Exploring the fundamentals of AWS networking

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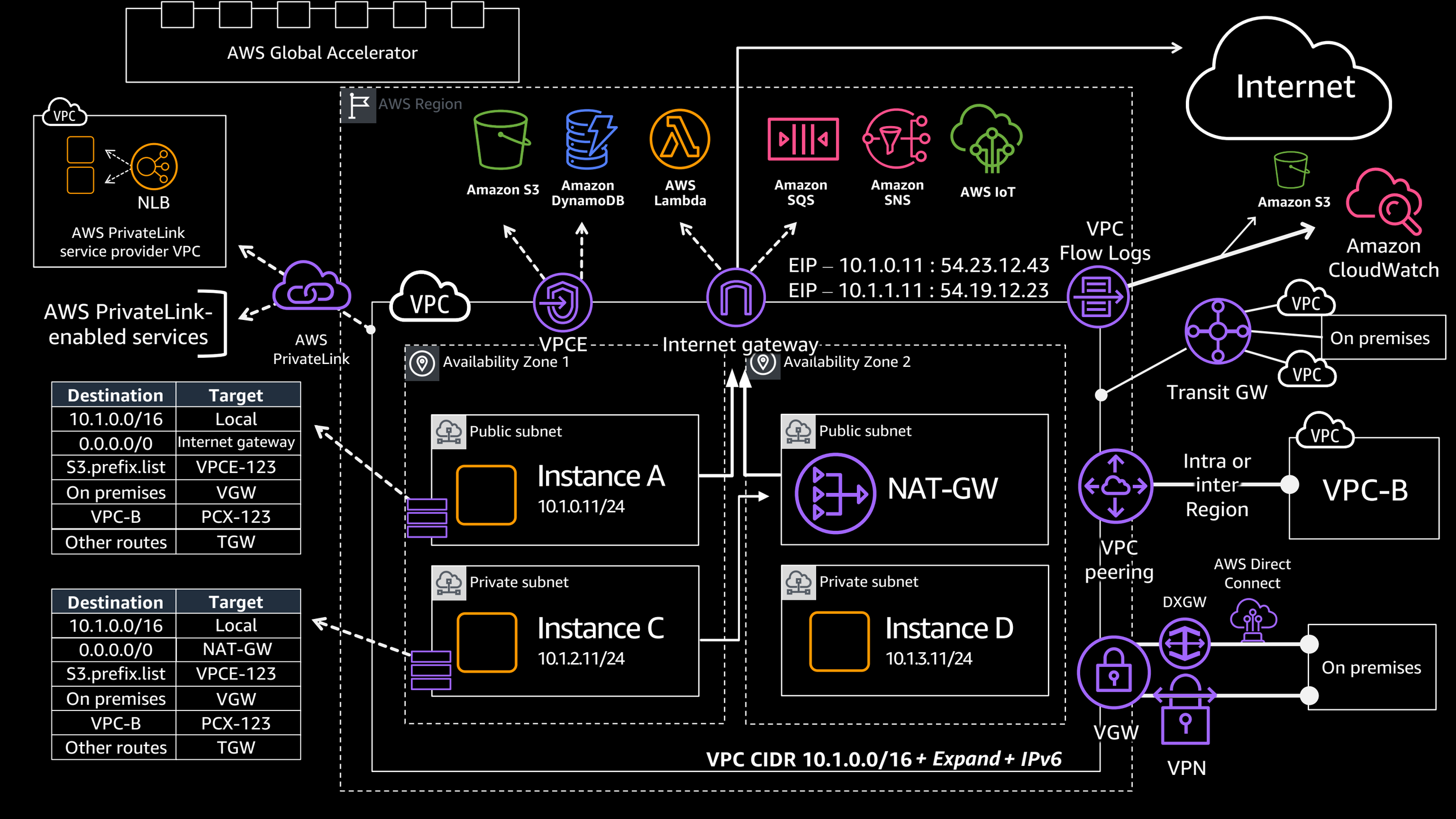
Amazon Web Services



Destination	Target
10.1.0.0/16	Local
0.0.0.0/0	Internet gateway
S3.prefix.list	VPCE-123
On premises	VGW
VPC-B	PCX-123
Other routes	TGW

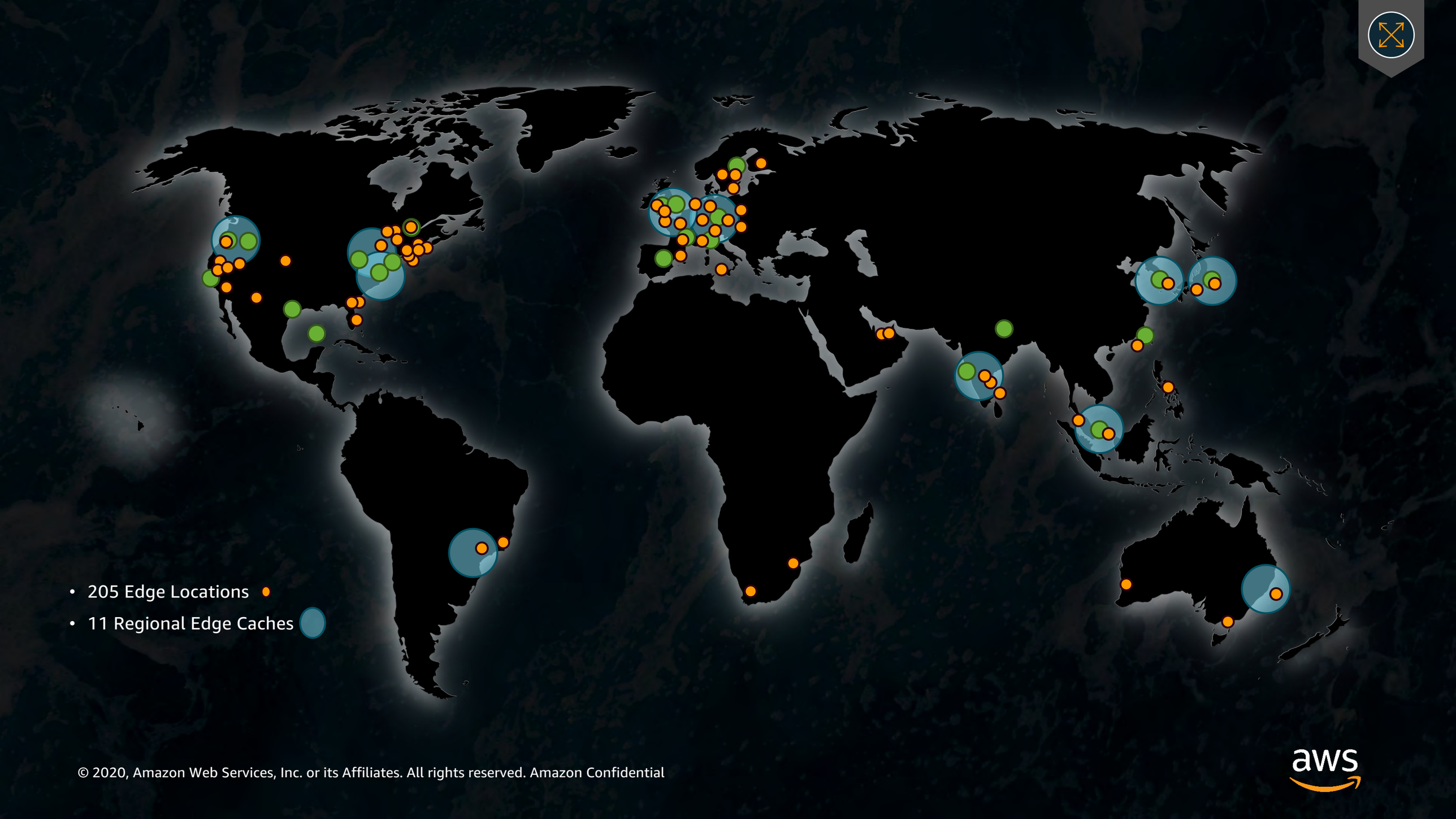
Destination	Target
10.1.0.0/16	Local
0.0.0.0/0	NAT-GW
S3.prefix.list	VPCE-123
On premises	VGW
VPC-B	PCX-123
Other routes	TGW

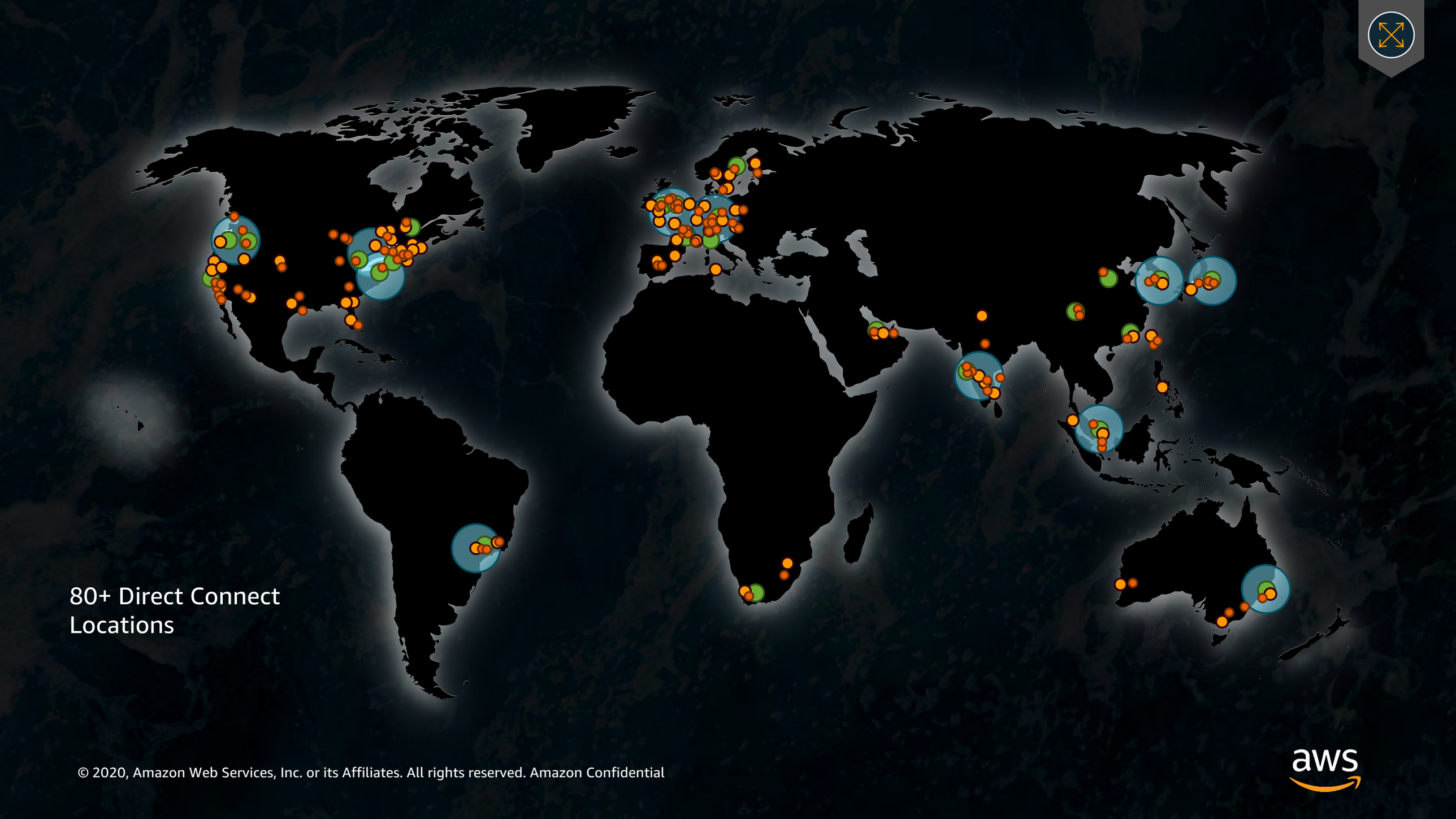
That was the agenda for this session

The fundamentals

AWS Global Infrastructure

- 24 Regions with 76 Availability Zones
- 3 Regions coming soon:
  Spain, Jakarta and Osaka



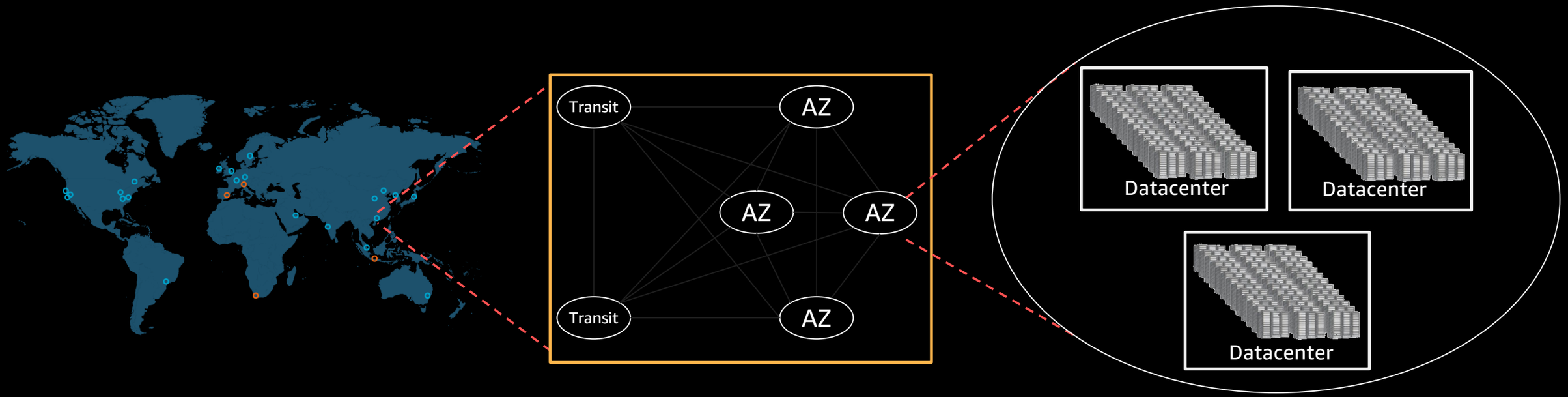


AWS Global Network

- Redundant 100 GbE network
- Private network capacity between all AWS Region, except China

AWS Region design

AWS Regions are comprised of multiple AZs for high availability, high scalability, and high fault tolerance. Applications and data are replicated in real time and consistent in the different AZs.



A Region is a physical location in the world where we have multiple **Availability Zones.**

Availability Zones consist of one or more discrete data centers, each with redundant power, networking, and connectivity, housed in separate facilities.

VPC concepts and fundamentals

What is a VPC?

VPC concepts and fundamentals

IP addressing

Creating subnets

Routing in a VPC

DNS in-VPC with Amazon Route 53

Internet Access

Choosing an IP address range

Choosing an IP address range for your VPC

Avoid ranges that overlap with other networks to which you might connect

Size your VPC appropriately

Largest /16 smallest /28

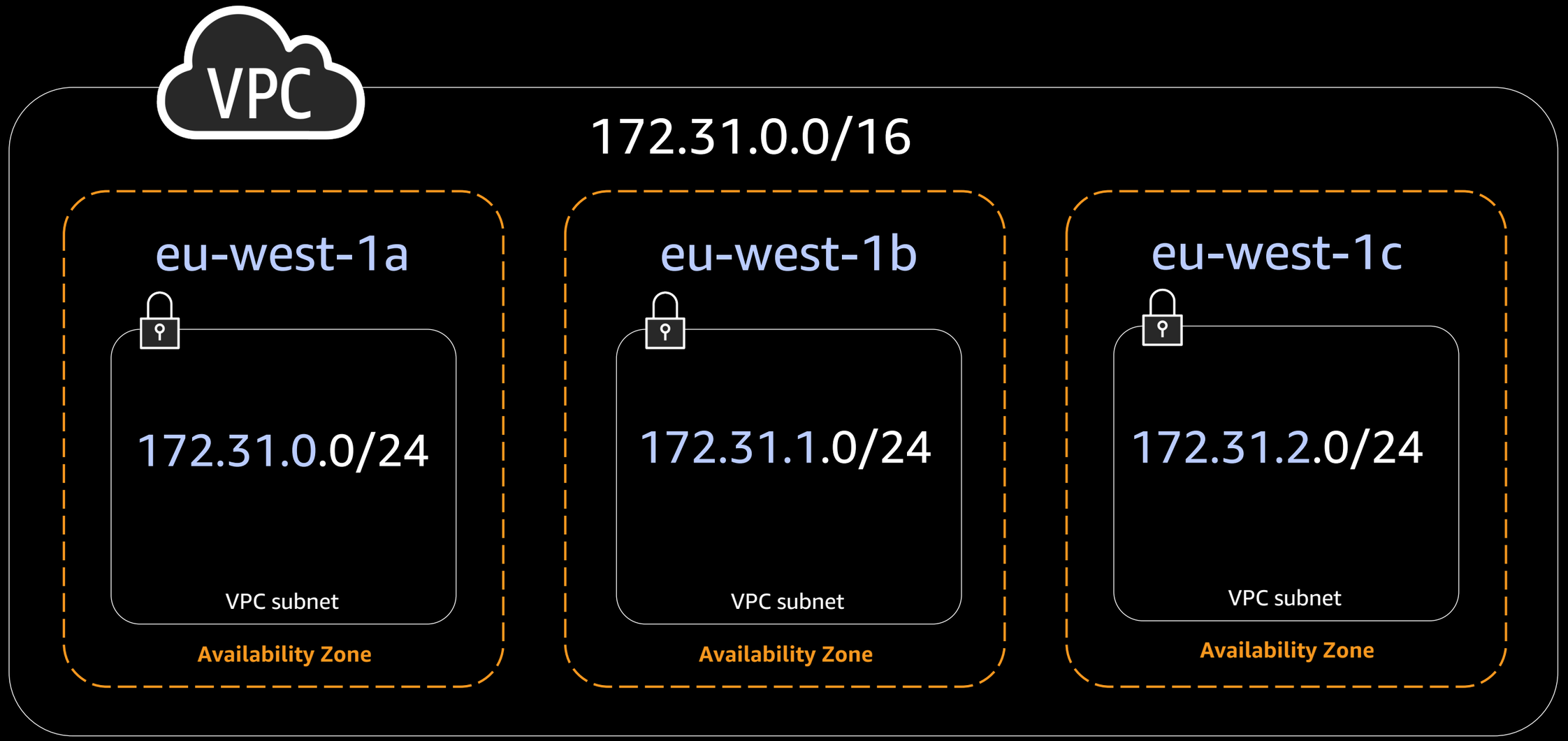
172.31.0.0/16

Recommended: RFC1918 range

Expandable

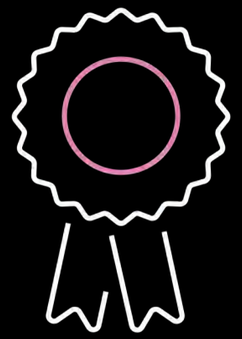
Creating subnets in a VPC

VPC subnets and Availability Zones

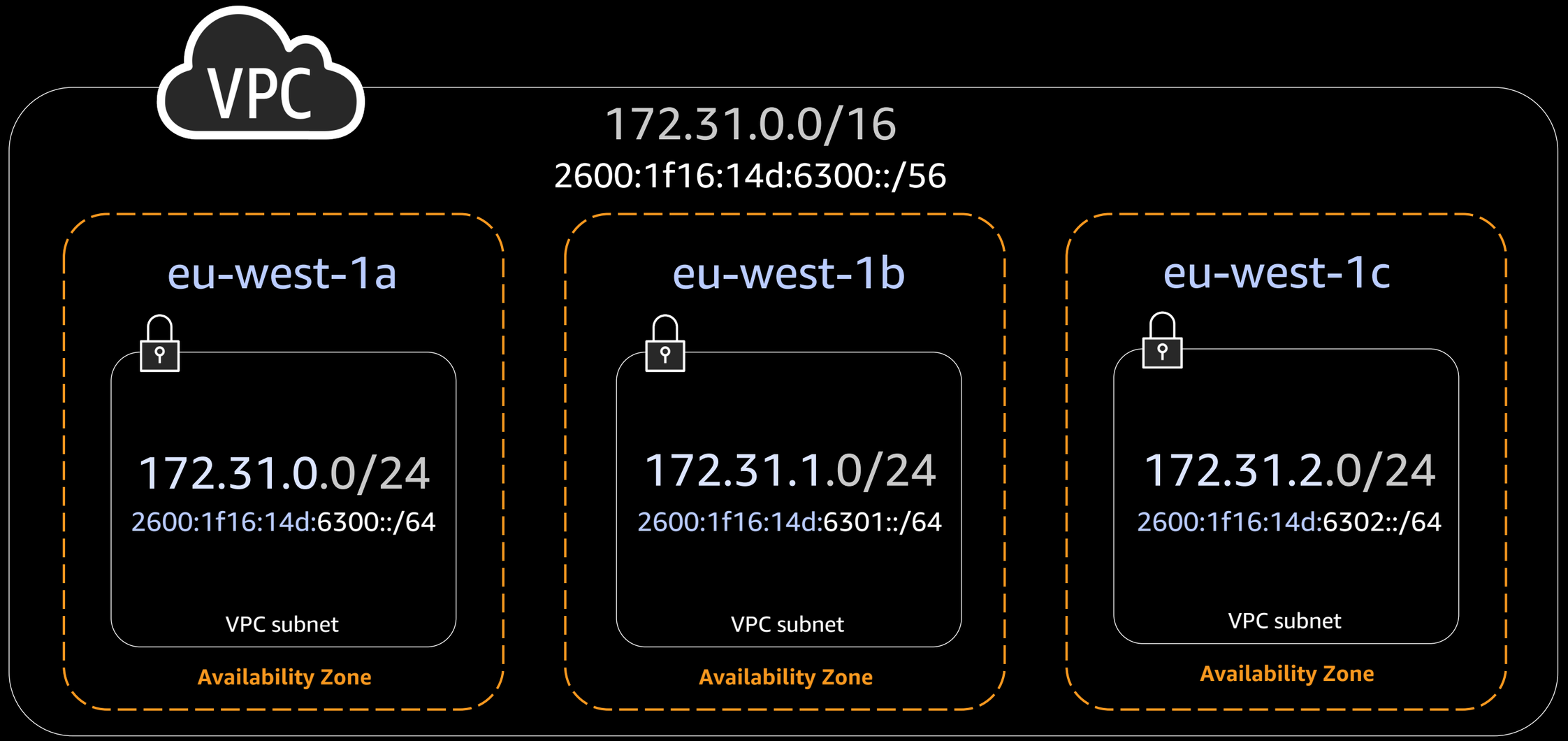


IPv6 in your VPC

- Can have a dual-stack VPC by adding an IPv6 CIDR
- Fixed sizes for VPC and subnets
  - /56 VPC (4,722,366,482,869,645,213,696 addresses)
  - /64 subnets (18,446,744,073,709,551,616 addresses)

