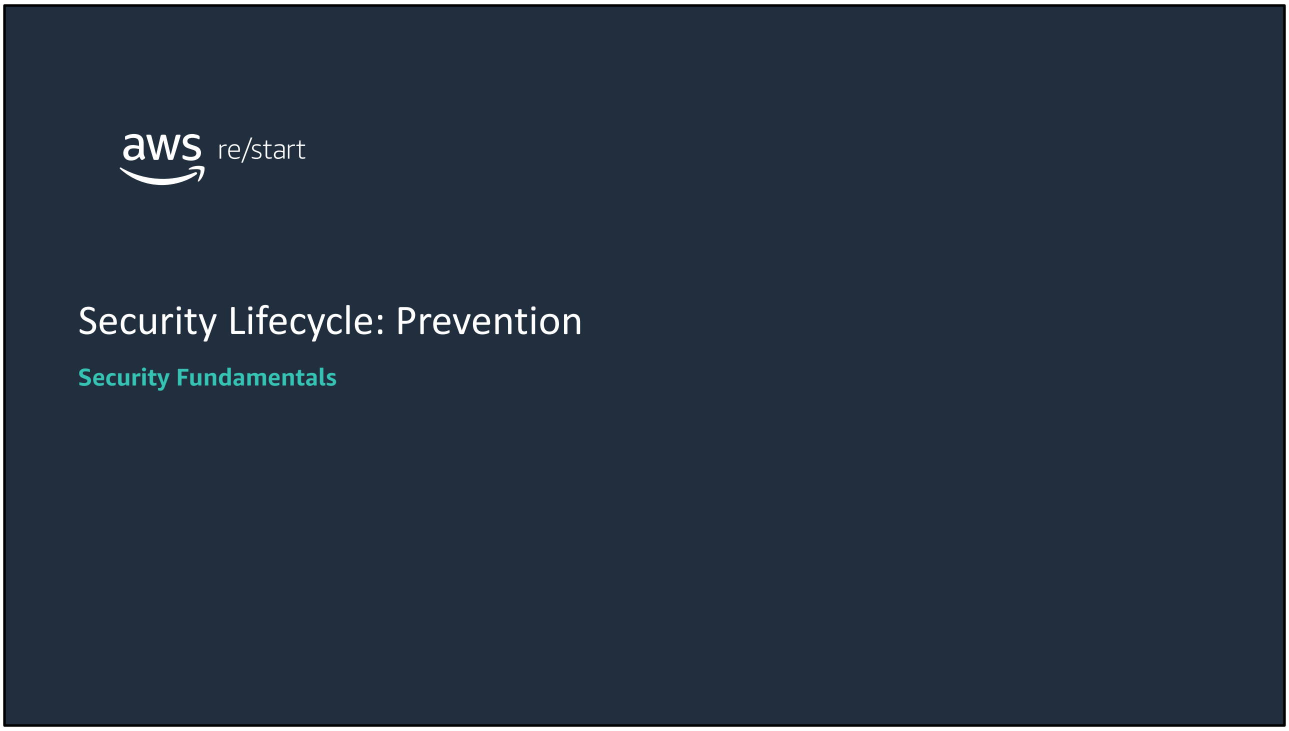

aws re/start

Security Lifecycle: Prevention

Security Fundamentals

Welcome to Security Lifecycle: Prevention.

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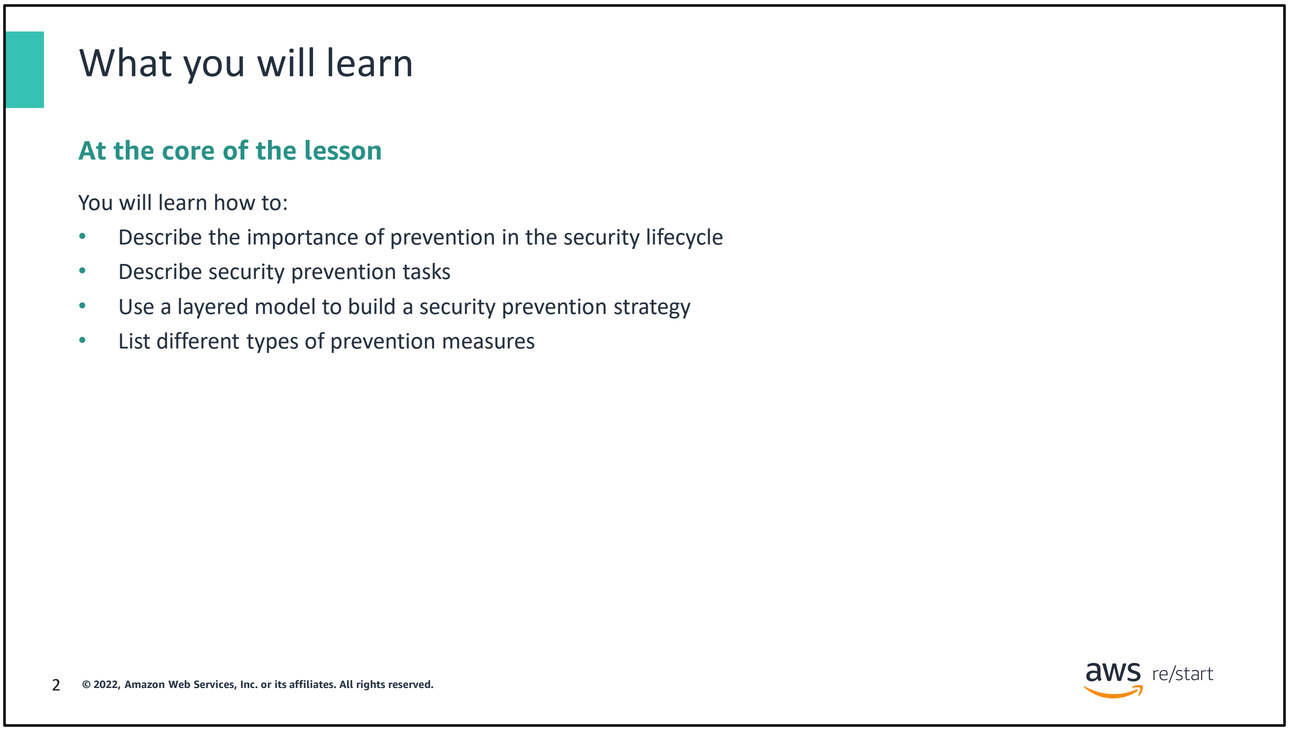


What you will learn

At the core of the lesson

You will learn how to:

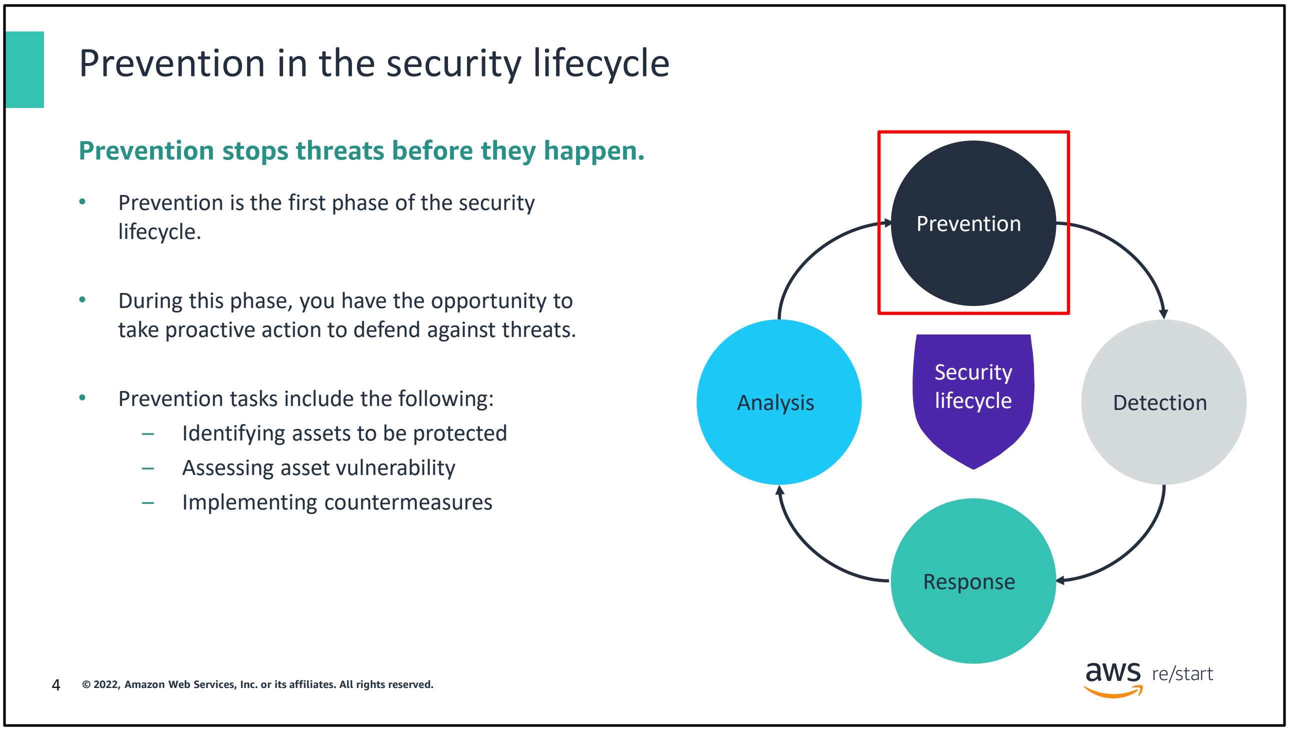
- Describe the importance of prevention in the security lifecycle
- Describe security prevention tasks
- Use a layered model to build a security prevention strategy
- List different types of prevention measures

In this lesson, you will learn how to:

- Describe the importance of prevention in the security lifecycle
- Describe security prevention tasks
- Use a layered model to build a security prevention strategy
- List different types of prevention measures

Introduction to prevention

This section introduces the importance of prevention in the security lifecycle and identifies major prevention tasks.



