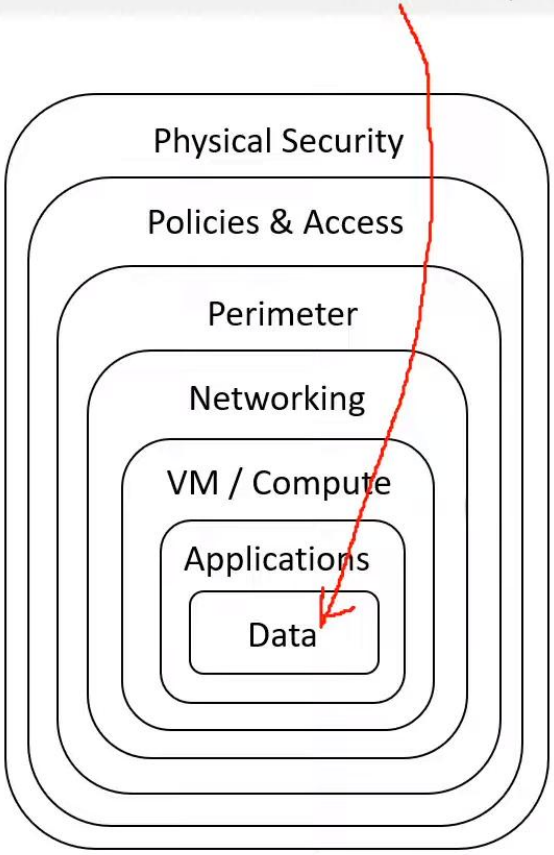
Defense in Depth



The 7 Layers of Security

1. Data
access to business and customer data, and encryption to protect data.

2. Application
applications are secure and free of security vulnerabilities.

3. Compute
Access to virtual machines (ports, on-premise, cloud)

4. Network
limit communication between resources using segmentation and access controls.

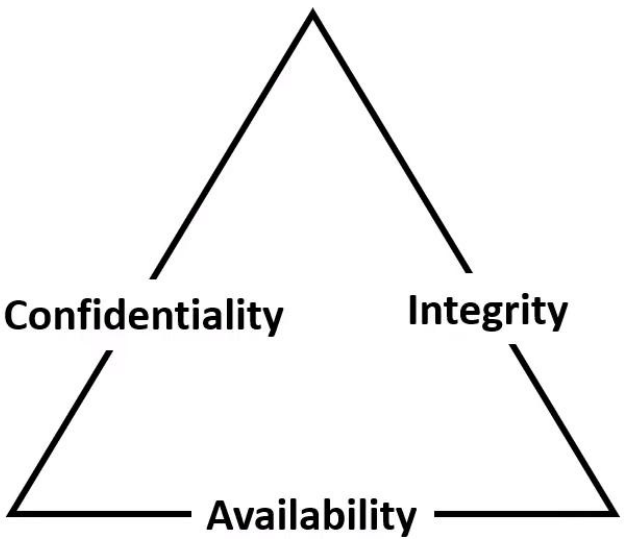
5. Perimeter
distributed denial of service (DDoS) protection to filter large-scale attacks before they can cause a denial of service for users.

6. Identity and access
controlling access to infrastructure and change control.

7. Physical
limiting access to a datacenter to only authorized personnel.

Confidentiality, Integrity, Availability (CIA)

Confidentiality, Integrity, and Availability (CIA) triad is a model describing the foundation to security principles and their trade-off relationship.



Confidentiality
confidentiality is a component of privacy that implements to protect our data from unauthorized viewers. In practice this can be using cryptographic keys to encrypt our data, and using keys to encrypt our keys (envelope encryption)

Integrity
maintaining and assuring the accuracy and completeness of data over its entire lifecycle. In Practice utilizing ACID compliant databases for valid transactions. Utilizing tamper-evident or tamper proof Hardware security modules. (HSM)

Availability
information needs to be made be available when needed
In Practice: High Availability, Mitigating DDoS, Decryption access

The CIA triad was first mentioned in a **NIST publication from 1977.**
There have been efforts to expand and modernize or suggest alternatives to CIA triad:

- (1998) Six Atomic Elements of Information eg. confidentiality, possession, integrity, authenticity, availability, and utility
- (2004) NIST Engineering Principles for Information Technology Security — 33 security principles

Vulnerabilities

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/clf-c01

What is a vulnerability?

a hole or a weakness in the application, which can be a design flaw or an implementation bug, that allows an attacker to cause harm to the stakeholders of an application

