CONF42: CLOUD NATIVE 2023

One Step Ahead

Modern Application Architectures with AWS Step Functions

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Solutions Architect

The AWS Serverless ecosystem is much more than compute

COMPUTE


AWS Lambda


AWS Fargate

DATA STORES


Amazon S3


Amazon Aurora Serverless


Amazon DynamoDB

INTEGRATION


Amazon EventBridge


Amazon API Gateway


Amazon SQS

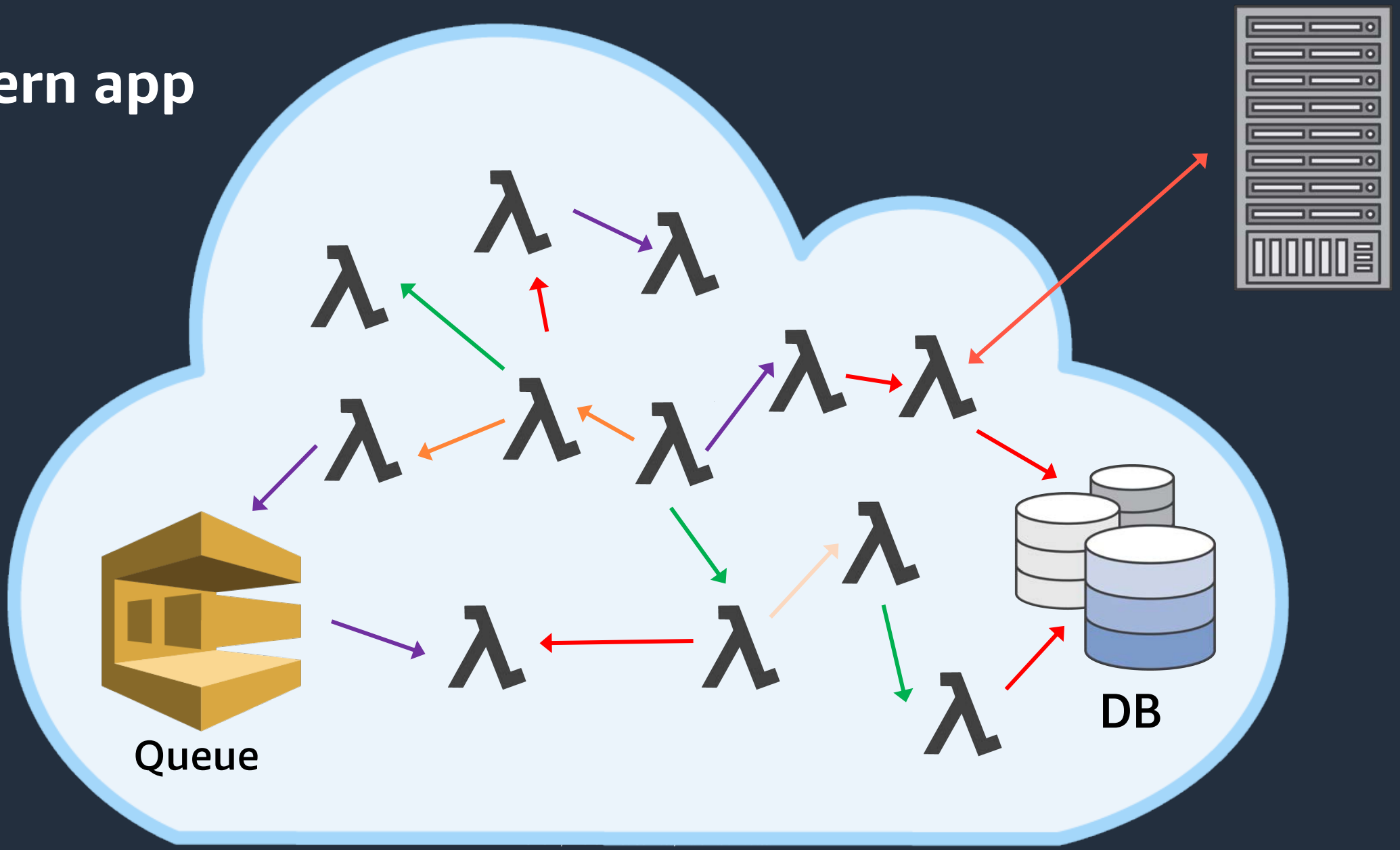

Amazon SNS


AWS Step Functions

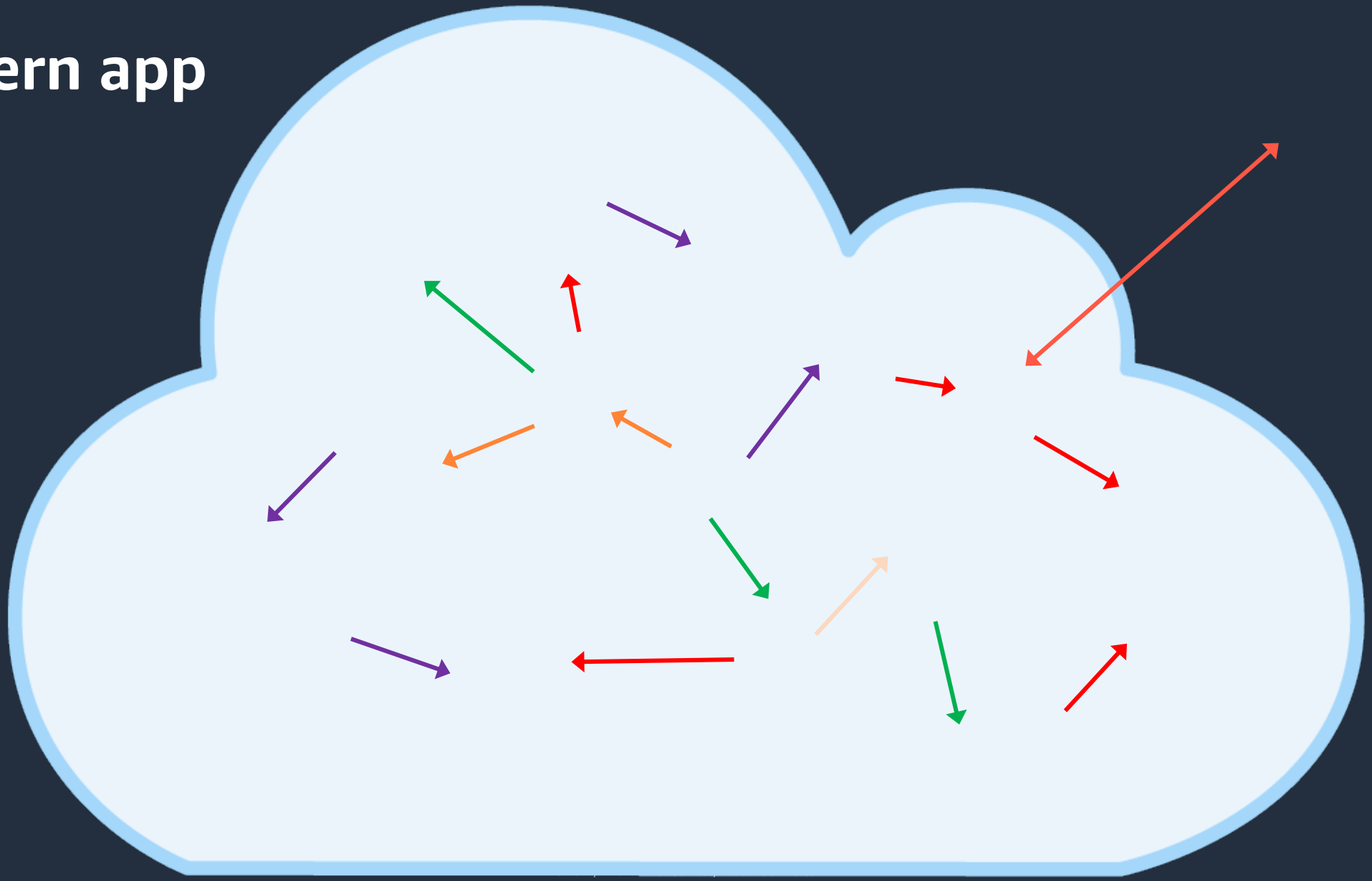

AWS AppSync

Why orchestration?

Modern app



Modern app

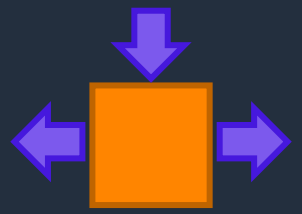


Why orchestration?