Prevention in the security lifecycle

Prevention stops threats before they happen.

- Prevention is the first phase of the security lifecycle.
- During this phase, you have the opportunity to take proactive action to defend against threats.
- Prevention tasks include the following:
  - Identifying assets to be protected
  - Assessing asset vulnerability
  - Implementing countermeasures

Security lifecycle

Prevention

Detection

Response

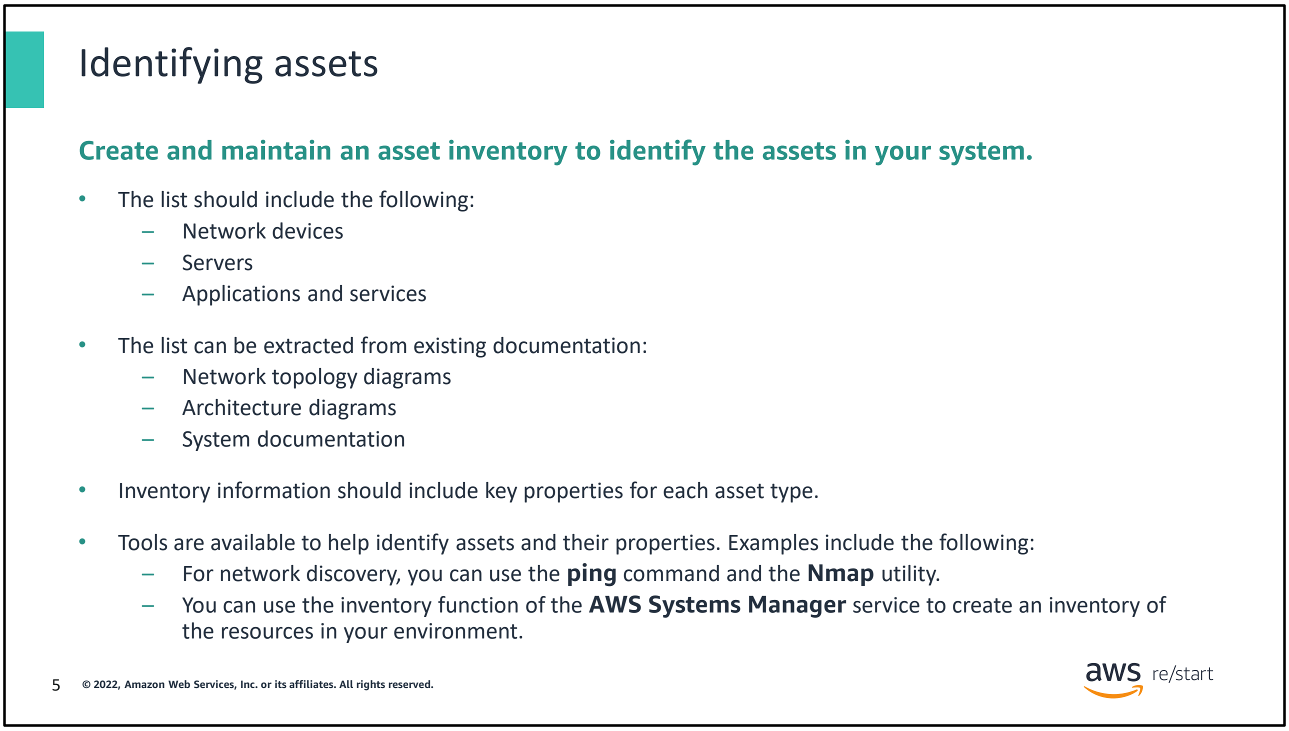
Analysis

Prevention is the first and arguably the most important phase of the security lifecycle. It offers the opportunity to proactively stop threats from becoming breaches through the implementation of security controls.

In the prevention stage, you:

- Identify the assets to be protected: You build an inventory of the networking devices, computers, applications, and other physical and digital resources that you must protect.
- Assess asset vulnerability: You examine each asset in the inventory and determine the type and level of protection that the asset needs.
- Implement countermeasures: For each asset to be protected, you implement security controls to prevent attacks against the asset from being successful.

The next slides examine these tasks in more detail.



Identifying assets

Create and maintain an asset inventory to identify the assets in your system.

- The list should include the following:
  - Network devices
  - Servers
  - Applications and services
- The list can be extracted from existing documentation:
  - Network topology diagrams
  - Architecture diagrams
  - System documentation
- Inventory information should include key properties for each asset type.
- Tools are available to help identify assets and their properties. Examples include the following:
  - For network discovery, you can use the **ping** command and the **Nmap** utility.
  - You can use the inventory function of the **AWS Systems Manager** service to create an inventory of the resources in your environment.

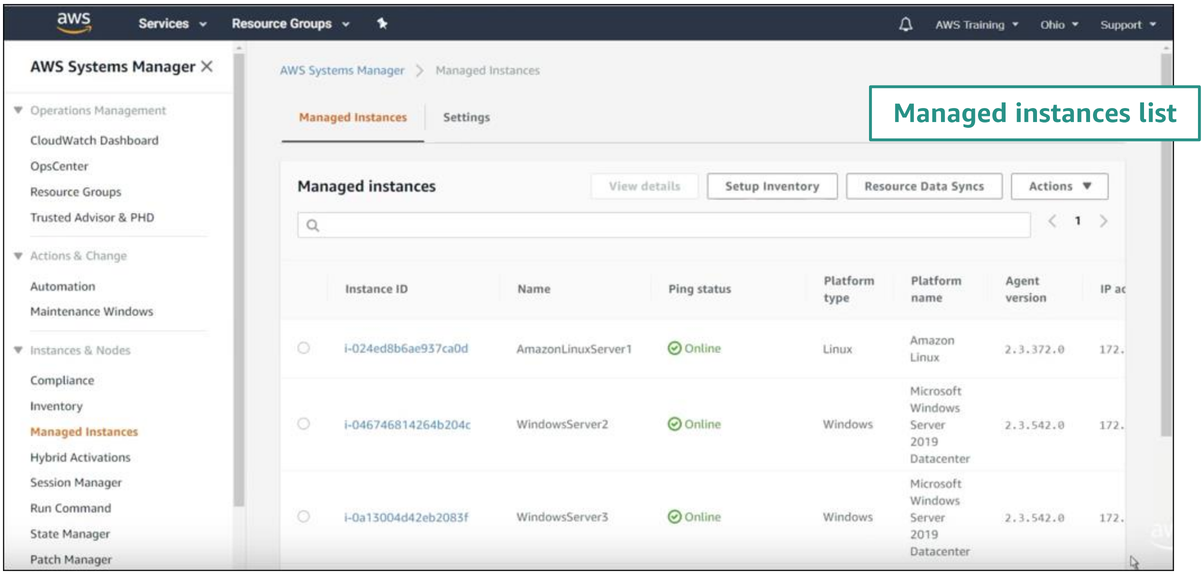
You must know what resources are in your computing environment so that you can protect them. Therefore, the first step in prevention is to create an inventory of your computing assets. This inventory can be extracted from existing design documents, such as network topology diagrams, architecture diagrams, and other system documentation. The list should provide a clear understanding of what components are in your environment. It also should convey what their key properties are (for example, the IP address of network devices) and how they relate to each other.

Various tools can help you in this task. For example, for network discovery:

- You can use the ping command to determine the IP address of hosts in your environment and their reachability.
- You can use the open-source Nmap utility to discover the available hosts on a network and gather important information such as the services that they're running.

In the AWS Cloud, the AWS Systems Manager service provides an inventory function that you can use to list the managed instances in your account. For each instance, the service can identify key information, such as the instance's IP address and operating system and the applications installed on the instance.

AWS Systems Manager inventory function example (1 of 3)



Managed instances

	Instance ID	Name	Ping status	Platform type	Platform name	Agent version	IP ac
○	i-024ed8b6ae937ca0d	AmazonLinuxServer1	✓ Online	Linux	Amazon Linux	2.3.372.0	172.
○	i-046746814264b204c	WindowsServer2	✓ Online	Windows	Microsoft Windows Server 2019 Datacenter	2.3.542.0	172.
○	i-0a13004d42eb2083f	WindowsServer3	✓ Online	Windows	Microsoft Windows Server 2019 Datacenter	2.3.542.0	172.