Allowing Domains or Accounts to Expire
Buffer Overflow
Business logic vulnerability
CRLF Injection
CSV Injection
Catch NullPointerException
Covert storage channel
Deserialization of untrusted data
Directory Restriction Error
Doubly freeing memory
Empty String Password
Expression Language Injection
Full Trust CLR Verification issue
Heartbleed Bug
Improper Data Validation
Improper pointer subtraction
Information exposure through query strings
Injection problem
Insecure Compiler Optimization
Insecure Randomness
Insecure Temporary File
Insecure Third Party Domain Access
Insecure Transport
Insufficient Entropy
Insufficient Session-ID Length
Least Privilege Violation
Memory leak
Missing Error Handling
Missing XML Validation
Multiple admin levels
Null Dereference
OWASP .NET Vulnerability Research
Overly Permissive Regular Expression
PHP File Inclusion
PHP Object Injection
PRNG Seed Error
Password Management Hardcoded Password
Password Plaintext Storage
Poor Logging Practice
Portability Flaw
Privacy Violation
Process Control
Return Inside Finally Block
Session Variable Overloading
String Termination Error
Unchecked Error Condition
Unchecked Return Value Missing Check against Null
Undefined Behavior
Unreleased Resource
Unrestricted File Upload
Unsafe JNI
Unsafe Mobile Code
Unsafe function call from a signal handler
Unsafe use of Reflection
Use of Obsolete Methods
Use of hard-coded password
Using a broken or risky cryptographic algorithm
Using freed memory
Vulnerability template
XML External Entity (XXE) Processing

Encryption

What is cryptography?

The practice and study of techniques for secure communication in the presence of third parties called adversaries

What is encryption?

The process of encoding (scrabbling) information **using** a **key** and a **cypher** to store sensitive data in an unintelligible format as a means of protection. An encryption takes in plaintext and produces **ciphertext**.

The **enigma machine** was used during WW2. A different key for each day was used to set the position of the rotors. It relied on simple cypher substitution.

Cyphers

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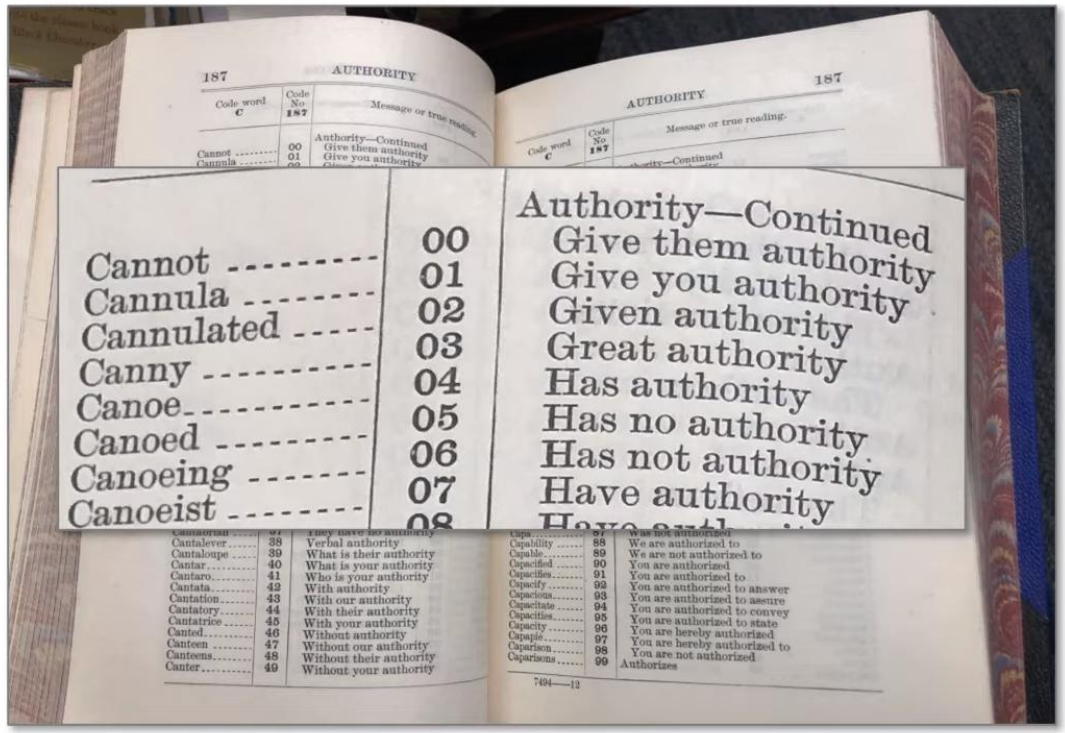
What is a cypher?

