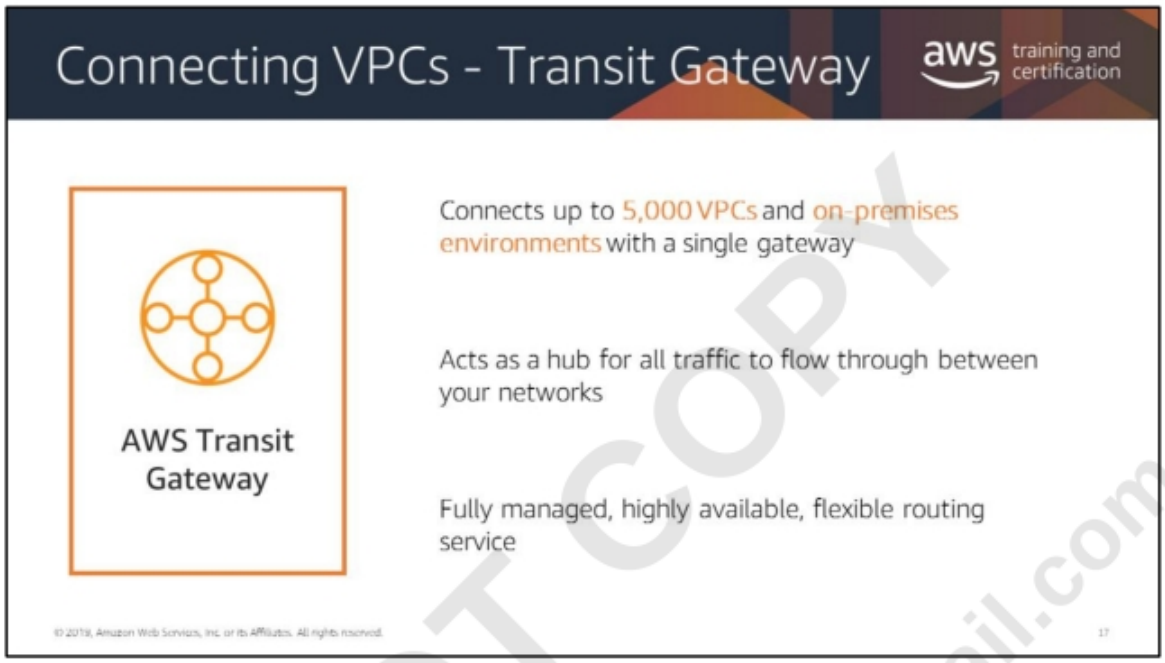
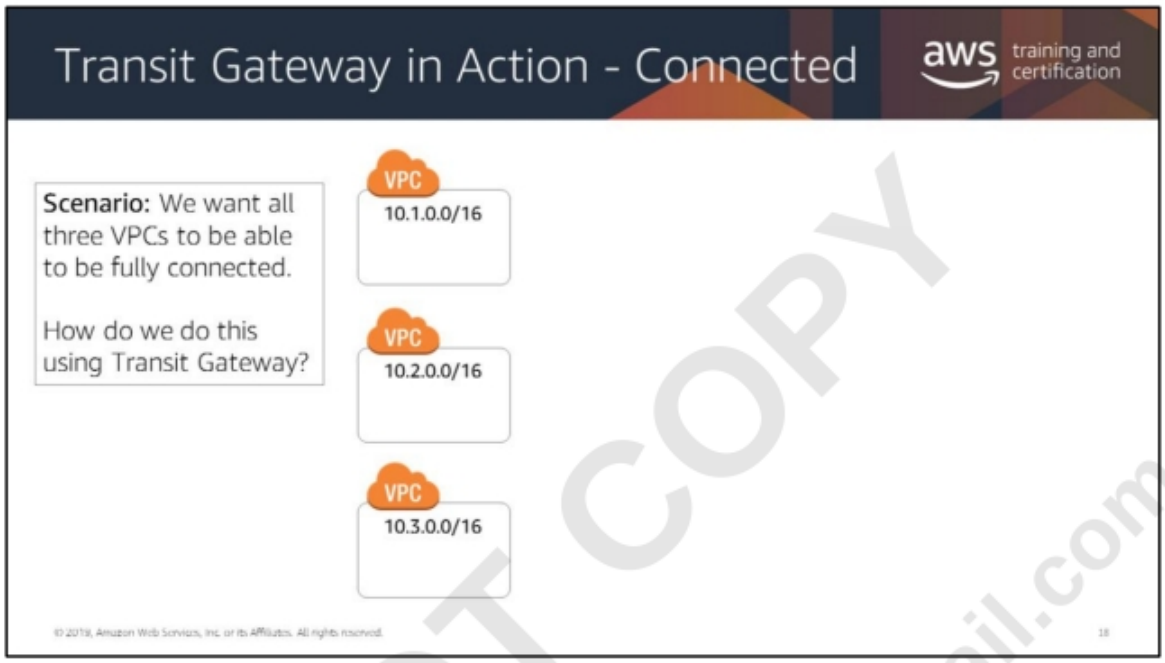
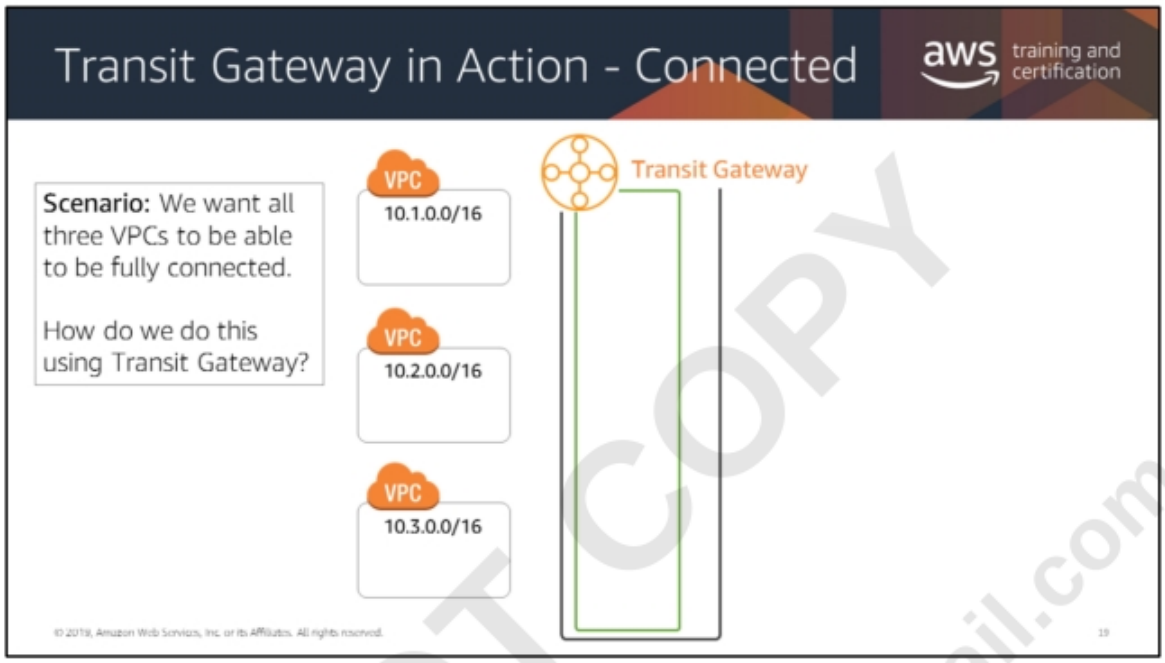
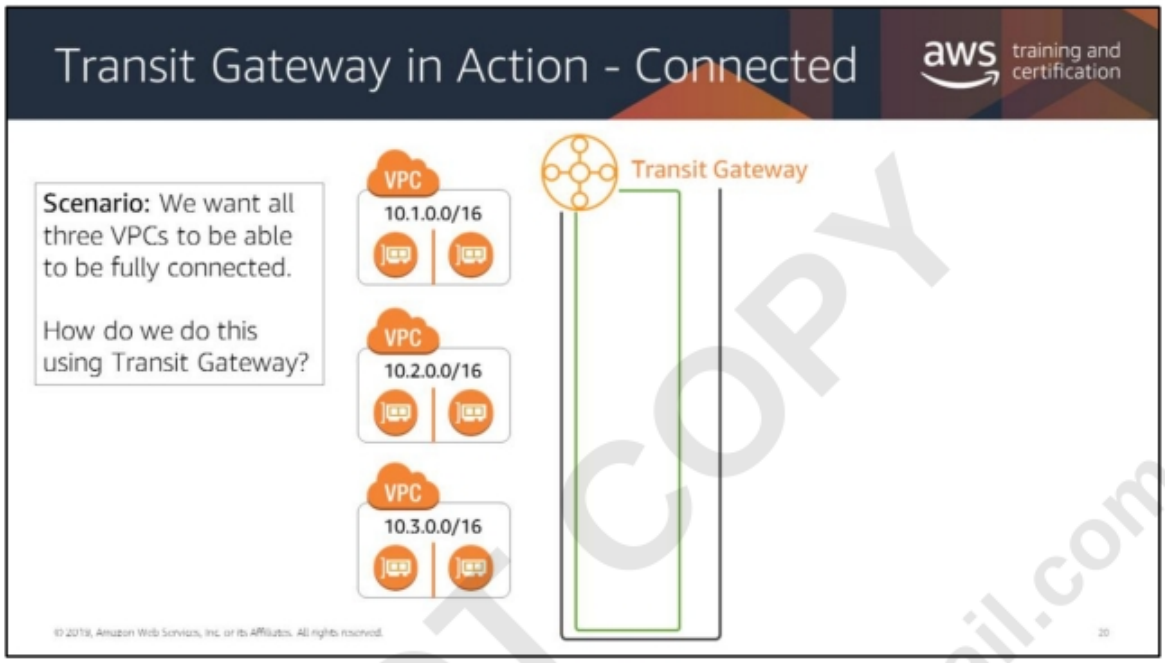