Managed instances list

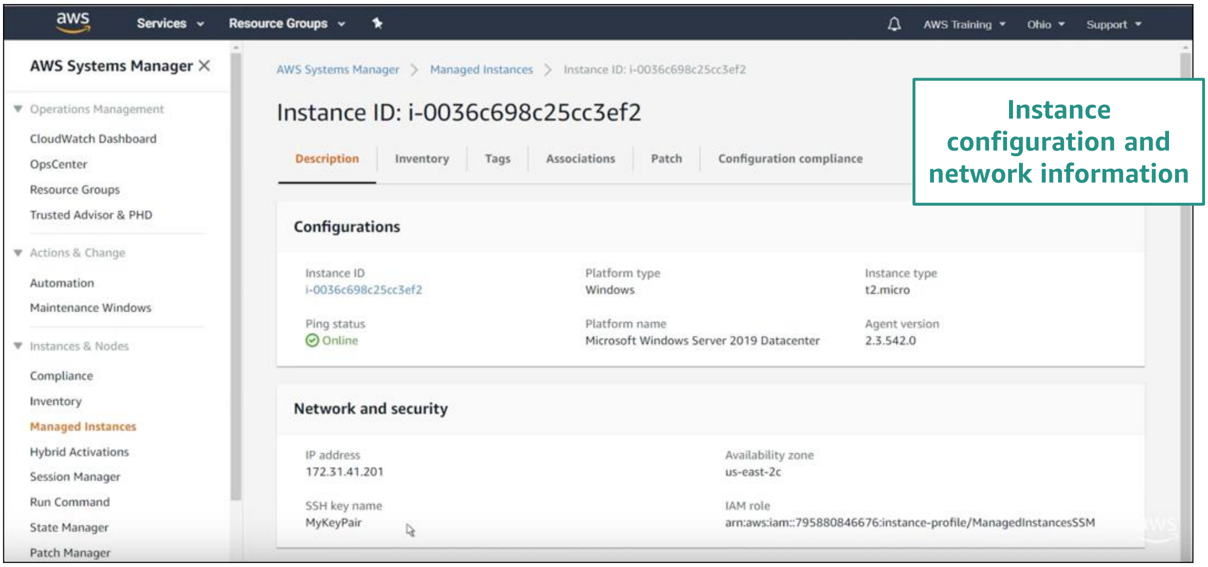
aws re/start

The next three slides show example screen captures of the AWS Systems Manager console. These screen captures illustrate the information that the Systems Manager inventory function provides.

The screen capture on this slide shows the Managed Instances tab of the Systems Manager console. This tab displays a list of all of the managed Amazon Elastic Compute Cloud (Amazon EC2) instances in the user's AWS account.

The information displayed for each instance includes its ID, name, ping status (which reflects the instance's state), platform type, and IP address.

AWS Systems Manager inventory function example (2 of 3)



Instance ID: i-0036c698c25cc3ef2

Configurations

Instance ID: i-0036c698c25cc3ef2

Platform type: Windows

Instance type: t2.micro

Ping status: Online

Platform name: Microsoft Windows Server 2019 Datacenter

Agent version: 2.3.542.0

Network and security

IP address: 172.31.41.201

Availability zone: us-east-2c

SSH key name: MyKeyPair

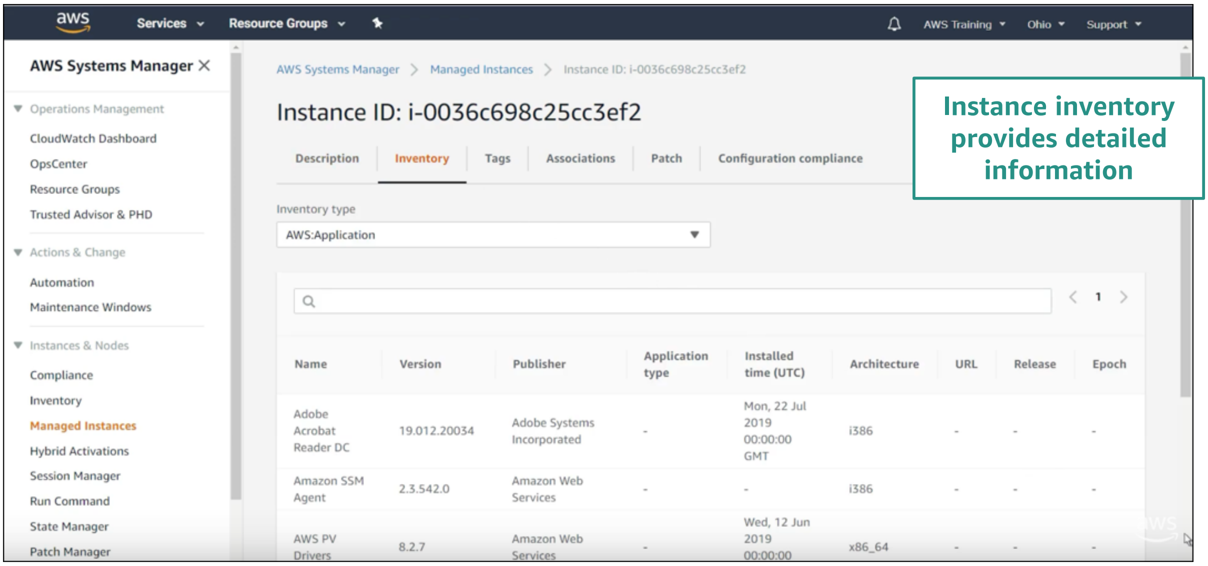
IAM role: arn:aws:iam::795880846676:instance-profile/ManagedInstancesSSM

Instance configuration and network information

When you select an instance from the Managed Instances list, the console shows additional information about the instance through several tabs.

On the Description tab, you see more configuration details, including the **Availability Zone** where the instance is running. It also displays security information, such as the **key pair** that is used to remotely log in to the instance. You will learn more about EC2 instance key pairs later in the course.

AWS Systems Manager inventory function example (3 of 3)



Instance ID: i-0036c698c25cc3ef2

Inventory type: AWS:Application

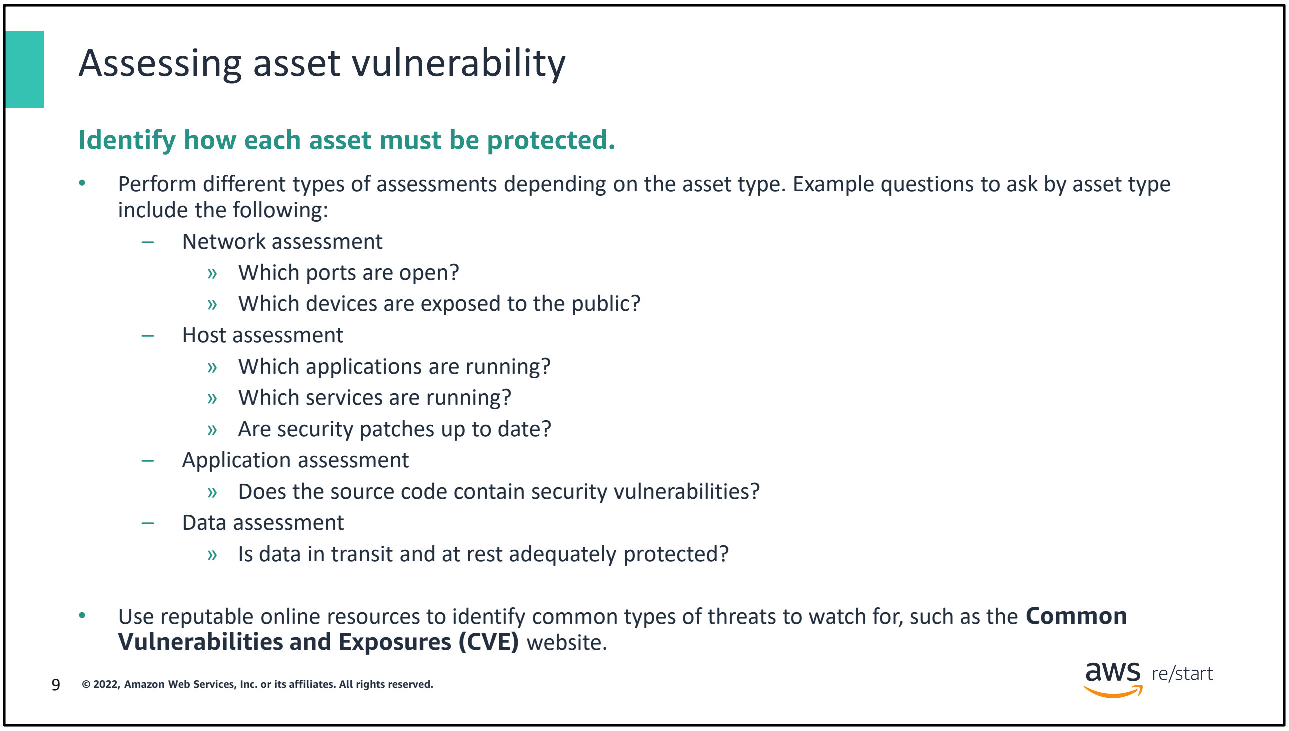
Name	Version	Publisher	Application type	Installed time (UTC)	Architecture	URL	Release	Epoch
Adobe Acrobat Reader DC	19.012.20034	Adobe Systems Incorporated	-	Mon, 22 Jul 2019 00:00:00 GMT	i386	-	-	-
Amazon SSM Agent	2.3.542.0	Amazon Web Services	-	-	i386	-	-	-
AWS PV Drivers	8.2.7	Amazon Web Services	-	Wed, 12 Jun 2019 00:00:00	x86_64	-	-	-

Instance inventory provides detailed information

On the Inventory tab for a selected EC2 instance, you can see the various types of detailed inventory information that AWS Systems Manager captures. This information includes the following:

- **Installed applications:** Names, version, and publisher
- **Installed AWS components:** Drivers, such as EC2 drivers, and agents, such as the Systems Manager agent
- **Files:** Name, size, version, creation date, modification, and last accessed times
- **Network configuration:** IP address, media access control (MAC) address, subnet mask, and Domain Name System (DNS) servers
- **Windows updates:** Hotfix ID, installed by, and installed date
- **Services:** Name, status, dependent services, service type, and start type
- **Instance details:** System name, operating systems (OS) name, OS version, and OS architecture

The screen capture on this slide shows the list of installed applications on the selected EC2 instance.



