

# **AWS Solutions Architecture Notes**

Your Name

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## **Chapter 1**

# **Course Introduction**



## Chapter 2

# Identity & Federation

### 2.1 IAM - What should you know by now

- Users: Long term credentials - Groups - Roles: short-term credentials, uses STS - EC2 Instance Roles: Uses the EC2 metadata service. One role of a time per instance - Service Roles: API Gateways, CodeDeploy etc - Cross Account roles - Policies - AWS Managed - Customer Managed - Inline Policies - Resource Based Policies (S3 Bucket, SQS queues, etc.....)

#### 2.1.1 IAM Policies Deep Dive

- Anatomy of a policy: JSON doc with Effect, Action, Resource, Conditions, Policy Variables - Explicit DENY has precedence over ALLOW - Best practice: use least privilege for maximum security - Access Advisor: See permissions granted and when last accessed - Access Analyser: Analyse resources that are shared with external entity - Navigate Examples at:

#### 2.1.2 IAM AWS Managed Policies - Administrator Access example

Listing 2.1: Sample JSON Data

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
```

### 2.1.3 IAM Policies Conditions

### 2.1.4 IAM Policies Variables and Tags

### 2.1.5 IAM Roles vs Resource Based Policies

- Attach a policy to a resource (example: S3 bucket policy) versus attaching of a using a role as a proxy - When you assume a role (user, application or service), you give up your original permissions and take the permissions assigned to the role. - When using a resource-based policy, the principal doesn't have to give up any permissions - Example: User in account A needs to scan a DynamoDB table in Account A and dump it in an S3 bucket in Account B

### 2.1.6 IAM Permissions Boundaries

- IAM permission boundaries are supported for users and roles (not groups) - Advanced feature to use a managed policy to set the maximum permissions an IAM entity can get - Can be used in combinations of AWS organisations SCP

### 2.1.7 Use cases

- Delegate responsibilities to non administrators within their permission boundaries, for example create new IAM users
- Allow developers to self-assign policies and managed their own permissions while making sure they can't 'escalate' their privileges (i.e make themselves admin)
- Useful to restrict one specific user (instead of a whole account using Organisations and SCP)

### 2.1.8 IAM Access Analyser

- Find out which resources are shared externally - S3 Buckets - IAM Roles - KMS Keys - Lambda Functions and Layers - SQS queues - Secrets Manager Secrets - Define Zone of Trust = AWS Account or AWS Organisation - Access outside of zone trusts = findings

### 2.1.9 IAM Access Analyser

- IAM Access Analyser Policy Validation - Validates your policy against IAM policy grammar and best practices - General warnings, security warnings errors suggestions - Provides actionable recommendations - IAM Access Analyser Policy Generation - Generates IAM policy based on access activity - CloudTrail logs is reviewed to generate the policy with the fine-grained permissions and the appropriate Actions and Services - Reviews CloudTrail logs for up to 90 days

## 2.2 STS

### 2.2.1 Using STS to Assume a Role

- Define an IAM Role within your account or cross-account - Define which principals can access this IAM role - Using AWS STS (Security Token Service) to retrieve credentials and impersonate

the IAM role you have access to (AssumeRole API) - Temporary credentials can be valid between 15 to 12 hours.

### 2.2.2 Assuming a Role with STS

- Provide access for an IAM user in one AWS account that you own to access resources in another account that you own.
- Provide access to IAM users in AWS accounts owned by third parties
- Provide access for services offered by AWS to AWS resources
- Provide access for externally authenticated users (identity federation)
- Ability to revoke active sessions and credentials for a role (by adding a policy using a time statement - AWSRevokeOlderSessions)

When you assume a role (user, application or service), you give up your original permissions and take the permissions assigned to the role.

### 2.2.3 Providing Access to an IAM User in Yours or Another AWS Account That You Own

- You can grant your IAM users permissions to switch to roles within your AWS account or to roles defined in other AWS accounts that you own.
- Benefits:

  - You must explicitly grant your users permission to assume the role
  - Your users must actively switch to the role using the AWS management console or assume the role using the AWS CLI or AWS API
  - You can add multi-factor authentication (MFA) protection to the role so that only users who sign in with an MFA device can assume the role.
  - Least Privilege + auditing using CloudTrail

### 2.2.4 Providing Access to AWS Accounts Owned by Third Parties

- Zone of trust = accounts, organisations that you own
- Outside Zone ofTrust = 3rd parties
- Use IAM Access Analyser to find out which resources are exposed
- For granting access to a third party:

  - The third part AWS account ID
  - An External ID (secret between you and the third party)
  - To uniquely associate with the role between you and 3rd party
  - Must be provided when defining the trust and when assuming the role
  - Must be chosen by the third party
  - Define permissions in the IAM policy

### Session Tags in STS

- Tags that you pass when you assume an IAM Role or federate user in STS - aws:PrincipalTag Condition
- Compares the tags attached to the principal making the request with the tag you specified in the policy.
- Example: Allow a principal to pass session tags only if the principal making the request has the specified tags.

### STS Important APIs

- AssumeRole: access a role within your account or cross-account
- AssumeRoleWithSAML: return credentials for users logged with SAML
- AssumeRoleWithWebIdentity: return creds for users logged with an IdP
- Example providers include Amazon Cognito, Login with Amazon, Facebook, Google or any OpenID Connect-compatible identity provider.
- AWS Recommends using Cognito
- GetSessionToken: for MFA from a user or AWS account root user
- GetFederationToken: obtain temporary creds for a federated user, usually a proxy app that will give the creds for a federated user, usually a proxy app that will give the creds to a distributed app inside a corporate network.