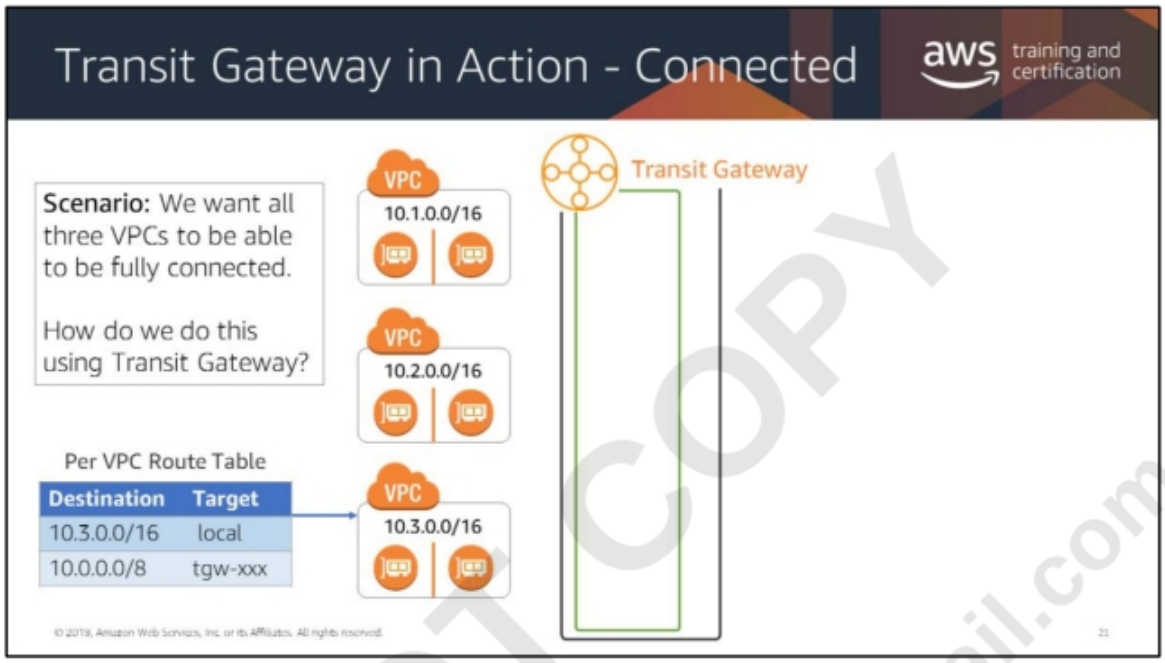
There are many situations where having connectivity between multiple VPCs is highly desirable. Having to manage VPC peering connections over a large group can be annoying and difficult. It's vital to keep in mind how large your environment might become over time, how well it will scale, and how you will organize these VPCs.



