aws

Crawl, walk, run: Accelerating security maturity in the AWS Cloud

AWS Prescriptive Guidance

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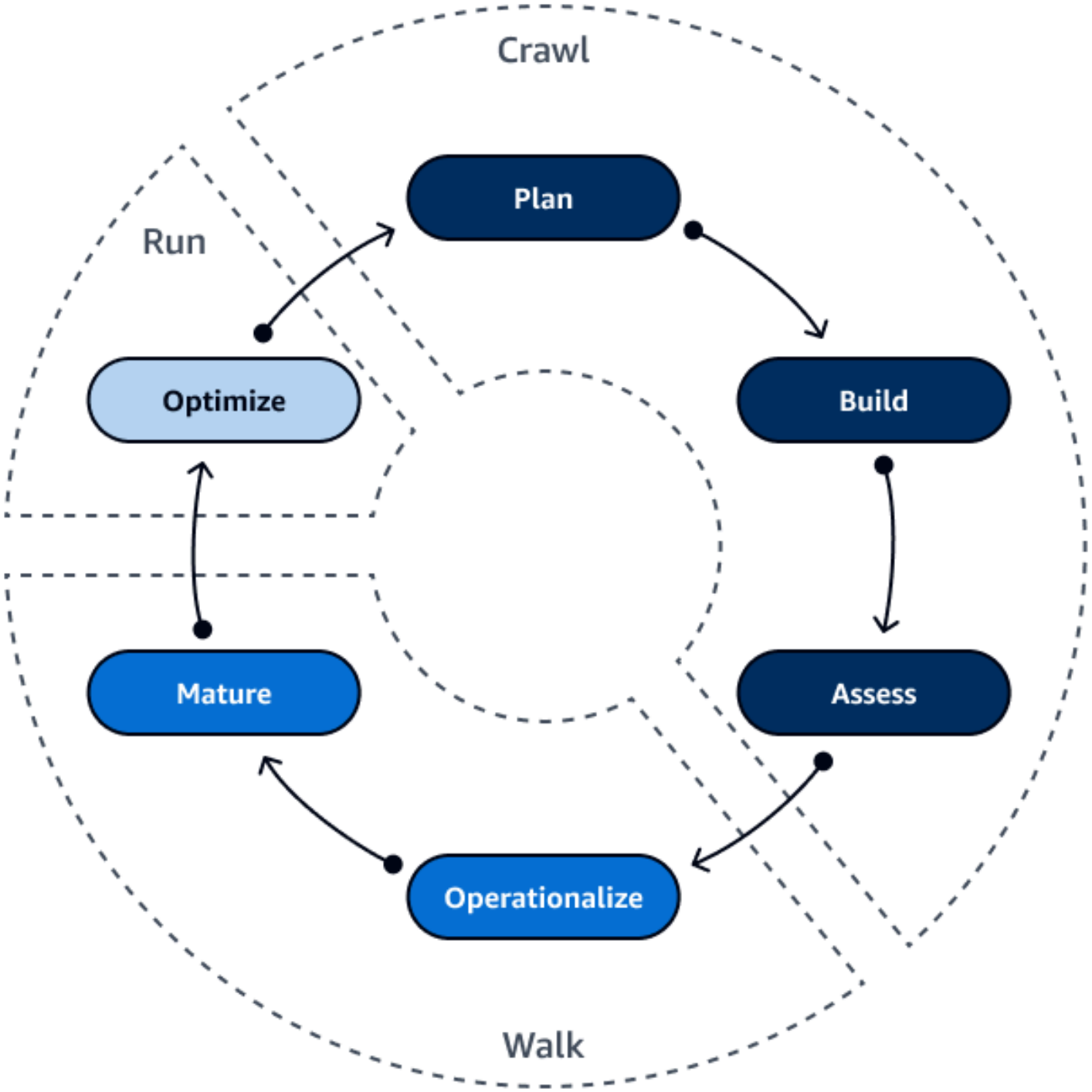
December 2023 (document history)

For many organizations, security is the number one priority and consideration when migrating to the cloud. Implementing cloud security capabilities and controls is not a one-time activity—it's an iterative model. You gradually increase your security posture and maturity as you increase cloud operations. For example, you might start with AWS managed policies and then, when your organization is ready, you can implement custom policies that follow the principle of least privilege.

This guide provides a roadmap for using a *crawl, walk, run* methodology to accelerate your organization's maturity in cloud security. It defines a step-by-step approach to automate security capabilities. It also pragmatically explains how to get the most functionality out of AWS services and features. This guide helps you understand the challenges and opportunities in the cloud and how to quickly move forward and achieve success with AWS.

A cloud journey requires building frameworks, managing and maturing operations, and optimizing processes. The following image shows the phases in each stage of the crawl, walk, run methodology: plan, build, assess, operationalize, mature, and optimize.



The crawl stage consists of planning, building the foundation, and assessing your current security posture. In the walk stage, you operationalize your people, processes, and technology, and then you mature your operations through tuning and measurement. The run stage consists of optimizing through assessment and automation.

Crawl stage: Planning, building, and assessing

The crawl stage starts with planning. Planning involves determining the security scope and choosing the model that best fits your organization. After you establish the plan, you can start building a foundation. This is followed by assessing your current security posture and setting up a discipline as soon as you build the security infrastructure. The crawl stage is iterative. Iteration in the cloud is faster than iteration in an on-premises environment. As you mature your cloud capabilities, the process for iteration accelerates.

The following are the phases in the crawl stage:

- Plan – How do you figure out your scope and select a model?
- Build – How are you going to establish the framework?
- Assess – What is your current security posture?

Plan: Establishing your security scope and model

Planning is an iterative process as you mature your security model. Key steps in the planning process include:

- Understanding the security scope – Security scope varies and depends on how the cloud is used.
- Choosing a security model – Identify the best-fitting security model for your security use case.
- Creating a business objective model – Define clear goals and mechanisms to measure success.

As you develop your plan, consider the following:

- Be willing to iterate. Iteration is constant in the cloud. Iteration helps you identify gaps in the plan.
- Do not start with services. Start with your plan instead of picking out what services you need. This helps drive your organization to its intended outcomes.

Understanding the security scope

The AWS shared responsibility model defines how you share responsibility with AWS for security and compliance in the cloud. AWS secures the infrastructure that runs all of the services offered in the AWS Cloud, and you are responsible for securing your use of those services, such as your data and applications.

This shared model can help relieve your compliance and operational burden because AWS operates, manages, and controls many components, from the host operating system and virtualization layer down to the physical security of the facilities in which the service operates. Managed services help you reduce your security and compliance obligations by allowing AWS to manage some security tasks, such as patching and vulnerability management. Using managed services is a best practice in the AWS Well-Architected Framework. In general, as infrastructure is modernized, more responsibility is shifted onto the service provider.

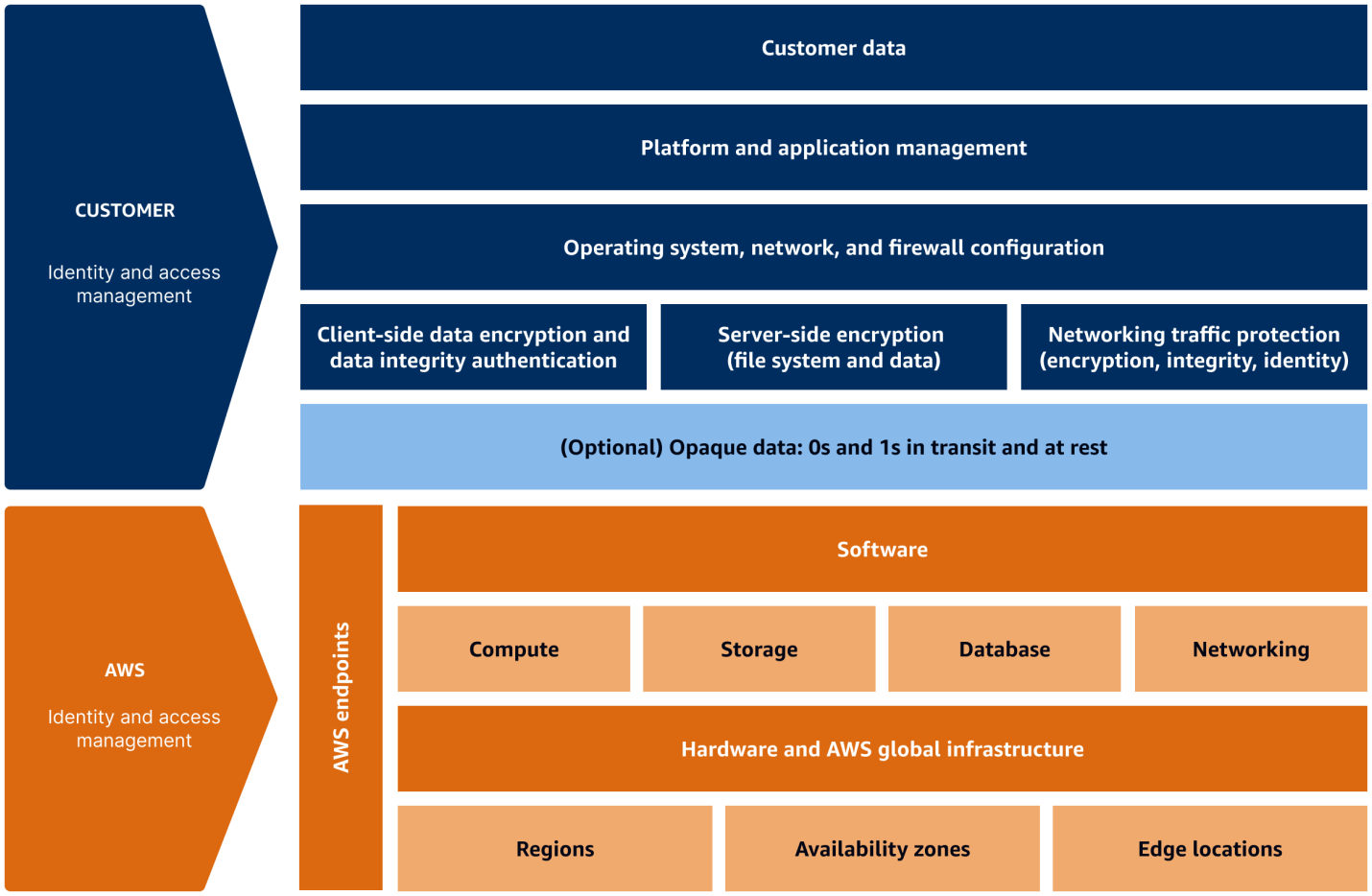
The following are three different service examples to help you understand how your security scope changes based on which services you choose:

- Infrastructure services
- Container services
- Serverless services

Your responsibility for security is not static, and it changes with the type of architecture that you select. Your time, effort, and costs are affected by the cloud architecture you choose.

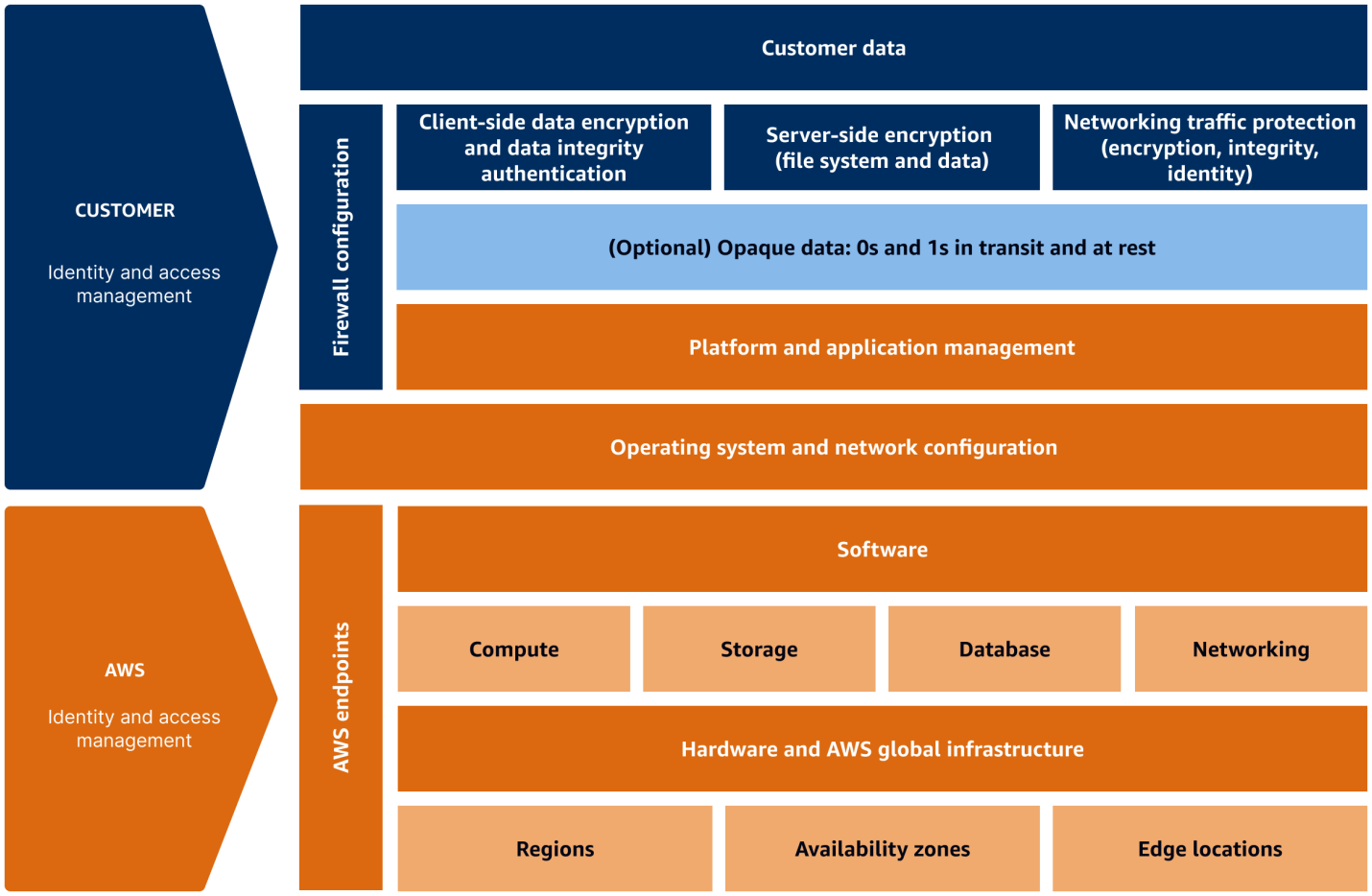
Infrastructure services

For infrastructure services, AWS focuses on securing the underlying infrastructure. Within infrastructure services, the scope is larger for the customer because they need to address platform security, OS patching, and application management, as compared to the other models. Amazon Elastic Compute Cloud (Amazon EC2) is an example of a common infrastructure service.



