ENGENHARIA DE SOFTWARE

41492-ES

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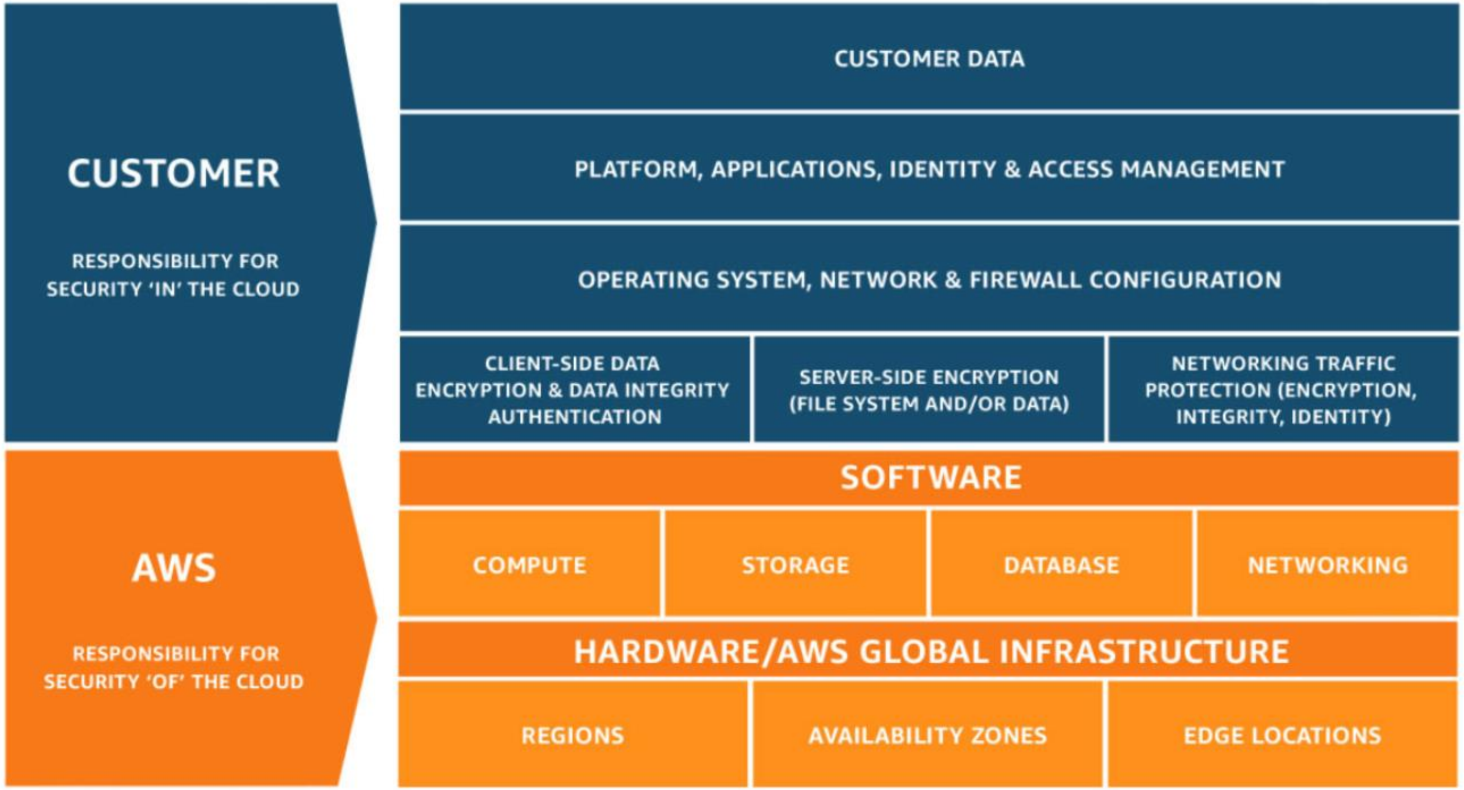
Module 4: AWS Cloud Security

SECTION 1: AWS SHARED RESPONSIBILITY MODEL

AWS shared responsibility model



CUSTOMER

RESPONSIBILITY FOR SECURITY 'IN' THE CLOUD

CUSTOMER DATA

PLATFORM, APPLICATIONS, IDENTITY & ACCESS MANAGEMENT

OPERATING SYSTEM, NETWORK & FIREWALL CONFIGURATION

CLIENT-SIDE DATA ENCRYPTION & DATA INTEGRITY AUTHENTICATION

SERVER-SIDE ENCRYPTION (FILE SYSTEM AND/OR DATA)

NETWORKING TRAFFIC PROTECTION (ENCRYPTION, INTEGRITY, IDENTITY)

AWS

RESPONSIBILITY FOR SECURITY 'OF' THE CLOUD

SOFTWARE

COMPUTE

STORAGE

DATABASE

NETWORKING

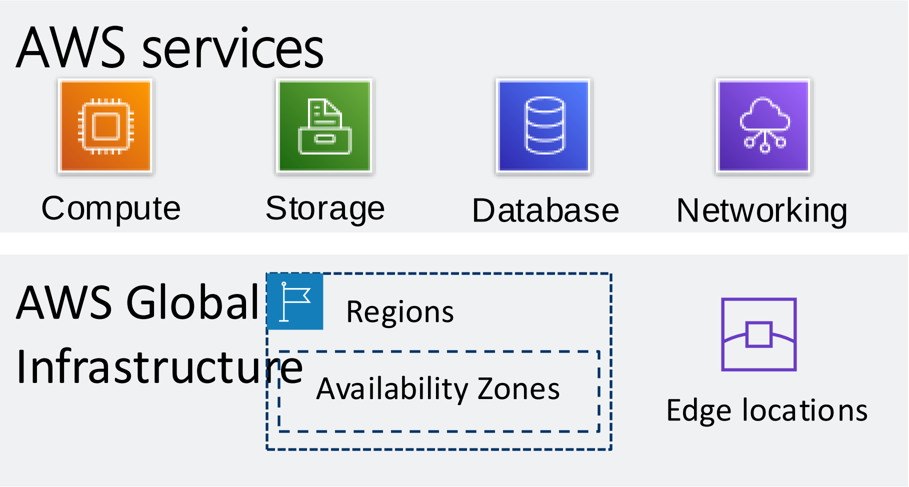
HARDWARE/AWS GLOBAL INFRASTRUCTURE

REGIONS

AVAILABILITY ZONES

EDGE LOCATIONS

AWS responsibility: Security *of* the cloud



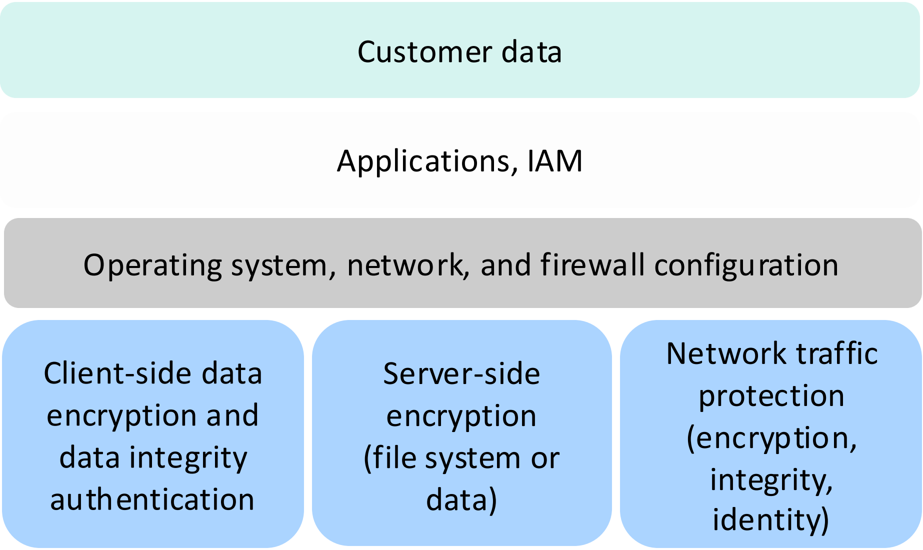
AWS services

AWS Global Infrastructure

AWS responsibilities:

- Physical security of data centers
  - Controlled, need-based access
- Hardware and software infrastructure
  - Storage decommissioning, host operating system (OS) access logging, and auditing
- Network infrastructure
  - Intrusion detection
- Virtualization infrastructure
  - Instance isolation

Customer responsibility: Security *in* the cloud



Customer data

Applications, IAM

Operating system, network, and firewall configuration

Client-side data encryption and data integrity authentication

Server-side encryption (file system or data)

Network traffic protection (encryption, integrity, identity)

Customer-configurable

Customer responsibilities:

- Amazon Elastic Compute Cloud (Amazon EC2) instance operating system
  - Including patching, maintenance
- Applications
  - Passwords, role-based access, etc.
- Security group configuration
- OS or host-based firewalls
  - Including intrusion detection or prevention systems
- Network configurations
- Account management
  - Login and permission settings for each user

Service characteristics and security responsibility (1 of 2)

Example services managed by the customer

Amazon EC2

Amazon Elastic Block Store (Amazon EBS)

Amazon Virtual Private Cloud (Amazon VPC)

Example services managed by AWS

AWS Lambda

Amazon Relational Database Service (Amazon RDS)

AWS Elastic Beanstalk

Infrastructure as a service (IaaS)

- Customer has more flexibility over configuring networking and storage settings
- Customer is responsible for managing more aspects of the security
- Customer configures the access controls

Platform as a service (PaaS)

- Customer does not need to manage the underlying infrastructure
- AWS handles the operating system, database patching, firewall configuration, and disaster recovery
- Customer can focus on managing code or data

Service characteristics and security responsibility (2 of 2)

SaaS examples

AWS Trusted Advisor

AWS Shield

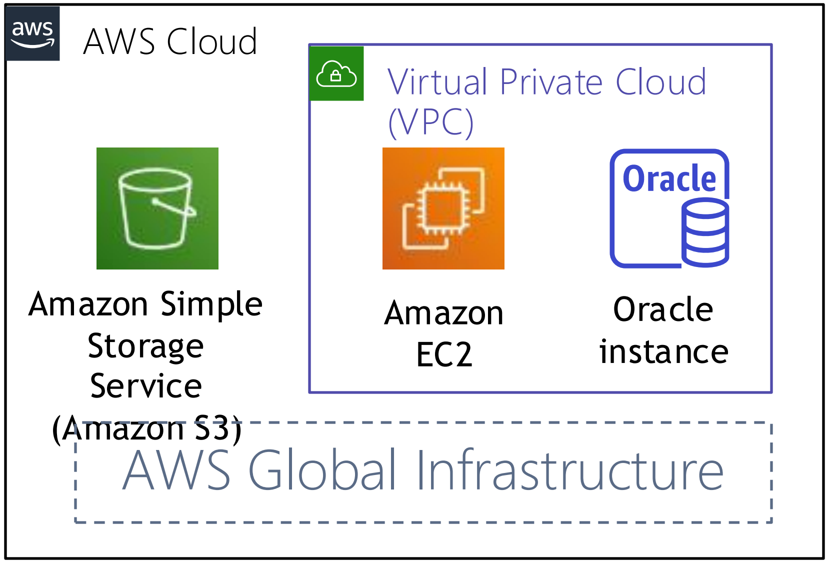
Amazon Chime

Software as a service (SaaS)

- Software is centrally hosted
- Licensed on a subscription model or pay-as-you-go basis.
- Services are typically accessed via web browser, mobile app, or application programming interface (API)
- Customers do not need to manage the infrastructure that supports the service

Activity: Scenario 1 of 2

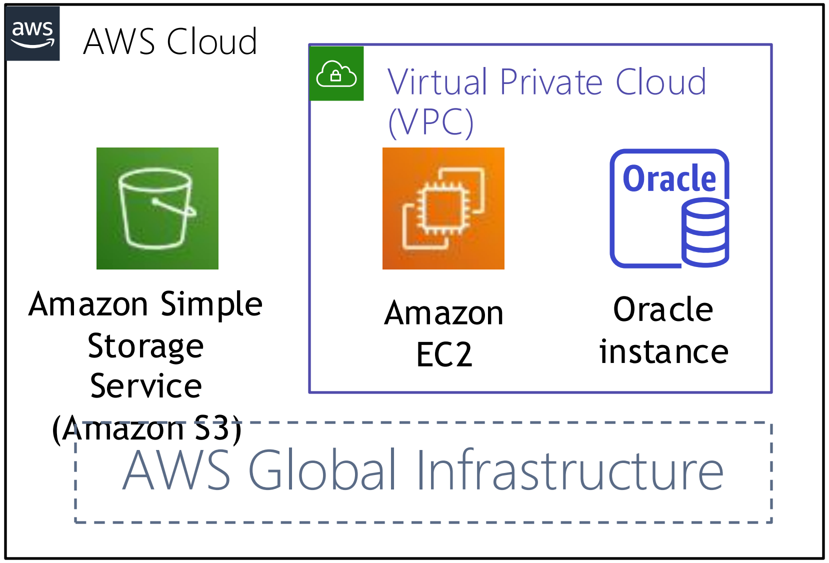
Consider this deployment. Who is responsible – AWS or the customer?


aws
AWS Cloud
Virtual Private Cloud (VPC)
Amazon Simple Storage Service (Amazon S3)
Amazon EC2
Oracle
Oracle instance
AWS Global Infrastructure

1. Upgrades and patches to the operating system on the EC2 instance?
2. Physical security of the data center?
3. Virtualization infrastructure?
4. EC2 security group settings?
5. Configuration of applications that run on the EC2 instance?
6. Oracle upgrades or patches If the Oracle instance runs as an Amazon RDS instance?
7. Oracle upgrades or patches If Oracle runs on an EC2 instance?
8. S3 bucket access configuration?