Assessing asset vulnerability

Identify how each asset must be protected.

- Perform different types of assessments depending on the asset type. Example questions to ask by asset type include the following:
  - Network assessment
    - Which ports are open?
    - Which devices are exposed to the public?
  - Host assessment
    - Which applications are running?
    - Which services are running?
    - Are security patches up to date?
  - Application assessment
    - Does the source code contain security vulnerabilities?
  - Data assessment
    - Is data in transit and at rest adequately protected?
- Use reputable online resources to identify common types of threats to watch for, such as the **Common Vulnerabilities and Exposures (CVE)** website.

As soon as you have identified your list of assets, you can perform a vulnerability assessment on each one of them. The goal of vulnerability assessment is to search for security weaknesses or potential exposures so that you can implement countermeasures against them. It involves analyzing the asset's security posture by asking questions relevant to the asset type, its intended use, and its desired level of protection.

Some example questions to evaluate the security posture of an asset are shown in this slide by asset type. In general, its functions include the following:

- **The host assessment** evaluates how vulnerable servers are to attacks.
- **The network assessment** evaluates the accessibility of networks and network devices.
- **The data assessment** examines the level of protection for data traveling through the system (data in transit) and data stored in the system (data at rest). It protects this data from the perspective of the confidentiality, integrity, and availability (CIA) triad.
- **The application assessment** evaluates the security vulnerability in an application's source code.

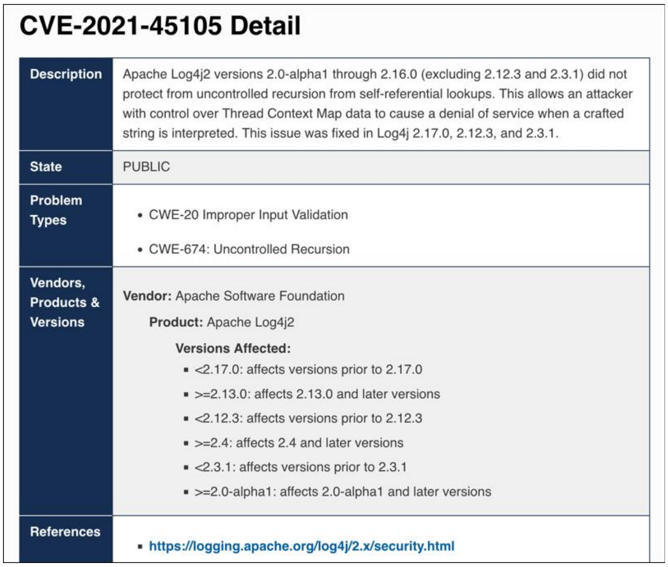
As you analyze the security vulnerability of an asset, you should consider the potential threats. It is often useful to know the common types of threats that have been identified in the industry for the asset’s type. One resource that provides such information is the Common Vulnerabilities and Exposures (CVE) website (https://cve.mitre.org/). The CVE website is an online resource that lists publicly disclosed cybersecurity vulnerabilities. The United States government’s Cyber Security and Infrastructure Agency (CISA) sponsors this website.

Automated tools, such as database scanners and application scanners, are available to help identify both existing and potential security vulnerabilities. When they detect a known vulnerability, some of the scanning tools point to the corresponding CVE entry.

Common vulnerabilities and exposures example

Vulnerability information includes:

- Identification of the affected component
- Description of the threat
- Identification of a fix
- References to additional vulnerability details



CVE-2021-45105 Detail

Description	Apache Log4j2 versions 2.0-alpha1 through 2.16.0 (excluding 2.12.3 and 2.3.1) did not protect from uncontrolled recursion from self-referential lookups. This allows an attacker with control over Thread Context Map data to cause a denial of service when a crafted string is interpreted. This issue was fixed in Log4j 2.17.0, 2.12.3, and 2.3.1.
State	PUBLIC
Problem Types	• CWE-20 Improper Input Validation • CWE-674: Uncontrolled Recursion
Vendors, Products & Versions	**Vendor:** Apache Software Foundation **Product:** Apache Log4j2 **Versions Affected:** ▪ <2.17.0: affects versions prior to 2.17.0 ▪ >=2.13.0: affects 2.13.0 and later versions ▪ <2.12.3: affects versions prior to 2.12.3 ▪ >=2.4: affects 2.4 and later versions ▪ <2.3.1: affects versions prior to 2.3.1 ▪ >=2.0-alpha1: affects 2.0-alpha1 and later versions
References	▪ https://logging.apache.org/log4j/2.x/security.html

This slide shows an example of a vulnerability that was recorded in the CVE website. It identifies the vulnerability as affecting the **Apache Log4j2** software and describes the threat as potentially causing a **denial of service** attack. It also indicates **that a later version of the software includes a fix**.

Implementing countermeasures

Establish a security strategy, and implement measures to protect assets.

- Use a layered security prevention strategy.
- Implement prevention measures through the following:
  - Network hardening
  - Systems hardening
  - Data security controls
  - Identity management

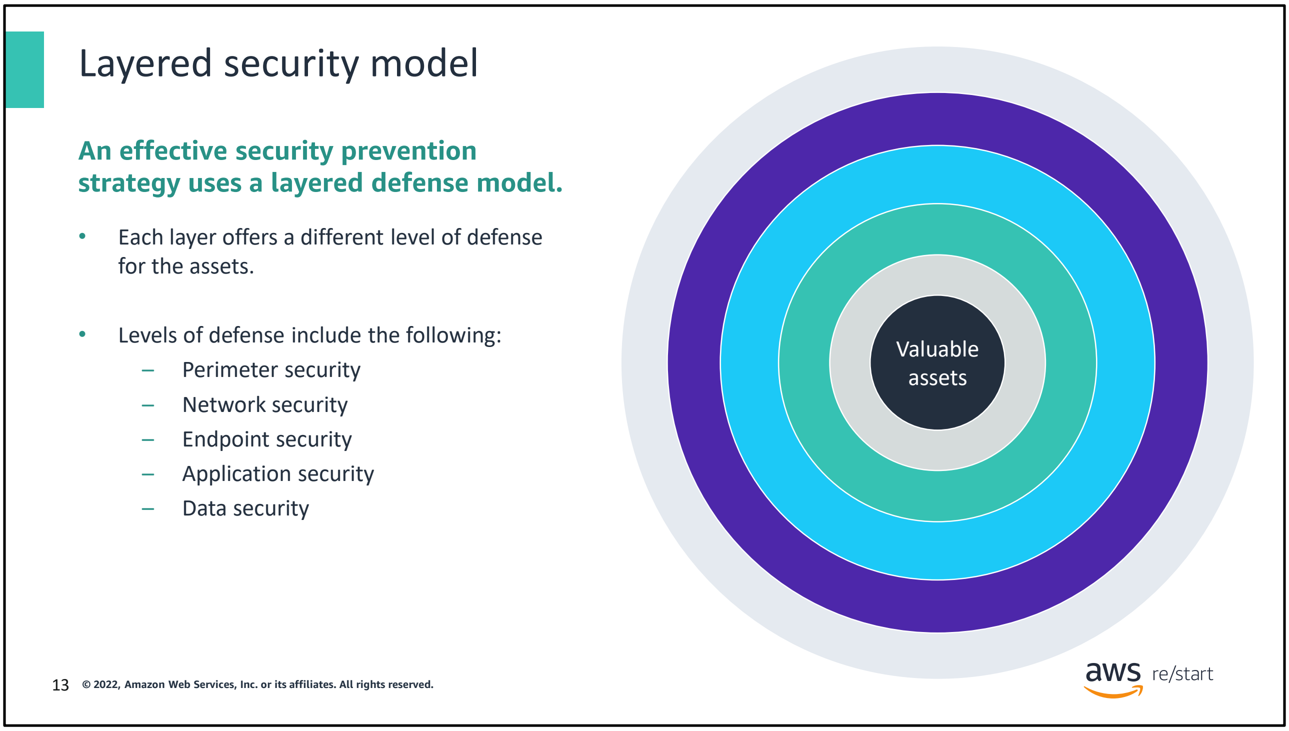
After you have analyzed and determined the security requirements of your assets, establish a security strategy, and implement security controls to protect your assets.