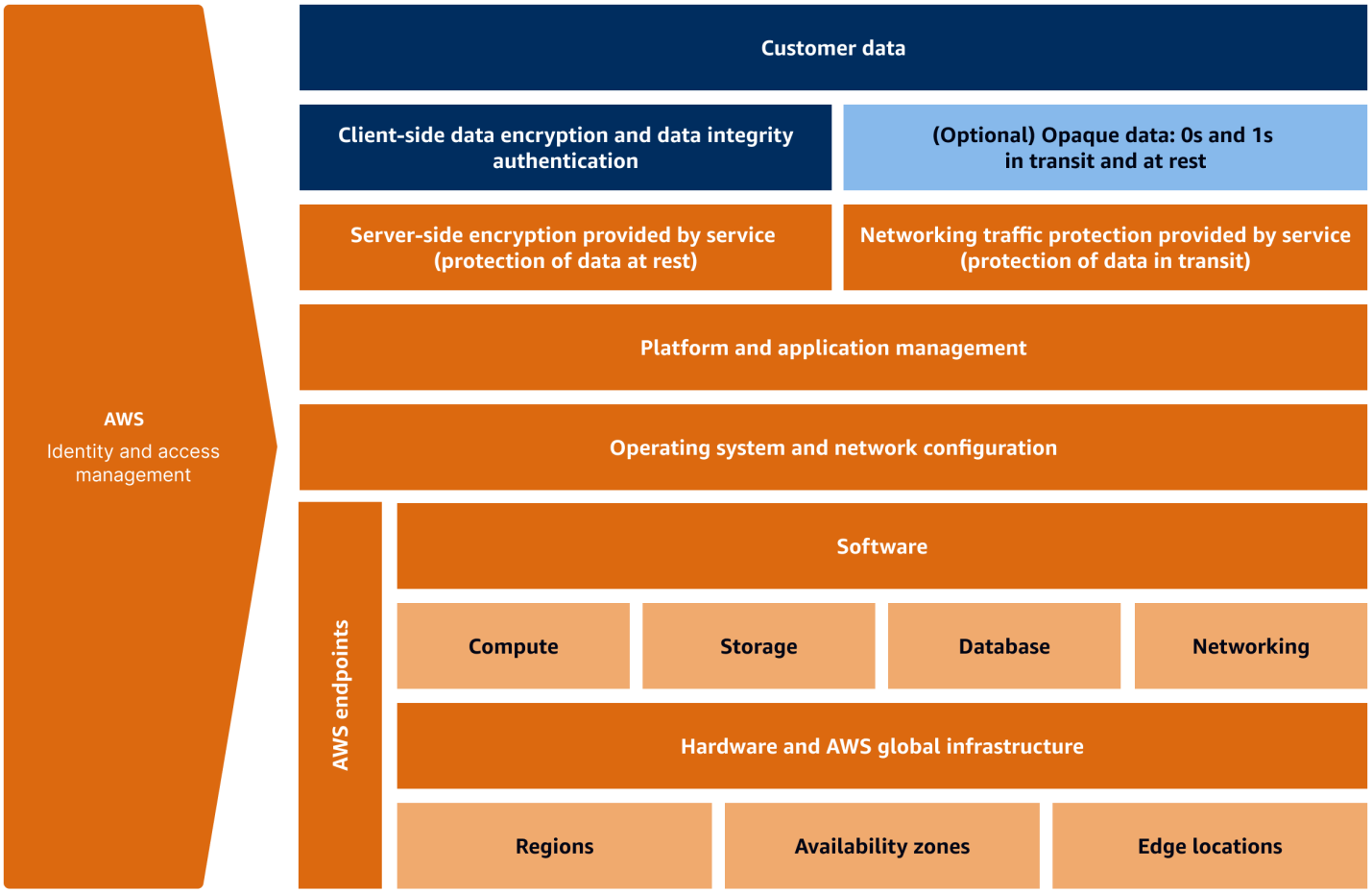
Container services

As the infrastructure becomes more abstracted and modernized, the footprint becomes smaller. Your scope shrinks because responsibility for some security elements shifts to AWS. Container services is an example which some of the backend responsibilities shift back to AWS. For example, AWS becomes responsible for the operating system (OS) configuration, network configuration, platform management, and application management. Examples of common container services include Amazon Elastic Kubernetes Service (Amazon EKS), Amazon Elastic Container Registry (Amazon ECR), Amazon Elastic Container Service (Amazon ECS), and AWS Fargate.



Serverless services

When using serverless services, nearly all of the responsibility for security belongs to AWS. The scope of your responsibility is minimal. For example, a managed serverless database (DB) eliminates the need for you to secure the network, hardware, and operating system. All OS and DB patching is covered by AWS. Your only concern is securing access to the data through encryption and authentication.



Choosing a security model

You can choose from various security models or approaches for AWS. The choice of approach and the best-fitting model depends on your audience, the target business outcomes, and the overall business process. It is possible to use a blend of multiple models.

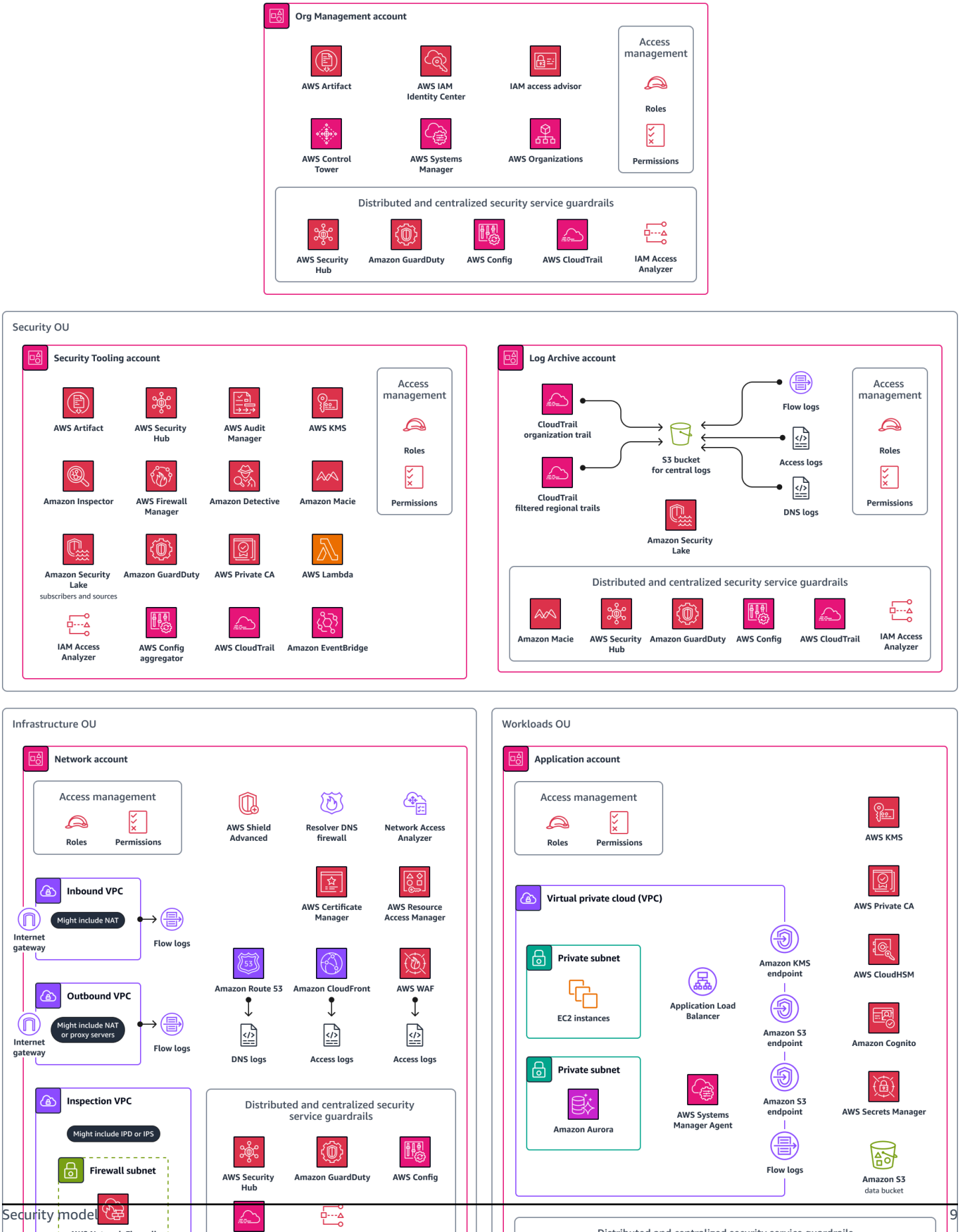
The following are a few common models:

- Architectural model
- Maturity model
- Governance model

Each model has its own set of benefits and drawbacks. It is important to consider which approach is best suited for your organization. Involve security professionals early in the process of modernizing your infrastructure and adopting cloud strategies. The model you choose has a significant impact on the roles and responsibilities within your organization.

Architectural model

The following image shows the AWS Security Reference Architecture. This architectural approach provides a blueprint for a security model. This approach is best suited when you are engaging with technical teams within your organization. It helps set an ideal future-state goal. It also aligns with many compliance and AWS frameworks.


Org Management account
AWS Artifact
AWS IAM Identity Center
IAM access advisor
Access management
Roles
Permissions
AWS Control Tower
AWS Systems Manager
AWS Organizations
Distributed and centralized security service guardrails
AWS Security Hub
Amazon GuardDuty
AWS Config
AWS CloudTrail
IAM Access Analyzer
Security OU
Security Tooling account
AWS Artifact
AWS Security Hub
AWS Audit Manager
AWS KMS
Access management
Roles
Permissions
Amazon Inspector
AWS Firewall Manager
Amazon Detective
Amazon Macie
Amazon Security Lake
subscribers and sources
Amazon GuardDuty
AWS Private CA
AWS Lambda
IAM Access Analyzer
AWS Config aggregator
AWS CloudTrail
Amazon EventBridge
Log Archive account
CloudTrail organization trail
CloudTrail filtered regional trails
S3 bucket for central logs
Flow logs
Access logs
DNS logs
Amazon Security Lake
Access management
Roles
Permissions
Distributed and centralized security service guardrails
Amazon Macie
AWS Security Hub
Amazon GuardDuty
AWS Config
AWS CloudTrail
IAM Access Analyzer
Infrastructure OU
Network account
Access management
Roles
Permissions
AWS Shield Advanced
Resolver DNS firewall
Network Access Analyzer
Inbound VPC
Might include NAT
Internet gateway
Flow logs
AWS Certificate Manager
AWS Resource Access Manager
Outbound VPC
Might include NAT or proxy servers
Internet gateway
Flow logs
Amazon Route 53
Amazon CloudFront
AWS WAF
DNS logs
Access logs
Access logs
Inspection VPC
Might include IPD or IPS
Firewall subnet
AWS Network Firewall
Distributed and centralized security service guardrails
AWS Security Hub
Amazon GuardDuty
AWS Config
AWS CloudTrail
IAM Access Analyzer
Shared Services account
Workloads OU
Application account
Access management
Roles
Permissions
AWS KMS
AWS Private CA
Virtual private cloud (VPC)
Private subnet
EC2 instances
Application Load Balancer
Amazon KMS endpoint
Amazon S3 endpoint
Amazon S3 endpoint
Flow logs
AWS CloudHSM
Amazon Cognito
Private subnet
Amazon Aurora
AWS Systems Manager Agent
AWS Secrets Manager
Amazon S3
data bucket
Distributed and centralized security service guardrails
Amazon Macie
AWS Security Hub
Amazon GuardDuty
AWS Config
AWS CloudTrail
IAM Access Analyzer

Advantages of the architectural model:

- Aligns with Health Insurance Portability and Accountability Act (HIPAA) and Health Information Trust Alliance Common Security Framework (HITRUST CSF) requirements
- Provides an architectural perspective
- Aligns to cloud strategies and guidance for large enterprises
- Aligns with the AWS Cloud Adoption Framework (AWS CAF)
- Aligns with the AWS Well-Architected Framework

Disadvantage of the architectural model:

- Is technology-focused rather than business-focused

Maturity model

The AWS Security Maturity Model approach focuses on managing and reducing risk by prioritizing the implementation of security measures. This approach is well-suited for security directors and CISOs, but it's not business-focused.

Advantages of the maturity model:

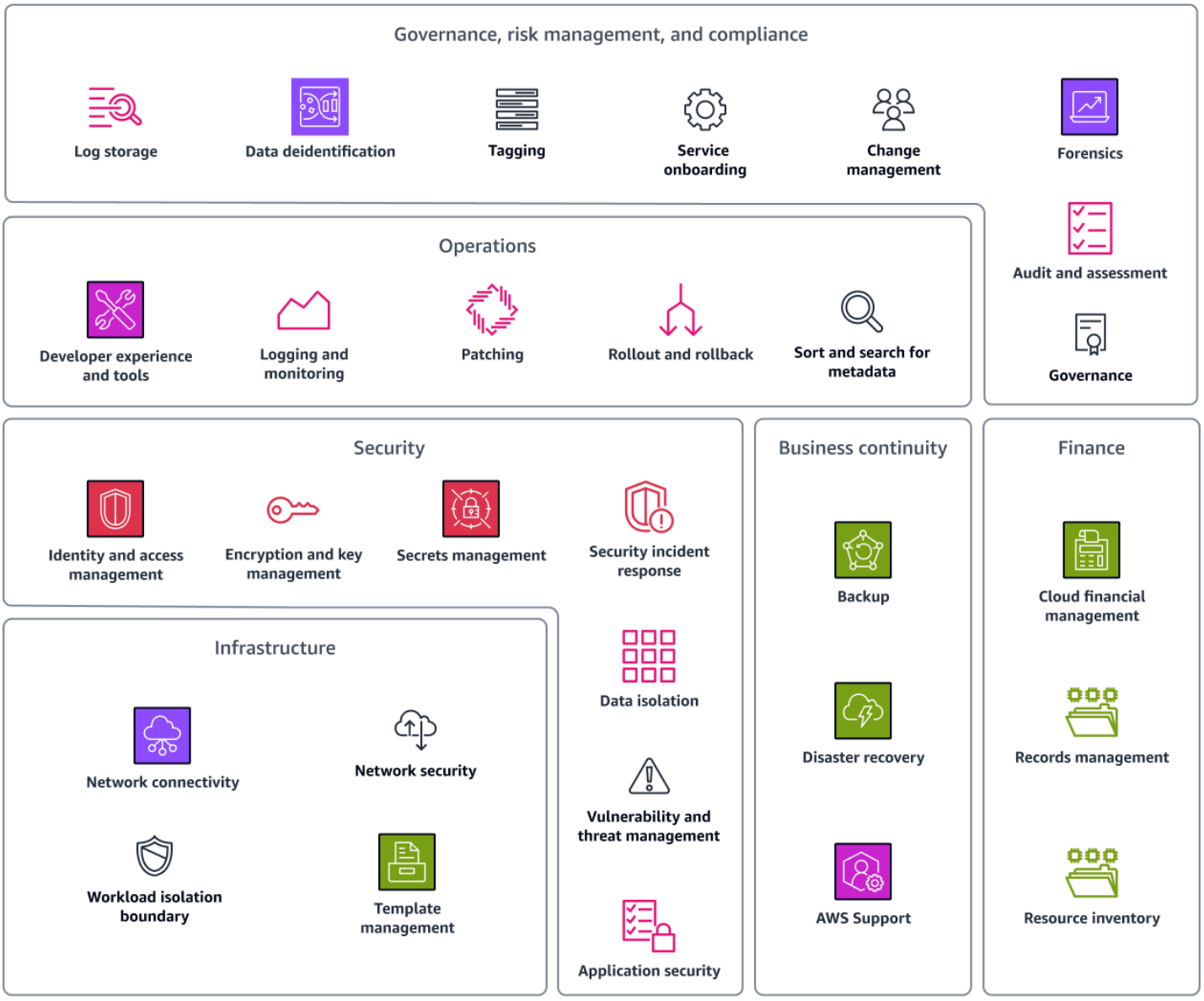
- Is security focused
- Is a model that focuses on using an agile-based implementation approach
- Helps you quickly reduce risk
- Aligns with the AWS Cloud Adoption Framework (AWS CAF)

Disadvantages of the maturity model:

- Is technology-focused rather than business-focused

Governance model

The Cloud Foundation on AWS model uses a governance, risk management, and compliance (GRC) approach to help organizations meet security and compliance requirements. It defines the overall policies your cloud environment should follow. The capabilities within this model help you define action items, define your risk appetite, and align internal policies.



The Cloud Foundation model is a capability and governance guide that helps you build and evolve your AWS Cloud environment. It is based on a set of definitions, scenarios, guidance, and automations. The guide includes the people, process, and technology aspects of establishing an AWS Cloud environment. It covers six categories of capabilities that are essential for a cloud foundation:

- Governance, risk management, and compliance
- Operations
- Security
- Business continuity

- Finance
- Infrastructure

The guide also provides examples, timelines, and further reading for each capability.