## 2.2.5 Identity Federation in AWS

- Give users outside of AWS permissions to access AWS resources in your account - You don't need to create IAM Users (user management is outside AWS) - Use cases: - A corporate has its own identity system (e.g Active Directory) - Web / Mobile application that needs access to AWS resources - Identity Federation can have many flavours: - SAML 2.0 - Custom Identity Broker - Web Identity Federation With(out) Amazon Cognito - IAM Identity Centre

### SAML 2.0 Federation

- Security Assertion Markup Language 2.0 (SAML 2.0) - Open standard used by many identity providers (e.g ADFS) - Supports integration with Microsoft Active Directory Federations Services (ADFS) - Or any SAML 2.0 - compatible IdPs with AWS - Access the AWS Console, AWS CLI or AWS API using temporary credentials - No need to create IAM Users for each of your employees - Need to setup a trust between AWS IAM and SAML 2.0 Identity Provider (both ways) - Under-the-hood: Uses the STS API AssumeRoleWithSAML - SAML 2.0 Federation is the "old way", IAM Identity Center Federation is the new managed and simpler way

### SAML 2.0 Federation - AWS API Access

### SAML 2.0 Federation - AWS Console Access

### SAML 2.0 Federation - Active Directory DS (ADFS)

### Custom Identity Broker Application

- Use only if identity provider is NOT compatible with SAML 2.0 - The identity broker is NOT compatible with SAML 2.0 - The identity broker must determine the appropriate IAM Role - Uses the STS API AssumeRole or GetFederationToken

### Web Identity Federation - Without Cognito

- Not recommended by AWS - use cognito instead

### Web Identity Federation - With Cognito

- Preferred over for Web Identity Federation - Create IAM Roles using Cognito with the least privilege needed - Build trust between the OIDC IdP and AWS - Cognito benefits: - Supports anonymous users - Supports MFA - Data Synchronisation - Cognito replaces a Token Vending Machine (TVM)

### Web Identity Federation - IAM Policy

- After being authenticated with Web Identity Federation, you can identify the user with an IAM policy variable - Example:

## 2.2.6 AWS Directory Services (AD)?

- Found on any Windows Server with AD Domain Services - Database of objects: User Accounts, Computers, Printers, File Shares, Security Groups - Centralised security management, create account, assign permissions - Objects are organised in trees - A group of trees

### What is ADFS (AS Federation Services)?

- ADFS provides Single Sign-On across applications - SAML across 3rd party: AWS Console, Dropbox, Office365, etc.....

### AWS Directory Services

- AWS Managed Microsoft AD - Create your own AD in AWS, manage users, locally supports MFA - Establish "trust" connection with your own on premises - AD Connector - Directory Gateway (proxy) to redirect to on-premises AD, supports MFA - Users are managed on the on-premise AD - Simple AD - AD-compatible managed directory on AWS - Cannot be joined with on-premise AD

### AWS Directory Services and AWS Managed Microsoft AD

- Managed Service: Microsoft AD in your AWS VPC - EC2 Windows Instances: - EC2 Windows instances can join the domain and run traditional AD applications (sharepoint, etc) - Seamlessly Domain Join Amazon EC2 Instances from Multiple Accounts and VPCs - Integrations - RDS for SQL Server, AWS Workspaces, Quicksight..... - AWS SSO to provide access to third party applications - Standalone repository in AWS or joined to on-premises AD - Multi AZ deployment of AD in 2 AZ, of DC (Domain Controllers) can be increased for scaling - Automated backups - Automated Multi-Region replication of your directory

### AWS Microsoft Managed AD - Integrations

#### Connect to on-premise AD

- Ability to connect your on-premise Active Directory to AWS Managed Microsoft AD - Must establish a Direct Connection (DX) or VPN connection - Can setup three kinds of forest trust - One-way trust: AWS -> On-Premise - One-way trust: On-Premise -> AWS - Two-way forest: trust - AWS -> On-Premise - Forest trust is different than synchronisation (replication is not supported)

### Solution Architecture: Active Directory Replication

- You may want to create a replica of your AD on EC2 in the cloud to minimise latency of in case DX or VPN goes down - Establish trust between the AWS Managed Microsoft AD and EC2

### AWS Directory Services AD Connector

- AD Connector is a directory gateway to redirect director requests to your on premises Microsoft Active Directory - No caching capability - Managed users solely on-premise, no possibility of setting up a trust - VPN or Direct Connect - Doesn't work with SQL Server, doesn't do seamless joining, can't share director.

## **AWS Directory Services Simple AD**

- Simple AD is an inexpensive Active Directory-compatible service with the common directory features - Supports joining EC2 instances, manage users and groups - Does not support MFA, RDS SQL server, AWS SSO - Small: 500 users, large: 5000 users - Powered by Samba 4, compatible with Microsoft AD - lower cost, low scale, basic AD compatible or LDAP compatibility - No trust relationship

## **2.2.7 AWS Organisations**

### **AWS Organisations - OrganizationAccountAccessRole**

- IAM role which grants full administrator permissions in the Member account to the Management account - Used to perform admin tasks in the Member accounts (e.g - creating IAM users) - Could be assumed by IAM users in the Management account - Automatically added to all new Member account created with AWS organisations - Must be created manually if you invite an existing Member account

### **Multi Account Strategies**

- Create accounts per department, per cost centre, per dev / test / prod, based on regulatory restrictions (using SCP), for better resource isolation (ex:VPC), to have separate per-account service limits isolated account for logging. - Multi Account vs. On Account MultiVPC - Use tagging standards for billing purposes - Enable CloudTrail on all accounts, send logs to central S3 account - Send CloudWatch logs to central logging account - Strategy to create an account for security

### **Organisational Units (OU) - Examples**

#### **AWS Organisation - Feature Modes**

- Consolidated billing features: - Consolidated Billing across all accounts - single payment method - Pricing benefits from aggregated usage (volume discount for EC2, S3.....)

#### **All Features (Default)**

- Includes consolidated billing features, SCP - Invited accounts must approve enabling all features - Ability to apply an SCP to prevent member accounts from leaving the org - Can't switch back to Consolidated Billing Features only

#### **AWS Organisations - Reserved Instances**

- For billing purposes, the consolidated billing features of AWS organisations treats all the accounts in the organisation as one account. - The means that all accounts in the organisation can receive the hourly cost benefit of Reserved Instances that are purchased by any other account. - The payer account (Management account) of an organisation can turn off Reserved Instance (RI) discount and Saving Plans discount sharing for any accounts in that organisation, including the payer account. - This means that RIs and Saving Plans discounts aren't shared between any accounts that have sharing turned off. - To share an RI or Savings Plans discount with an account, both accounts must have sharing turned on.



## **AWS Organisation - Moving Accounts**

- Remove the member account from the AWS organisation - Send an invite to the member account from the AWS organisation - Accept the invite to the new Organisation from the member account.