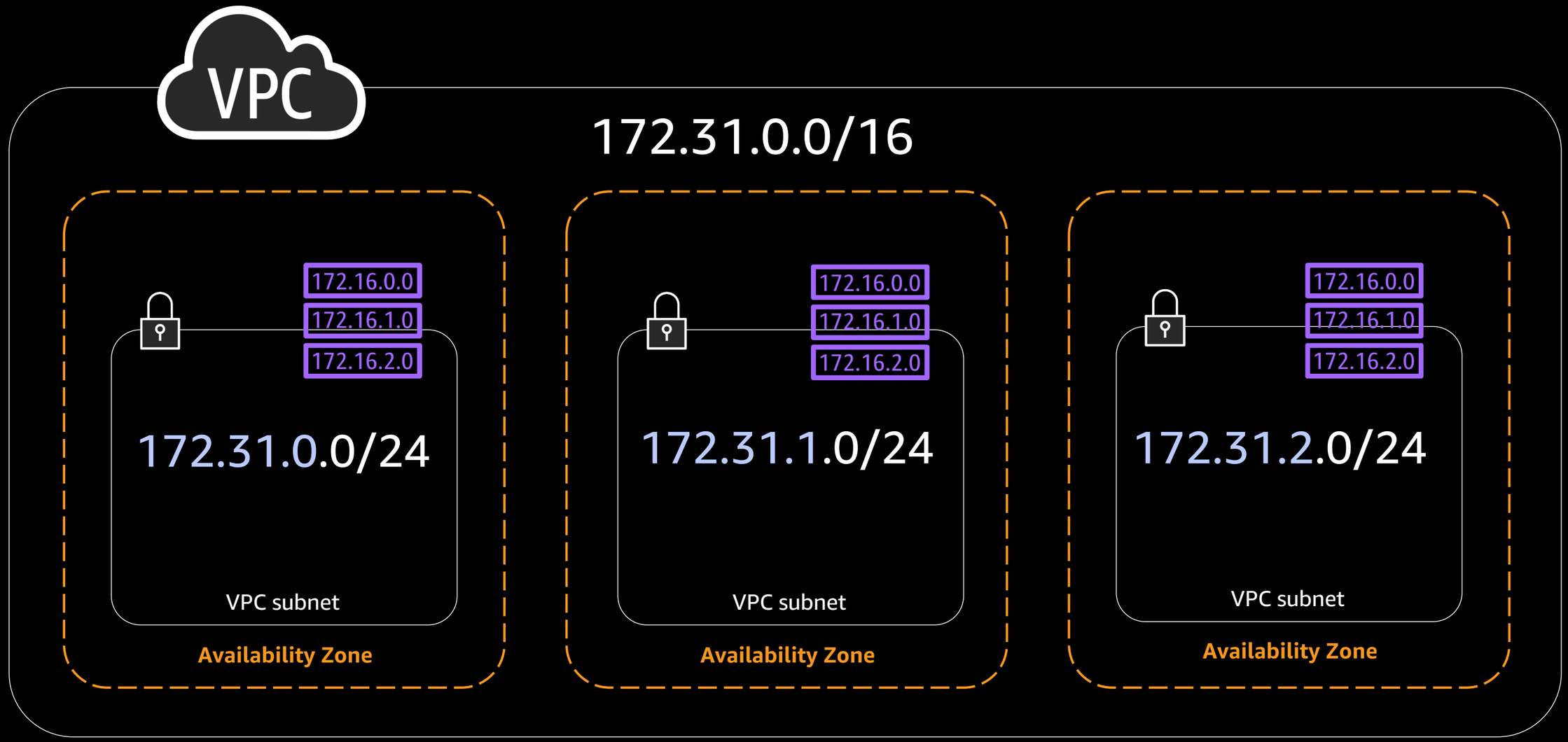


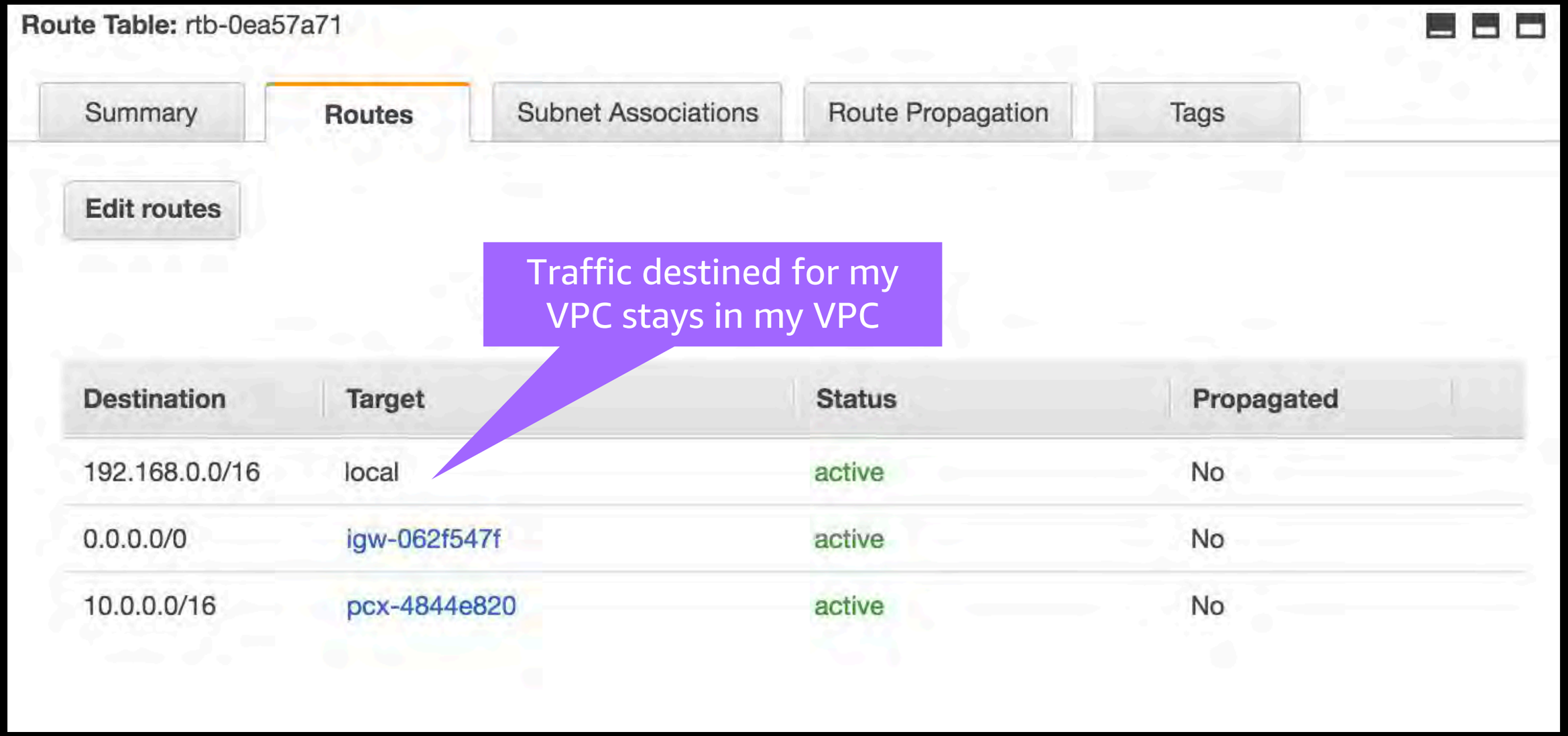
VPC subnets and Availability Zones



Routing in a VPC

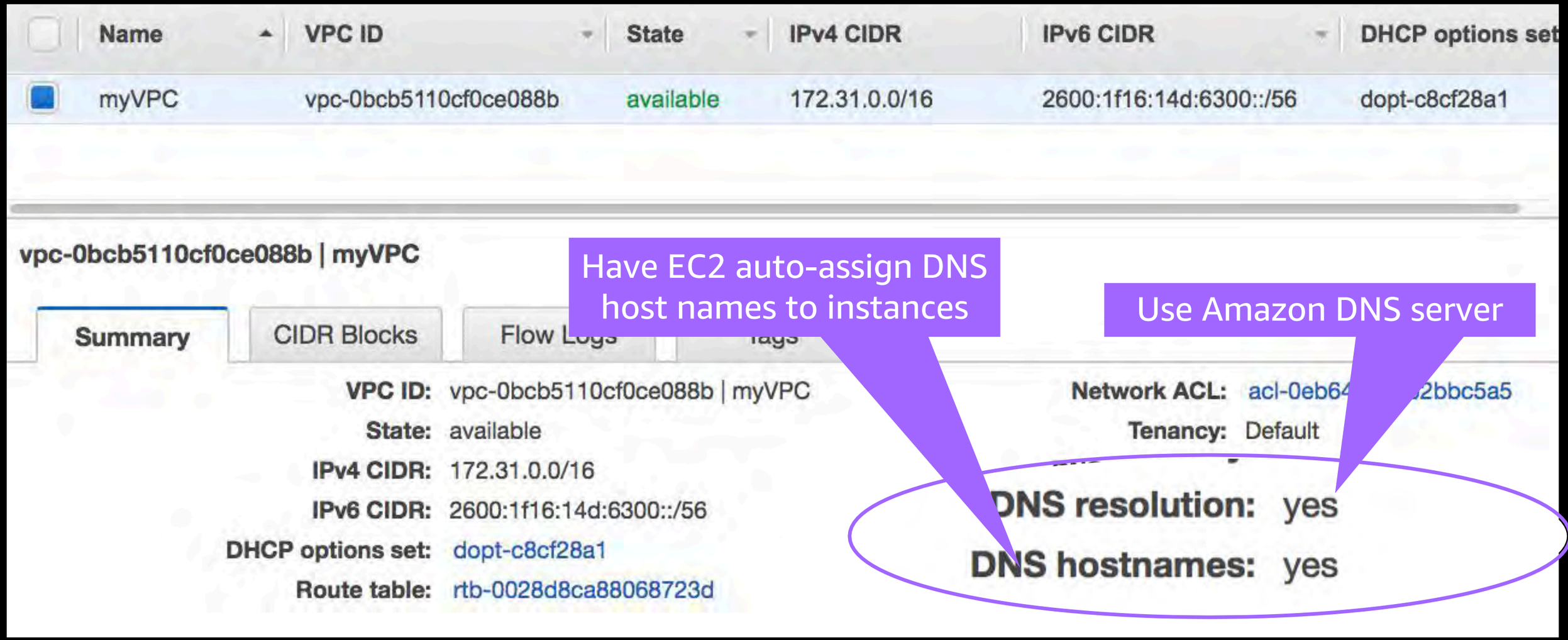
Route tables



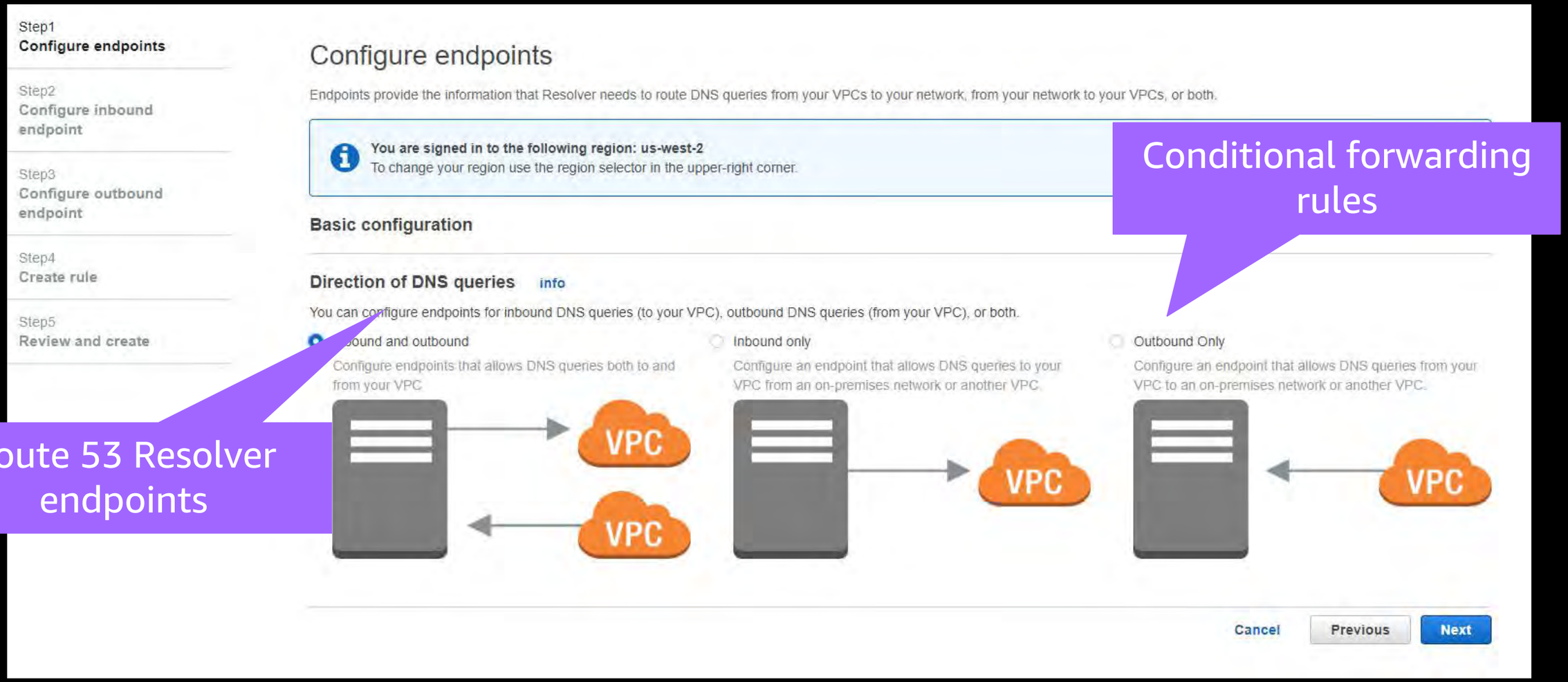


DNS in a VPC

VPC DNS options



Amazon Route 53 Resolver for hybrid clouds



Route 53 Resolver endpoints

Conditional forwarding rules

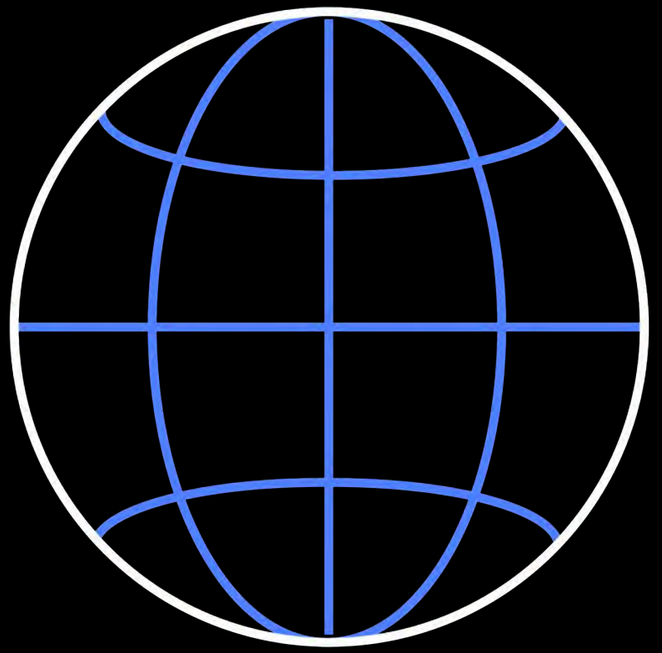
Internet Breakout

The “5 Things” required for Internet traffic

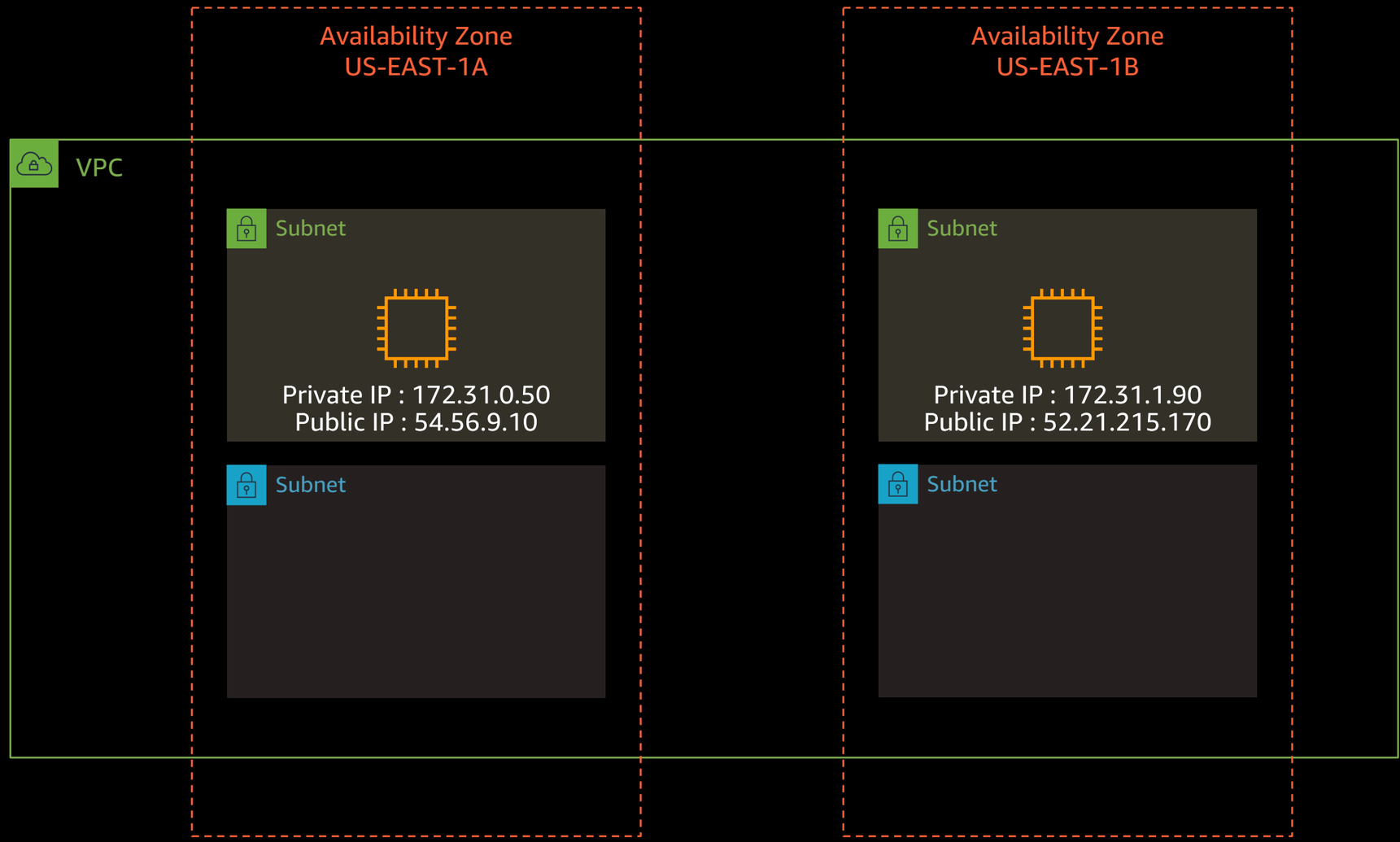
1. Public IP Address
2. Internet Gateway Attached to a VPC
3. Route to an Internet Gateway
4. NACL Allow Rule
5. Security Group Allow Rule

Public IP addresses for your instances

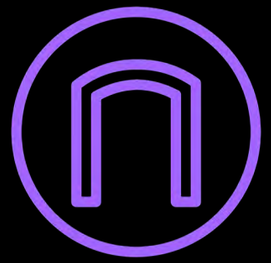
- Auto-assign public IP addresses
- Elastic IP Addresses (EIP)
  - Amazon EIP Pool
  - Bring Your Own IP (BYOIP) Pool



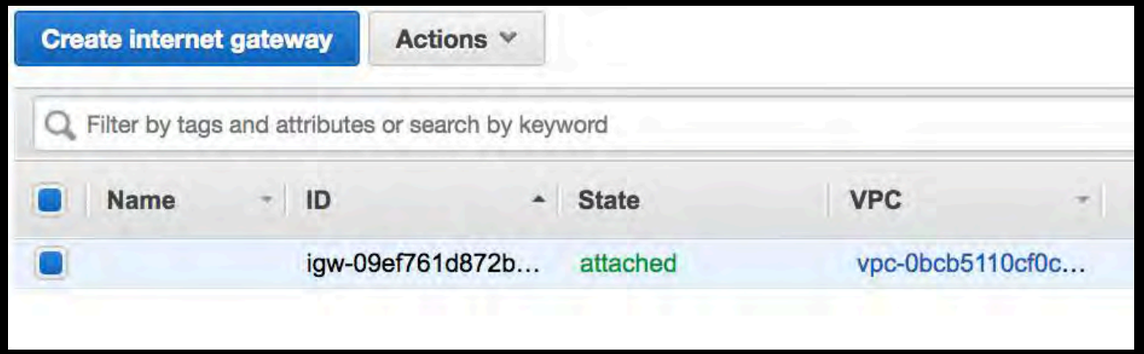
Public IP addresses



Internet access



172.16.0.0
172.16.1.0
172.16.2.0



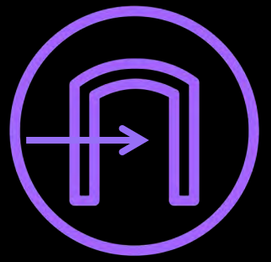
Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
0.0.0.0/0	igw-09ef761d872bd7540	Active	No
::/0	igw-09ef761d872bd7540	Active	No

"To get to the IPv4 Internet (0.0.0.0/0) go via the Internet Gateway (IGW)"

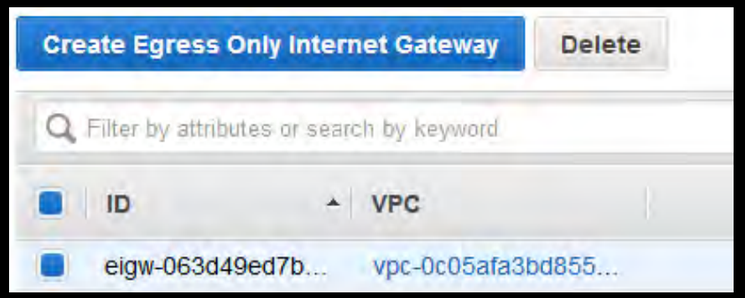
"To get to the IPv6 Internet (::/0) go via the Internet Gateway (IGW)"

aws

Internet access



172.16.0.0
172.16.1.0
172.16.2.0



Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
0.0.0.0/0	igw-09ef761d872bd7540	Active	No
::/0	eigw-063d49ed7bb0f8c36	Active	No

“To get to the IPv6 Internet (::/0) go via the Egress Only Internet Gateway (EIGW)”

Different routes for different subnets

172.16.0.0
172.16.1.0
172.16.2.0

Public subnet

Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
0.0.0.0/0	igw-09ef761d872bd7540	Active	No
::/0	igw-09ef761d872bd7540	Active	No

“To get to the Internet go via the Internet Gateway (IGW)”

Private subnet

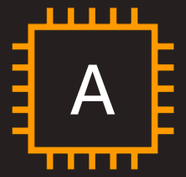
Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No

“To get to anything in the VPC – stay local. No route anywhere else.”

aws

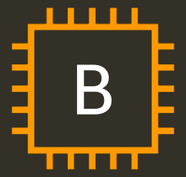
Public & private subnets

Private subnet

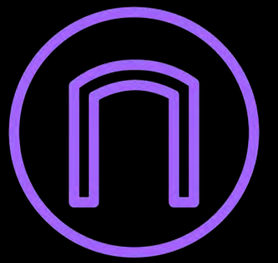


Private IP : 172.31.128.75

Public subnet



Private IP : 172.31.0.50
Public IP : 54.56.9.10



Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No

Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
0.0.0.0/0	igw-09ef761d872bd7540	Active	No
::/0	igw-09ef761d872bd7540	Active	No

“Instance A has a path to and from Instance B.”

”Instance B has a path to and from the Internet.”

Network Address Translation (NAT) Gateway

Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
0.0.0.0/0	nat-0964c62a07d6491f5	Active	No

Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
0.0.0.0/0	igw-09ef761d872bd7540	Active	No
::/0	igw-09ef761d872bd7540	Active	No

The Route Table for the Private Subnet says to send all IPv4 Internet Traffic to the NAT Gateway.

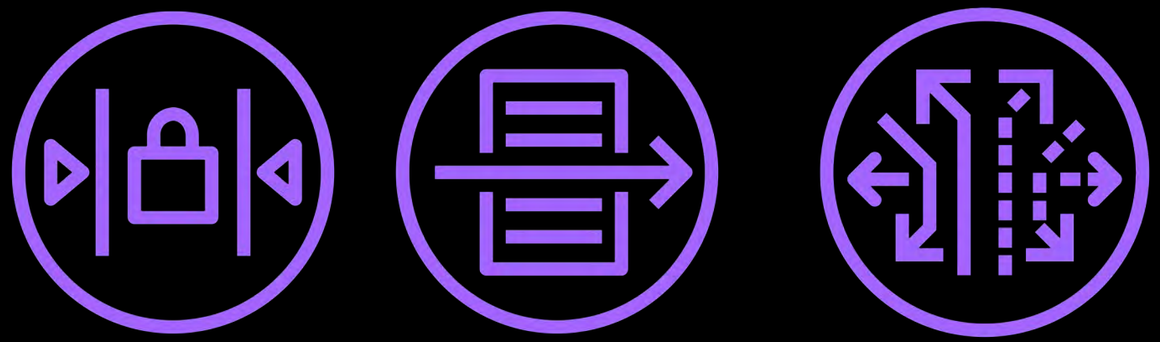
The NAT Gateway translates all traffic it receives such that it appears to come from itself.

The Route Table for the Public Subnet says to send all Internet Traffic to the Internet Gateway.

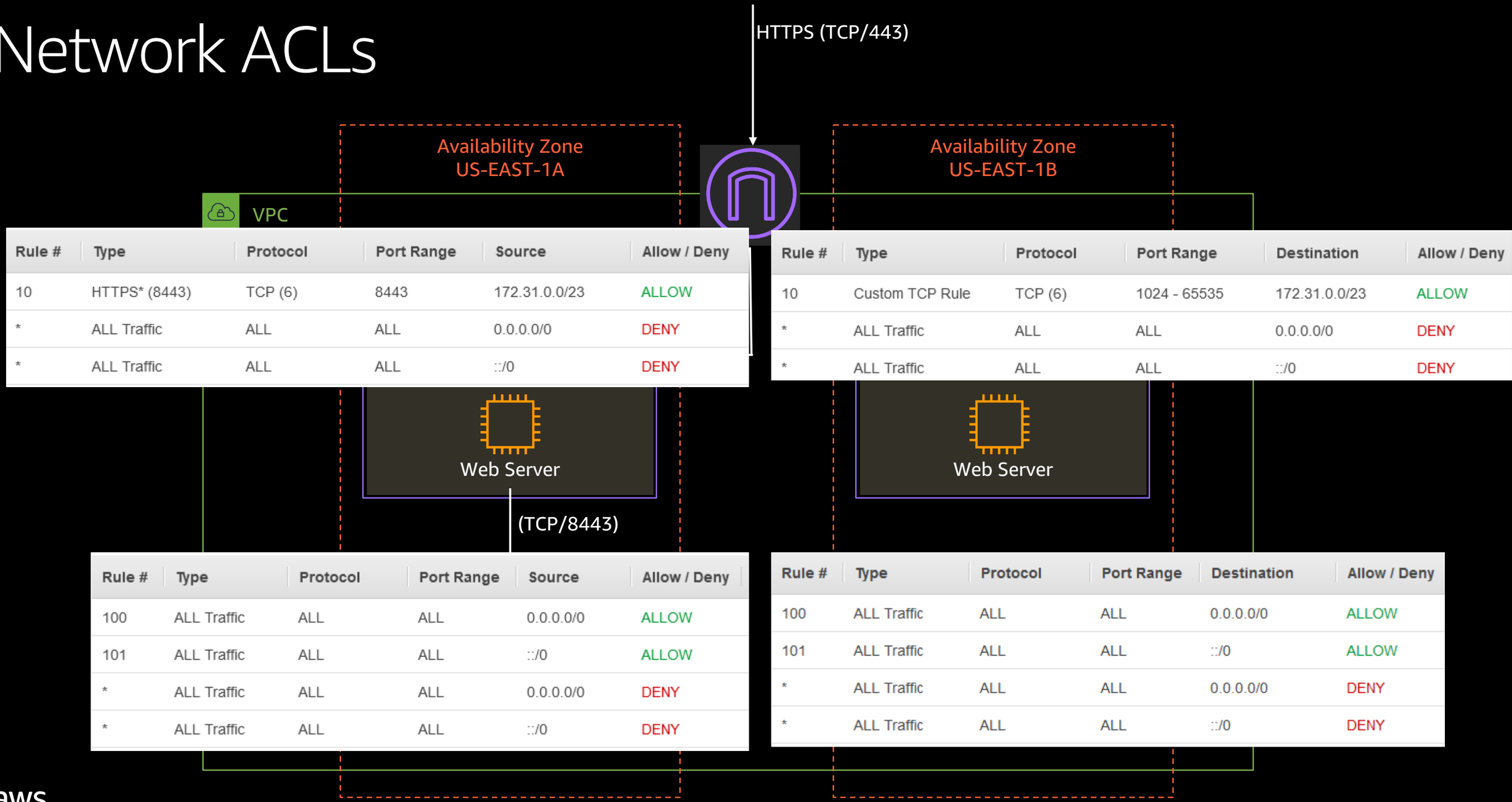
Network security

Network security

- Network ACLs
- Security Groups
- VPC Flow Logs
- Amazon VPC Traffic Mirroring



Network ACLs



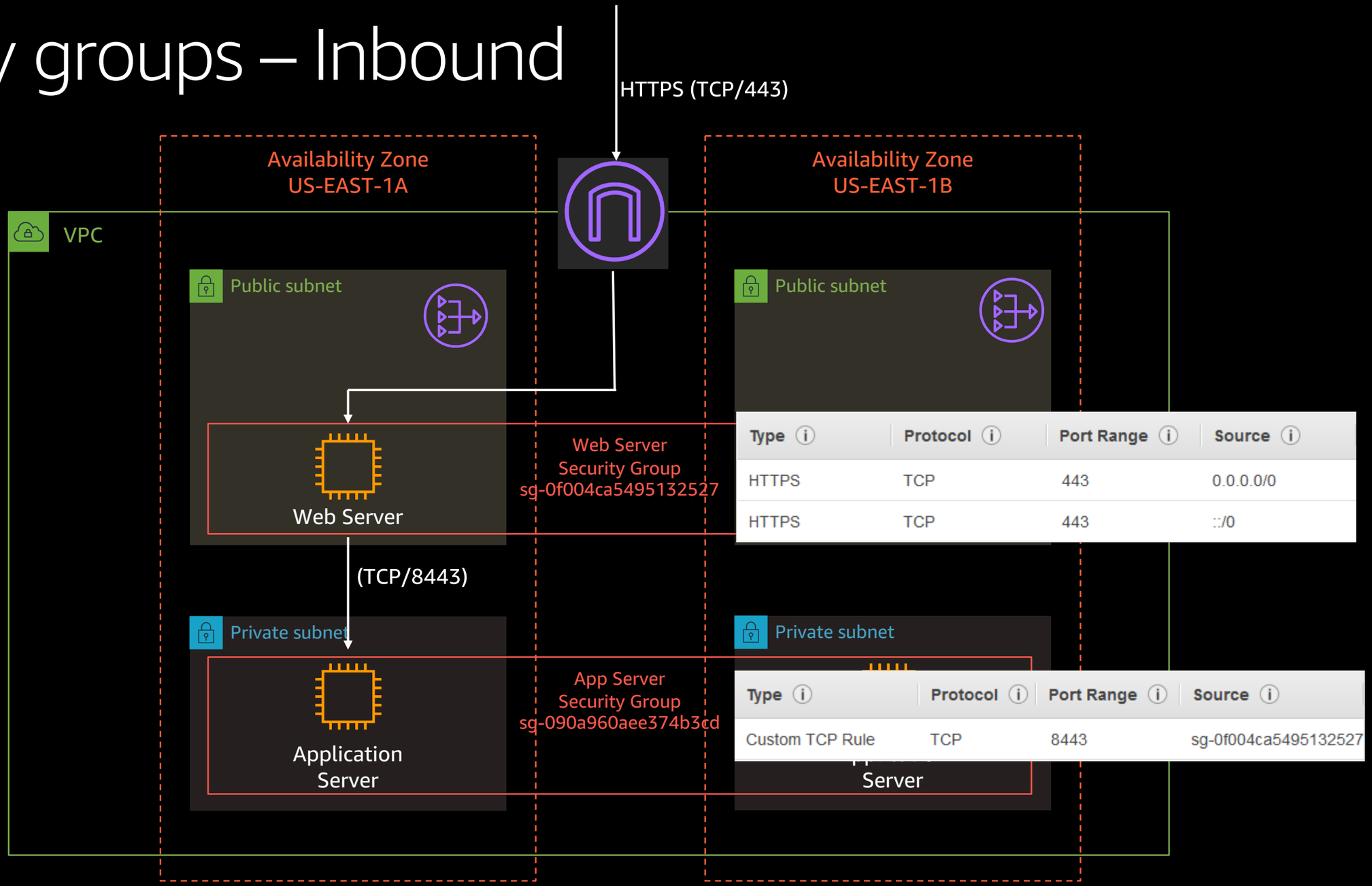
Rule #	Type	Protocol	Port Range	Source	Allow / Deny
10	HTTPS* (8443)	TCP (6)	8443	172.31.0.0/23	ALLOW
*	ALL Traffic	ALL	ALL	0.0.0.0/0	DENY
*	ALL Traffic	ALL	ALL	::/0	DENY

Rule #	Type	Protocol	Port Range	Destination	Allow / Deny
10	Custom TCP Rule	TCP (6)	1024 - 65535	172.31.0.0/23	ALLOW
*	ALL Traffic	ALL	ALL	0.0.0.0/0	DENY
*	ALL Traffic	ALL	ALL	::/0	DENY

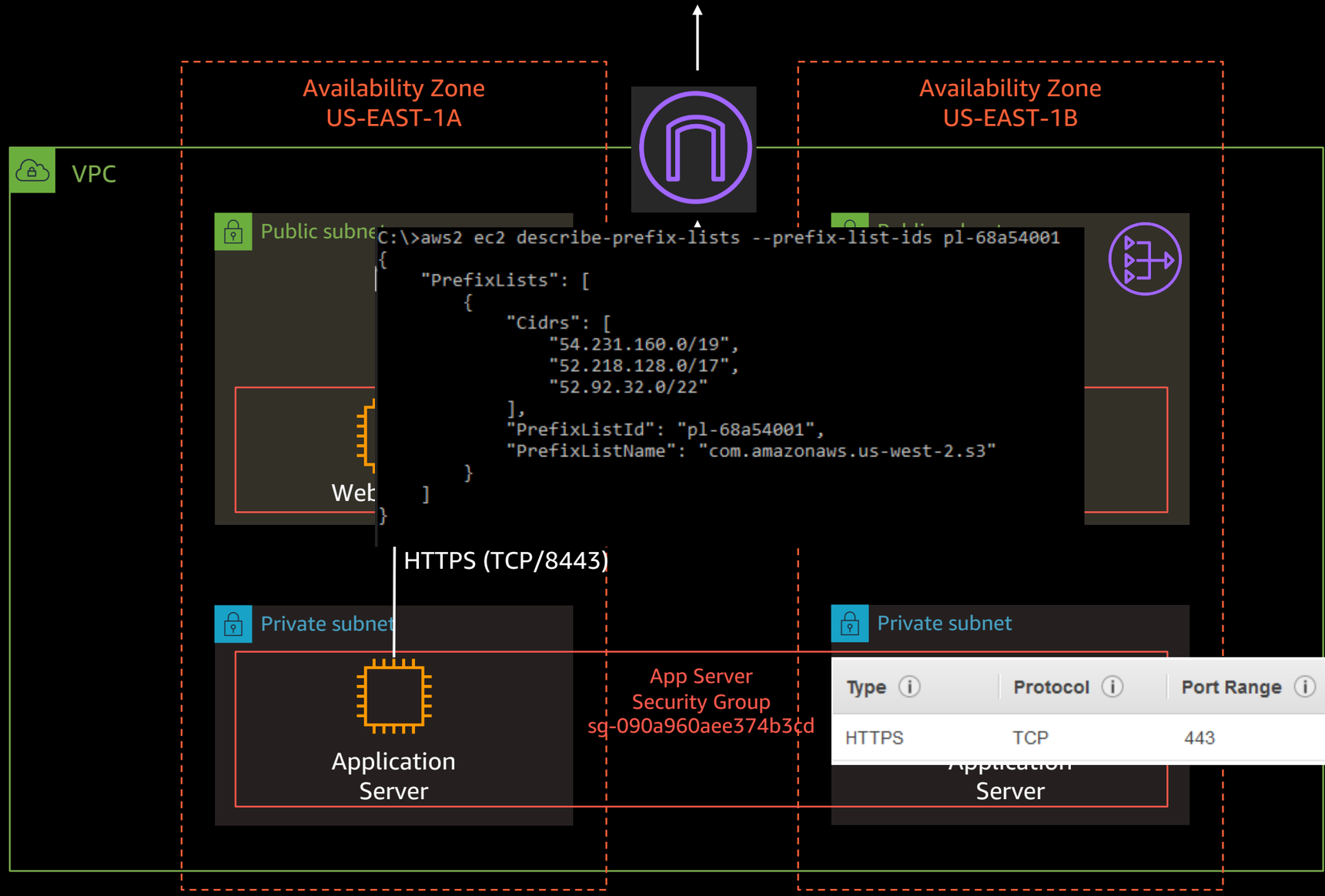
Rule #	Type	Protocol	Port Range	Source	Allow / Deny
100	ALL Traffic	ALL	ALL	0.0.0.0/0	ALLOW
101	ALL Traffic	ALL	ALL	::/0	ALLOW
*	ALL Traffic	ALL	ALL	0.0.0.0/0	DENY
*	ALL Traffic	ALL	ALL	::/0	DENY

Rule #	Type	Protocol	Port Range	Destination	Allow / Deny
100	ALL Traffic	ALL	ALL	0.0.0.0/0	ALLOW
101	ALL Traffic	ALL	ALL	::/0	ALLOW
*	ALL Traffic	ALL	ALL	0.0.0.0/0	DENY
*	ALL Traffic	ALL	ALL	::/0	DENY

Security groups – Inbound



Security groups – Outbound



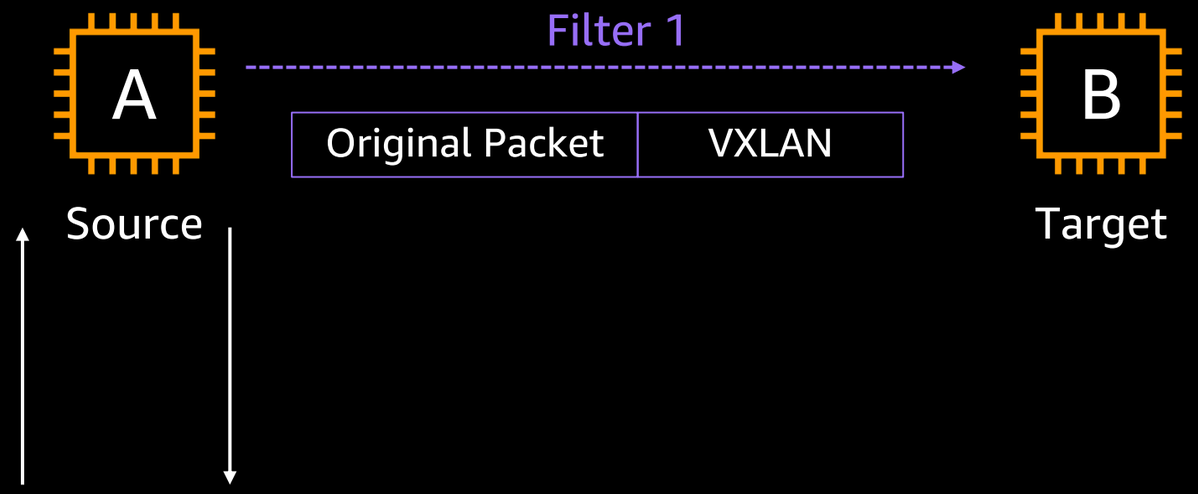
VPC flow logs

- Amazon CloudWatch Logs or Amazon S3
- Does not impact throughput or latency
- Apply to VPC, Subnet, or ENI
- Accepted, Rejected, or All traffic

version	3
account-id	384767312345
interface-id	eni-0b62d5e000e412345
srcaddr	108.56.192.231
dstaddr	172.31.0.202
srcport	50565
dstport	80
protocol	6
packets	7
bytes	751
start	1573704396
end	1573704455
action	ACCEPT
log-status	OK
vpc-id	vpc-0af48868ceeb12345
subnet-id	subnet-02ab634d2e4c12345
instance-id	i-0a998a68301112345
tcp-flags	3
type	IPv4
pkt-srcaddr	108.56.192.231
pkt-dstaddr	172.31.0.202

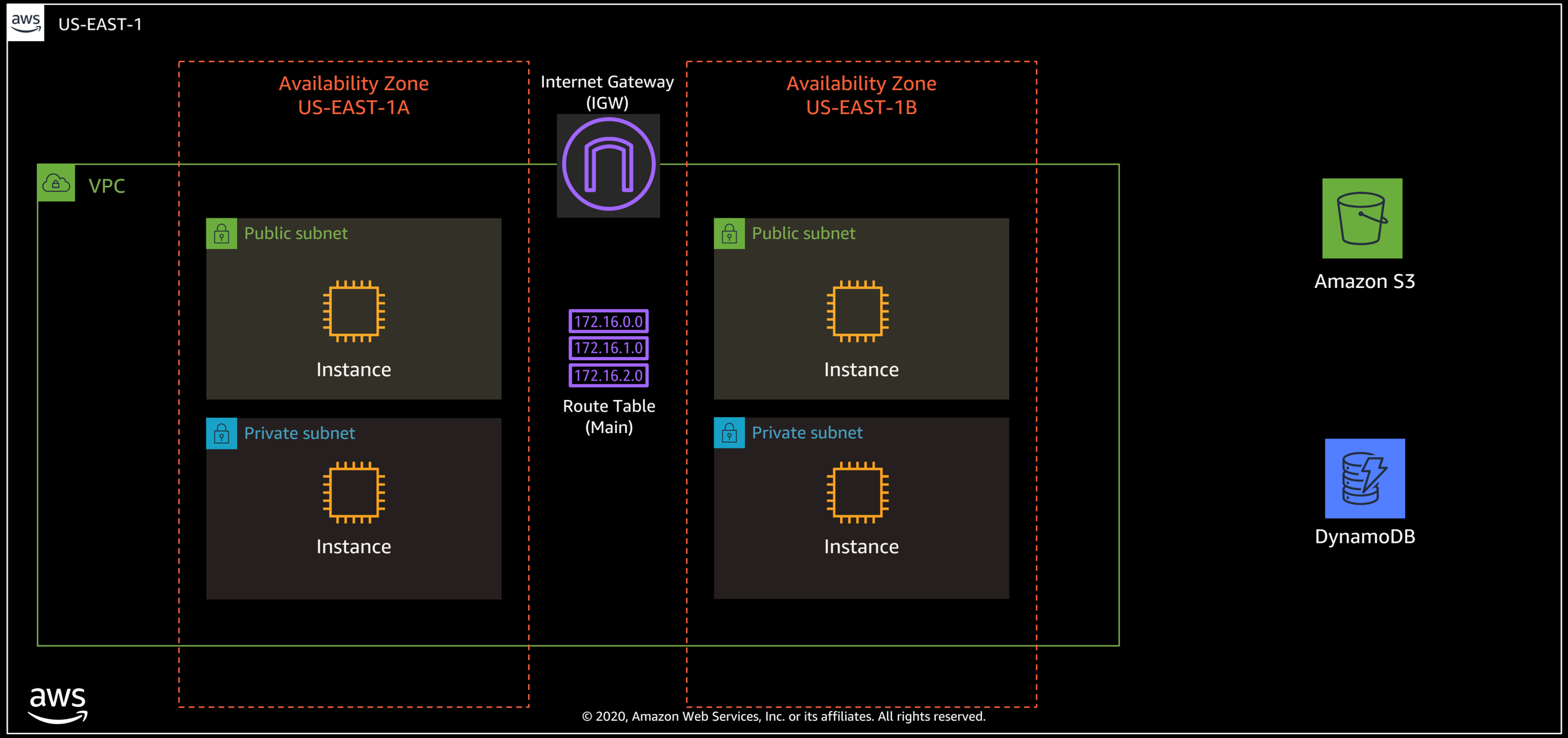
Amazon VPC traffic mirroring

- Mirror to another ENI or Network Load Balancer with UDP listener
- Packet copy. Shares interface bandwidth.
- Traffic mirror filters to define “interesting traffic”
- Traffic mirror session is the combination of source, target, and filter