Advantages of the governance model:

- Has a broad technology focus
- Is designed for reliability
- Uses an operational approach

Disadvantage of the governance model:

- Is technology-focused rather than business-focused

Creating a business objective model

The business objective model involves defining business outcomes. It is similar to the AWS Cloud Adoption Framework and the AWS Well-Architected Framework. This approach focuses on what the business is interested in by interpreting the target business outcomes. The value of this approach is that it is easy to tie business objectives to security objectives. An example of a business objective is "Enable secure external connections and accelerated provisioning of new users and environments, by automating visibility and measuring against best practices to continuously drive down risk." You establish technology objectives that help you meet corresponding business outcomes. The business objective model ties back to security objectives, such as maintaining visibility. You then implement a technical objective, such as AWS Identity and Access Management (IAM) security best practices, in order to reduce security risk.

Advantages of business objective approach:

- Includes cost justification
- Provides a clear, business-aligned security direction
- Defines measures of success through achieving target business outcomes

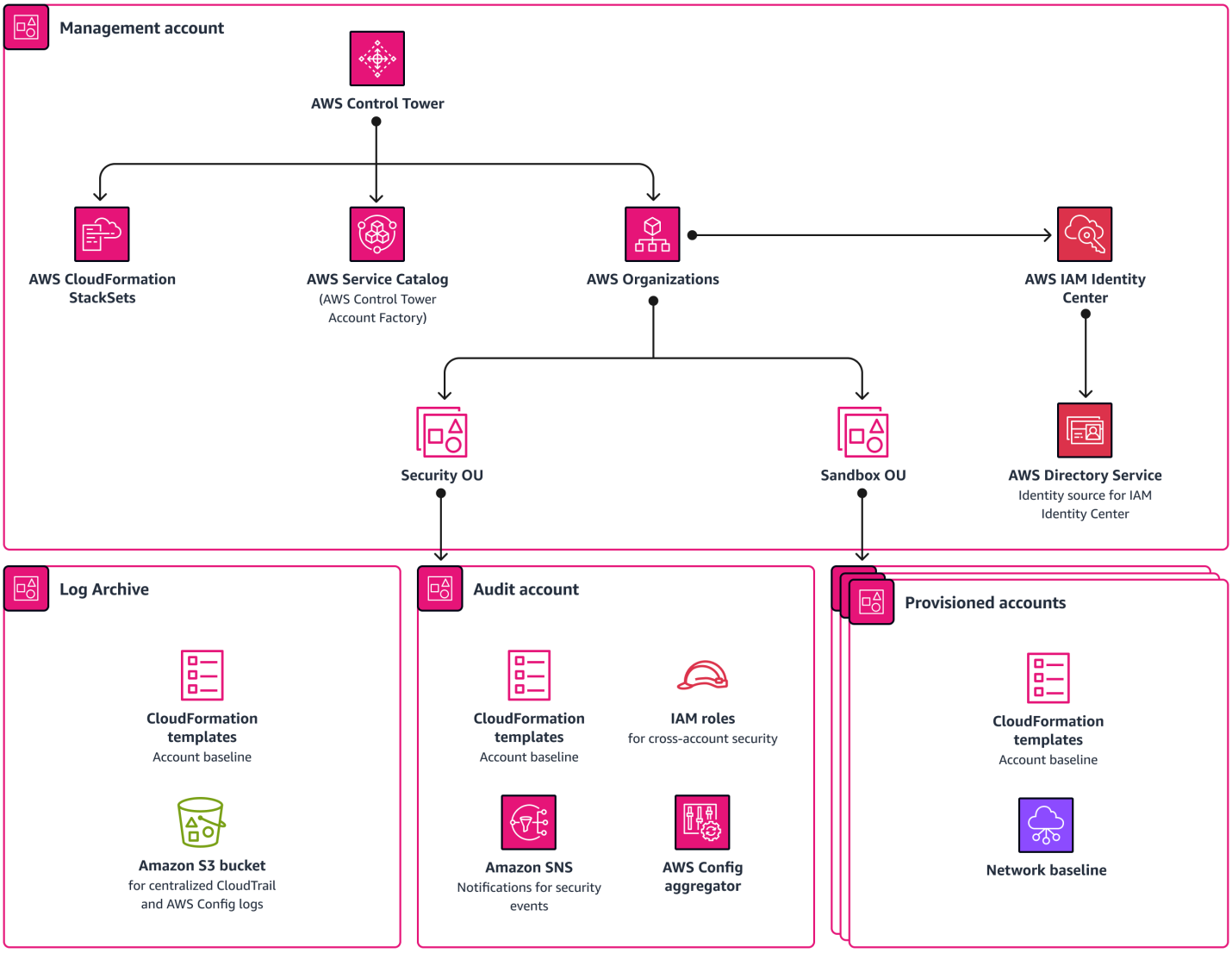
Disadvantages of business objective approach:

- Can be time consuming because you have to figure out what the business wants

- Is business-focused rather than technology-focused

Build: Laying the groundwork for a strong cloud security foundation

Now that you have a plan, the next step is laying the groundwork. This step demonstrates how to build an initial cloud foundation on AWS that is secure, resilient, scalable, and automated across multiple accounts. Laying the groundwork can be specifically designed and customized according to your business goals. You can adapt controls to a new landing zone, or you can include them in an existing landing zone. The automations in AWS Control Tower can help you lay the security groundwork in the AWS Cloud. The following image shows a landing zone that is set up through AWS Control Tower.



AWS Control Tower orchestrates multiple AWS services on your behalf, such as AWS Organizations, AWS Service Catalog, and AWS IAM Identity Center. You can set up a new landing zone within an hour, and that landing zone is designed to meet your security and compliance requirements. AWS Control Tower sets up your landing zone according to prescriptive security best practices. AWS Control Tower helps you manage cloud provisioning by enhancing visibility and control over accounts and end users. It helps administrators efficiently allocate and oversee compute resources, implement role-based access control, monitor performance through logging and monitoring tools, effectively manage costs, automate deployment processes, enforce security measures, and ensure compliance to industry standards.

AWS Control Tower is the fastest way to set up and govern a secure, compliant, multi-account AWS environment based on best practices. For more information about the working with AWS Control

Tower and the best practices outlined in the AWS multi-account strategy, see AWS multi-account strategy: Best practices guidance.

Although AWS Control Tower is the fastest approach, it's not the only one. The important part is that you set up a landing zone that, at a minimum, provides the following:

- Multi-account management
- Identity and federated access management
- A centralized archive for logs
- Cross-account audit access
- End-user account provisioning
- Centralized monitoring and notifications

Assess: Evaluating your current cloud security posture

Before you deploy anything to the landing zone, assess your landing zone to make sure it meets your requirements and to establish a baseline. This practice is called a *cloud posture assessment*. It helps you identify and remediate risks across your cloud infrastructure. Assessing your cloud security posture provides visibility of the relevant security controls in the cloud environment.

The following are the benefits of a cloud posture assessment:

- It helps you understand your current security posture and get recommendations to reduce your risk profile, remediate existing vulnerabilities, or correct misconfigurations.
- It helps you identify security best practices so that you can avoid missteps and reduce business risks.
- It provides metrics that help you track improvement and measure success.

This section reviews services and tools, AWS Security Hub CSPM and Prowler, that you can use to perform a cloud posture assessment in your environment.

Prowler

Prowler is an open source command-line tool that helps you assess, audit, and monitor your accounts for adherence to AWS security best practices and other security frameworks and standards. It inspects your configuration and identifies security issues. You can use Prowler in

multi-account environments, and third-party vendors can also use it to assess the security of your AWS environment.

The following are the benefits of Prowler:

- It is free and open source.
- It has flexible deployment options and is scalable.
- It runs compliance checks, such as for Center for Internet Security (CIS) Benchmark for AWS, General Data Protection Regulation (GDPR), and HIPAA.
- It helps you create snapshots and baselines.

AWS Security Hub CSPM

AWS Security Hub CSPM provides a comprehensive view of your security state in AWS. It also helps you check your environment against security industry standards and best practices. It is integrated with AWS Control Tower so that you can configure Security Hub CSPM detective controls through the AWS Control Tower service. The objective of accelerating security maturity is to mature the assessment process from a one-time snapshot to a continuous process for monitoring progress.

The following are the benefits of Security Hub CSPM:

- It provides a unified dashboard that shows current status of the environment and helps you identify and remediate issues.
- It performs continuous assessments with automated checks.

Walk stage: Operationalizing and maturing

The walk stage focuses on operationalization. During this stage, your organization needs to evaluate its current operating model, determine how it should be adapted for the cloud, implement those changes, and then measure progress. This includes addressing skills, operating processes, and technology. Tuning the cloud deployment and measuring progress is vital throughout the walk stage to validate success.

The following are the phases in the walk stage:

- Operationalize – How do you prepare your people, technology, and processes for the cloud?
- Mature – How do you measure progress and success?

Operationalize: Preparing your organization for a mature cloud security posture

In order to move forward with the process of deploying operational loads into the cloud, it is important to focus on the alignment of people, process, and technology. This is particularly crucial in the cloud environment because processes and skills likely differ from on-premises operations. In this section, you use a framework to align your people, processes, and technology, and then you confirm that the framework has helped you achieve your expected outcomes.

AWS Cloud Adoption Framework

The AWS Cloud Adoption Framework (AWS CAF) helps you accelerate your business outcomes through innovative use of AWS services and features. AWS CAF identifies six specific organizational perspectives that underpin successful cloud transformations: Business, People, Governance, Platform, Security, and Operations. Each perspective contains capabilities that can improve your cloud readiness and help you accelerate your cloud transformation journey.

The following image shows the six perspectives in the AWS CAF and the capabilities in each perspective. For more information, see Foundational capabilities in *An Overview of the AWS Cloud Adoption Framework*.

Expected outcomes

When you use the AWS CAF to align your people, processes, and technology, you can expect to achieve the following outcomes:

- **DevSecOps pipeline and process** – Implementing a DevOps pipeline with integrated security tools can help you more securely deploy infrastructure as a code (IaC). You can implement code-

scanning and security checks in the pipeline process, such as cfn_nag (GitHub), which is an open source static code analyzer.

- **Tagging and asset management** – Tags can help you more efficiently and consistently manage resources in the cloud. For more information, see Tagging your AWS resources. It's important to develop a dynamic asset management strategy that can adapt to the constantly changing nature of the cloud. AWS Systems Manager Inventory helps you assign tags so that you can quickly search, manage, and identify your resources.
- **Monitoring and detective integration** – It is crucial to establish a method for sending alerts from the cloud to on-premises security operations centers (SOCs) and security information and event management (SIEM) systems. Amazon GuardDuty is a continuous security monitoring service that analyzes and processes logs to identify unexpected and potentially unauthorized activity in your AWS environment. It also integrates with many third-party tools.
- **Cloud incident response plan and program** – It is important to make sure that the personnel responsible for handling the cloud alerts are familiar with the process of ingesting those alerts and know how to respond to cloud alerts, as compared to on-premises alerts. To improve incident response capabilities, train personnel to use Amazon Detective for log analysis. Amazon Detective helps you analyze, investigate, and identify the root cause of security findings or suspicious activities. Amazon Detective should be part of an incident response plan.
- **Cloud vulnerability management** – The process of managing vulnerabilities in the cloud differs from on-premises environments. In addition to traditional vulnerability management, you also must assess the infrastructure code layer. Amazon Inspector is an automated vulnerability management service that continually evaluates your resources for vulnerabilities and unintended network exposure.
- **Cloud posture management** – Cloud posture management, as described in the Assess section, is an important aspect of cloud security. You can use AWS Security Hub CSPM to automate security best practice checks and evaluate your overall cloud posture across all of your AWS accounts.
- **Cloud security training** – It is essential to provide appropriate training to employees so they become proficient in cloud security. This includes providing access to resources and allocating time for employees to acquire the necessary knowledge and skills. AWS provides many training resources to upskill and educate, such as AWS Skill Builder.

Mature: Tuning and measuring processes, tools, and risk

In the mature phase of the cloud security model, the focus is on aligning security teams with the AWS Cloud Adoption Framework (AWS CAF) security capabilities and on instituting agile

processes. This alignment helps specialized teams accelerate innovation in short sprints while also incorporating roadmaps and long-range planning. The mature phase emphasizes collaboration with IT operations and scaling up deep, specialized cloud skills. Each security capability implements key tools and processes to enhance efficiency and impact, accompanied by the development of metrics and reporting mechanisms to measure incremental changes and overall impact.

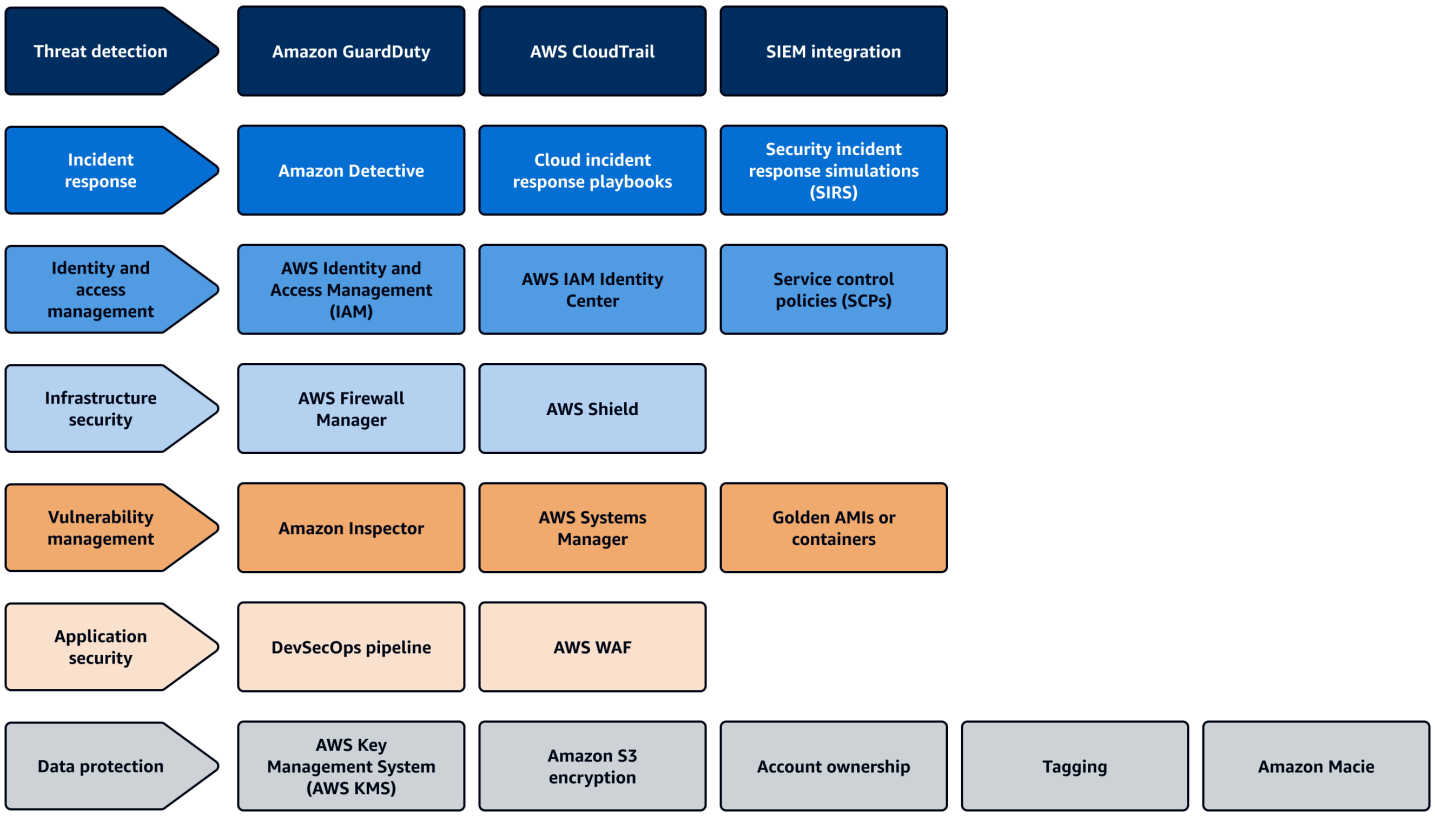
In this phase, you:

- Tune and measure processes
- Tune and measure tools
- Tune and measure risk
- Review examples of use cases in the mature phase

Tune and measure processes

The agile approach provides more flexibility and innovation, and it can help you quickly test and implement new ideas. Divide your security teams into specialized roles, such as incident responders and vulnerability managers. The roles should align with the categories in the following image, which correspond to the capabilities in the AWS Cloud Adoption Framework (AWS CAF). The agile approach encourages teams to think big, invent, simplify, and identify potential gaps in security. This results in the creation of a backlog of user stories or roadmaps for future improvements.