## **Service Control Policies (SCP)**

- Define allowlist or blocklist IAM actions - Applied at the OU or Account level - Does not apply to the Management Account - SCP is applied to all the Users and Roles in the account, including Root user - The SCP does not affect Service-linked roles - Service-linked roles enable other AWS services to integrate with AWS organisations and can't be restricted by SCP's - SCP must have an explicit Allow from the root of each OU in the direct path to the target account (does not allow anything by default) - Use cases: - Restrict access to certain services (for example: can't use EMR) - Enforce PCI compliance by explicitly disabling services.

## **SCP Hierarchy**

- Management Account - Can do anything (no SCP apply) - Account A - Can do anything - EXCEPT S3 (explicit Deny from Sandbox OU) - EXCEPT EC2 (explicit deny) - Account B and C - Can do anything - EXCEPT S3 (explicit Deny from Sandbox OU) - Account D - Can access EC2 - Prod OU and Account E and F

## **SCP Examples - Blocklist and Allowlist strategies**

### **IAM Policy Evaluation Logic**

### **Restricting Tags with IAM policies**

- You can restrict specific tags on AWS resources - Using the aws:TagKeys Condition Key - Validate the Tag Keys attached to a resource against the Tag Keys in the IAM Policy - Example: Allow IAM users to create EBS Volumes only if it has the "Env" and "CostCenter" Tags - Use either ForAllValues (must have all keys) or ForAnyValue (must have any of these keys at a minimum)

## **Using SCP to restrict creating resources without appropriate tags**

- Prevent IAM Users/Roles in the affected member accounts from creating resources if they don't have a specific Tag

## **AWS Organisations - Tag Policies**

- Helps you standardise tags across resources in an AWS organisation - Ensure consistent tags, audit tagged resources, maintain proper resources categorisation - You define Tag keys and their allowed values - Helps with AWS Cost Allocation Tags and Attribute-based Access Control - Prevent any non-compliant tagging operations on specified services and resources - Generate a report that lists all tagged/ non compliant resources - Use Amazon EventBridge to monitor non-compliant tags

## **AWS Organisation - AI Service Opt-out Policies**

- Certain AWS AI services may use your content for continuous improvement of Amazon AI/ML services - Example: Amazon Lex, Amazon Comprehend, Amazon Polly..... - You can opt-out of having your content stored or used by AWS AI services - Create an Opt-out Policy that enforces this setting across all Member accounts and AWS Regions - You can opt-out all AI services or selected services - Can be attached to Organisation Root, specific OU or individual Member account

## **AWS Organisations - Backup policies**

- AWS Backup enables you to create Backup Plans that define how to backup your AWS resources - JSON Documents that define backup plans across an AWS Organisation - Gives you granular control over backup up your resources (e.g backup frequency, time window, backup region,.....) - Can be attached to Organisation Root, specific OU or individual Member account - Immutable backup plans appear in Member accounts (view only)

## **Using SCP to Deny a Region `aws:RequeustRegion`**

### **2.2.8 AWS IAM Identity Center**

#### **AWS IAM Identity Center -successor to AWS Single Sign-On-**

- One login (single sign-on) for all your - AWS accounts in AWS organisations - Business cloud applications (e.g, Salesforce, Box, Microsoft 365) - SAML2.0 enabled applications - EC2 windows instances

- Identity Providers - Built-in identity store in IAM identity center - 3rd party Active Directory (AD), OneLogin, Okta

- AWS IAM Identity Center - Login Flow

#### **AWS IAM Identity Center**

#### **AWS IAM Identity Center - Fine-grained Permissions and Assignments**

- Multi-Account Permissions - Manage access across AWS accounts in your AWS Organisation - Permission Sets - a collection of one or more IAM policies assigned to users and groups to define AWS access - Application Assignments - SSO access to many SAML 2.0 business applications (Salesforce, Box, Microsoft 365) - Provide required URLs, certificates and metadata - Attribute-Based Access Control (ABAC) - Fine-grained permissions based on users' attributes stored in IAM identity center identity store - Example: Cost center, title, locale - Use case: Define permission once, then modify AWS access by changing the attributes

#### **AWS Control Tower**

- Easy way to setup and govern a secure and compliant multi-account AWS environment based on best practices - Benefits: - Automate the set up of your environment in a few clicks - Automate ongoing policy management using guardrails - Detect policy violations and remediate them

- Monitor compliance through an interactive dashboard - AWS ControlTower runs on top AWS Organisations: - It automatically sets up AWS Organisations to organise accounts and implement SCPs (Service Control Policies)

### **AWS Controller Tower - Account Factory**

- Automates account provisioning and deployments - Enables you to create pre-approved base-lines and configuration options for AWS accounts in your organisation (e.g VPC default configuration, subnets, region, ...) - Uses AWS service catalog to provision new AWS accounts

### **AWS Control Tower - Detect and Remediate Policy Violations**

- Guardrail - Provide ongoing governance for your Control Tower environment (AWS Accounts) - Preventive - using SCPs (e.g Disallow Creation of Access Keys for the Root User) - Detective - users AWS Config (e.g Detect Whether MFA for the Root User is Enabled) - Example: identify non-compliant resources (e.g, untagged resources)

### **AWS Control Tower - Guardrails Levels**

- Mandatory - Automatically enabled and enforced by AWS control tower - Example: Disallow public Read access to the Log Archive account - Strongly Recommended - Based on AWS best practices (optional) - Example: Enable encryption for EBS volumes attached to EC2 instances - Elective - Commonly used by enterprises (optional) - Examples: Disallow delete actions without MFA in S3 buckets

## **2.3 AWS Resource Access Manager (RAM)**

- Share AWS resources that you own with other AWS accounts - Share with any account or within your Organisation - Avoid resource duplication! - VPC Subnets - Allow to have all the resources launched in the same subnets - Must be from the same AWS organisations - Cannot share security groups and defaultVPC - Participants can manage their own resources in there - Participants can't view, modify, delete resources that belong to other participants or the owner - AWS Transit Gateway - Route 53 (Resolver Rules, DNS Firewall Rule Groups) - License Manager Configurations

### **AWS Resource Access Manager (RAM)**

- Aurora DB Clusters - ACM Private Certificate Authority - CodeBuild Project - EC2 (Dedicated Hosts, Capacity Reservation) - AWS Glue (Catalog, Database, Table) - AWS Network Firewall Policies - AWS Resources groups - Systems Manager Incident Manager (Contacts, Response Plans) - AWS Outposts (Outpost, Site)

### **Resource Access Manager - VPC example**

- Each account..... - Is responsible for its own resources - Cannot view modify or delete other resources in other accounts - Network is shared so..... - Anything deployed in the VPC can talk to other resources in the VPC - Applications are accessed easily across accounts, using a private

IP - Security groups from other accounts can be referenced for maximum security - Use cases - Applications within the same trust boundaries - Applications with a high degree of interconnectivity

### **Resource Access Manager Managed Prefix List**

- A set of one or more CIDR blocks - Makes it easier to configure and maintain Security Groups and Route Tables - Customer-Managed Prefix List - Set of CIDRs that you define and manage by you - Can be shared with other AWS accounts or AWS Organisation - Modify to update many security groups at once - AWS-Managed Prefix List - Set of CIDRs for AWS services - You can't create, modify, share or delete them.