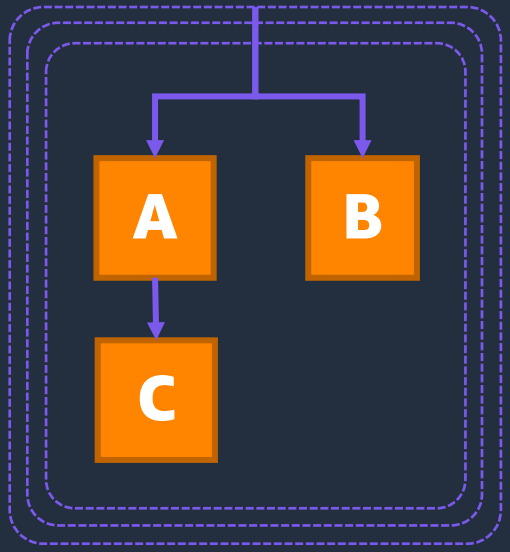
"I want to sequence tasks"

"I want to retry failed tasks"

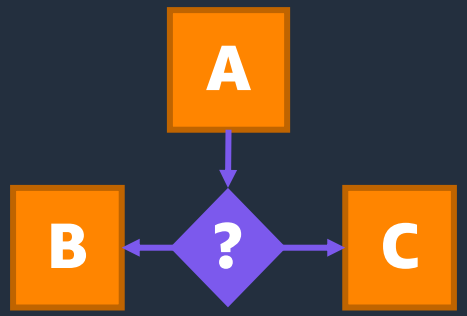
"I want try/catch/finally"



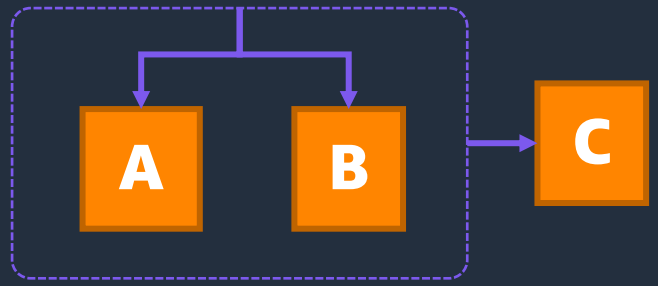
"I want concurrent and iterative tasks"



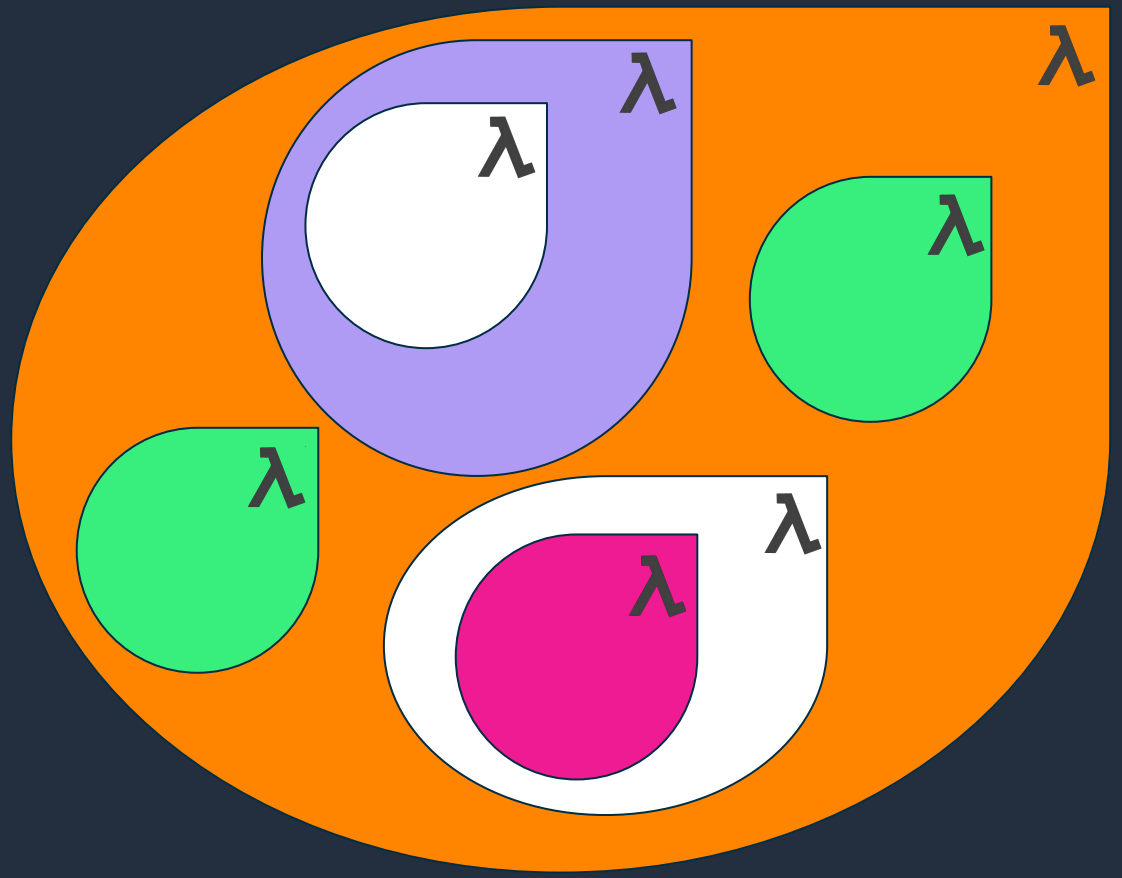
"I want to select tasks based on data"