An agile process allows for more dynamic and adaptive solutions, instead of relying solely on the capabilities of a specific tool. *Fail fast* is a philosophy that uses frequent and incremental testing to reduce the development lifecycle, and it is a critical part of an agile approach. Make a change, test it out, and then decide whether to continue with the current approach or switch to an alternate one. If the teams work in this cycle, it helps your organization stay current with the fast-paced nature of the cloud. Focused training is also crucial, and you should provide training that is specific to a particular domain of cloud security.



> **Note**
>
> This image doesn't contain the security assurance and security governance capabilities in the AWS CAF. This guide focuses on security operations, and security assurance and governance are outside the scope of this guide. For more information about security assurance, see AWS re:Inforce 2023 - Scaling compliance with AWS Control Tower on YouTube.

In your organization, use an agile approach that helps your organization keep up with rapid development and change in the cloud. The following are some ways to start experimenting and iterating in your cloud environment:

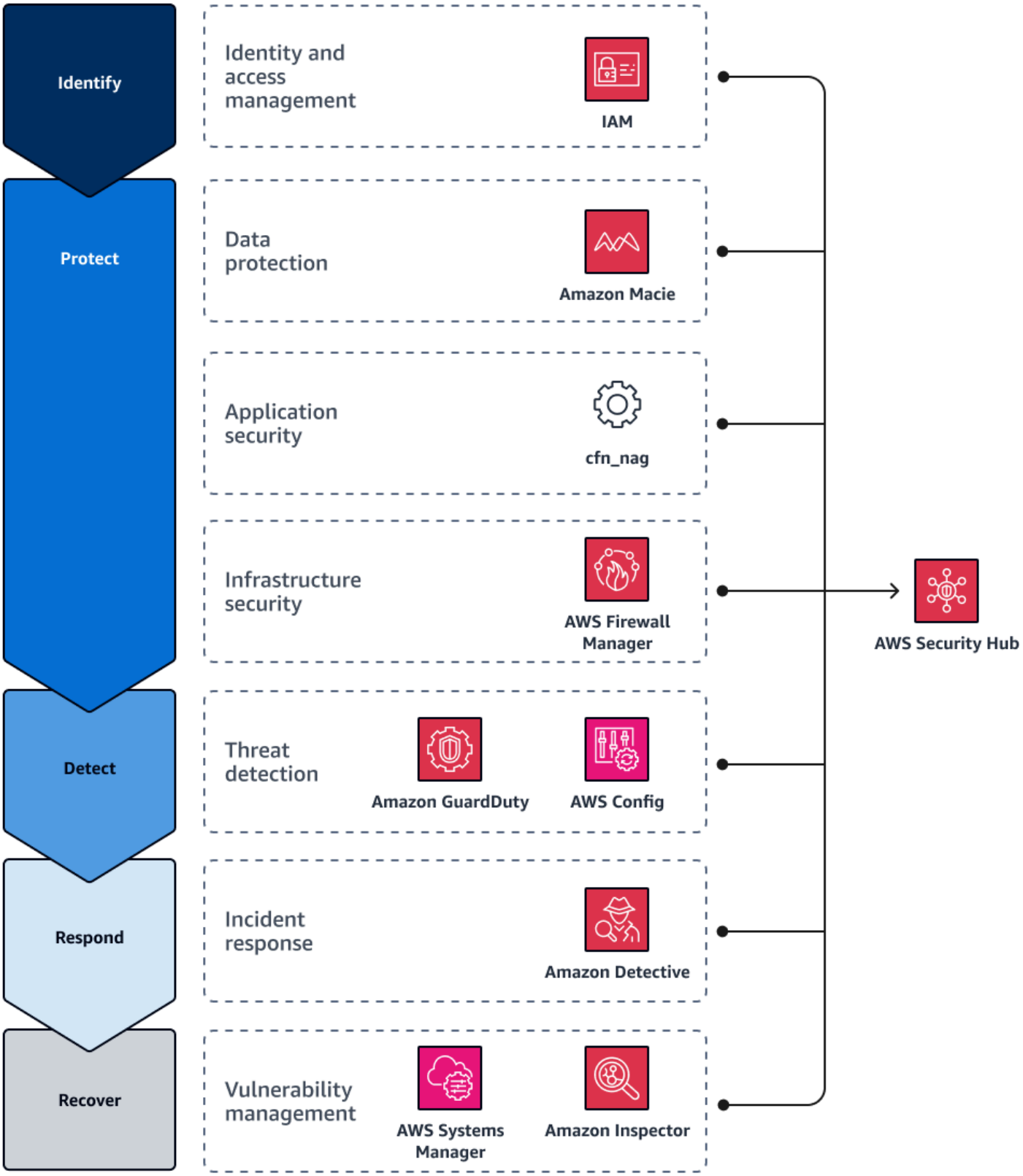
- Specialize on the categories defined in AWS CAF, as shown in the previous image.
- To be more dynamic, focus on innovating instead of operations.
- Move quickly in sprints by allowing people to test, fail fast, and implement quickly and continue with this cycle to keep up with the business.

- To support continuous operations, where possible, align processes for cloud-based and on-premises environments.
- To help individuals drill down and focus on one area, provide focused training instead of broad training.
- Encourage people to think big, investigate "what ifs," and create backlogs (such as roadmaps or gaps).

Tune and measure tools

After you establish specialized teams for different security domains, align the teams with each other. AWS Security Hub CSPM can help you achieve this. Security Hub CSPM provides a centralized, unified dashboard to monitor progress against frameworks. It also integrates with AWS security services any many third-party tools.

The National Institute of Standards and Technology (NIST) Cybersecurity Framework on the NIST website is comprised of five functions: identify, protect, detect, respond, and recover. The following image shows how you can use different AWS services during each function and then configure those services to send their findings to Security Hub CSPM for consolidated reporting. If you choose to use other tools, you can use the Security Hub CSPM API, AWS Command Line Interface (AWS CLI), and AWS Security Finding Format (ASFF) to create custom integrations. For more information about Security Hub CSPM integrations with other services, see Product integrations in AWS Security Hub CSPM in the Security Hub CSPM documentation.



Security Hub CSPM integrates with all of these services and tools and provides the following:

- Provides a unified dashboard that shows updates and helps teams to iterate in place
- Automatically integrates with AWS security services, such as Amazon Macie, Amazon GuardDuty , and Amazon Detective
- Supports integration with third-party tools, such as Prowler and cfn_nag
- Supports custom integrations with tools, such as Security Hub CSPM API, AWS CLI, and the AWS Security Finding Format (ASFF)

Tune and measure risk

During the mature phase of the walk stage, you can use AWS Security Hub CSPM to continually tune and measure security risk. Security Hub CSPM continually assesses an organization's security posture and takes actions to remediate identified issues. Security Hub CSPM centralizes and prioritizes security findings from across AWS accounts, services, and supported third-party partners. This helps you analyze security trends and identify the high priority security issues.

Security Hub CSPM performs hundreds of security checks and classifies them based on risk to your AWS environment. You can view your score against security controls in a unified dashboard in the Security Hub CSPM console. For more information, see Determining security scores in the Security Hub CSPM documentation. Through this dashboard, the DevSecOps function can quickly identify any checks that have failed, the severity of the security issue, and which AWS Region and resource is affected. Once identified, the DevSecOps team can prioritize and remediate the issue. As issues are remediated, Security Hub CSPM automatically updates the state.

Review examples of use cases in the mature phase

The following are examples of the mature phase. These examples dive deeper into the models, tools, and processes for different business objectives, at a practical level.

Mature: Threat detection example

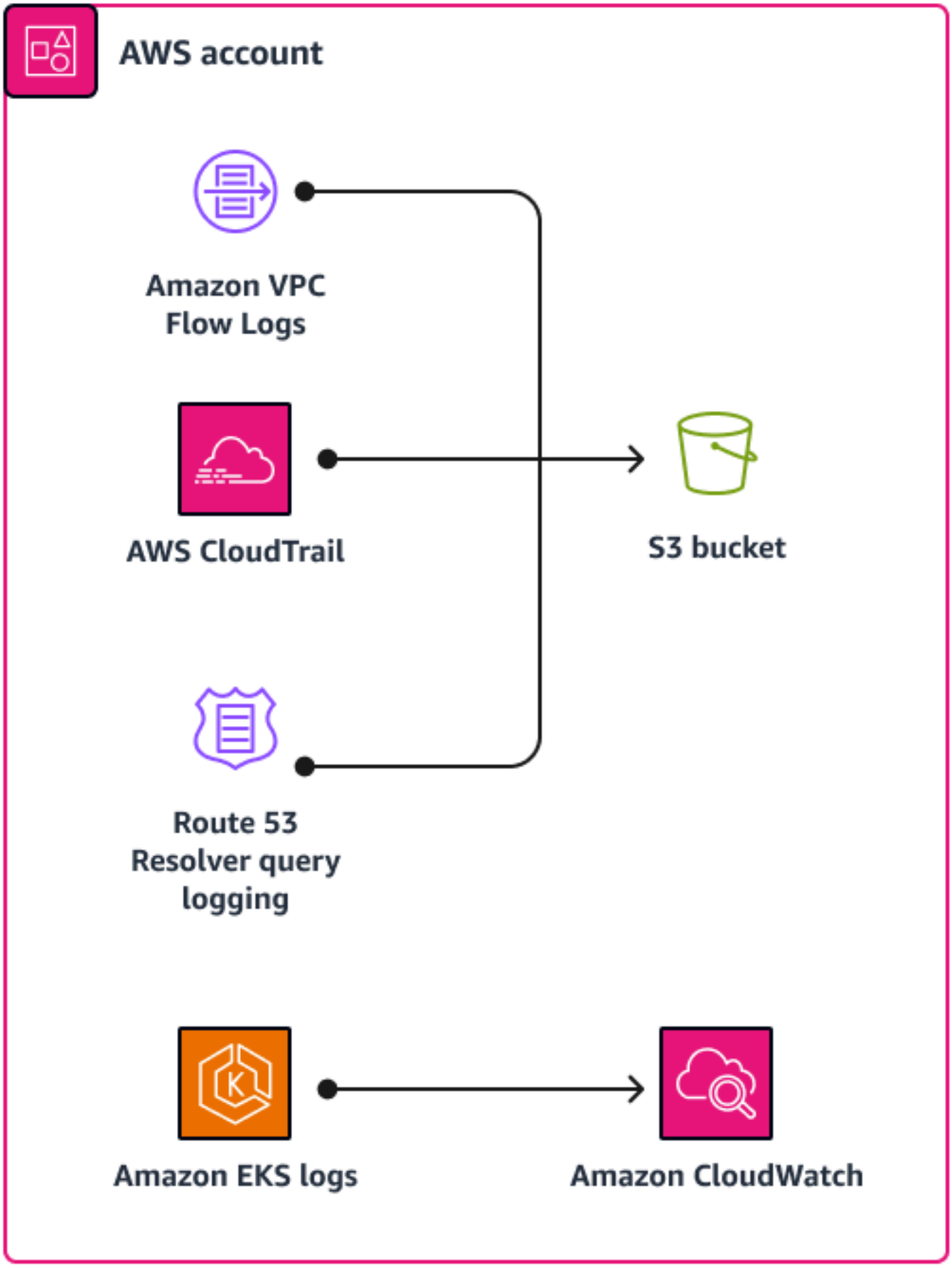
Business outcome for detective controls: Increase visibility and speed of detection of cloud incidents in order to lower risk and enable accelerated use and development of cloud resources.

Tool: Assisted Log Enabler for AWS (GitHub) is an open source tool that helps you turn on logging in the middle of a security incident. It can quickly increase your visibility into an incident.

Sample use case: Consider the single account use case depicted in the following diagram. There are events that require further investigation. You are unsure whether logging is enabled. In this

case, the best course of action is to perform a dry run with the Assisted Log Enabler to see which services are enabled or disabled. Assisted Log Enabler checks for AWS CloudTrail trails, DNS query logs, VPC flow logs, and other logs. If they are not enabled, Assisted Log Enabler enables them. Assisted Log Enabler can check for and turn on logging across all AWS Regions.

You can also throttle Assisted Log Enabler up or down. After you complete your dry run, close the event, and resolve the issue, you realize that you no longer need this level of logging. You can quickly clean up the deployment to stop logging. This feature allows you to use Assisted Log Enabler as a triage tool.


AWS account
Amazon VPC Flow Logs
AWS CloudTrail
S3 bucket
Route 53 Resolver query logging
Amazon EKS logs
Amazon CloudWatch

The following are the key features of Assisted Log Enabler for AWS:

- You can run it in a single-account or multi-account environment.
- You can use it to establish a baseline for logging into your environment.
- You can use the dry run feature to check the current state and determine which services have logging enabled.
- You can select which services you want to enable logging for.
- You can throttle Assisted Log Enabler up or down, for your use case.

Mature: IAM example

IAM business outcome: Automate visibility and measure against best practices to continuously reduce risk, to enable secure, external connections, and to quickly provision new users and environments

Tool: AWS Identity and Access Management Access Analyzer (IAM Access Analyzer) helps you identify resources that are shared with an external entity, validates IAM policies against policy grammar and best practices, and generates IAM policies based on historical access activity. We highly recommend that you enable IAM Access Analyzer at both the account and organization levels.

Service benefits: IAM Access Analyzer provides a wealth of insightful findings. It can identify your organization's resources and accounts that are shared with an external entity. It can detect resources such as a public S3 bucket, an AWS KMS key shared with another account, or a role shared with an external account, giving you excellent visibility into identifying resources that are not under your organization's control. It not only validates IAM policies but can also generate them for you.

