VPC Section

VPC – Crash Course

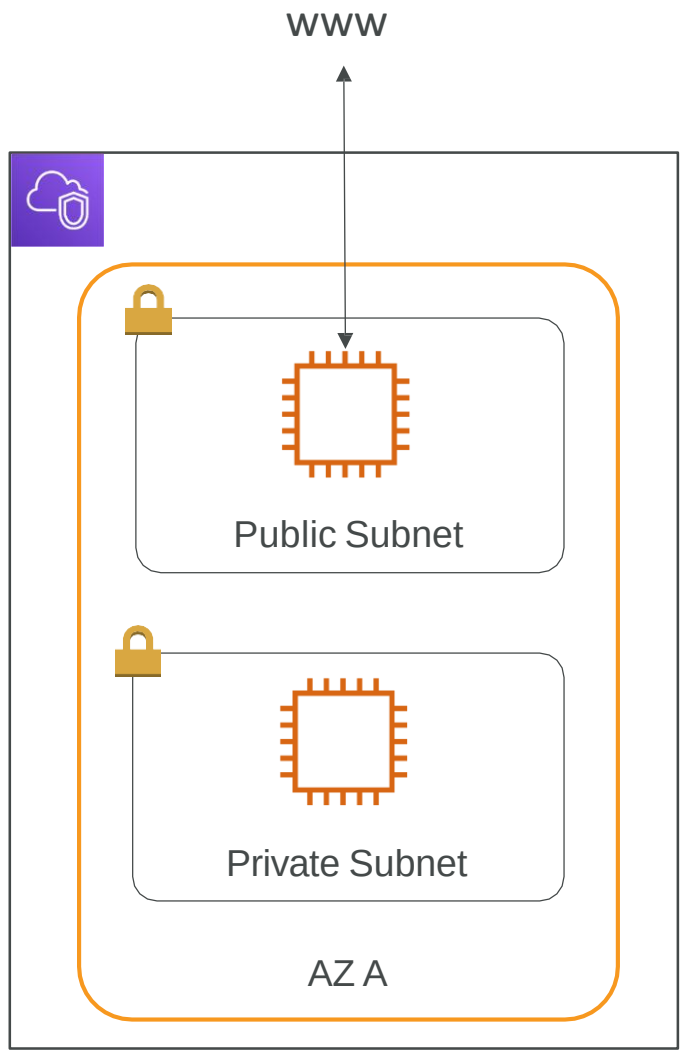
- VPC is something you should know in depth for the AWS Certified Solutions Architect Associate & AWS Certified SysOps Administrator

- At the AWS Certified Cloud Practitioner Level, you should know about:
  - VPC, Subnets, Internet Gateways & NAT Gateways
  - Security Groups, Network ACL (NACL), VPC Flow Logs
  - VPC Peering, VPC Endpoints
  - Site to Site VPN & Direct Connect
  - Transit Gateway

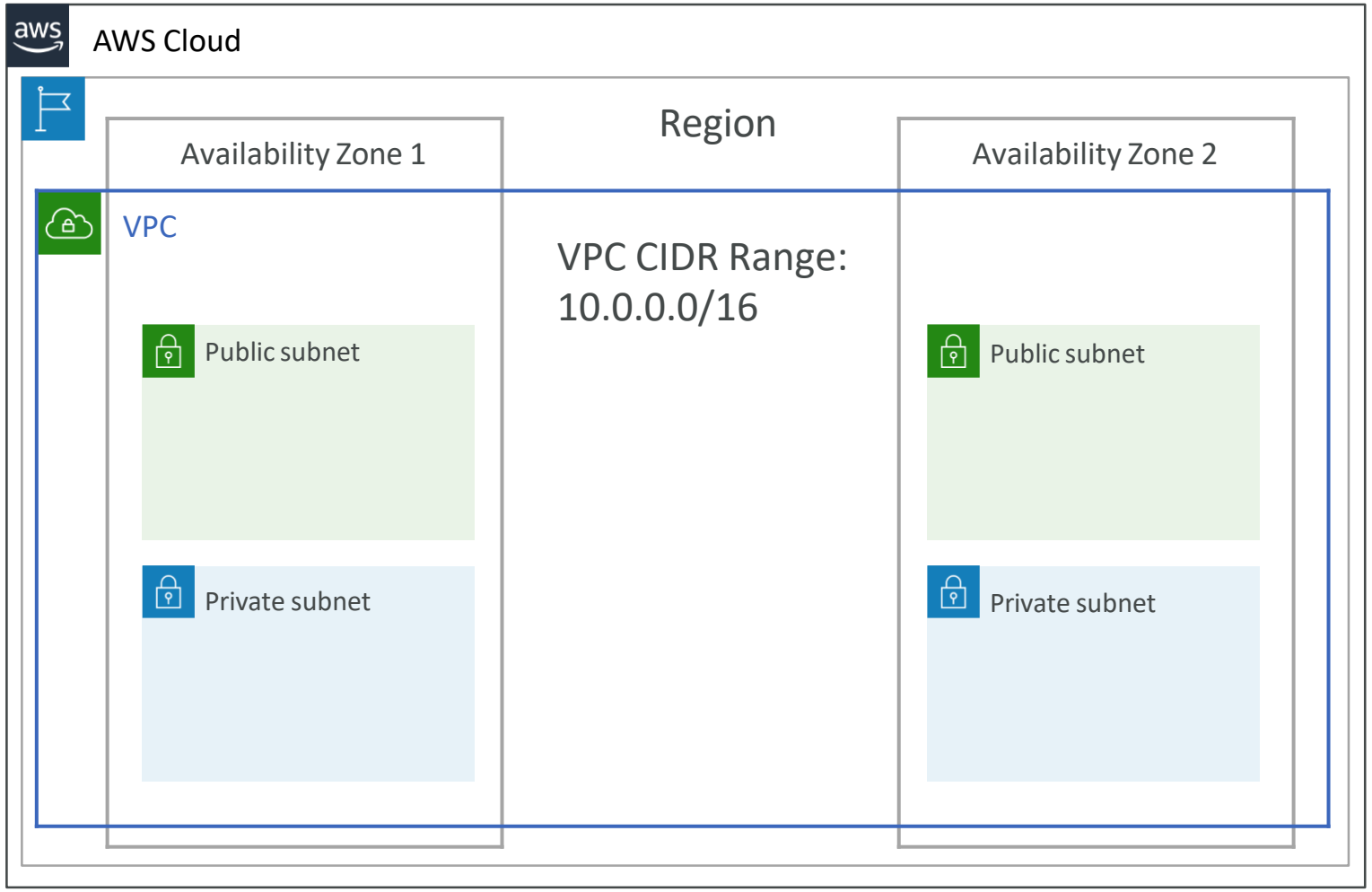
- I will just give you an overview, less than 1 or 2 questions at your exam.
- We'll have a look at the "default VPC" (created by default by AWS for you)
- There is a summary lecture at the end. It's okay if you don't understand it all

VPC & Subnets Primer

- VPC - Virtual Private Cloud: private network to deploy your resources (regional resource)
- Subnets allow you to partition your network inside your VPC (Availability Zone resource)
- A public subnet is a subnet that is accessible from the internet
- A private subnet is a subnet that is not accessible from the internet
- To define access to the internet and between subnets, we use Route Tables.



