AWS Content Analysis

Implementation Guide

AWS Content Analysis: Implementation Guide

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AWS Content Analysis

AWS Implementation Guide

AWS Solutions Builder Team

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This implementation guide discusses architectural considerations and configuration steps for deploying the AWS Content Analysis solution in the Amazon Web Services (AWS) Cloud. It includes links to an AWS CloudFormation template that launches and configures the AWS services required to deploy this solution using AWS best practices for security and availability.

The guide is intended for IT infrastructure architects and developers who have practical experience architecting in the AWS Cloud.

Overview

Amazon Web Services (AWS) offers powerful and cost-effective services to help customers process, analyze, and extract meaningful data from media files. Customers who want to obtain a broader understanding of their media libraries can use AWS services to develop solutions to analyze and extract valuable metadata. Customers can also use various machine learning tools to develop their own analytical solutions in the AWS Cloud. However, using these services together in a single unified application that combines insights derived from multiple AWS artificial intelligence (AI) services requires custom integration work.

The AWS Content Analysis solution combines Amazon Rekognition, Amazon Transcribe, Amazon Translate, and Amazon Comprehend to offer a suite of comprehensive capabilities to analyze a customer's media content. Amazon Rekognition provides highly accurate object, scene, and activity detection; person identification and pathing; and celebrity recognition in videos. Amazon Transcribe provides an automatic speech recognition service while Amazon Translate translates the content between languages. Amazon Comprehend extracts key phrases and entities from the media file transcripts in AWS accounts without machine learning expertise.

The AWS Content Analysis solution is a tailored application based on the open source project Media Insights Engine (MIE). The Media Insights Engine provides a framework to make it easier for developers to build applications that transform or analyze videos on AWS. For more information about how this solution can be modified to your own needs, see the documentation for the MIE project.

Cost

You are responsible for the cost of the AWS services used while running the AWS Content Analysis solution. The primary cost factors are from using Amazon Rekognition and Amazon Elasticsearch Service (Amazon ES). Videos cost about $0.50 per minute to process, but can vary between $0.10 per minute and $0.60 per minute depending on the video content. If you disable Amazon Rekognition in your workflow configuration, then video costs can decrease to approximately $0.04 per minute. Data storage and Amazon ES will cost approximately $10.00 per day regardless of the quantity or type of video content.

After a video is uploaded into the solution, the costs for processing are a one-time expense. However, data storage costs occur daily, as shown in the following screenshot from AWS Cost Explorer.

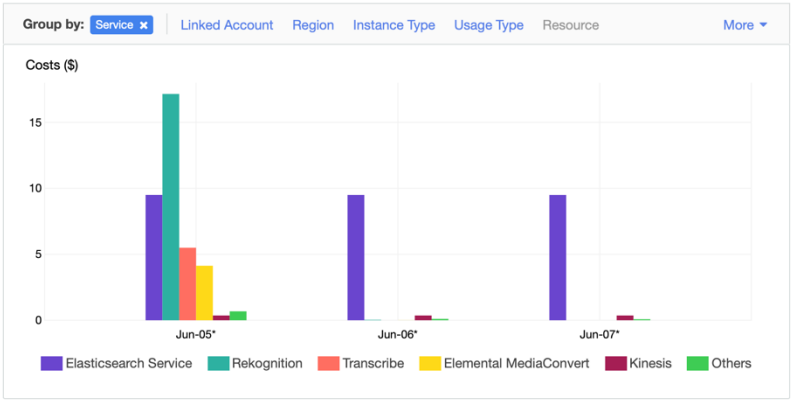

Figure 1: Sample cost using AWS Cost Explorer

For more information about cost, see the pricing webpage for each AWS service you will be using in this solution. If you need to process a large volume of videos, we recommend that you contact your AWS account representative for at-scale pricing.

Architecture overview

Deploying this solution builds the following environment in the AWS Cloud.

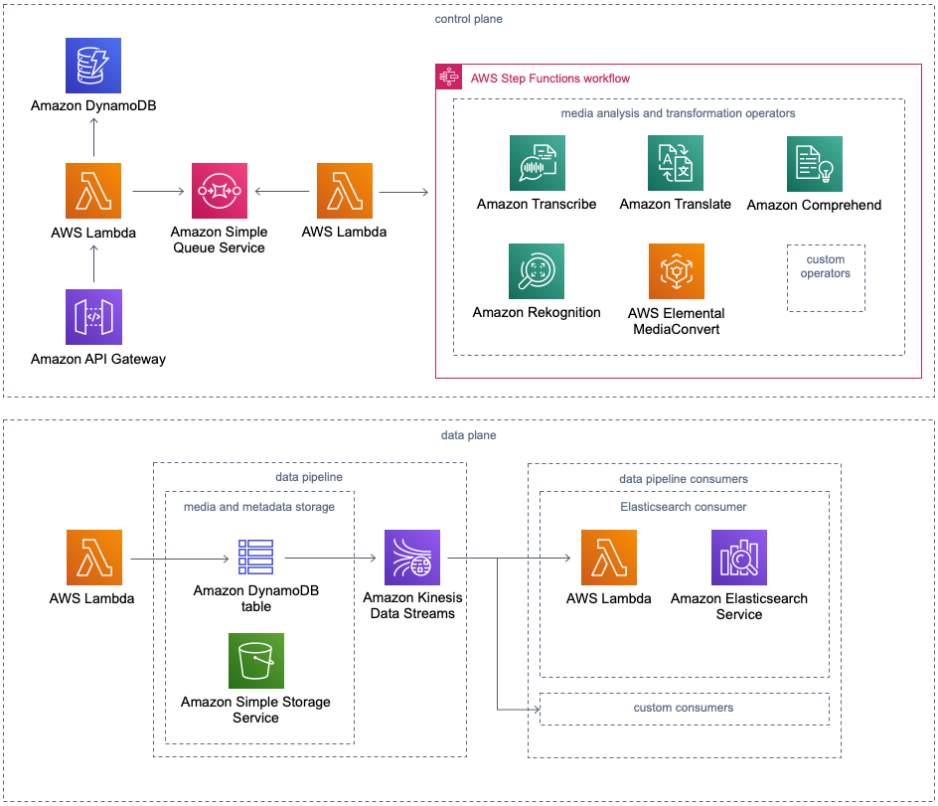

Figure 2: AWS Content Analysis architecture on AWS

The AWS CloudFormation template deploys an Amazon API Gateway RESTful API to expose control plane and data plane operations. The control plane orchestrates all the operations that are involved in analytical workflows. Workflows are defined by state machines in the AWS Step Functions service. There is currently only one workflow supported in this solution—`MIECompleteWorkflow`—which handles the processing of videos.