Run stage: Optimizing your cloud security operations

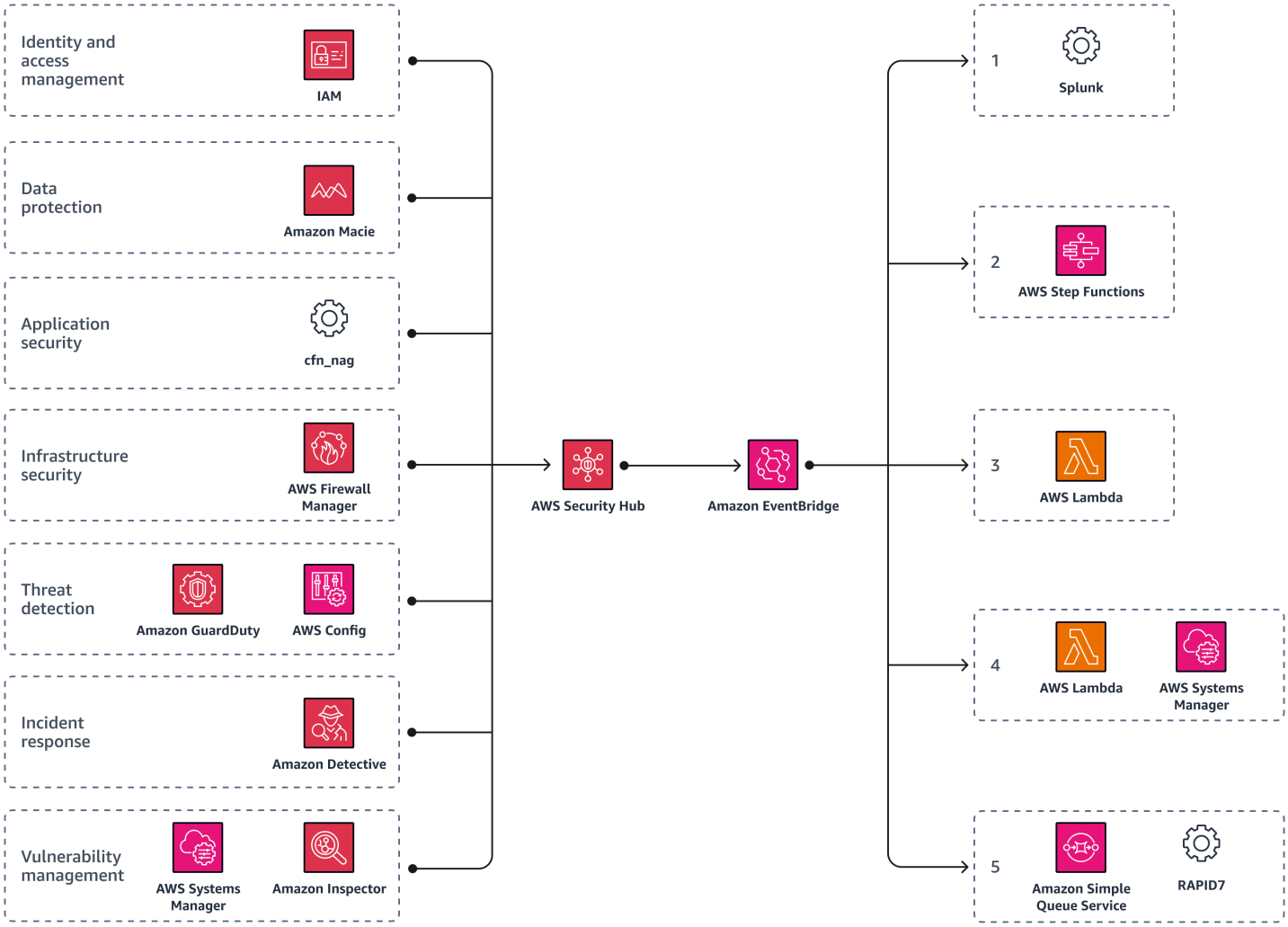
After you implement a baseline in the walk stage, your organization progresses to the run stage. This stage is focused on demonstrating the cybersecurity capabilities that are available in the cloud, many of which are not possible or are very difficult to implement with on-premises solutions. This stage brings together different security components and automates processes. Automations free up your resources so that they can focus on high-value work.

The following is the only phase in the run stage:

- Optimize – How do I improve this process and add automation?

Optimize: Automate and iterate your cloud security operations

In the optimize phase, you automate your security operations. Like the crawl and walk stages, you can use AWS Security Hub CSPM during the run stage to achieve automation and iteration. The following image shows how Security Hub CSPM can trigger a custom Amazon EventBridge rule that defines automatic actions to take against specific findings and insights. For more information, see Automations in the Security Hub CSPM documentation.



By using Security Hub CSPM as a central automation hub, you can also forward activities to Splunk. Splunk can then detect the ones that are anomalous and trigger corresponding actions in EventBridge. This helps you automate repetitive tasks and provides more time for skilled team members to focus on higher-value activities. You can also use AWS Step Functions to collect logs, take forensic snapshots, quarantine compromised servers, and replace them with a golden image. Additionally, you can use an AWS Lambda function that uses AWS Systems Manager to remediate vulnerabilities across the environment and uses an Amazon Simple Queue Service (Amazon SQS) function to validate the security of the systems. By taking this approach, it's possible to quickly contain and remediate security incidents with minimal impact to normal business operations.

The following is an example of repeated automated actions, as shown in the previous image:

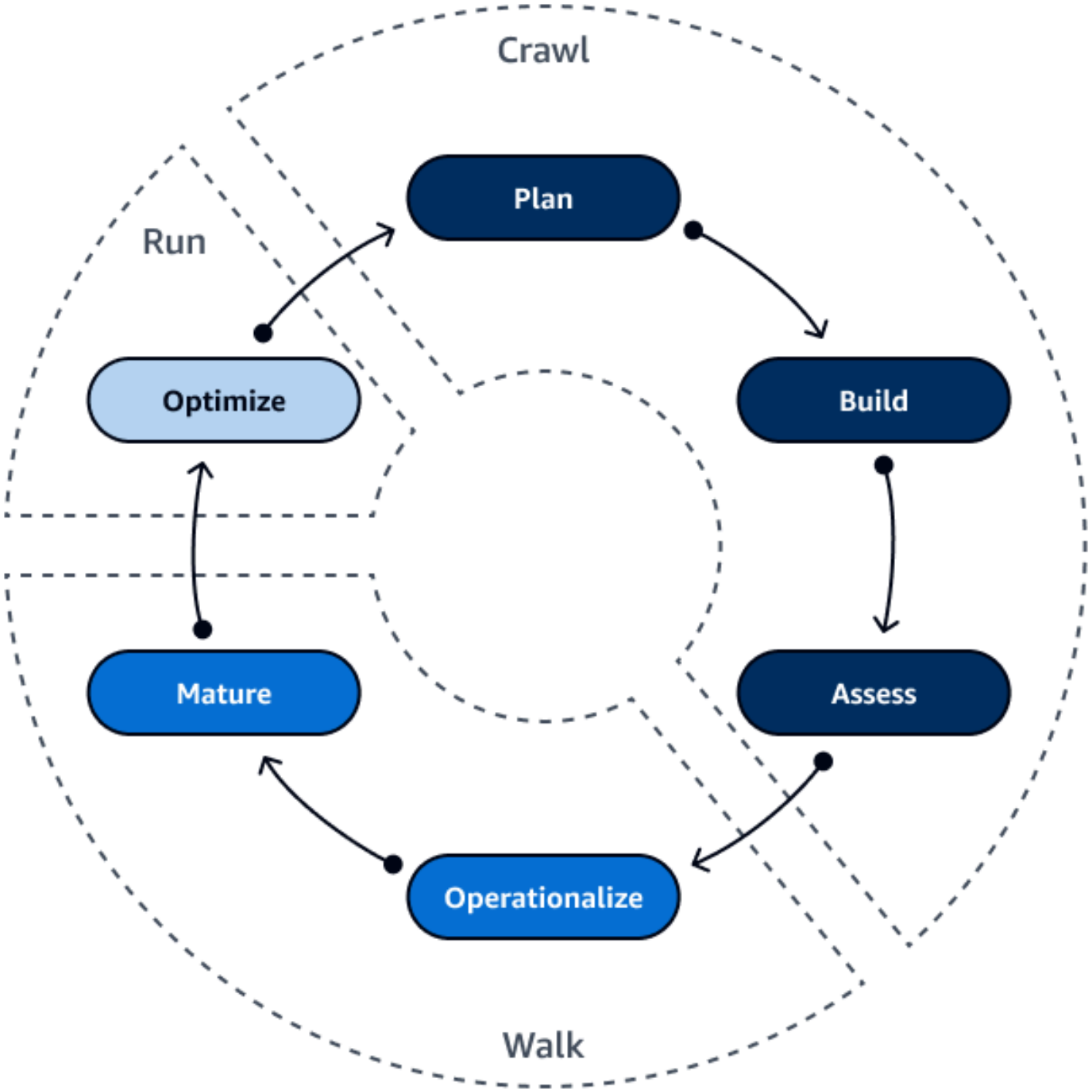
1. Use Splunk to detect questionable activity.
2. Use Step Functions to collect logs, revoke access, quarantine, and take forensic snapshots.

3. Use an EventBridge rule to start a Lambda function that quarantines, takes forensic snapshots, and replaces compromised servers with a golden image.
4. Start a Lambda function that uses Systems Manager to remediate and apply patches throughout the rest of the environment.
5. Start an Amazon SQS message that uses the Rapid7 scanner to scan and validate whether the AWS resource is secure.

For more information, see How to automate incident response in the AWS Cloud for EC2 instances in the AWS Security Blog.

Conclusion: Crawl, walk, run, then fly!

In summary, the *crawl, walk, run* model is a framework that helps you gradually improve your security posture and adopt best practices for securing AWS infrastructure. This process continues to evolve as new technologies and business needs arise. By following this framework and using the resources provided by AWS, you can establish a solid foundation for cloud security, effectively manage security risks, accelerate security maturity, and drive innovation.



In the crawl stage, you set the foundation. You define what your security plan is, use a defined security best practice architecture, and drive a continuous assessment toward your organization's business objectives.

In the walk stage, you take the first steps. You look at policies, build out playbooks, train people, and align strategies. This stage helps you understand how to take advantage of innovation to keep up with the technologies in the cloud.

In the run stage, you think big. You use automation and strategically place your skilled people in the right place. You implement automation to drive continuous assessment toward your organization's business objectives.

Now, it is time for you fly. Use the recommendations in this guide to accelerate your security maturity in the AWS Cloud.

Resources

Frameworks and models

- AWS Cloud Adoption Framework (AWS CAF)
- AWS Well-Architected Framework
- AWS Security Reference Architecture (AWS SRA)
- AWS Security Maturity Model
- HIPAA Reference Architecture
- HITRUST Reference Architecture

AWS services

- AWS Control Tower
- AWS Identity and Access Management Access Analyzer
- AWS Security Hub CSPM

Other AWS resources

- Automated Security Response on AWS in the AWS Solutions Library
- Automate Your IT Operations Using AWS Step Functions and Amazon CloudWatch Events in the AWS Compute Blog
- How to automate incident response in the AWS Cloud for EC2 instances in the AWS Security Blog
- How to perform automated incident response in a multi-account environment in the AWS Security Blog
- AWS re:Inforce 2022 - Crawl, walk, run: Accelerating security maturity video on YouTube
- AWS re:Inforce 2022 - Crawl, walk, run: Accelerating security maturity PowerPoint presentation (Attachment)

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Document history

The following table describes significant changes to this guide. If you want to be notified about future updates, you can subscribe to an RSS feed.

Change	Description	Date
Initial publication	—	December 20, 2023

AWS Prescriptive Guidance glossary

The following are commonly used terms in strategies, guides, and patterns provided by AWS Prescriptive Guidance. To suggest entries, please use the **Provide feedback** link at the end of the glossary.

Numbers

7 Rs

Seven common migration strategies for moving applications to the cloud. These strategies build upon the 5 Rs that Gartner identified in 2011 and consist of the following:

- Refactor/re-architect – Move an application and modify its architecture by taking full advantage of cloud-native features to improve agility, performance, and scalability. This typically involves porting the operating system and database. Example: Migrate your on-premises Oracle database to the Amazon Aurora PostgreSQL-Compatible Edition.
- Replatform (lift and reshape) – Move an application to the cloud, and introduce some level of optimization to take advantage of cloud capabilities. Example: Migrate your on-premises Oracle database to Amazon Relational Database Service (Amazon RDS) for Oracle in the AWS Cloud.
- Repurchase (drop and shop) – Switch to a different product, typically by moving from a traditional license to a SaaS model. Example: Migrate your customer relationship management (CRM) system to Salesforce.com.
- Rehost (lift and shift) – Move an application to the cloud without making any changes to take advantage of cloud capabilities. Example: Migrate your on-premises Oracle database to Oracle on an EC2 instance in the AWS Cloud.
- Relocate (hypervisor-level lift and shift) – Move infrastructure to the cloud without purchasing new hardware, rewriting applications, or modifying your existing operations. You migrate servers from an on-premises platform to a cloud service for the same platform. Example: Migrate a Microsoft Hyper-V application to AWS.
- Retain (revisit) – Keep applications in your source environment. These might include applications that require major refactoring, and you want to postpone that work until a later time, and legacy applications that you want to retain, because there's no business justification for migrating them.

- Retire – Decommission or remove applications that are no longer needed in your source environment.

A

A2A (Agent-to-Agent)

A stateful protocol for agent-to-agent collaboration supporting task delegation and state transfer.

ABAC

See attribute-based access control.

abstracted services

See managed services.

ACID

See atomicity, consistency, isolation, durability.

active-active migration

A database migration method in which the source and target databases are kept in sync (by using a bidirectional replication tool or dual write operations), and both databases handle transactions from connecting applications during migration. This method supports migration in small, controlled batches instead of requiring a one-time cutover. It's more flexible but requires more work than active-passive migration.

active-passive migration

A database migration method in which the source and target databases are kept in sync, but only the source database handles transactions from connecting applications while data is replicated to the target database. The target database doesn't accept any transactions during migration.

Agent

An AI system that can autonomously reason, plan, and take actions using tools to achieve goals.

Agent Ops

Operational practices for building, testing, deploying, and running AI agents in production at scale.

aggregate function

A SQL function that operates on a group of rows and calculates a single return value for the group. Examples of aggregate functions include `SUM` and `MAX`.

AI

See artificial intelligence.

AIOps

See artificial intelligence operations.

anonymization

The process of permanently deleting personal information in a dataset. Anonymization can help protect personal privacy. Anonymized data is no longer considered to be personal data.

anti-pattern

A frequently used solution for a recurring issue where the solution is counter-productive, ineffective, or less effective than an alternative.

application control

A security approach that allows the use of only approved applications in order to help protect a system from malware.

application portfolio

A collection of detailed information about each application used by an organization, including the cost to build and maintain the application, and its business value. This information is key to the portfolio discovery and analysis process and helps identify and prioritize the applications to be migrated, modernized, and optimized.

artificial intelligence (AI)

The field of computer science that is dedicated to using computing technologies to perform cognitive functions that are typically associated with humans, such as learning, solving problems, and recognizing patterns. For more information, see What is Artificial Intelligence?

artificial intelligence operations (AIOps)

The process of using machine learning techniques to solve operational problems, reduce operational incidents and human intervention, and increase service quality. For more information about how AIOps is used in the AWS migration strategy, see the operations integration guide.

asymmetric encryption

An encryption algorithm that uses a pair of keys, a public key for encryption and a private key for decryption. You can share the public key because it isn't used for decryption, but access to the private key should be highly restricted.

atomicity, consistency, isolation, durability (ACID)

A set of software properties that guarantee the data validity and operational reliability of a database, even in the case of errors, power failures, or other problems.

attribute-based access control (ABAC)

The practice of creating fine-grained permissions based on user attributes, such as department, job role, and team name. For more information, see ABAC for AWS in the AWS Identity and Access Management (IAM) documentation.

authoritative data source

A location where you store the primary version of data, which is considered to be the most reliable source of information. You can copy data from the authoritative data source to other locations for the purposes of processing or modifying the data, such as anonymizing, redacting, or pseudonymizing it.

Availability Zone

A distinct location within an AWS Region that is insulated from failures in other Availability Zones and provides inexpensive, low-latency network connectivity to other Availability Zones in the same Region.

AWS Cloud Adoption Framework (AWS CAF)

A framework of guidelines and best practices from AWS to help organizations develop an efficient and effective plan to move successfully to the cloud. AWS CAF organizes guidance into six focus areas called perspectives: business, people, governance, platform, security, and operations. The business, people, and governance perspectives focus on business skills and processes; the platform, security, and operations perspectives focus on technical skills and processes. For example, the people perspective targets stakeholders who handle human resources (HR), staffing functions, and people management. For this perspective, AWS CAF provides guidance for people development, training, and communications to help ready the organization for successful cloud adoption. For more information, see the AWS CAF website and the AWS CAF whitepaper.

AWS Workload Qualification Framework (AWS WQF)

A tool that evaluates database migration workloads, recommends migration strategies, and provides work estimates. AWS WQF is included with AWS Schema Conversion Tool (AWS SCT). It analyzes database schemas and code objects, application code, dependencies, and performance characteristics, and provides assessment reports.