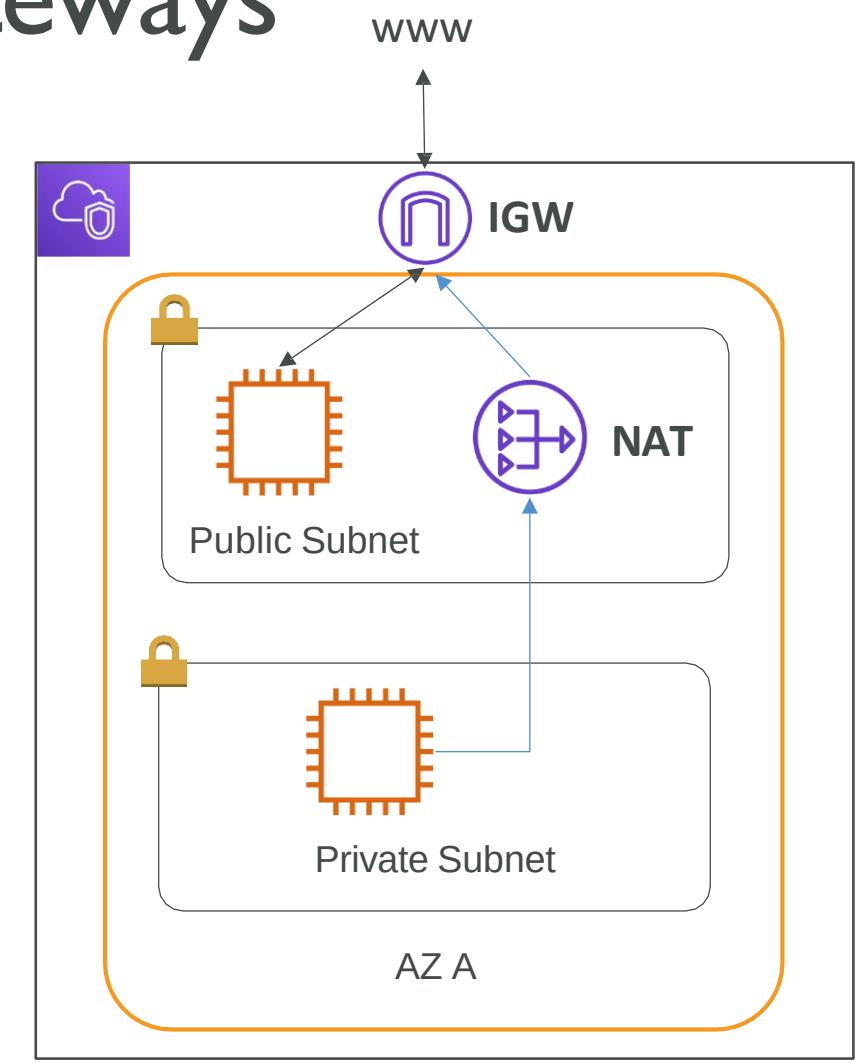
VPC Diagram


aws
AWS Cloud
Region
Availability Zone 1
Availability Zone 2
VPC
VPC CIDR Range:
10.0.0.0/16
Public subnet
Private subnet
Public subnet
Private subnet

Internet Gateway & NAT Gateways

- Internet Gateways helps our VPC instances connect with the internet
- Public Subnets have a route to the internet gateway.

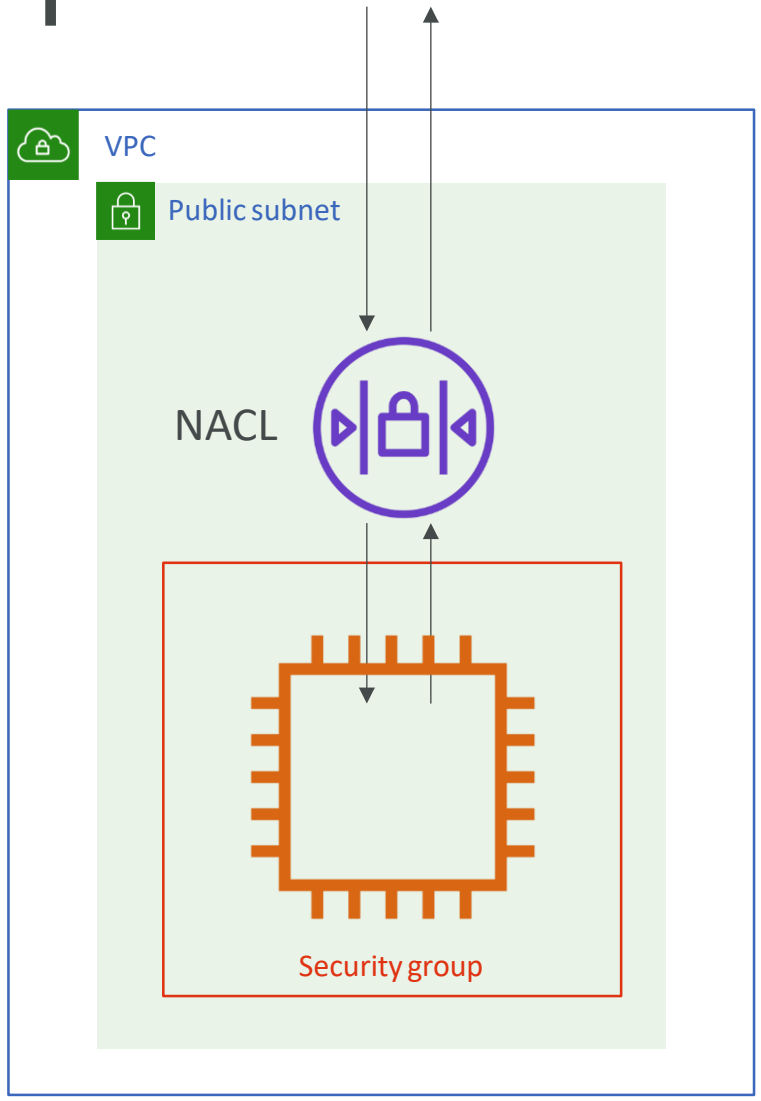
- NAT Gateways (AWS-managed) & NAT Instances (self-managed) allow your instances in your Private Subnets to access the internet while remaining private



Network ACL & Security Groups

- NACL (Network ACL)
  - A firewall which controls traffic from and to subnet
  - Can have ALLOW and DENY rules
  - Are attached at the Subnet level
  - Rules only include IP addresses

- Security Groups
  - A firewall that controls traffic to and from an ENI / an EC2 Instance
  - Can have only ALLOW rules
  - Rules include IP addresses and other security groups



Network ACLs vs Security Groups

Security Group	Network ACL
Operates at the instance level	Operates at the subnet level
Supports allow rules only	Supports allow rules and deny rules
Is stateful: Return traffic is automatically allowed, regardless of any rules	Is stateless: Return traffic must be explicitly allowed by rules
We evaluate all rules before deciding whether to allow traffic	We process rules in number order when deciding whether to allow traffic
Applies to an instance only if someone specifies the security group when launching the instance, or associates the security group with the instance later on	Automatically applies to all instances in the subnets it's associated with (therefore, you don't have to rely on users to specify the security group)

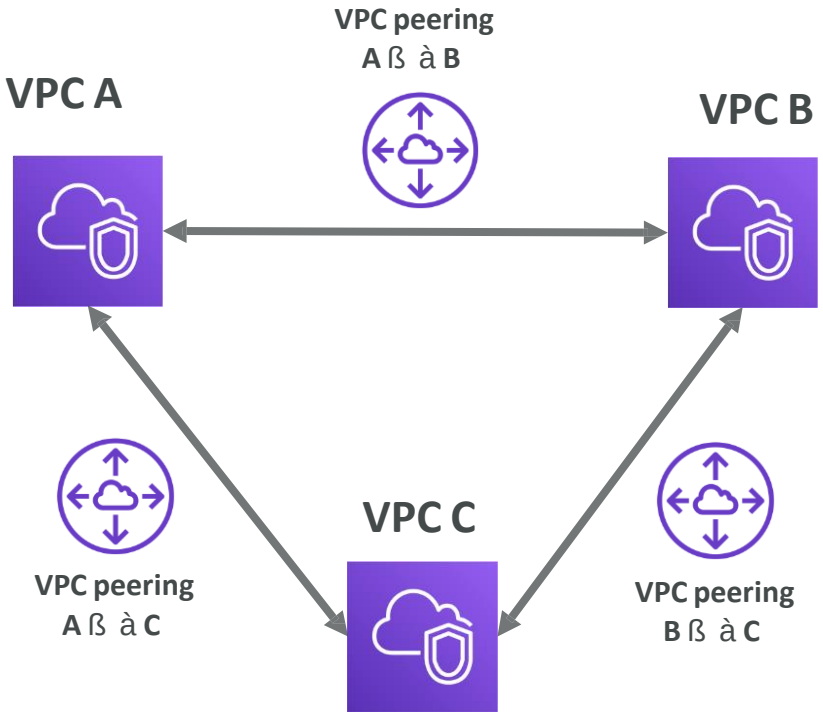
https://docs.aws.amazon.com/vpc/latest/userguide/VPC_Security.html#VPC_Security_Comparison

VPC Flow Logs

- Capture information about IP traffic going into your interfaces:
  - VPC Flow Logs
  - Subnet Flow Logs
  - Elastic Network Interface Flow Logs
- Helps to monitor & troubleshoot connectivity issues. Example:
  - Subnets to internet
  - Subnets to subnets
  - Internet to subnets
- Captures network information from AWS managed interfaces too: Elastic Load Balancers, ElastiCache, RDS, Aurora, etc…
- VPC Flow logs data can go to S3 / CloudWatch Logs