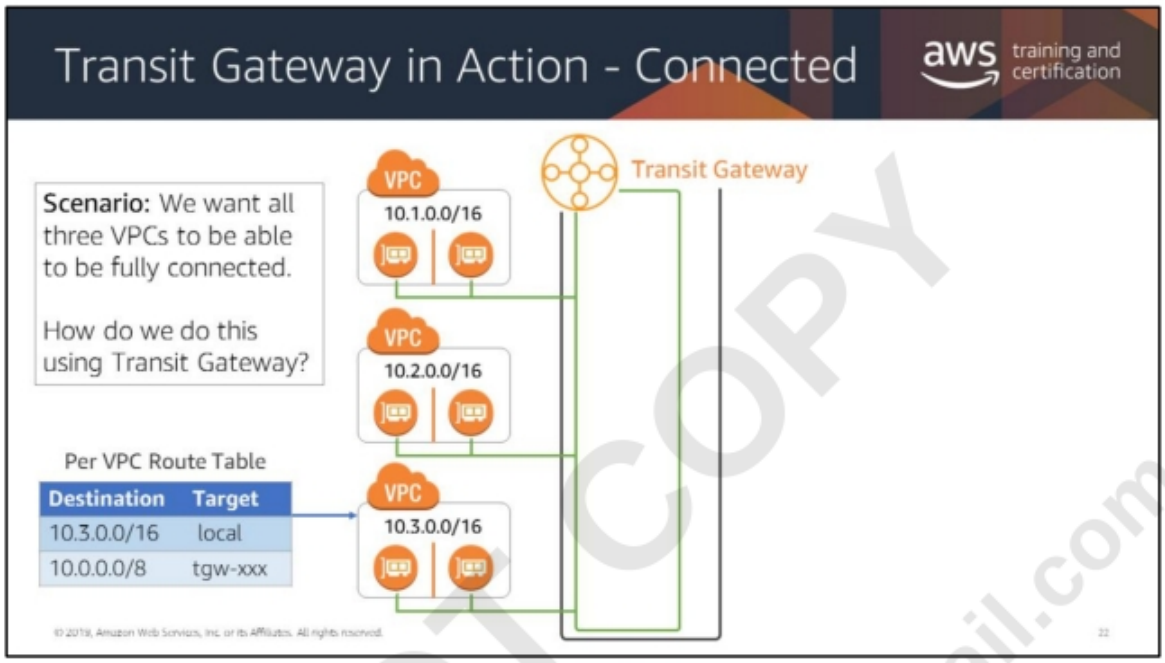
The first step to creating this connectivity is to set up a transit gateway. This can be done through the Amazon EC2 dashboard. Various charges apply for using transit gateway – make sure your architecture and budget can support this.



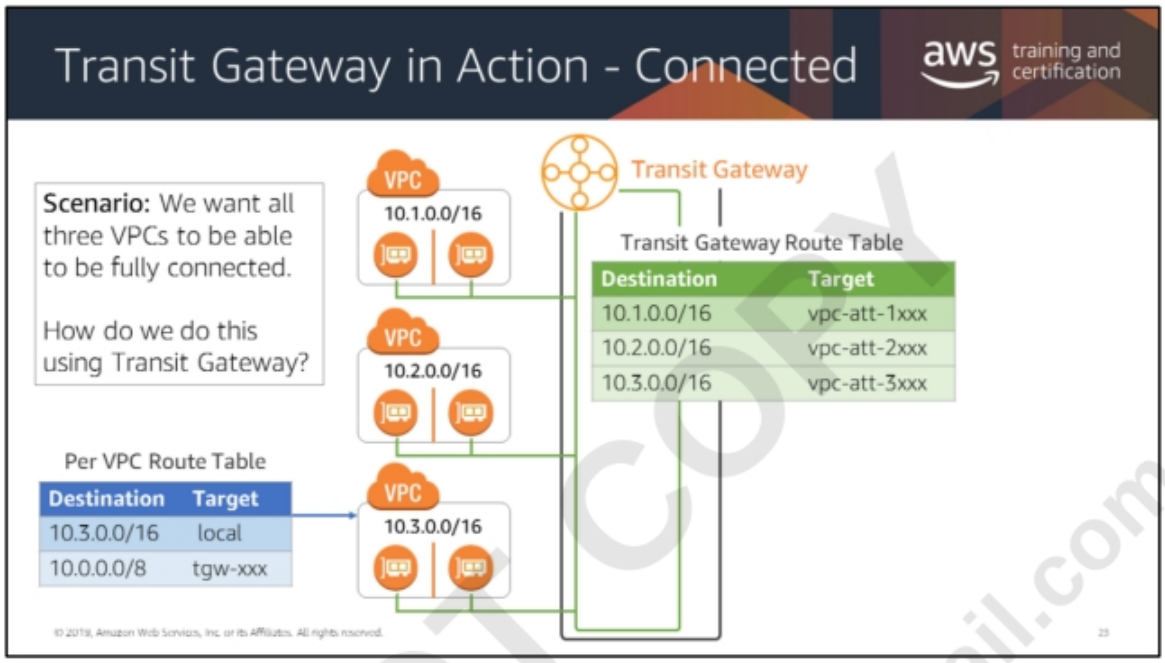
Transit Gateway operates though network interfaces which are deployed into subnets. To effectively use Transit Gateway, you need to deploy one attachment into each Availability Zone your target VPC occupies.