Activity: Scenario 1 of 2 Answers

Consider this deployment. Who is responsible – AWS or the customer?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Amazon EC2
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Oracle instance
AWS Global Infrastructure

1. Upgrades and patches to the operating system on the EC2 instance?
   - ANSWER: The customer
2. Physical security of the data center?
   - ANSWER: AWS
3. Virtualization infrastructure?
   - ANSWER: AWS
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   - ANSWER: The customer
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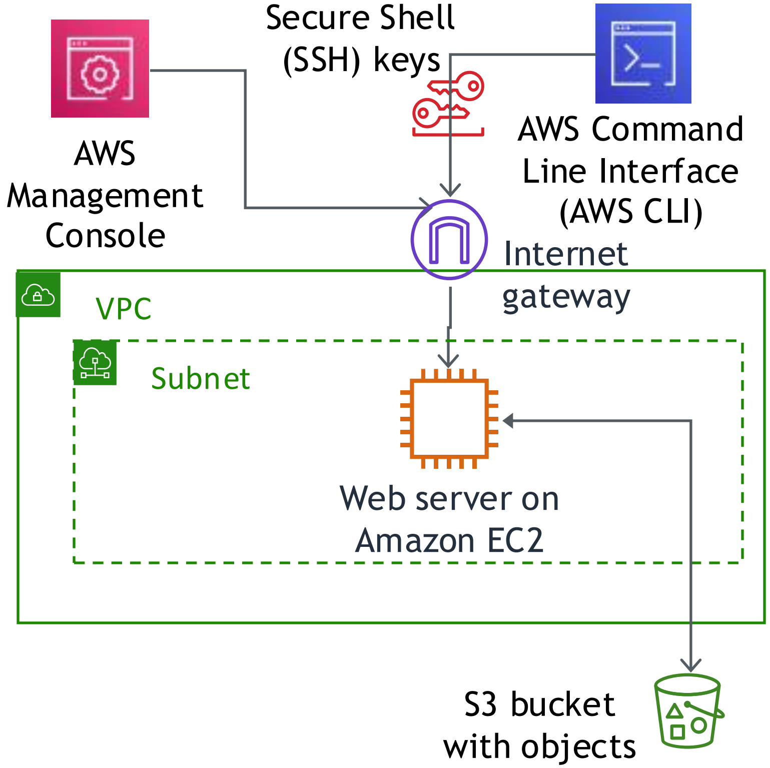
   - ANSWER: The customer
6. Oracle upgrades or patches If the Oracle instance runs as an Amazon RDS instance?
   - ANSWER: AWS
7. Oracle upgrades or patches If Oracle runs on an EC2 instance?
   - ANSWER: The customer
8. S3 bucket access configuration?
   - ANSWER: The customer

Activity: Scenario 2 of 2

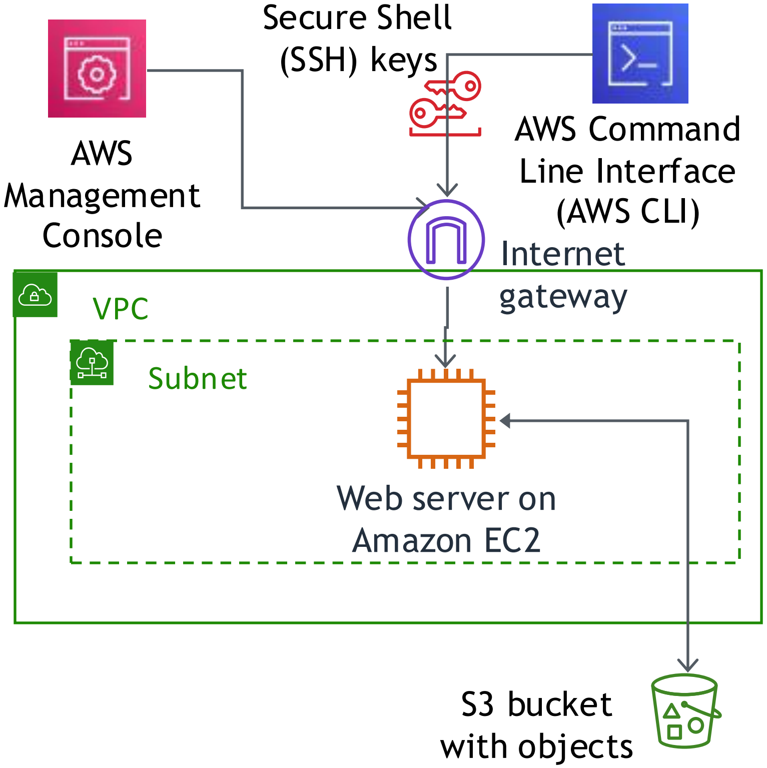
Consider this deployment. Who is responsible - AWS or the customer?



1. Ensuring that the AWS Management Console is not hacked?
2. Configuring the subnet?
3. Configuring the VPC?
4. Protecting against network outages in AWS Regions?
5. Securing the SSH keys
6. Ensuring network isolation between AWS customers' data?
7. Ensuring low-latency network connection between the web server and the S3 bucket?
8. Enforcing multi-factor authentication for all user logins?

Activity: Scenario 2 of 2 Answers

Consider this deployment. Who is responsible - AWS or the customer?



1. Ensuring that the AWS Management Console is not hacked?
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7. Ensuring low-latency network connection between the web server and the S3 bucket?
   - ANSWER: AWS
8. Enforcing multi-factor authentication for all user logins?
   - ANSWER: The customer

Module 4: AWS Cloud Security

SECTION 2: AWS IDENTITY AND ACCESS MANAGEMENT (IAM)

AWS Identity and Access Management (IAM)

- Use IAM to manage access to AWS resources –
  - A resource is an entity in an AWS account that you can work with
  - Example resources; An Amazon EC2 instance or an Amazon S3 bucket

- *Example* – Control who can terminate Amazon EC2 instances

- Define fine-grained access rights –
  - Who can access the resource
  - Which resources can be accessed and what can the user do to the resource
  - How resources can be accessed

- IAM is a no-cost AWS account feature

AWS Identity and Access Management (IAM)

IAM: Essential components

IAM user

A person *or* application that can authenticate with an AWS account.

IAM group

A collection of IAM users that are granted identical authorization.

IAM policy

The document that defines which resources can be accessed and the level of access to each resource.

IAM role

Useful mechanism to grant a set of permissions for making AWS service requests.

Authenticate as an IAM user to gain access

When you define an **IAM user**, you select what *types of access* the user is permitted to use.

Programmatic access

- Authenticate using:
  - Access key ID
  - Secret access key
- Provides AWS CLI and AWS SDK access

AWS CLI

AWS Tools and SDKs

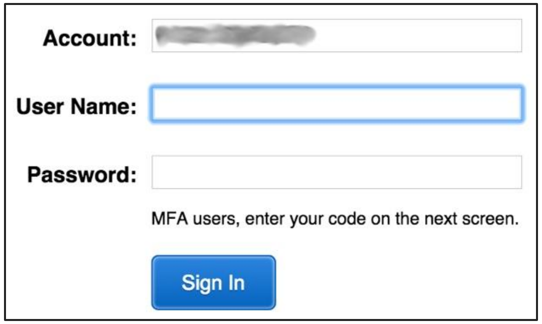
AWS Management Console access

- Authenticate using:
  - 12-digit Account ID *or* alias
  - IAM user name
  - IAM password
- If enabled, multi-factor authentication (MFA) prompts for an authentication code.