VPC Peering

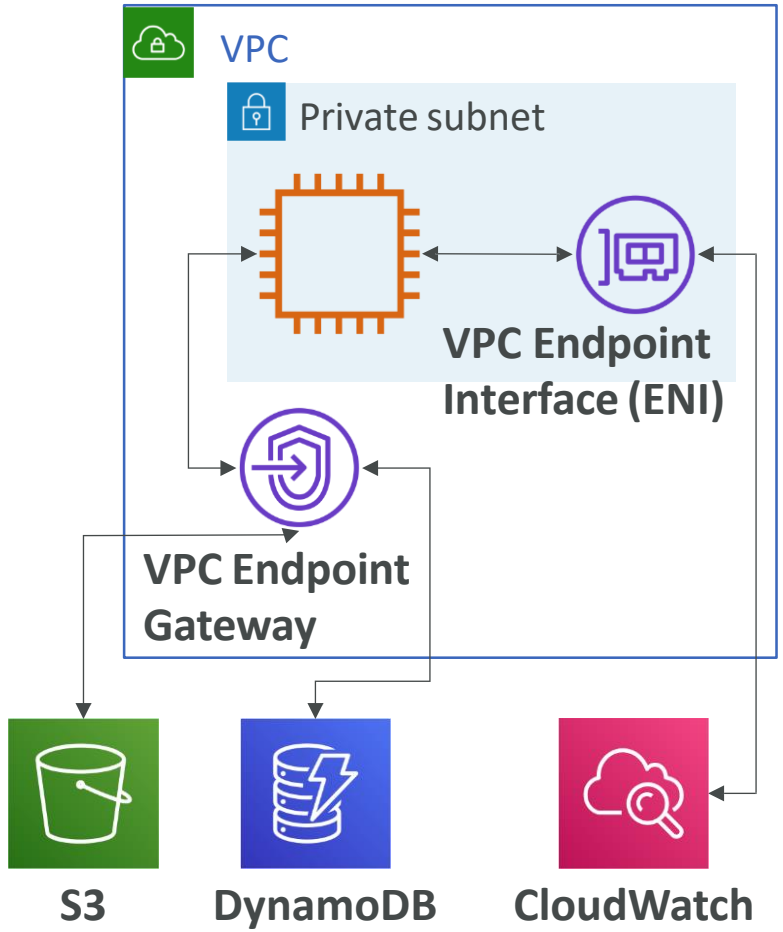
- Connect two VPC, privately using AWS' network
- Make them behave as if they were in the same network
- Must not have overlapping CIDR (IP address range)
- VPC Peering connection is not transitive (must be established for each VPC that need to communicate with one another)



VPC Endpoints

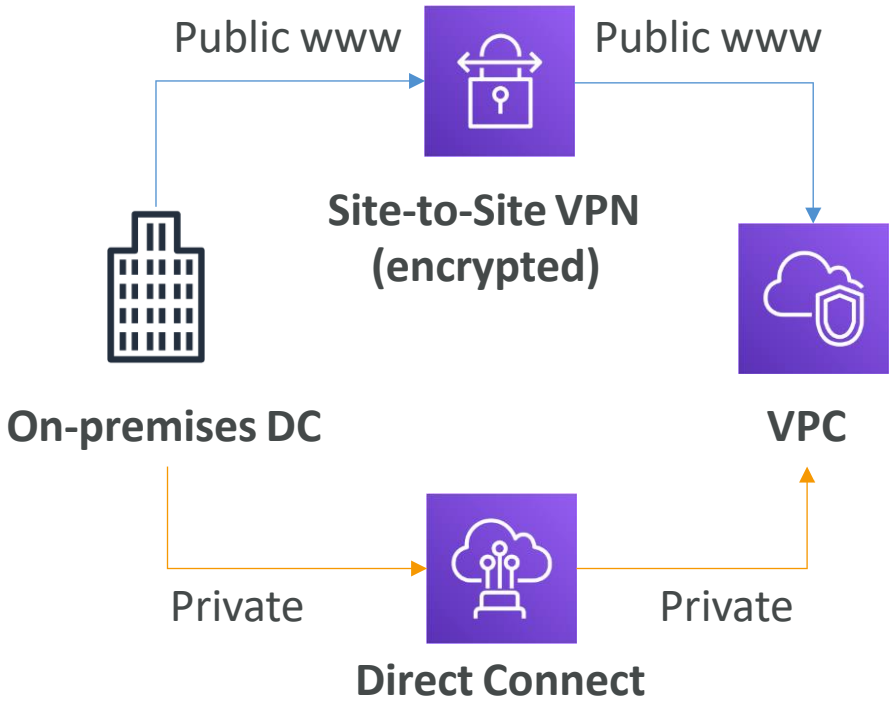
- Endpoints allow you to connect to AWS Services using a private network instead of the public www network
- This gives you enhanced security and lower latency to access AWS services

- VPC Endpoint Gateway: S3 & DynamoDB
- VPC Endpoint Interface: the rest



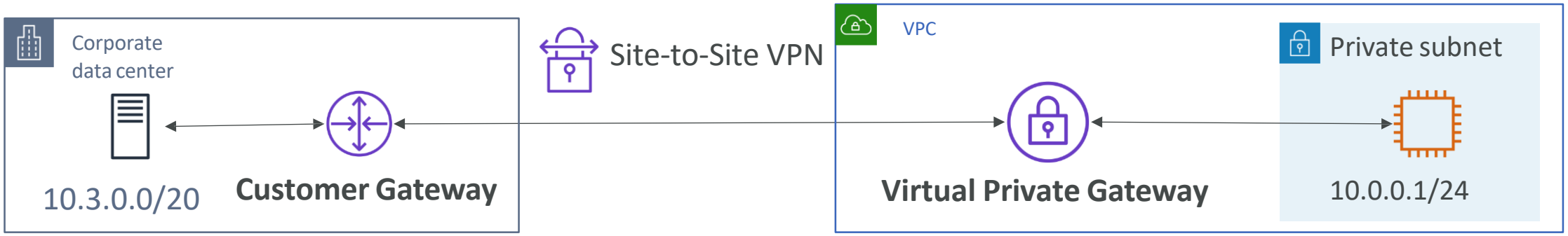
Site to Site VPN & Direct Connect

- Site to Site VPN
  - Connect an on-premises VPN to AWS
  - The connection is automatically encrypted
  - Goes over the public internet
- Direct Connect (DX)
  - Establish a physical connection between on-premises and AWS
  - The connection is private, secure and fast
  - Goes over a private network
  - Takes at least a month to establish

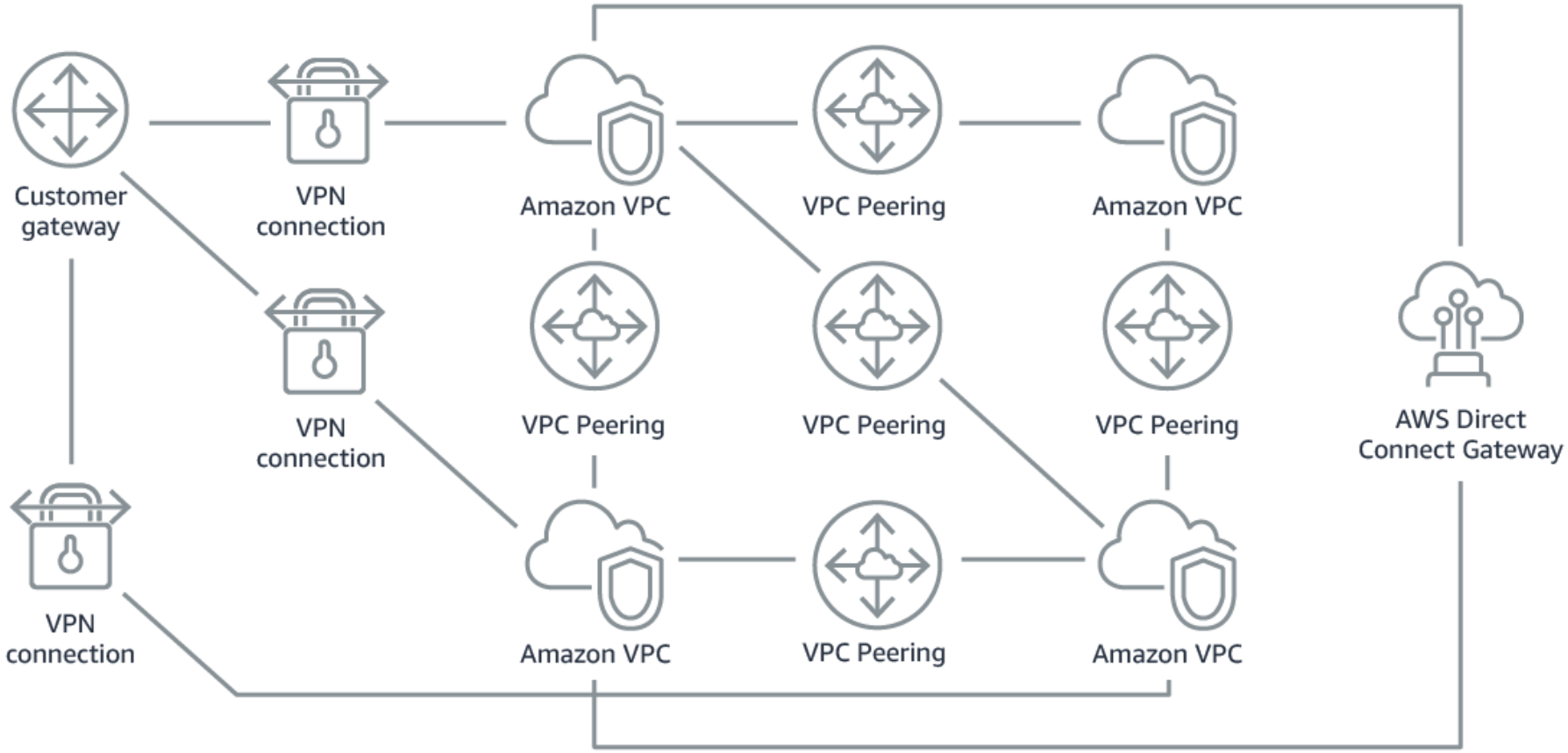


Site-to-Site VPN

- On-premises: must use a Customer Gateway (CGW)
- AWS: must use a Virtual Private Gateway (VGW)