An algorithm that performs encryption or decryption. Cipher is synonymous with “code”

What is ciphertext

Ciphertext is the result of encryption performed on plaintext via an algorithm

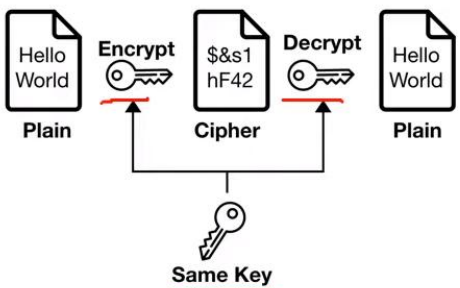


A **codebook** is a type of document used for gathering and storing cryptography codes

Cryptographic Keys

What is a cryptographic key?

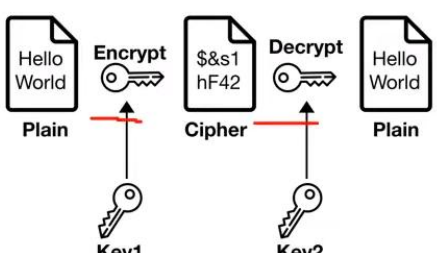
A key is a variable used in conjunction with an encryption algorithm in order to encrypt or decrypt data.



What is symmetric encryption?

The same key is used for encoding and decoding.

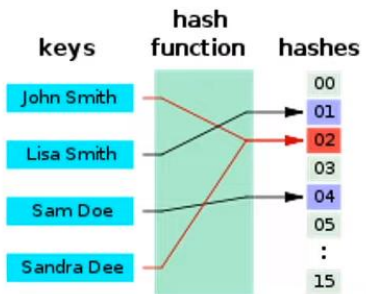
eg **Advanced Encryption Standard (AES)**



What is asymmetric encryption?

Two keys are used. One to encode and one to decode eg. **Rivest–Shamir–Adleman (RSA)**

Hashing and Salting



What is hashing function?
A function that accepts arbitrary size value and maps it to a fixed-size data structure. Hashing can reduce the size of the store value.

Hashing is a **one-way process** and is **deterministic**
A deterministic function always returns the same output for the same input.

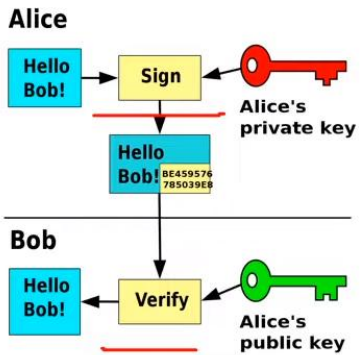
Hashing Passwords
Hashing functions are used to store passwords in database so that a password does not reside in a plaintext format.

To authenticate a user, when a user inputs their password, it is hashed, and the hash is compared to the store hashed. If they match then the user has successful logged in.

Popular hashing functions are **MD5, SHA256 and Bcrypt**
If an attacker knowns what function you are using and stole your database, they could enumerate a dictionary of password to determine the password.

Salting Passwords
A salt is a random string not known to the attacker that the hash function accepts to mitigate the deterministic nature of hashing functions

Digital Signatures and Signing



What is a digital signature

A mathematical scheme for verifying the authenticity of digital messages or documents.

A Digital signature gives us **tamper-evidence** .

- Did someone mess (modify) the data?
- Is this data is not from the expected sender?

There are three algorithms to digital signatures:

- **Key generation** – generates a public and private key.
- **Signing** - the process of generating a digital signature with a **private key** and inputted message
- **Signing verification –** verify the authenticity of the message with a **public key**

```
ssh-keygen -t rsa
```

SSH uses a public and private key to authorize remote access into a remote machine e.g. Virtual Machine. It is common to use RSA
ssh-keygen is a **well known command** to generate a public and private key

What is Code Signing?

When you use a digital signature to ensure **computer code** has not been tampered

In-Transit vs At-Rest Encryption

Encryption In-Transit
Data that is secure when moving between locations
Algorithms: **TLS, SSL**

Encryption At-Rest
Data that is secure when residing on storage or within a database
Algorithms: **AES, RSA**

Transport Layer Security (TLS)
An encryption protocol for data integrity between two or more communicating computer application.
TLS 1.0, 1.1 are deprecated. **TLS 1.2** and **1.3** is the current best practice

Secure Sockets Layers (SSL)
An encryption protocol for data integrity between two or more communicating computer application
SSL 1.0, 2.0 and 3.0 *are deprecated*

Common Compliance Programs

Compliance Programs

A set of internal policies and procedures of a company to comply with laws, rules, and regulations or to uphold business reputation.

Health Insurance Portability and Accountability Act of 1996) is United States legislation that provides data privacy and security provisions for safeguarding medical information.

The Payment Card Industry Data Security Standard (PCI DSS)

When you want to sell things online and you need to handle credit card information.