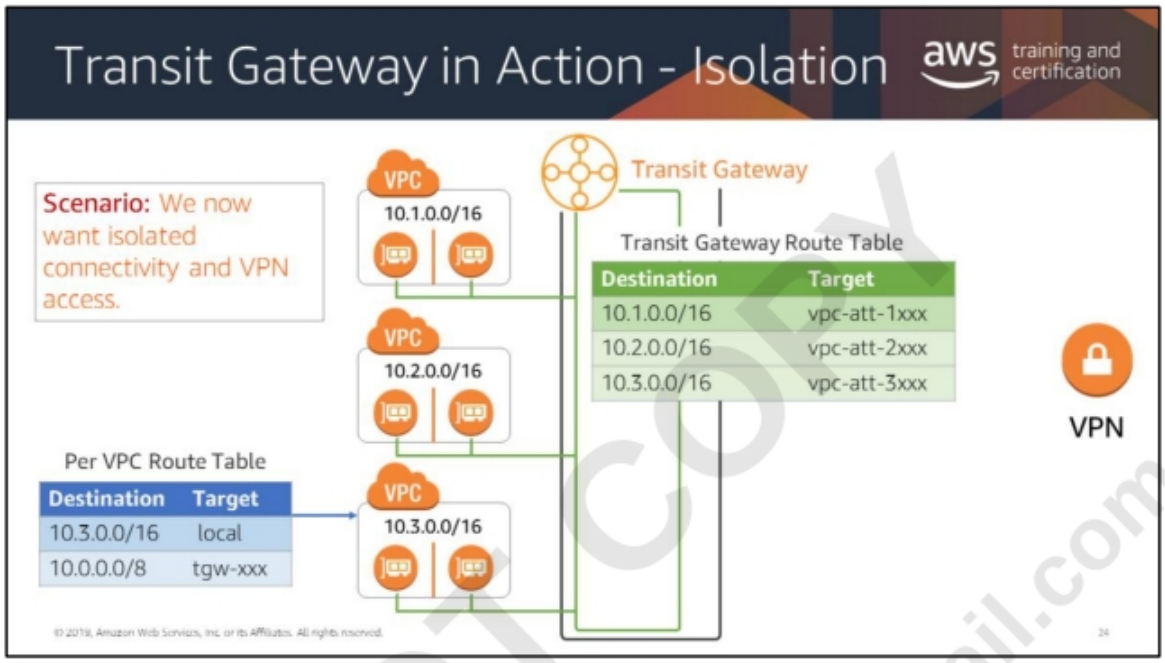
In each route table of your VPC, make sure traffic is routing outwards towards the Transit Gateway attachment.



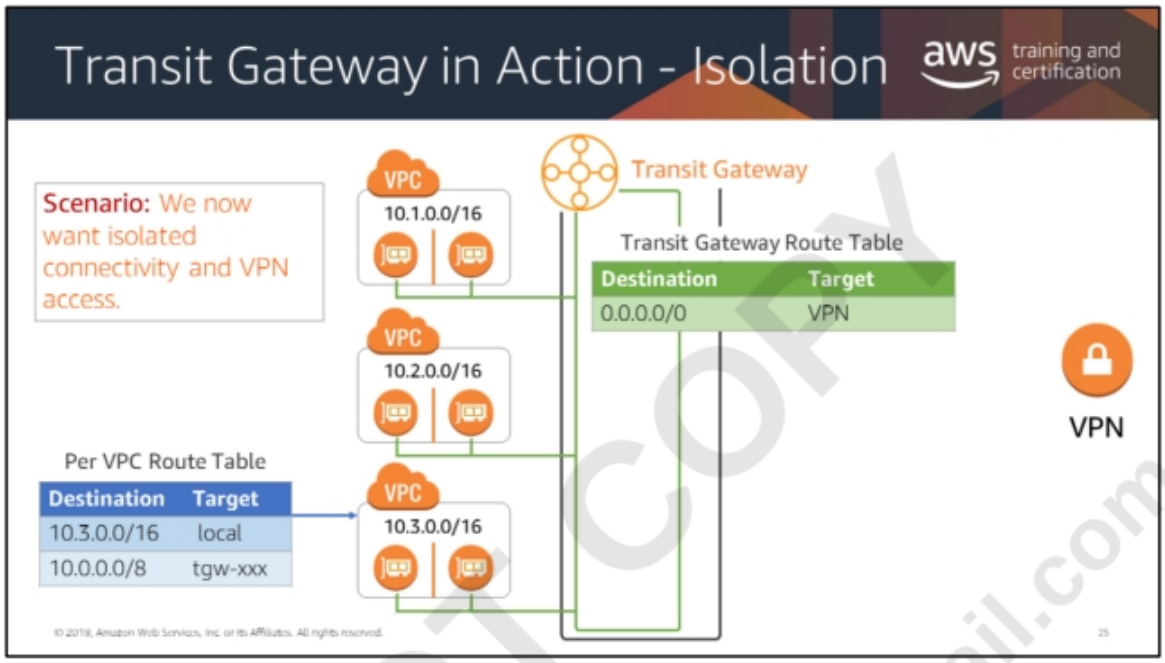
These attachments are connected to the Transit Gateway.