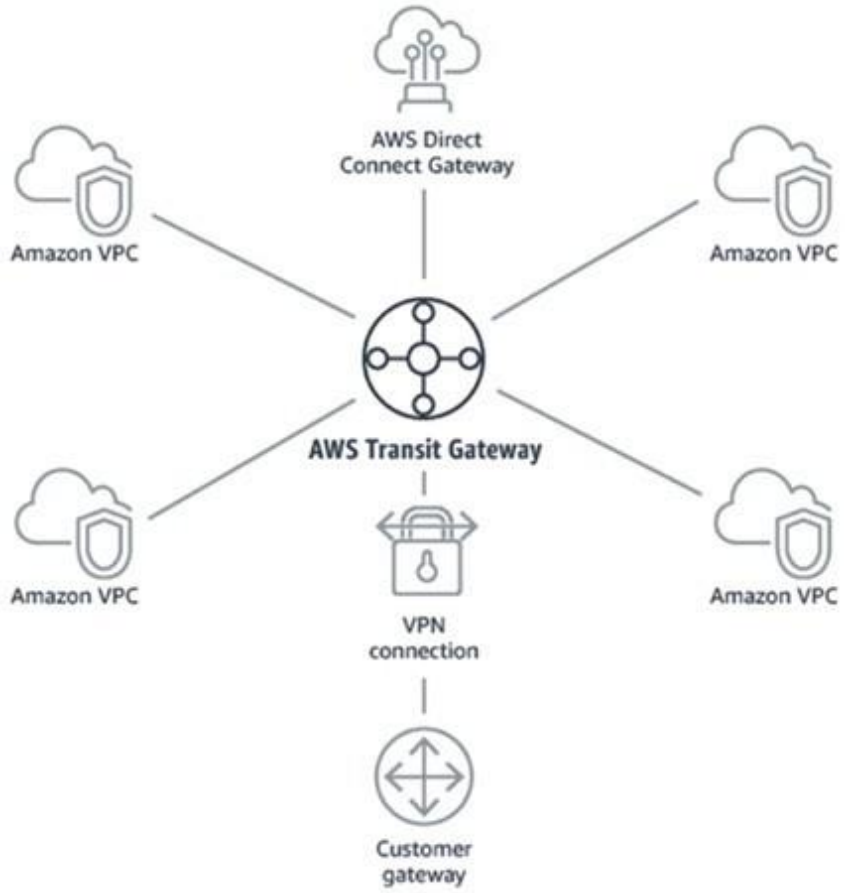


Network topologies can become complicated



Transit Gateway

- For having transitive peering between thousands of VPC and on-premises, hub-and-spoke (star) connection
- One single Gateway to provide this functionality
- Works with Direct Connect Gateway, VPN connections



VPC Closing Comments

- VPC: Virtual Private Cloud
- Subnets: Tied to an AZ, network partition of the VPC
- Internet Gateway: at the VPC level, provide Internet Access
- NAT Gateway / Instances: give internet access to private subnets
- NACL: Stateless, subnet rules for inbound and outbound
- Security Groups: Stateful, operate at the EC2 instance level or ENI
- VPC Peering: Connect two VPC with non overlapping IP ranges, nontransitive
- VPC Endpoints: Provide private access to AWS Services within VPC
- VPC Flow Logs: network traffic logs
- Site to Site VPN: VPN over public internet between on-premises DC and AWS
- Direct Connect: direct private connection to AWS
- Transit Gateway: Connect thousands of VPC and on-premises networks together

Security & Compliance Section

AWS Shared Responsibility Model

- AWS responsibility - Security of the Cloud
  - Protecting infrastructure (hardware, software, facilities, and networking) that runs all the AWS services
  - Managed services like S3, DynamoDB, RDS, etc.
- Customer responsibility - Security in the Cloud
  - For EC2 instance, customer is responsible for management of the guest OS (including security patches and updates), firewall & network configuration, IAM
  - Encrypting application data
- Shared controls:
  - Patch Management, Configuration Management, Awareness & Training

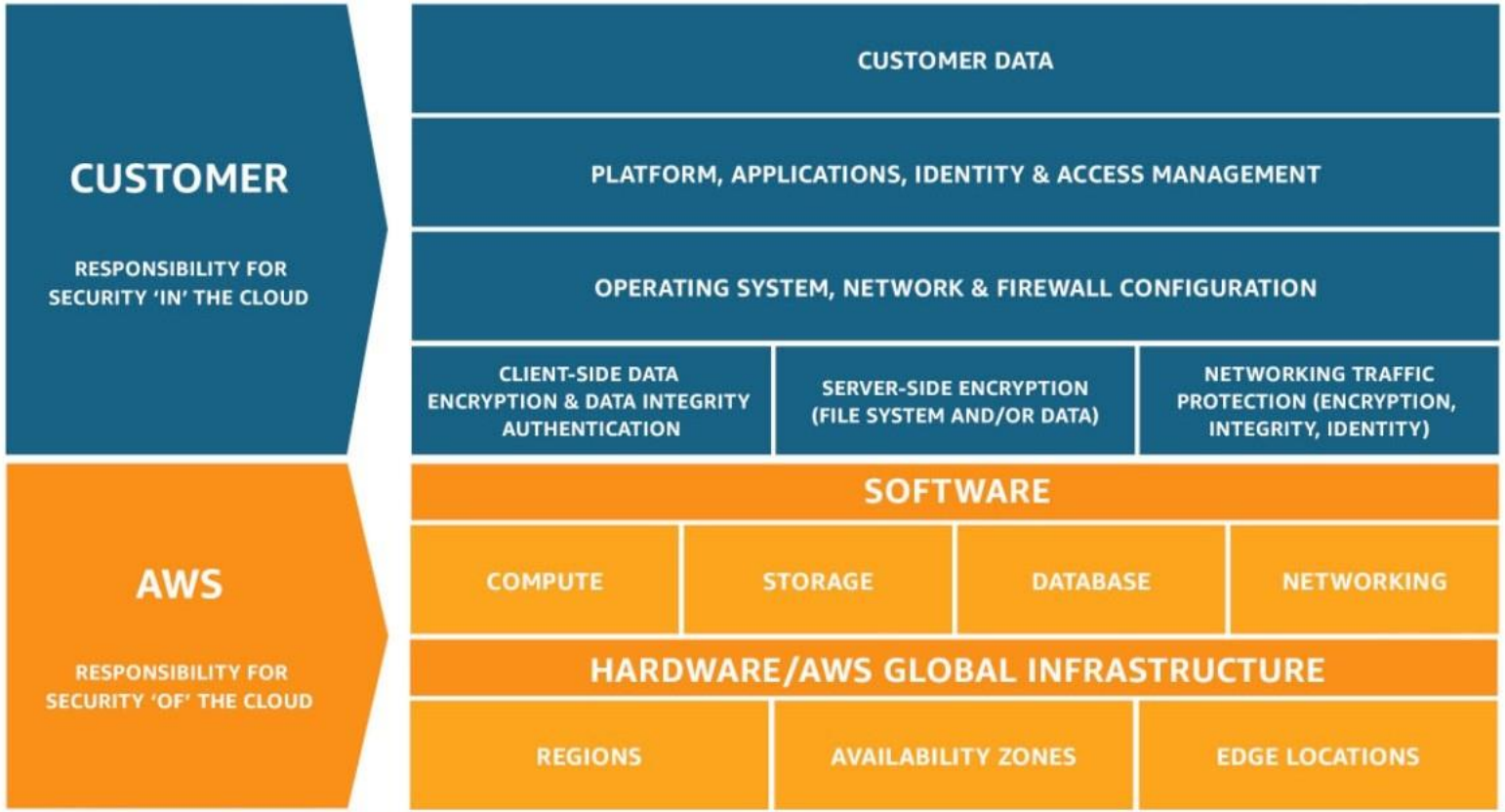
Example, for RDS

- AWS responsibility:
  - Manage the underlying EC2 instance, disable SSH access
  - Automated DB patching
  - Automated OS patching
  - Audit the underlying instance and disks & guarantee it functions
- Your responsibility:
  - Check the ports / IP / security group inbound rules in DB's SG
  - In-database user creation and permissions
  - Creating a database with or without public access
  - Ensure parameter groups or DB is configured to only allow SSL connections
  - Database encryption setting