A best practice is to implement a security strategy that uses **multiple layers** of security. Each layer provides a specific type of protection, including protecting networks, systems, data, and user identity.

You will explore how to design a security strategy and identify different types of prevention measures in more detail in the next sections.

Prevention strategy

In this section, you will learn the value of using a layered model to build a prevention security strategy.



Layered security model

An effective security prevention strategy uses a layered defense model.

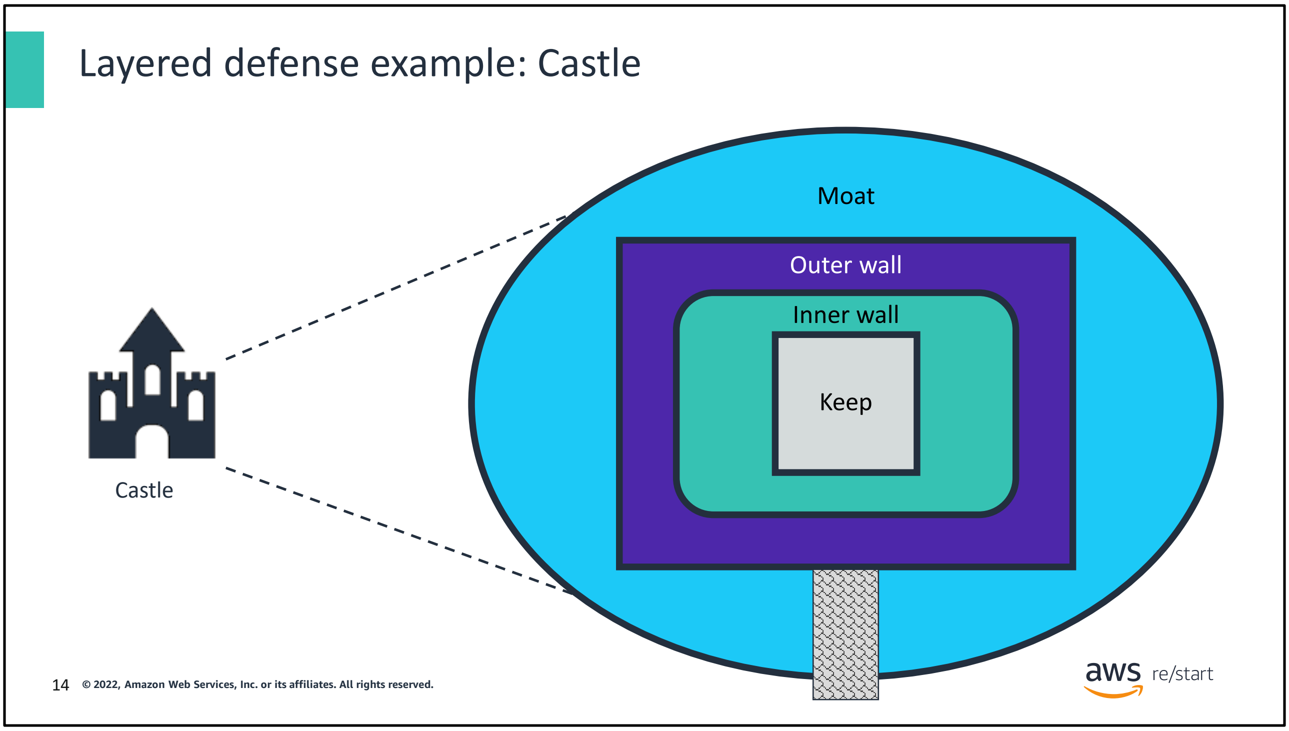
- Each layer offers a different level of defense for the assets.
- Levels of defense include the following:
  - Perimeter security
  - Network security
  - Endpoint security
  - Application security
  - Data security

An effective security prevention strategy protects valuable assets by using a layered defense model. By implementing **multiple layers** of security, an attacker would have to penetrate all of the layers in order to gain access to the protected asset.

Some examples of security layers include the following:

- **Perimeter security:** Secures the perimeter networks by using controls such as firewalls or an intrusion prevention system (IPS)
- **Network security:** Prevents unauthorized network access by using network access control lists (network ACLs), for example
- **Endpoint security:** Uses software such as an antivirus program to protect a host
- **Application security:** Protects applications with specialized firewalls, and monitoring and scanning tools
- **Data security:** Protects access to data through identity and access management

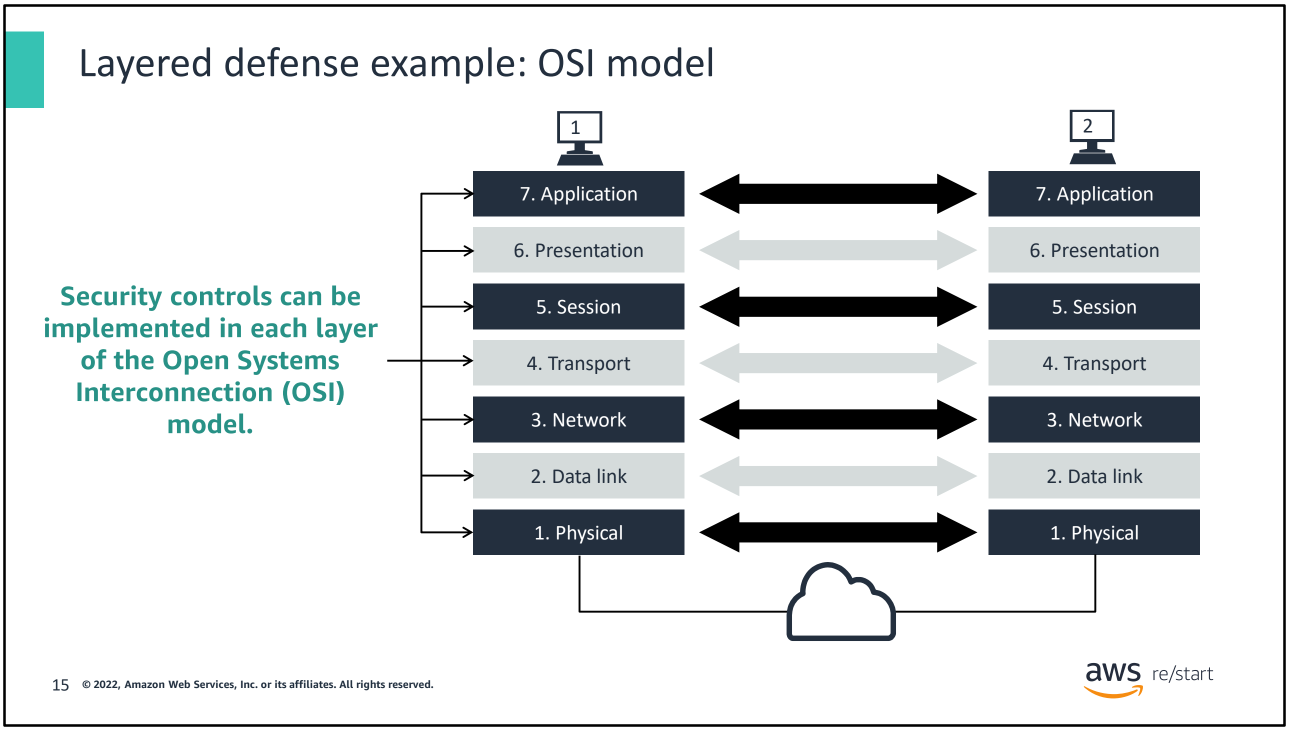
You will learn more about these layers and the tools that they use in the next modules.



Layered defense example: Castle

As an example of a layered defense, consider the architecture of a castle. The castle might have a moat as its first level of defense. The castle also includes an outer wall, an inner wall, and finally, the *keep*, where the protected assets reside. Each layer must be defeated in order for an attacking army to reach the keep and take the castle.

Similarly, companies implement many layers of defense on their systems to make the systems more difficult to breach.



Layered defense example: OSI model

Security controls can be implemented in each layer of the Open Systems Interconnection (OSI) model.