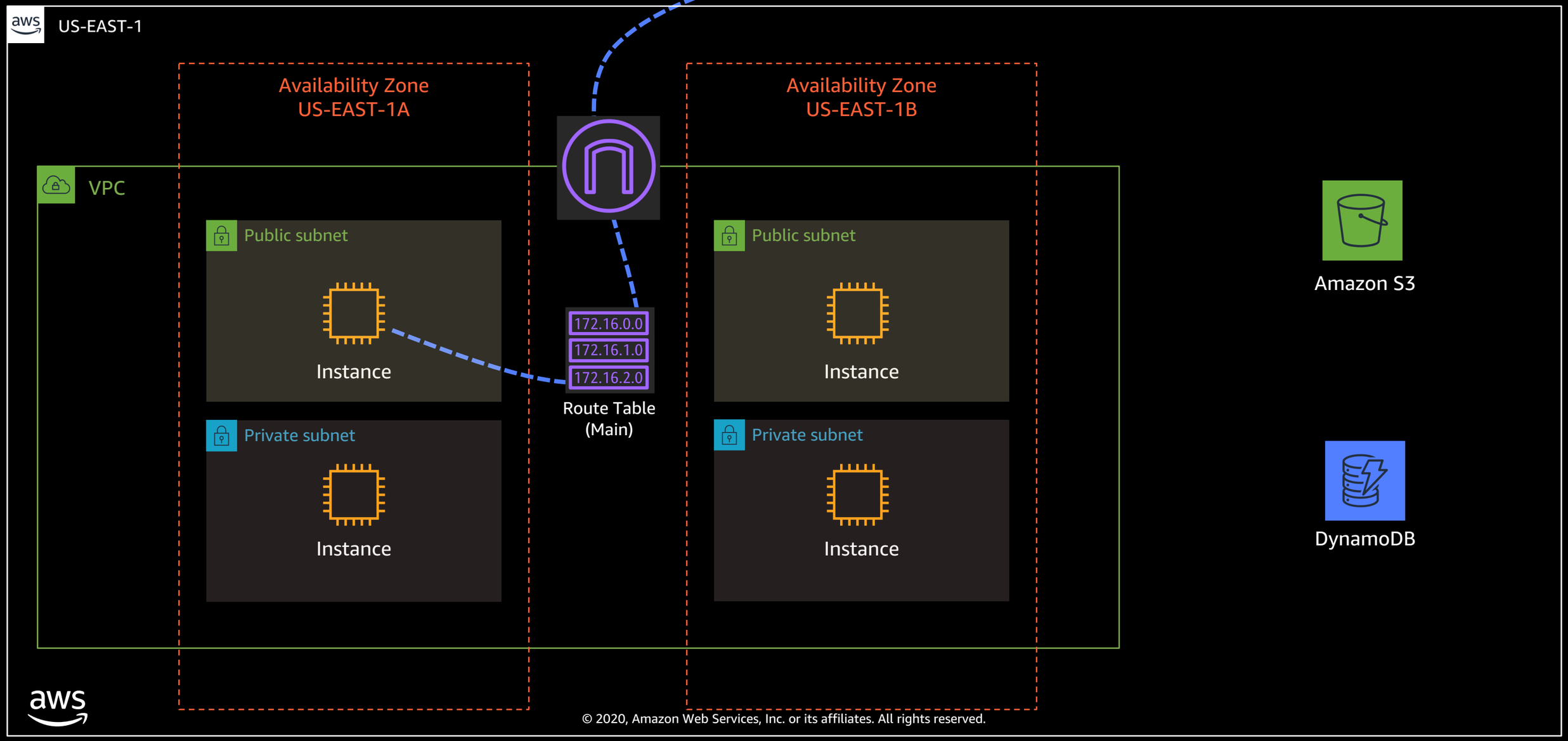


VPC endpoints

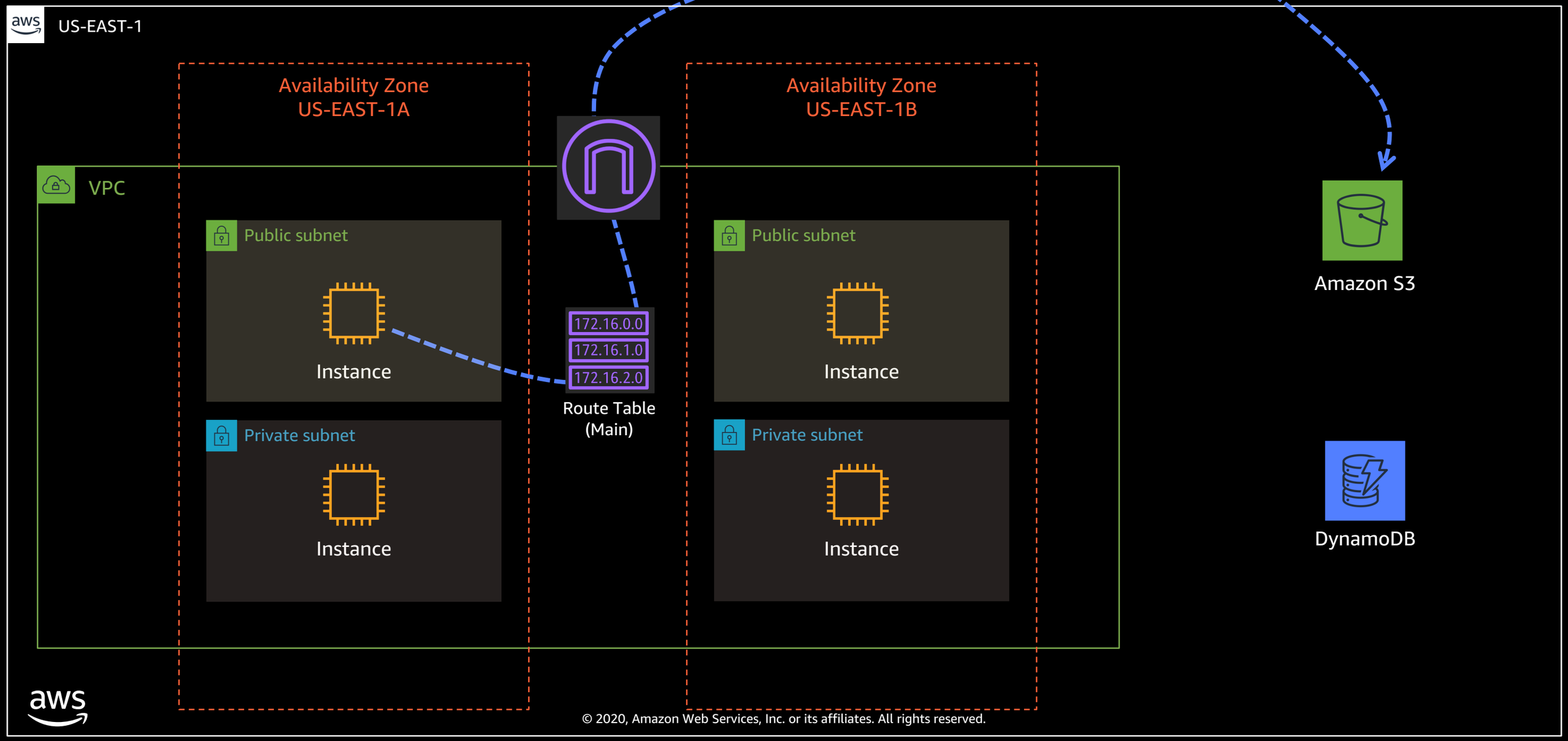
Gateway VPC endpoints



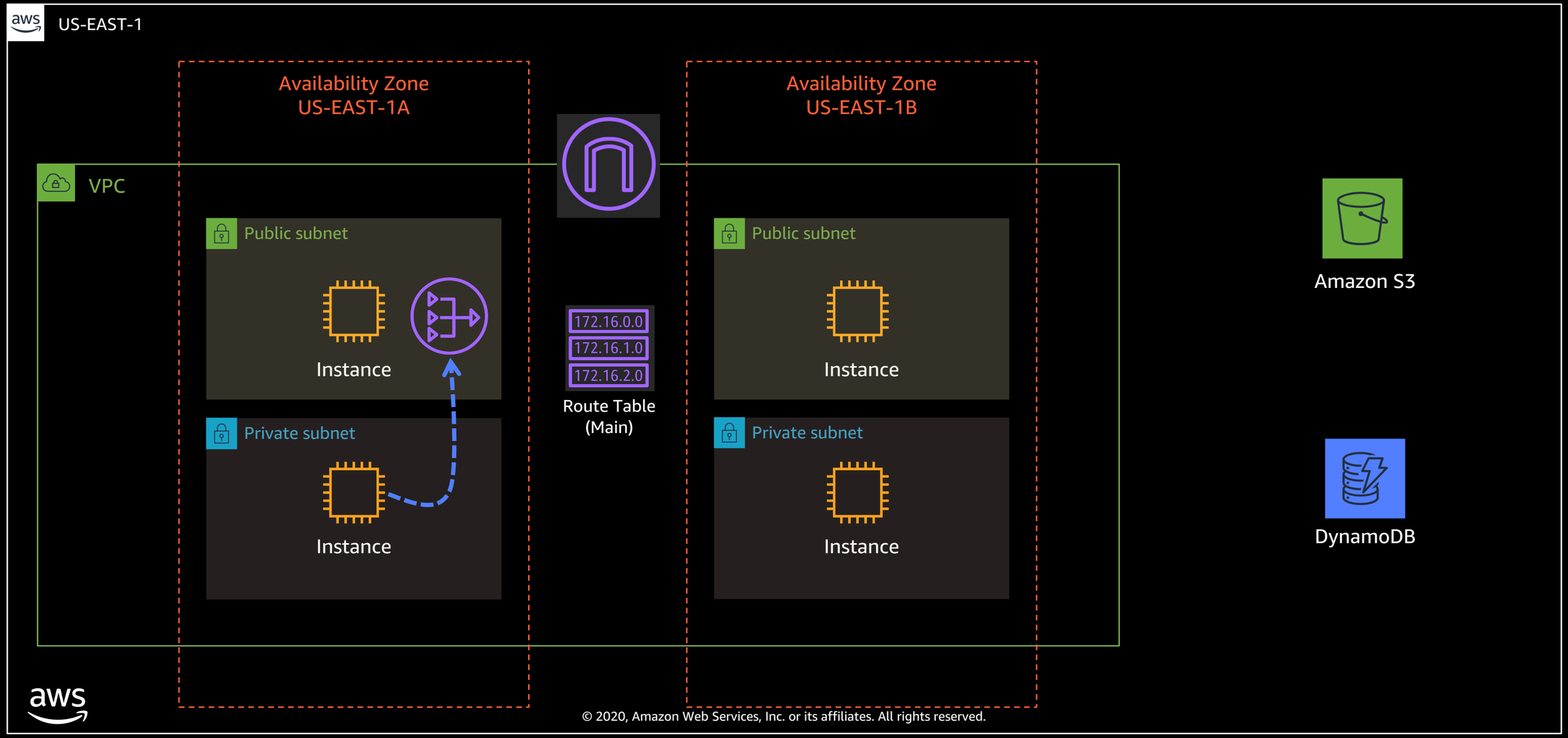
Gateway VPC endpoints



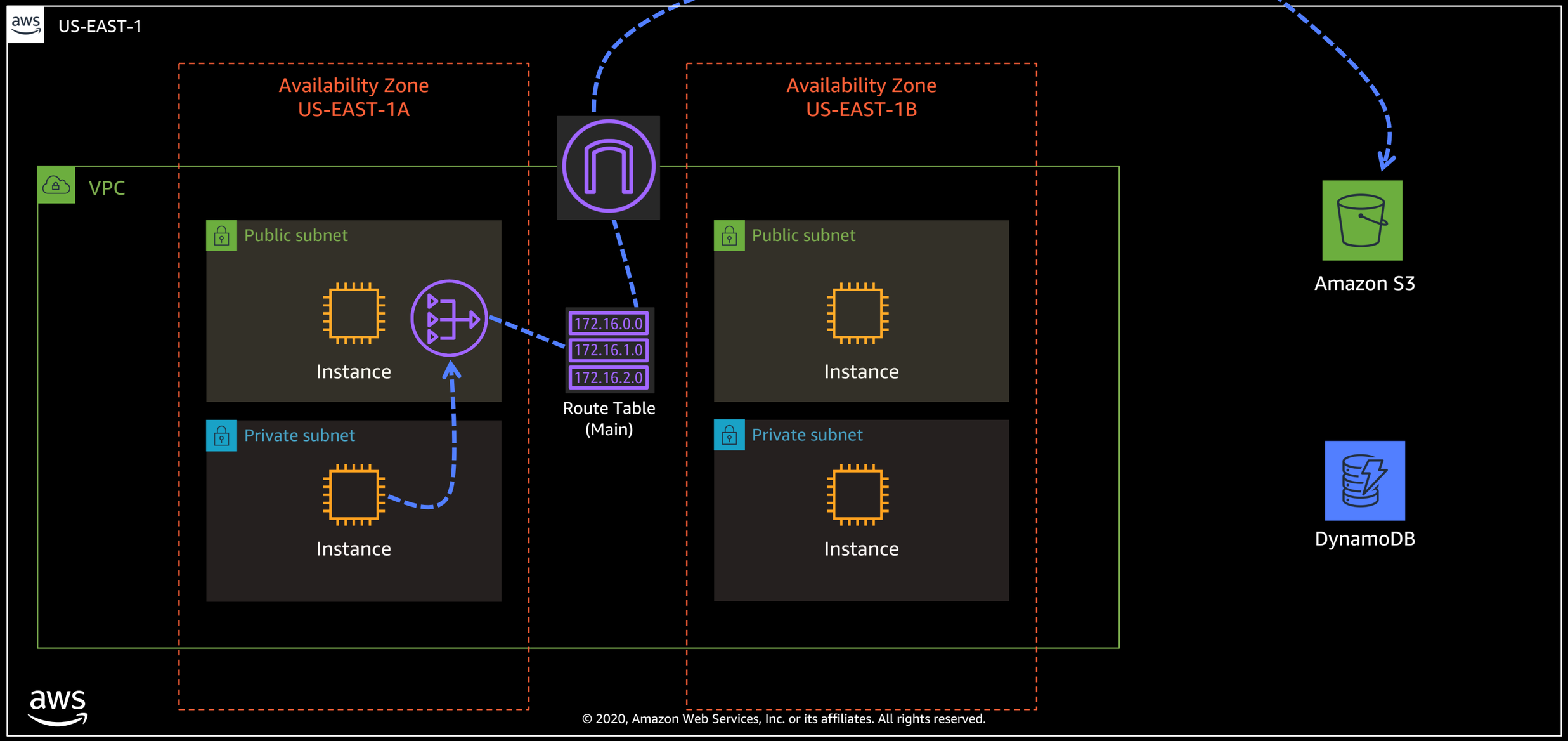
Gateway VPC endpoints



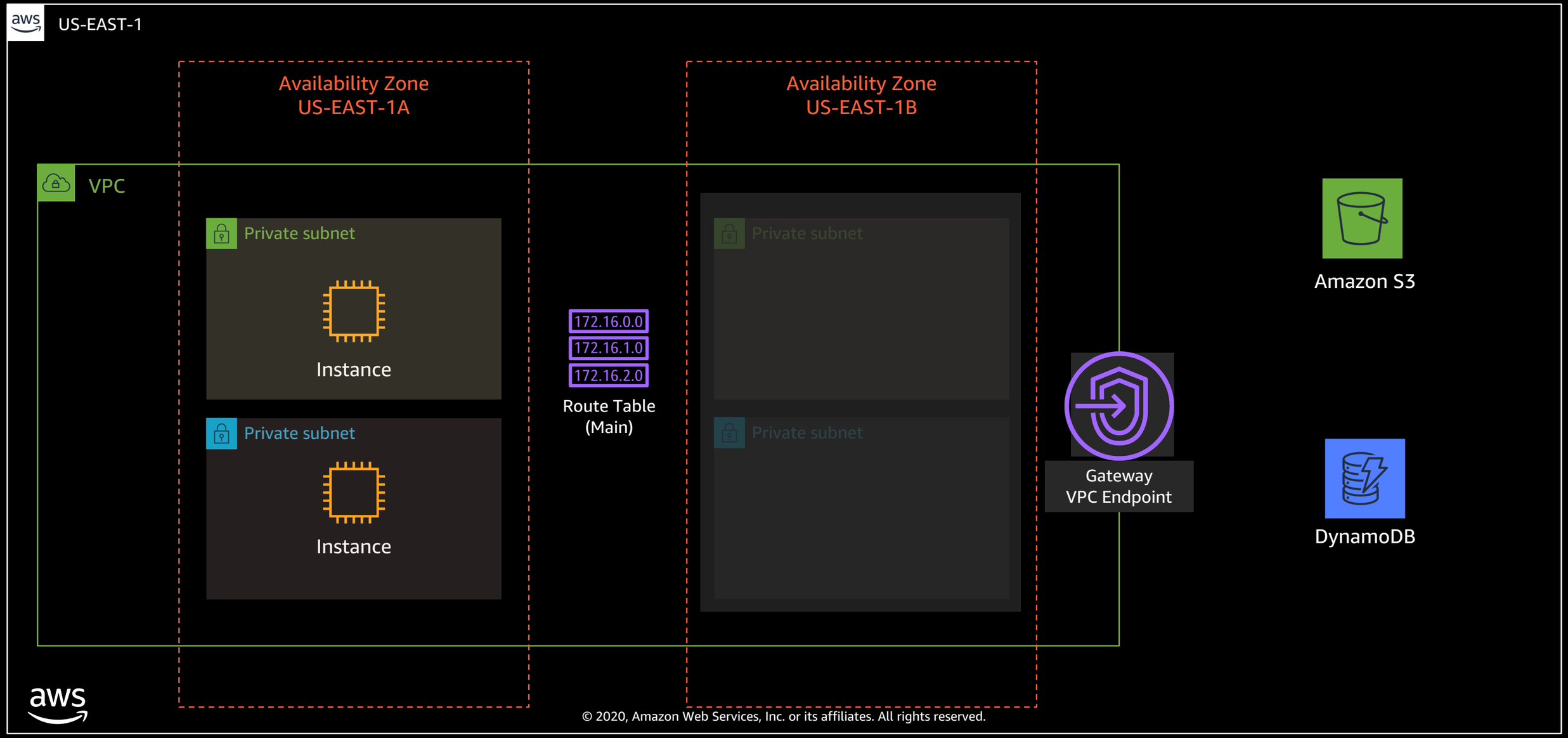
Gateway VPC endpoints



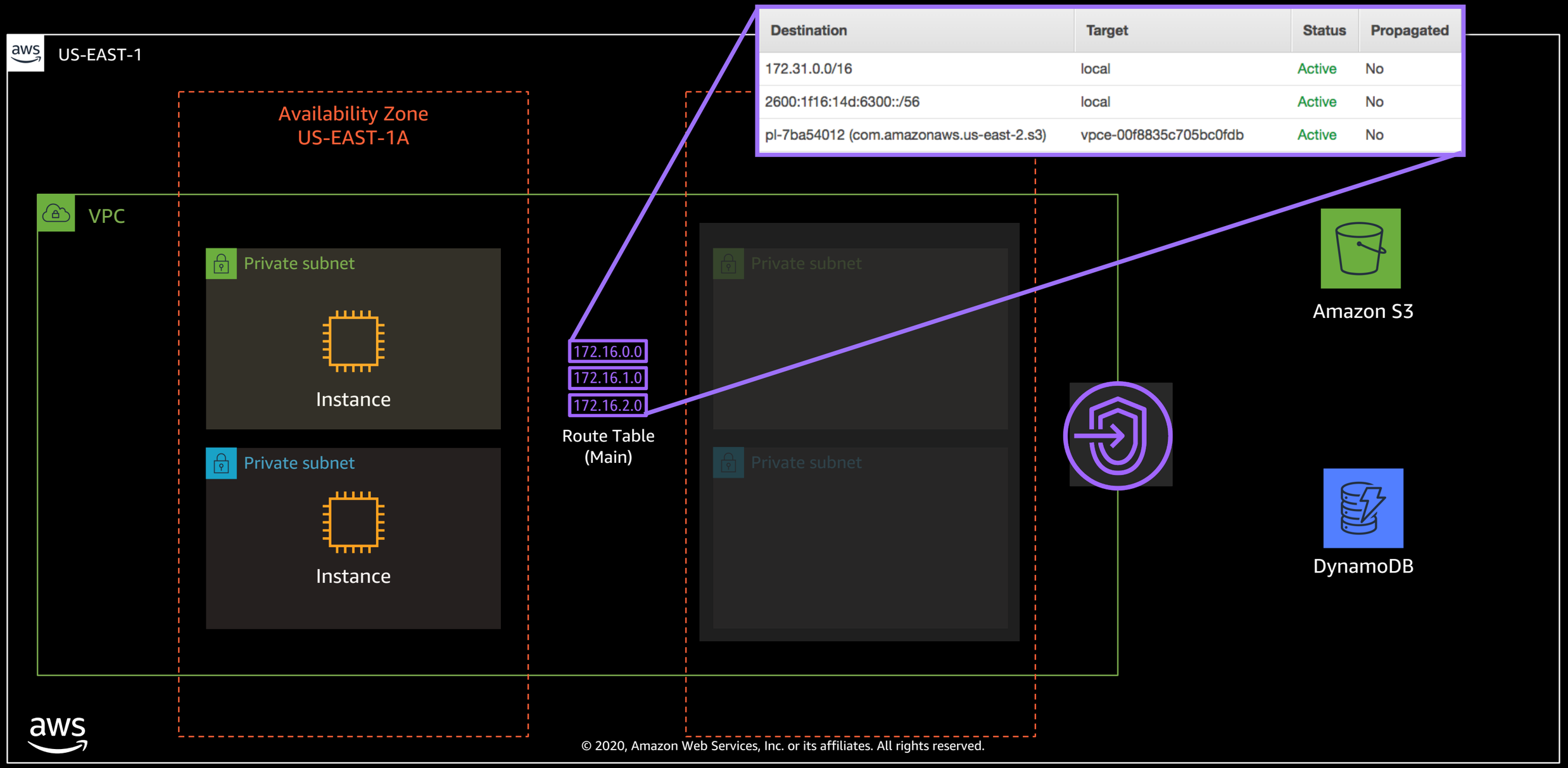
Gateway VPC endpoints



Gateway VPC endpoints

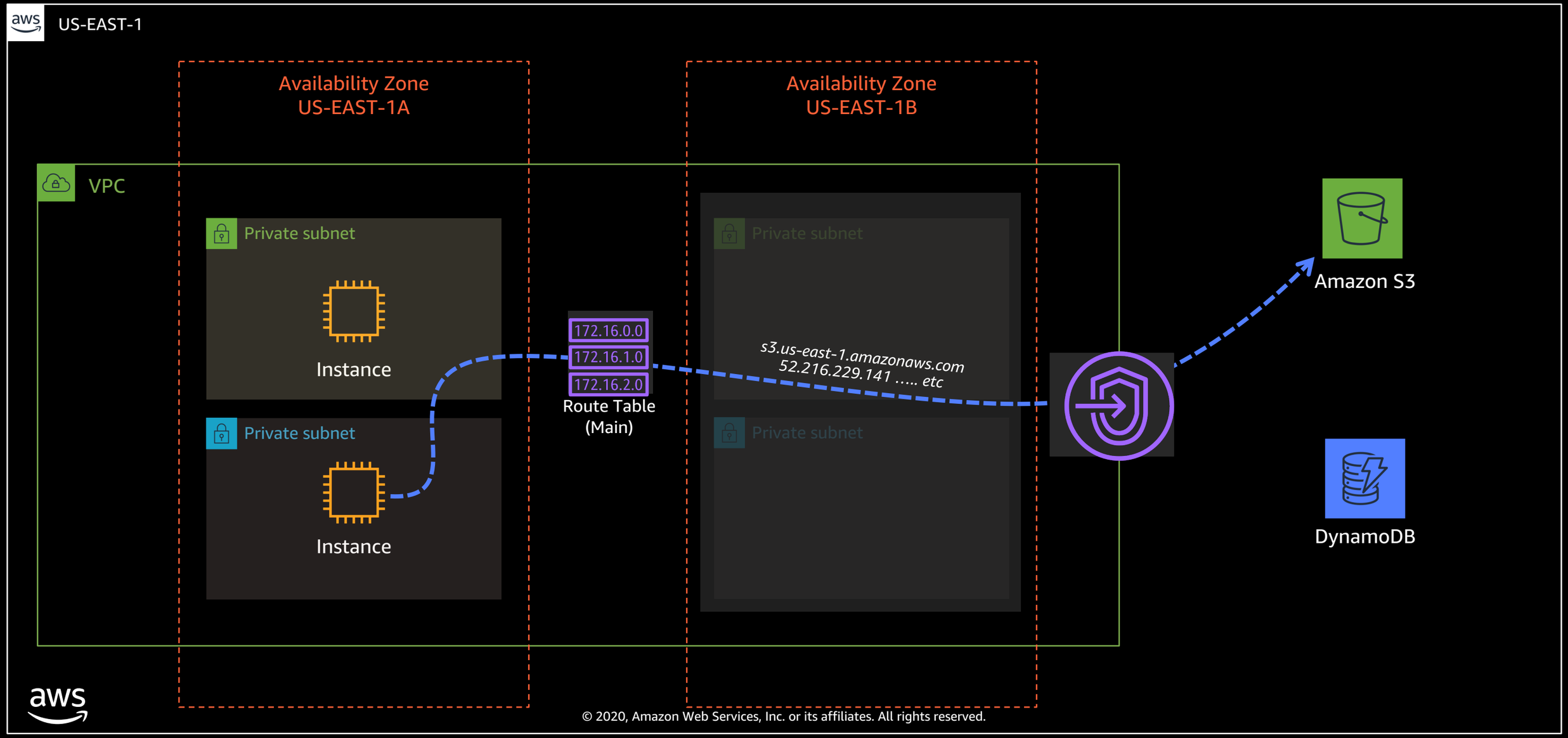


Gateway VPC endpoints

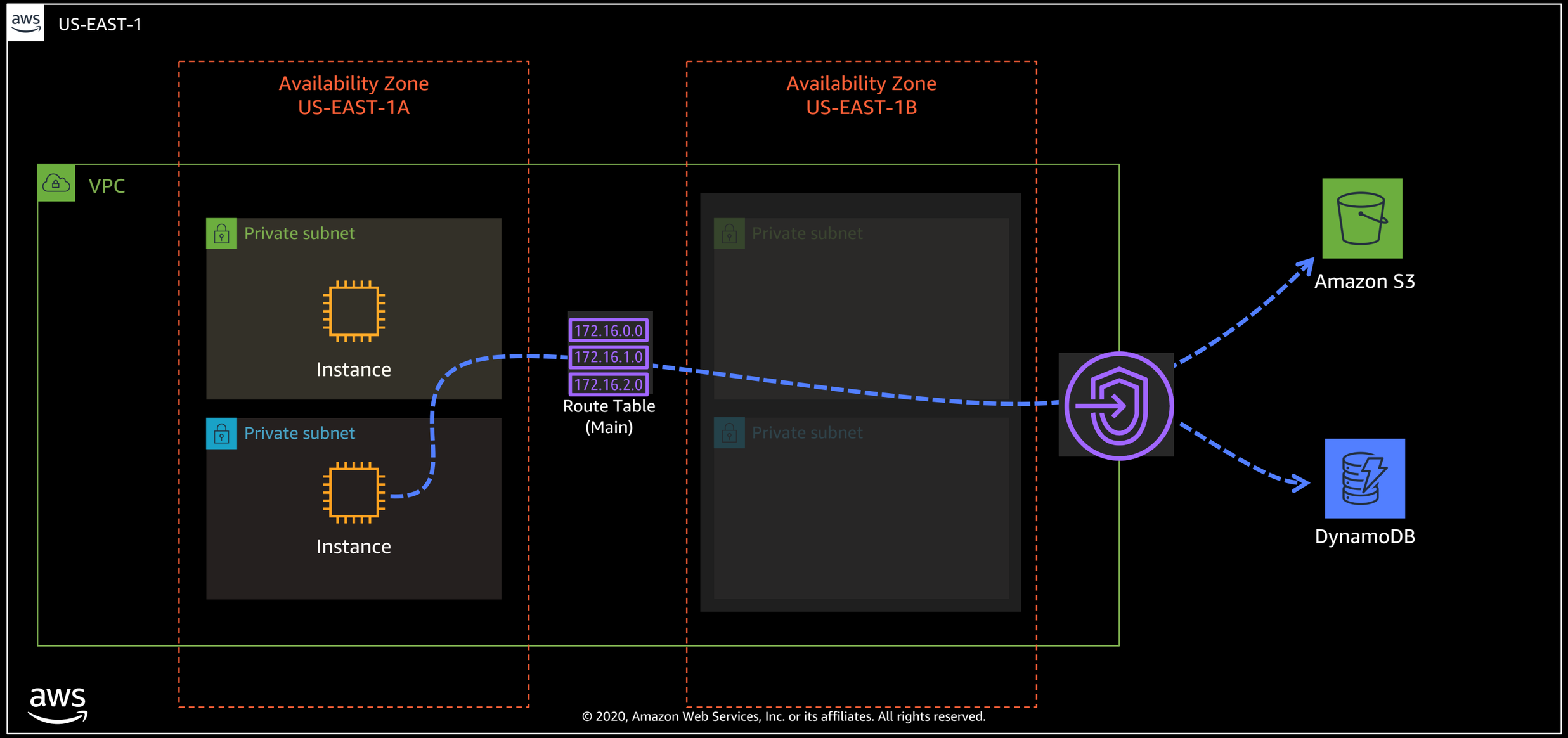


Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
pl-7ba54012 (com.amazonaws.us-east-2.s3)	vpce-00f8835c705bc0fdb	Active	No

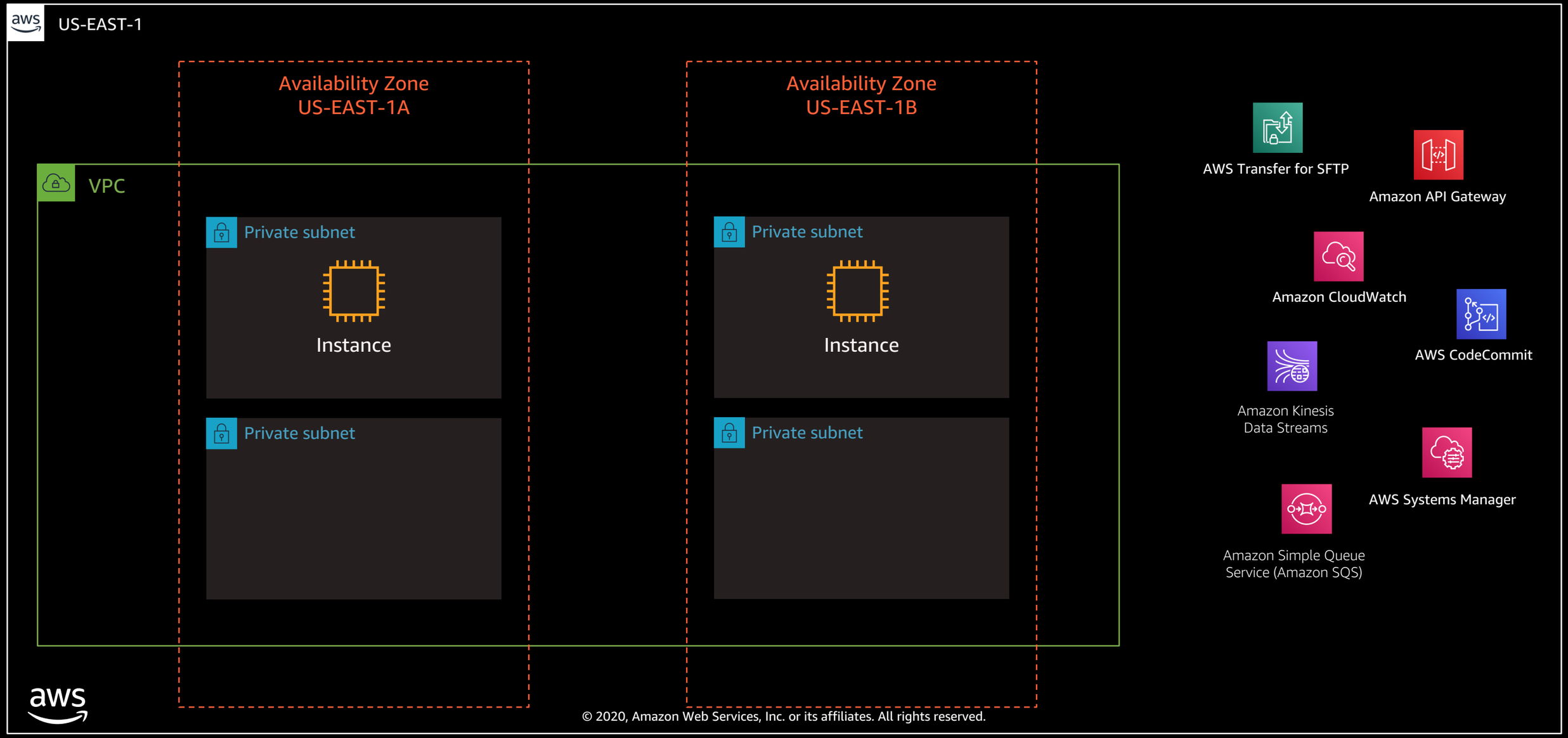
Gateway VPC endpoints



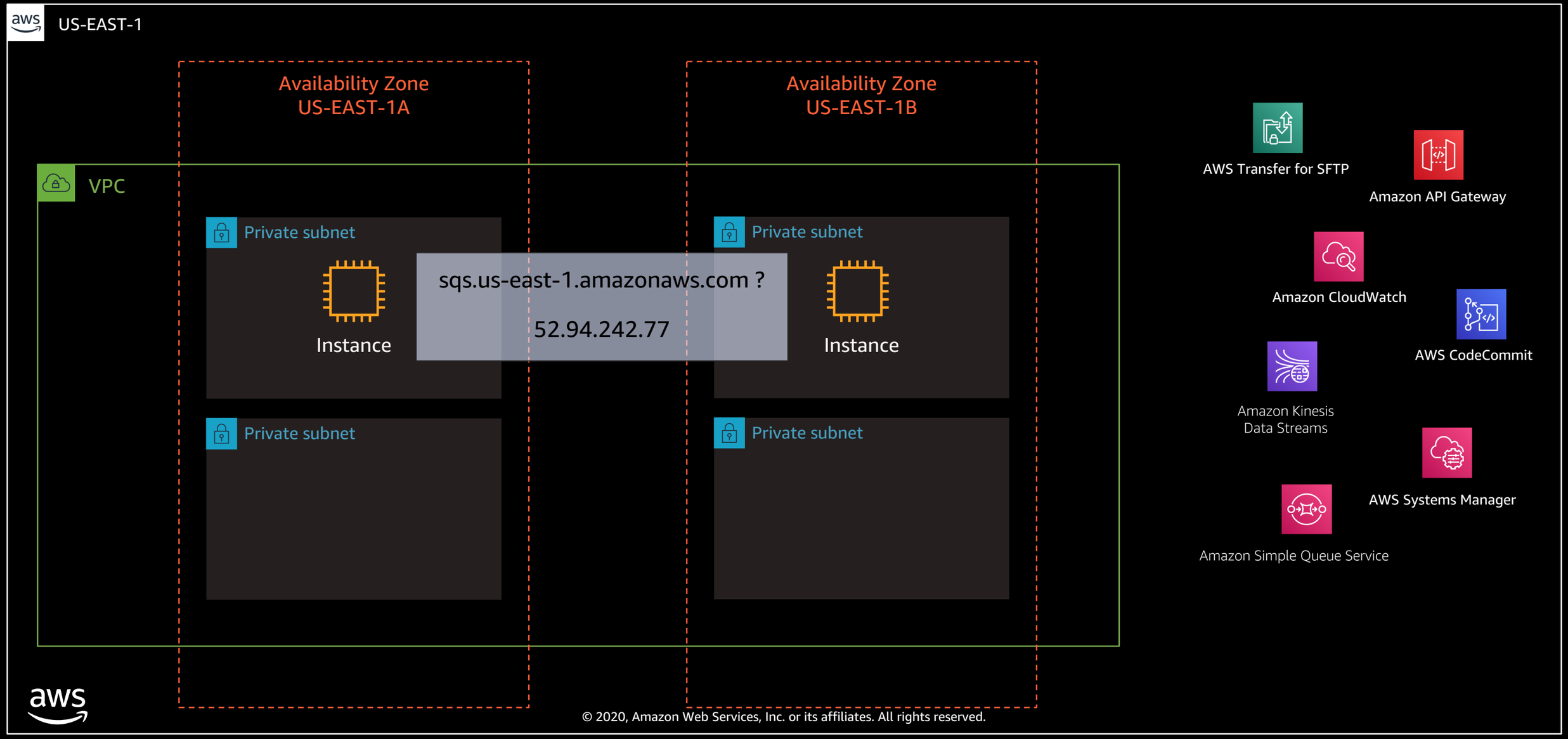
Gateway VPC endpoints



Interface VPC endpoints (AWS PrivateLink)



Interface VPC endpoints (AWS PrivateLink)