Example, for S3

- AWS responsibility:
  - Guarantee you get unlimited storage
  - Guarantee you get encryption
  - Ensure separation of the data between different customers
  - Ensure AWS employees can't access your data
- Your responsibility:
  - Bucket configuration
  - Bucket policy / public setting
  - IAM user and roles
  - Enabling encryption

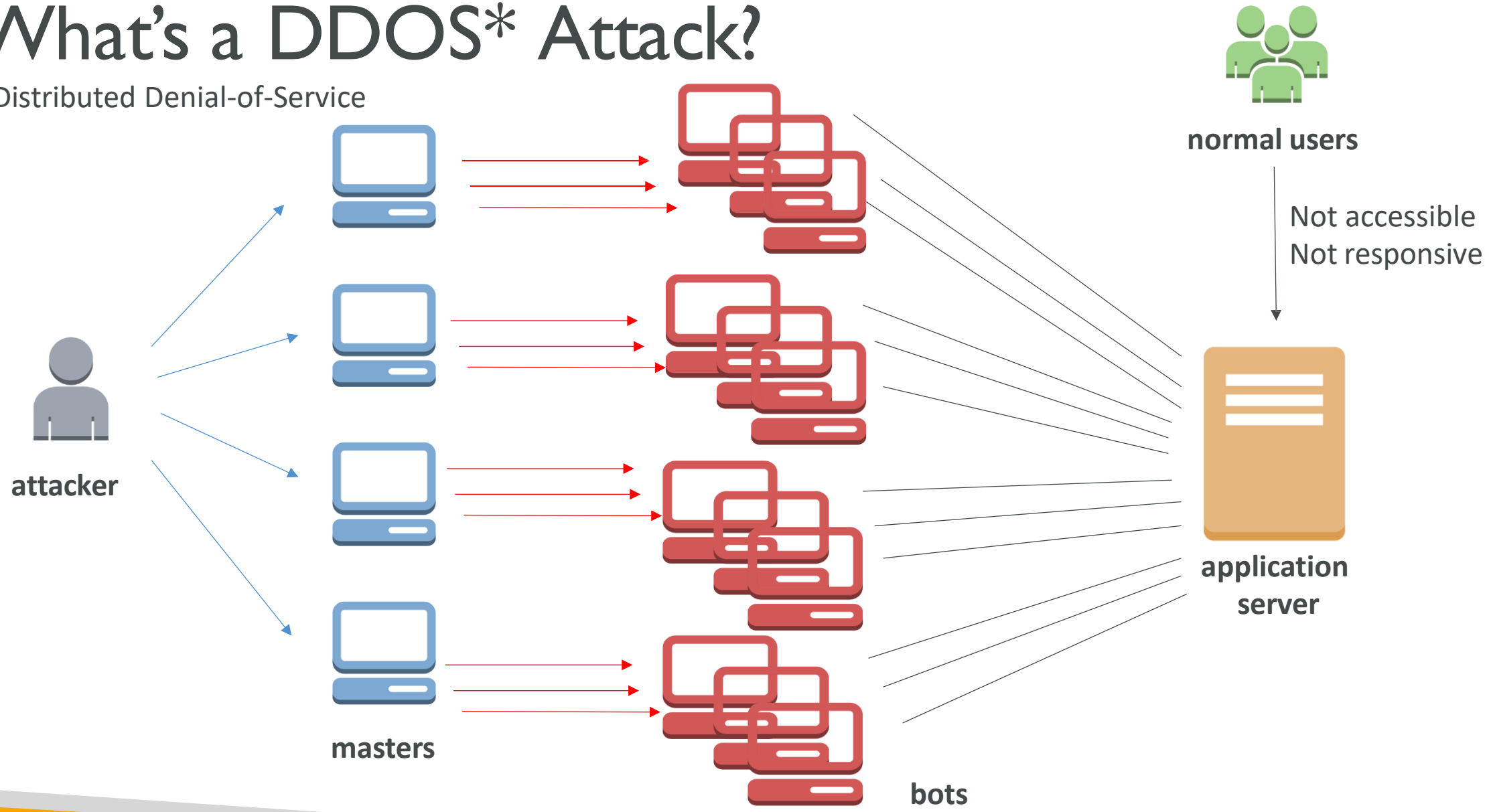
Shared Responsibility Model diagram



https://aws.amazon.com/compliance/shared-responsibility-model/

What's a DDOS* Attack?

*Distributed Denial-of-Service

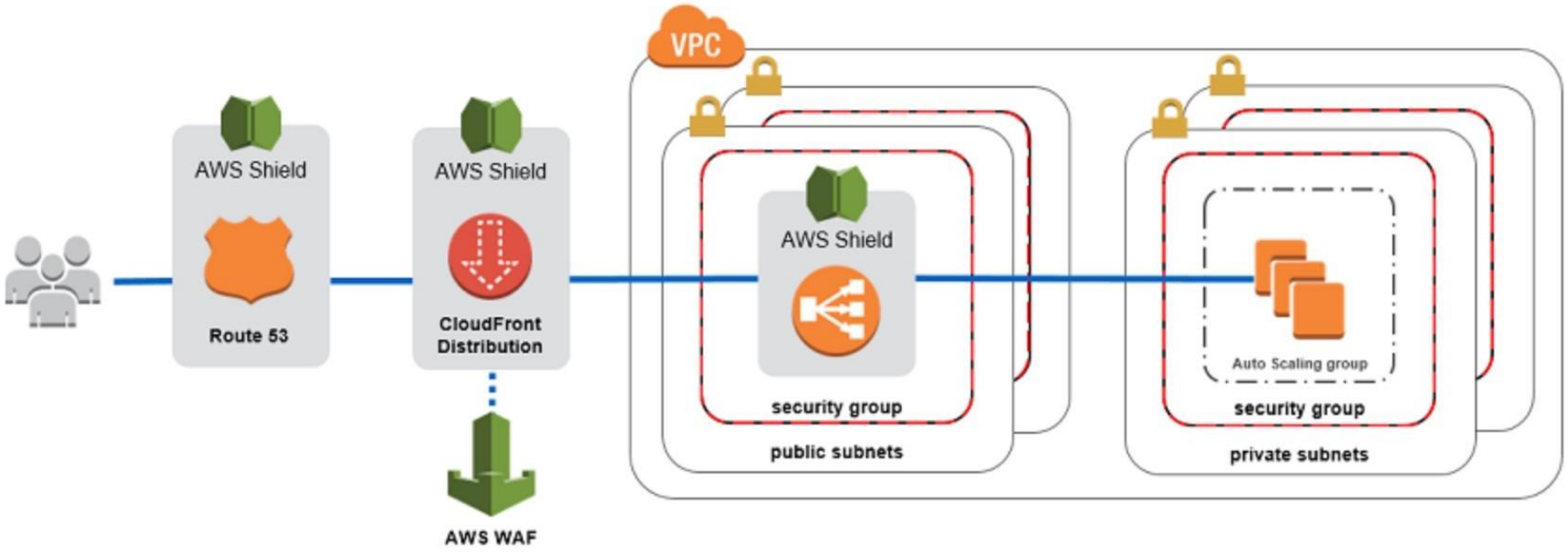


DDOS Protection on AWS

- AWS Shield Standard: protects against DDOS attack for your website and applications, for all customers at no additional costs
- AWS Shield Advanced: 24/7 premium DDoS protection
- AWS WAF: Filter specific requests based on rules
- CloudFront and Route 53:
  - Availability protection using global edge network
  - Combined with AWS Shield, provides attack mitigation at the edge

- Be ready to scale – leverage AWS Auto Scaling

Sample Reference Architecture for DDoS Protection



https://aws.amazon.com/answers/networking/aws-ddos-attack-mitigation/

AWS Shield

- AWS Shield Standard:
  - Free service that is activated for every AWS customer
  - Provides protection from attacks such as SYN/UDP Floods, Reflection attacks and other layer 3/layer 4 attacks
- AWS Shield Advanced:
  - Optional DDoS mitigation service ($3,000 per month per organization)
  - Protect against more sophisticated attack on Amazon EC2, Elastic Load Balancing (ELB), Amazon CloudFront, AWS Global Accelerator, and Route 53
  - 24/7 access to AWS DDoS response team (DRP)
  - Protect against higher fees during usage spikes due to DDoS