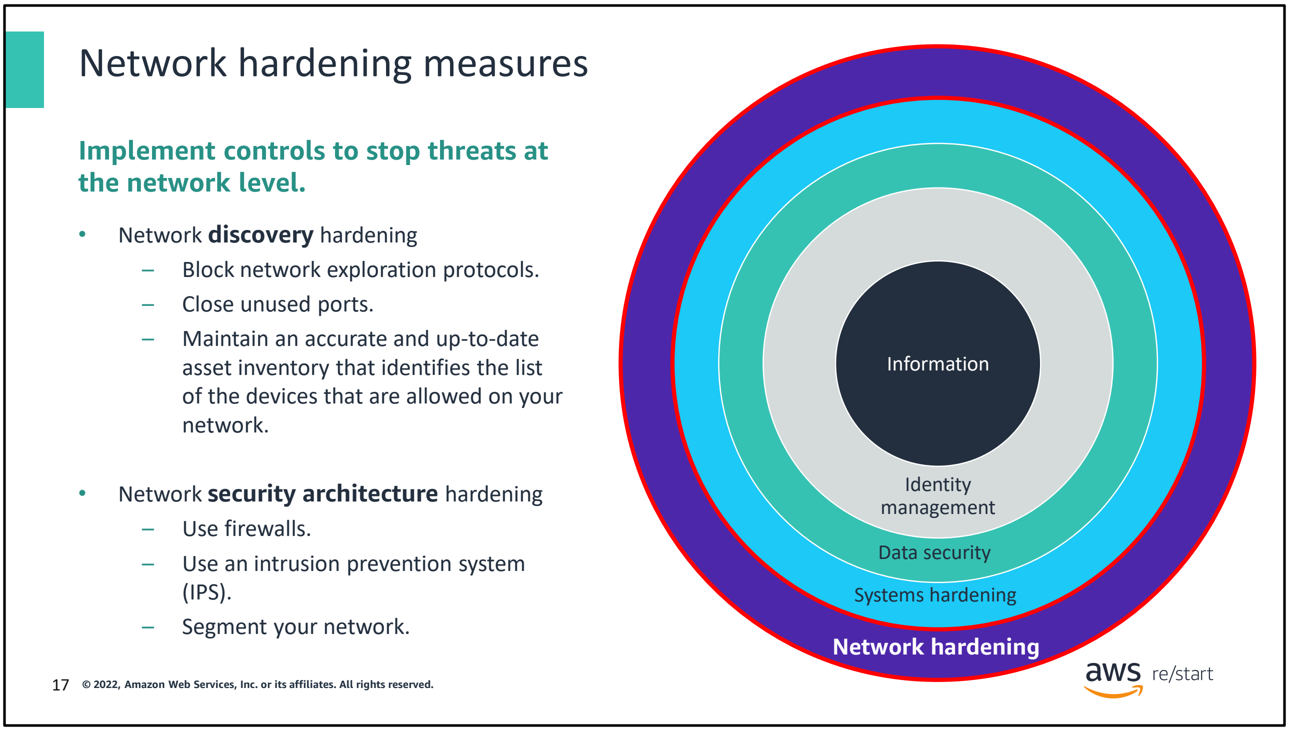
The OSI model provides another example of how security can be implemented in layers. Each of the model’s layers provides an opportunity to implement a security solution:

- **Physical** layer: Network devices and equipment are protected from physical access to keep intruders out.
- **Data link** layer: Filters are applied to network switches help prevent attacks based on media access control (MAC) addresses.
- **Network** and **transport** layers: Implementing firewalls and access control lists (ACLs) helps to mitigate unauthorized access to internal systems.
- **Session** and **presentation** layers: By using authentication and encryption methods, you can prevent unauthorized data accesses.
- **Application** layer: Solutions, such as virus scanners and an IDS, help protect applications.

Protect each layer separately to make it as difficult as possible for an outside party to breach your defenses and gain access to your resources.

Types of prevention measures

This section lists different types of prevention measures and serves as an introduction to subsequent modules in the course.



Network hardening measures

Implement controls to stop threats at the network level.

- Network **discovery** hardening
  - Block network exploration protocols.
  - Close unused ports.
  - Maintain an accurate and up-to-date asset inventory that identifies the list of the devices that are allowed on your network.
- Network **security architecture** hardening
  - Use firewalls.
  - Use an intrusion prevention system (IPS).
  - Segment your network.

Information

Identity management

Data security

Systems hardening

Network hardening

aws re/start

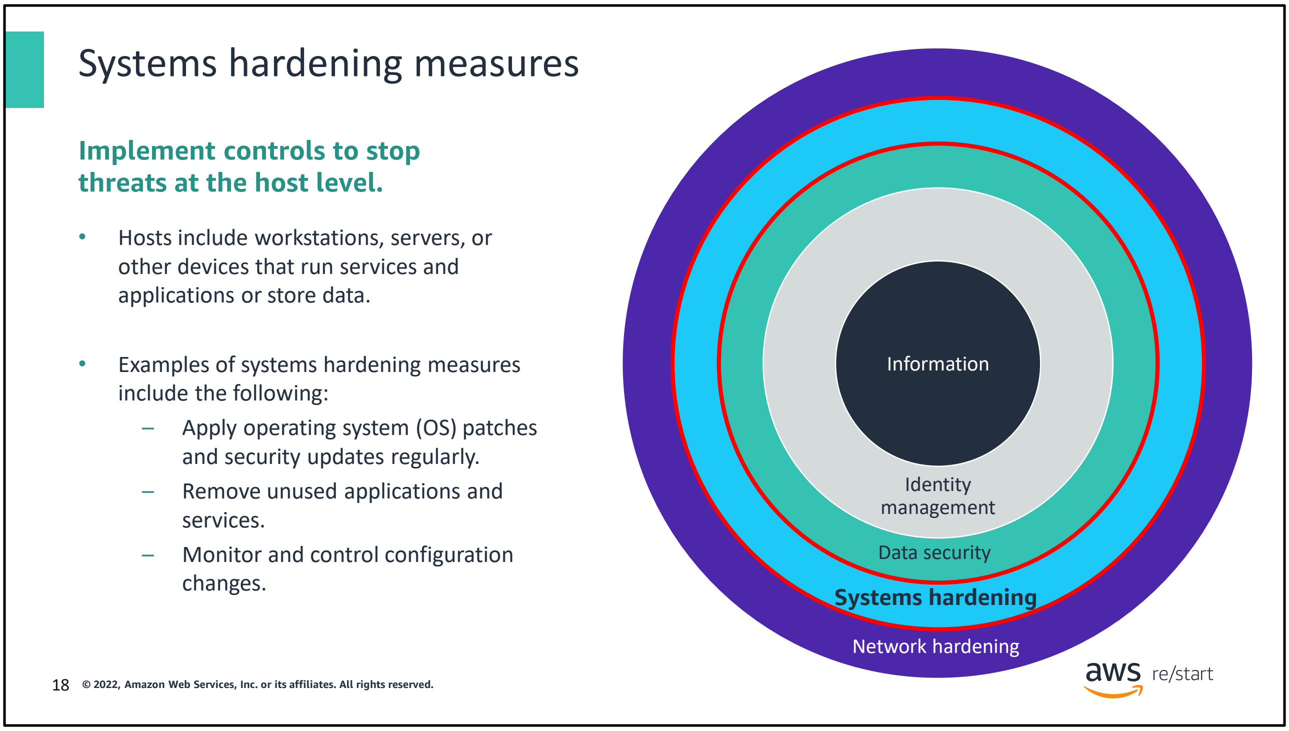
The first layer of security prevention measures focuses on protecting the network. This protection can be achieved through **network discovery hardening** and **network security architecture hardening**. This slide lists some examples of actions for each type of hardening.

The goal of **network discovery hardening** is to prevent an attacker from discovering, exploring, or mapping the network. Unfortunately, the same tools that network administrators use to explore or map networks can compromise network security if malicious entities are allowed to use them. (Examples of these tools include ping and Nmap.) As a result, network discovery tools should be blocked because they can be used to exploit network systems.

Another effective network hardening action is to close network ports that are not used because they present open doors for attackers to come in. In addition, you can use your asset inventory list to identify and enforce the list of devices that are allowed on your network. If a device that is not on the allow list appears on your network, you can immediately investigate and take proper action.

Hardening the security architecture of your network is another important prevention measure. For example, you can use firewalls in your network topology to protect resources such as web servers and database servers. A firewall permits only a certain type of traffic (based on protocol and source IP address) to come into the protected resource. You can also use segments to break down the network so that critical resources run in their own segment, which gives them additional protection. For example, database servers could be such a critical resource.

You will learn more about network hardening measures in a separate module.



Systems hardening measures

Implement controls to stop threats at the host level.

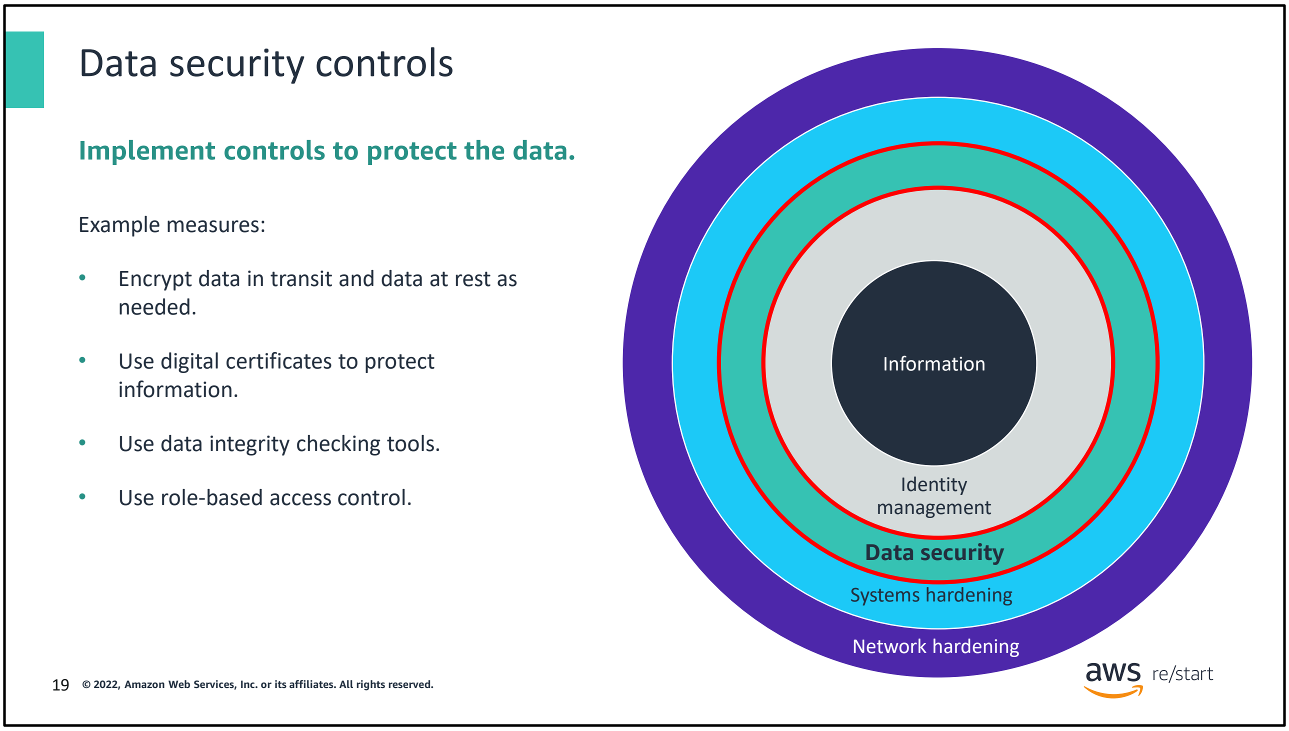
- Hosts include workstations, servers, or other devices that run services and applications or store data.
- Examples of systems hardening measures include the following:
  - Apply operating system (OS) patches and security updates regularly.
  - Remove unused applications and services.
  - Monitor and control configuration changes.