AWS Management Console

IAM MFA

- MFA provides increased security.
- In addition to **username** and **password**, MFA requires a unique authentication code to access AWS services.

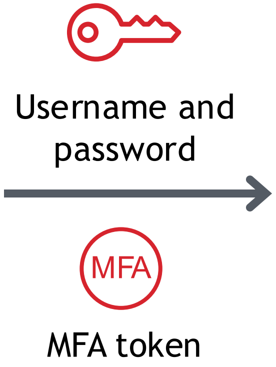


Account: [redacted]

User Name:

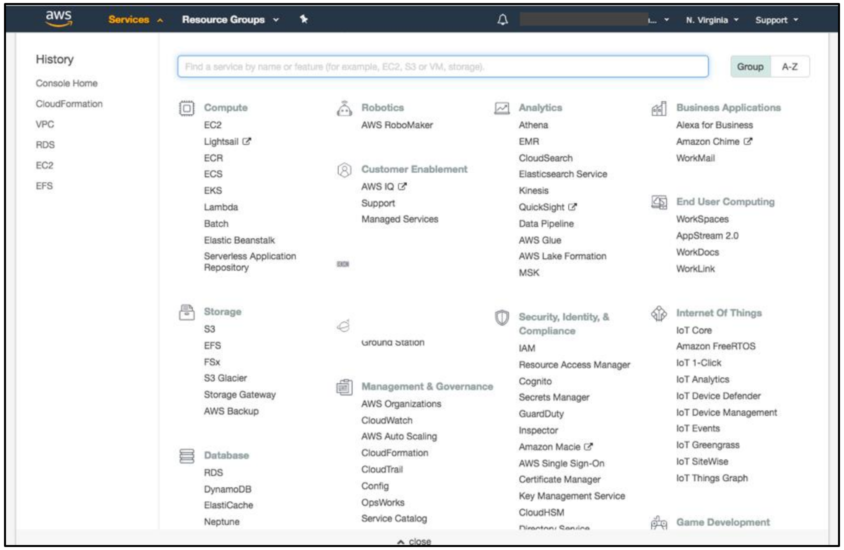
Password:

MFA users, enter your code on the next screen.



Username and password

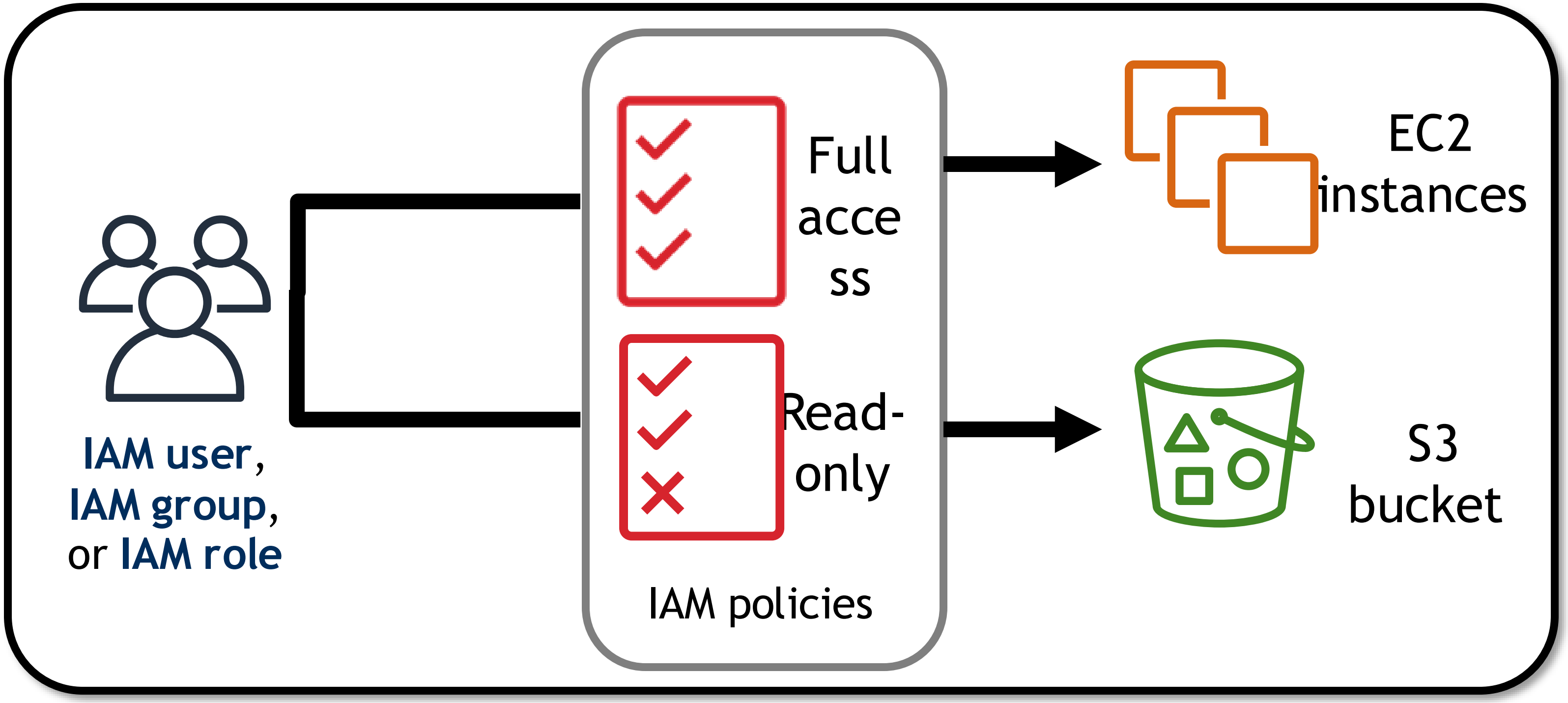
MFA token



AWS Management Console

Authorization: What actions are permitted

After the user or application is connected to the AWS account, what are they allowed to do?



IAM: Authorization

- Assign permissions by creating an IAM policy.
- Permissions determine **which resources and operations** are allowed:
  - All permissions are implicitly denied by default.
  - If something is explicitly denied, it is never allowed.

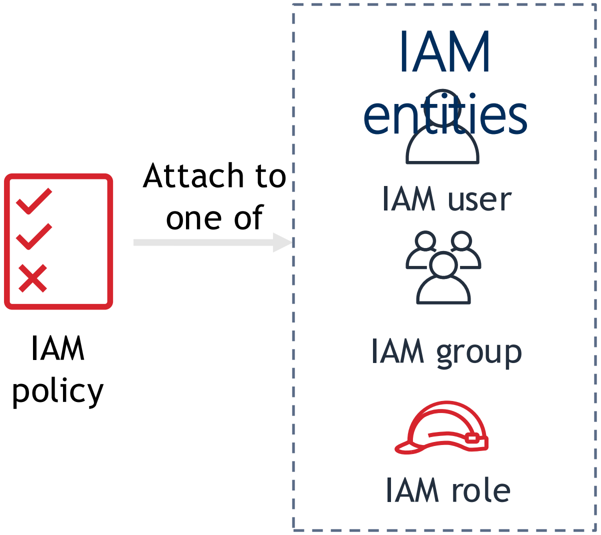
Best practice: Follow the principle of least privilege.