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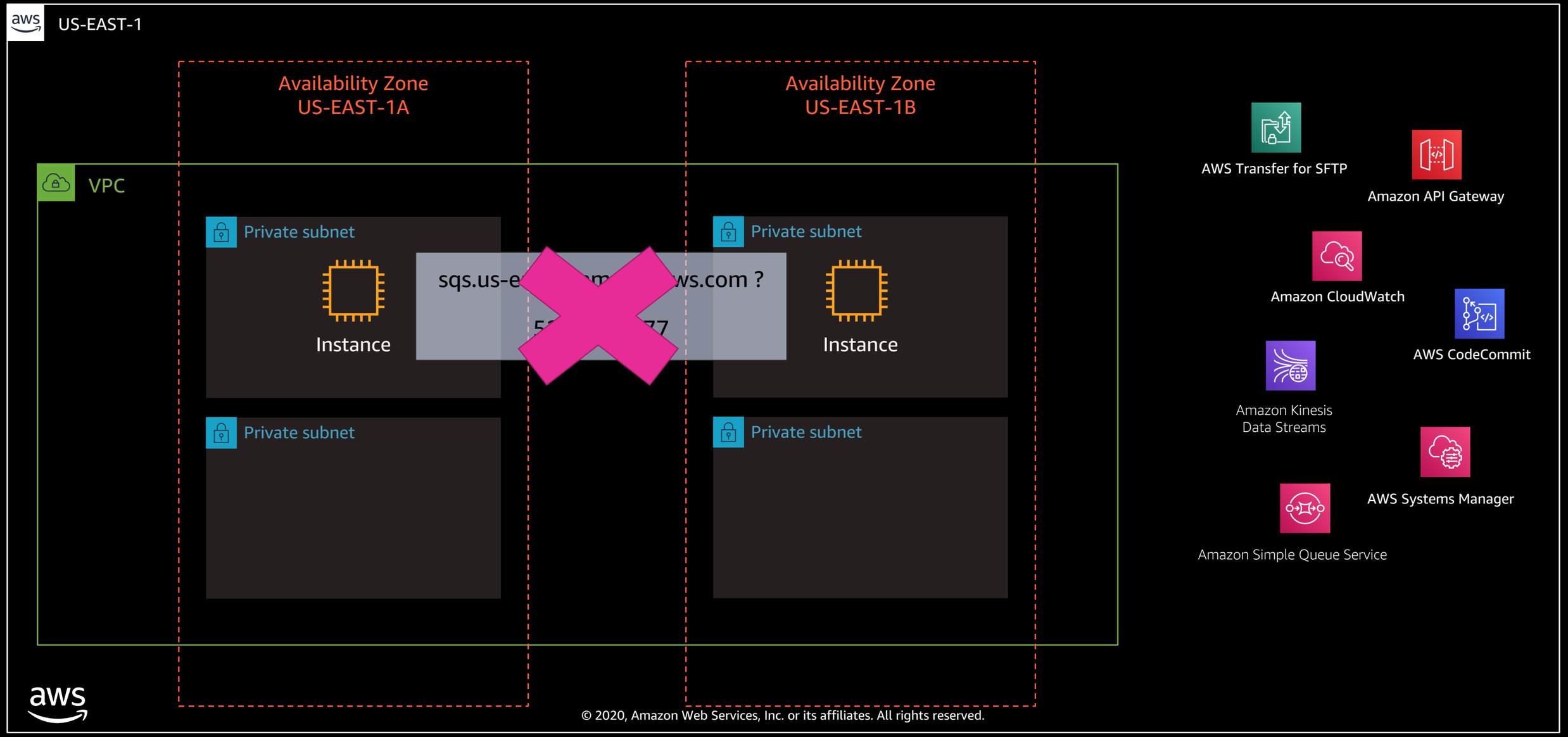
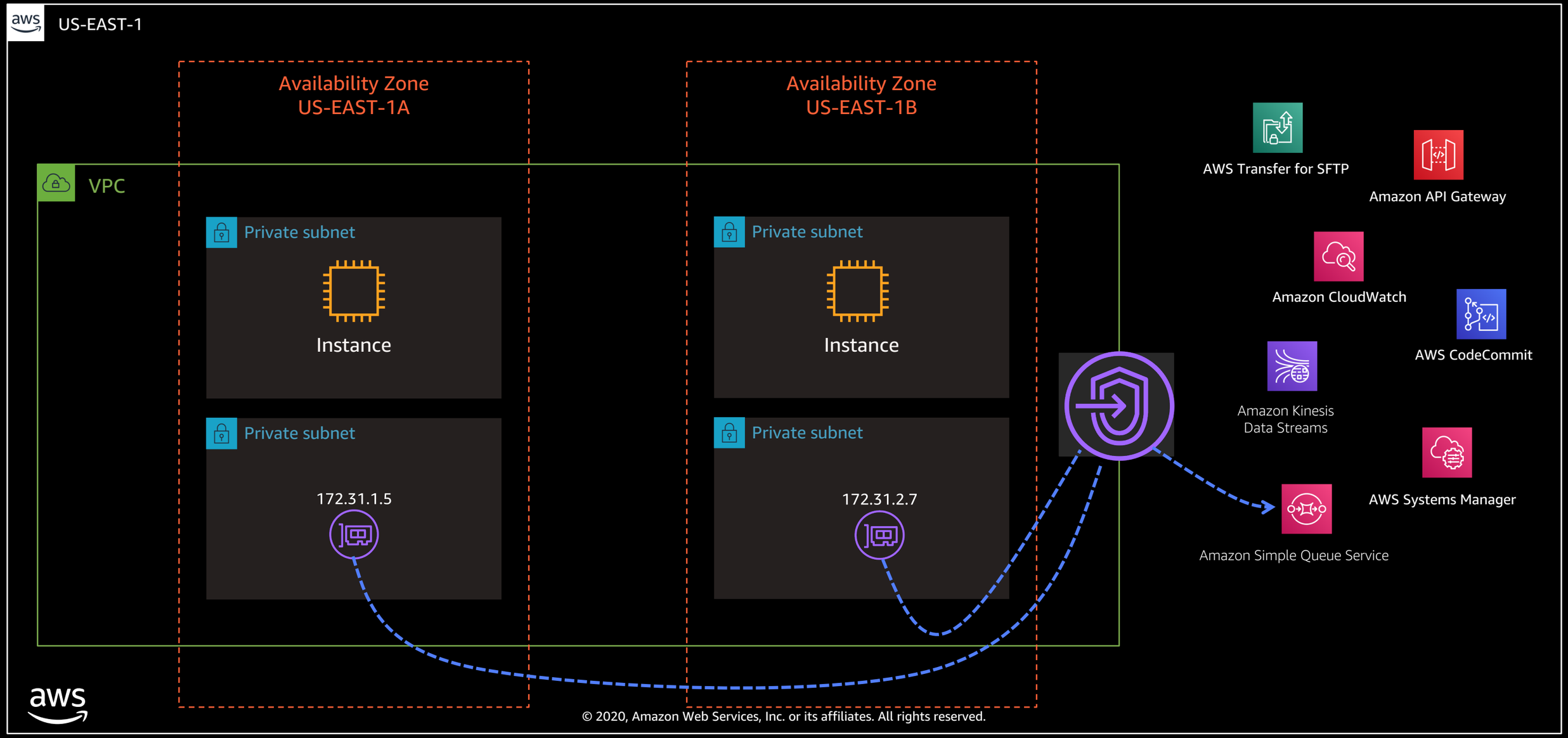
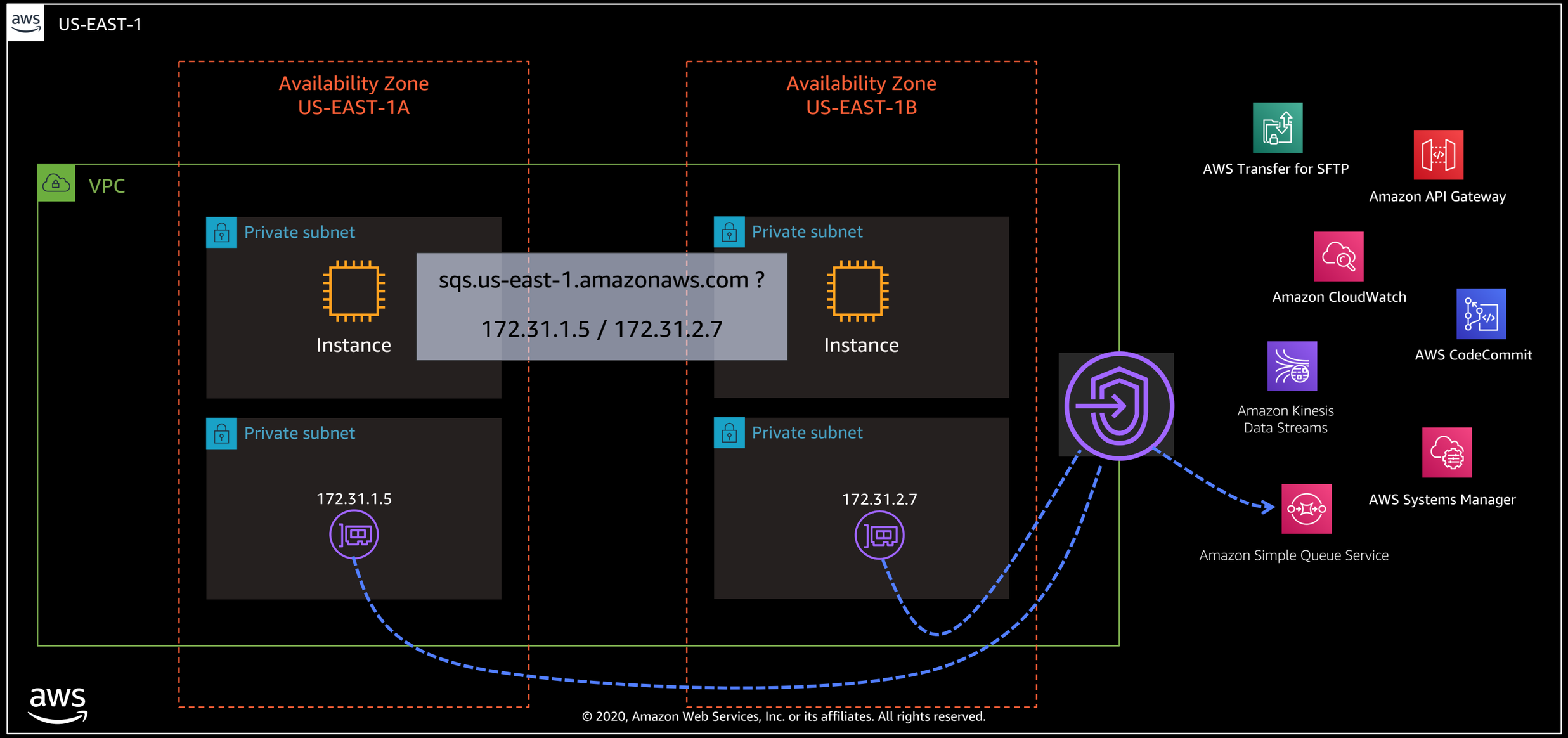


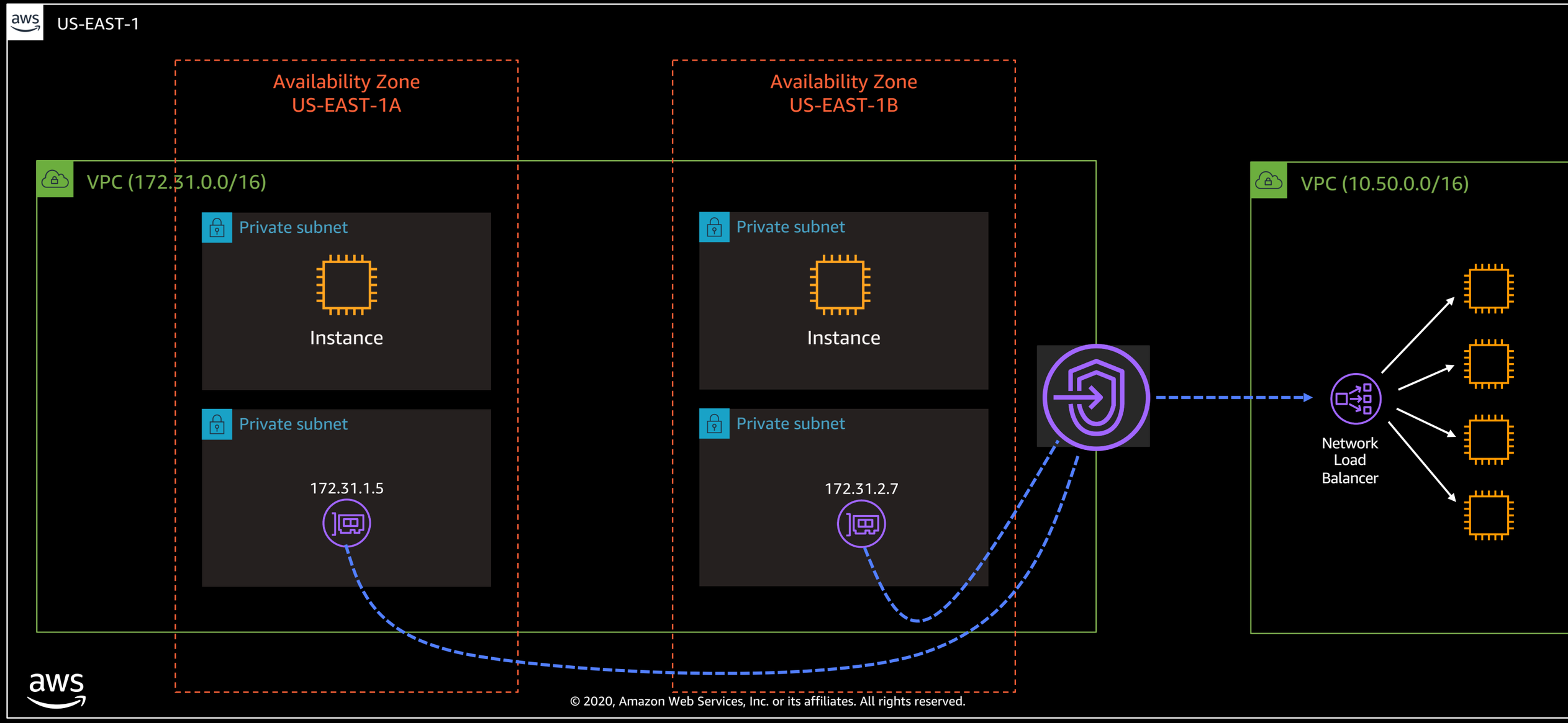
Interface VPC endpoints (AWS PrivateLink)



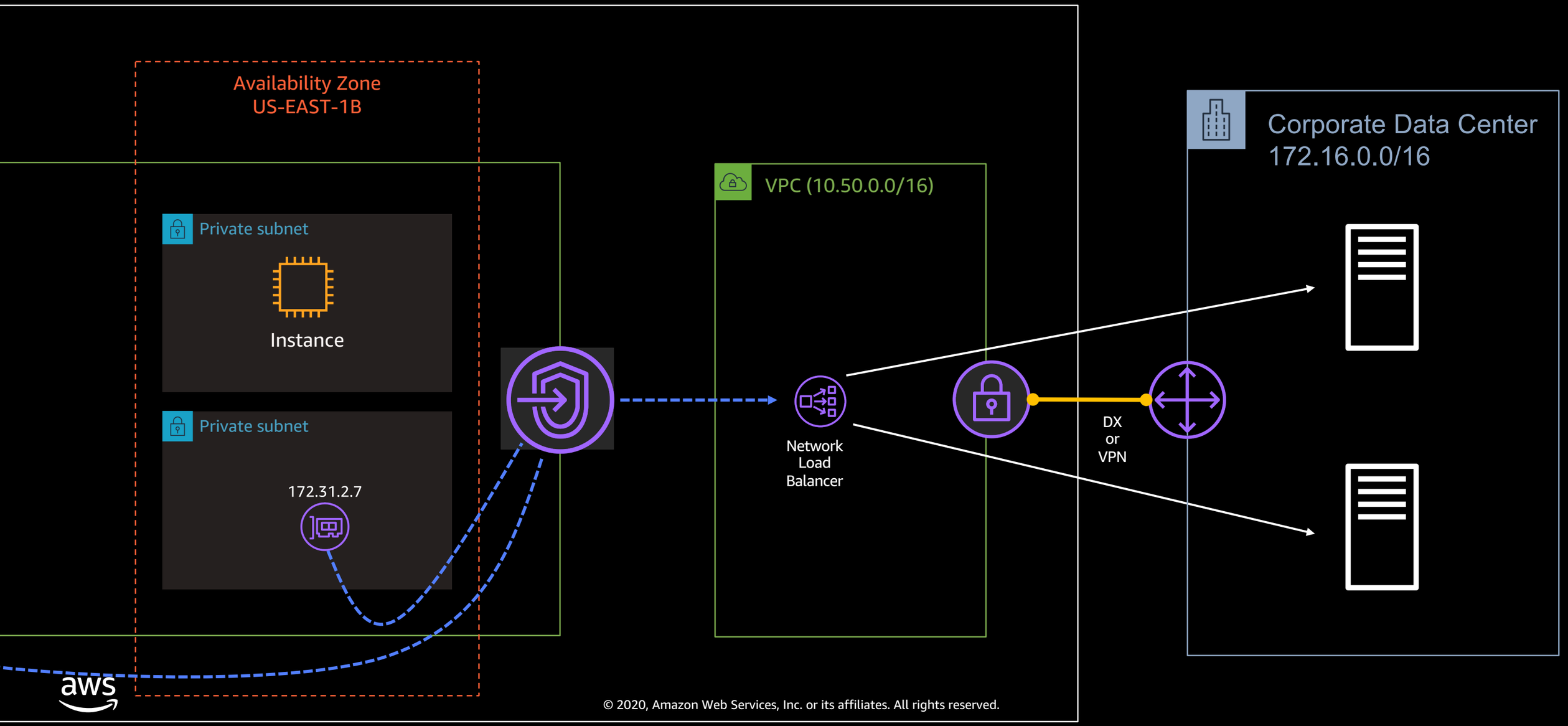
Interface VPC endpoints (AWS PrivateLink)



AWS PrivateLink – your own services



AWS PrivateLink – Your own services – On-prem



Endpoint policies

- A VPC endpoint policy is an AWS Identity and Access Management (IAM) resource policy that you attach to an endpoint
- An endpoint policy does not override or replace IAM user policies or service-specific policies (such as S3 bucket policies)

Example for S3

- IAM policy at VPC endpoint: You may only access the “Data” bucket
- IAM policy at S3 bucket: Access to this bucket is only allowed from VPCE-X

Shared VPCs

Account and VPC segmentation

Larger VPCs or accounts

- AWS Identity and Access Management (IAM)
- Strict security groups and routing
- Identifying resources with tags

Policy and IAM

Smaller VPCs or accounts

- Automation of infrastructure
- AWS Direct Connect and VPN standards
- Subnet and routing standards

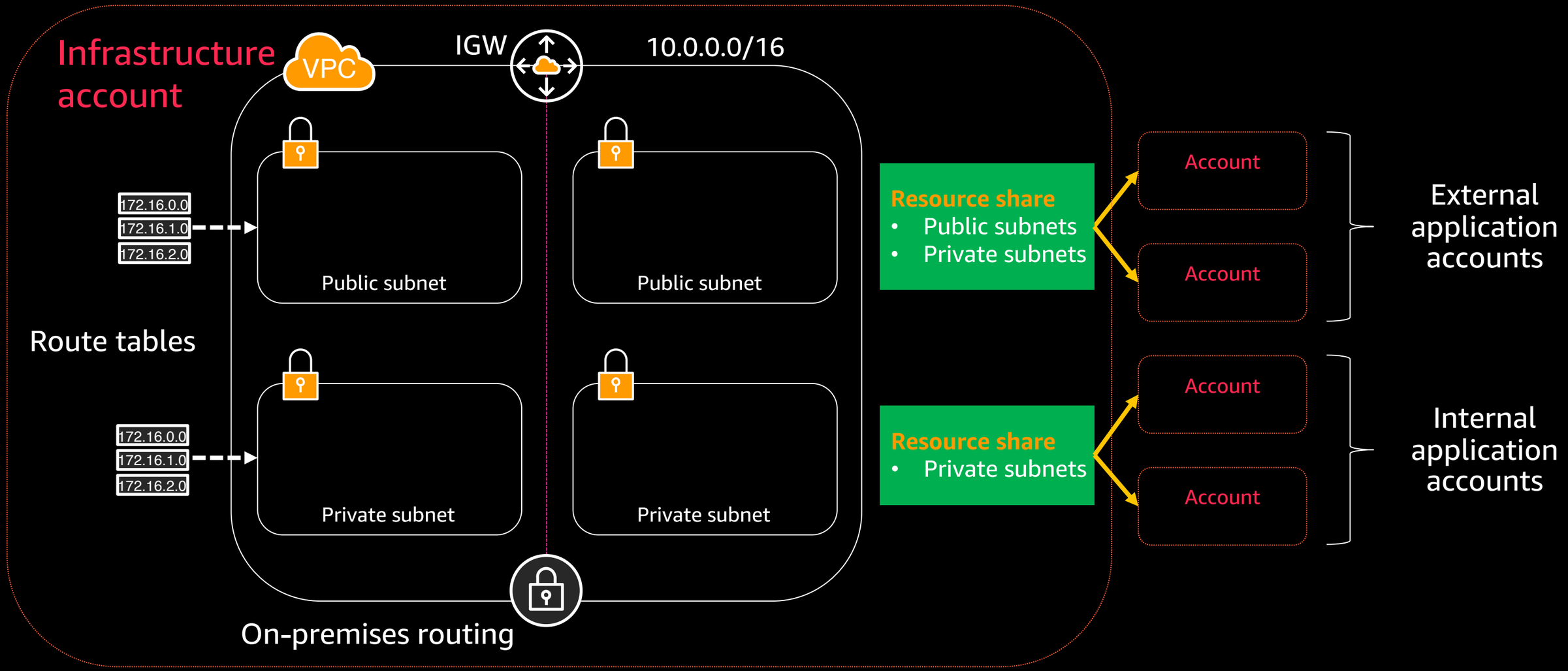
Infrastructure and networking

Why not both?

Provide granular account control
with centralized infrastructure

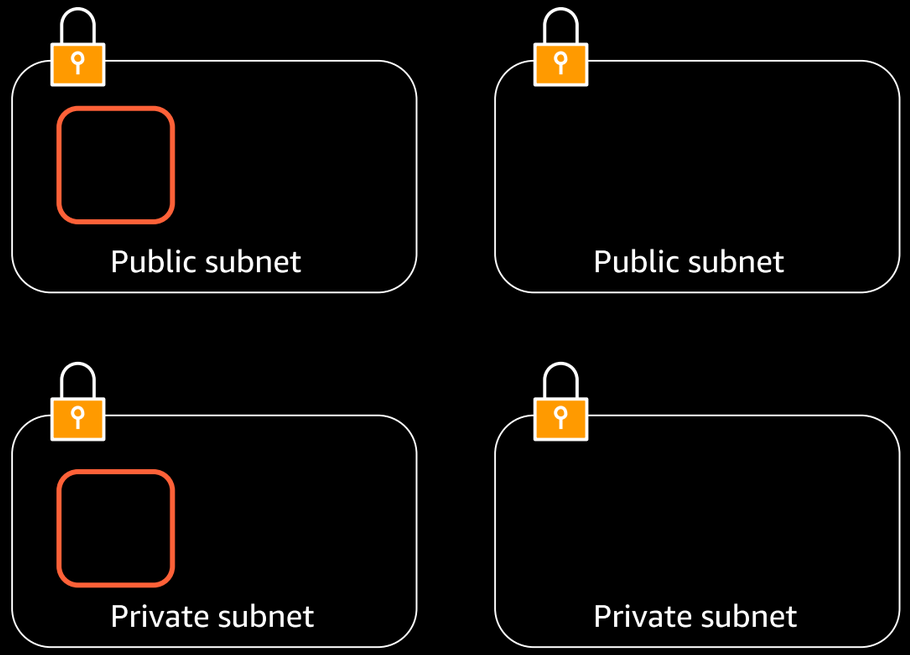
VPC Sharing and Resource Access Manager

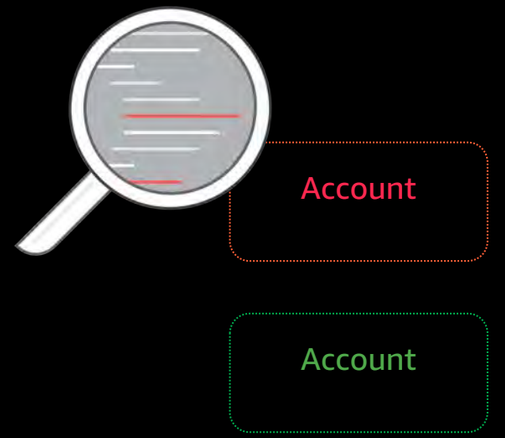
Share subnets between accounts in an AWS Organization



VPC Sharing and Resource Access Manager

Account owners only see subnets and their resources





External accounts

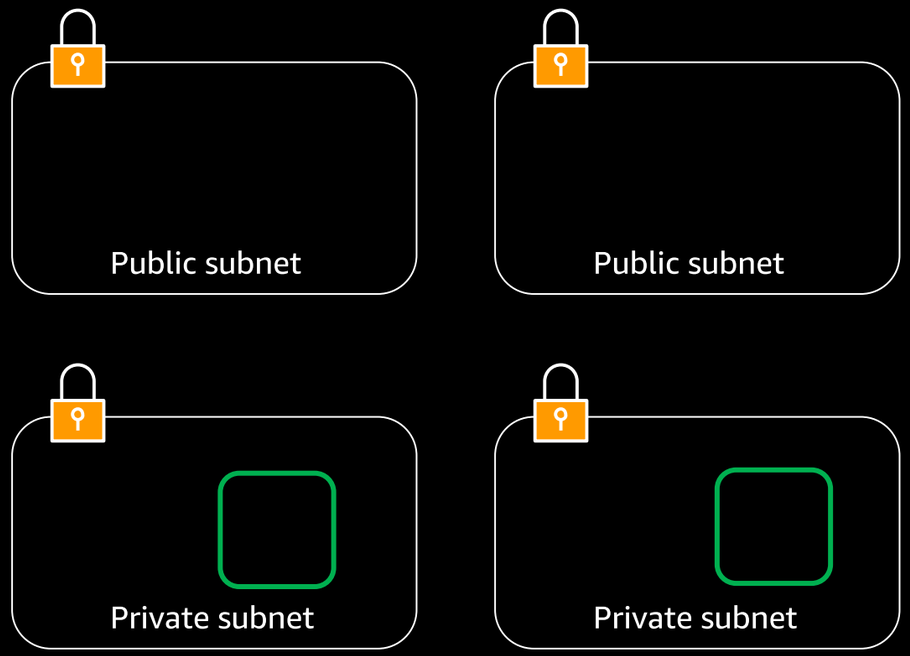
Internal accounts

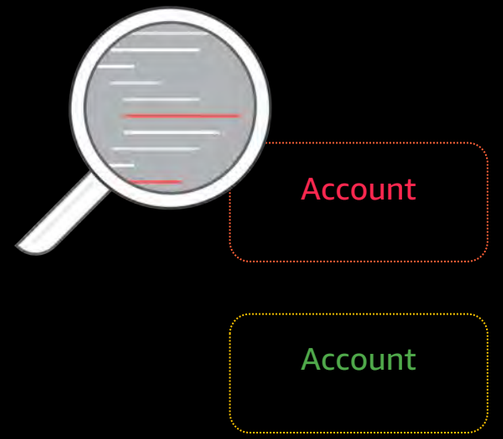
Accounts see their resources and have control:

- Security groups
- Data
- Instance details
- Account configuration

VPC Sharing and Resource Access Manager

Account owners only see subnets and their resources





External accounts

Internal accounts

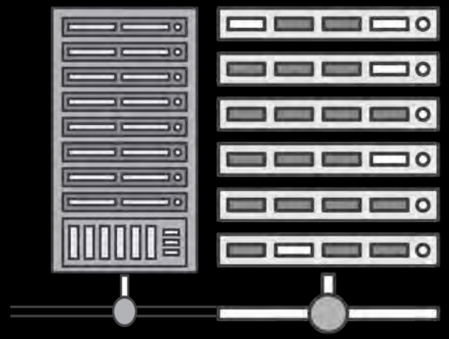
Accounts see their resources and have control:

- Security groups
- Data
- Instance details
- Account configuration

VPC Sharing benefits

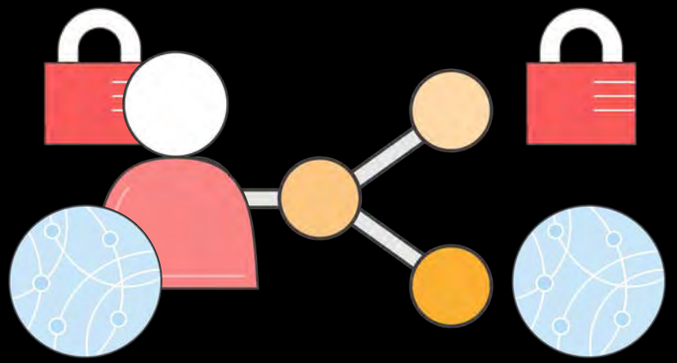
Separation of duties

- Infrastructure strictly controls routing, IP addresses, and VPC structure
- Developers own their resources, accounts, and security groups



Less unused resources

- Higher density subnets, add up to 5 additional CIDRs
- More efficient use of VPN and AWS Direct Connect



Decouple accounts and networks

- Account protection and billing without additional infrastructure
- Many accounts with fewer networks
- Avoid VPC peering charges

Other account considerations

One size does not need to fit all

- Example: production may use separate VPCs, development can use a shared VPC
- **AWS Transit Gateway can handle large amounts of VPCs if needed**

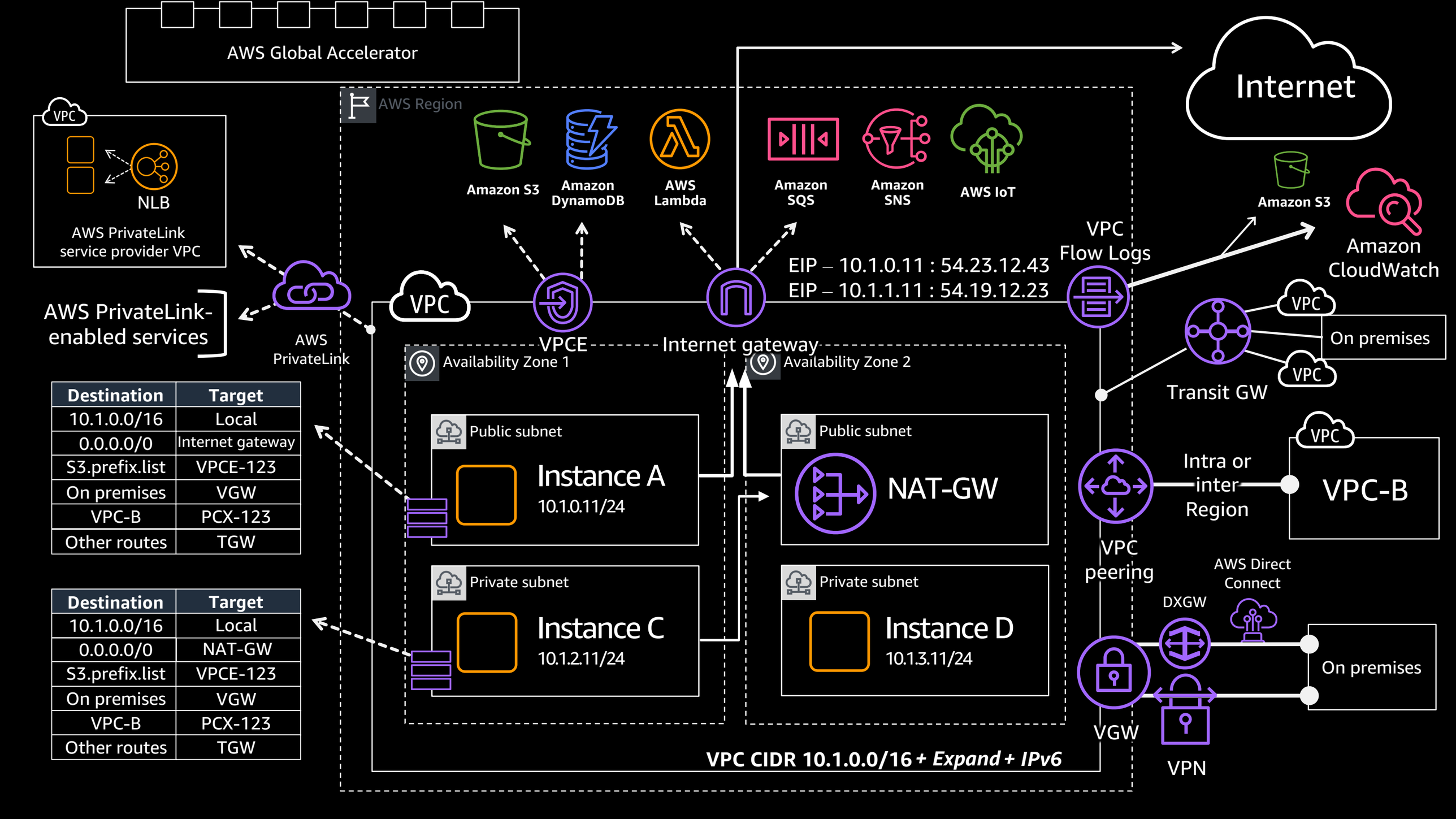
VPC Sharing works within an AWS Organization

VPC Sharing doesn’t restrict resource utilization

- NAT gateways, VPN, subnet address space, and security groups have shared limits
- VPC Sharing doesn’t change any VPC limits, only account limits
- Give highly scalable services like AWS Lambda dedicated IP space

15 min Q/A and Break

Connectivity options for VPCs



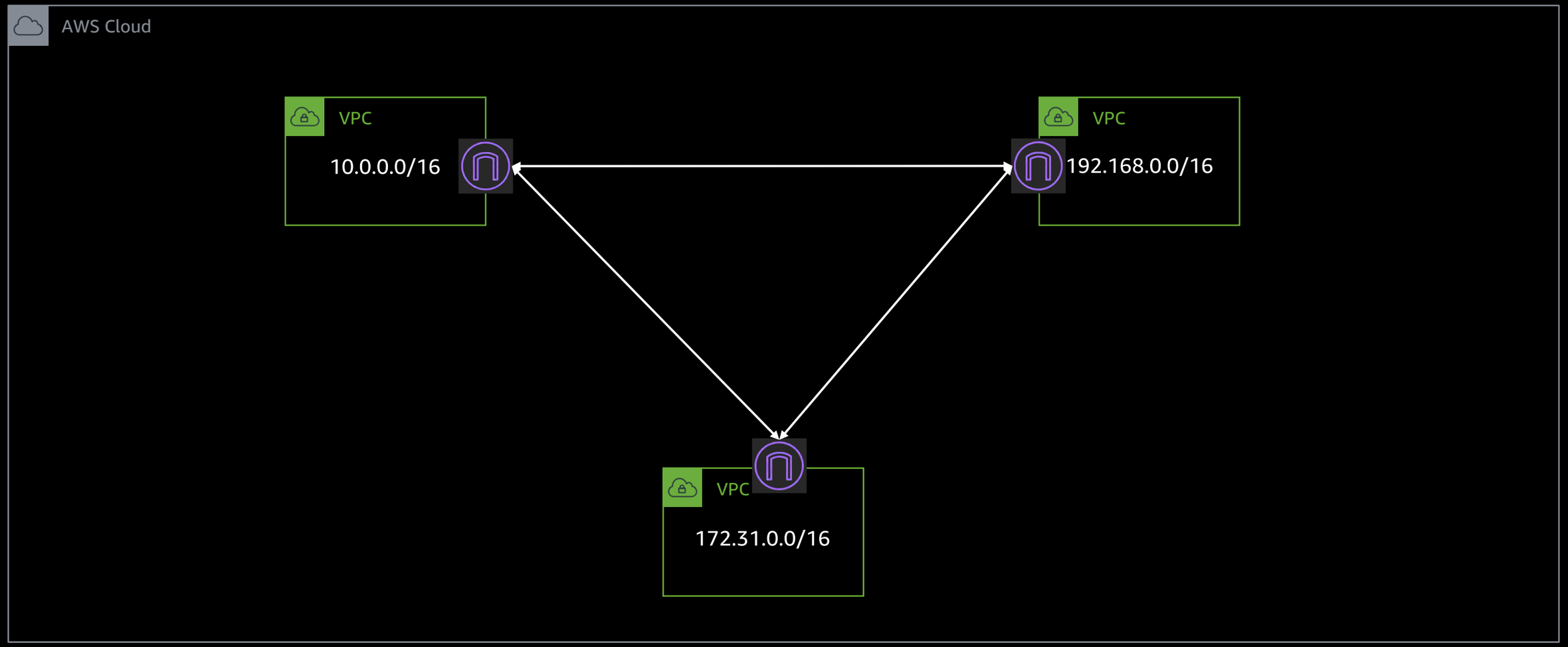
Destination	Target
10.1.0.0/16	Local
0.0.0.0/0	Internet gateway
S3.prefix.list	VPCE-123
On premises	VGW
VPC-B	PCX-123
Other routes	TGW

Destination	Target
10.1.0.0/16	Local
0.0.0.0/0	NAT-GW
S3.prefix.list	VPCE-123
On premises	VGW
VPC-B	PCX-123
Other routes	TGW