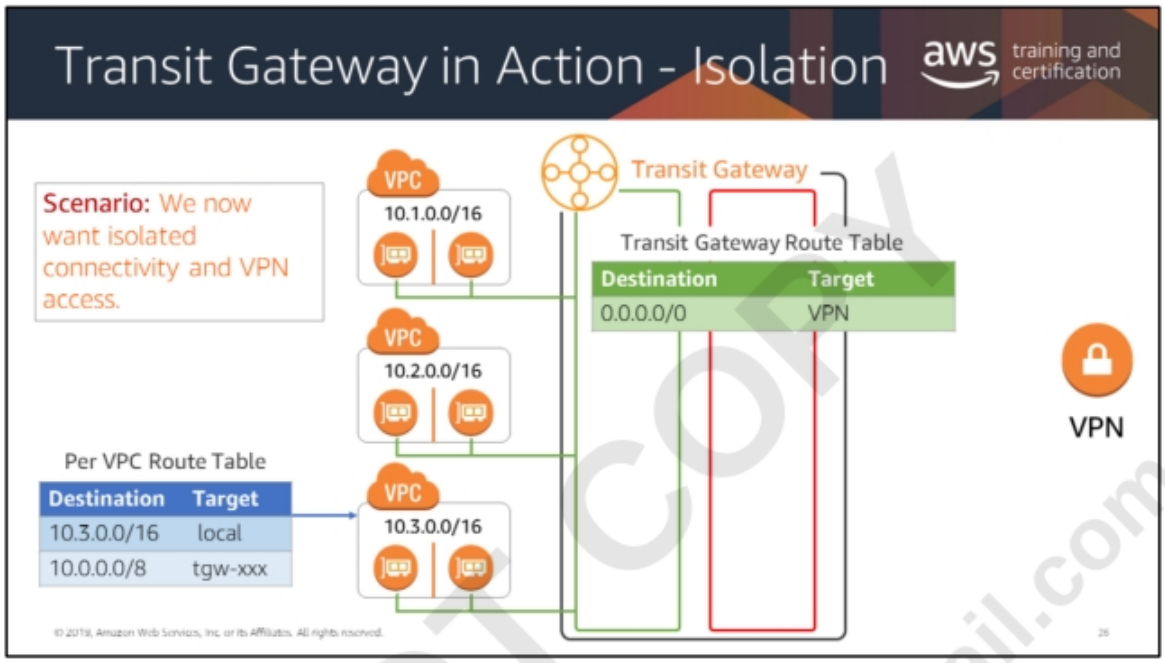
Inside the Transit Gateway, you can create route tables to direct traffic how you see fit. You can have multiple route tables for very specific interactions. In our case, we just have the one to allow full connectivity.



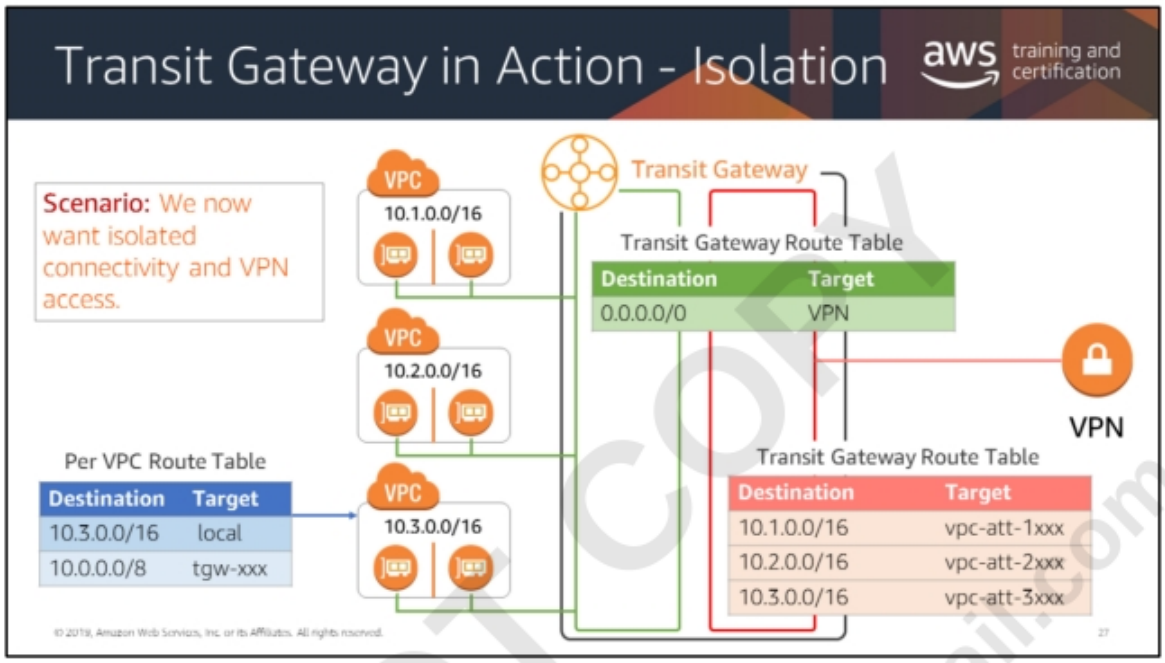
A common architecture is having full access to your environment from a VPN source. In this scenario, we also do not want our VPCs to be able to talk with each other.



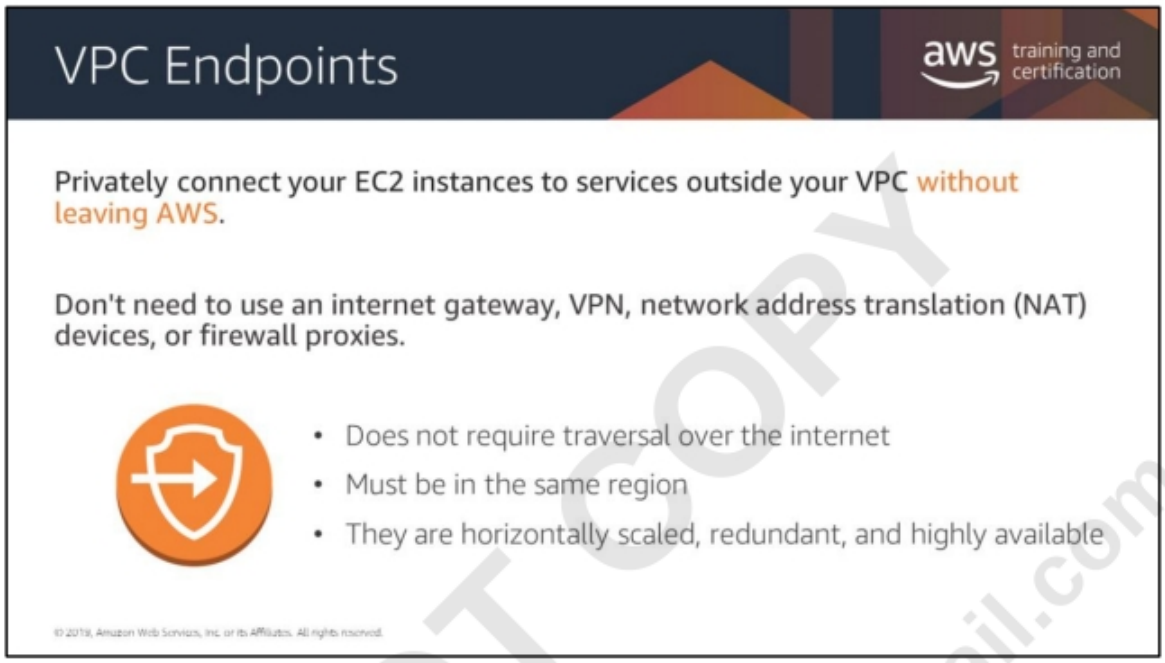
First, we change the routes for the initial table to point towards the VPN connection. This will stop the VPCs from communicating with each other and provide outbound access.