As operators within a workflow are executed, they interact with the data plane to store and retrieve media objects and metadata generated by the workflow. The data plane uses an Amazon Simple Storage Service (Amazon S3) bucket to store uploaded video files, derived metadata results, and derived media objects like thumbnails, audio files, and transcoded video files. Writing metadata to the data plane triggers a copy of the data to be stored in Amazon Kinesis Data Streams which, in turn, causes the data to be indexed in an Amazon Elasticsearch Service (Amazon ES) cluster. The relationship of metadata and media objects with uploaded media files is saved in an Amazon DynamoDB table.

This solution also creates a static web application and deploys it in an Amazon S3 bucket to allow users to immediately start analyzing media files with a graphical user interface (GUI). Amazon CloudFront is used to restrict access to the solution's website bucket contents.

Solution components

Supported input types

This solution uses AWS Elemental MediaConvert to transcode uploaded videos into the MP4 format required by the analysis operators and supports the same video formats. For information about the file formats supported by MediaConvert, see Supported Input Codecs and Containers in the *MediaConvert User Guide*.

Web application

The AWS Content Analysis solution features a simple static web application hosted in Amazon Simple Storage Service (Amazon S3) for uploading, analyzing, and browsing video collections. It uses Amazon Cognito for user authentication, Amazon API Gateway for search and metadata retrieval, and AWS Amplify for interacting with cloud services.

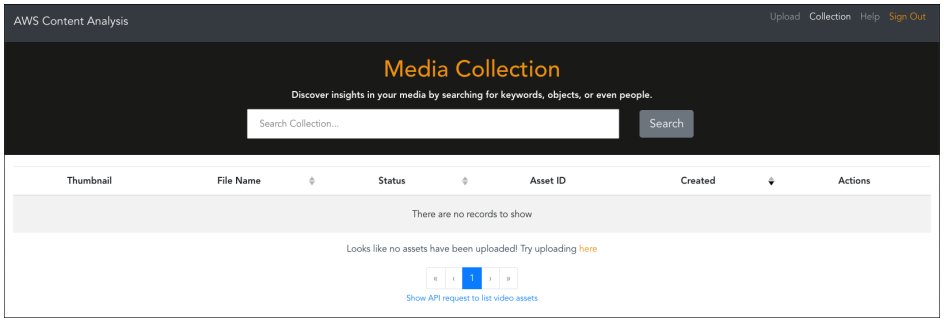

Figure 3: Web application home page

When authenticated users upload files through the application, the files are stored in private folders that correspond to their unique Amazon Cognito identifier to ensure fine-grained access control using AWS Identity and Access Management (IAM) policies.

Deployment considerations

Limits

As of the date of this publication, the AWS Content Analysis solution limits the size of files that can be uploaded using the web application to 3 GB.

Regional deployment

This solution uses the Amazon Rekognition, Amazon Translate, Amazon Comprehend, and Amazon Transcribe services, which are currently available in specific AWS Regions only. Therefore, you must launch this solution in an AWS Region where these AWS Services are available. For the most current service availability by Region, see AWS service offerings by Region.

AWS CloudFormation template

This solution uses AWS CloudFormation to automate the deployment of the AWS Content Analysis solution in the AWS Cloud. It includes the following CloudFormation template, which you can download before deployment.

aws-content-analysis.template: Use this template to launch the AWS Content Analysis solution and all associated components. The default configuration deploys Amazon Simple Storage Service (Amazon S3) buckets, an Amazon Elasticsearch Service cluster, AWS Lambda functions, AWS Step Functions state machines, an Amazon API Gateway RESTful API, an Amazon CloudFront distribution, Amazon Cognito user pools, Amazon Simple Notification Service (Amazon SNS) topics, and Amazon DynamoDB tables. You can also customize the template based on your specific needs.

Automated deployment

Before you launch the solution, review the architecture, configuration, network security, and other considerations discussed in this guide. Follow the step-by-step instructions in this section to configure and deploy the solution into your account.

Time to deploy: Approximately 20 minutes

Deployment overview

Use the following steps to deploy this solution on AWS. For detailed instructions, follow the links for each step.

Step 1. Launch the stack (p. 7)

- Launch the AWS CloudFormation template into your AWS account.
- Enter values for required parameters: **AdminEmail** and **DeployDemoSite**.

Step 2. Access the web application (p. 8)

- Identify the URL.

Step 3. Upload a video (p. 9)

Step 4. Search a video (p. 10)

- Use full text queries.
- Search high confidence data.
- Search data from individual operators.
- Search related concepts across multiple operators.

Step 5. (Optional) Create user accounts (p. 12)

Step 1. Launch the stack

This automated AWS CloudFormation template deploys the solution in the AWS Cloud.

> **Note**
> You are responsible for the cost of the AWS services used while running this solution. See the Cost (p. 2) section for more details. For full details, see the pricing webpage for each AWS service you will be using in this solution.

1. Sign in to the AWS Management Console and click the button below to launch the `aws-content-analysis.template` AWS CloudFormation template.

You can also download the template as a starting point for your own implementation.

2. The template launches in the US East (N. Virginia) Region by default. To launch the solution in a different AWS Region, use the Region selector in the console navigation bar.