The next layer of security prevention measures addresses protecting the hosts that run your services and applications or that store your data. This security layer is known as systems hardening.

Examples of systems hardening measures include the following:

- **Applying OS patches and security updates on a regular basis:** As OS vendors identify known vulnerabilities, they publish patches to correct them. It is important that you apply these patches when they become available in order to prevent vulnerabilities at the OS level from being exploited.
- **Removing unused applications and services: U**nused or older versions of applications and services might sometimes expose security vulnerabilities that can be maliciously exploited. By uninstalling them, you not only eliminate the potential security exposure but also free up the runtime and storage resources that they consume.
- **Monitoring and controlling configuration changes:** Ideally, all configuration changes that you make to a system are performed using an automated tool that enforces best practice change control policies and procedures. You should also monitor all configuration changes so that you can always answer the important questions of, Who changed what, where, and when?

You will learn more about systems hardening measures in a separate module.



Data security controls

Implement controls to protect the data.

Example measures:

- Encrypt data in transit and data at rest as needed.
- Use digital certificates to protect information.
- Use data integrity checking tools.
- Use role-based access control.

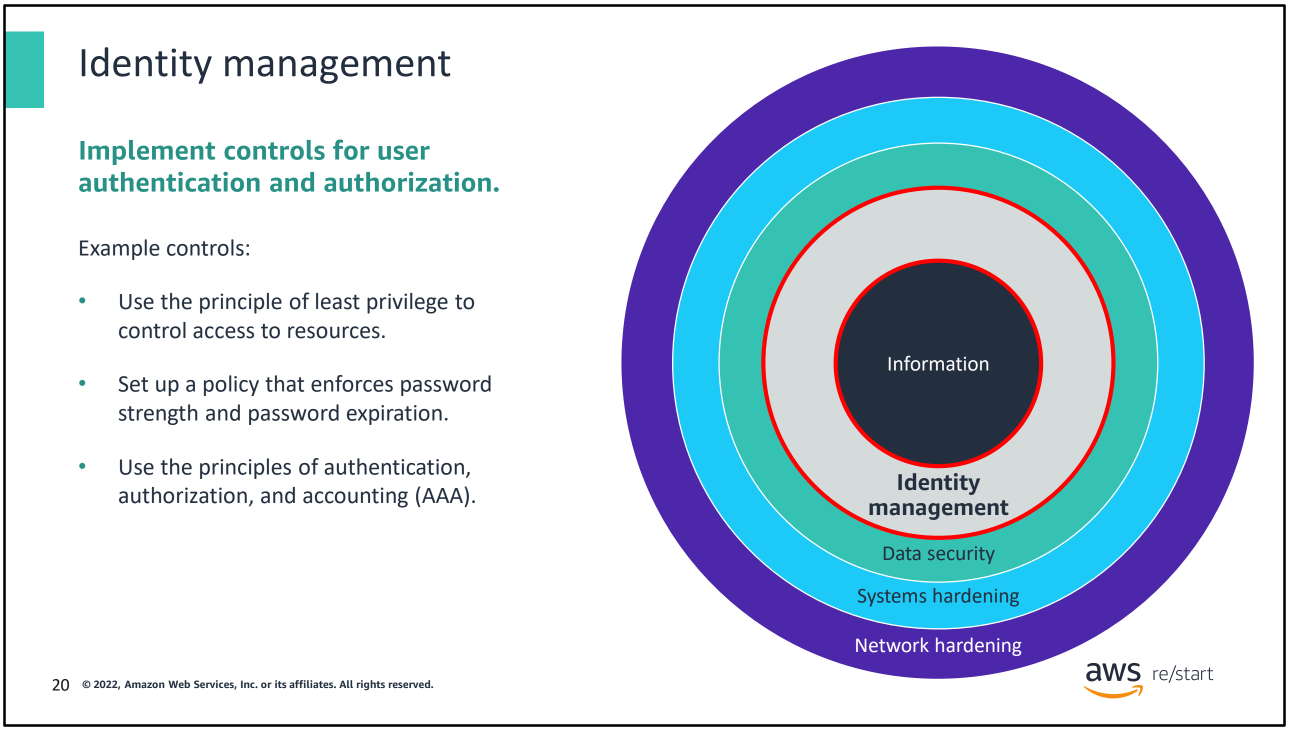
Information
Identity management
Data security
Systems hardening
Network hardening

aws re/start

Data security is the next layer of prevention measures in the layered secured model. It focuses on protecting data through the use of various control mechanisms, including the following:

- Encrypting data in transit and data at rest: Encryption protects the **confidentiality** of information. For example, a digital certificate can be used to encrypt messages between a sender and a receiver.
- Using data integrity checking tools: For example, use a hashing tool to generate a unique value based on the content of a data file before a sender transmits the file. When the receiver receives the file, the same hashing tool is used to generate the value again. If both the before and after transmission values are the same, the data file’s **integrity** has not been compromised.
- Using role-based access control: Access control affects the **availability** of information. It ensures that data is made available only to users that are authorized to access the data.

You will learn more about data security controls in separate modules.



Identity management

Implement controls for user authentication and authorization.

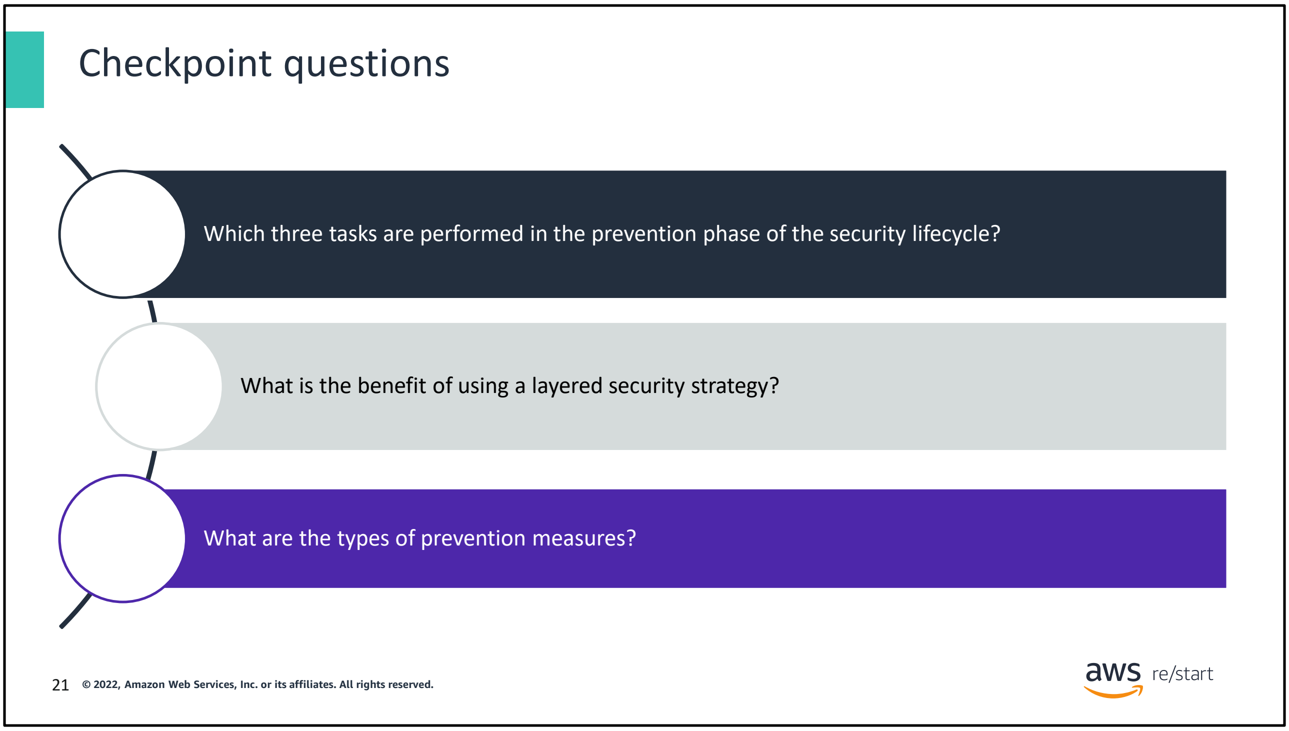
Example controls:

- Use the principle of least privilege to control access to resources.
- Set up a policy that enforces password strength and password expiration.
- Use the principles of authentication, authorization, and accounting (AAA).