B

bad bot

A bot that is intended to disrupt or cause harm to individuals or organizations.

BCP

See business continuity planning.

behavior graph

A unified, interactive view of resource behavior and interactions over time. You can use a behavior graph with Amazon Detective to examine failed logon attempts, suspicious API calls, and similar actions. For more information, see Data in a behavior graph in the Detective documentation.

big-endian system

A system that stores the most significant byte first. See also endianness.

binary classification

A process that predicts a binary outcome (one of two possible classes). For example, your ML model might need to predict problems such as “Is this email spam or not spam?" or "Is this product a book or a car?"

bloom filter

A probabilistic, memory-efficient data structure that is used to test whether an element is a member of a set.

blue/green deployment

A deployment strategy where you create two separate but identical environments. You run the current application version in one environment (blue) and the new application version in the other environment (green). This strategy helps you quickly roll back with minimal impact.

bot

A software application that runs automated tasks over the internet and simulates human activity or interaction. Some bots are useful or beneficial, such as web crawlers that index information on the internet. Some other bots, known as *bad bots*, are intended to disrupt or cause harm to individuals or organizations.

botnet

Networks of bots that are infected by malware and are under the control of a single party, known as a *bot herder* or *bot operator*. Botnets are the best-known mechanism to scale bots and their impact.

branch

A contained area of a code repository. The first branch created in a repository is the *main branch*. You can create a new branch from an existing branch, and you can then develop features or fix bugs in the new branch. A branch you create to build a feature is commonly referred to as a *feature branch*. When the feature is ready for release, you merge the feature branch back into the main branch. For more information, see About branches (GitHub documentation).

break-glass access

In exceptional circumstances and through an approved process, a quick means for a user to gain access to an AWS account that they don't typically have permissions to access. For more information, see the Implement break-glass procedures indicator in the AWS Well-Architected guidance.

brownfield strategy

The existing infrastructure in your environment. When adopting a brownfield strategy for a system architecture, you design the architecture around the constraints of the current systems and infrastructure. If you are expanding the existing infrastructure, you might blend brownfield and greenfield strategies.

buffer cache

The memory area where the most frequently accessed data is stored.

business capability

What a business does to generate value (for example, sales, customer service, or marketing). Microservices architectures and development decisions can be driven by business capabilities.

For more information, see the Organized around business capabilities section of the Running containerized microservices on AWS whitepaper.

business continuity planning (BCP)

A plan that addresses the potential impact of a disruptive event, such as a large-scale migration, on operations and enables a business to resume operations quickly.

C

CAF

See AWS Cloud Adoption Framework.

canary deployment

The slow and incremental release of a version to end users. When you are confident, you deploy the new version and replace the current version in its entirety.

CCoE

See Cloud Center of Excellence.

CDC

See change data capture.

change data capture (CDC)

The process of tracking changes to a data source, such as a database table, and recording metadata about the change. You can use CDC for various purposes, such as auditing or replicating changes in a target system to maintain synchronization.

chaos engineering

Intentionally introducing failures or disruptive events to test a system's resilience. You can use AWS Fault Injection Service (AWS FIS) to perform experiments that stress your AWS workloads and evaluate their response.

CI/CD

See continuous integration and continuous delivery.

classification

A categorization process that helps generate predictions. ML models for classification problems predict a discrete value. Discrete values are always distinct from one another. For example, a model might need to evaluate whether or not there is a car in an image.

Citizen Developer

A business user who creates AI applications using no-code/low-code platforms without specialized technical skills.

client-side encryption

Encryption of data locally, before the target AWS service receives it.

Cloud Center of Excellence (CCoE)

A multi-disciplinary team that drives cloud adoption efforts across an organization, including developing cloud best practices, mobilizing resources, establishing migration timelines, and leading the organization through large-scale transformations. For more information, see the CCoE posts on the AWS Cloud Enterprise Strategy Blog.

cloud computing

The cloud technology that is typically used for remote data storage and IoT device management. Cloud computing is commonly connected to edge computing technology.

cloud operating model

In an IT organization, the operating model that is used to build, mature, and optimize one or more cloud environments. For more information, see Building your Cloud Operating Model.

cloud stages of adoption

The four phases that organizations typically go through when they migrate to the AWS Cloud:

- Project – Running a few cloud-related projects for proof of concept and learning purposes
- Foundation – Making foundational investments to scale your cloud adoption (e.g., creating a landing zone, defining a CCoE, establishing an operations model)
- Migration – Migrating individual applications
- Re-invention – Optimizing products and services, and innovating in the cloud

These stages were defined by Stephen Orban in the blog post The Journey Toward Cloud-First & the Stages of Adoption on the AWS Cloud Enterprise Strategy blog. For information about how they relate to the AWS migration strategy, see the migration readiness guide.

CMDB

See configuration management database.

code repository

A location where source code and other assets, such as documentation, samples, and scripts, are stored and updated through version control processes. Common cloud repositories include GitHub or Bitbucket Cloud. Each version of the code is called a *branch*. In a microservice structure, each repository is devoted to a single piece of functionality. A single CI/CD pipeline can use multiple repositories.

cold cache

A buffer cache that is empty, not well populated, or contains stale or irrelevant data. This affects performance because the database instance must read from the main memory or disk, which is slower than reading from the buffer cache.

cold data

Data that is rarely accessed and is typically historical. When querying this kind of data, slow queries are typically acceptable. Moving this data to lower-performing and less expensive storage tiers or classes can reduce costs.

computer vision (CV)

A field of AI that uses machine learning to analyze and extract information from visual formats such as digital images and videos. For example, Amazon SageMaker AI provides image processing algorithms for CV.

configuration drift

For a workload, a configuration change from the expected state. It might cause the workload to become noncompliant, and it's typically gradual and unintentional.

configuration management database (CMDB)

A repository that stores and manages information about a database and its IT environment, including both hardware and software components and their configurations. You typically use data from a CMDB in the portfolio discovery and analysis stage of migration.

conformance pack

A collection of AWS Config rules and remediation actions that you can assemble to customize your compliance and security checks. You can deploy a conformance pack as a single entity in

an AWS account and Region, or across an organization, by using a YAML template. For more information, see Conformance packs in the AWS Config documentation.

continuous integration and continuous delivery (CI/CD)

The process of automating the source, build, test, staging, and production stages of the software release process. CI/CD is commonly described as a pipeline. CI/CD can help you automate processes, improve productivity, improve code quality, and deliver faster. For more information, see Benefits of continuous delivery. CD can also stand for *continuous deployment*. For more information, see Continuous Delivery vs. Continuous Deployment.

CV

See computer vision.

D

data at rest

Data that is stationary in your network, such as data that is in storage.

data classification

A process for identifying and categorizing the data in your network based on its criticality and sensitivity. It is a critical component of any cybersecurity risk management strategy because it helps you determine the appropriate protection and retention controls for the data. Data classification is a component of the security pillar in the AWS Well-Architected Framework. For more information, see Data classification.

data drift

A meaningful variation between the production data and the data that was used to train an ML model, or a meaningful change in the input data over time. Data drift can reduce the overall quality, accuracy, and fairness in ML model predictions.

data in transit

Data that is actively moving through your network, such as between network resources.

data mesh

An architectural framework that provides distributed, decentralized data ownership with centralized management and governance.

data minimization

The principle of collecting and processing only the data that is strictly necessary. Practicing data minimization in the AWS Cloud can reduce privacy risks, costs, and your analytics carbon footprint.

data perimeter

A set of preventive guardrails in your AWS environment that help make sure that only trusted identities are accessing trusted resources from expected networks. For more information, see Building a data perimeter on AWS.

data preprocessing

To transform raw data into a format that is easily parsed by your ML model. Preprocessing data can mean removing certain columns or rows and addressing missing, inconsistent, or duplicate values.

data provenance

The process of tracking the origin and history of data throughout its lifecycle, such as how the data was generated, transmitted, and stored.

data subject

An individual whose data is being collected and processed.

data warehouse

A data management system that supports business intelligence, such as analytics. Data warehouses commonly contain large amounts of historical data, and they are typically used for queries and analysis.

database definition language (DDL)

Statements or commands for creating or modifying the structure of tables and objects in a database.

database manipulation language (DML)

Statements or commands for modifying (inserting, updating, and deleting) information in a database.

DDL

See database definition language.

deep ensemble

To combine multiple deep learning models for prediction. You can use deep ensembles to obtain a more accurate prediction or for estimating uncertainty in predictions.

deep learning

An ML subfield that uses multiple layers of artificial neural networks to identify mapping between input data and target variables of interest.

defense-in-depth

An information security approach in which a series of security mechanisms and controls are thoughtfully layered throughout a computer network to protect the confidentiality, integrity, and availability of the network and the data within. When you adopt this strategy on AWS, you add multiple controls at different layers of the AWS Organizations structure to help secure resources. For example, a defense-in-depth approach might combine multi-factor authentication, network segmentation, and encryption.

delegated administrator

In AWS Organizations, a compatible service can register an AWS member account to administer the organization's accounts and manage permissions for that service. This account is called the *delegated administrator* for that service. For more information and a list of compatible services, see Services that work with AWS Organizations in the AWS Organizations documentation.

deployment

The process of making an application, new features, or code fixes available in the target environment. Deployment involves implementing changes in a code base and then building and running that code base in the application's environments.

development environment

See environment.

detective control

A security control that is designed to detect, log, and alert after an event has occurred. These controls are a second line of defense, alerting you to security events that bypassed the preventative controls in place. For more information, see Detective controls in *Implementing security controls on AWS*.

development value stream mapping (DVSM)

A process used to identify and prioritize constraints that adversely affect speed and quality in a software development lifecycle. DVSM extends the value stream mapping process originally designed for lean manufacturing practices. It focuses on the steps and teams required to create and move value through the software development process.

digital twin

A virtual representation of a real-world system, such as a building, factory, industrial equipment, or production line. Digital twins support predictive maintenance, remote monitoring, and production optimization.

dimension table

In a star schema, a smaller table that contains data attributes about quantitative data in a fact table. Dimension table attributes are typically text fields or discrete numbers that behave like text. These attributes are commonly used for query constraining, filtering, and result set labeling.

disaster

An event that prevents a workload or system from fulfilling its business objectives in its primary deployed location. These events can be natural disasters, technical failures, or the result of human actions, such as unintentional misconfiguration or a malware attack.

disaster recovery (DR)

The strategy and process you use to minimize downtime and data loss caused by a disaster. For more information, see Disaster Recovery of Workloads on AWS: Recovery in the Cloud in the AWS Well-Architected Framework.

DML

See database manipulation language.

domain-driven design

An approach to developing a complex software system by connecting its components to evolving domains, or core business goals, that each component serves. This concept was introduced by Eric Evans in his book, *Domain-Driven Design: Tackling Complexity in the Heart of Software* (Boston: Addison-Wesley Professional, 2003). For information about how you can use domain-driven design with the strangler fig pattern, see Modernizing legacy Microsoft ASP.NET (ASMX) web services incrementally by using containers and Amazon API Gateway.

DR

See disaster recovery.

drift detection

Tracking deviations from a baselined configuration. For example, you can use AWS CloudFormation to detect drift in system resources, or you can use AWS Control Tower to detect changes in your landing zone that might affect compliance with governance requirements.

DVSM

See development value stream mapping.

E

EDA

See exploratory data analysis.

EDI

See electronic data interchange.

edge computing

The technology that increases the computing power for smart devices at the edges of an IoT network. When compared with cloud computing, edge computing can reduce communication latency and improve response time.

electronic data interchange (EDI)

The automated exchange of business documents between organizations. For more information, see What is Electronic Data Interchange.

encryption

A computing process that transforms plaintext data, which is human-readable, into ciphertext.

encryption key

A cryptographic string of randomized bits that is generated by an encryption algorithm. Keys can vary in length, and each key is designed to be unpredictable and unique.

endianness

The order in which bytes are stored in computer memory. Big-endian systems store the most significant byte first. Little-endian systems store the least significant byte first.

endpoint

See service endpoint.

endpoint service

A service that you can host in a virtual private cloud (VPC) to share with other users. You can create an endpoint service with AWS PrivateLink and grant permissions to other AWS accounts or to AWS Identity and Access Management (IAM) principals. These accounts or principals can connect to your endpoint service privately by creating interface VPC endpoints. For more information, see Create an endpoint service in the Amazon Virtual Private Cloud (Amazon VPC) documentation.

enterprise resource planning (ERP)

A system that automates and manages key business processes (such as accounting, MES, and project management) for an enterprise.

envelope encryption

The process of encrypting an encryption key with another encryption key. For more information, see Envelope encryption in the AWS Key Management Service (AWS KMS) documentation.

environment

An instance of a running application. The following are common types of environments in cloud computing:

- development environment – An instance of a running application that is available only to the core team responsible for maintaining the application. Development environments are used to test changes before promoting them to upper environments. This type of environment is sometimes referred to as a *test environment*.
- lower environments – All development environments for an application, such as those used for initial builds and tests.
- production environment – An instance of a running application that end users can access. In a CI/CD pipeline, the production environment is the last deployment environment.

- upper environments – All environments that can be accessed by users other than the core development team. This can include a production environment, preproduction environments, and environments for user acceptance testing.

epic

In agile methodologies, functional categories that help organize and prioritize your work. Epics provide a high-level description of requirements and implementation tasks. For example, AWS CAF security epics include identity and access management, detective controls, infrastructure security, data protection, and incident response. For more information about epics in the AWS migration strategy, see the program implementation guide.

ERP

See enterprise resource planning.

exploratory data analysis (EDA)

The process of analyzing a dataset to understand its main characteristics. You collect or aggregate data and then perform initial investigations to find patterns, detect anomalies, and check assumptions. EDA is performed by calculating summary statistics and creating data visualizations.

F

fact table

The central table in a star schema. It stores quantitative data about business operations. Typically, a fact table contains two types of columns: those that contain measures and those that contain a foreign key to a dimension table.

fail fast

A philosophy that uses frequent and incremental testing to reduce the development lifecycle. It is a critical part of an agile approach.

fault isolation boundary

In the AWS Cloud, a boundary such as an Availability Zone, AWS Region, control plane, or data plane that limits the effect of a failure and helps improve the resilience of workloads. For more information, see AWS Fault Isolation Boundaries.

feature branch

See branch.

features

The input data that you use to make a prediction. For example, in a manufacturing context, features could be images that are periodically captured from the manufacturing line.

feature importance

How significant a feature is for a model's predictions. This is usually expressed as a numerical score that can be calculated through various techniques, such as Shapley Additive Explanations (SHAP) and integrated gradients. For more information, see Machine learning model interpretability with AWS.

feature transformation

To optimize data for the ML process, including enriching data with additional sources, scaling values, or extracting multiple sets of information from a single data field. This enables the ML model to benefit from the data. For example, if you break down the "2021-05-27 00:15:37" date into "2021", "May", "Thu", and "15", you can help the learning algorithm learn nuanced patterns associated with different data components.

few-shot prompting

Providing an LLM with a small number of examples that demonstrate the task and desired output before asking it to perform a similar task. This technique is an application of in-context learning, where models learn from examples (*shots*) that are embedded in prompts. Few-shot prompting can be effective for tasks that require specific formatting, reasoning, or domain knowledge. See also zero-shot prompting.

FGAC

See fine-grained access control.

fine-grained access control (FGAC)

The use of multiple conditions to allow or deny an access request.

flash-cut migration

A database migration method that uses continuous data replication through change data capture to migrate data in the shortest time possible, instead of using a phased approach. The objective is to keep downtime to a minimum.

FM

See foundation model.

foundation model (FM)

A large deep-learning neural network that has been training on massive datasets of generalized and unlabeled data. FMs are capable of performing a wide variety of general tasks, such as understanding language, generating text and images, and conversing in natural language. For more information, see What are Foundation Models.