IAM permissions

Note: The scope of IAM service configurations is **global**. Settings apply across all AWS Regions.

IAM policies

- An IAM policy is a document that defines permissions
  - Enables fine-grained access control
- Two types of policies – *identity-based* and *resource-based*
- Identity-based policies –
  - Attach a policy to any IAM entity
    - An IAM user, an IAM group, or an IAM role
  - Policies specify:
    - Actions that *may* be performed by the entity
    - Actions that *may not* be performed by the entity
  - A single *policy* can be attached to multiple *entities*
  - A single *entity* can have multiple *policies* attached to it
- Resource-based policies
  - Attached to a resource (such as an S3 bucket)



IAM policy example

```
{
  "Version": "2012-10-17",
  "Statement":[{
    "Effect":"Allow",
    "Action":["DynamoDB:*","s3:*"],
    "Resource":[
       "arn:aws:dynamodb:region:account-number-without-hyphens:table/table-name",
     "arn:aws:s3:::bucket-name",
     "arn:aws:s3:::bucket-name/*"]
    },
    {
    "Effect":"Deny",
    "Action":["dynamodb:*","s3:*"],
    "NotResource":["arn:aws:dynamodb:region:account-number-without-hyphens:table/table-name”,
     "arn:aws:s3:::bucket-name",
     "arn:aws:s3:::bucket-name/*"]
    }
  ]
}
```

Explicit allow gives users access to a specific DynamoDB table and…

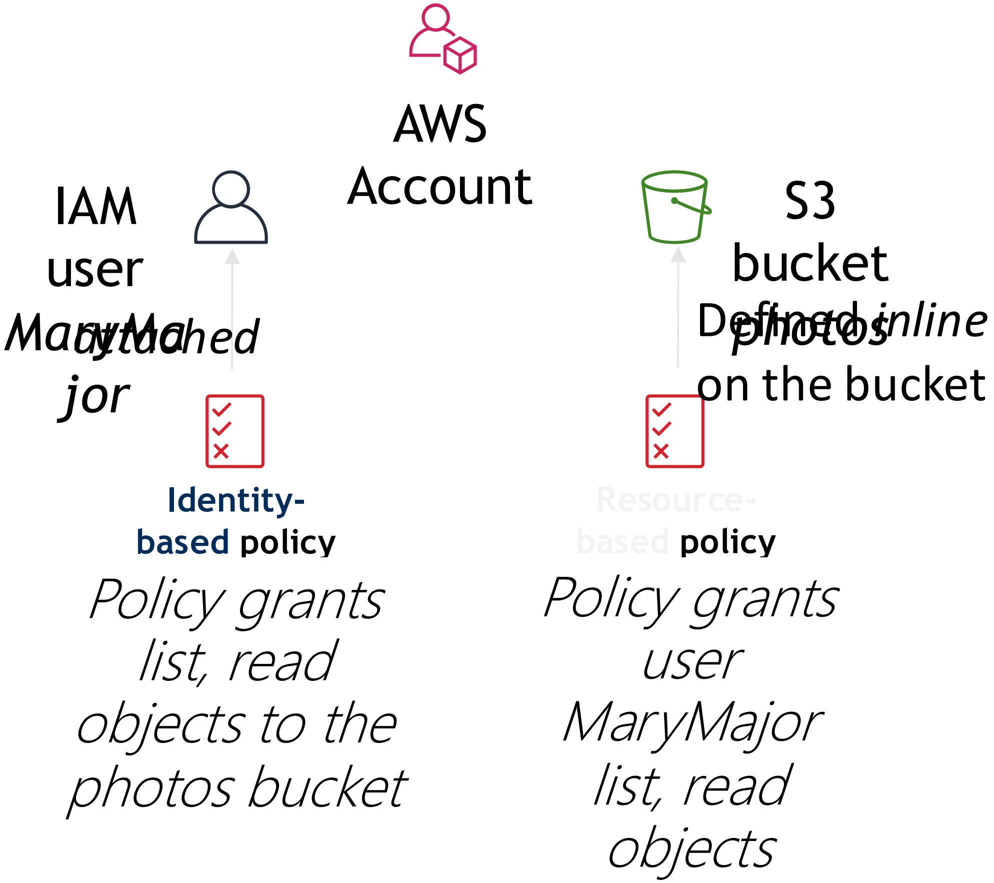
…Amazon S3 buckets.

Explicit deny ensures that the users cannot use any other AWS actions or resources other than that table and those buckets.

An explicit deny statement **takes precedence** over an allow statement.

Resource-based policies

- *Identity-based policies* are attached to a user, group, or role
- Resource-based policies are attached to a resource (*not* to a user, group or role)
- Characteristics of resource-based policies –
  - Specifies who has access to the resource and what actions they can perform on it
  - The policies are *inline* only, not managed
- Resource-based policies are supported only by some AWS services



AWS Account

IAM user *MaryMajor*

attached

S3 bucket *photos*

Defined *inline* on the bucket

Identity-based policy

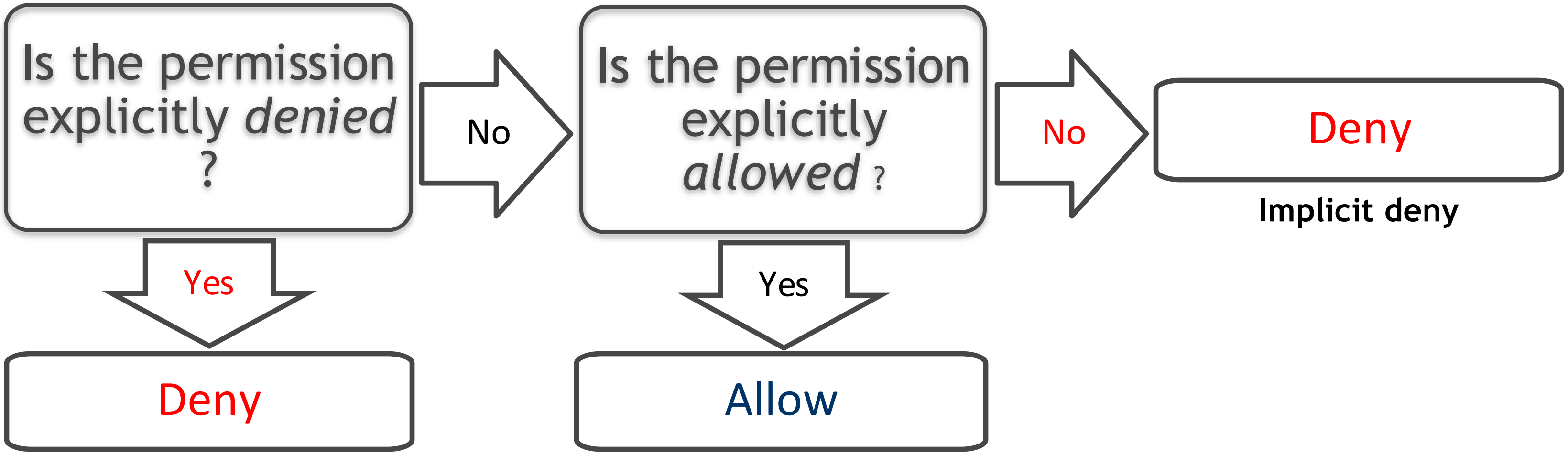
Policy grants list, read objects to the photos bucket