Common Compliance Programs

International Organization for Standardization (ISO) / International Electrotechnical Commission

ISO/IEC 27001 — control implementation guidance

ISO/IEC 27017 — enhanced focus on cloud security

ISO/IEC 27018 — protection of personal data in the cloud. eg. PII

ISO/IEC 27701 — Privacy Information Management System (PIMS) framework

- outlines controls and processes to manage data privacy and protect PII.

System and Organization Controls (SOC)

SOC 1 — 18 standard and report on the effectiveness of internal controls (SSAE) at a service organization

- relevant to their client's internal control over financial reporting (ICFR).

SOC 2 — evaluates internal controls, policies, and procedures that directly relate to the security of a system at a service organization

SOC 3 — A report based on the Trust Services Criteria that can be freely distributed

Payment Card Industry Data Security Standard (PCI DSS)

a set of security standards designed to ensure that ALL companies that accept, process, store or transmit credit card information maintain a secure environment.

Federal Information Processing Standard (FIPS) 140-2

US and Canadian government standard that specifies the security requirements for cryptographic modules that protect sensitive information.

Common Compliance Programs

Personal Health Information Protection Act (PHIPA)
An Ontario provincial law (Canada) that regulates patient Protected Health Information

Health Insurance Portability and Accountability Act (HIPAA).
US federal law that regulates patient Protected Health Information

Cloud Security Alliance (CSA) STAR Certification
Independent third-party assessment of a cloud provider's security posture

Common Compliance Programs

Cheat sheets, Practice Exams and Flash cards 👉 www.exampro.co/clf-c01

Federal Risk and Authorization Management Program (FedRAMP)
US government standardized approach to security authorizations for Cloud Service Offerings

Criminal Justice Information Services (CJIS)
Any US state or local agency that wants to access the FBI's CJIS database is required to adhere to the CJIS Security Policy.

General Data Protection Regulation (GDPR)
A European privacy law. Imposes new rules on companies, government agencies, non-profits, and other organizations that offer goods and services to people in the European Union (EU), or that collect and analyze data tied to EU residents.

Penetration Testing

What is PenTesting?

An authorized simulated cyberattack on a computer system, performed to evaluate the security of the system.

Pen Testing **is allowed** to be performed on AWS!

Permitted Services

- Amazon EC2 instances
- NAT Gateways
- 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

- **Prohibited Activities**
- DNS zone walking via Amazon Route 53 Hosted Zones
- *Subject to the **DDoS Simulation Testing policy**
  - 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)

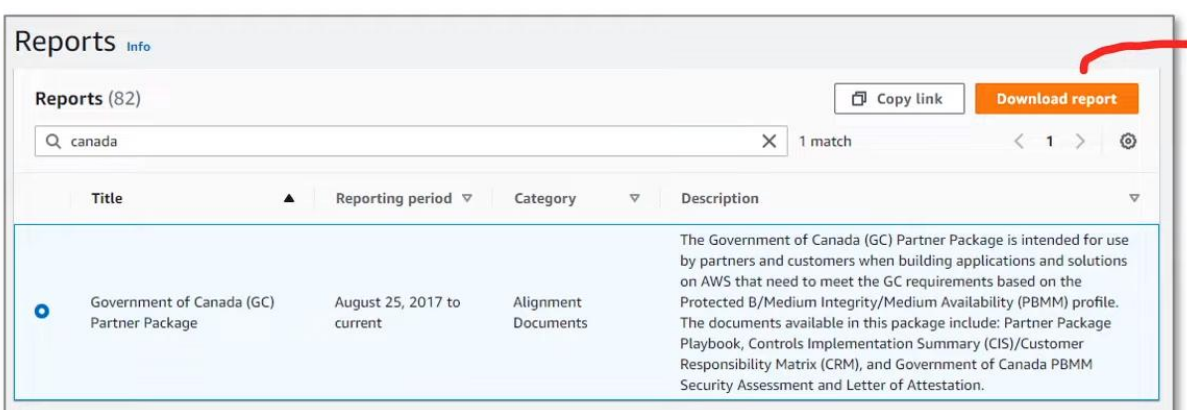
For **Other Simulated Events** you will need to submit a request to AWS. A reply could take up to 7 days.

AWS Artifact

AWS Artifact is a self-serve portal for on-demand access to **AWS compliance reports**

AICPA SOC · ISO 27001 · PCI Security Standards Council PARTICIPATING ORGANIZATION · C5 · irap · FR FedRAMP