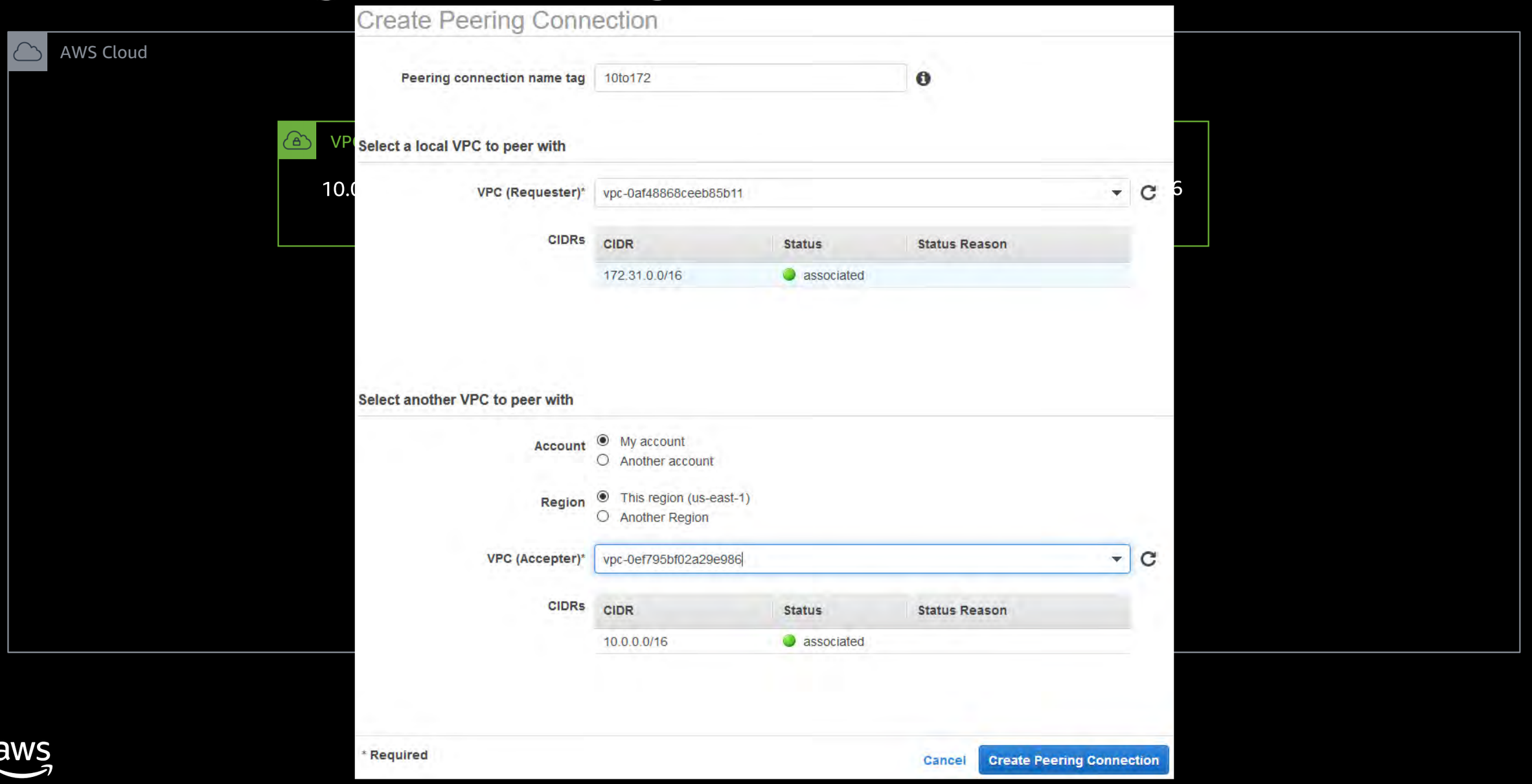
That was the agenda for this session

Connecting to other VPCs

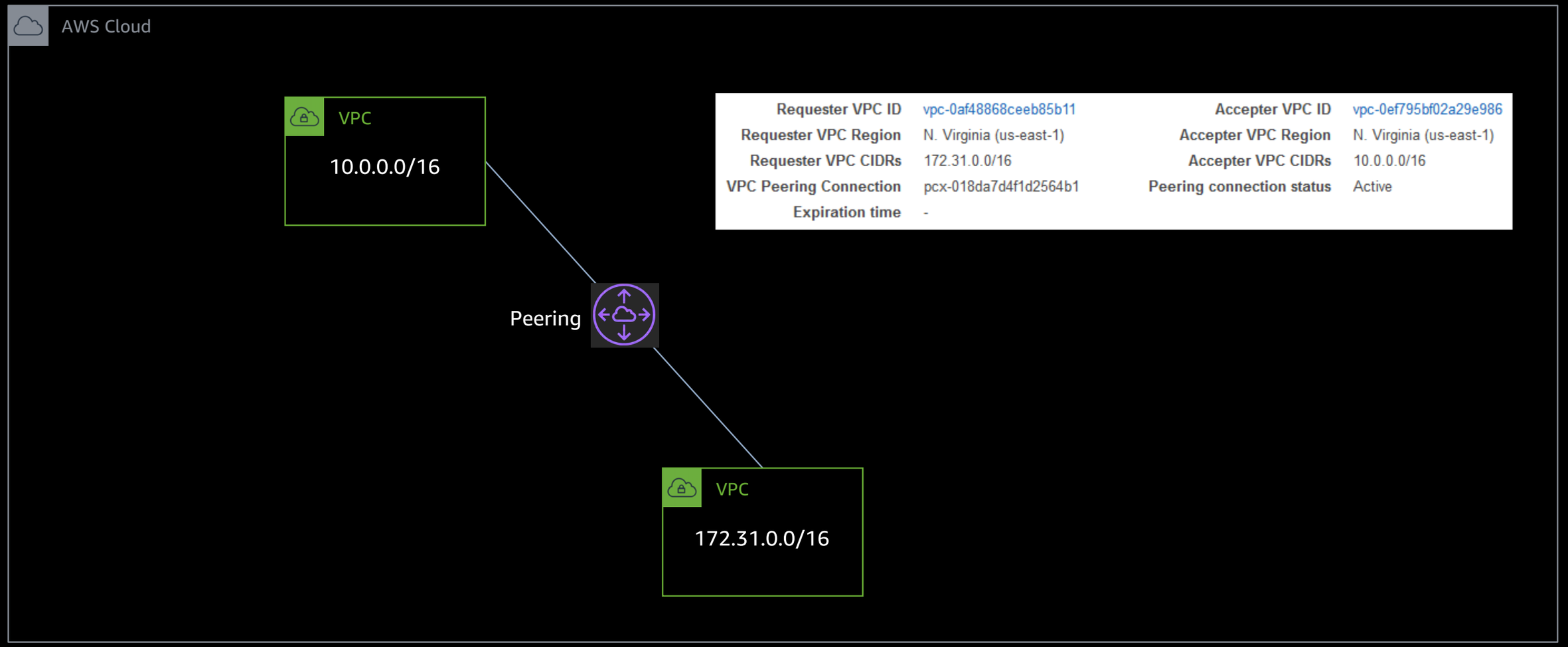
Connecting between VPCs



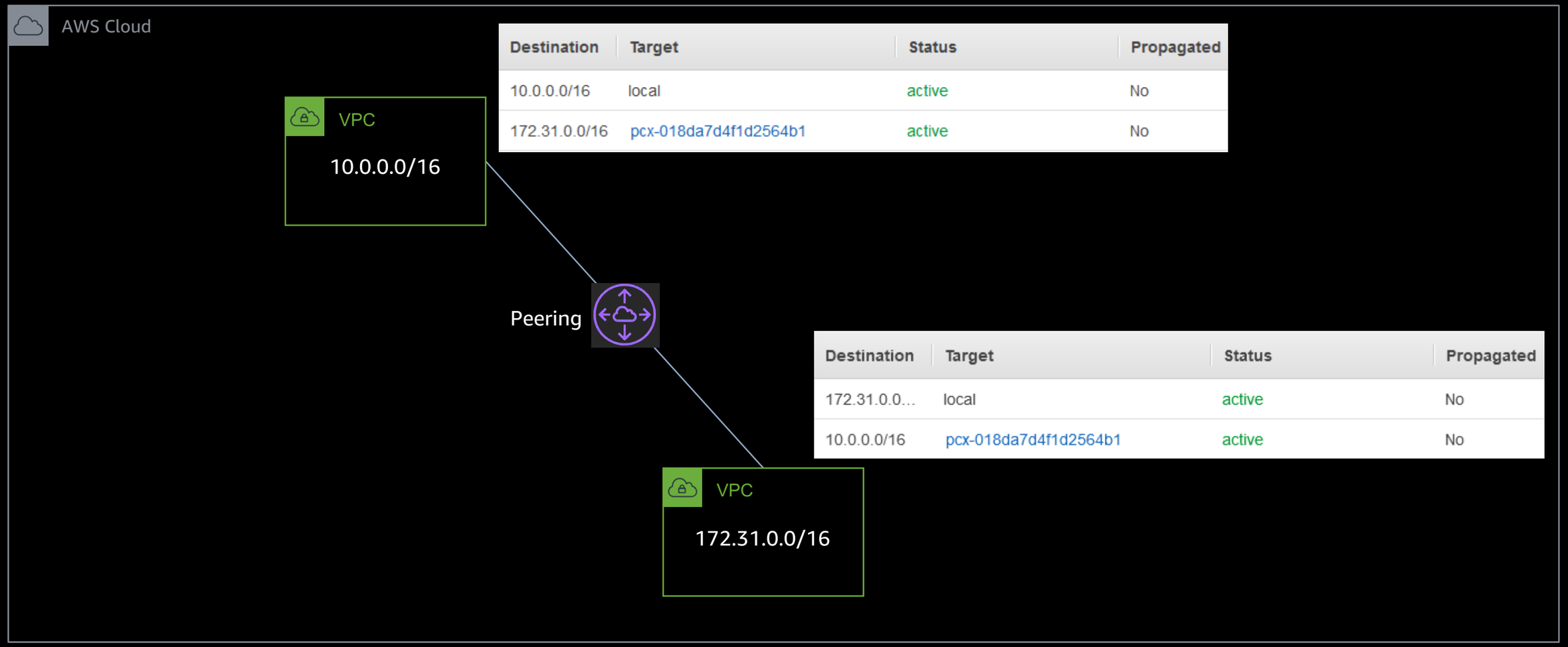
VPC peering – same region



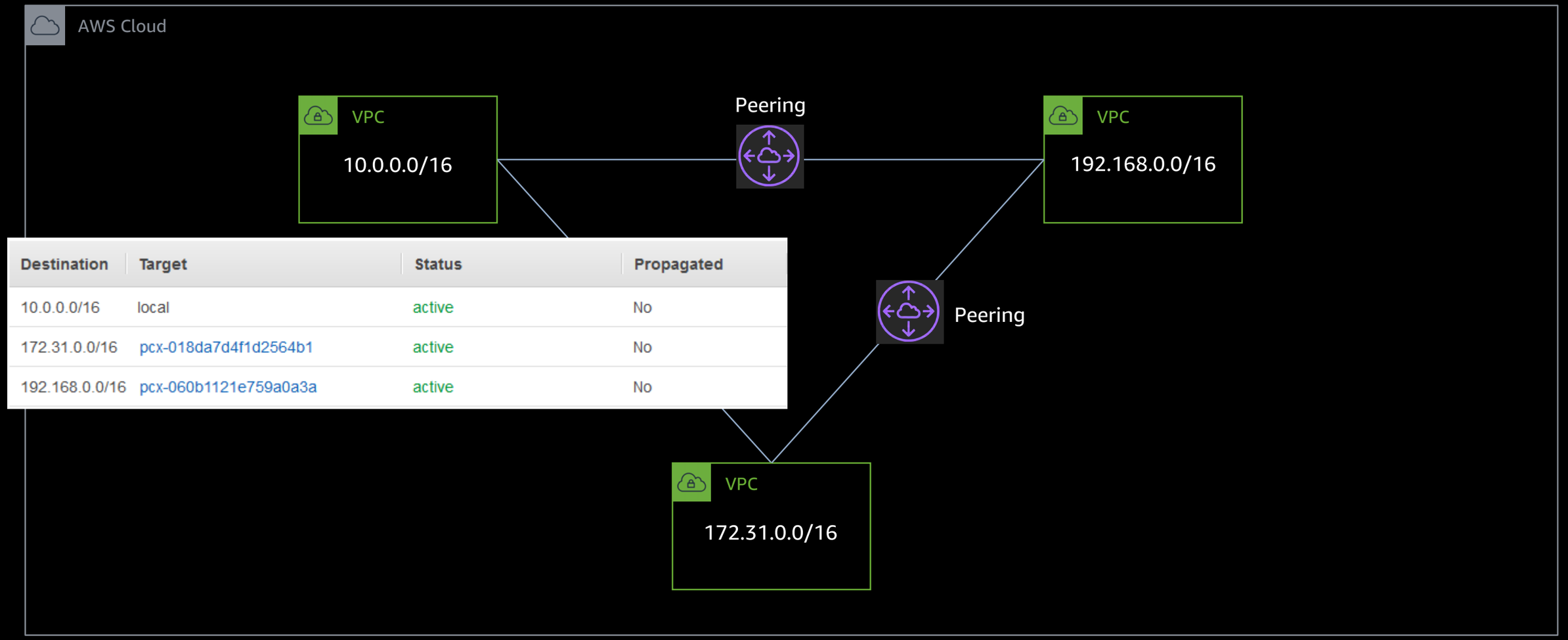
VPC peering – same region



VPC peering – same region

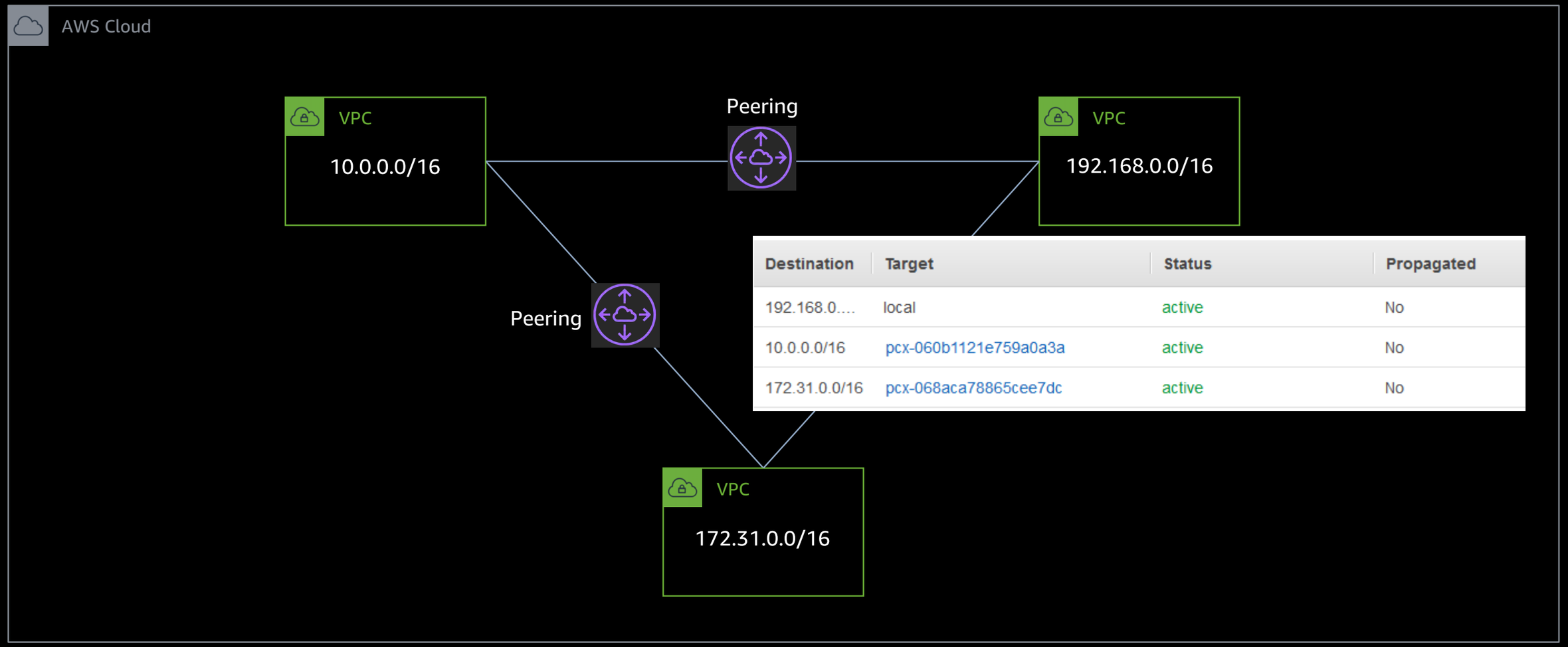


VPC peering – same region

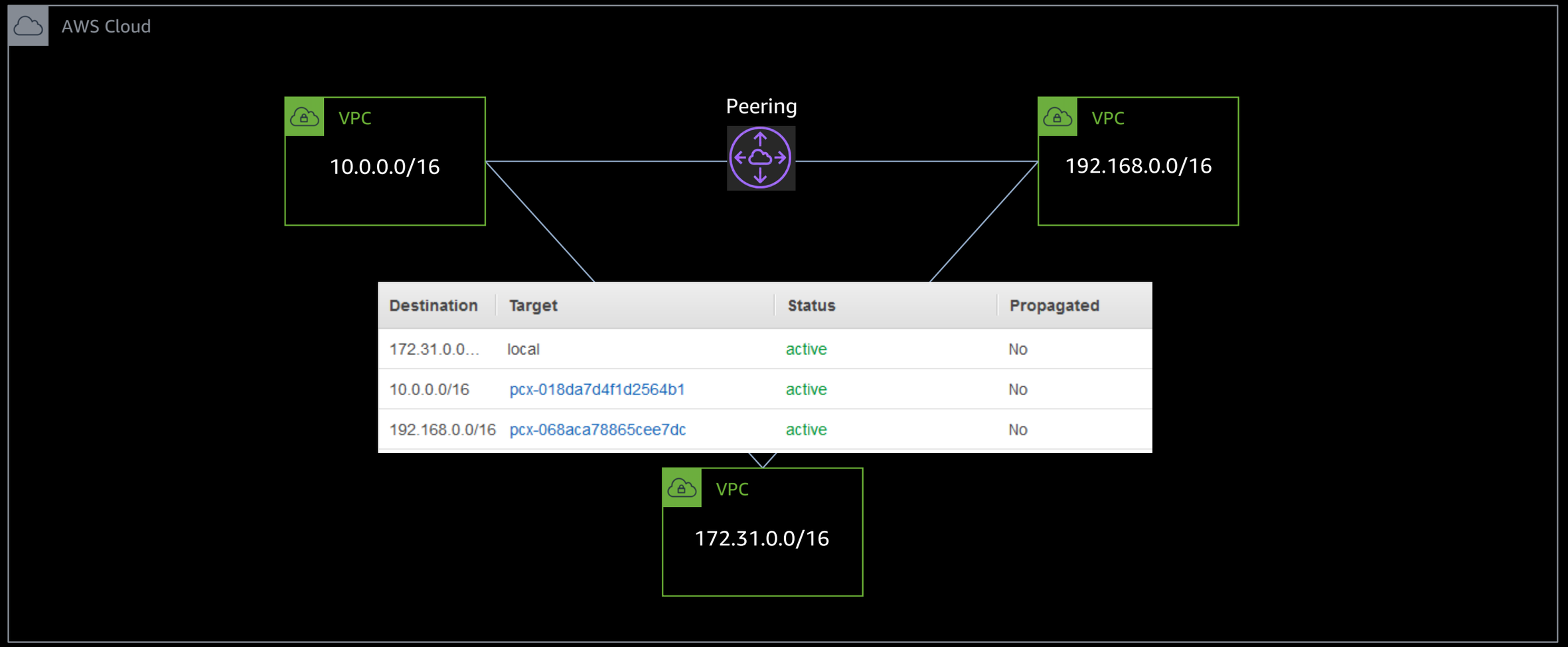


Destination	Target	Status	Propagated
10.0.0.0/16	local	active	No
172.31.0.0/16	pcx-018da7d4f1d2564b1	active	No
192.168.0.0/16	pcx-060b1121e759a0a3a	active	No

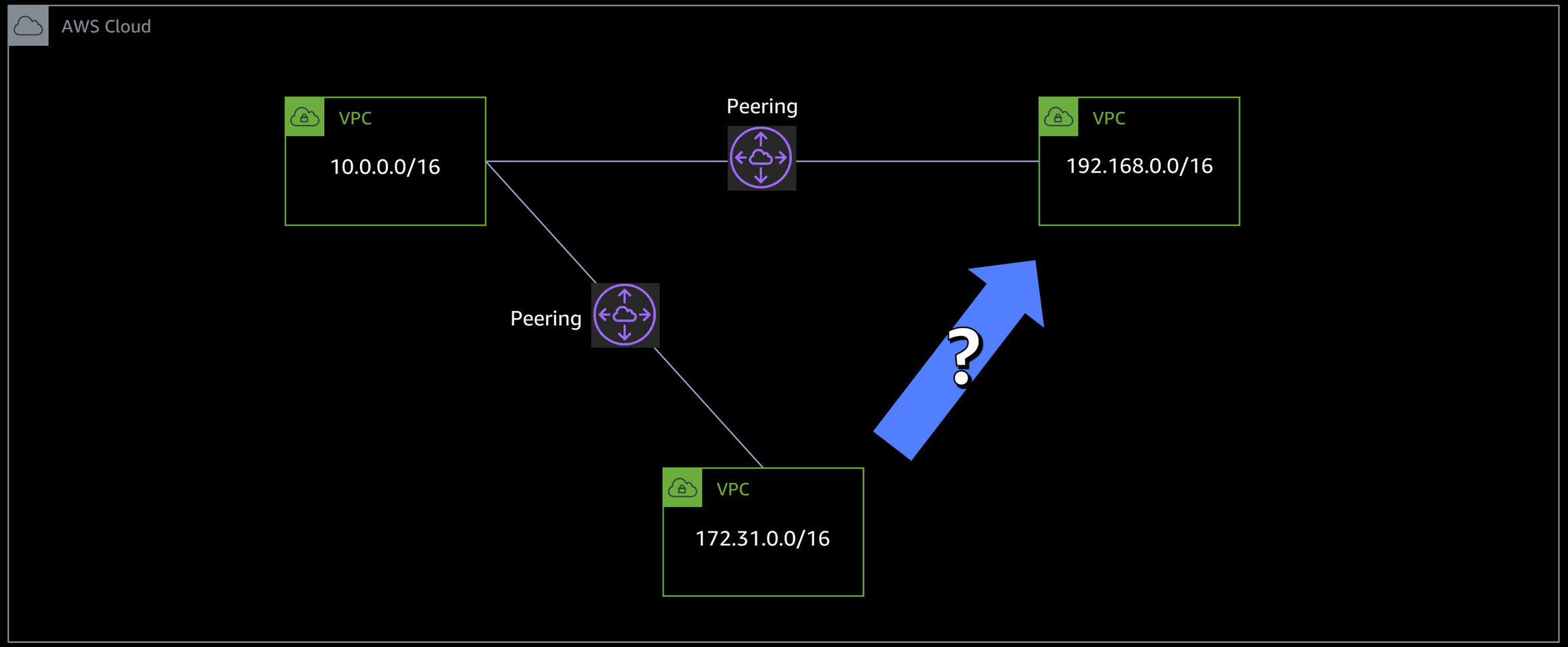
VPC peering – same region



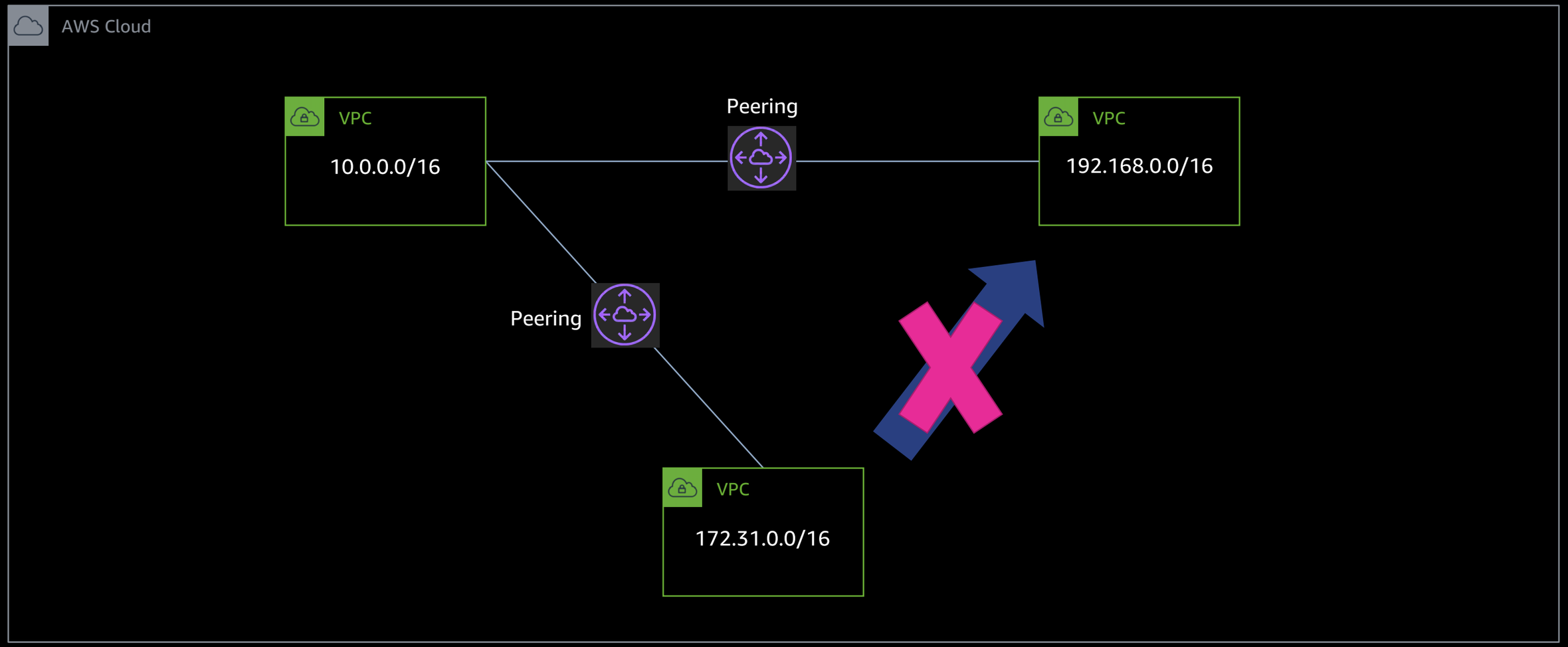
VPC peering – same region



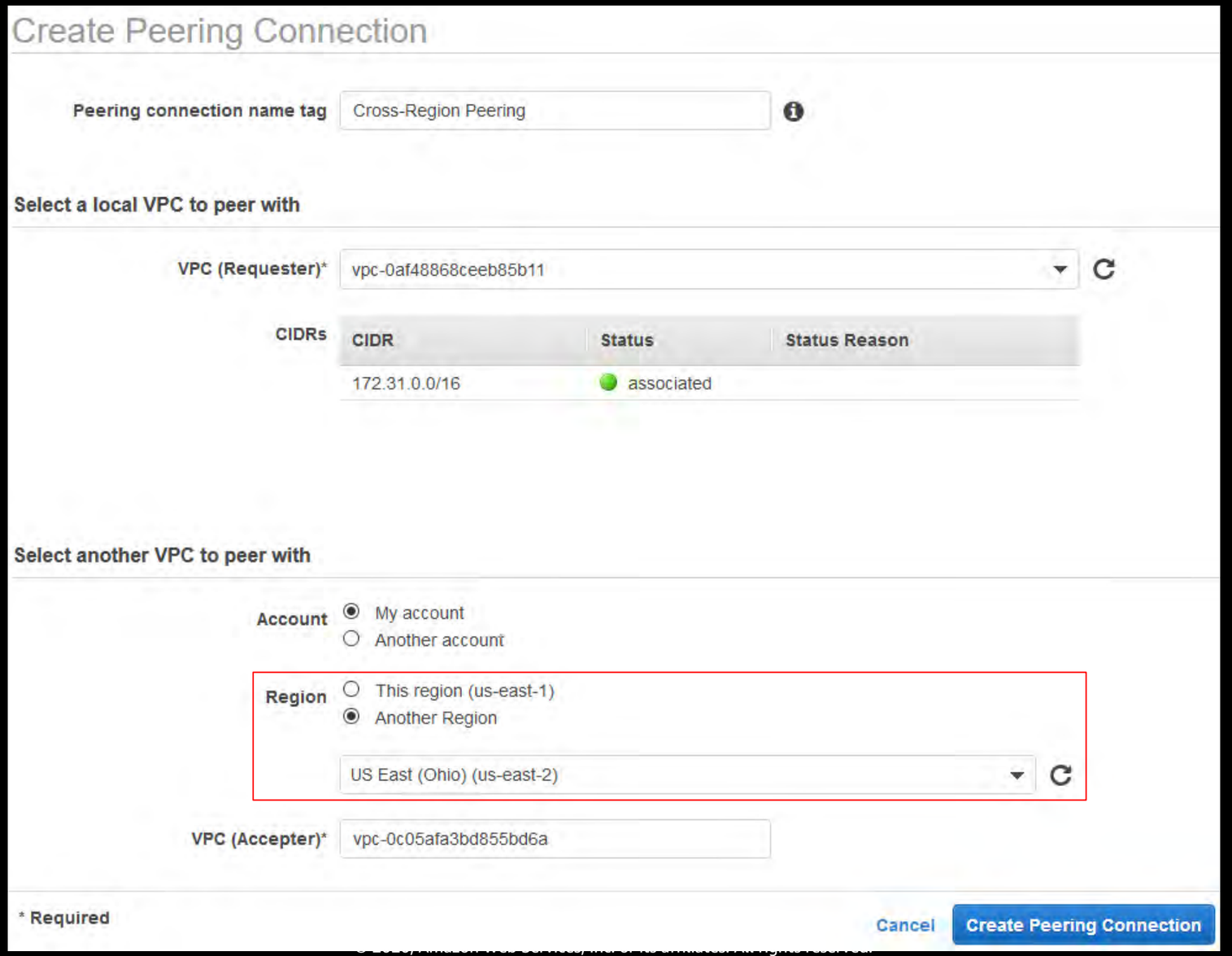
VPC peering – same region



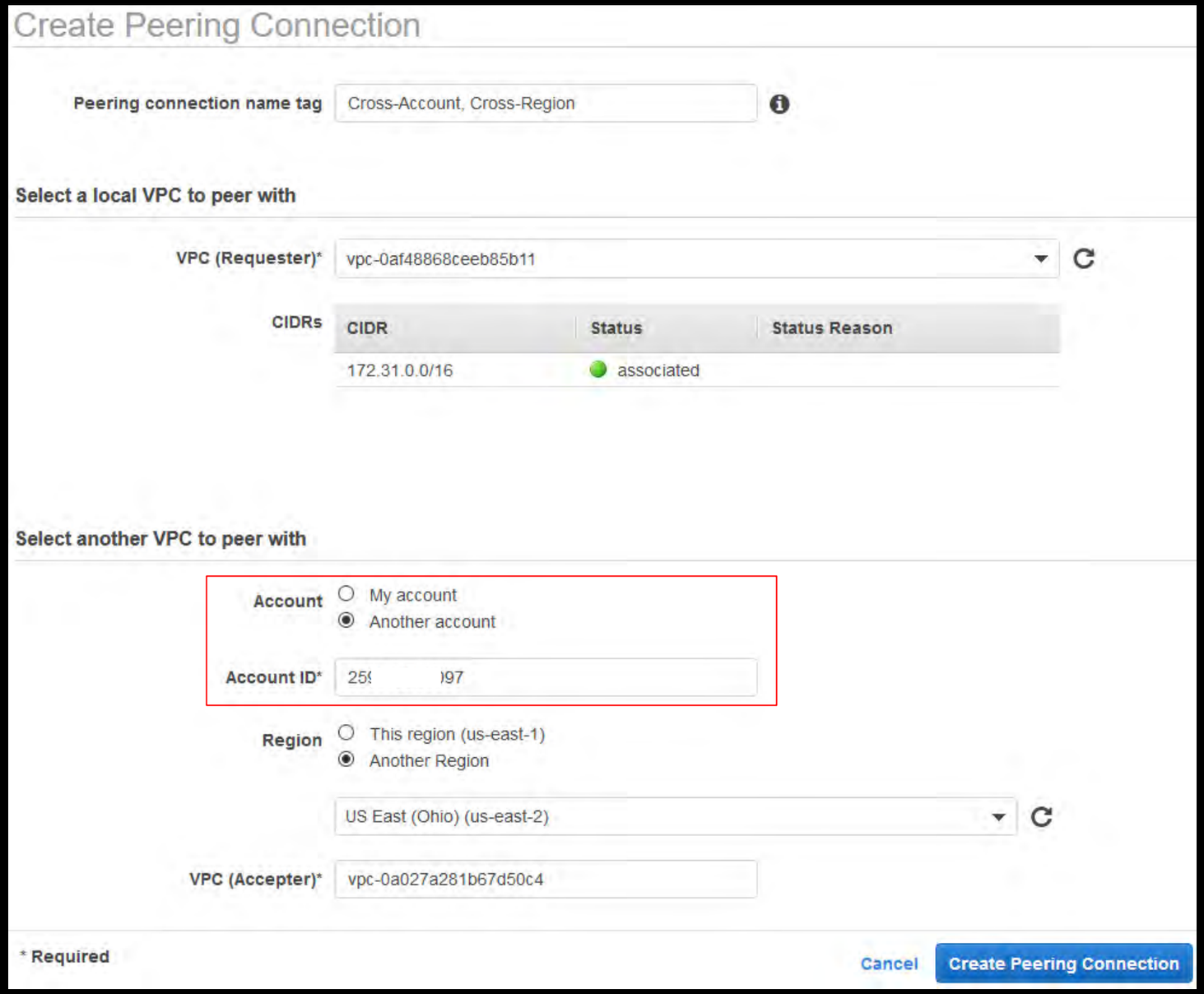
VPC peering – same region



VPC peering – different region



VPC peering – different account

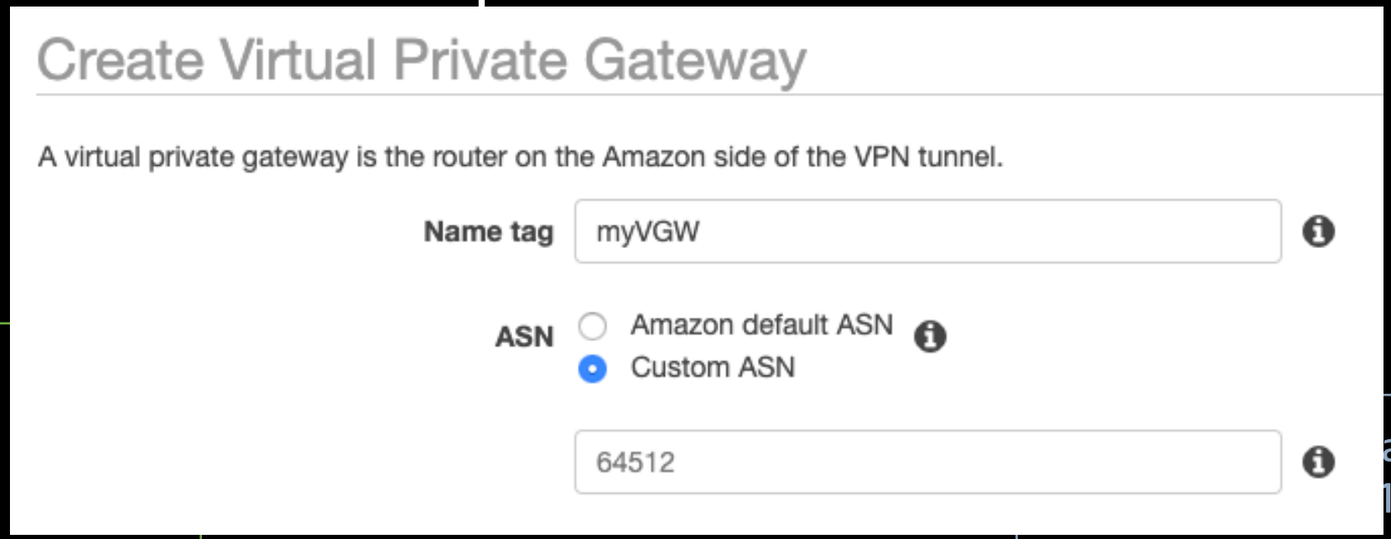


VPC peering – things to know

- Can reference security groups from the peer VPC in the same region
- Can enable DNS hostname resolution to return private IP addresses
- Can peer for both IPv4 & IPv6 addresses
- Cannot have overlapping IP addresses
- Cannot have multiple peers between the same pair of VPCs
- Cannot use jumbo frames across inter-region VPC peering