Finally, the last layer of security prevention measures is identity management. Identity management defines rules that specify who has access to specific information (authentication) and what they can do with it (authorization). Examples of identity management controls include the following:

- Use the **principle of least privilege** to control access to resources: You should grant users the permission to access only the resources that they are authorized to.
- Set up a **policy** that enforces password strength and password expiration: Passwords are a mechanism that is used for authentication. A good password policy prevents passwords from being easily guessed and requires them to be changed on a periodic basis.
- Use the principles of **authentication, authorization, and accounting (AAA):** In addition to authentication and authorization controls, auditing measures should also be put in place. These measures are implemented by capturing resource usage information, and they facilitate security auditing.

You will learn more about identity management in a separate module.



Checkpoint questions

Which three tasks are performed in the prevention phase of the security lifecycle?

What is the benefit of using a layered security strategy?

What are the types of prevention measures?

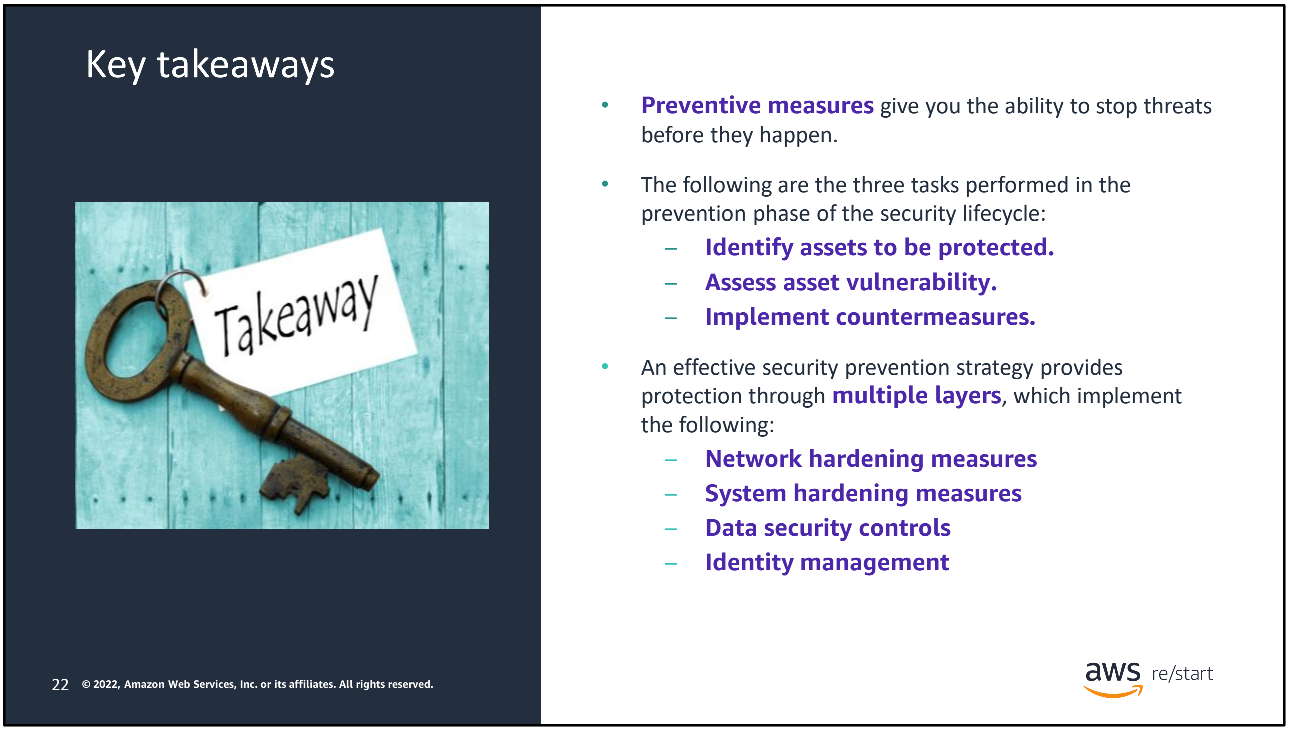
1. The following are the tasks that are performed in the prevention phase of the security lifecycle:

   - Identify assets to be protected.
   - Assess asset vulnerability.
   - Implement countermeasures.

2. A layered security strategy establishes multiple layers of defense against attacks. For an attack to succeed, it must overcome each layer, which makes it difficult.

3. The types of prevention measures include the following:

   - Network hardening measures
   - System hardening measures
   - Data security controls
   - Identity management



Key takeaways

- **Preventive measures** give you the ability to stop threats before they happen.
- The following are the three tasks performed in the prevention phase of the security lifecycle:
  - **Identify assets to be protected.**
  - **Assess asset vulnerability.**
  - **Implement countermeasures.**
- An effective security prevention strategy provides protection through **multiple layers**, which implement the following:
  - **Network hardening measures**
  - **System hardening measures**
  - **Data security controls**
  - **Identity management**

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Key takeaways from this lesson include the following:

- Preventive measures give you the ability to stop threats before they happen.

- The following are the three tasks performed in the prevention phase of the security lifecycle:

  - Identify assets to be protected.
  - Assess asset vulnerability.
  - Implement countermeasures.

- An effective security prevention strategy provides protection through multiple layers, which implement the following:

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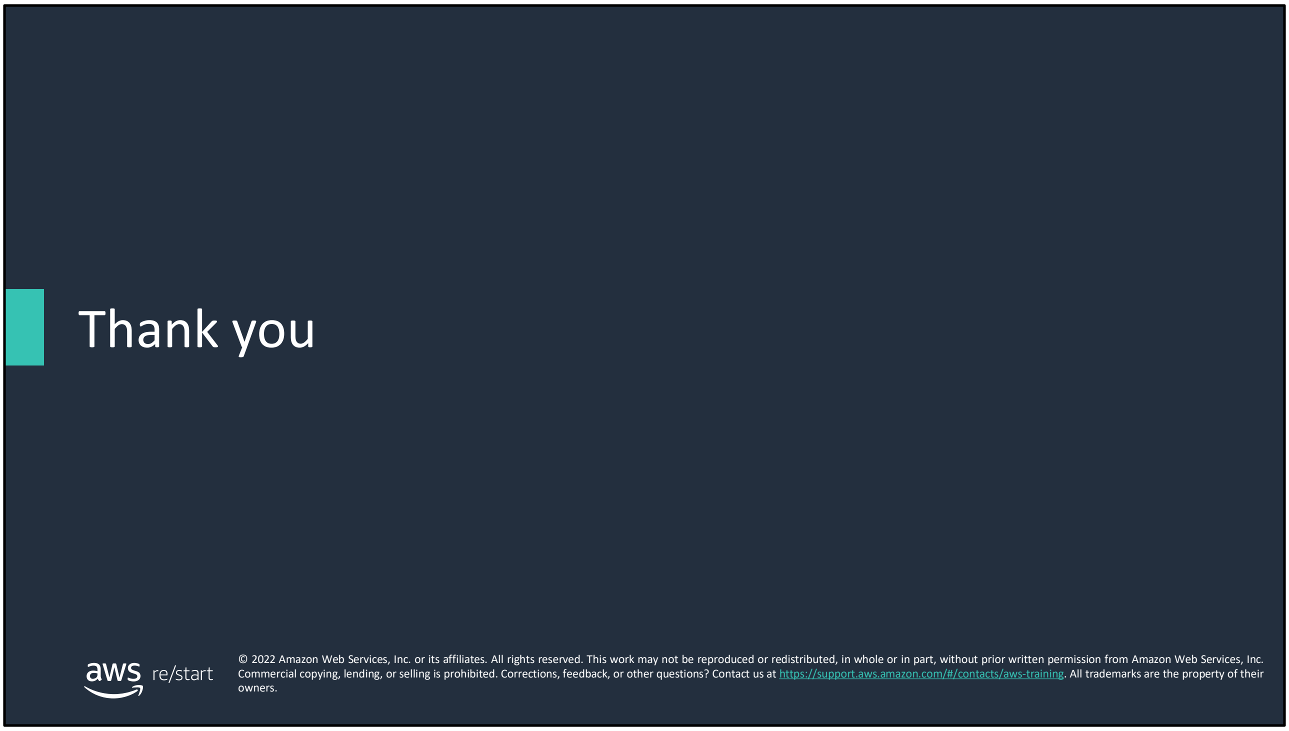
  - System hardening measures
  - Data security controls
  - Identity management



Thank you

aws re/start