   Note
   This solution uses the Amazon Rekognition, Amazon Translate, Amazon Comprehend, and Amazon Transcribe services, which are currently available in specific AWS Regions only. Therefore, you must launch this solution in an AWS Region where these services are available. For the most current availability by region, see AWS service offerings by Region.

3. On the **Create stack** page, verify that the correct template URL shows in the **Amazon S3 URL** text box and choose **Next**.
4. On the **Specify stack details** page, assign a name to your solution stack.
5. Under **Parameters**, review the parameters for the template and modify them as necessary. This solution uses the following default values.

Parameter	Default	Description
AdminEmail	*<Requires input>*	Email address for the MIE administrator. This user receives an email with a temporary password to the web application once the AWS CloudFormation template has launched.
DeployDemoSite	`true`	When set to `true`, deploys a frontend web application to explore extracted metadata.

6. Choose **Next**.
7. On the **Configure stack options** page, choose **Next**.
8. On the **Review** page, review and confirm the settings. Check the box acknowledging that the template will create AWS Identity and Access Management (IAM) resources and may require an AWS CloudFormation capability.

   Note
   This solution may require an AWS CloudFormation capability: `CAPABILITY_AUTO_EXPAND`, which is a parameter that supports the use of macros. For information about this AWS CloudFormation capability, see CreateStack in the *AWS CloudFormation API Reference*.

9. Choose **Create stack** to deploy the stack.

   You can view the status of the stack in the AWS CloudFormation console in the **Status** column. You should see a status of **CREATE_COMPLETE** in approximately 20 minutes.

Step 2. Access the web application

After the solution successfully launches, you can access the web application. The solution sends an email containing information to access the web application, including a temporary password.

Identify the URL

Use the following procedure to identify the URL for the web application. This will enable you to sign in.

1. Navigate to the AWS CloudFormation console and select the solution's stack.
2. On the **Stacks** page, select the **MediaInsightsWebApp** nested stack and select the **Outputs** tab.
3. On the **Outputs** page, **Key** column, locate **CloudfrontURL**, select the corresponding **Value**, and open the web application in a new tab or browser window.

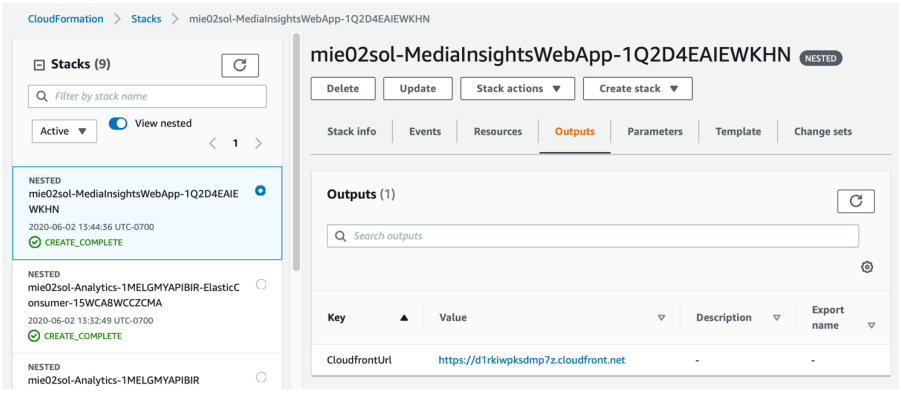

Figure 4: Web application URL

4. Sign in with your username and temporary password, then create a new password when prompted.

Figure 5 shows the AWS Content Analysis web application.

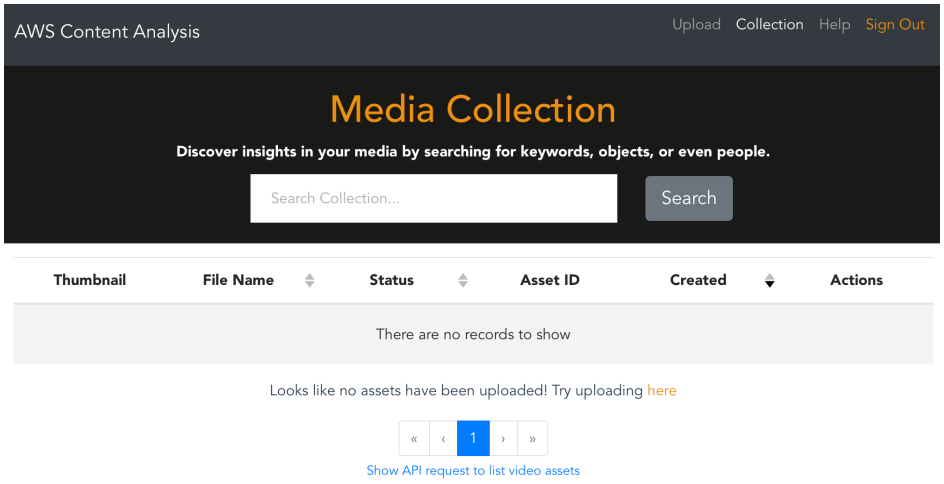

Figure 5: AWS Content Analysis web application home page

Step 3. Upload a video

Use the following procedure to upload videos and to start an analysis.

1. Sign in to the AWS Content Analysis web application and choose **Upload**.
2. From the **Upload Videos** page, drag and drop one or more media files into the upload box as shown in Figure 6.

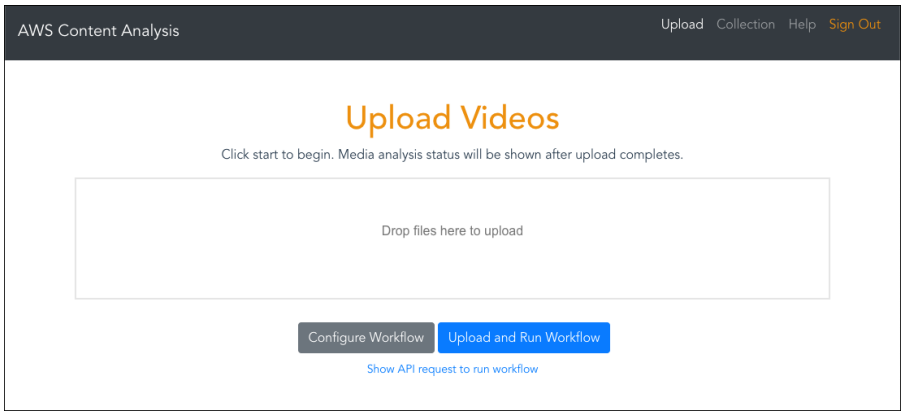

Figure 6: Upload videos page

3. To disable any of the analysis operators, choose **Configure Workflow**. By default, all analysis operators are enabled, as shown in Figure 7. Operator descriptions are included in Appendix A (p. 16).