### **Resource Access Manager Route 53 Outbound Resolver**

- Helps you scale forwarding rules to your DNS in case you have multiple accounts and VPC

## **2.4 Summary of Identity and Federation**

- Users and Accounts all in AWS
- AWS Organisations
- AWS Control Tower to setup secure and compliant multi-account AWS environment (best practices)
- Federation with SAML
- Federation without SAML with a custom IdP (GetFederationToken)
- IAM Identity Center to connect to multiple AWS Accounts (Organisation) and SAML apps
- Web Identity Federation (not recommended)
- Cognito for most web and mobile applications (has anonymous mode, MFA)
- AWS Directory Service:
  - Managed Microsoft AD - standalone or setup trust AD with on-premises, has MFA, seamless joins, RDS integration
  - AD Connector - proxy requests to on-premises
  - Simple AD - standalone and cheap AD-compatible with no MFA, no advanced capabilities
- AWS RAM to share resource (example VPC subnets)



## **Chapter 3**

# **Security**

### **3.1 CloudTrail**

### **3.2 CloudTrail - EventBridge Integration**

### **3.3 CloudTrail - SA Pro**

### **3.4 KMS**

### **3.5 Parameter Store**

### **3.6 Secrets Manager**

### **3.7 RDS Security**

### **3.8 SSL Encryption, SNI, MITM**

### **3.9 AWS Certificate Manager - ACM**

### **3.10 CloudHSM**

### **3.11 Solution Architecture - SSL on ELB**

### **3.12 S3 Security**

### **3.13 S3 Access Points**

### **3.14 S3 Multi-Region Access Points**

### **3.15 S3 Multi-Region Access Points - Hands On**

### **3.16 S3 Object Lambda**

### **3.17 DDoS and AWS Shield**

### **3.18 AWS WAF - Web Application Firewall**



## **Chapter 4**

# **Compute & Load Balancing**

### **4.1 Solution Architecture on AWS**

### **4.2 EC2**

### **4.3 High Performance Computing (HPC)**

### **4.4 Auto Scaling**

### **4.5 Auto Scaling Update Strategies**

### **4.6 Spot Instances and Spot Fleet**

### **4.7 Amazon ECS - Elastic Container Service**

### **4.8 Amazon ECS - Elastic Container Registry**

### **4.9 Amazon EKS - Elastic Kubernetes Service**

### **4.10 AWS App Runner**

### **4.11 ECS Anywhere and EKS Anywhere**

### **4.12 AWS Lambda - Part 1**

### **4.13 AWS Lambda - Part 2**

### **4.14 Elastic Load Balancers - Part 1**

### **4.15 Elastic Load Balancers - Part 2**

### **4.16 API Gateway**

### **4.17 API Gateway - Part 2**

### **4.18 AWS AppSync**



# **Chapter 5**

## **Storage**

- 5.1 EBS and Local Instance Store**
- 5.2 Amazon EFS**
- 5.3 Amazon S3**
- 5.4 Amazon S3 - Storage Class Analysis**
- 5.5 Amazon S3 - Storage Lens**
- 5.6 S3 Solution Architecture**
- 5.7 Amazon FSx**
- 5.8 Amazon FSx - Solution Architecture**
- 5.9 AWS DataSync**
- 5.10 AWS DataSync - Solution Architecture**
- 5.11 AWS Data Exchange**
- 5.12 AWS Transfer Family**
- 5.13 AWS Storage Services Price Comparison**



# Chapter 6

## Caching

### 6.1 Cloudfront - Part 1

- Content Delivery Network (CDN) - Improves read performance, content is cached at the edge - 225+ Point of Presence globally (215+ Edge Locations and 13 Regional Edge Caches) - Protect against Network and Application layer attacks (e.g DDoS attacks) - Integration with AWS Shield, AWS WAF and route 53 - Can expose external HTTPS and can talk to internal HTTPS backends
- Supports WebSocket protocol

#### 6.1.1 CloudFront - Origins

- S3 Bucket - For distributing files - For uploading to S3 (using CloudFront as an ingress) - Enhanced security with CloudFront Origin Access Control (OAC) - MediaStore Container and MediaPackage Endpoint - To deliver Video on Demand (VOD) or live streaming video using AWS Media Services
- VPC Origin - For applications hosted in VPC private subnets - Application Load Balance / Network Load Balancer / EC2 Instances - Customer Origin (HTTP) - API Gateway (for more control... otherwise use API Gateway Edge) - S3 Bucket configured as a website (enable Static Website hosting) - Any HTTP backend you want

#### 6.1.2 CloudFront - S3 as an Origin

#### 6.1.3 CloudFront vs S3 Cross Region Replication

- CloudFront: - Global Edge network - Files are cached for a TTL (maybe a day) - Great for static content that must be available everywhere
  - S3 Cross Region Replication - Must be setup for each region you want replication to happen
- Files are updated in near real-time - Read only - Great for dynamic content that needs to be available at low-latency in few regions

#### 6.1.4 CloudFront - ALB or EC2 as an origin Using VPC Origins

- Allows you to deliver content from your applications hosted in your VPC private subnets (no need to expose them on the Internet) - Deliver traffic to private - Application Load Balancer - Network Load Balancer - EC2 Instances

### **6.1.5 CloudFront - EC2 or ALB as an origin**

### **6.1.6 CloudFront - Restrict Access to Application Load Balancers and Custom Origins**

- Prevent direct access to you ALB or Custom Origins (only access through CloudFront) - First, configurations CloudFront to add a CustomHTTPHeader to requests it sends to the ALB - Second, configure the ALB to only forward requests that contain that Customer HTTP Header - Keep the custom header name and value secret!