Connectivity to on-premises networks

AWS site-to-site VPN setup – VGW

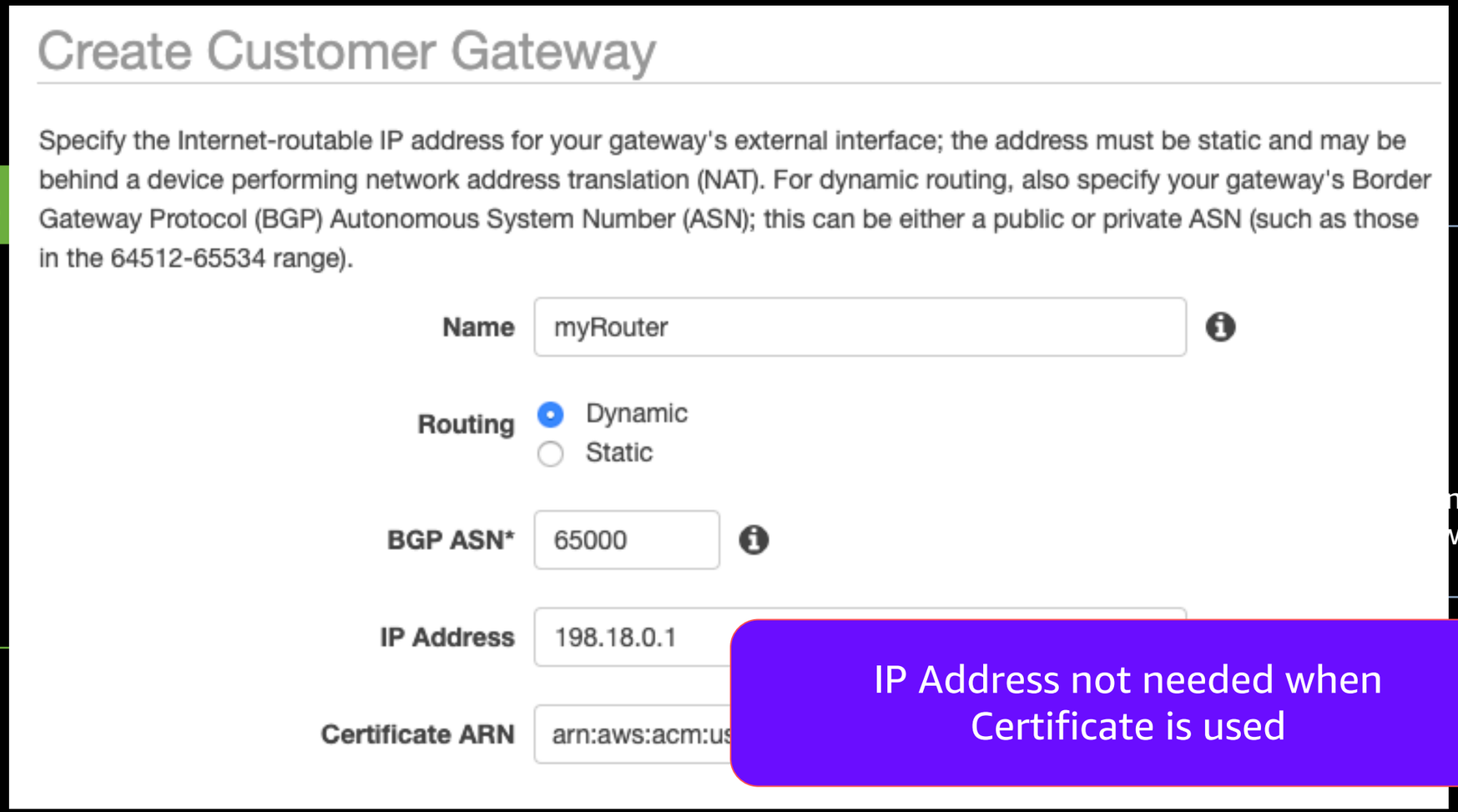


VPC 10.0.0.0/16

Virtual Private Gateway

ata Center
16

AWS site-to-site VPN – CGW

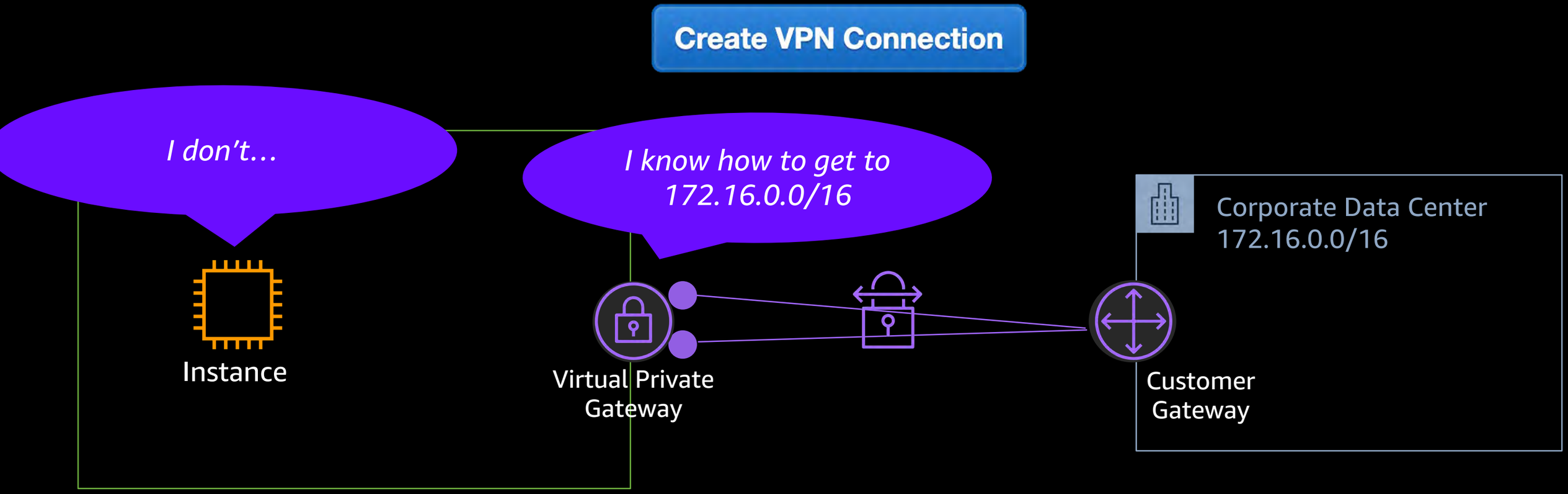


Corporate Data Center
172.16.0.0/16

mer
way

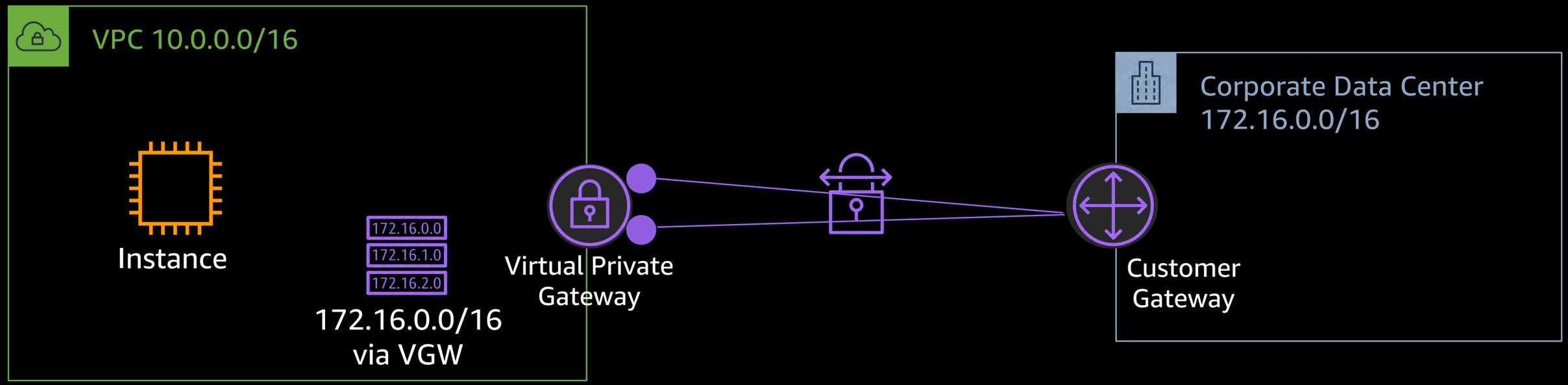
IP Address not needed when Certificate is used

AWS site-to-site VPN



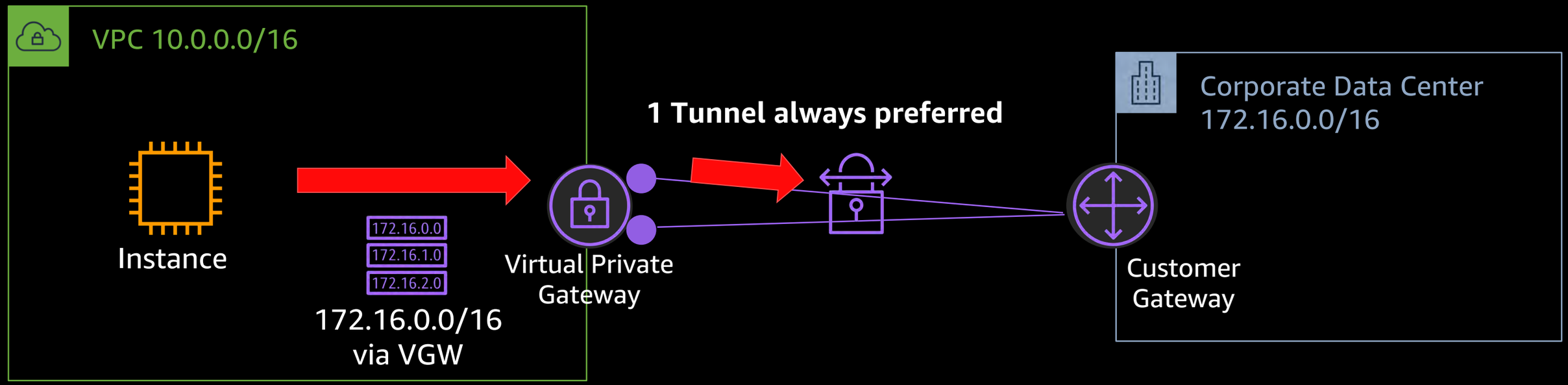
1x VPN Connection = 2x VPN Tunnels

AWS site-to-site VPN



1x VPN Connection = 2x VPN Tunnels

AWS site-to-site VPN



1x VPN Connection = 2x VPN Tunnels

1x VPN Tunnel = 1.25Gbps

AWS Direct Connect

AWS Direct Connect

Dedicated network connection to AWS providing **consistent** performance and **reduced** bandwidth costs

AWS Direct Connect – Physical connection

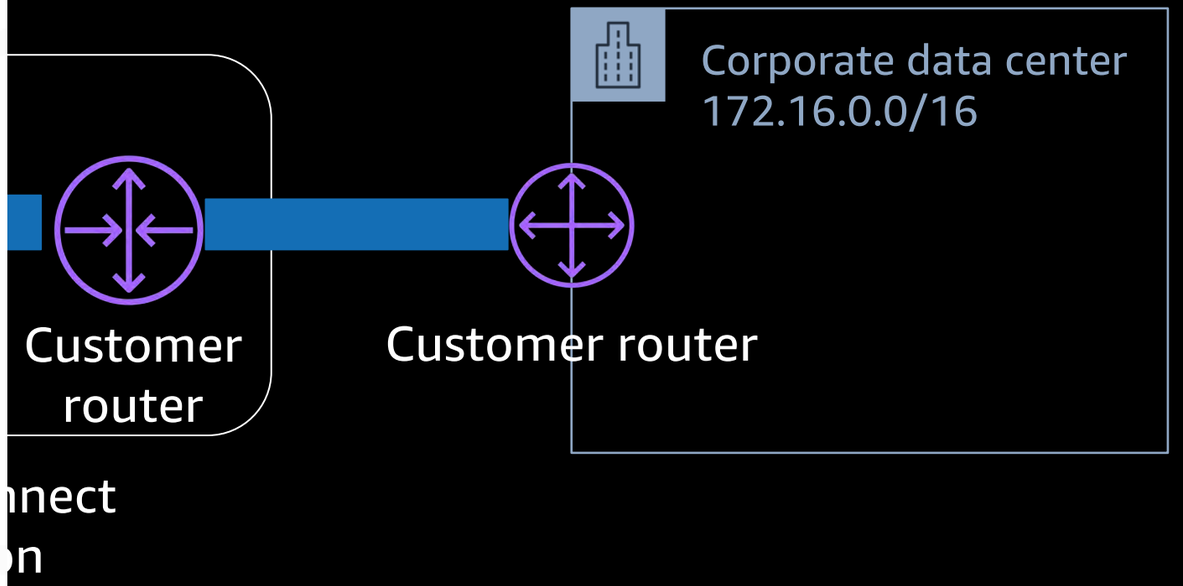
Connection settings

Name
A name to help you identify the connection.
myDirectConnect
Name must contain no more than 100 characters. Valid characters are a-z, 0-9, and – (hyphen)

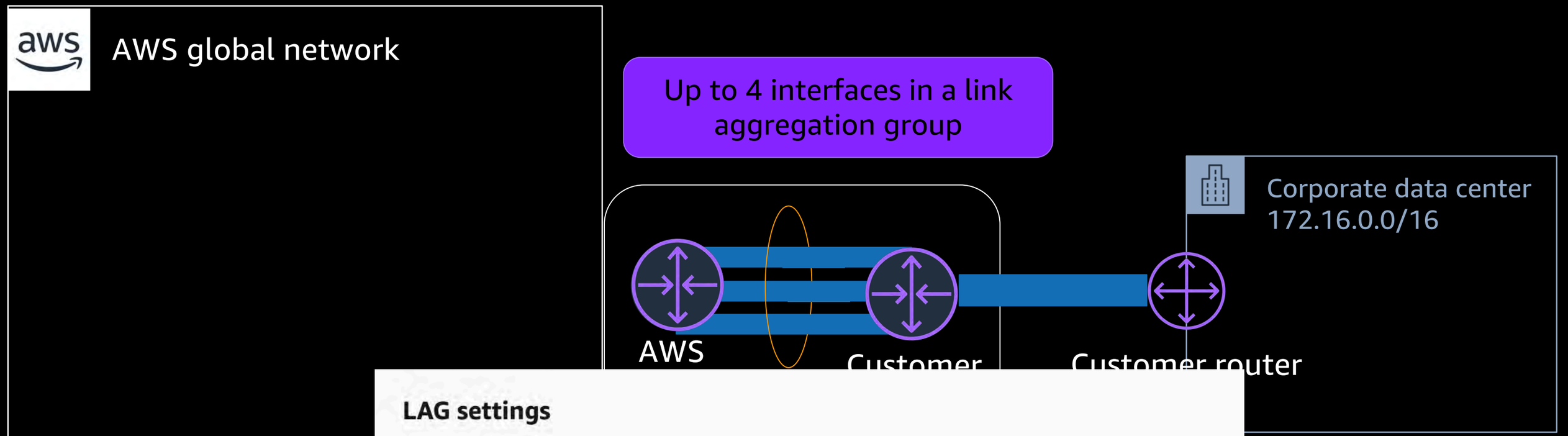
Location
The location in which your connection is located.
CoreSite NY1, New York, NY

Sub location
Sub location within the location.
24th Floor

Port speed
Desired bandwidth for the new connection.
- 1Gbps
- 10Gbps



AWS Direct Connect – Link aggregation



LAG settings

LAG name

A name to help you identify the LAG.

My_Lag

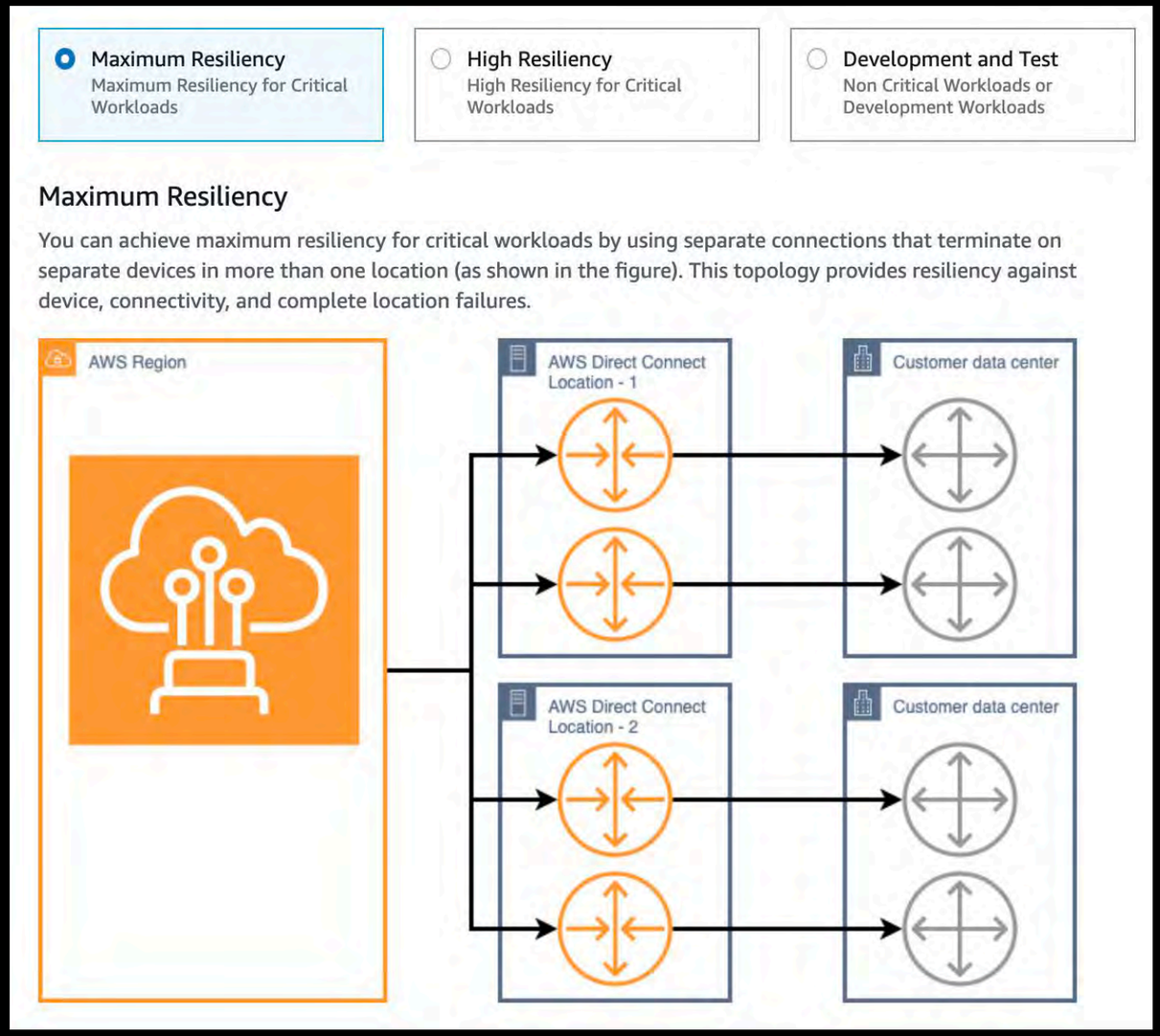
Name must contain no more than 100 characters. Valid characters are a-z, 0-9, and – (hyphen)

Minimum links - *optional*

The number of connections that must be link-up in order for the LAG to transition to link-up.

2

AWS Direct Connect new features – Resiliency toolkit

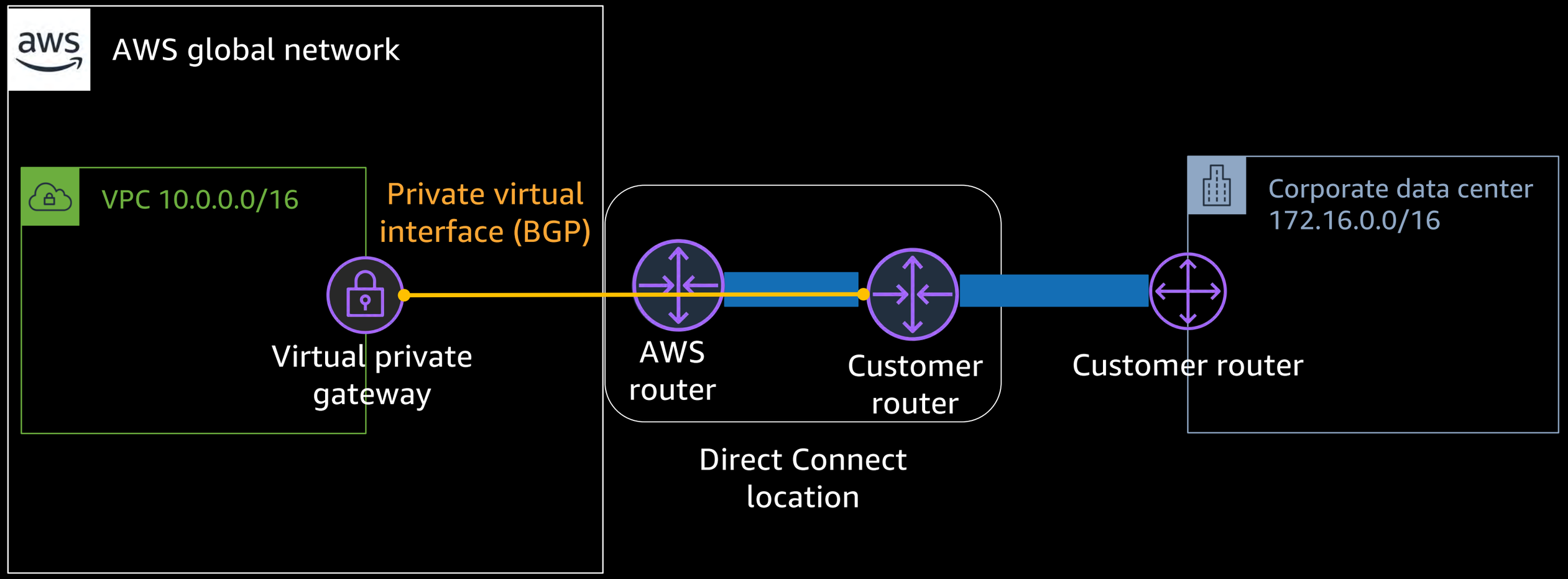


AWS Direct Connect – Interface types

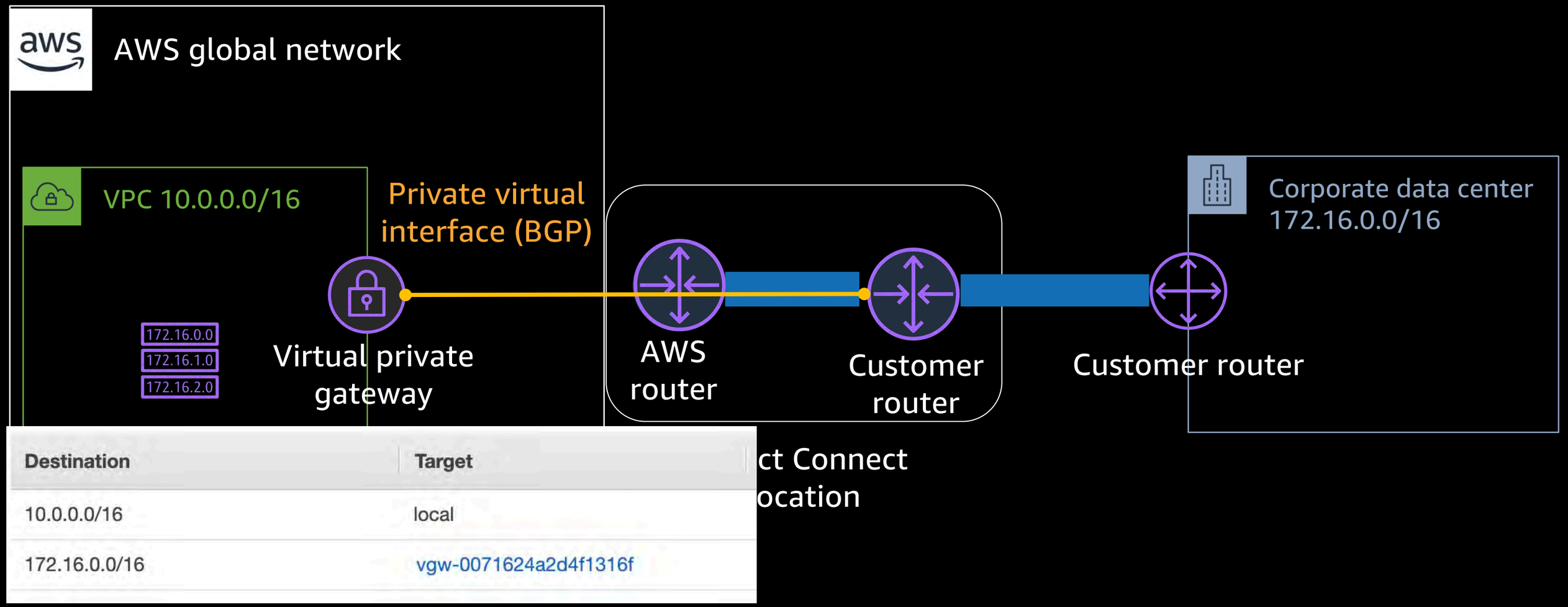
- **Private VIF** – Used to connect to Amazon VPCs using private IP addresses; directly or via Direct Connect gateway
- **Transit VIF** – Used to connect to transit gateways via Direct Connect gateway
- **Public VIF** – Used to access all AWS public services using public IP addresses

All virtual interfaces are 802.1Q VLANs with BGP peering

AWS Direct Connect – Private VIF

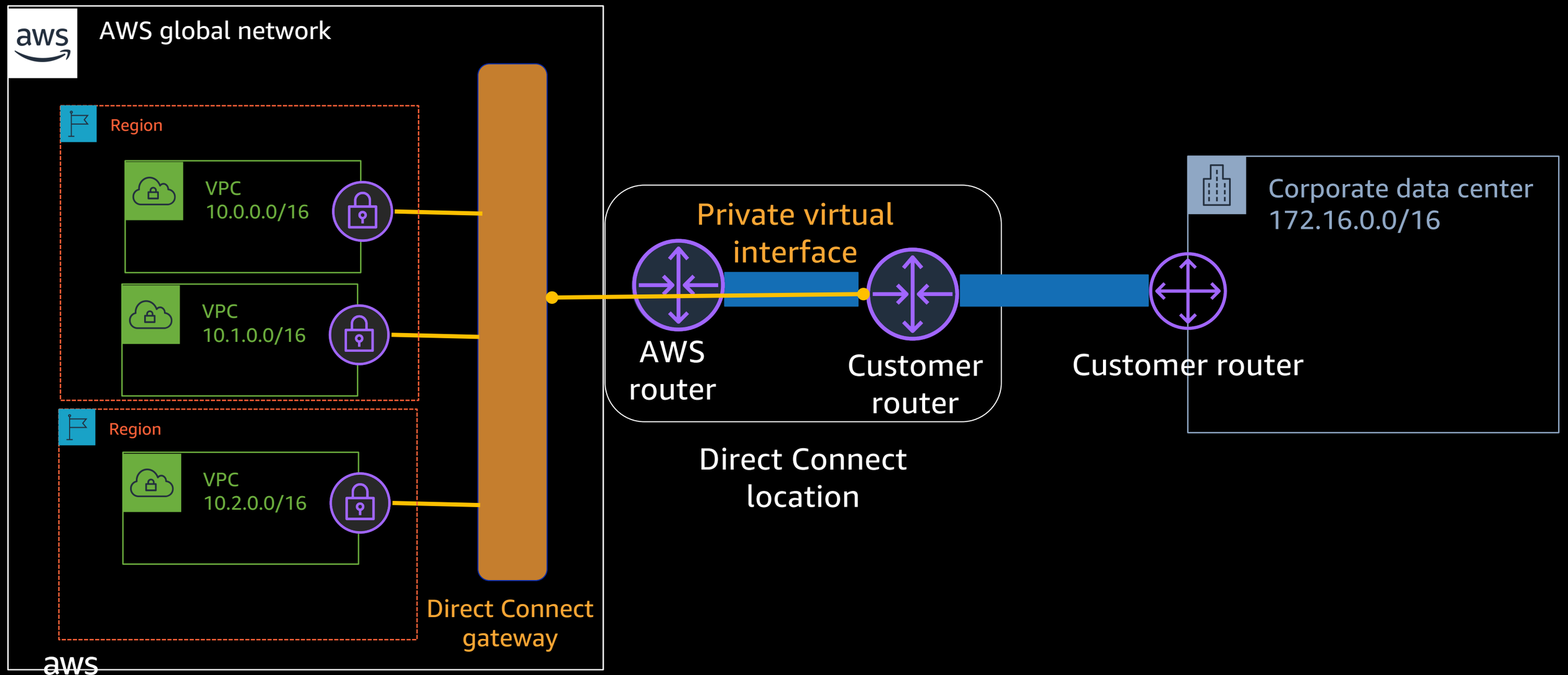


AWS Direct Connect – Private VIF

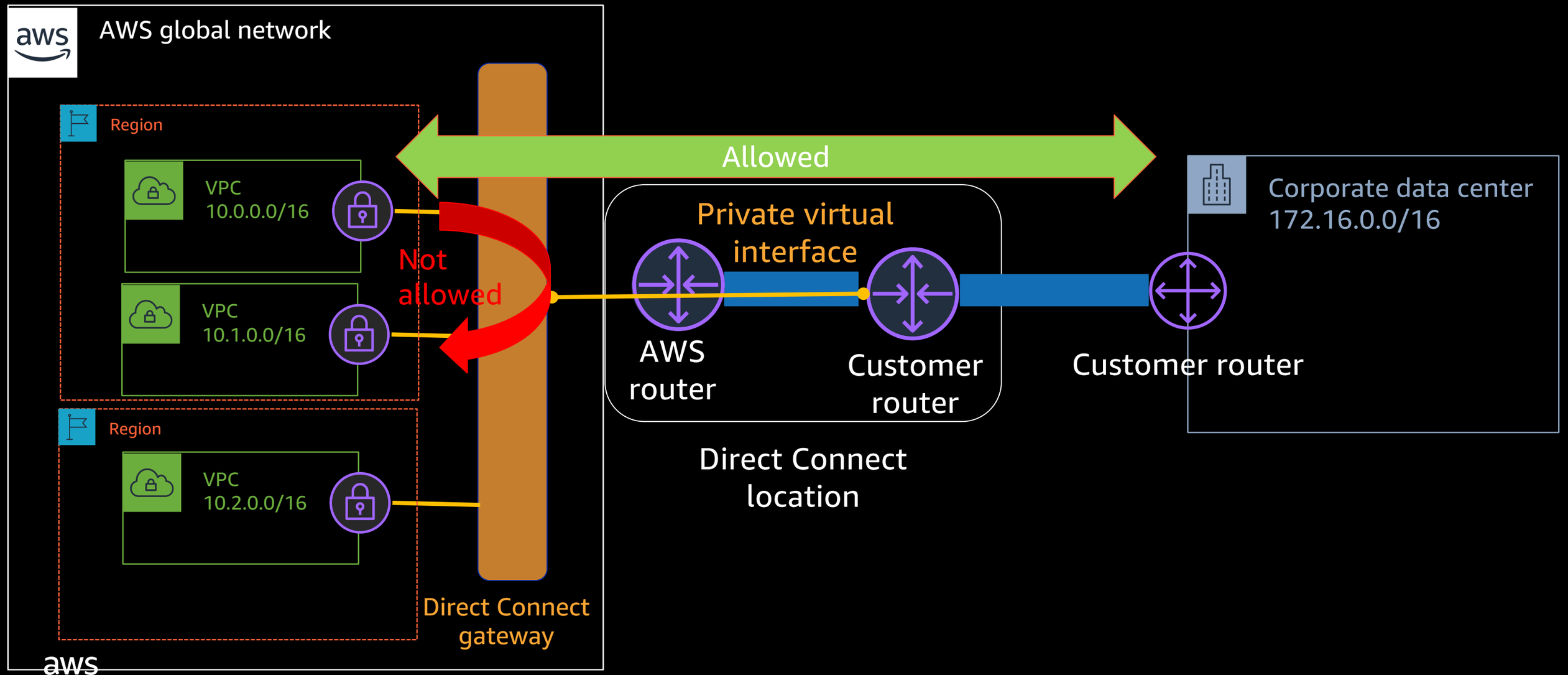


Destination	Target
10.0.0.0/16	local
172.16.0.0/16	vgw-0071624a2d4f1316f

AWS Direct Connect gateway – Private VIF

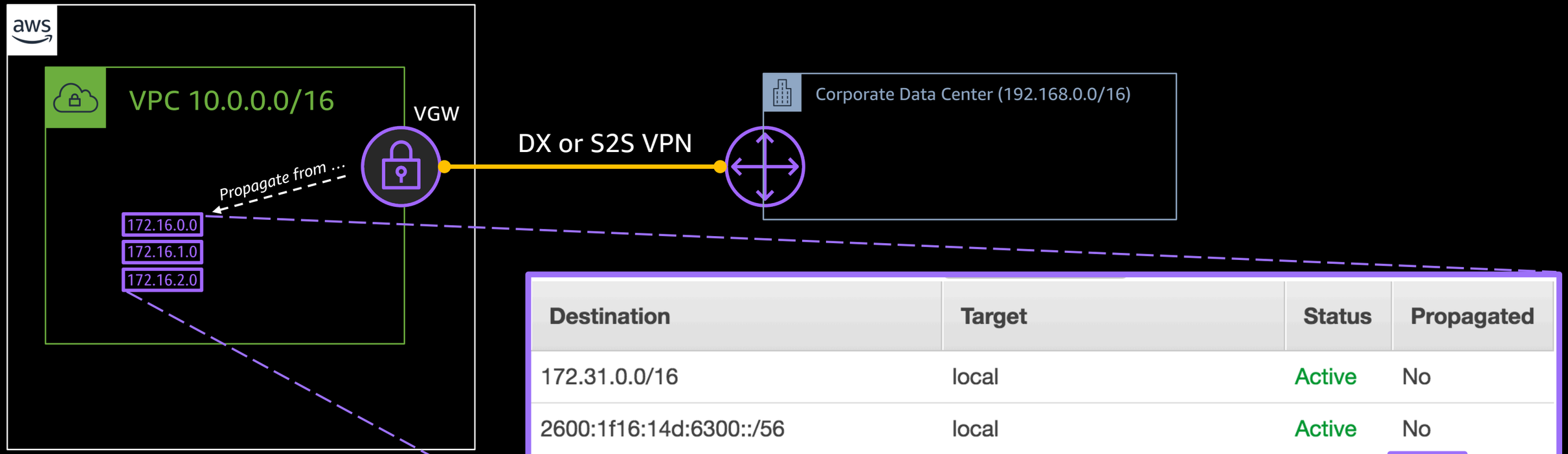


AWS Direct Connect Gateway – Traffic flow



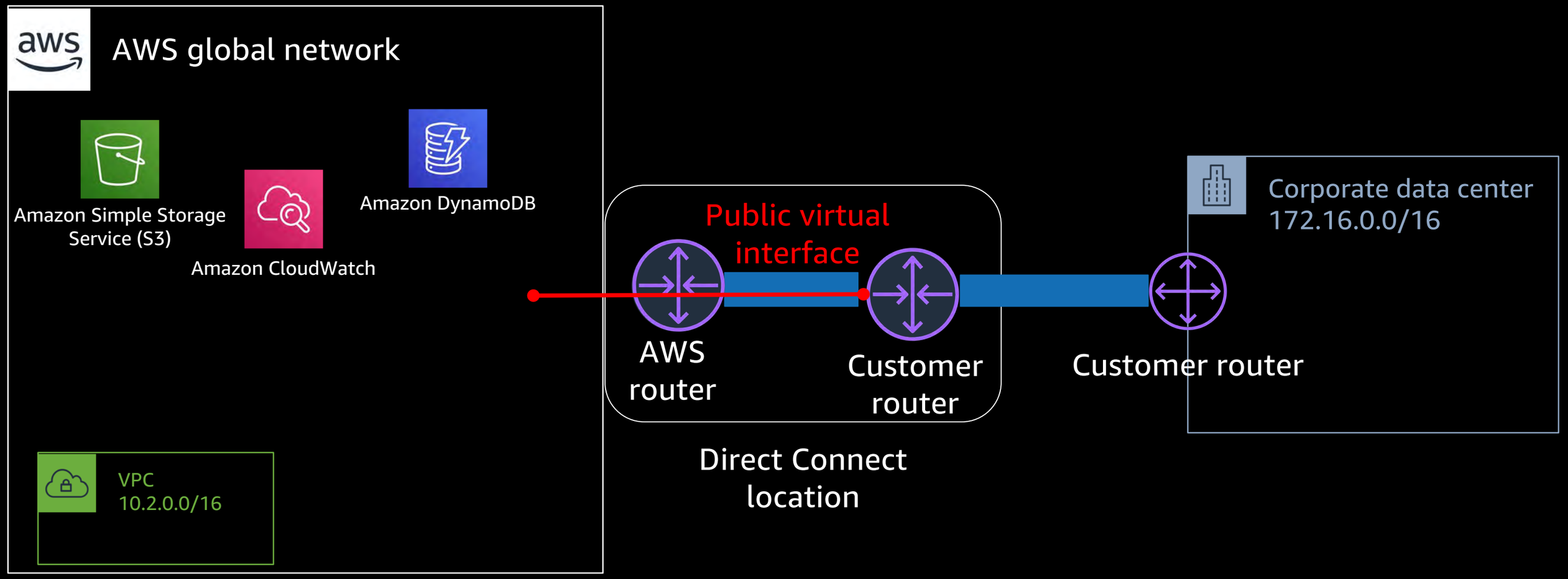
Route propagation

- Enable propagation on the Route Table
- Automatically populates with anything the VGW learns via BGP