AWS WAF – Web Application Firewall

- Protects your web applications from common web exploits (Layer 7)
- Layer 7 is HTTP (vs Layer 4 is TCP)
- Deploy on Application Load Balancer, API Gateway, CloudFront

- Define Web ACL (Web Access Control List):
  - Rules can include IP addresses, HTTP headers, HTTP body, or URI strings
  - Protects from common attack - SQL injection and Cross-Site Scripting (XSS)
  - Size constraints, geo-match (block countries)
  - Rate-based rules (to count occurrences of events) – for DDoS protection

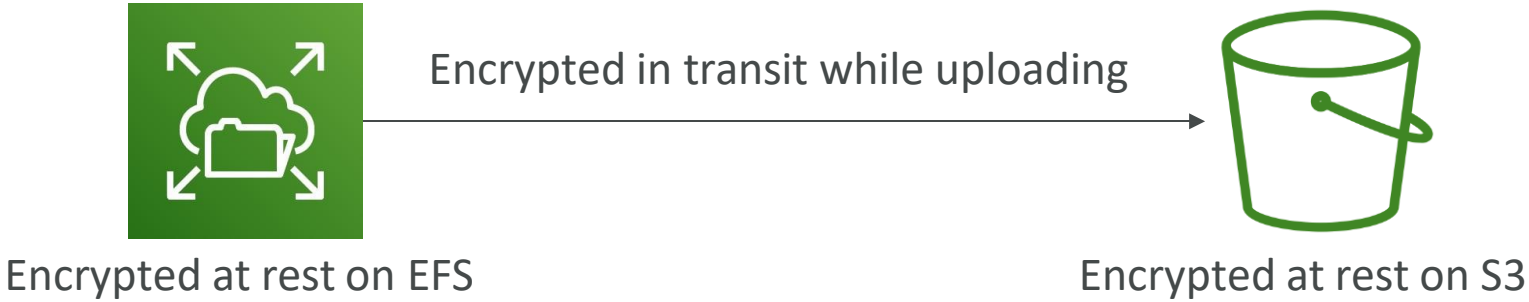
Penetration Testing on AWS Cloud

- AWS customers are welcome to carry out security assessments or penetration tests against their AWS infrastructure without prior approval for 8 services:
  - Amazon EC2 instances, NAT Gateways, and Elastic Load Balancers
  - Amazon RDS
  - Amazon CloudFront
  - Amazon Aurora
  - Amazon API Gateways
  - AWS Lambda and Lambda Edge functions
  - Amazon Lightsail resources
  - Amazon Elastic Beanstalk environments
- List can increase over time (you won't be tested on that at the exam)

Penetration Testing on your AWS Cloud

- Prohibited Activities
  - DNS zone walking via Amazon Route 53 Hosted Zones
  - Denial of Service (DoS), Distributed Denial of Service (DDoS), Simulated DoS, Simulated DDoS
  - Port flooding
  - Protocol flooding
  - Request flooding (login request flooding, API request flooding)
- For any other simulated events, contact aws-security-simulated-event@amazon.com
- Read more: https://aws.amazon.com/security/penetration-testing/

Data at rest vs. Data in transit



- At rest: data stored or archived on a device
  - On a hard disk, on a RDS instance, in S3 Glacier Deep Archive, etc.
- In transit (in motion): data being moved from one location to another
  - Transfer from on-premises to AWS, EC2 to DynamoDB, etc.
  - Means data transferred on the network
- We want to encrypt data in both states to protect it!
- For this we leverage encryption keys

AWS KMS (Key Management Service)

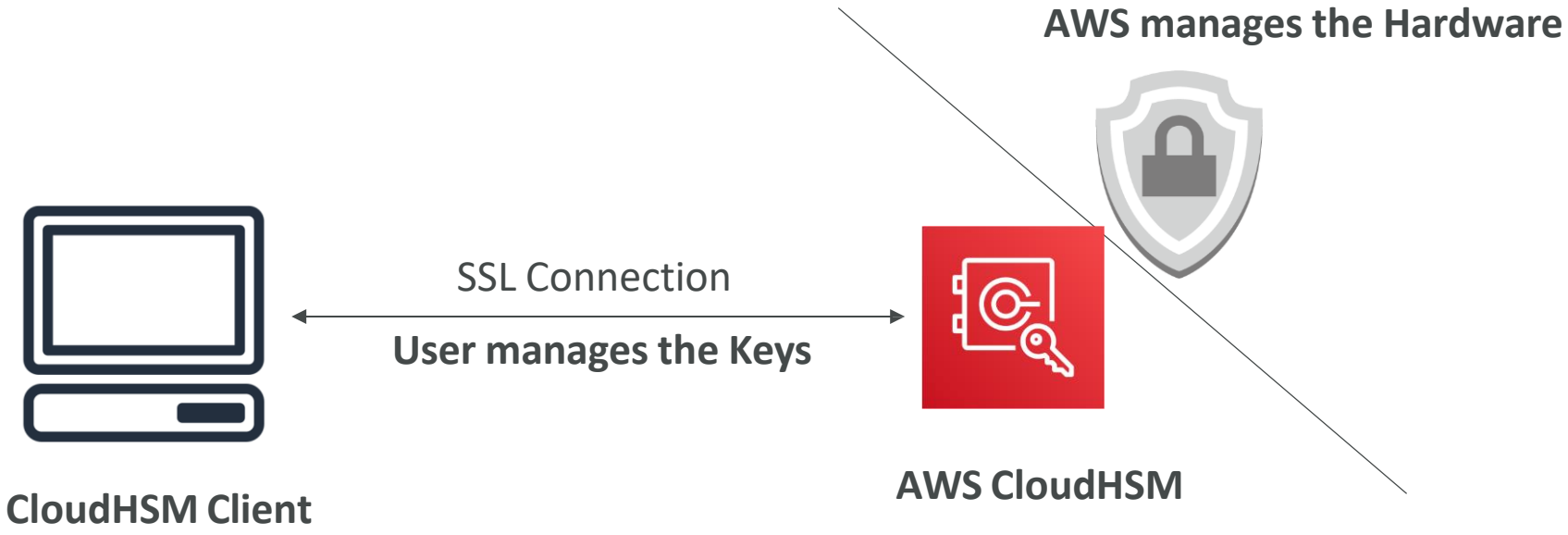
- Anytime you hear "encryption" for an AWS service, it's most likely KMS
- KMS = AWS manages the encryption keys for us
- Encryption Opt-in:
  - EBS volumes: encrypt volumes
  - S3 buckets: Server-side encryption of objects
  - Redshift database: encryption of data
  - RDS database: encryption of data
  - EFS drives: encryption of data
- Encryption Automatically enabled:
  - CloudTrail Logs
  - S3 Glacier
  - Storage Gateway

CloudHSM

- KMS => AWS manages the software for encryption
- CloudHSM => AWS provisions encryption hardware
- Dedicated Hardware (HSM = Hardware Security Module)
- You manage your own encryption keys entirely (not AWS)
- HSM device is tamper resistant, FIPS 140-2 Level 3 compliance