Resource-based policy

Policy grants user MaryMajor list, read objects

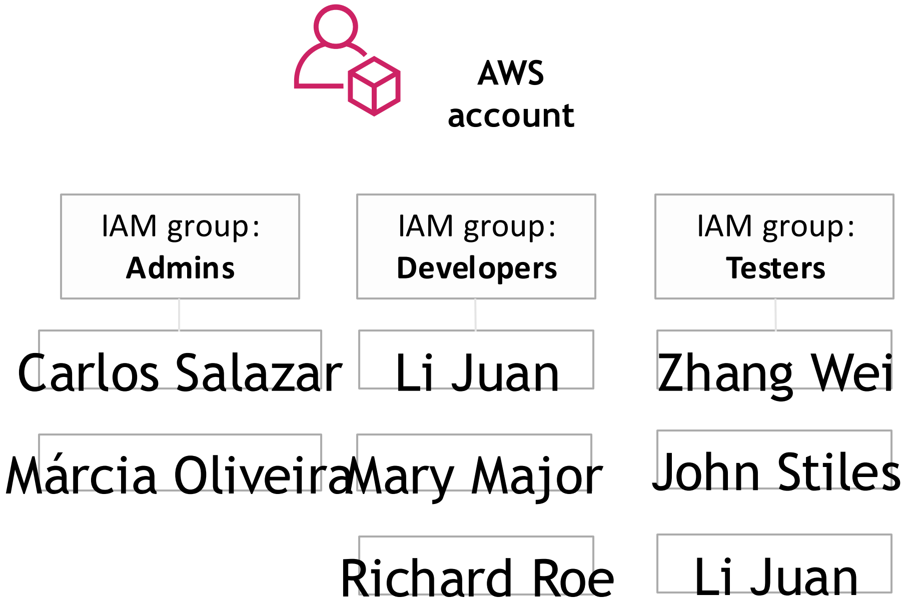
IAM permissions

How IAM determines permissions:


Is the permission explicitly *denied* ?
No
Is the permission explicitly *allowed* ?
No
Deny
Implicit deny
Yes
Deny
Yes
Allow

IAM groups

- An IAM group is a collection of IAM users
- A group is used to grant the same permissions to multiple users
  - Permissions granted by attaching IAM *policy* or policies to the group
- A user can belong to multiple groups
- There is no default group
- Groups cannot be nested



AWS account

IAM group: **Admins**

Carlos Salazar

Márcia Oliveira

IAM group: **Developers**

Li Juan

Mary Major

Richard Roe

IAM group: **Testers**

Zhang Wei

John Stiles

Li Juan

IAM roles

- An IAM role is an IAM identity with specific permissions
- Similar to an IAM user
  - Attach permissions policies to it
- Different from an IAM user
  - Not uniquely associated with one person
  - Intended to be *assumable* by a person, application, or service
- Role provides *temporary* security credentials
- Examples of how IAM roles are used to delegate access –
  - Used by an IAM user in the same AWS account as the role
  - Used by an AWS service—such as Amazon EC2—in the same account as the role
  - Used by an IAM user in a different AWS account than the role

IAM role

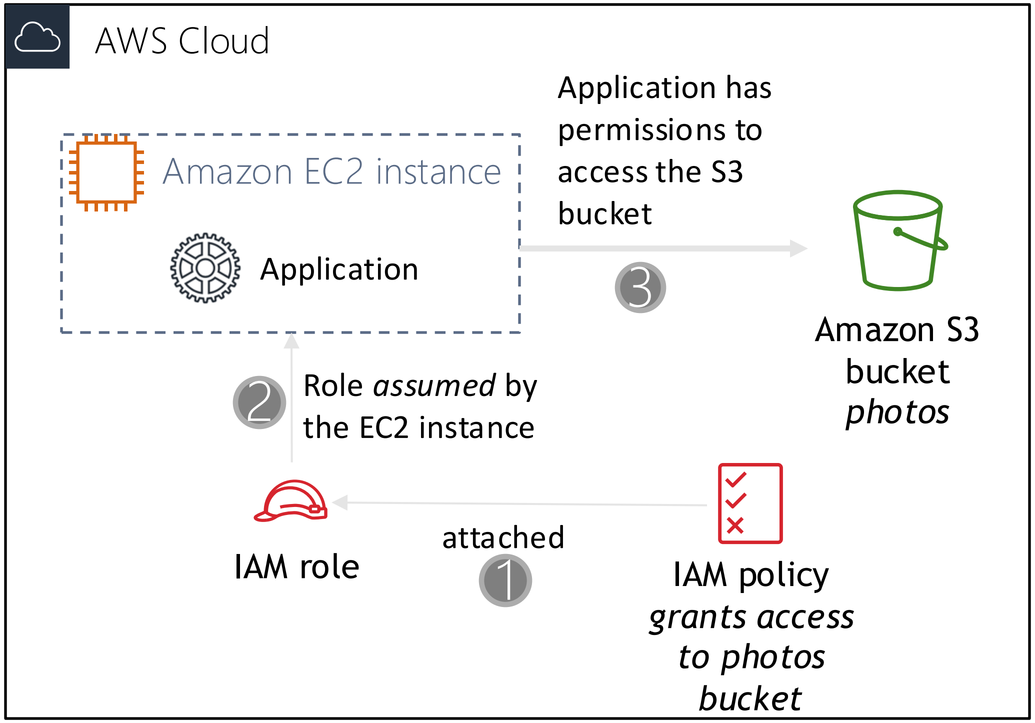
Example use of an IAM role

Scenario:

- An application that runs on an EC2 instance needs access to an S3 bucket

Solution:

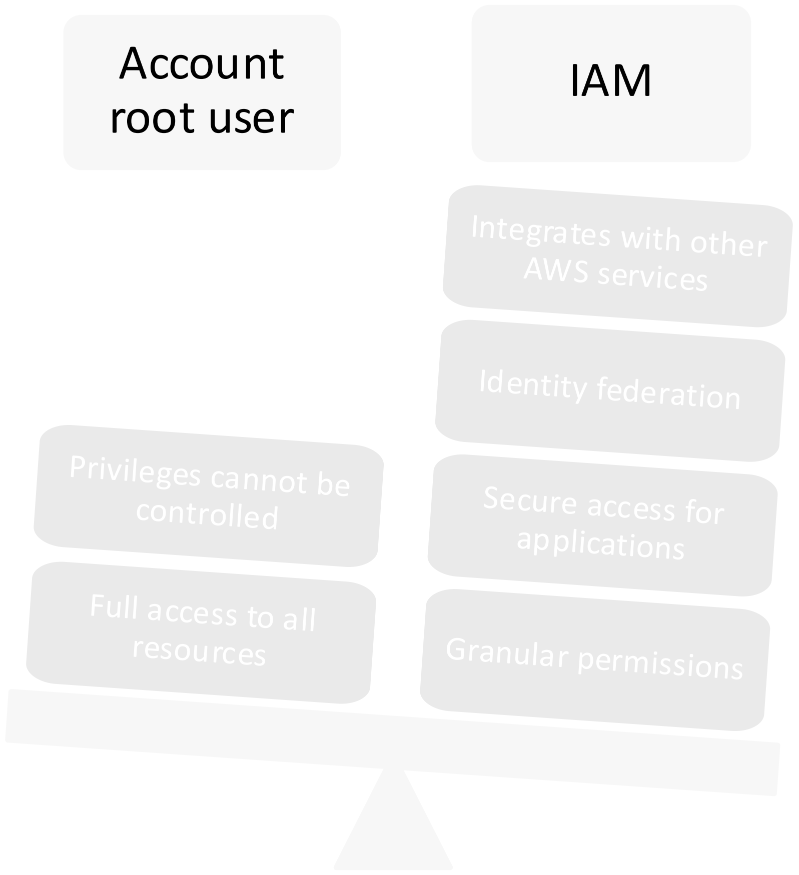
- Define an IAM policy that grants access to the S3 bucket.
- Attach the policy to a role
- Allow the EC2 instance to assume the role