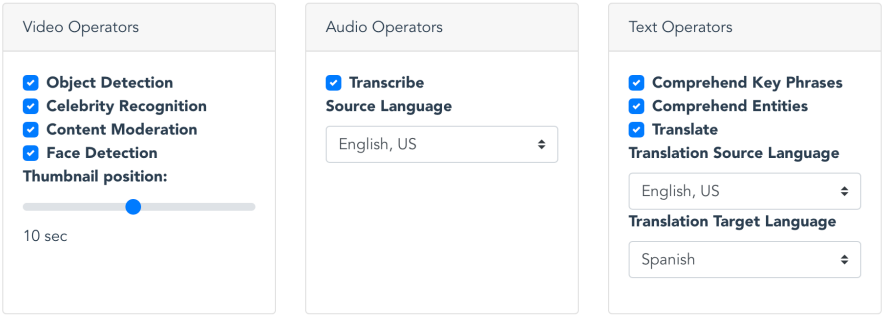

Figure 7: Workflow Operator categories

4. To start the analyses, choose **Upload and Run Workflow**.

After the workflow has completed, an Execution History table appears below the Operator categories to verify that the video was successfully uploaded and analyzed.

Step 4. Search a video

The workflow operators analyze the media file and indexes and then catalog the information in an Amazon Elasticsearch Service (Amazon ES) instance. You can search all aspects of a media file using Lucene, the Elasticsearch query language. The following examples show common search patterns using Amazon ES.

Use full-text queries

Full-text queries enable you to search for any type of data that exists in the video catalog. For example, the Amazon Rekognition celebrity detection service will return the full names of celebrities detected in a video. Figure 8 shows a search for a celebrity by first and last name. Figure 9 shows the search results.

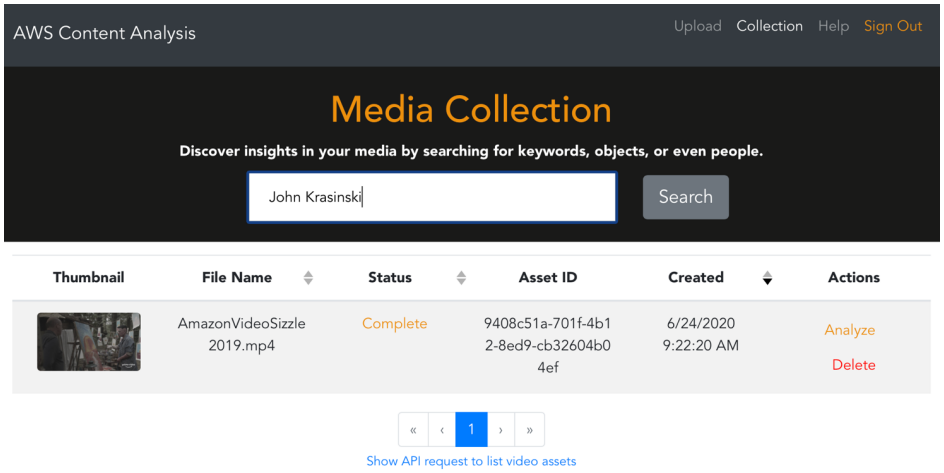

Figure 8: Using the search function in the web application

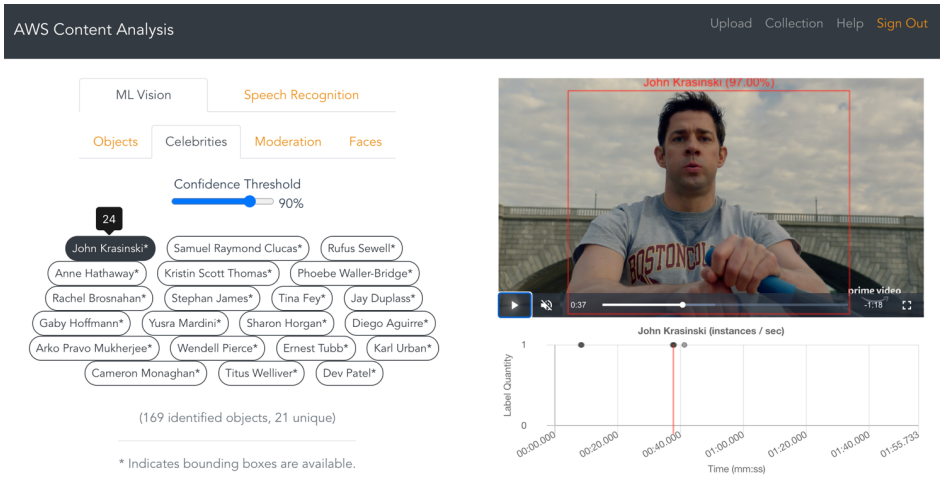

Figure 9: Search results in the web application

Search high confidence data

After the analysis workflow completes, labels returned by Amazon Rekognition are assigned a confidence value. You can use that value to filter search results. For example, `Violence AND Confidence:>80` will search for videos containing violence with an 80% or higher confidence threshold.

Search data from individual operators

Searches will query the metadata catalog in Amazon ES. For example, a search for the term *violence* would match videos containing the *violence* label from content moderation and would also match video transcripts that contain the word *violence*. You can restrict your search to focus Content Moderation results with operator names, for example: `Operator:content_moderation AND (Name:violence AND Confidence:>80)`.