### **6.1.7 CloudFront - Origin Groups**

- To increase high-availability and do failover - Origin Group: one primary and on secondary - If the primary origin fail; the second on is used - Origins can be cross AWS regions

## **6.2 Cloudfront - Part 2**

### **6.2.1 CloudFront Geo Restrictions**

- You can restrict who can access your distribution - Allow list: Allow you users to access your content only if they're in one of the countries on a list of approved - Block list: Prevent your users from accessing your content if they're in one of the countries on a blacklist of banned countries..... lol - The "country" is determined using a third party Geo-IP database - Use case: Copyright Laws to control access to content - Note: the geo header CloudFront-Viewer-Country is in Lambda at Edge

### **6.2.2 CloudFront - Pricing**

- CloudFront Edge locations are all around the world - The cost of data out per edge location varies

### **6.2.3 CloudFront - Price Classes**

- You can reduce the number of edge locations for cost reductions - Three price classes - Price Class All: all regions - best performance - Price Class 200: most regions, but excludes the most expensive regions - Price Class 100: only the least expensive regions

### **6.2.4 CloudFront Signed URL Diagram**

- Signed URL with expiration to control access to content in CloudFront - The Signed URL are generated by an API call into CloudFront as a trusted signer

### **6.2.5 CloudFront Signed URL vs S3 Pre-Signed URL**

- CloudFront Signed URL: - Allow access to a path, no matter the origin - Account wide key-pair, only the root can manage - Can filter by IP, path, date, expiration - Can leverage caching features  
- S3 Pre-Signed URL: - Issue a request as the person who pre-signed URL - Uses the IAM key of the signed IAM principal - Limited lifetime

### 6.2.6 CloudFront - Custom Error Pages

- Return an object to the viewer (e.g. html) when your origin returns an HTTP 4xx or 5xx status code to CloudFront - Use Error Caching Minimum TTL to specify how long CloudFront caches the customer error pages

## 6.3 Lambda at Edge and CloudFront Functions

### 6.3.1 CloudFront - Customisation at the edge

- Many modern applications execute some form of the logic at the edge - Edge function: - A code that you write and attach to CloudFront distributions - Runs close to your users to minimise latency - Doesn't have any cache, only to change requests/ responses - CloudFront provides two types: CloudFront Functions and Lambda at Edge Use cases: - Manipulate HTTP requests and responses - Implement request filtering before reaching your application - User authentication and authorisation - Generate HTTP resources at the edge - A/B Testing - Bot mitigation - You don't have to manage any servers, deployed globally

### 6.3.2 CloudFront Functions and Lambda at Edge

### 6.3.3 CloudFront - CloudFront Functions

- Lightweight functions written in JavaScript - For high-scale latency-sensitive CDN customisation - Sub-ms startup times, million of requests per second - Run at Edge Locations - Processed-Based isolation - Used to change viewer requests and responses: - Viewer Requests: after CloudFront receives a request from a viewer - Viewer Response: before CloudFront forwards the response to the viewer - Native feature of CloudFront (manage code entirely within CloudFront)

### 6.3.4 CloudFront - Lambda at Edge

- Lambda functions written in NodeJS or Python - Scale to 1000s of requests/ second - Runs at the nearest Regional Edge Cache - VM-based isolation - Used to change CloudFront requests and responses - Viewer Request - after CloudFront receives a request from a viewer - Origin Request - before CloudFront forwards the response to the origin - Origin response - after CloudFront receives the response from the origin - Viewer Response - before CloudFront forwards the response to the viewer - Author your functions in one AWS Region (some region) then CloudFront replicates to its locations

### 6.3.5 CloudFront Functions with Lambda at Edge

CloudFront Functions and Lambda at Edge can be used together Note: You can't combine CloudFront Functions and Lambda at Edge in viewer events (viewer request and viewer response)

### 6.3.6 Using Lambda at Edge only

Use when you need some of the capabilities of Lambda at Edge that aren't available with CloudFront Functions (e.g. longer execution time, network access,....)

### 6.3.7 CloudFront Functions vs. Lambda at Edge

### 6.3.8 CloudFront Functions vs Lambda at Edge Use Cases

- CloudFront Functions - Cache key normalisation - Transform request attributes (headers, cookies, query string, URL) to create an optimal Cache Key - Header manipulation - Insert/modify/ delete HTTP headers in the request or response - URL rewrites or redirects - Request authentication and authorisation - Create and validate user-generated tokens (e.g JWT) to allow/deny requests

Lambda at Edge - Longer execution time (several ms) - Adjustable CPU or memory - Your code depends on a third libraries (e.g AWS SDK to access other AWS Services) - Network access to use external services for processing - File system access or access to the body of HTTP requests

### 6.3.9 CloudFront Functions vs. Lambda at Edge - Authentication and Authorisation

CloudFront Functions

Lambda at Edge

### 6.3.10 Lambda@Edge: Loading content based on User-Agent

### 6.3.11 Lambda at Edge - Global Application

## 6.4 Lambda at Edge Reduce Latency

### 6.4.1 Lambda at Edge - Route to different origin

## 6.5 Amazon ElastiCache

### 6.5.1 Amazon ElastiCache Overview

- The same way RDS is to get managed Relational Databases..... - ElastiCache is to get managed Redis or Memcached - Caches are in memory databases with really high performance and low latency - Helps reduce load off of databases for read intensive workloads - Helps make your application stateless - AWS takes care of OS maintenance / patching, optimisations, setup, configuration, monitoring failure recovery and backups. - **Using ElastiCache involves heavy application code changes**

### 6.5.2 ElastiCache Solution Architecture - DB Cache

- Applications queries ElastiCache, if not available, get from RDS and store in ElastiCache - Helps relieve load in RDS - Cache must have an invalidation strategy to make sure only the most current data is used there.