AWS Cloud
Amazon EC2 instance
Application
Application has permissions to access the S3 bucket
3
Amazon S3 bucket *photos*
2
Role *assumed* by the EC2 instance
IAM role
attached
1
IAM policy *grants access to photos bucket*

Module 4: AWS Cloud Security

SECTION 3: SECURING A NEW AWS ACCOUNT

AWS account root user access versus IAM access


Account root user
IAM
Integrates with other AWS services
Identity federation
Secure access for applications
Granular permissions
Privileges cannot be controlled
Full access to all resources

- **Best practice**: Do not use the AWS account root user except when necessary.
  - Access to the account root user requires logging in with the *email address* **(and password)** that you used to create the account.
- Example actions that can only be done with the account root user:
  - Update the account root user password
  - Change the AWS Support plan
  - Restore an IAM user's permissions
  - Change account settings (for example, contact information, allowed Regions)

Securing a new AWS account: Account root user

Step 1: Stop using the account root user as soon as possible.

- The account root user has unrestricted access to all your resources.

- To stop using the account root user:
  1. While you are logged in as the account root user, create an IAM user for yourself. Save the access keys if needed.
  2. Create an IAM group, give it full administrator permissions, and add the IAM user to the group.
  3. Disable and remove your account root user access keys, if they exist.
  4. Enable a password policy for users.
  5. Sign in with your new IAM user credentials.
  6. Store your account root user credentials in a secure place.

Securing a new AWS account: MFA

Step 2: Enable multi-factor authentication (MFA).

- Require MFA for your account root user and for all IAM users.
- You can also use MFA to control access to AWS service APIs.

- Options for retrieving the MFA token –
  - Virtual MFA-compliant applications:
    - Google Authenticator.
    - Authy Authenticator (Windows phone app).
  - U2F security key devices:
    - For example, YubiKey.
  - Hardware MFA options:
    - Key fob or display card offered by Gemalto.

MFA

MFA token

Securing a new AWS account: AWS CloudTrail

Step 3: Use AWS CloudTrail.

- CloudTrail tracks user activity on your account.
  - Logs all API requests to resources in all supported services your account.
- Basic AWS CloudTrail event history is enabled by default and is free.
  - It contains all management event data on latest 90 days of account activity.

- To access CloudTrail –
  1. Log in to the **AWS Management Console** and choose the **CloudTrail** service.
  2. Click **Event history** to view, filter, and search the last 90 days of events.
- To enable logs beyond 90 days and enable specified event alerting, create a trail.
  1. From the CloudTrail Console trails page, click **Create trail**.
  2. Give it a name, apply it to all Regions, and create a new Amazon S3 bucket for log storage.
  3. Configure access restrictions on the S3 bucket (for example, only admin users should have access).

Securing a new AWS account: Billing reports

Step 4: Enable a billing report, such as the AWS Cost and Usage Report.

- Billing reports provide information about your use of AWS resources and estimated costs for that use.
- AWS delivers the reports to an Amazon S3 bucket that you specify.
  - Report is updated at least once per day.
- The **AWS Cost and Usage Report** tracks your AWS usage and provides estimated charges associated with your AWS account, either by the hour or by the day.

Module 4: AWS Cloud Security

SECTION 4: SECURING ACCOUNTS

AWS Organizations

- AWS Organizations enables you to consolidate multiple AWS accounts so that you centrally manage them.
- Security features of AWS Organizations:
  - Group AWS accounts into organizational units (OUs) and attach different access policies to each OU.
  - Integration and support for IAM
    - Permissions to a user are the intersection of what is allowed by AWS Organizations and what is granted by IAM in that account.
  - Use service control policies to establish control over the AWS services and API actions that each AWS account can access

AWS Organizations

AWS Organizations: Service control policies

- Service control policies (SCPs) offer centralized control over accounts.
  - Limit permissions that are available in an account that is part of an organization.
- Ensures that accounts comply with access control guidelines.
- SCPs are *similar* to IAM permissions policies –
  - They use similar syntax.
  - However, an SCP never grants permissions.
  - Instead, SCPs specify the maximum permissions for an organization.

AWS Key Management Service (AWS KMS)

AWS Key Management Service (AWS KMS) features:

- Enables you to **create and manage encryption keys**
- Enables you to control the use of encryption across AWS services and in your applications.
- Integrates with AWS CloudTrail to log all key usage.
- Uses hardware security modules (HSMs) that are validated by Federal Information Processing Standards (FIPS) 140-2 to protect keys

AWS Key Management Service (AWS KMS)

Amazon Cognito

Amazon Cognito features:

- Adds user sign-up, sign-in, and access control to your web and mobile applications.
- Scales to millions of users.
- Supports sign-in with social identity providers, such as Facebook, Google, and Amazon; and enterprise identity providers, such as Microsoft Active Directory via Security Assertion Markup Language (SAML) 2.0.

Amazon Cognito

AWS Shield

- AWS Shield features:
  - Is a managed distributed denial of service (DDoS) protection service
  - Safeguards applications running on AWS
  - Provides always-on detection and automatic inline mitigations
  - *AWS Shield Standard* enabled for at no additional cost. *AWS Shield Advanced* is an optional paid service.
- Use it to minimize application downtime and latency.