Choose you report



View the PDF

PDF

XLSX

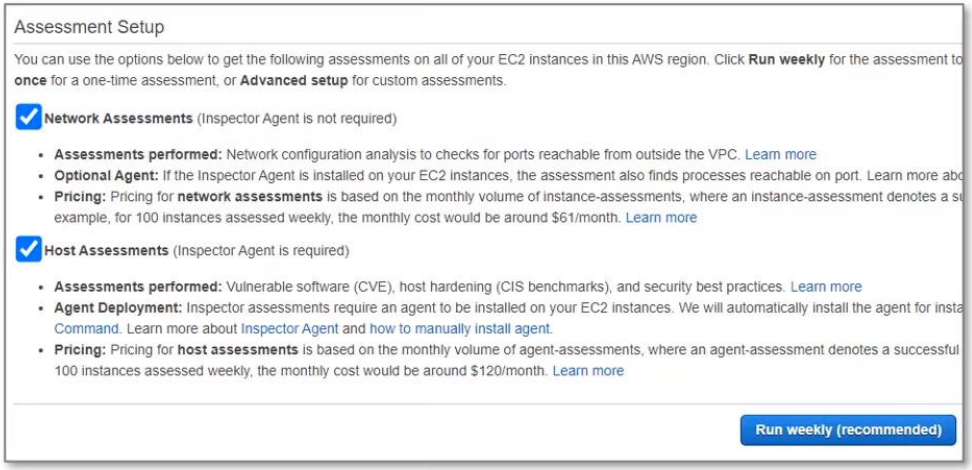
Download the Excel

AWS Inspector

What is Hardening?

The act of eliminating as many **security** risks as possible. Hardening is common for Virtual Machines where you run a collection of security checks known as a security benchmark

AWS Inspector runs a **security benchmark** against specific EC2 instances.
You can run a variety of security benchmarks.
Can perform both **Network** and **Host** Assessments



- Install the AWS agent on your EC2 instances.
- Run an assessment for your assessment target.
- Review your findings and remediate security issues.

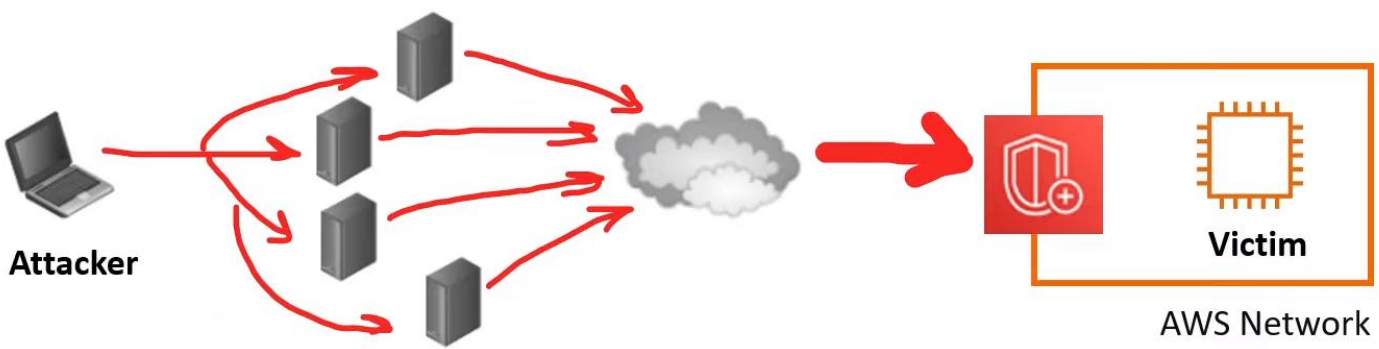
One very popular benchmark you can run is by CIS which has **699 checks!**

CIS Center for Internet Security®

Distributed Denial of Service (DDoS)

What is a DDoS (Distributed Denial of Service) Attack?

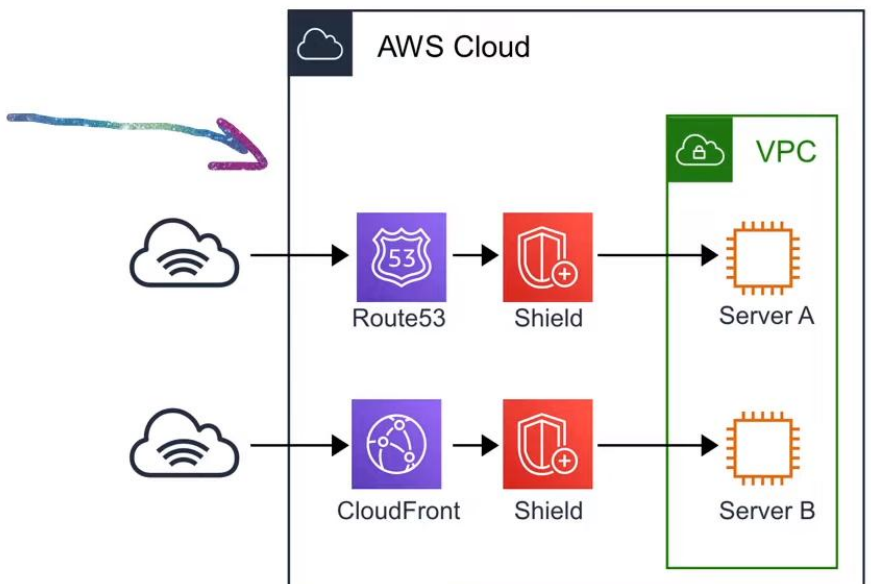
A malicious attempt to disrupt normal traffic by flooding a website with large amounts of fake traffic.