Now that we want to create an isolated environment, that is connected to VPN only. Add another Route table inside the Transit Gateway.



Set these destinations to point from the VPN to the target VPCs. There you have it: isolated and secure VPN access with no cross communication.



An Amazon VPC *endpoint* enables a private connection between a VPC and another AWS service without leaving the AWS network. An endpoint enables Amazon EC2 instances to communicate with an AWS service in the same region from their private IP addresses. It does not require traversal over the internet or through a NAT instance, a VPN connection, or DX. VPC endpoints also provide additional security features such as the ability to add policies to control which Amazon S3 buckets in a VPC can access or to lock down S3 buckets to specific VPCs. Currently, AWS supports VPC endpoints for connections with Amazon S3 and Amazon DynamoDB only.

Endpoints are virtual devices. They are horizontally scaled, redundant, and highly available VPC components that allow communication between instances in your VPC and services without imposing availability risks or bandwidth constraints on your network traffic.

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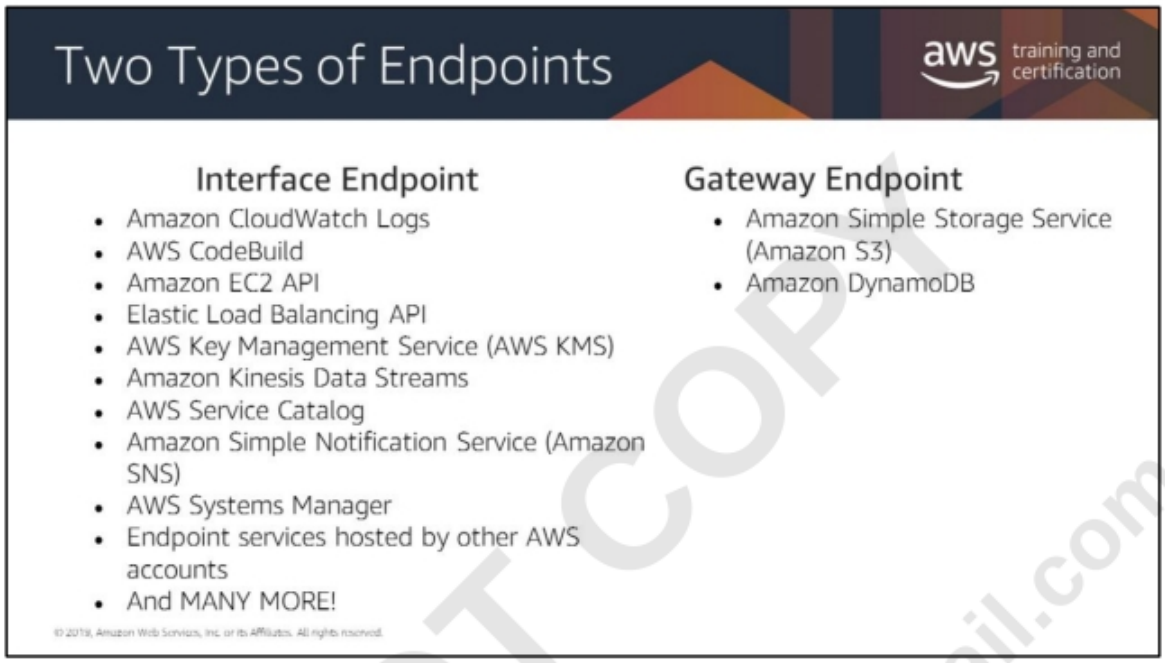
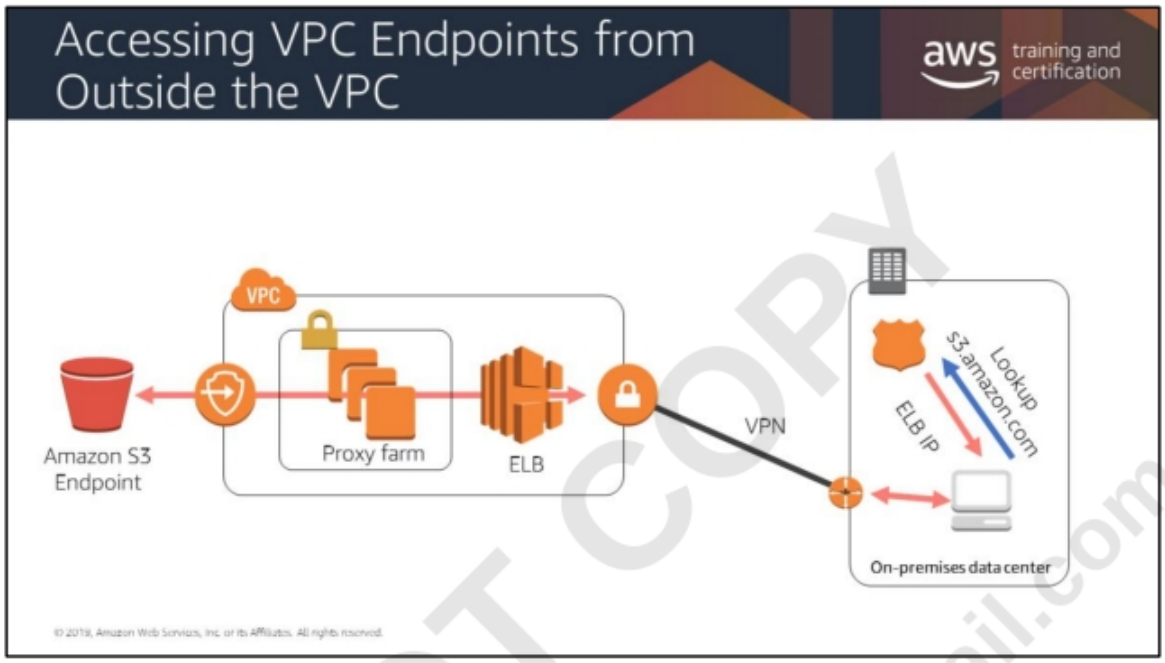