AWS Shield

Module 4: AWS Cloud Security

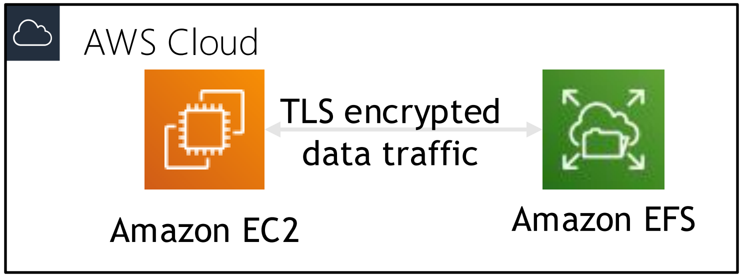
SECTION 5: SECURING DATA ON AWS

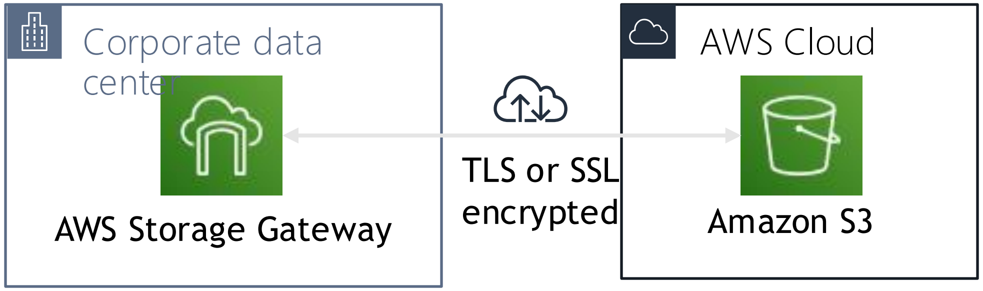
Encryption of data *at rest*

- Encryption encodes data with a secret key, which makes it unreadable
  - Only those who have the secret key can decode the data
  - AWS KMS can manage your secret keys
- AWS supports encryption of data at rest
  - Data at rest = Data stored physically (on disk or on tape)
  - You can encrypt data stored in any service that is supported by AWS KMS, including:
    - Amazon S3
    - Amazon EBS
    - Amazon Elastic File System (Amazon EFS)
    - Amazon RDS managed databases

Encryption of data *in transit*

- Encryption of data in transit (data moving across a network)
  - Transport Layer Security (TLS)—formerly SSL—is an open standard protocol
  - AWS Certificate Manager provides a way to manage, deploy, and renew TLS or SSL certificates
- Secure HTTP (HTTPS) creates a secure tunnel
  - Uses TLS or SSL for the bidirectional exchange of data
- AWS services support data in transit encryption.
  - Two examples:





Securing Amazon S3 buckets and objects

- Newly created S3 buckets and objects are private and protected by default.
- When use cases require sharing data objects on Amazon S3 –
  - It is essential to manage and control the data access.
  - Follow the **permissions that follow the principle of least privilege** and consider using Amazon S3 encryption.
- Tools and options for controlling access to S3 data include –
  - Amazon S3 Block Public Access feature: Simple to use.
  - IAM policies: A good option when the user can authenticate using IAM.
  - Bucket policies
  - Access control lists (ACLs): A legacy access control mechanism.
  - AWS Trusted Advisor bucket permission check: A free feature.

Module 4: AWS Cloud Security

SECTION 6: WORKING TO ENSURE COMPLIANCE

AWS compliance programs

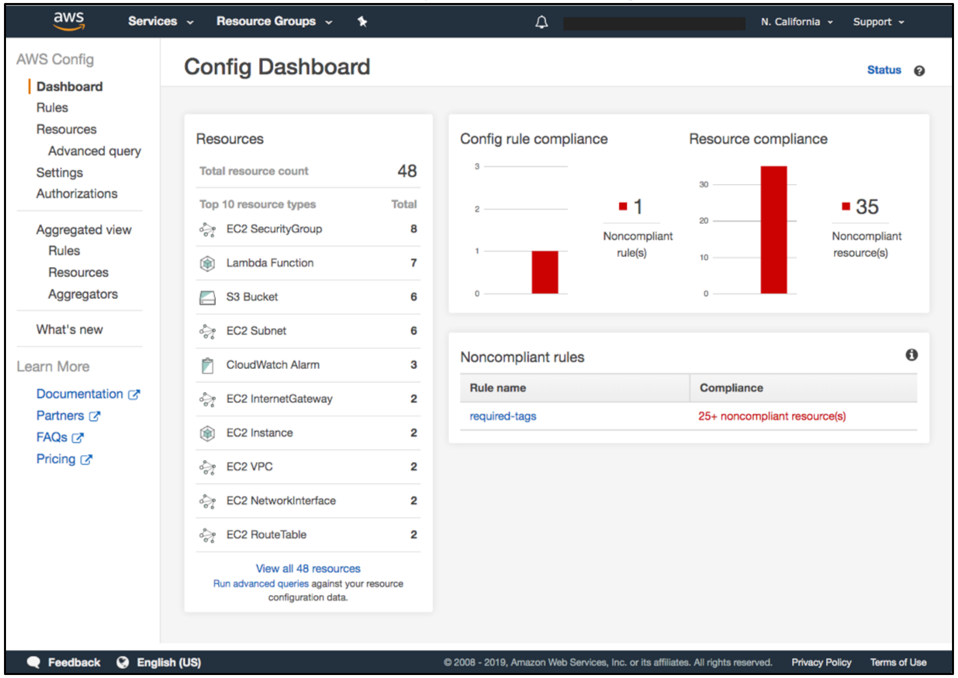
- Customers are subject to many different security and compliance regulations and requirements.
- AWS engages with certifying bodies and independent auditors to provide customers with detailed information about the policies, processes, and controls that are established and operated by AWS.

- Compliance programs can be broadly categorized –
  - Certifications and attestations
    - Assessed by a third-party, independent auditor
    - Examples: ISO 27001, 27017, 27018, and ISO/IEC 9001
  - Laws, regulations, and privacy
    - AWS provides security features and legal agreements to support compliance
    - Examples: EU General Data Protection Regulation (GDPR), HIPAA
  - Alignments and frameworks
    - Industry- or function-specific security or compliance requirements
    - Examples: Center for Internet Security (CIS), EU-US Privacy Shield certified

AWS Config

AWS Config

Example AWS Config Dashboard view



[redacted]

AWS Config
- Dashboard
- Rules
- Resources
  - Advanced query
- Settings
- Authorizations

- Aggregated view
  - Rules
  - Resources
  - Aggregators

What's new

Learn More
- Documentation
- Partners
- FAQs
- Pricing

Config Dashboard

Status

Resources

Total resource count 48

Top 10 resource types	Total
EC2 SecurityGroup	8
Lambda Function	7
S3 Bucket	6
EC2 Subnet	6
CloudWatch Alarm	3
EC2 InternetGateway	2
EC2 Instance	2
EC2 VPC	2
EC2 NetworkInterface	2
EC2 RouteTable	2

View all 48 resources

Run advanced queries against your resource configuration data.

Config rule compliance

Resource compliance

Noncompliant rules

Rule name	Compliance
required-tags	25+ noncompliant resource(s)

Feedback
English (US)
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- ➢ Assess, audit, and evaluate the configurations of AWS resources.
- ➢ Use for continuous monitoring of configurations.
- ➢ Automatically evaluate *recorded* configurations versus *desired* configurations.
- ➢ Review configuration changes.
- ➢ View detailed configuration histories.
- ➢ Simplify compliance auditing and security analysis.

AWS Artifact

AWS Artifact

- Is a resource for compliance-related information
- Provide access to security and compliance reports, and select online agreements
- Can access example downloads:
  - AWS ISO certifications
  - Payment Card Industry (PCI) and Service Organization Control (SOC) reports
- Access AWS Artifact directly from the AWS Management Console
  - Under **Security, Identify & Compliance**, click **Artifact**.