Sample HSM device

CloudHSM Diagram

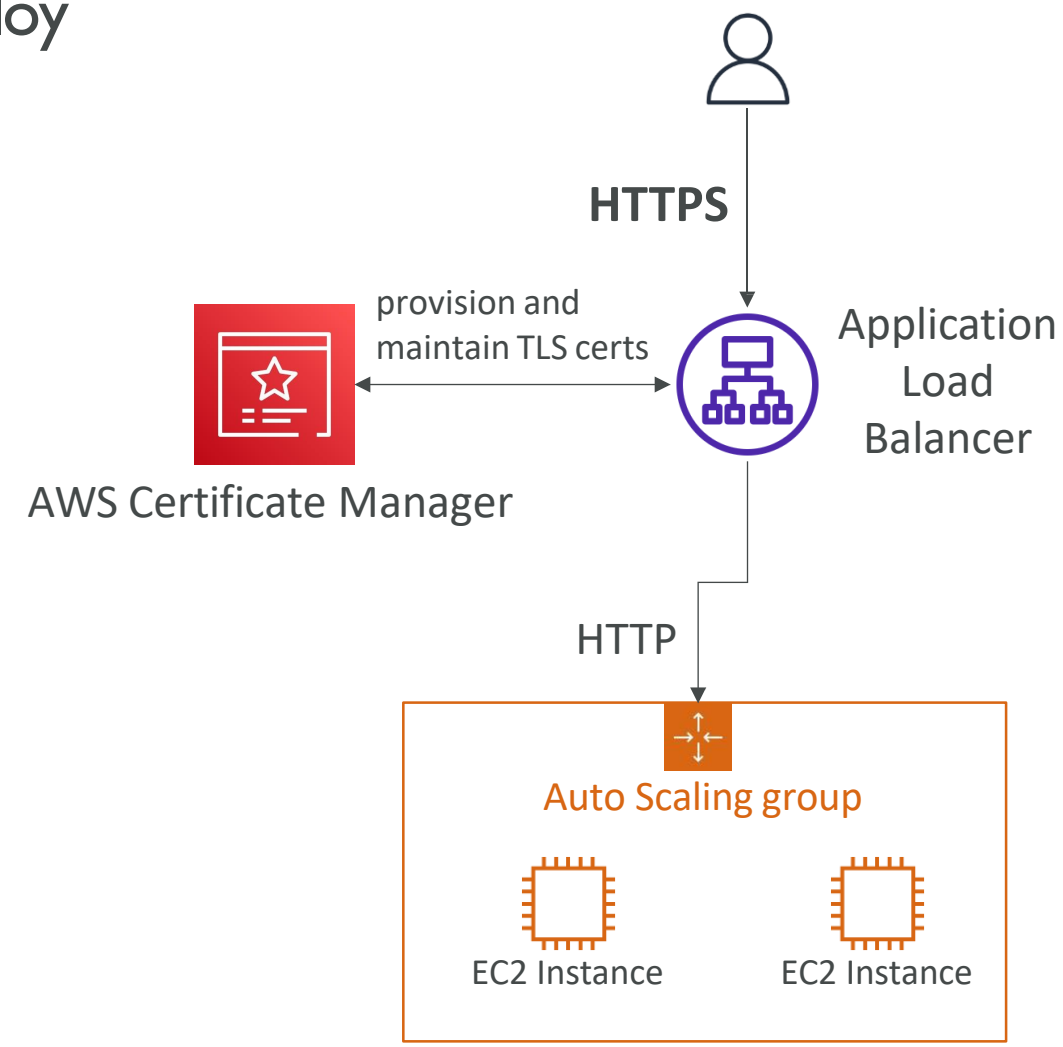


Types of Customer Master Keys: CMK

- Customer Managed CMK:
  - Create, manage and used by the customer, can enable or disable
  - Possibility of rotation policy (new key generated every year, old key preserved)
  - Possibility to bring-your-own-key
- AWS managed CMK:
  - Created, managed and used on the customer's behalf by AWS
  - Used by AWS services (aws/s3, aws/ebs, aws/redshift)
- AWS owned CMK:
  - Collection of CMKs that an AWS service owns and manages to use in multiple accounts
  - AWS can use those to protect resources in your account (but you can't view the keys)
- CloudHSM Keys (custom keystore):
  - Keys generated from your own CloudHSM hardware device
  - Cryptographic operations are performed within the CloudHSM cluster

AWS Certificate Manager (ACM)

- Let's you easily provision, manage, and deploy SSL/TLS Certificates
- Used to provide in-flight encryption for websites (HTTPS)
- Supports both public and private TLS certificates
- Free of charge for public TLS certificates
- Automatic TLS certificate renewal
- Integrations with (load TLS certificates on)
  - Elastic Load Balancers
  - CloudFront Distributions
  - APIs on API Gateway



AWS Secrets Manager

- Newer service, meant for storing secrets
- Capability to force rotation of secrets every X days
- Automate generation of secrets on rotation (uses Lambda)
- Integration with Amazon RDS (MySQL, PostgreSQL, Aurora)
- Secrets are encrypted using KMS

- Mostly meant for RDS integration

AWS Artifact (not really a service)

- Portal that provides customers with on-demand access to AWS compliance documentation and AWS agreements
- Artifact Reports - Allows you to download AWS security and compliance documents from third-party auditors, like AWS ISO certifications, Payment Card Industry (PCI), and System and Organization Control (SOC) reports
- Artifact Agreements - Allows you to review, accept, and track the status of AWS agreements such as the Business Associate Addendum (BAA) or the Health Insurance Portability and Accountability Act (HIPAA) for an individual account or in your organization

- Can be used to support internal audit or compliance

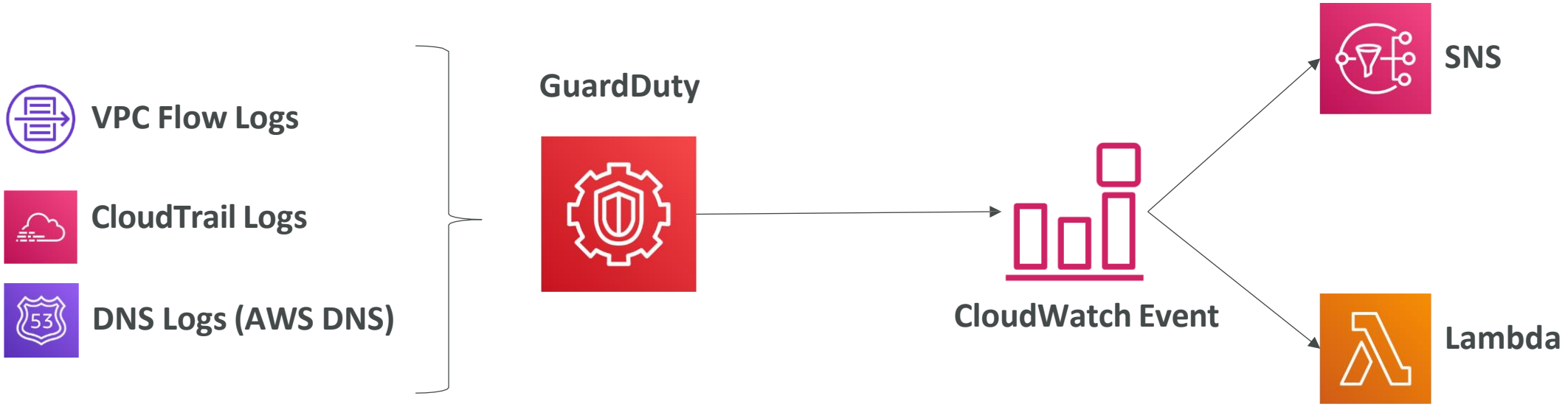
Amazon GuardDuty

- Intelligent Threat discovery to Protect AWS Account
- Uses Machine Learning algorithms, anomaly detection, 3rd party data
- One click to enable (30 days trial), no need to install software

- Input data includes:
  - CloudTrail Logs: unusual API calls, unauthorized deployments
  - VPC Flow Logs: unusual internal traffic, unusual IP address
  - DNS Logs: compromised EC2 instances sending encoded data within DNS queries

- Can setup CloudWatch Event rules to be notified in case of findings
- CloudWatch Events rules can target AWS Lambda or SNS

Amazon GuardDuty



Amazon Inspector

- Automated Security Assessments for EC2 instances
- Analyze the running OS against known vulnerabilities
- Analyze against unintended network accessibility
- AWS Inspector Agent must be installed on OS in EC2 instances

- After the assessment, you get a report with a list of vulnerabilities

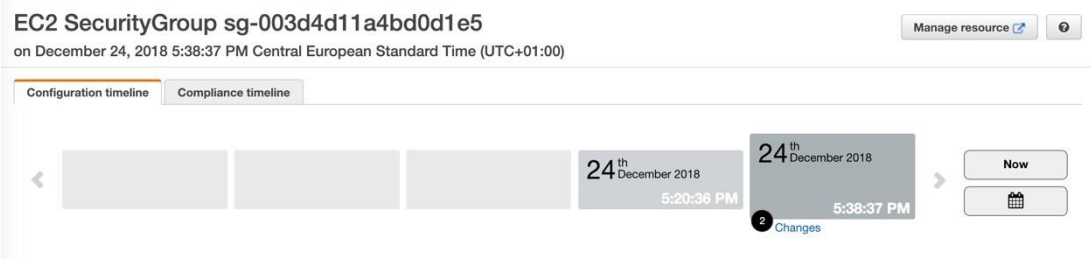
AWS Config

- Helps with auditing and recording compliance of your AWS resources
- Helps record configurations and changes over time
- Possibility of storing the configuration data into S3 (analyzed by Athena)
- Questions that can be solved by AWS Config:
  - Is there unrestricted SSH access to my security groups?
  - Do my buckets have any public access?
  - How has my ALB configuration changed over time?
- You can receive alerts (SNS notifications) for any changes
- AWS Config is a per-region service
- Can be aggregated across regions and accounts