AWS Shield

AWS Shield is a **managed** DDoS (Distributed Denial of Service) protection service that safeguards applications running on AWS

When you route your traffic through **Route53** or **CloudFront** you are using **AWS Shield Standard**



Protects you against **Layer 3, 4** and **7** attacks

- 7 Application
- 4 Transport
- 3 Network

AWS Shield

Shield Standard FREE

protection against most common DDoS attacks

- access to tools and best practices to build a DDoS resilient architecture.
- Automatically available on all AWS services.

Shield Advanced *3000 USD / Year

additional protection against larger and more sophisticated attacks

Available On

- Amazon Route 53
- Amazon CloudFront
- Elastic Load Balancing
- AWS Global Accelerator
- Elastic IP (Amazon EC1 and Network Load Balancer)

Notable Features

- Visibility and Reporting on Layer 3,4 and 7
- Access to Team and Support (with Business or Enterprise Support)
- DDoS Cost Protection
- Comes with SLA

Both plans integrate with AWS Web Application Firewall (WAF) to give you Layer 7 (Application) protection

Amazon Guard Duty

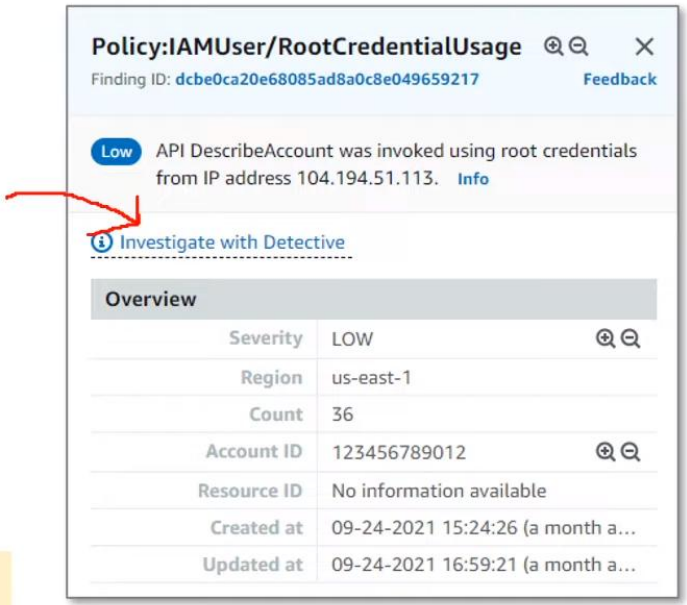
What is IDS/IPS?

Intrusion Detection System and Intrusion Protection System.

A device or software application that monitors a network or systems for malicious activity or policy violations.