### 6.5.3 ElastiCache Solution Architecture - User Session Store

- User logs into any of the application - The application writes the session data into ElastiCache - The user hits another instance of our application - The instance retrieves the data the user is already logged in

#### **6.5.4 ElastiCache - Redis vs Memcached**

- Redis - Multi AZ with Auto-Failover - Read Replicas to scale reads and have high availability - Persistent, Data Durability: Append Only File (AOF), backup and restore features - Memcached - Multi-node for partitioning of data (sharding) - Non Persistent - Backup and restore (Serverless) - Mult-threaded architecture

### **6.6 Handling Extreme Rates**





## **Chapter 7**

# **Databases**

**7.1 DyanamoDB**

**7.2 Amazon OpóenSearch**

**7.3 RDS**

**7.4 Aurora - Part 1**

**7.5 Aurora - Part 2**



## **Chapter 8**

# **Service Communication**

**8.1 Step Functions**

**8.2 SQS**

**8.3 Amazon MQ**

**8.4 Amazon SNS**

**8.5 Amazon SNS - SQS Fan Out Pattern**

**8.6 Amazon SNS - Message Delivery Retries**



## **Chapter 9**

# **Data Engineering**

- 9.1 Amazon Kinesis Data Streams**
- 9.2 Amazon Data Firehose**
- 9.3 Amazon Managed Service for Apache Flink**
- 9.4 Streaming Architectures**
- 9.5 Amazon MSK**
- 9.6 AWS Batch**
- 9.7 Amazon EMR**
- 9.8 Running Jobs on AWS**
- 9.9 AWS Glue**
- 9.10 Redshift**
- 9.11 Amazon DocumentDB**
- 9.12 Amazon Timestream**
- 9.13 Amazon Athena**
- 9.14 Amazon QuickSight**
- 9.15 Big Data Architecture**



## **Chapter 10**

# **Monitoring**

**10.1 CloudWatch**

**10.2 CloudWatch Logs**

**10.3 Amazon EventBridge**

**10.4 X-Ray**

**10.5 AWS Personal Health Dashboard**





## **Chapter 11**

# **Deployment and Instance Management**

**11.1 Elastic Beanstalk**

**11.2 CodeDeploy**

**11.3 CloudFormation**

**11.4 Service Catalog**

**11.5 SAM - Serverless Application Model**

**11.6 AWS CDK - Cloud Development Kit**

**11.7 AWS Systems Manager - SSM**

**11.8 AWS Cloud Map**



# Chapter 12

## Cost Control

### 12.1 Cost Allocation Tags

- With Tags we can track resources that relate to each other
- With Cost Allocation Tags we can enable detailed costing reports
- Just like Tags, but they show up as columns in Reports
- AWS Generated Cost Allocation Tags
  - Automatically applied to the resource you create
  - Start with Prefix aws: (e.g. aws: createdBy)
  - They're not applied to resources created before the activation
- User tags
  - Defined by the user
  - Start with Prefix user:
- Cost Allocation Tags just appear in the Billing Console
- Takes up to 24 hours for the tags to show up in the report

### 12.2 AWS Tag Editor

- Allows you to managed tags of multiple resources at once - You can add/update/delete tags - Search tagged/untagged resources in all AWS Regions

### 12.3 Trusted Advisor

- No need to install anything - high level AWS account assessment - Analyse your AWS accounts and provides recommendation - Cost Optimisation - Performance - Security - Fault Tolerance - Service Limits - Operational Excellence - Core Checks and recommendations - all customers - Can enable weekly email notification from the console - Full Trusted Advisor - Available for Business and Enterprise support plans - Ability to set CloudWatch alarms when reaching limits - Programmatic Access using AWS support API

Column1	Basic Support
AWS Trusted Advisor Best Practice Checks	7 Core Checks
Enhanced Technical Support	24x7 customer service, documentation, whitepapers and support
Case Severity / Response Times	Data12
Data16	Data17

Table 12.1: Example Table with 4 Rows and 5 Columns

### Trusted Advisor - Good to Know

- Can check if an S3 bucket is made public - But cannot check for S3 objects that are public inside of your bucket - Use Amazon EventBridge / S3 Events instead / AWS Config Rules
  - Service Limits - Limits can only be monitored in Trusted Advisor (cannot be changed) - Cases must be created manually in AWS Support Centre to increase limits - OR use the AWS Service quotas service

## 12.4 AWS Service Quotas

- Notify you when you're close to a service quota value threshold - Create CloudWatch Alarms on the Service Quotas console - Example: Lambda concurrent executions - Helps you know if you need to request a quota increase or shutdown resources before limit is reached

## 12.5 EC2 Launch Types and Savings Plans

- On Demand Instances - short workload, predictable pricing, reliable. - Spot Instances - short workloads for check, can lose instances (not reliable) - Reserved: (Minimum 1 year) - Reserved Instances - long workloads - Convertible Reserved Instances - long workloads with flexible instances - Dedicated Instances: no other customers will share you hardware - Dedicated Hosts: book an entire physical server, control instance placement - Great for software licenses that operate at the core, or socket level - Can define host affinity so that instance reboots are kept on the same host

### 12.5.1 AWS Savings Plan

- New pricing model to get a discount based on long-term usage - Commit to a certain type of usage: ex \$10 per hour for 1 to 3 years - Any usage beyond the savings plan is billed at the on-demand price
  - EC2 Instance Savings plan (72% - same discount as Standard RIs) - Select instance family and locked to a specific region - Flexible across size, OS (Windows to Linux) tenancy. (dedicated or default) - Compute Savings Plan - Ability to move between instance family, region, compute type and OS and tenancy - SageMaker Savings plan (up to 64% off)

## 12.6 S3 Cost Savings

### 12.6.1 S3 Storage Classes

- Amazon S3 Standard - General Purpose - Amazon S3 Standard-Infrequent Access (IA) - Amazon S3 One Zone-Infrequent Access - Amazon S3 Glacier Instant Retrieval - Amazon S3 Glacier Flexible Retrieval - Amazon S3 Glacier Deep Archive - Amazon S3 Intelligent Tiering

Can move between classes manually or using S3 lifecycle configurations

### 12.6.2 S3 - Other Cost Savings

- S3 Lifecycle Rules: transition objects between tiers - Compress Objects - to save space - S3 Requester Pays: - In general, bucket owners pay for all Amazon S3 storage and data transfer costs associated with their bucket - With Requester Pays buckets, the requester instead of the bucket owner pays the cost of the request and the data downloaded from the bucket - The bucket owner always pays the cost of storing data - Helpful when you want to share large datasets with other accounts - If an IAM role is assumed the owner account of that role pays for the request