AWS Config Resource

- View compliance of a resource over time

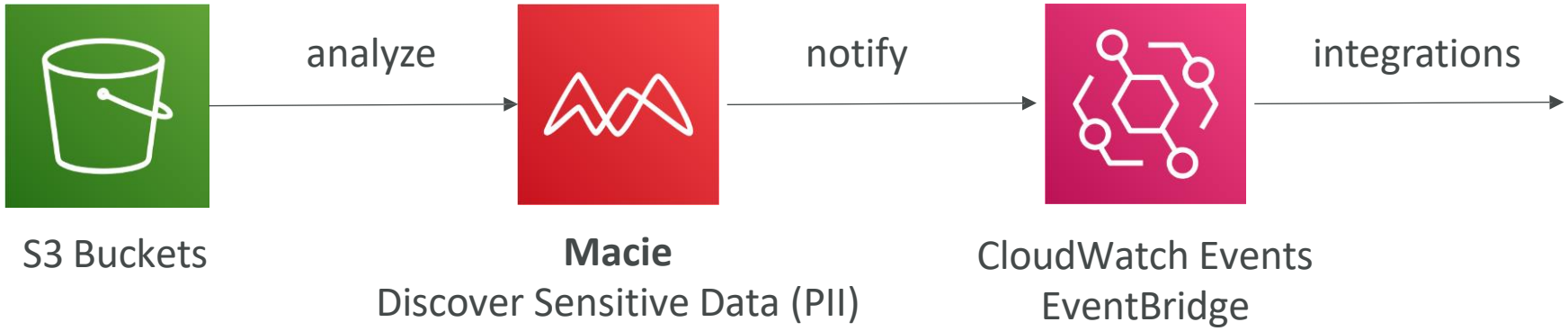
- View configuration of a resource over time



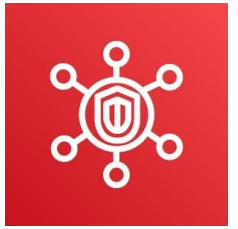
- View CloudTrail API calls if enabled

Amazon Macie

- Amazon Macie is a fully managed data security and data privacy service that uses machine learning and pattern matching to discover and protect your sensitive data in AWS.
- Macie helps identify and alert you to sensitive data, such as personally identifiable information (PII)

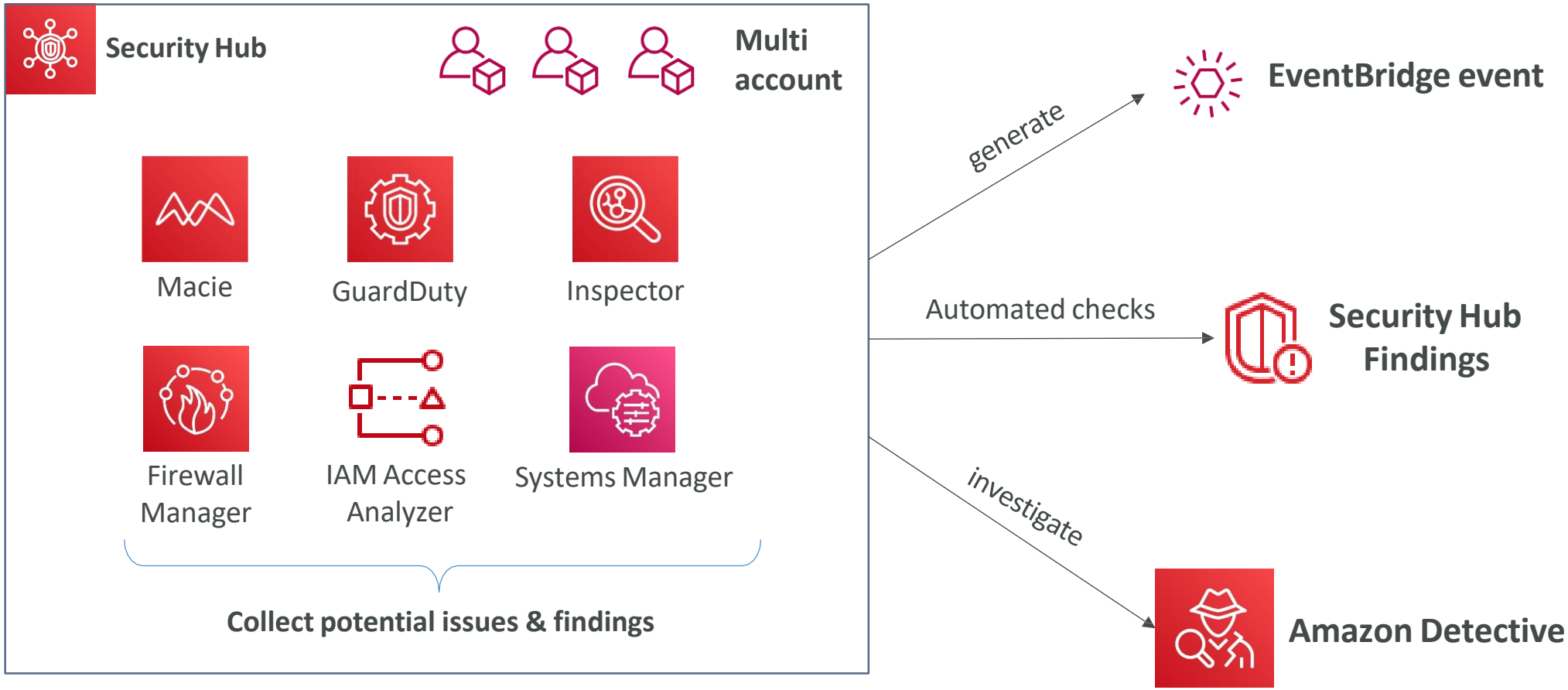


AWS Security Hub



- Central security tool to manage security across several AWS accounts and automate security checks
- Integrated dashboards showing current security and compliance status to quickly take actions
- Automatically aggregates alerts in predefined or personal findings formats from various AWS services & AWS partner tools:
  - GuardDuty
  - Inspector
  - Macie
  - IAM Access Analyzer
  - AWS Systems Manager
  - AWS Firewall Manager
  - AWS Partner Network Solutions
- Must first enable the AWS Config Service

AWS Security Hub



Amazon Detective

- GuardDuty, Macie, and Security Hub are used to identify potential security issues, or findings
- Sometimes security findings require deeper analysis to isolate the root cause and take action – it's a complex process
- Amazon Detective analyzes, investigates, and quickly identifies the root cause of security issues or suspicious activities (using ML and graphs)
- Automatically collects and processes events from VPC Flow Logs, CloudTrail, GuardDuty and create a unified view
- Produces visualizations with details and context to get to the root cause

AWS Abuse

- Report suspected AWS resources used for abusive or illegal purposes
- Abusive & prohibited behaviors are:
  - Spam – receving undesired emails from AWS-owned IP address, websites & forums spammed by AWS resources
  - Port scanning – sending packets to your ports to discover the unsecured ones
  - DoS or DDoS attacks – AWS-owned IP addresses attempting to overwhlem or crash your servers/softwares
  - Intrusion attempts – logging in on your resources
  - Hosting objectionable or copyrighted content – distributing illegal or copyrighted content without consent
  - Distributing malware – AWS resources distributing softwares to harm computers or machines
- Contact the AWS Abuse team: AWS abuse form, or abuse@amazonaws.com

Root user privileges

- Root user = Account Owner (created when the account is created)
- Has complete access to all AWS services and resources
- Lock away your AWS account root user access keys!
- Do not use the root account for everyday tasks, even administrative tasks
- Actions that can be performed only by the root user:
  - Change account settings (account name, email address, root user password, root user access keys)
  - View certain tax invoices
  - Close your AWS account
  - Restore IAM user permissions
  - Change or cancel your AWS Support plan
  - Register as a seller in the Reserved Instance Marketplace
  - Configure an Amazon S3 bucket to enable MFA
  - Edit or delete an Amazon S3 bucket policy that includes an invalid VPC ID or VPC endpoint ID
  - Sign up for GovCloud

Section Summary: Security & Compliance

- Shared Responsibility on AWS
- Shield: Automatic DDoS Protection + 24/7 support for advanced
- WAF: Firewall to filter incoming requests based on rules
- KMS: Encryption keys managed by AWS
- CloudHSM: Hardware encryption, we manage encryption keys
- AWS Certificate Manager: provision, manage, and deploy SSL/TLS Certificates
- Artifact: Get access to compliance reports such as PCI, ISO, etc…
- GuardDuty: Find malicious behavior with VPC, DNS & CloudTrail Logs
- Inspector: For EC2 only, install agent and find vulnerabilities

Section Summary: Security & Compliance

- Config: Track config changes and compliance against rules
- Macie: Find sensitive data (ex: PII data) in Amazon S3 buckets
- CloudTrail: Track API calls made by users within account
- AWS Security Hub: gather security findings from multiple AWS accounts
- Amazon Detective: find the root cause of security issues or suspicious activities
- AWS Abuse: Report AWS resources used for abusive or illegal purposes
- Root user privileges:
  - Change account settings
  - Close your AWS account
  - Change or cancel your AWS Support plan
  - Register as a seller in the Reserved Instance Marketplace