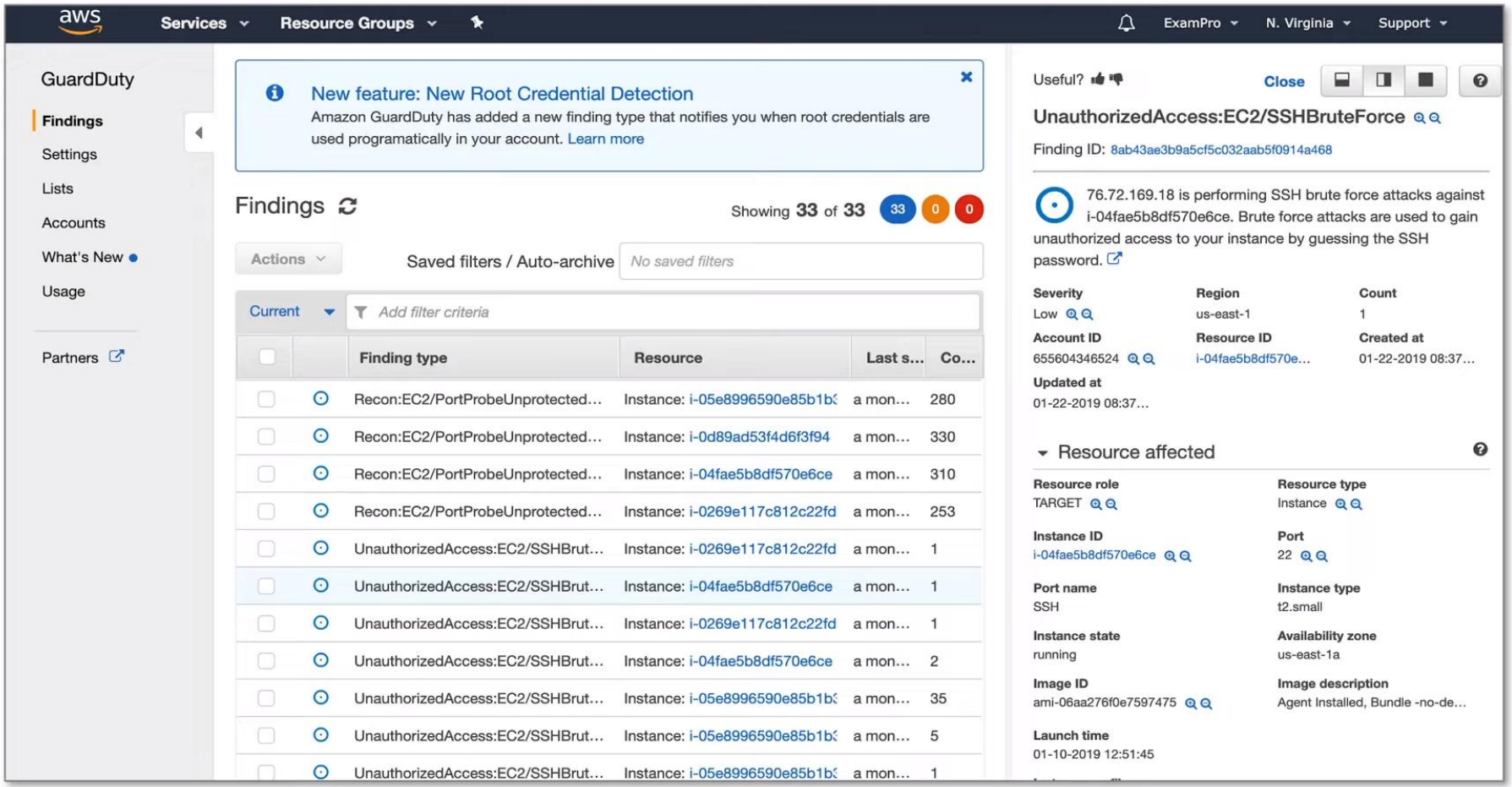
Guard Duty is a **threat detection service** that continuously monitors for malicious, suspicious activity and unauthorized behavior. It uses Machine Learning to analyze the following AWS logs:

- CloudTrail Logs
- VPC Flow Logs
- DNS logs



It will alert you of **Findings** which you can automate a incident response via CloudWatch Events or with 3rd Party Services

Amazon Guard Duty



Amazon Macie

Macie is a fully managed service that continuously monitors **S3 data access** activity for anomalies, and generates detailed alerts when it detects risk of unauthorized access or inadvertent data leaks.

Macie works by uses Machine Learning to Analyze your CloudTrail logs

Macie has a variety of alerts

- Anonymized Access
- Config Compliance
- Credential Loss
- Data Compliance
- File Hosting
- Identity Enumeration
- Information Loss
- Location Anomaly
- Open Permissions
- Privilege Escalation
- Ransomware
- Service Disruption
- Suspicious Access

Macie's will identify your most at-risk users which could lead to a compromise

AWS Virtual Private Network (VPN)

AWS VPN lets you establish a **secure** and **private tunnel** from your network or device to the AWS global network

AWS Site-to-Site VPN
securely connect on-premises network or branch office site to VPC

AWS Client VPN
securely connect users to AWS or on-premises networks

What is IPSec?
Internet Protocol Security (IPsec) is a secure network protocol suite that authenticates and encrypts the packets of data to provide secure encrypted communication between two computers over an Internet Protocol network. It is used in virtual private networks (VPNs)

AWS WAF

AWS **Web Application Firewall (WAF)** protect your web applications from common web exploits

Write your own **rules** to ALLOW or DENY traffic based on the contents of an HTTP requests

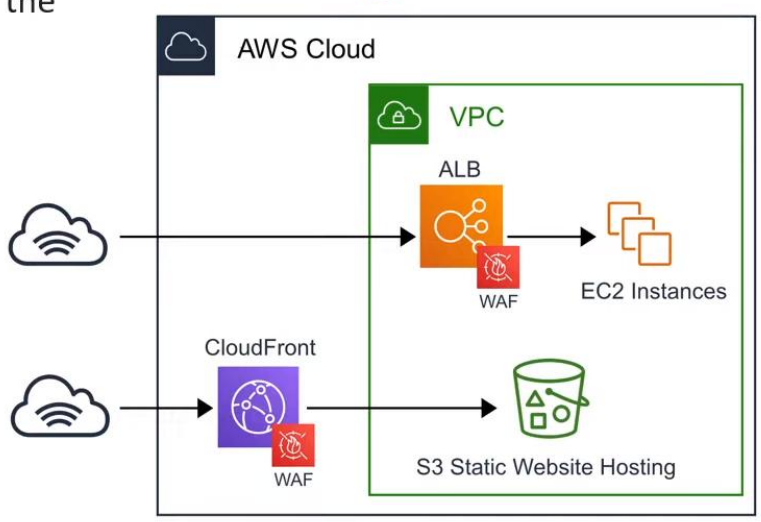
Use a **ruleset** from a trusted AWS Security Partner in the AWS WAF Rules Marketplace