You can use the following operator names to filter search queries:

- label_detection
- celebrity_detection

- content_moderation
- face_detection
- transcribe
- key_phrases
- entities

Search related concepts across multiple operators

You can also conduct compound searches using multiple operator names. For example, the following search query will return *violence* identified by content moderation and *guns* or *weapons* identified by label detection: `(Operator:content_moderation AND Name:Violence AND Confidence:>80) OR (Operator:label_detection AND (Name:Gun OR Name:Weapon))`.

Step 5. (Optional) Create user accounts

If more than one person needs access to the web application, then the solution administrator can set up additional users with the following procedure in Amazon Cognito.

1. Sign in to the Amazon Cognito console.
2. Choose **Manage User Pools**.
3. In the **Your User Pools** page, select the name of the user pool containing the prefix **MIE**.
4. On the **MieUserPool** page, from the left navigation pane, choose **Users and Groups**.
5. On the **Users** tab, choose **Create user**.

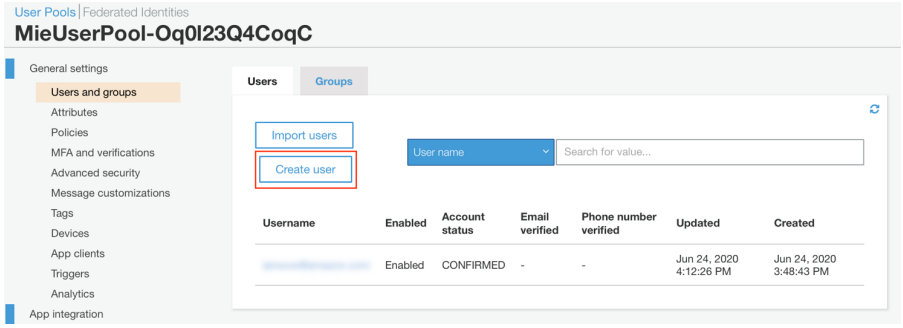

Figure 10: Amazon Cognito user pools create a user

6. In the **Create user** dialog box, enter a username and temporary password (ensure the options to send an invitation to the user and the verifications for phone number and email are not selected).
7. Choose **Create user**.
8. On the **MieUserPool** page, under the **Username** column, select the user you just created.

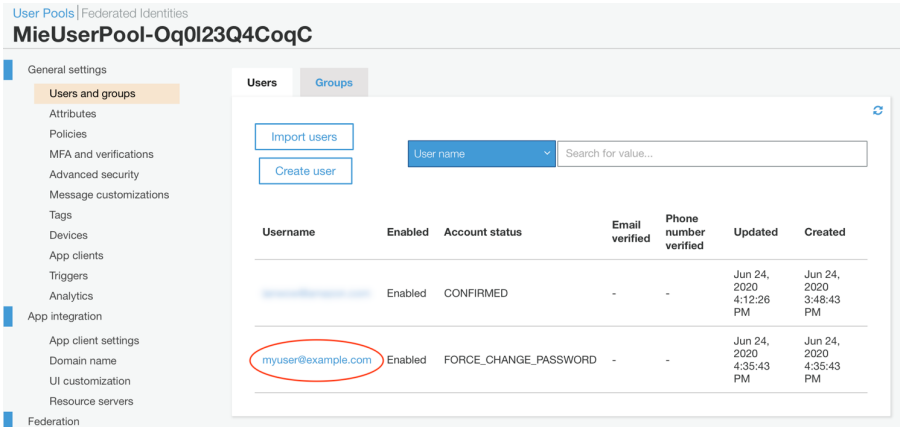

Figure 11: Amazon Cognito user pools page

9. On the **Users** page, choose **Add to group**.
10. In the **Add user** dialog box, access the drop-down list and select **MieDevelopersGroup**.

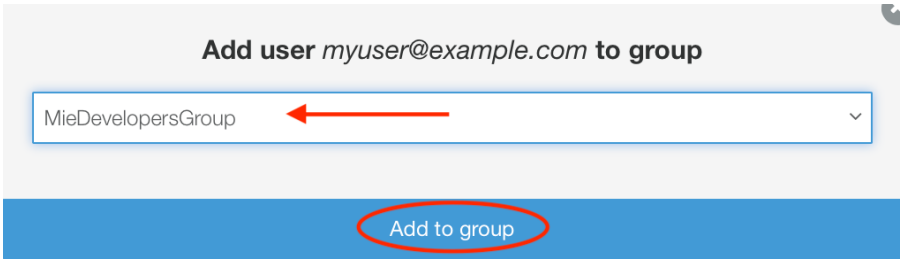

Figure 12: Add a user to a group

The user can now access the web application, upload media files, and run the analysis workflows.

Security

When you build systems on AWS infrastructure, security responsibilities are shared between you and AWS. This shared model can reduce your operational burden as AWS operates, manages, and controls the components from the host operating system and virtualization layer down to the physical security of the facilities in which the services operate. For more information about security on AWS, visit AWS Cloud Security.

Server-side encryption

AWS highly recommends that customers encrypt sensitive data in transit and at rest. This solution automatically encrypts media files and metadata at rest with Amazon Simple Storage Service (Amazon S3) Server-Side Encryption (SSE). This solution's Amazon Simple Notification Service (Amazon SNS) topics and Amazon DynamoDB tables are also encrypted at rest using SSE.

Amazon CloudFront

This solution deploys a static website hosted in an Amazon S3 bucket. To help reduce latency and improve security, this solution includes an Amazon CloudFront distribution with an origin access identity, which is a special CloudFront user that helps restrict access to the solution's website bucket contents. For more information, see Restricting Access to Amazon S3 Content by Using an Origin Access Identity in the *Amazon CloudFront Developer Guide*.