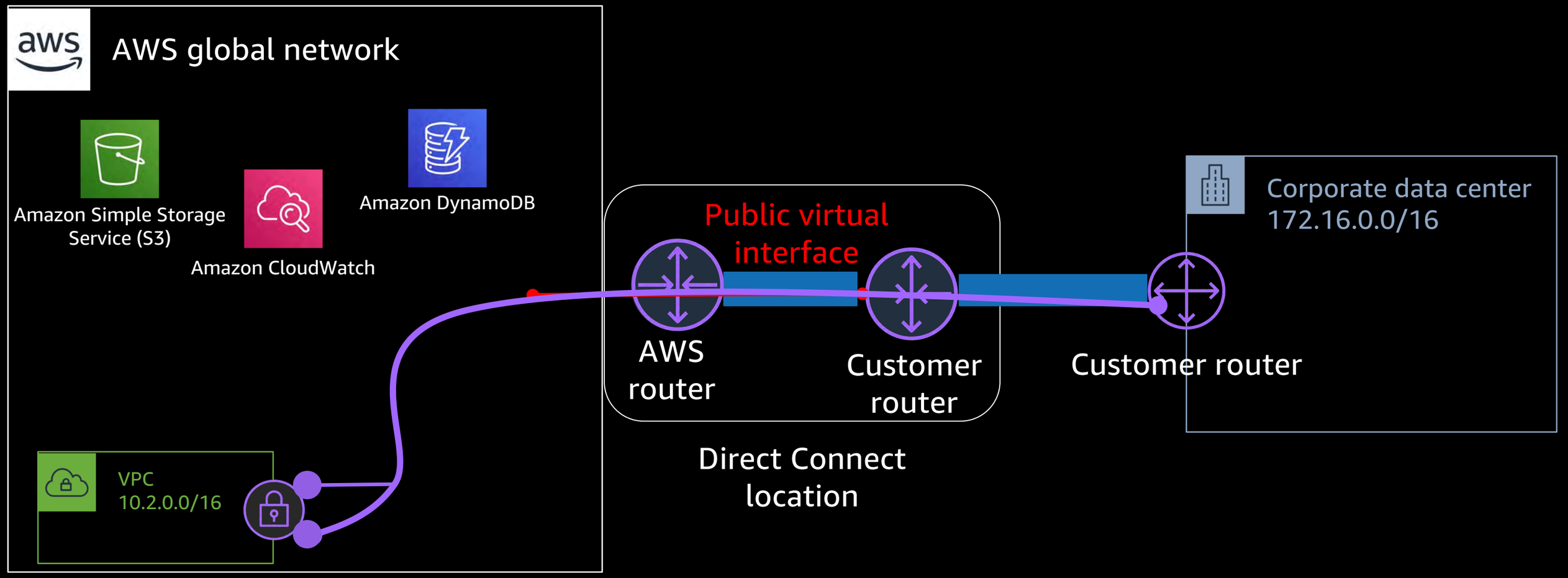


Destination	Target	Status	Propagated
172.31.0.0/16	local	Active	No
2600:1f16:14d:6300::/56	local	Active	No
192.168.0.0/16	vgw-09ff4714b32814f5e	Active	Yes

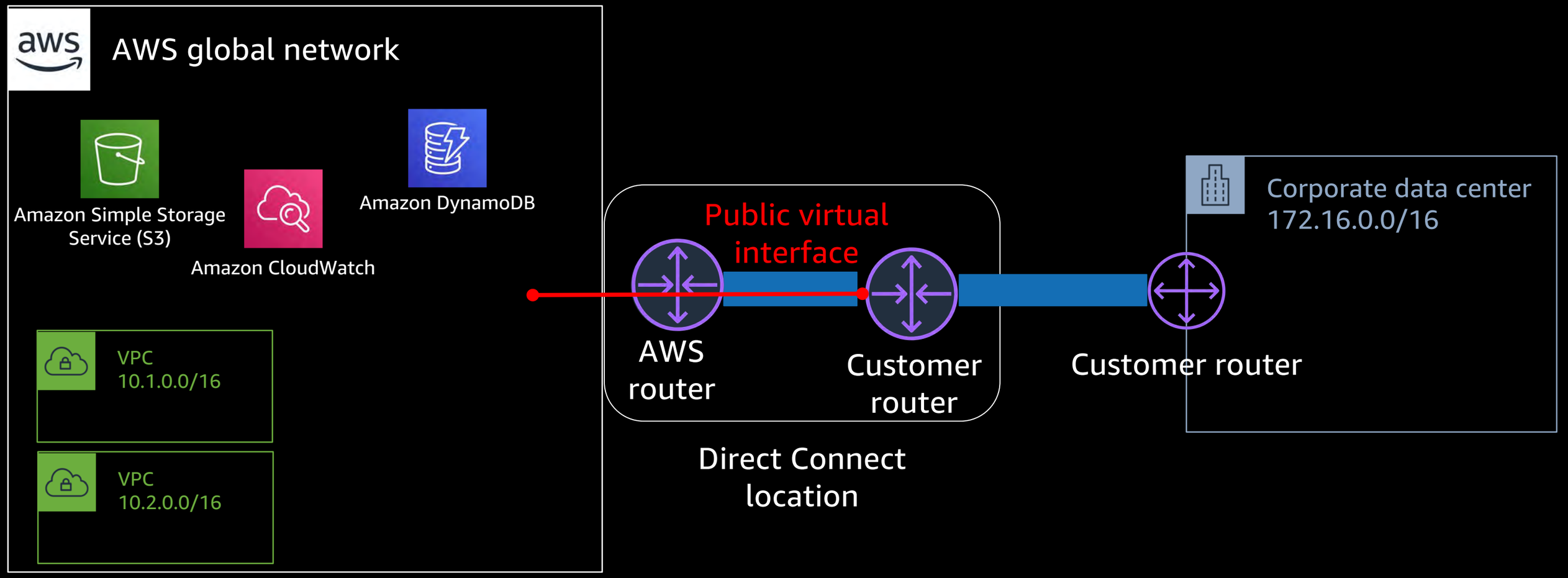
AWS Direct Connect – Public VIF



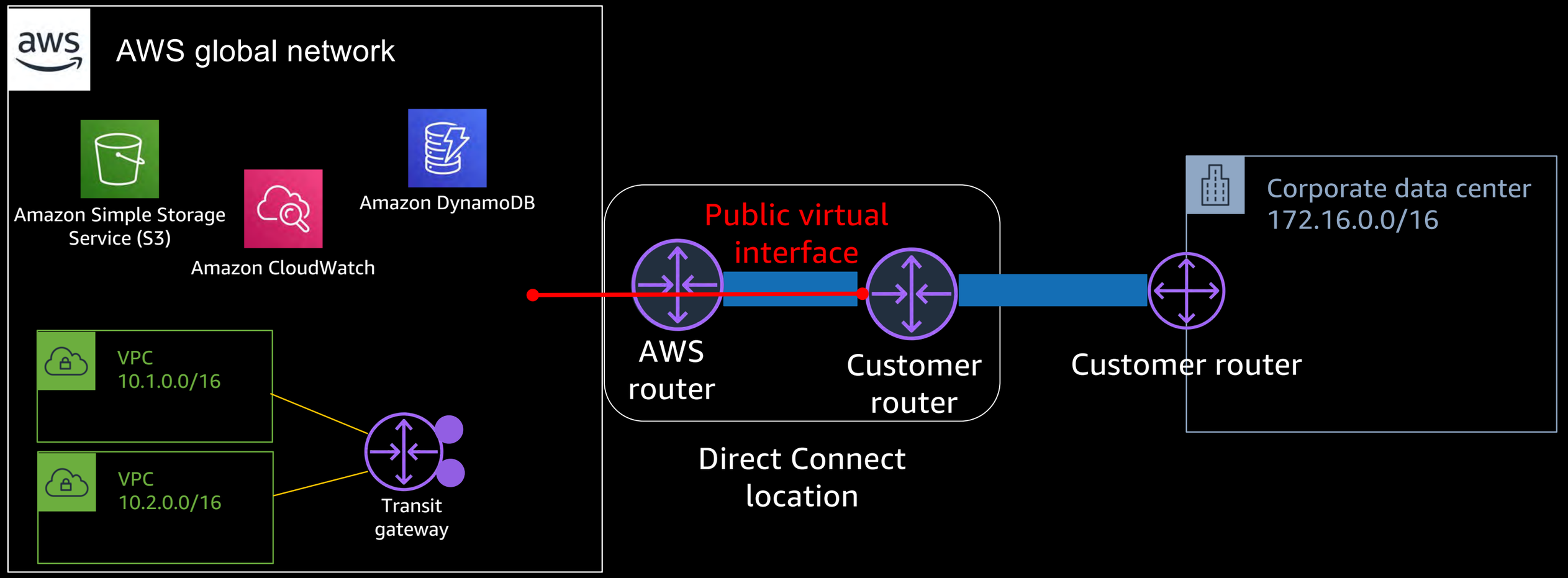
AWS Direct Connect – Public VIF + AWS VPN



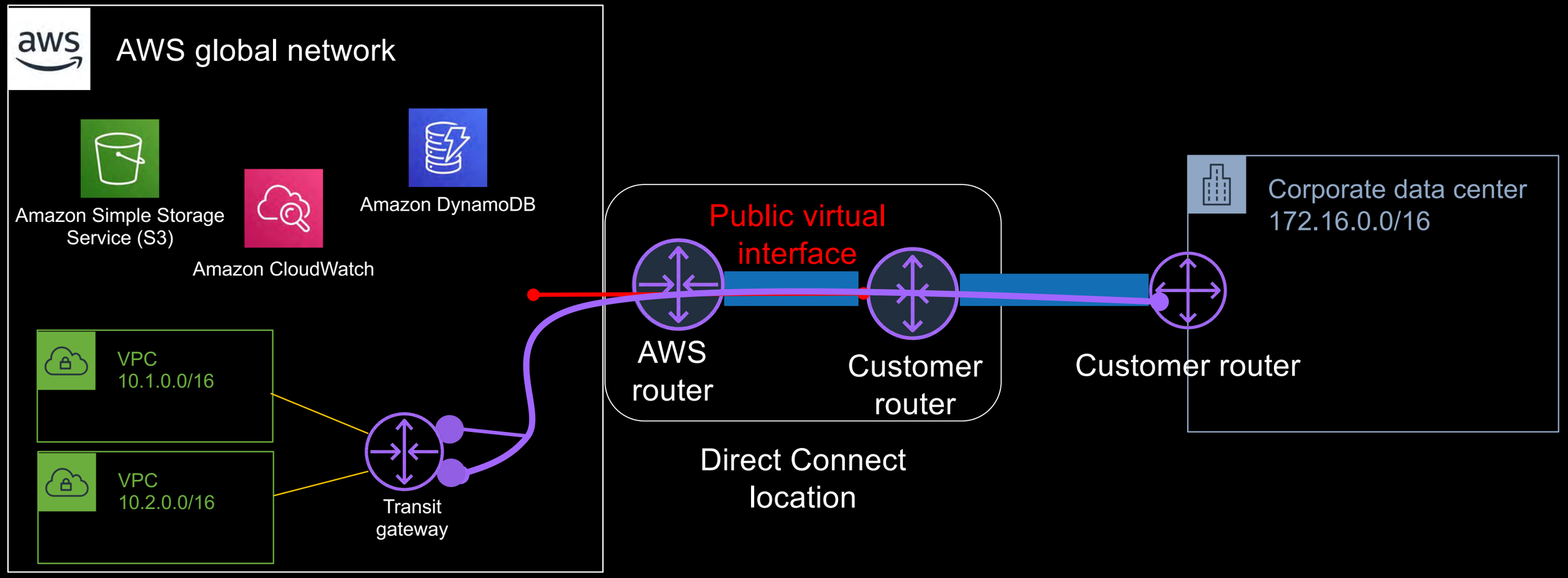
AWS Direct Connect – Public VIF + AWS VPN



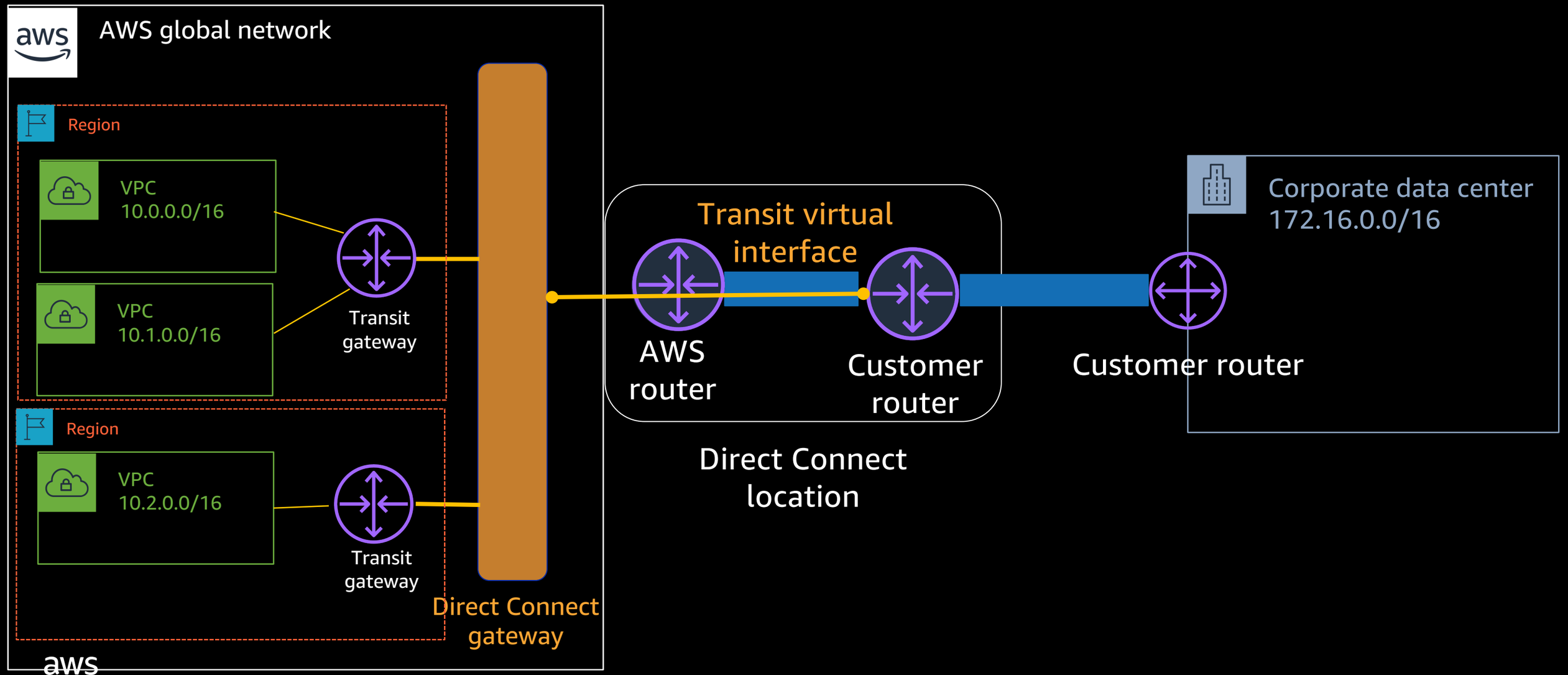
AWS Direct Connect – Public VIF + AWS VPN



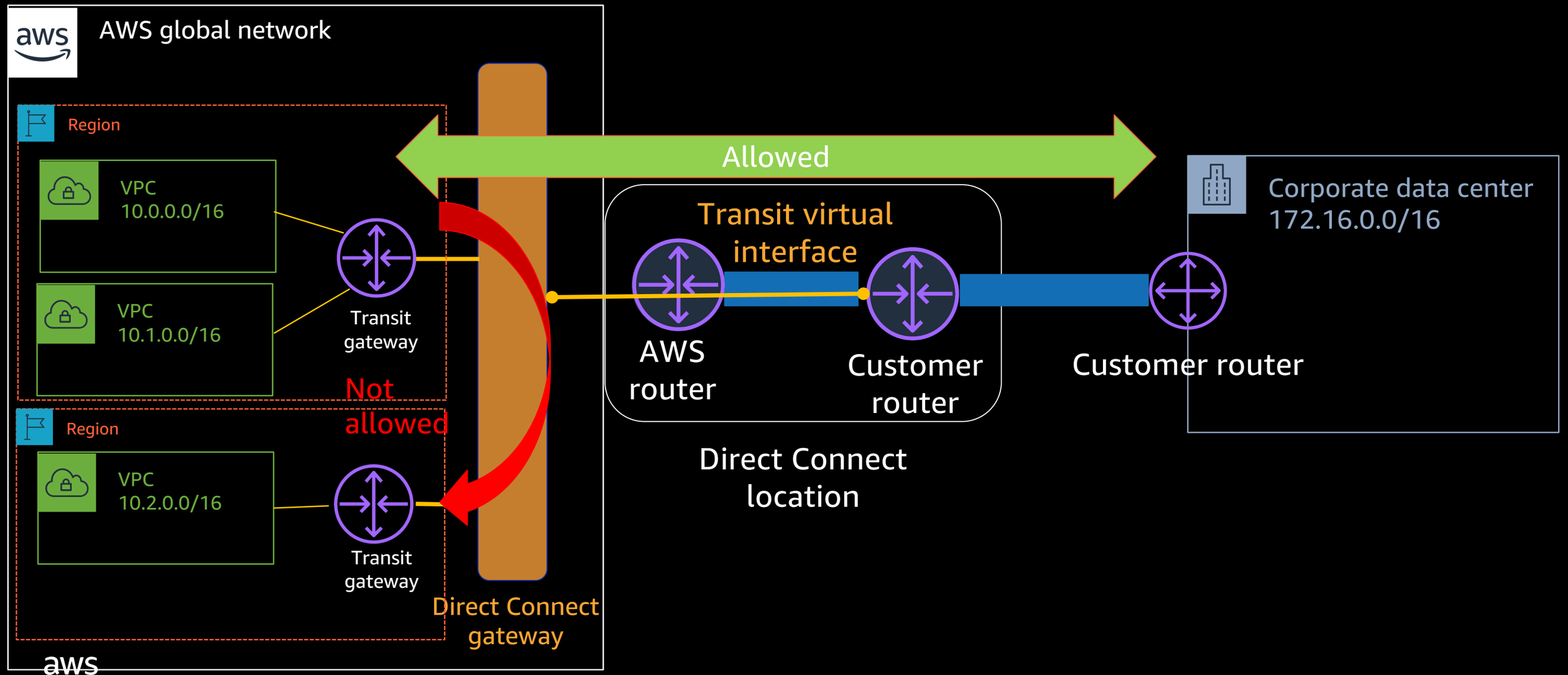
AWS Direct Connect – Public VIF + AWS VPN



AWS Direct Connect Gateway – Transit VIF

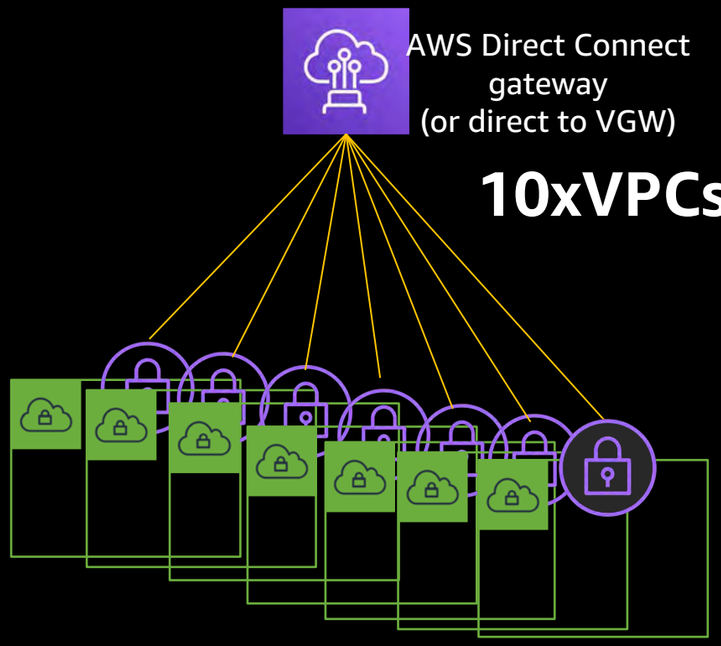


AWS Direct Connect Gateway – Traffic flow

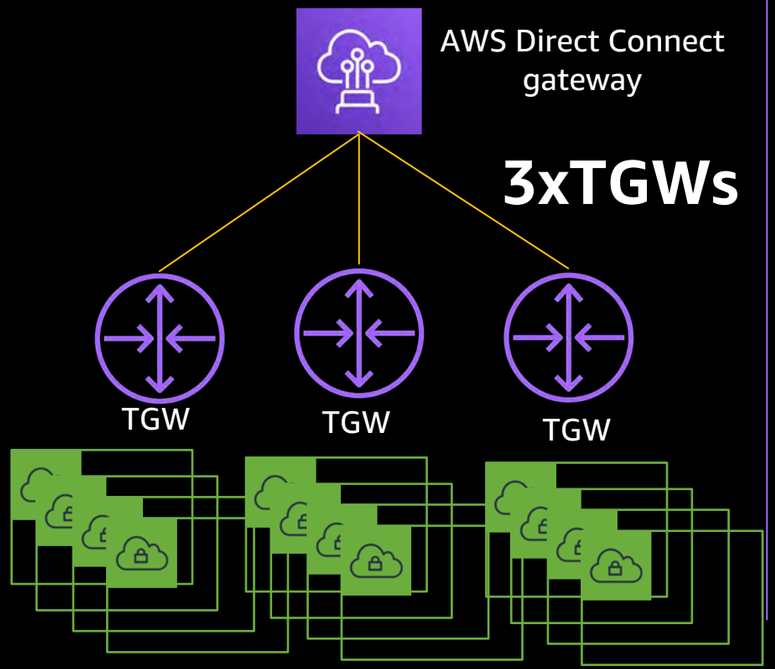


AWS Direct Connect – Interface types

Private VIF



Transit VIF

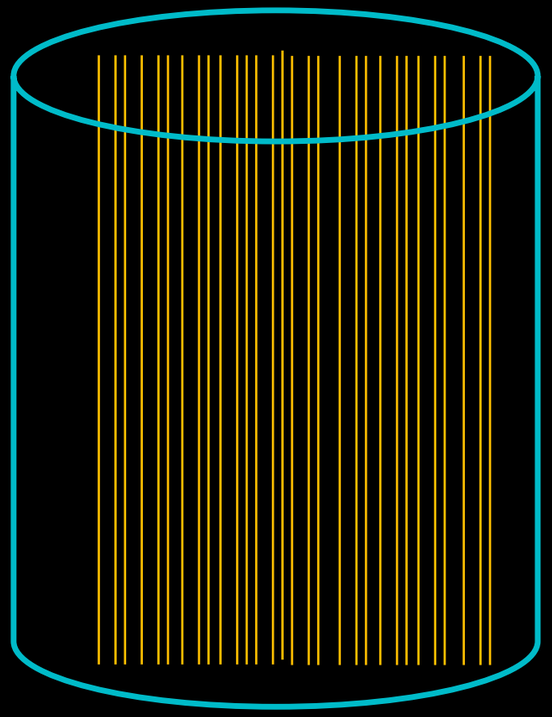


Public VIF

Direct Connect gateway allows for connecting to resources in any AWS Region (except for China)

Direct Connect connection types

1 Gbps or 10 Gbps

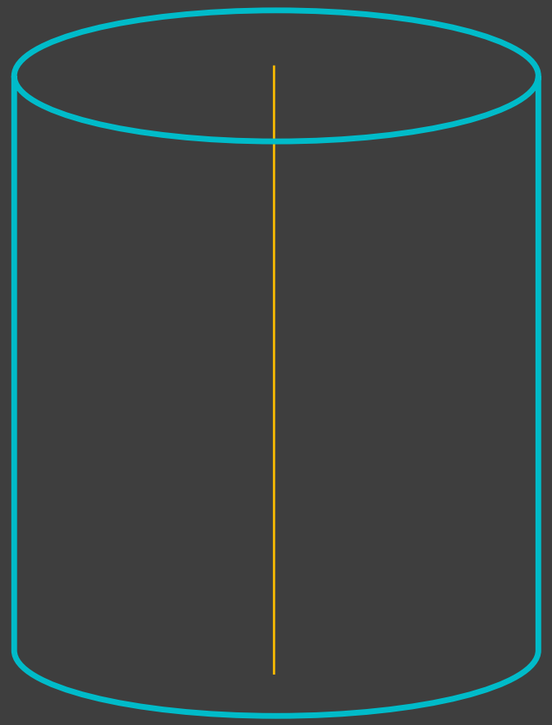


50 VIFs

AND 1 transit VIF

Dedicated connection

50 Mbps -> 10 Gbps



1 VIF **OR**

1 transit VIF (1Gbps + only)

Hosted connection

50 Mbps -> 10 Gbps
(can be oversubscribed)

1 VIF

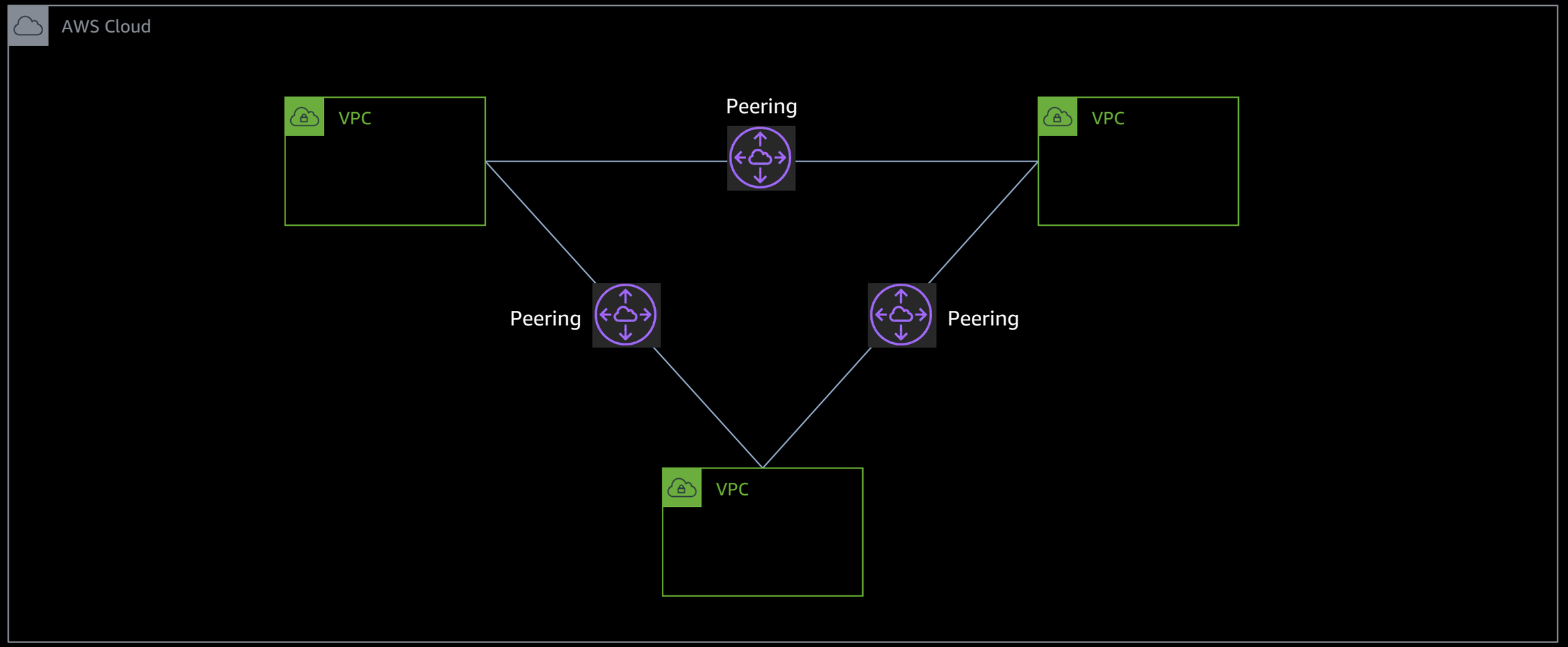
no transit VIF

(Partner) Hosted virtual interface

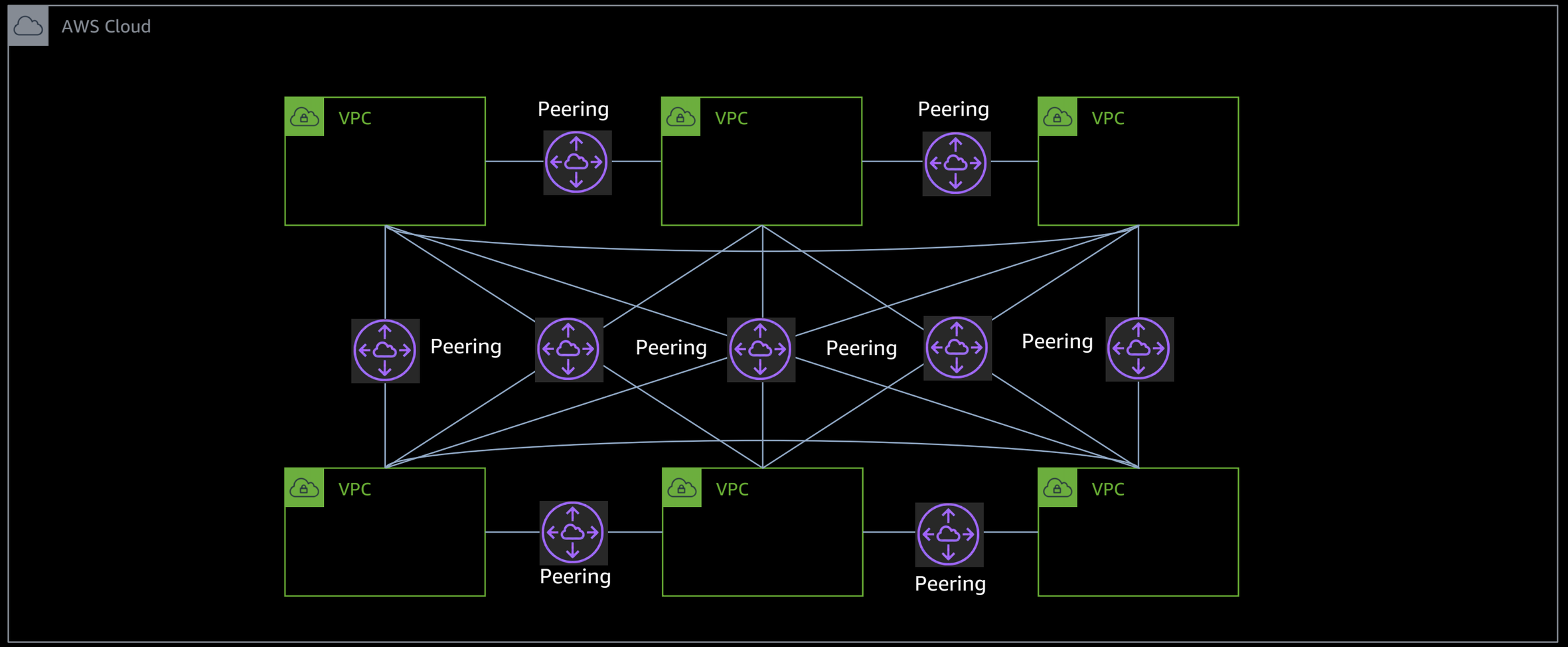
ONLY FROM PARTNERS

AWS Transit Gateway

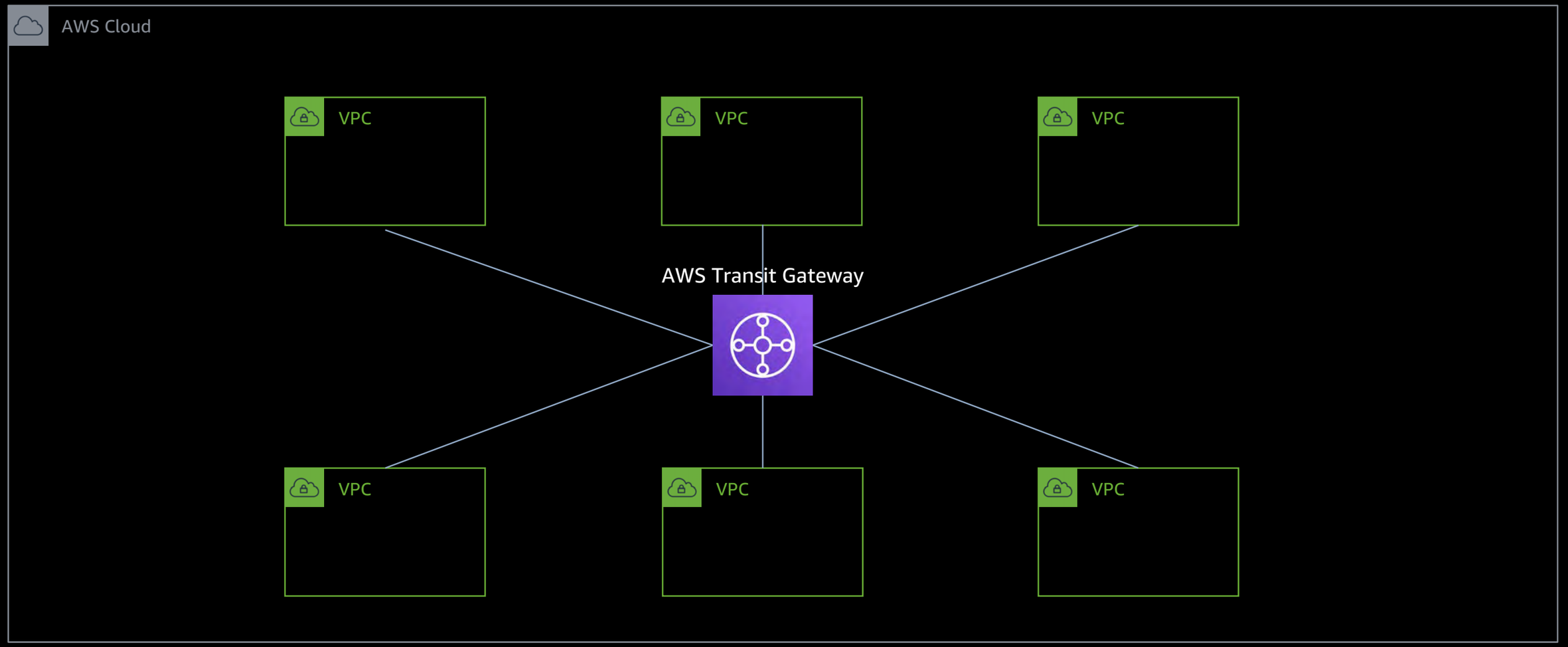
Interconnecting VPCs at scale – VPC peering