An *interface endpoint* is an elastic network interface with a private IP address that serves as an entry point for traffic destined to a supported service.

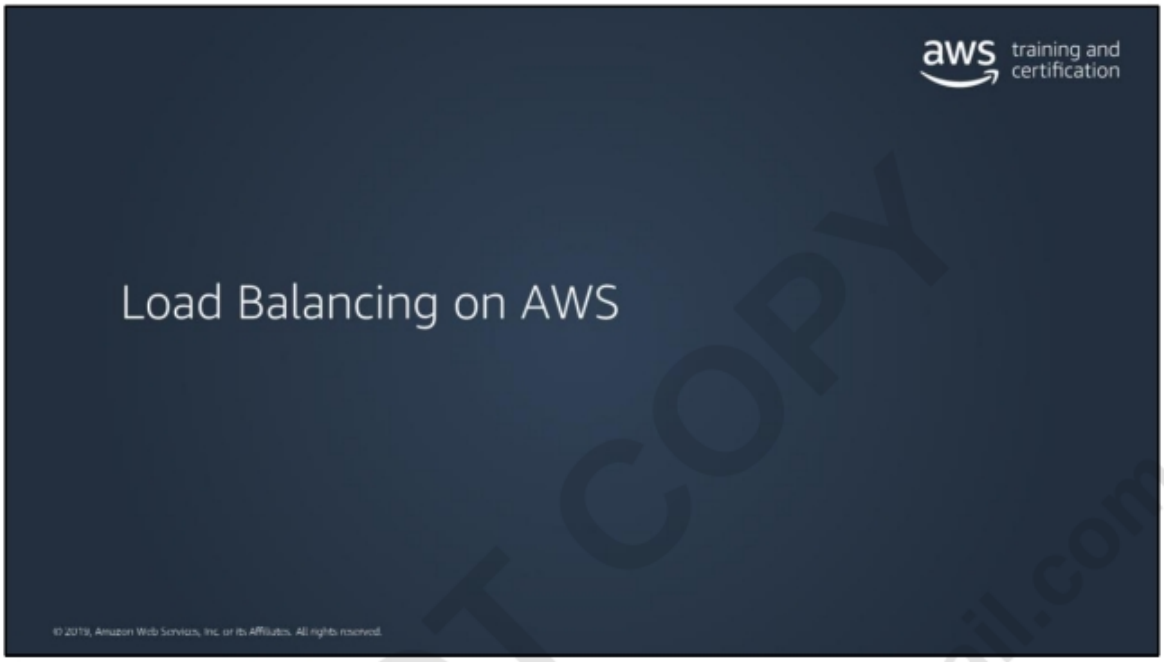
A *gateway endpoint* is a gateway that is a target for a specified route in your route table, used for traffic destined to a supported AWS service.

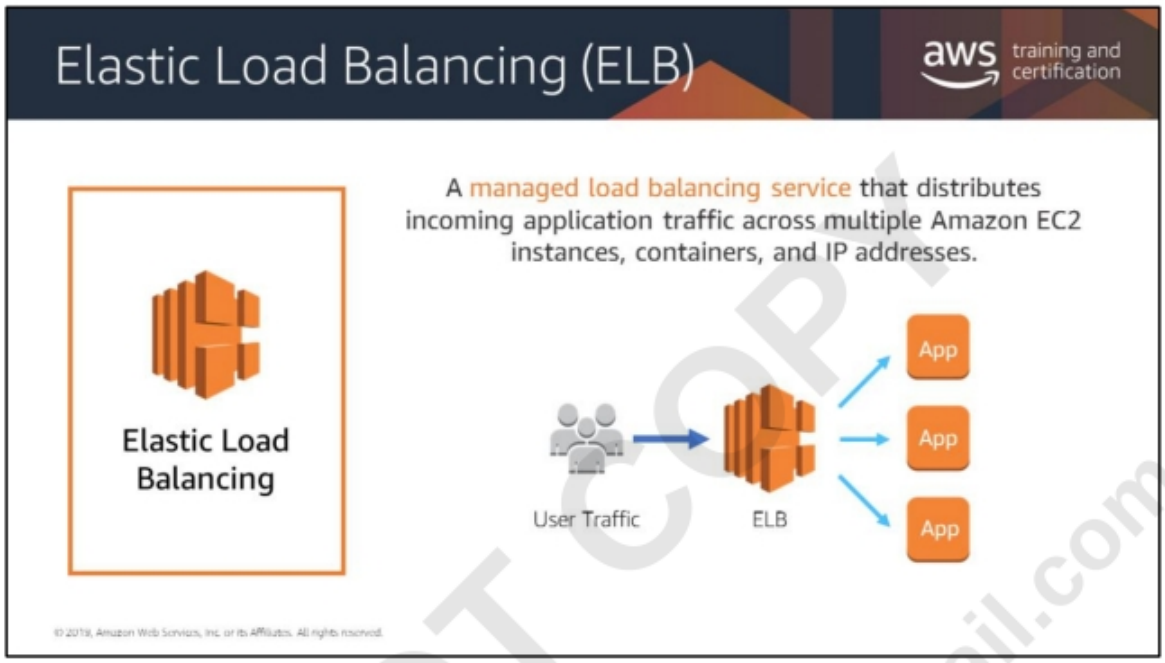


Corporate Domain Name Service (DNS)
The first step in using a VPC endpoint from a remote network is to identify the traffic to redirect through the endpoint. This solution uses corporate DNS servers to override DNS resolution for VPC-endpoint-specific traffic. In the example above, the DNS servers are configured to resolve s3.amazonaws.com to an internal ELB load balancer, which redirects traffic destined for US Standard S3 buckets to the VPC endpoint. This sends Amazon S3 requests from the corporate network to the S3 bucket over a private VPN or DX connection instead of over the internet.