## 12.7 S3 Storage Classes - Reminder

### 12.7.1 S3 Storage Classes

- Amazon S3 Standard - General Purpose - Amazon S3 Standard-Infrequent Access (IA) - Amazon S3 One Zone-Infrequent Access - Amazon S3 Glacier Instant Retrieval - Amazon S3 Glacier Flexible Retrieval - Amazon S3 Glacier Deep Archive - Amazon S3 Intelligent Tiering

Can move between classes manually or using S3 lifecycle configurations

### 12.7.2 S3 Durability and Availability

- Durability: - High Durability (99.999999999, 11 nines) of objects across multiple AZ - If you store 10,000,000 object with Amazon S3, you can on average expect to incur a loss of a single object once every 10,000 years (nice....but basic math) - Same for all storage classes

- Availability - Measures how readily available a service is - Varies depending on storage class

- Example: S3 standard has 99.99% availability = not available 53 minutes a year

S3 Standard - General Purpose - 99.99% Availability - Used for frequently accessed data - Low latency and high throughput - Sustain 2 concurrent facility failures - Use Cases: Big Data analytics, mobile and gaming applications, content and distribution

S3 Storage Classes - Infrequent Access - For data that is less frequently accessed, but requires rapid access when needed - Lower cost than S3 standard

Amazon S3 Standard-Infrequent Access (S3 Standard-IA) - 99.9% Availability - Use cases: Disaster Recovery, backups

Amazon S3 One Zone-Infrequent Access (S3 One Zone-IA) - High durability (99.999999999) in a single AZ; data lost when AZ is destroyed - 99.5% Availability - Use Cases: Storing secondary backup copies of on-premise data or data you can recreate

Amazon S3 Glacier Storage Classes - Low-cost object storage meant for archiving / backup - Pricing: price for storage + object retrieval cost

- Amazon S3 Glacier Instant Retrieval - Millisecond retrieval, great for data accessed once a quarter - Minimum storage duration of 90 days - Amazon S3 Glacier Flexible Retrieval (Formerly

Amazon S3 Glacier) - Expedited (1 to 5 minutes), Standard (3 to 5 hours), Bulk (5 to 12 hours)  
- free - Minimum storage duration of 90 days - Amazon S3 Glacier Deep Archive - for long term storage - Standard (12 hours), Bulk (48 Hours) - Minimum Storage duration of 180 days

### **12.7.3 S3 Intelligent Tiering**

- Small monthly monitoring and auto-tiering fee - Moves objects automatically between Access Tiers based on usage - There are no retrieval charges in S3 Intelligent-Tiering
  - Frequent Access tier (automatic): default tier - Infrequent Access Tier (automatic): objects not accessed for 30 days - Archive Instant Access tier (automatic): objects not accessed for 90 days - Archive Access tier (optional): configurable from 90 days to 700+ days - Deep Archive Access tier (optional): config from 180 days to 700+ days

## **S3 Storage Classes Comparison**

### **S3 Storage Classes - Price Comparison**

## **12.8 AWS Budgets and Cost Explorer**

### **12.8.1 AWS Budgets**

- Create budget and send alarms when costs exceeds the budget - 4 Types of budgets: Usage, Cost, Reservation, Savings Plans - For Reserved Instances (RI) - Track utilisation - Supports EC2, ElastiCache, RDS, Redshift - Up to 5 SNS notifications per budget - Can filter by: Service, Linked Account, Tag, Purchase Option, Instance Type, Region, Availability Zone, API Operations, etc.....
- Same options as AWS Cost Explorer - 2 budgets are free than \$0.002 / day / budget

### **12.8.2 Budget Actions**

- Run actions on your behalf when a budget exceeds a certain cost or usage threshold - Supports 3 actions types - Applying an IAM Policy to a user, group or IAM role - Applying Service Control Policy (SCP) to an OU - Stop EC2 or RDS Instances - Actions can be executed automatically or require a workflow approval process - Reduced unintentional overspending in your account.

### **12.8.3 Centralised Budget Management**

### **12.8.4 DeCentralised Budget Management**

### **12.8.5 Cost Explorer**

- Visualise, understand and manage your AWS costs and usage over time - Create custom reports that analyse cost and usage data - Analyse you data at a high level: total costs and usage across all accounts - Or Monthly, hourly, resource level granularity - Choose an optimal Savings PPlan (to lower prices on your bill) - Forecast usage up to 12 months based on previous usage

## 12.9 AWS Compute Optimiser

- Reduce costs and improve performance by recommending optimal AWS resources for your workloads - Helps you choose optimal configurations and right-size your workloads (over/under provisioned) - Uses Machine Learning to analyse your resources configurations and their utilisation CloudWatch metrics - Supported resources - EC2 Instances - EC2 Auto Scaling Groups - EBS volumes - Lambda functions - Lower your costs by up to 25% - Recommendations can be exported to S3

### 12.9.1 Computer Optimiser - CloudWatch Agent

- Needed to analyse Memory Utilisation - Not needed for CPU, NetworkIn/Out, DiskReadOps, DiskWriteOps

## 12.10 EC2 Reserved Instance

- Reserved Instances in an AWS Organisation - All accounts share the Reserved Instances and Savings Plan - The payer account (Management account) of an organisation can turn off Reserved Instance (RI) discount and Savings Plans discount sharing for any accounts in that organisation, including the payer account. - Renewal of Reserved Instances - You can queue (schedule or reserve ahead of time) your reserved instances - To renew a RI, just queue an RI purchase whenever the previous one expires





## **Chapter 13**

# **Migration**

- 13.1 Cloud Migration Strategies - The 7Rs**
- 13.2 Storage Gateway**
- 13.3 Storage Gateway - Advanced Concepts**
- 13.4 Snow Family**
- 13.5 Snow Family - Improving Performance**
- 13.6 AWS DMS - Database Migration Services**
- 13.7 AWS CART - Cloud Adoption Readiness Tool**
- 13.8 Disaster Recovery**
- 13.9 AWS FIS - Fault Injection Simulator**
- 13.10 VM Migrations Services**
- 13.11 AWS Migration Evaluator**
- 13.12 AWS Backup**



# **Chapter 14**

## **VPC**

**14.1 VPC - Basics**

**14.2 VPC - Peering**

**14.3 Transit Gateway**

**14.4 VPC Endpoints**

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**14.5 VPC Endpoint Policies**