Interconnecting VPCs at scale – VPC peering



Multiple VPCs access models – AWS Transit Gateway



Attachment

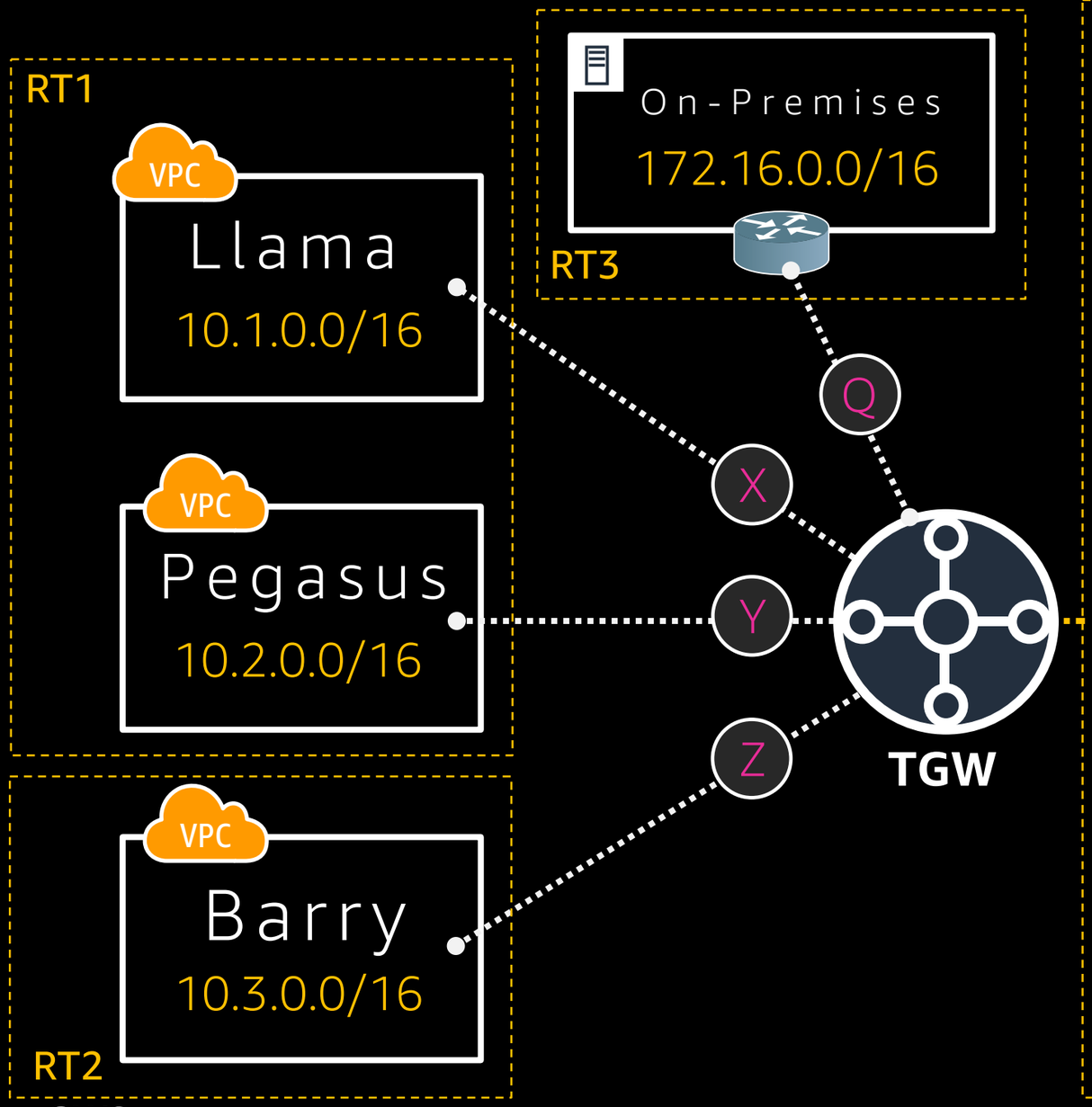
The connection from an Amazon VPC, VPN, and DX GW to a Transit Gateway

Association

The route table used to route packets coming from an attachment

Propagation

The route table where the attachment's routes are installed



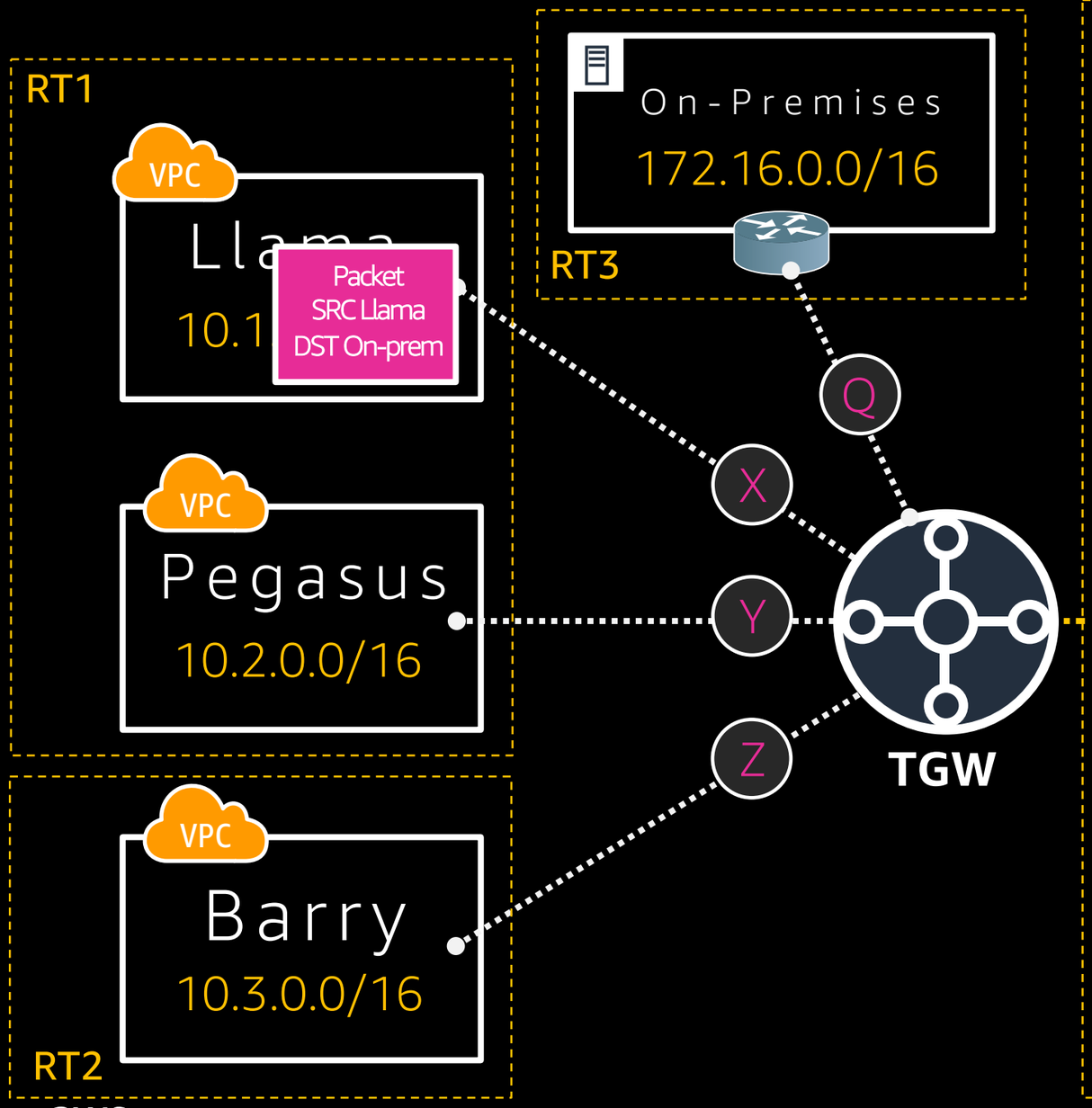
TGW Route Table(s)

	Associations	Propagations	Routes
RT1	Llama from X Pegasus from Y	Llama from X Pegasus from Y On-prem from Q	10.1.0.0/16 via X 10.2.0.0/16 via Y 172.16.0.0/16 via Q

	Associations	Propagations	Routes
RT2	Barry from Z	Barry from Z On-prem from Q	10.3.0.0/16 via Z 172.16.0.0/16 via Q

	Associations	Propagations	Routes
RT3	On-prem from Q	On-prem from Q Llama from X Pegasus from Y Barry from Z	172.16.0.0/16 via Q 10.1.0.0/16 via X 10.2.0.0/16 via Y 10.3.0.0/16 via Z

aws



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	Associations	Propagations	Routes
RT2	Barry from Z	Barry from Z On-prem from Q	10.3.0.0/16 via X 172.16.0.0/16 via Q

	Associations	Propagations	Routes
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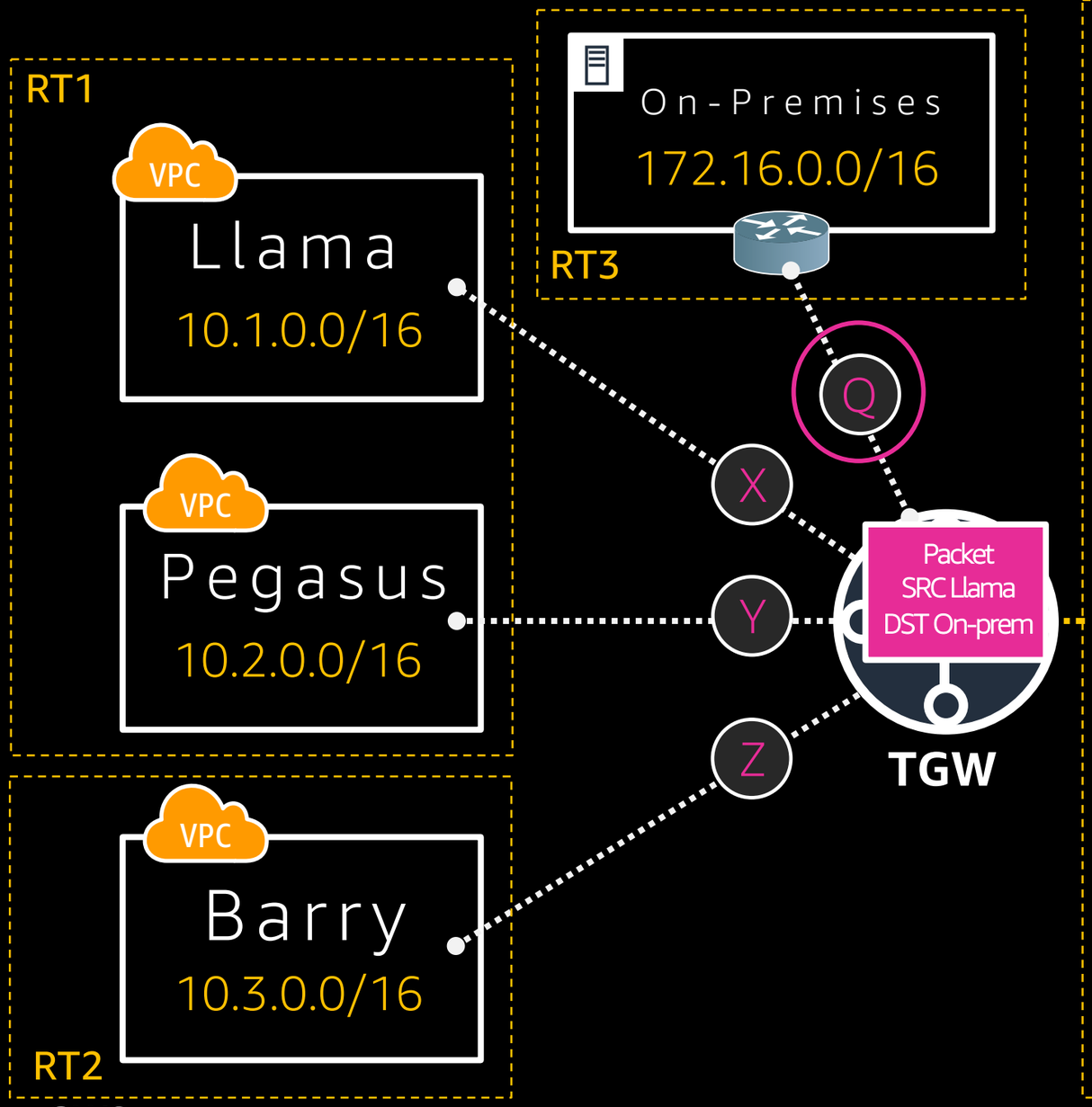
aws



TGW Route Table(s)

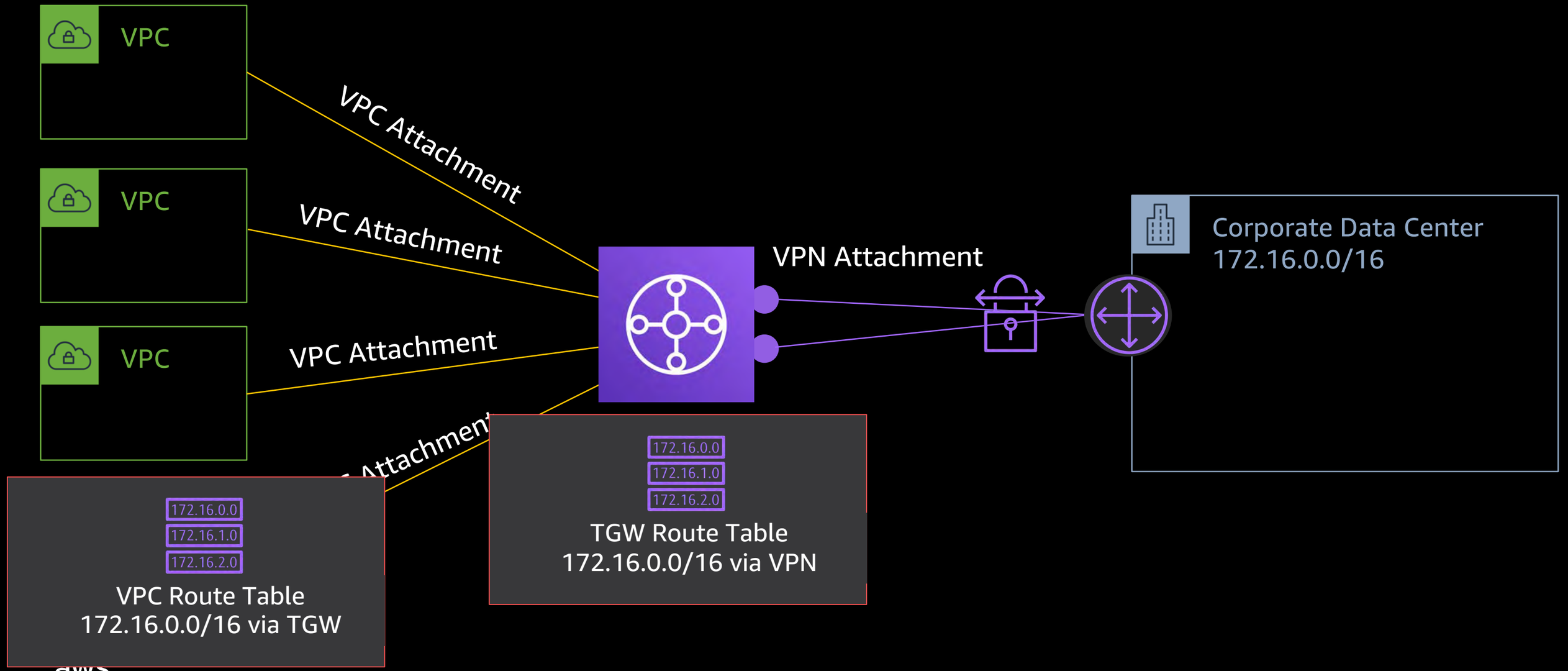
	Associations	Propagations	Routes
RT1	Llama from X	Llama from X	10.1.0.0/16 via X
	Pegasus from Y	Pegasus from Y	10.2.0.0/16 via Y
		On-prem from Q	172.16.0.0/16 via Q

	Associations	Propagations	Routes
RT2	Barry from Z	Barry from Z	10.3.0.0/16 via X
		On-prem from Q	172.16.0.0/16 via Q

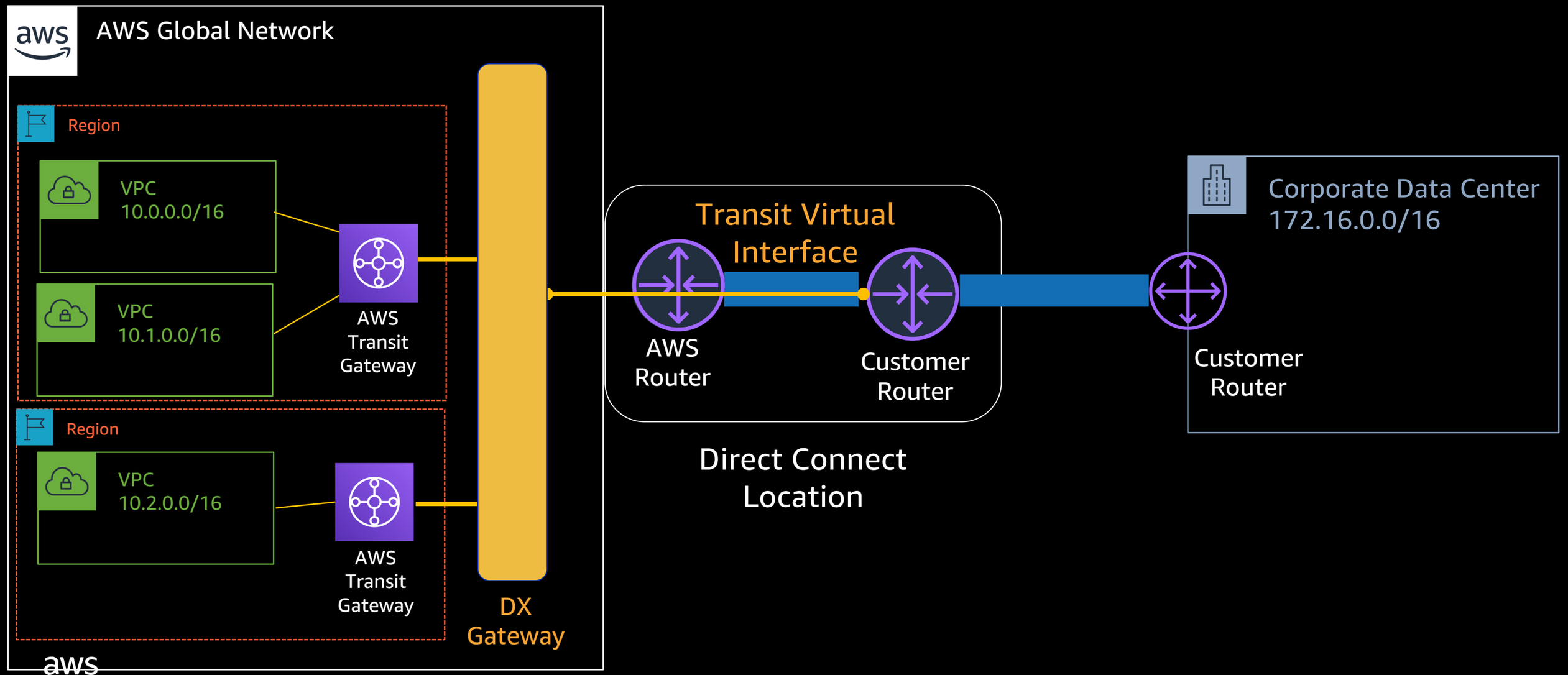
	Associations	Propagations	Routes
RT3	On-prem from Q	On-prem from Q	172.16.0.0/16 via Q
		Llama from X	10.1.0.0/16 via X
		Pegasus from Y	10.2.0.0/16 via Y
		Barry from Z	10.3.0.0/16 via Z

aws

AWS Transit Gateway with AWS site-to-site VPN



AWS Transit Gateway with DX gateway



Transit Gateways per account/Transit Gateway attachments per Amazon VPC

5

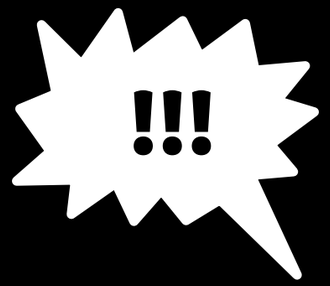
Maximum burstable bandwidth per attachment

50 Gbps

Maximum bandwidth
per VPN connection

* 1.25 Gbps

*With ECMP, you can distribute traffic over multiple tunnels,
e.g., 8 tunnels = 10 Gbps



Routes per AWS Transit Gateway

10,000

Number of AWS Transit Gateway attachments per Region per account

5,000

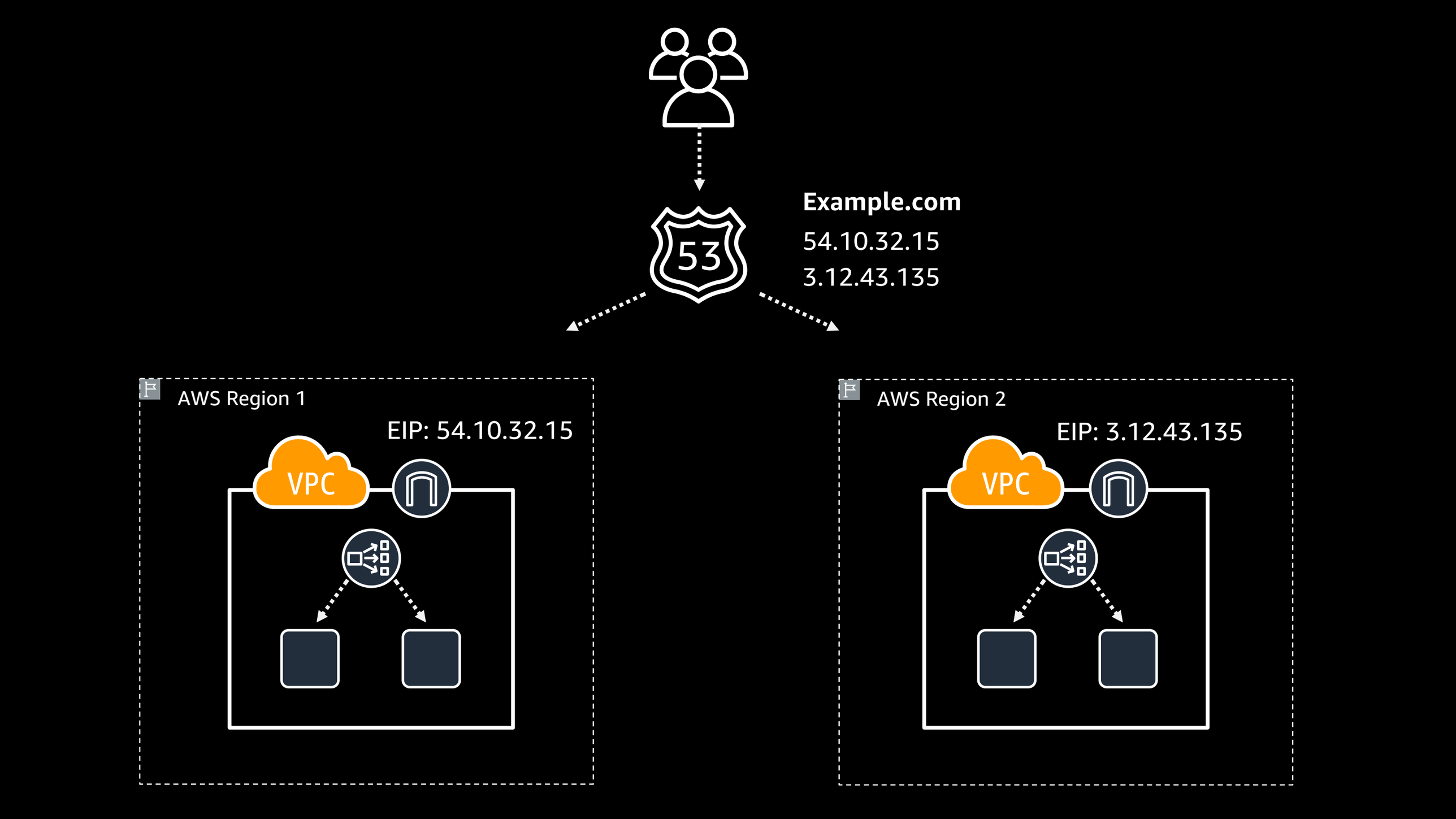
Cross-Region connectivity?

AWS Transit Gateway allows for cross Region peering

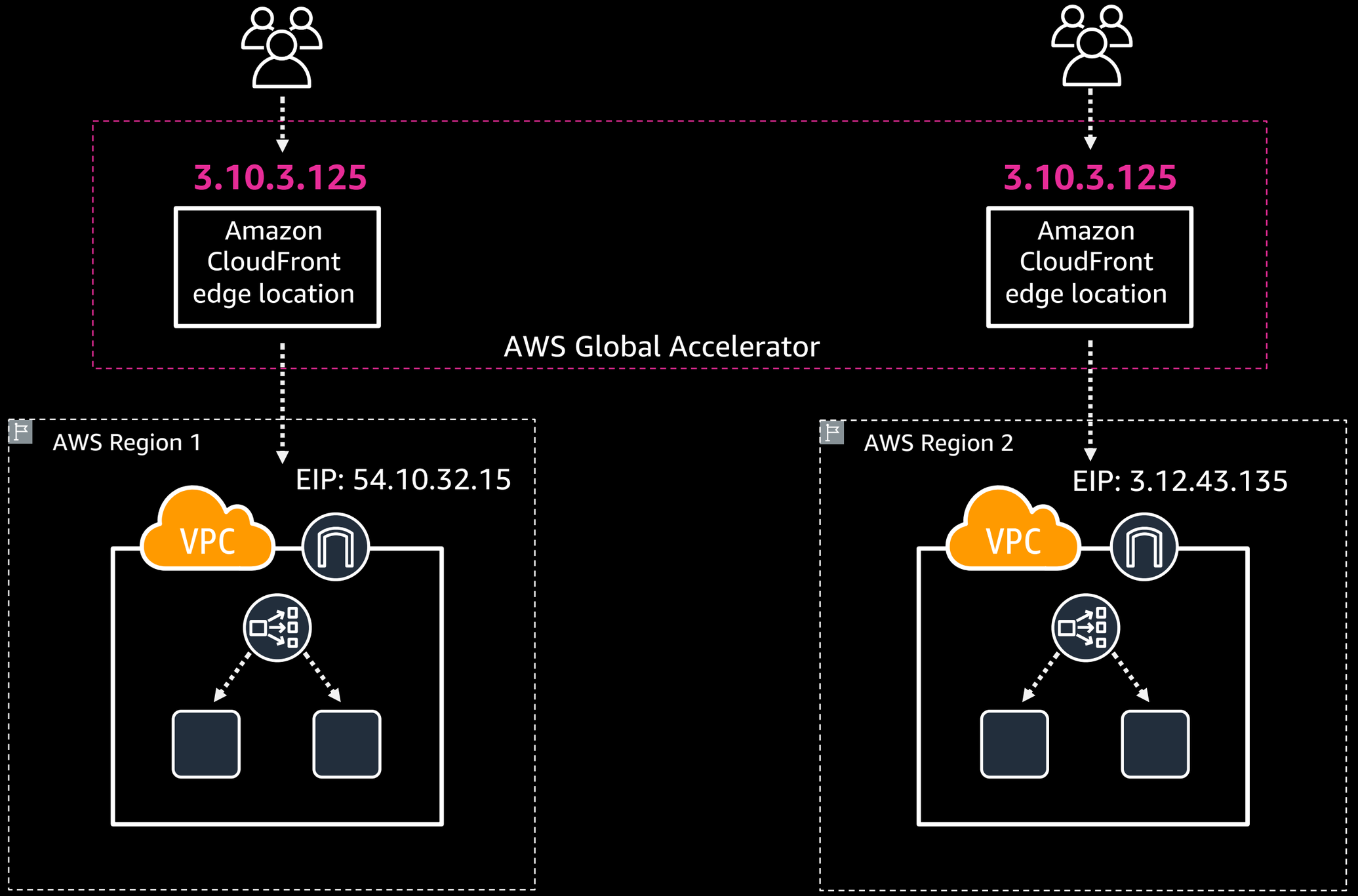
. . .and there’s more

AWS Global Accelerator

Before


Example.com
54.10.32.15
3.12.43.135
AWS Region 1
EIP: 54.10.32.15
VPC
AWS Region 2
EIP: 3.12.43.135
VPC

After


3.10.3.125
Amazon CloudFront edge location
3.10.3.125
Amazon CloudFront edge location
AWS Global Accelerator
AWS Region 1
EIP: 54.10.32.15
VPC
AWS Region 2
EIP: 3.12.43.135
VPC

AWS global network

Traffic routed through AWS Global Accelerator traverses AWS global network (instead of the public internet)

Client state

Applications can keep state, with connections routed to the same endpoint, after initial connection

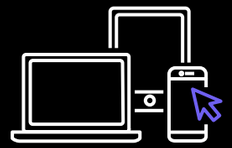
Static anycast IPs

AWS Global Accelerator uses static IP addresses as a fixed entry point to your applications, which are anycast from AWS edge locations

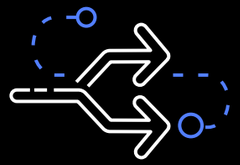
NEW! AVAILABLE TODAY

AWS Accelerated Site-to-Site VPN

High availability and improved performance of Site-to-Site VPN



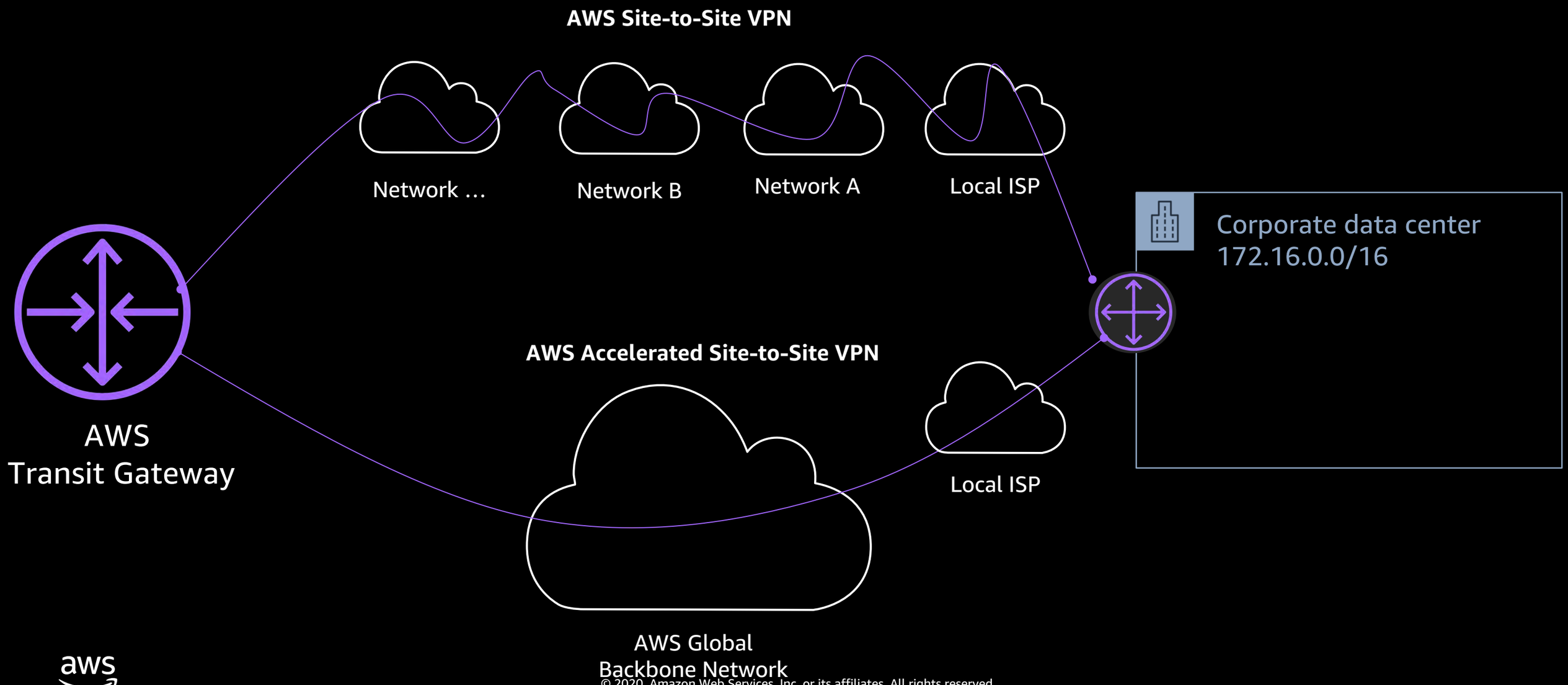
Securely connect multiple sites



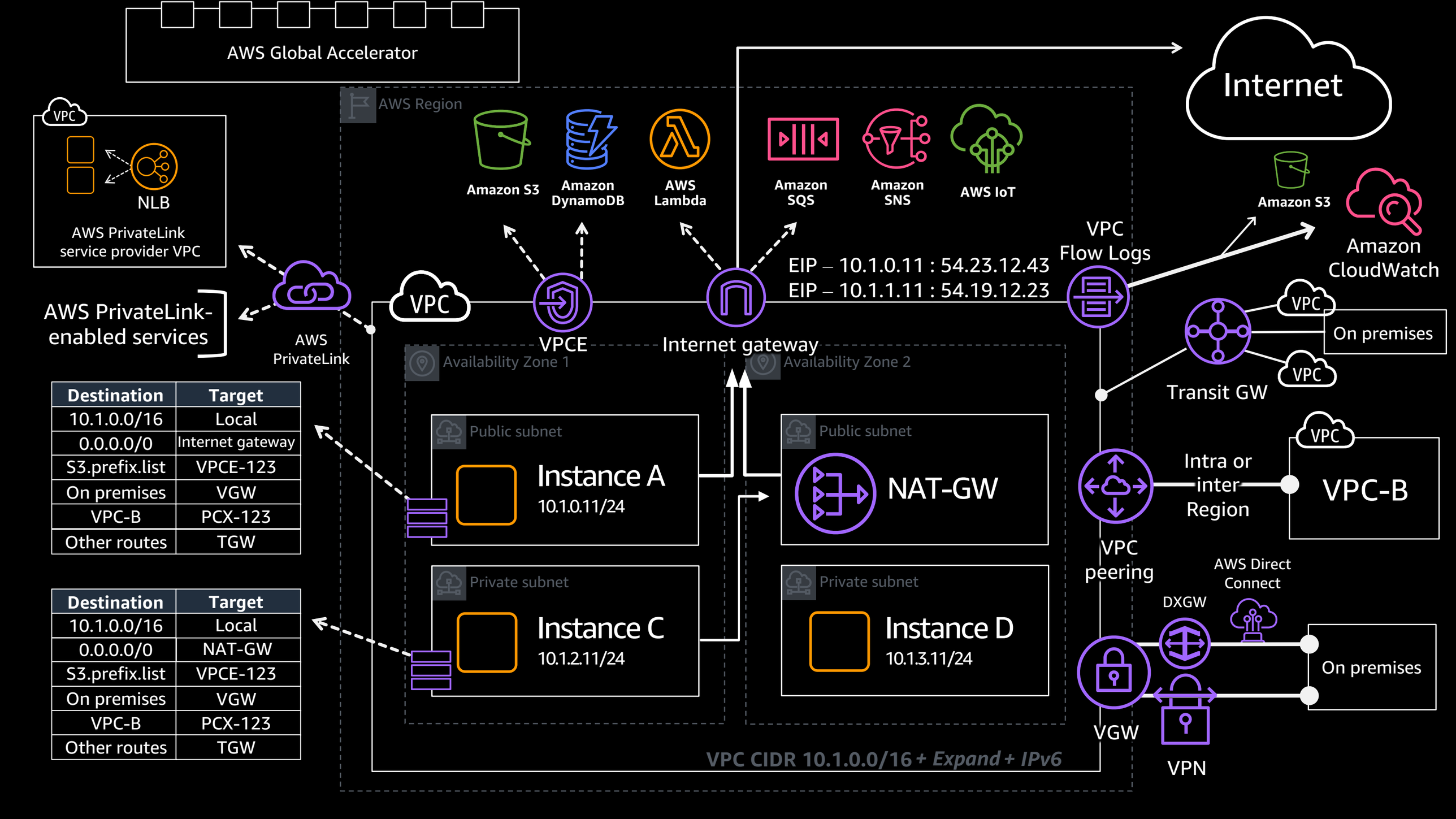
Improve performance of your VPN connections

Highly available

AWS Accelerated Site-to-Site VPN



Let’s bring it all back together…


AWS Global Accelerator
Internet
AWS Region
VPC
NLB
AWS PrivateLink service provider VPC
Amazon S3
Amazon DynamoDB
AWS Lambda
Amazon SQS
Amazon SNS
AWS IoT
Amazon S3
Amazon CloudWatch
VPC Flow Logs
EIP – 10.1.0.11 : 54.23.12.43
EIP – 10.1.1.11 : 54.19.12.23
AWS PrivateLink-enabled services
AWS PrivateLink
VPC
VPCE
Internet gateway
Availability Zone 1
Availability Zone 2
Public subnet
Instance A
10.1.0.11/24
Public subnet
NAT-GW
Private subnet
Instance C
10.1.2.11/24
Private subnet
Instance D
10.1.3.11/24
VPC CIDR 10.1.0.0/16 + Expand + IPv6
VPC
On premises
VPC
Transit GW
VPC
Intra or inter Region
VPC-B
VPC peering
AWS Direct Connect
DXGW
On premises
VGW
VPN
Destination
Target
10.1.0.0/16
Local
0.0.0.0/0
Internet gateway
S3.prefix.list
VPCE-123
On premises
VGW
VPC-B
PCX-123
Other routes
TGW
Destination
Target
10.1.0.0/16
Local
0.0.0.0/0
NAT-GW
S3.prefix.list
VPCE-123
On premises
VGW
VPC-B
PCX-123
Other routes
TGW

Thank you!

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