WAF can be attached to either **CloudFront** or an **Application Load Balancer**

OWASP Open Web Application Security Project

Protect web applications from attacks covered in the **OWASP Top 10** most dangerous attacks:

1. Injection
2. Broken Authentication
3. Sensitive data exposure
4. XML External Entities (XXE)
5. Broken Access control
6. Security misconfigurations
7. Cross Site Scripting (XSS)
8. Insecure Deserialization
9. Using Components with known vulnerabilitie
10. Insufficient logging and monitoring



Hardware Security Module (HSM)

A **Hardware Security Module (HSM)**.
Its a piece of hardware designed to store encryption keys.
HSM hold keys in memory and never write them to disk.

Federal Information Processing Standard (FIPS)
US and Canadian government standard that specifies the security requirements for cryptographic modules that protect sensitive information.

HSM's that are **multi-tenant** are **FIPS 140-2 Level 2 Compliant**
(multiple customers virtually isolated on an HSM)

eg. AWS KMS

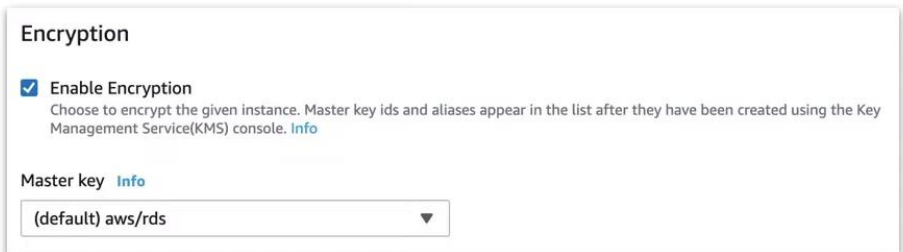
HSM's that are **single-tenant** are **FIPS 140-2 Level 3 Compliant**
(single customer on a dedicated HSM)

eg. AWS CloudHSM

AWS Key Management Service

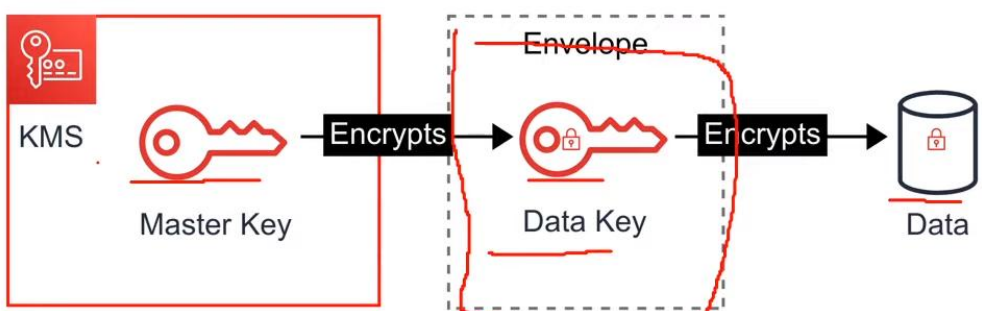
AWS Key Management Service (KMS) is a managed service that makes it easy for you to create and control the encryption keys used to encrypt your data.

- KMS is a multi-tenant HSM (hardware security module)
- Many AWS services are integrated to use KMS to encrypt your data with a simple checkbox
- KMS uses Envelope Encryption.



Envelope Encryption
When you encrypt your data, your data is protected, but you have to protect your encryption key.

When you encrypt your data key with a master key as an additional layer of security.



CloudHSM

CloudHSM is a single-tenant HSM as a service that automates hardware provisioning, software patching, high availability and backups.

AWS CloudHSM enables you to generate and use your encryption keys on a FIPS 140-2 Level 3 validated hardware.

Built on Open HSM industry standards to integrate with:

- PKCS#11
- Java Cryptogrpahy Extensions (JCE)
- Microsoft CryptoNG (CNG) libraries

You can also transfer your keys to other commercial HSM solutions to make it easy for you to migrate keys on or off of AWS.

Configure AWS KMS to use AWS CloudHSM cluster as a custom key store rather than the default KMS key store.