Additional resources

- AWS CloudFormation
- Amazon Route 53
- AWS Lambda
- Amazon Rekognition
- Amazon Cognito
- Amazon Simple Storage Service
- Amazon DynamoDB
- Amazon Transcribe
- Amazon Translate
- Amazon Comprehend
- Amazon API Gateway
- Amazon Elasticsearch Service
- AWS Step Functions
- Amazon CloudFront
- Amazon Kinesis Data Streams

Appendix A: Guide to analysis operators

When uploading videos, users can select which of the following services to include in the analysis workflow that starts after upload completes:

- Amazon Rekognition to:
  - Detect objects in videos
  - Detect celebrities in videos
  - Detect faces in videos
  - Detect potentially unsafe or inappropriate content in videos
- Amazon Transcribe to convert speech to text from video audio tracks
- Amazon Translate to convert text from one language to another
- Amazon Comprehend to:
  - Identify entities in text
  - Identify key phrases in text

By default, all analysis operators are enabled, as shown in Figure 7.

Use Amazon Rekognition to detect objects and activities in videos

Use the following procedure to detect objects and activities in videos using Amazon Rekognition.

1. Sign in to the AWS Content Analysis web application.
2. Choose **Upload**.
3. From the **Upload Videos** page, drag and drop one or more video files into the upload box.
4. Choose **Configure Workflow** and verify that the Amazon Rekognition features are enabled including object detection and other detection options in the workflow settings dialog.
5. Choose **Upload** and **Run Workflow**. Wait for the workflow status to show as complete before continuing to the next step.
6. Choose **Collection**.
7. Locate the media file you want to analyze and under the **Actions** column choose **Analyze**.
8. From the **ML Vision** tab, explore the Amazon Rekognition metadata for your content.

Use Amazon Transcribe to convert speech to text from audio and video assets

Use the following procedure to convert speech to text from video assets using Amazon Transcribe.

1. Sign in to the AWS Content Analysis web application.

2. Choose **Upload**.
3. From the **Upload Videos** page, drag and drop one or more media files into the upload box.
4. Choose **Configure Workflow** and verify that the **Transcribe** option is selected.
5. In the **Source Language** drop-down list, select the language you want.
6. Choose **Upload** and **Run Workflow**. Wait for the workflow status to show as complete before continuing to the next step.
7. Choose **Collection**.
8. Locate the media file you want to analyze and under the **Actions** column, choose **Analyze**.
9. From the **Speech Recognition** tab, explore the Amazon Transcribe metadata for your content.

Use Amazon Comprehend to identify entities in text

Use the following procedure identify entities in text using Amazon Comprehend.

1. Sign in to the AWS Content Analysis web application.
2. Choose **Upload**.
3. From the **Upload Videos** page, drag and drop one or more media files into the upload box.
4. Choose **Configure Workflow** and verify that the **Transcribe** option is selected.
5. In the **Source Language** drop-down list, select the language you want.
6. In the **Text Operators** box, verify that the **Comprehend Entities** option is selected.
7. Choose **Upload** and **Run Workflow**. Wait for the workflow status to show complete before continuing to the next step.
8. Choose **Collection**.
9. Locate the media file you want to analyze and under the **Actions** column, choose **Analyze**.
10. From the **Speech Recognition** tab, explore the Amazon Comprehend metadata for your content.

Appendix B: Customizing the solution

The AWS Content Analysis solution is a reference application for the Media Insights Engine (MIE) open source project. For guidance to customize this solution, use the Media Insights Engine GitHub repository.

You can use this solution as an API for your own front-end application using the following API documentation. The web application included with this solution also enables you to see API details for various user actions, as shown in Figure 13.

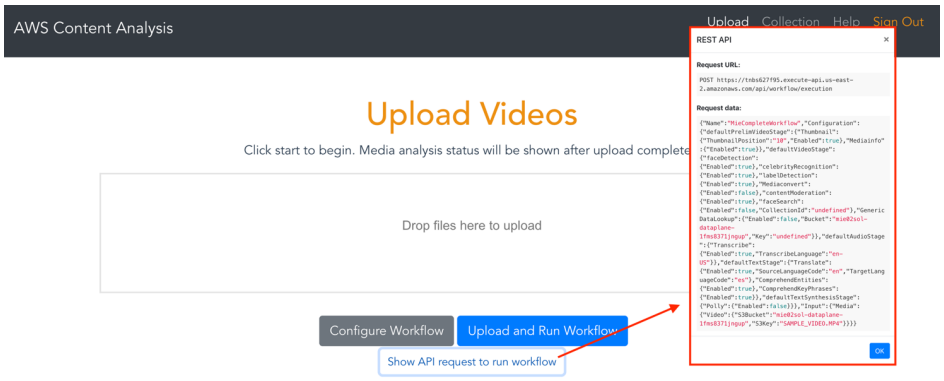

Figure 13: In app API references

API documentation

- Run workflow:

```
POST https://{ WorkflowApiEndpoint }/api/workflow/execution
```

- Retrieve the workflow execution status:

```
GET https://{ WorkflowApiEndpoint }/api/metadata/{asset_id}
```

- List video assets:

```
GET https://{ DataplaneApiEndpoint }/api/metadata/
```

- Get asset metadata:

```
GET https://{ DataplaneApiEndpoint }/api/metadata/{ asset_id }
```

For more information about the API, refer to the Media Insights Engine GitHub repository.

AWS CloudFormation outputs

Most of the reusable resources that make up the core of this solution are included as outputs to the AWS CloudFormation stack. You will likely need to understand what these are in order to customize this solution to suit your own needs. The stack outputs are described below:

- **DataplaneApiEndpoint:** The endpoint for accessing the data plane APIs to create, update, delete, and retrieve media assets.
- **DataplaneBucket:** The Amazon Simple Storage Service (Amazon S3) bucket used to store derived media (*derived assets*) and raw analysis metadata created by the AWS Content Analysis workflows.
- **ElasticsearchEndpoint:** The endpoint of the Elasticsearch cluster used to store analysis metadata for search.
- **WorkflowApiEndpoint:** The endpoint for accessing the workflow APIs to create, update, delete, and execute the solution workflows.