FM gateway

A centralized intermediary that controls and normalizes access to foundation models. Also known as an *LLM gateway*.

G

generative AI

A subset of AI models that have been trained on large amounts of data and that can use a simple text prompt to create new content and artifacts, such as images, videos, text, and audio. For more information, see What is Generative AI.

geo blocking

See geographic restrictions.

geographic restrictions (geo blocking)

In Amazon CloudFront, an option to prevent users in specific countries from accessing content distributions. You can use an allow list or block list to specify approved and banned countries. For more information, see Restricting the geographic distribution of your content in the CloudFront documentation.

Gitflow workflow

An approach in which lower and upper environments use different branches in a source code repository. The Gitflow workflow is considered legacy, and the trunk-based workflow is the modern, preferred approach.

golden image

A snapshot of a system or software that is used as a template to deploy new instances of that system or software. For example, in manufacturing, a golden image can be used to provision

software on multiple devices and helps improve speed, scalability, and productivity in device manufacturing operations.

greenfield strategy

The absence of existing infrastructure in a new environment. When adopting a greenfield strategy for a system architecture, you can select all new technologies without the restriction of compatibility with existing infrastructure, also known as brownfield. If you are expanding the existing infrastructure, you might blend brownfield and greenfield strategies.

guardrail

A high-level rule that helps govern resources, policies, and compliance across organizational units (OUs). *Preventive guardrails* enforce policies to ensure alignment to compliance standards. They are implemented by using service control policies and IAM permissions boundaries. *Detective guardrails* detect policy violations and compliance issues, and generate alerts for remediation. They are implemented by using AWS Config, AWS Security Hub CSPM, Amazon GuardDuty, AWS Trusted Advisor, Amazon Inspector, and custom AWS Lambda checks.

guardrails (AI)

Safety mechanisms that filter, validate, and constrain agent inputs and outputs to help ensure responsible and safe AI behavior.

H

HA

See high availability.

heterogeneous database migration

Migrating your source database to a target database that uses a different database engine (for example, Oracle to Amazon Aurora). Heterogeneous migration is typically part of a re-architecting effort, and converting the schema can be a complex task. AWS provides AWS SCT that helps with schema conversions.

high availability (HA)

The ability of a workload to operate continuously, without intervention, in the event of challenges or disasters. HA systems are designed to automatically fail over, consistently deliver

high-quality performance, and handle different loads and failures with minimal performance impact.

historian modernization

An approach used to modernize and upgrade operational technology (OT) systems to better serve the needs of the manufacturing industry. A *historian* is a type of database that is used to collect and store data from various sources in a factory.

holdout data

A portion of historical, labeled data that is withheld from a dataset that is used to train a machine learning model. You can use holdout data to evaluate the model performance by comparing the model predictions against the holdout data.

human-in-the-loop (HitL)

A workflow pattern where agent execution pauses for human review and approval at critical decision points.

homogeneous database migration

Migrating your source database to a target database that shares the same database engine (for example, Microsoft SQL Server to Amazon RDS for SQL Server). Homogeneous migration is typically part of a rehosting or replatforming effort. You can use native database utilities to migrate the schema.

hot data

Data that is frequently accessed, such as real-time data or recent translational data. This data typically requires a high-performance storage tier or class to provide fast query responses.

hotfix

An urgent fix for a critical issue in a production environment. Due to its urgency, a hotfix is usually made outside of the typical DevOps release workflow.

hypercare period

Immediately following cutover, the period of time when a migration team manages and monitors the migrated applications in the cloud in order to address any issues. Typically, this period is 1–4 days in length. At the end of the hypercare period, the migration team typically transfers responsibility for the applications to the cloud operations team.

I

IaC

See infrastructure as code.

identity-based policy

A policy attached to one or more IAM principals that defines their permissions within the AWS Cloud environment.

idle application

An application that has an average CPU and memory usage between 5 and 20 percent over a period of 90 days. In a migration project, it is common to retire these applications or retain them on premises.

IIoT

See industrial Internet of Things.

immutable infrastructure

A model that deploys new infrastructure for production workloads instead of updating, patching, or modifying the existing infrastructure. Immutable infrastructures are inherently more consistent, reliable, and predictable than mutable infrastructure. For more information, see the Deploy using immutable infrastructure best practice in the AWS Well-Architected Framework.

inbound (ingress) VPC

In an AWS multi-account architecture, a VPC that accepts, inspects, and routes network connections from outside an application. The AWS Security Reference Architecture recommends setting up your Network account with inbound, outbound, and inspection VPCs to protect the two-way interface between your application and the broader internet.

incremental migration

A cutover strategy in which you migrate your application in small parts instead of performing a single, full cutover. For example, you might move only a few microservices or users to the new system initially. After you verify that everything is working properly, you can incrementally move additional microservices or users until you can decommission your legacy system. This strategy reduces the risks associated with large migrations.

Industry 4.0

A term that was introduced by Klaus Schwab in 2016 to refer to the modernization of manufacturing processes through advances in connectivity, real-time data, automation, analytics, and AI/ML.

infrastructure

All of the resources and assets contained within an application's environment.

infrastructure as code (IaC)

The process of provisioning and managing an application's infrastructure through a set of configuration files. IaC is designed to help you centralize infrastructure management, standardize resources, and scale quickly so that new environments are repeatable, reliable, and consistent.

industrial Internet of Things (IIoT)

The use of internet-connected sensors and devices in the industrial sectors, such as manufacturing, energy, automotive, healthcare, life sciences, and agriculture. For more information, see Building an industrial Internet of Things (IIoT) digital transformation strategy.

inspection VPC

In an AWS multi-account architecture, a centralized VPC that manages inspections of network traffic between VPCs (in the same or different AWS Regions), the internet, and on-premises networks. The AWS Security Reference Architecture recommends setting up your Network account with inbound, outbound, and inspection VPCs to protect the two-way interface between your application and the broader internet.

Internet of Things (IoT)

The network of connected physical objects with embedded sensors or processors that communicate with other devices and systems through the internet or over a local communication network. For more information, see What is IoT?

interpretability

A characteristic of a machine learning model that describes the degree to which a human can understand how the model's predictions depend on its inputs. For more information, see Machine learning model interpretability with AWS.

IoT

See Internet of Things.

IT information library (ITIL)

A set of best practices for delivering IT services and aligning these services with business requirements. ITIL provides the foundation for ITSM.

IT service management (ITSM)

Activities associated with designing, implementing, managing, and supporting IT services for an organization. For information about integrating cloud operations with ITSM tools, see the operations integration guide.

ITIL

See IT information library.

ITSM

See IT service management.

L

label-based access control (LBAC)

An implementation of mandatory access control (MAC) where the users and the data itself are each explicitly assigned a security label value. The intersection between the user security label and data security label determines which rows and columns can be seen by the user.

landing zone

A landing zone is a well-architected, multi-account AWS environment that is scalable and secure. This is a starting point from which your organizations can quickly launch and deploy workloads and applications with confidence in their security and infrastructure environment. For more information about landing zones, see Setting up a secure and scalable multi-account AWS environment.

large language model (LLM)

A deep learning AI model that is pretrained on a vast amount of data. An LLM can perform multiple tasks, such as answering questions, summarizing documents, translating text into other languages, and completing sentences. For more information, see What are LLMs.

large migration

A migration of 300 or more servers.

LBAC

See label-based access control.

least privilege

The security best practice of granting the minimum permissions required to perform a task. For more information, see Apply least-privilege permissions in the IAM documentation.

lift and shift

See 7 Rs.

little-endian system

A system that stores the least significant byte first. See also endianness.

LLM

See large language model.

lower environments

See environment.

M

machine learning (ML)

A type of artificial intelligence that uses algorithms and techniques for pattern recognition and learning. ML analyzes and learns from recorded data, such as Internet of Things (IoT) data, to generate a statistical model based on patterns. For more information, see Machine Learning.

main branch

See branch.

malware

Software that is designed to compromise computer security or privacy. Malware might disrupt computer systems, leak sensitive information, or gain unauthorized access. Examples of malware include viruses, worms, ransomware, Trojan horses, spyware, and keyloggers.

managed services

AWS services for which AWS operates the infrastructure layer, the operating system, and platforms, and you access the endpoints to store and retrieve data. Amazon Simple Storage

Service (Amazon S3) and Amazon DynamoDB are examples of managed services. These are also known as *abstracted services*.

manufacturing execution system (MES)

A software system for tracking, monitoring, documenting, and controlling production processes that convert raw materials to finished products on the shop floor.

MAP

See Migration Acceleration Program.

MCP

See Model Context Protocol.

Model Context Protocol (MCP)

A stateless protocol for agent-to-tool communication.

MCP server

A service that exposes one or more tools through the Model Context Protocol.

mechanism

A complete process in which you create a tool, drive adoption of the tool, and then inspect the results in order to make adjustments. A mechanism is a cycle that reinforces and improves itself as it operates. For more information, see Building mechanisms in the AWS Well-Architected Framework.

member account

All AWS accounts other than the management account that are part of an organization in AWS Organizations. An account can be a member of only one organization at a time.

MES

See manufacturing execution system.

Message Queuing Telemetry Transport (MQTT)

A lightweight, machine-to-machine (M2M) communication protocol, based on the publish/subscribe pattern, for resource-constrained IoT devices.

microservice

A small, independent service that communicates over well-defined APIs and is typically owned by small, self-contained teams. For example, an insurance system might include

microservices that map to business capabilities, such as sales or marketing, or subdomains, such as purchasing, claims, or analytics. The benefits of microservices include agility, flexible scaling, easy deployment, reusable code, and resilience. For more information, see Integrating microservices by using AWS serverless services.

microservices architecture

An approach to building an application with independent components that run each application process as a microservice. These microservices communicate through a well-defined interface by using lightweight APIs. Each microservice in this architecture can be updated, deployed, and scaled to meet demand for specific functions of an application. For more information, see Implementing microservices on AWS.

Migration Acceleration Program (MAP)

An AWS program that provides consulting support, training, and services to help organizations build a strong operational foundation for moving to the cloud, and to help offset the initial cost of migrations. MAP includes a migration methodology for executing legacy migrations in a methodical way and a set of tools to automate and accelerate common migration scenarios.

migration at scale

The process of moving the majority of the application portfolio to the cloud in waves, with more applications moved at a faster rate in each wave. This phase uses the best practices and lessons learned from the earlier phases to implement a *migration factory* of teams, tools, and processes to streamline the migration of workloads through automation and agile delivery. This is the third phase of the AWS migration strategy.

migration factory

Cross-functional teams that streamline the migration of workloads through automated, agile approaches. Migration factory teams typically include operations, business analysts and owners, migration engineers, developers, and DevOps professionals working in sprints. Between 20 and 50 percent of an enterprise application portfolio consists of repeated patterns that can be optimized by a factory approach. For more information, see the discussion of migration factories and the Cloud Migration Factory guide in this content set.

migration metadata

The information about the application and server that is needed to complete the migration. Each migration pattern requires a different set of migration metadata. Examples of migration metadata include the target subnet, security group, and AWS account.

migration pattern

A repeatable migration task that details the migration strategy, the migration destination, and the migration application or service used. Example: Rehost migration to Amazon EC2 with AWS Application Migration Service.

Migration Portfolio Assessment (MPA)

An online tool that provides information for validating the business case for migrating to the AWS Cloud. MPA provides detailed portfolio assessment (server right-sizing, pricing, TCO comparisons, migration cost analysis) as well as migration planning (application data analysis and data collection, application grouping, migration prioritization, and wave planning). The MPA tool (requires login) is available free of charge to all AWS consultants and APN Partner consultants.

Migration Readiness Assessment (MRA)

The process of gaining insights about an organization's cloud readiness status, identifying strengths and weaknesses, and building an action plan to close identified gaps, using the AWS CAF. For more information, see the migration readiness guide. MRA is the first phase of the AWS migration strategy.

migration strategy

The approach used to migrate a workload to the AWS Cloud. For more information, see the 7 Rs entry in this glossary and see Mobilize your organization to accelerate large-scale migrations.

ML

See machine learning.

modernization

Transforming an outdated (legacy or monolithic) application and its infrastructure into an agile, elastic, and highly available system in the cloud to reduce costs, gain efficiencies, and take advantage of innovations. For more information, see Strategy for modernizing applications in the AWS Cloud.

modernization readiness assessment

An evaluation that helps determine the modernization readiness of an organization's applications; identifies benefits, risks, and dependencies; and determines how well the organization can support the future state of those applications. The outcome of the assessment is a blueprint of the target architecture, a roadmap that details development phases and

milestones for the modernization process, and an action plan for addressing identified gaps. For more information, see Evaluating modernization readiness for applications in the AWS Cloud.

monolithic applications (monoliths)

Applications that run as a single service with tightly coupled processes. Monolithic applications have several drawbacks. If one application feature experiences a spike in demand, the entire architecture must be scaled. Adding or improving a monolithic application's features also becomes more complex when the code base grows. To address these issues, you can use a microservices architecture. For more information, see Decomposing monoliths into microservices.

MPA

See Migration Portfolio Assessment.

MQTT

See Message Queuing Telemetry Transport.

multiclass classification

A process that helps generate predictions for multiple classes (predicting one of more than two outcomes). For example, an ML model might ask "Is this product a book, car, or phone?" or "Which product category is most interesting to this customer?"

mutable infrastructure

A model that updates and modifies the existing infrastructure for production workloads. For improved consistency, reliability, and predictability, the AWS Well-Architected Framework recommends the use of immutable infrastructure as a best practice.

O

OAC

See origin access control.

OAI

See origin access identity.

OCM

See organizational change management.

offline migration

A migration method in which the source workload is taken down during the migration process. This method involves extended downtime and is typically used for small, non-critical workloads.

OI

See operations integration.

OLA

See operational-level agreement.

online migration

A migration method in which the source workload is copied to the target system without being taken offline. Applications that are connected to the workload can continue to function during the migration. This method involves zero to minimal downtime and is typically used for critical production workloads.

OPC-UA

See Open Process Communications - Unified Architecture.

Open Process Communications - Unified Architecture (OPC-UA)

A machine-to-machine (M2M) communication protocol for industrial automation. OPC-UA provides an interoperability standard with data encryption, authentication, and authorization schemes.

operational-level agreement (OLA)

An agreement that clarifies what functional IT groups promise to deliver to each other, to support a service-level agreement (SLA).

operational readiness review (ORR)

A checklist of questions and associated best practices that help you understand, evaluate, prevent, or reduce the scope of incidents and possible failures. For more information, see Operational Readiness Reviews (ORR) in the AWS Well-Architected Framework.

operational technology (OT)

Hardware and software systems that work with the physical environment to control industrial operations, equipment, and infrastructure. In manufacturing, the integration of OT and information technology (IT) systems is a key focus for Industry 4.0 transformations.

operations integration (OI)

The process of modernizing operations in the cloud, which involves readiness planning, automation, and integration. For more information, see the operations integration guide.

organization trail

A trail that's created by AWS CloudTrail that logs all events for all AWS accounts in an organization in AWS Organizations. This trail is created in each AWS account that's part of the organization and tracks the activity in each account. For more information, see Creating a trail for an organization in the CloudTrail documentation.

organizational change management (OCM)

A framework for managing major, disruptive business transformations from a people, culture, and leadership perspective. OCM helps organizations prepare for, and transition to, new systems and strategies by accelerating change adoption, addressing transitional issues, and driving cultural and organizational changes. In the AWS migration strategy, this framework is called *people acceleration*, because of the speed of change required in cloud adoption projects. For more information, see the OCM guide.

origin access control (OAC)

In CloudFront, an enhanced option for restricting access to secure your Amazon Simple Storage Service (Amazon S3) content. OAC supports all S3 buckets in all AWS Regions, server-side encryption with AWS KMS (SSE-KMS), and dynamic `PUT` and `DELETE` requests to the S3 bucket.

origin access identity (OAI)

In CloudFront, an option for restricting access to secure your Amazon S3 content. When you use OAI, CloudFront creates a principal that Amazon S3 can authenticate with. Authenticated principals can access content in an S3 bucket only through a specific CloudFront distribution. See also OAC, which provides more granular and enhanced access control.