**14.6 PrivateLink**

**14.7 AWS S2S VPN**

**14.8 AWS Client VPN**

**14.9 Direct Connect**

**14.10 On-Premise Redundant Connections**

**14.11 VPC Flow Logs**

**14.12 AWS Network Firewall**



# Chapter 15

## Machine Learning

### 15.1 Rekognition Overview

- Find objects, people, text, scenes in images and videos using ML - Facial analysis and facial search to do user verification, people counting. - Create a database of "familiar faces" or compare against celebrities - Use cases: - Labeling - Content Moderation - Text Detection - Face Detection and Analysis (gender, age range, emotions....) - Face Search and Verification - Celebrity Recognition - Pathing (ex: for sports game analysis)

#### 15.1.1 Amazon Rekognition - Content Moderation

- Detect content that is inappropriate, unwanted or offensive (image and videos) - Used in social media, broadcast media, advertising and e-commerce situation to create a safer user experience - Set a Minimum Confidence Threshold for items that will be flagged - Flag sensitive content for manual review in Amazon Augmented AI (A2I) - Help comply with regulations

### 15.2 Transcribe Overview

- Automatically convert speech to text. - Uses a deep learning process called automatic speech recognition (ASR) to convert speech to text quickly and accurately. - Automatically remove Personally Identifiable Information (PII) using Redaction. - Supports Automatic Language Identification for multilingual audio - Use cases: - transcribe customer service calls - automate closed captioning and subtitling - generate metadata for media assets to create a fully searchable archive

### 15.3 Polly Overview

- Turn text into lifelike speech using deep learning - Allowing you to create applications that talk

#### 15.3.1 Amazon Polly - Lexicon & SSML

- Customise the pronunciation of words with Pronunciation lexicons - Stylized words: St3ph4ne =j "Stephane" - Acronyms: AWS =j "Amazon Web Services" - Upload the lexicons and use them in the SynthesizeSpeech operation. - Generate speech from plain text or from documents marked up with Speech Synthesis Markup Language (SSML) - enables more customisation -

Emphasising specific words or phrases. - Using phonetic pronunciation. - Including breathing sounds, whispering. - Using the Newscaster speaking style

## 15.4 Translate Overview

- Natural and accurate language translation - Allows you to localise content - such as websites and applications - for international users and to easily translate large volumes of text efficiently.

## 15.5 Lex + Connect Overview

- Amazon Lex: (same technology that powers Alexa) - Automatic Speech Recognition (ASR) to convert speech to text - Natural Language Understanding to recognise the intent of text, callers - Helps build chatbots and call centre bots - Amazon Connect: - Receive calls, create contact flows, cloud-based virtual contact centre - Can integrate with other CRM systems of AWS - No upfront payments, 80% cheaper than traditional contact center solutions *Hmmmm.....*

## 15.6 Comprehend Overview

- For Natural Language Processing - NLP - Fully managed and serverless service - Uses machine learning to find insights and relationships in text - Language of the text - Extracts key phrases, places, people, brands or events - Understands how positive or negative the text is - Analyses text using tokenization and parts of speech - Automatically organises a collection of text files by topic - Sample use cases: - Analyse customer interactions (emails) to find what leads to a positive or negative experience - Create and groups articles by topics that Comprehend will uncover

## 15.7 Comprehend Medical Overview

- Amazon Comprehend Medical detects and returns useful information in unstructured clinical text: - Physician's notes - Discharge summaries - Test results - Case notes - Uses NLP to detect Protected Health Information (PHI) - DetectPHI API - Store your documents in Amazon S3, analyse real-time data with Kinesis Data Firehose or use Amazon Transcribe to transcribe patient narratives into text that can be analysed by Amazon Comprehend Medical.

## 15.8 SageMaker Overview

- Fully managed service for developers / data scientists to build ML models - Typically difficult to do all processes in one place + provision servers

## 15.9 Kendra Overview

- Fully managed document search service powered by Machine Learning - Extract answers from within a document (text, pdf, HTML, PowerPoint, MS Word, FAQs) - Natural language search

capabilities - Learn from user interactions / feedback to promote preferred results (Incremental Learning) - Ability to manually fine-tune search results (importance of data, freshness, customer)

## 15.10 Personalise Overview

- Fully managed ML-service to build apps with real-time personalised recommendations - Example: personalised product recommendations/re-ranking, customised direct marketing Example: User bought gardening tools, provide recommendations on the next one to buy. - Same technology used by Amazon.com - Integrates into existing websites, applications, SMS, email marketing systems..... - Implement in days, not months (don't need to build, train and deploy ML solutions) - Use cases; retail stores, media and entertainment

## 15.11 Textract Overview

- Automatically extracts text, handwriting and data from any scanned documents using AI and ML  
- Extract data from forms and tables - Read and process any type of document (PDFs, images) - Use cases: - Financial Services (e.g, invoices, financial reports) - Healthcare (e.g medical records, insurance claims) - Public Sector (e.g tax forms, ID documents, passports)

## 15.12 Machine Learning Summary

- Rekognition - face detection, labeling, celebrity recognition
- Transcribe - audio to text (ex: subtitles)
- Polly - text to audio
- Translate - translations
- Lex - build conversational bots - chatbots
- Comprehend - natural language processing
- SageMaker - Machine learning for every developer and data scientist
- Kendra - ML-powered search engine
- Personalise - real-time personalised recommendations
- Textract - detect text and data in documents





## **Chapter 16**

# **Other Services**

**16.1 Other Services**

**16.2 IMPORTANT: CodeCommit Discontinuation**

**16.3 CI/CD**

**16.4 Amazon CodeGuru**

**16.5 Alexa for Business, Lex and Connect**

**16.6 Kinesis Video Streams**

**16.7 AWS WorkSpaces**

**16.8 Amazon AppStream 2.0**

**16.9 AWS Device Farm**

**16.10 Amazon Macie**

**16.11 Amazon SES**

**16.12 Amazon Pinpoint**

**16.13 EC2 Image Builder**

**16.14 Other Services Summary**



## **Chapter 17**

# **Exam Preparation**