Appendix C: State machines

This solution uses state machines to orchestrate performing analysis on media. There is a state machine for both image and video inputs. Each state machine is composed of parallel states called *stages* containing analysis operations. Each stage is executed sequentially. *Analysis operations* are sets of AWS Lambda functions that start, monitor, and collect results for specific types of analysis, for example, calling Amazon Rekognition APIs to detect labels in a video. Analysis operators are executed within the state machine.

The `MieCompleteWorkflow` video analysis state machine consists of the following stages:

- A `defaultPrelimVideoStage2` input preparation stage that checks the format of the video and gathers structural information about the video package using MediaInfo. It also uses AWS MediaConvert to create a proxy encode and audio file that will be used as the input to downstream stages. The MediaConvert job also generates thumbnail images for the GUI.
- A `defaultVideoStage` video analysis stage that analyzes the content of the video.
- A `defaultAudioStage` audio analysis stage that analyzes the audio content of the video.
- A `defaultTextStage` text analysis stage that analyzes the text from the audio stage using Amazon Translate to generate a translation and Amazon Comprehend to identify entities and key phrases from the text.
- A `defaultTextSynthesis` text synthesis stage.

When you upload a video from the web application it initiates the appropriate state machine. A link to the AWS Step Function console for state machine execution of each job is available from the link in the Status column of the job in the Collection view of the UI (see Figure 14). In order to initiate state machine, the web application sends an analysis workflow execution request to Amazon API Gateway where an AWS Lambda function validates the request and starts the analysis state machine. The web application uses a workflow status Amazon API Gateway request to periodically monitor the progress status and update the web application.

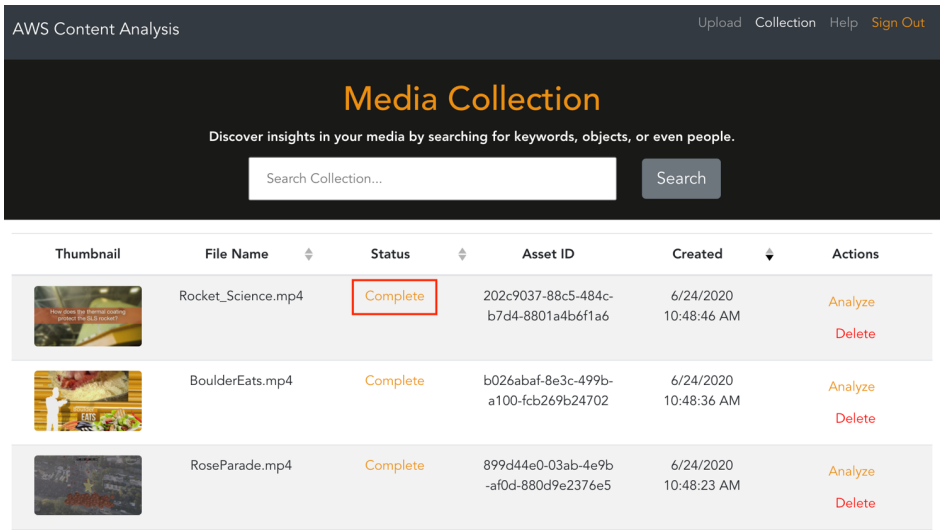

Figure 14: Link to state machine execution result in AWS console from the sample application