Elastic Load Balancing (ELB)
ELB automatically distributes incoming Amazon S3 TCP connections across multiple Amazon EC2 proxy instances. It enables greater levels of fault tolerance for the proxy farm by seamlessly providing the required amount of load balancing capacity needed to distribute S3 traffic across multiple proxy servers. Additionally, configure the ELB load balancer to leverage multiple Availability Zones for maximum fault tolerance.

Proxy Farm
The proxy farm proxies Amazon S3 traffic to the VPC endpoint. The proxy farm can use access control lists (ACLs) to provide additional control over VPC endpoint traffic. An ACL can specify which remote users or networks are authorized to leverage the solution, and can further restrict the VPC endpoints or destination domains that clients can access. Configure an Auto Scaling group to manage the proxy servers and automatically grow or shrink the number of required instances based on proxy server load.





The foundation of the web tier includes the use of ELB in the architecture. These load balancers not only send traffic to EC2 instances, but can also send metrics to Amazon CloudWatch, a managed monitoring service provided. The metrics from Amazon EC2 and ELB can act as triggers—so that if you notice a particularly high latency or that our servers are becoming over-utilized, you can take advantage of Auto Scaling to add more capacity to your web server fleet.

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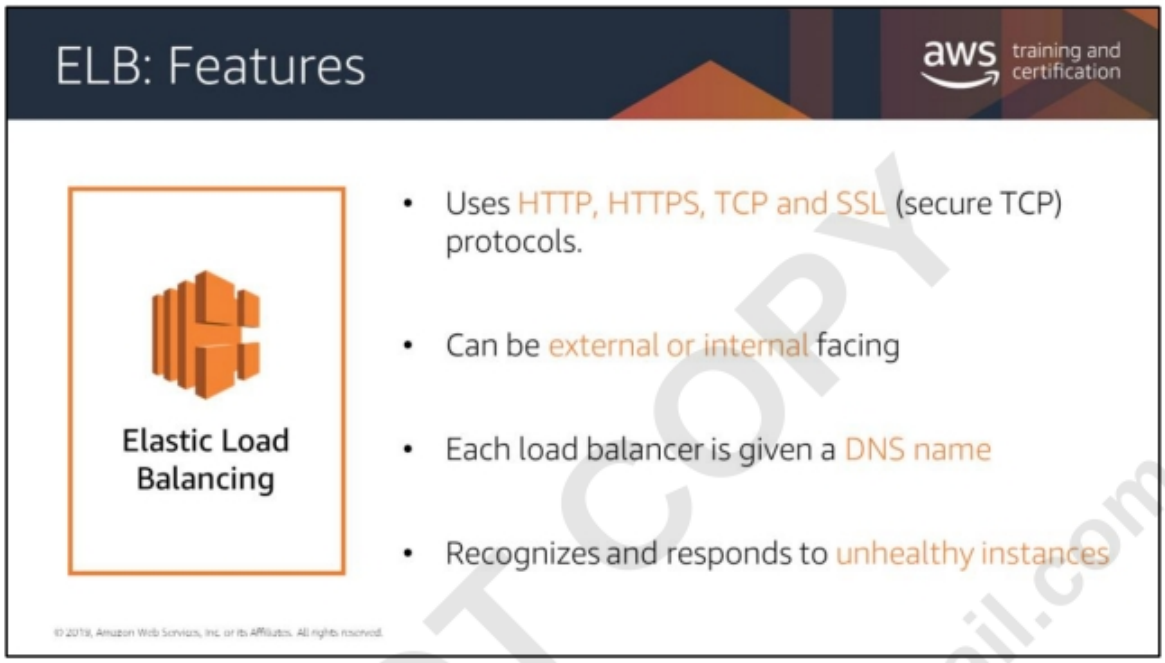

ELB automatically distributes incoming application traffic across multiple targets, such as Amazon EC2 instances, containers, and IP addresses. It can handle the varying load of your application traffic in a single Availability Zone or across multiple Availability Zones. ELB offers three types of load balancers that all feature the high availability, automatic scaling, and robust security necessary to make your applications fault-tolerant.

ELB supports three types of load balancers: Application Load Balancers, Network Load Balancers, and Classic Load Balancers. You can select a load balancer based on your application needs.

An **Application Load Balancer** functions at the application layer, the seventh layer of the Open Systems Interconnection (OSI) model. Application Load Balancers support content-based routing and supports applications that run in containers. They support native Web Sockets over HTTP or HTTPS as well as HTTP/2 with HTTPS listeners. They also check the health of the targets, whether it's an EC2 instance or a container. Websites and mobile apps, running in containers or on EC2 instances, will benefit from the use of Application Load Balancers.

The **Network Load Balancer** is designed to handle tens of millions of requests per second while maintaining high throughput at ultra-low latency, with no effort on your part. It accepts incoming traffic from clients and distributes this traffic across the targets within the **same** Availability Zone. Network Load Balancers operate at the connection level (Layer 4), routing connections to targets—Amazon EC2 instances, containers, and IP addresses based on IP protocol data. The Network Load Balancer is API-compatible with the Application Load Balancer, including full programmatic control of target groups and targets.

The Network Load Balancer is ideal for balancing TCP traffic. Network Load Balancers are optimized to handle sudden and volatile traffic patterns while using a single static IP address per Availability Zone.

The **Classic Load Balancer** provides basic load balancing across EC2 instances in multiple Availability Zones and operates at both the request level and connection level of the OSI.

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