ORR

See operational readiness review.

OT

See operational technology.

outbound (egress) VPC

In an AWS multi-account architecture, a VPC that handles network connections that are initiated from within an application. The AWS Security Reference Architecture recommends

setting up your Network account with inbound, outbound, and inspection VPCs to protect the two-way interface between your application and the broader internet.

P

permissions boundary

An IAM management policy that is attached to IAM principals to set the maximum permissions that the user or role can have. For more information, see Permissions boundaries in the IAM documentation.

personally identifiable information (PII)

Information that, when viewed directly or paired with other related data, can be used to reasonably infer the identity of an individual. Examples of PII include names, addresses, and contact information.

PII

See personally identifiable information.

playbook

A set of predefined steps that capture the work associated with migrations, such as delivering core operations functions in the cloud. A playbook can take the form of scripts, automated runbooks, or a summary of processes or steps required to operate your modernized environment.

PLC

See programmable logic controller.

PLM

See product lifecycle management.

policy

An object that can define permissions (see identity-based policy), specify access conditions (see resource-based policy), or define the maximum permissions for all accounts in an organization in AWS Organizations (see service control policy).

polyglot persistence

Independently choosing a microservice's data storage technology based on data access patterns and other requirements. If your microservices have the same data storage technology, they can encounter implementation challenges or experience poor performance. Microservices are more easily implemented and achieve better performance and scalability if they use the data store best adapted to their requirements.

portfolio assessment

A process of discovering, analyzing, and prioritizing the application portfolio in order to plan the migration. For more information, see Evaluating migration readiness.

predicate

A query condition that returns `true` or `false`, commonly located in a `WHERE` clause.

predicate pushdown

A database query optimization technique that filters the data in the query before transfer. This reduces the amount of data that must be retrieved and processed from the relational database, and it improves query performance.

preventative control

A security control that is designed to prevent an event from occurring. These controls are a first line of defense to help prevent unauthorized access or unwanted changes to your network. For more information, see Preventative controls in *Implementing security controls on AWS*.

principal

An entity in AWS that can perform actions and access resources. This entity is typically a root user for an AWS account, an IAM role, or a user. For more information, see *Principal* in Roles terms and concepts in the IAM documentation.

privacy by design

A system engineering approach that takes privacy into account through the whole development process.

private hosted zones

A container that holds information about how you want Amazon Route 53 to respond to DNS queries for a domain and its subdomains within one or more VPCs. For more information, see Working with private hosted zones in the Route 53 documentation.

proactive control

A security control designed to prevent the deployment of noncompliant resources. These controls scan resources before they are provisioned. If the resource is not compliant with the control, then it isn't provisioned. For more information, see the Controls reference guide in the AWS Control Tower documentation and see Proactive controls in *Implementing security controls on AWS*.

product lifecycle management (PLM)

The management of data and processes for a product throughout its entire lifecycle, from design, development, and launch, through growth and maturity, to decline and removal.

production environment

See environment.

programmable logic controller (PLC)

In manufacturing, a highly reliable, adaptable computer that monitors machines and automates manufacturing processes.

prompt chaining

Using the output of one LLM prompt as the input for the next prompt to generate better responses. This technique is used to break down a complex task into subtasks, or to iteratively refine or expand a preliminary response. It helps improve the accuracy and relevance of a model's responses and allows for more granular, personalized results.

pseudonymization

The process of replacing personal identifiers in a dataset with placeholder values. Pseudonymization can help protect personal privacy. Pseudonymized data is still considered to be personal data.

publish/subscribe (pub/sub)

A pattern that enables asynchronous communications among microservices to improve scalability and responsiveness. For example, in a microservices-based MES, a microservice can publish event messages to a channel that other microservices can subscribe to. The system can add new microservices without changing the publishing service.

Q

query plan

A series of steps, like instructions, that are used to access the data in a SQL relational database system.

query plan regression

When a database service optimizer chooses a less optimal plan than it did before a given change to the database environment. This can be caused by changes to statistics, constraints, environment settings, query parameter bindings, and updates to the database engine.

R

RACI matrix

See responsible, accountable, consulted, informed (RACI).

RAG

See Retrieval Augmented Generation.

ransomware

A malicious software that is designed to block access to a computer system or data until a payment is made.

RASCI matrix

See responsible, accountable, consulted, informed (RACI).

RCAC

See row and column access control.

read replica

A copy of a database that's used for read-only purposes. You can route queries to the read replica to reduce the load on your primary database.

re-architect

See 7 Rs.

recovery point objective (RPO)

The maximum acceptable amount of time since the last data recovery point. This determines what is considered an acceptable loss of data between the last recovery point and the interruption of service.

recovery time objective (RTO)

The maximum acceptable delay between the interruption of service and restoration of service.

refactor

See 7 Rs.

Region

A collection of AWS resources in a geographic area. Each AWS Region is isolated and independent of the others to provide fault tolerance, stability, and resilience. For more information, see Specify which AWS Regions your account can use.

regression

An ML technique that predicts a numeric value. For example, to solve the problem of "What price will this house sell for?" an ML model could use a linear regression model to predict a house's sale price based on known facts about the house (for example, the square footage).

rehost

See 7 Rs.

release

In a deployment process, the act of promoting changes to a production environment.

relocate

See 7 Rs.

replatform

See 7 Rs.

repurchase

See 7 Rs.

resiliency

An application's ability to resist or recover from disruptions. High availability and disaster recovery are common considerations when planning for resiliency in the AWS Cloud. For more information, see AWS Cloud Resilience.

resource-based policy

A policy attached to a resource, such as an Amazon S3 bucket, an endpoint, or an encryption key. This type of policy specifies which principals are allowed access, supported actions, and any other conditions that must be met.

responsible, accountable, consulted, informed (RACI) matrix

A matrix that defines the roles and responsibilities for all parties involved in migration activities and cloud operations. The matrix name is derived from the responsibility types defined in the matrix: responsible (R), accountable (A), consulted (C), and informed (I). The support (S) type is optional. If you include support, the matrix is called a *RASCI matrix*, and if you exclude it, it's called a *RACI matrix*.

responsive control

A security control that is designed to drive remediation of adverse events or deviations from your security baseline. For more information, see Responsive controls in *Implementing security controls on AWS*.

retain

See 7 Rs.

retire

See 7 Rs.

Retrieval Augmented Generation (RAG)

A generative AI technology in which an LLM references an authoritative data source that is outside of its training data sources before generating a response. For example, a RAG model might perform a semantic search of an organization's knowledge base or custom data. For more information, see What is RAG.

rotation

The process of periodically updating a secret to make it more difficult for an attacker to access the credentials.

row and column access control (RCAC)

The use of basic, flexible SQL expressions that have defined access rules. RCAC consists of row permissions and column masks.

RPO

See recovery point objective.

RTO

See recovery time objective.

runbook

A set of manual or automated procedures required to perform a specific task. These are typically built to streamline repetitive operations or procedures with high error rates.

S

SAML 2.0

An open standard that many identity providers (IdPs) use. This feature enables federated single sign-on (SSO), so users can log into the AWS Management Console or call the AWS API operations without you having to create user in IAM for everyone in your organization. For more information about SAML 2.0-based federation, see About SAML 2.0-based federation in the IAM documentation.

SCADA

See supervisory control and data acquisition.

SCP

See service control policy.

secret

In AWS Secrets Manager, confidential or restricted information, such as a password or user credentials, that you store in encrypted form. It consists of the secret value and its metadata. The secret value can be binary, a single string, or multiple strings. For more information, see What's in a Secrets Manager secret? in the Secrets Manager documentation.

security by design

A system engineering approach that takes security into account through the whole development process.

security control

A technical or administrative guardrail that prevents, detects, or reduces the ability of a threat actor to exploit a security vulnerability. There are four primary types of security controls: preventative, detective, responsive, and proactive.

security hardening

The process of reducing the attack surface to make it more resistant to attacks. This can include actions such as removing resources that are no longer needed, implementing the security best practice of granting least privilege, or deactivating unnecessary features in configuration files.

security information and event management (SIEM) system

Tools and services that combine security information management (SIM) and security event management (SEM) systems. A SIEM system collects, monitors, and analyzes data from servers, networks, devices, and other sources to detect threats and security breaches, and to generate alerts.

security response automation

A predefined and programmed action that is designed to automatically respond to or remediate a security event. These automations serve as detective or responsive security controls that help you implement AWS security best practices. Examples of automated response actions include modifying a VPC security group, patching an Amazon EC2 instance, or rotating credentials.

server-side encryption

Encryption of data at its destination, by the AWS service that receives it.

service control policy (SCP)

A policy that provides centralized control over permissions for all accounts in an organization in AWS Organizations. SCPs define guardrails or set limits on actions that an administrator can delegate to users or roles. You can use SCPs as allow lists or deny lists, to specify which services or actions are permitted or prohibited. For more information, see Service control policies in the AWS Organizations documentation.

service endpoint

The URL of the entry point for an AWS service. You can use the endpoint to connect programmatically to the target service. For more information, see AWS service endpoints in *AWS General Reference*.

service-level agreement (SLA)

An agreement that clarifies what an IT team promises to deliver to their customers, such as service uptime and performance.

service-level indicator (SLI)

A measurement of a performance aspect of a service, such as its error rate, availability, or throughput.

service-level objective (SLO)

A target metric that represents the health of a service, as measured by a service-level indicator.

shared responsibility model

A model describing the responsibility you share with AWS for cloud security and compliance. AWS is responsible for security *of* the cloud, whereas you are responsible for security *in* the cloud. For more information, see Shared responsibility model.

Shadow AI

Unauthorized AI applications built or used outside of governed channels within an organization.

SIEM

See security information and event management system.

single point of failure (SPOF)

A failure in a single, critical component of an application that can disrupt the system.

SLA

See service-level agreement.

SLI

See service-level indicator.

SLO

See service-level objective.

split-and-seed model

A pattern for scaling and accelerating modernization projects. As new features and product releases are defined, the core team splits up to create new product teams. This helps scale your organization's capabilities and services, improves developer productivity, and supports rapid innovation. For more information, see Phased approach to modernizing applications in the AWS Cloud.

SPOF

See single point of failure.

star schema

A database organizational structure that uses one large fact table to store transactional or measured data and uses one or more smaller dimensional tables to store data attributes. This structure is designed for use in a data warehouse or for business intelligence purposes.

strangler fig pattern

An approach to modernizing monolithic systems by incrementally rewriting and replacing system functionality until the legacy system can be decommissioned. This pattern uses the analogy of a fig vine that grows into an established tree and eventually overcomes and replaces its host. The pattern was introduced by Martin Fowler as a way to manage risk when rewriting monolithic systems. For an example of how to apply this pattern, see Modernizing legacy Microsoft ASP.NET (ASMX) web services incrementally by using containers and Amazon API Gateway.

subnet

A range of IP addresses in your VPC. A subnet must reside in a single Availability Zone.

supervisory control and data acquisition (SCADA)

In manufacturing, a system that uses hardware and software to monitor physical assets and production operations.

symmetric encryption

An encryption algorithm that uses the same key to encrypt and decrypt the data.

synthetic testing

Testing a system in a way that simulates user interactions to detect potential issues or to monitor performance. You can use Amazon CloudWatch Synthetics to create these tests.

system prompt

A technique for providing context, instructions, or guidelines to an LLM to direct its behavior. System prompts help set context and establish rules for interactions with users.

T

tags

Key-value pairs that act as metadata for organizing your AWS resources. Tags can help you manage, identify, organize, search for, and filter resources. For more information, see Tagging your AWS resources.

target variable

The value that you are trying to predict in supervised ML. This is also referred to as an *outcome variable*. For example, in a manufacturing setting the target variable could be a product defect.

task list

A tool that is used to track progress through a runbook. A task list contains an overview of the runbook and a list of general tasks to be completed. For each general task, it includes the estimated amount of time required, the owner, and the progress.

test environment

See environment.

training

To provide data for your ML model to learn from. The training data must contain the correct answer. The learning algorithm finds patterns in the training data that map the input data attributes to the target (the answer that you want to predict). It outputs an ML model that captures these patterns. You can then use the ML model to make predictions on new data for which you don't know the target.

tool

A function or API that an agent can invoke to perform operations in external systems.

transit gateway

A network transit hub that you can use to interconnect your VPCs and on-premises networks. For more information, see What is a transit gateway in the AWS Transit Gateway documentation.

trunk-based workflow

An approach in which developers build and test features locally in a feature branch and then merge those changes into the main branch. The main branch is then built to the development, preproduction, and production environments, sequentially.

trusted access

Granting permissions to a service that you specify to perform tasks in your organization in AWS Organizations and in its accounts on your behalf. The trusted service creates a service-linked role in each account, when that role is needed, to perform management tasks for you. For more information, see Using AWS Organizations with other AWS services in the AWS Organizations documentation.

tuning

To change aspects of your training process to improve the ML model's accuracy. For example, you can train the ML model by generating a labeling set, adding labels, and then repeating these steps several times under different settings to optimize the model.

two-pizza team

A small DevOps team that you can feed with two pizzas. A two-pizza team size ensures the best possible opportunity for collaboration in software development.

U

uncertainty

A concept that refers to imprecise, incomplete, or unknown information that can undermine the reliability of predictive ML models. There are two types of uncertainty: *Epistemic uncertainty* is caused by limited, incomplete data, whereas *aleatoric uncertainty* is caused by the noise and randomness inherent in the data.

undifferentiated tasks

Also known as *heavy lifting*, work that is necessary to create and operate an application but that doesn't provide direct value to the end user or provide competitive advantage. Examples of undifferentiated tasks include procurement, maintenance, and capacity planning.

upper environments

See environment.

V

vacuuming

A database maintenance operation that involves cleaning up after incremental updates to reclaim storage and improve performance.

version control

Processes and tools that track changes, such as changes to source code in a repository.

VPC peering

A connection between two VPCs that allows you to route traffic by using private IP addresses. For more information, see What is VPC peering in the Amazon VPC documentation.

vulnerability

A software or hardware flaw that compromises the security of the system.

W

warm cache

A buffer cache that contains current, relevant data that is frequently accessed. The database instance can read from the buffer cache, which is faster than reading from the main memory or disk.

warm data

Data that is infrequently accessed. When querying this kind of data, moderately slow queries are typically acceptable.

window function

A SQL function that performs a calculation on a group of rows that relate in some way to the current record. Window functions are useful for processing tasks, such as calculating a moving average or accessing the value of rows based on the relative position of the current row.

workload

A collection of resources and code that delivers business value, such as a customer-facing application or backend process.

workstream

Functional groups in a migration project that are responsible for a specific set of tasks. Each workstream is independent but supports the other workstreams in the project. For example, the portfolio workstream is responsible for prioritizing applications, wave planning, and collecting migration metadata. The portfolio workstream delivers these assets to the migration workstream, which then migrates the servers and applications.

WORM

See write once, read many.

WQF

See AWS Workload Qualification Framework.

write once, read many (WORM)

A storage model that writes data a single time and prevents the data from being deleted or modified. Authorized users can read the data as many times as needed, but they cannot change it. This data storage infrastructure is considered immutable.

Z

zero-day exploit

An attack, typically malware, that takes advantage of a zero-day vulnerability.

zero-day vulnerability

An unmitigated flaw or vulnerability in a production system. Threat actors can use this type of vulnerability to attack the system. Developers frequently become aware of the vulnerability as a result of the attack.

zero-shot prompting

Providing an LLM with instructions for performing a task but no examples (*shots*) that can help guide it. The LLM must use its pre-trained knowledge to handle the task. The effectiveness of zero-shot prompting depends on the complexity of the task and the quality of the prompt. See also few-shot prompting.

zombie application

An application that has an average CPU and memory usage below 5 percent. In a migration project, it is common to retire these applications.