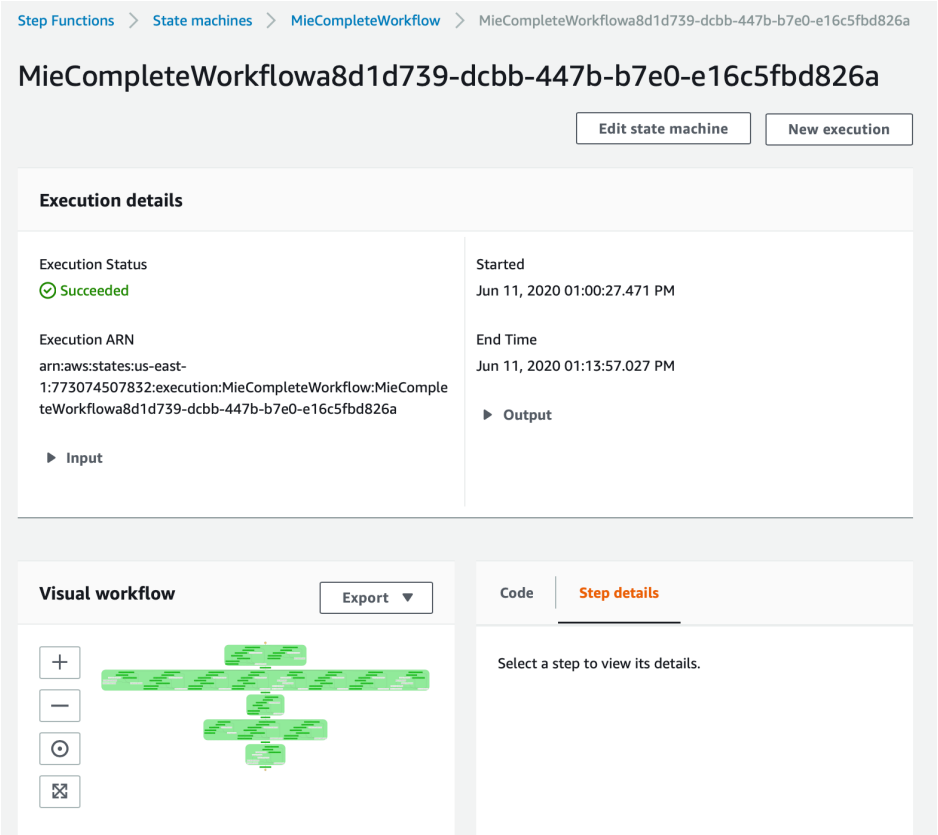

Figure 15: Video analysis workflow

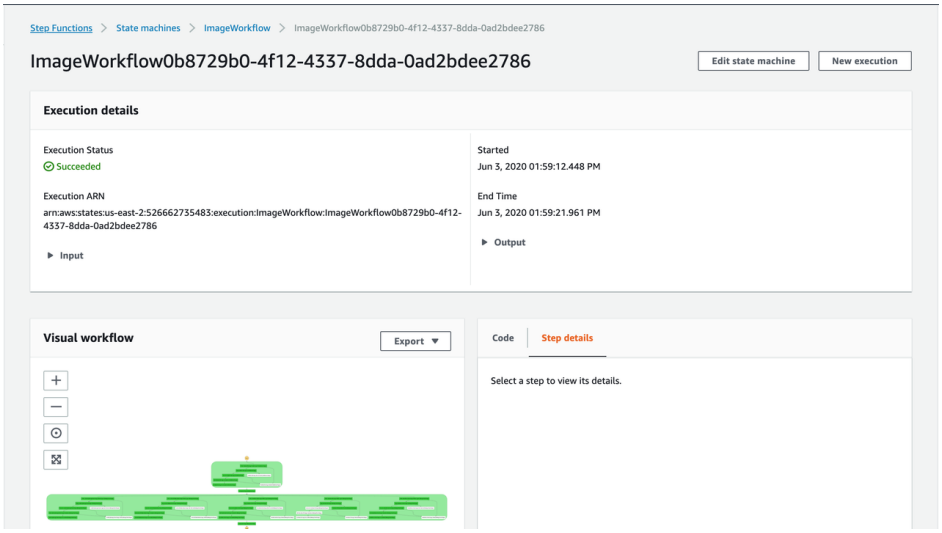

Figure 16: Image analysis workflow

Analysis operations

Analysis operations are sub-components of the MIE state machines. Each analysis operation in the `analysis` state machine has a consistent structure that uses a combination of Step Functions ASL logic and AWS Lambda functions to perform the following steps:

- **Check if the operation is enabled and validate input:** Each analysis operation can be enabled or disabled using the Configuration parameters that are passed in to the state machine from the execute workflow API Gateway request. Each operation checks if it is enabled or disabled before executing. If it is disabled it skips any subsequent steps.
- **Start analysis:** Triggers the start of a specific type of analysis on the input.
- **Check analysis status, collect, and store analysis results in the data plane:** Monitors the results of the analysis. When the analysis is complete, collects the results of the analysis and stores it in the data plane.
- **Handle errors:** If an error occurs in any step of an analysis operation, the operation will handle the error using the logic described in the following `analysis` state machine error handling section.

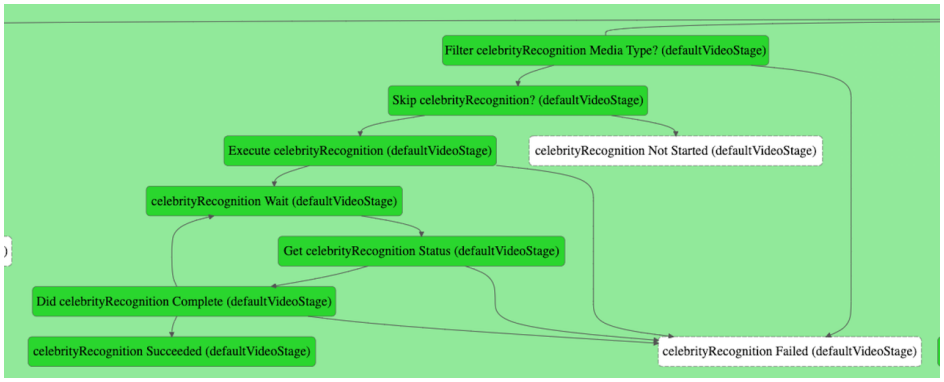

Figure 17: Example analysis operation state machine section (CelebrityRecognition)

Analysis state machine error handling

The state machines have a built-in retry logic using the `Catch and Retry` AWS Step Functions to improve the resiliency of the workflow.

```
"Retry": [ {
                "ErrorEquals": ["Lambda.ServiceException", "Lambda.AWSLambdaException",
 "Lambda.SdkClientException", "Lambda.Unknown", "MasExecutionError"],
                "IntervalSeconds": 2,
                "MaxAttempts": 2,
                "BackoffRate": 2
            }
            ],
            "Catch": [
            {
                "ErrorEquals": ["States.ALL"],
                "Next": "OPERATION_NAME Failed (STAGE_NAME)",
                "ResultPath": "$.Outputs"
            }
            ]
```

If the retries fail, the state machine calls the `OperatorFailedLambda` Lambda function to communicate that an error has occurred in the analysis. Other analysis operations in the same parallel state are allowed to complete and then the analysis state machine will stop execution when the error is detected in the `complete_stage_execution_lambda` Lambda function that is executed at the end of each parallel state of the `analysis` state machine.

Appendix D: Collection of operational metrics

This solution includes an option to send anonymous operational metrics to AWS. We use this data to better understand how customers use this solution and related services and products. When enabled, the following information is collected and sent to AWS:

- **Solution ID:** the AWS solution ID
- **Unique ID (UUID):** randomly generated, unique identifier for each deployment
- **Timestamp:** data-collection timestamp
- **Format:** the format of the uploaded media file
- **Size:** the size of the file the solutions processes
- **Duration:** the length of the uploaded video file

Note that AWS will own the data gathered via this survey. Data collection will be subject to the AWS Privacy Policy. To opt out of this feature, modify the AWS CloudFormation template mapping section as follows:

```
"Send" : {
   "AnonymousUsage" : { "Data" : "Yes" }
},
```

to

```
"Send" : {
   "AnonymousUsage" : { "Data" : "No" }
},
```

Source code

You can visit our GitHub repository to download the templates and scripts for this solution, and to share your customizations with others.

Contributors

The following individuals contributed to this document:

- Alexandria Burkleaux
- Brandon Dold
- Ian Downard
- Tom Gilman

Revisions

Date	Change
July 2020	Initial release
November 2020	Bug fixes; for more information, refer to the CHANGELOG.md file in the GitHub repository

Notices

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