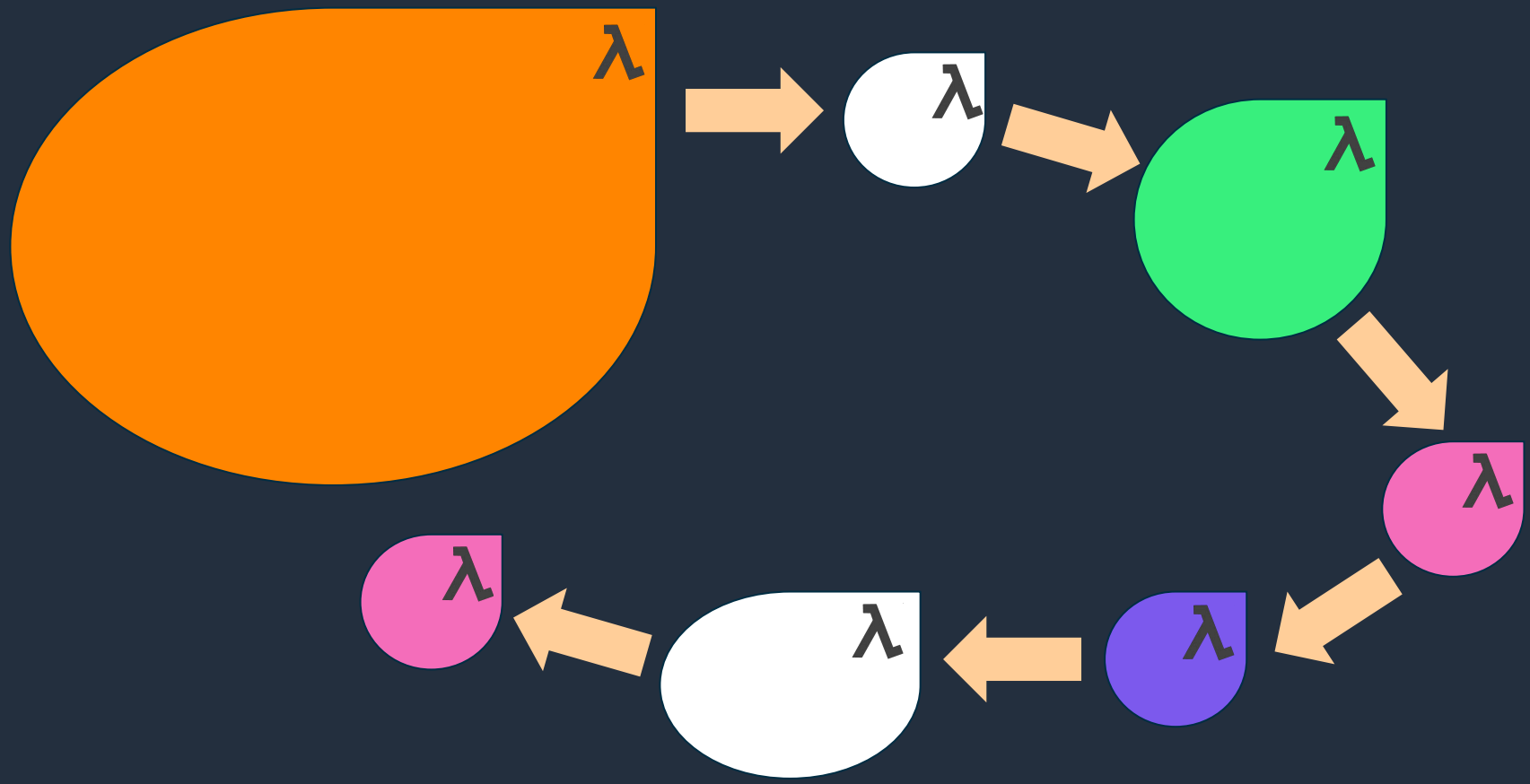
"I want to run tasks in parallel"



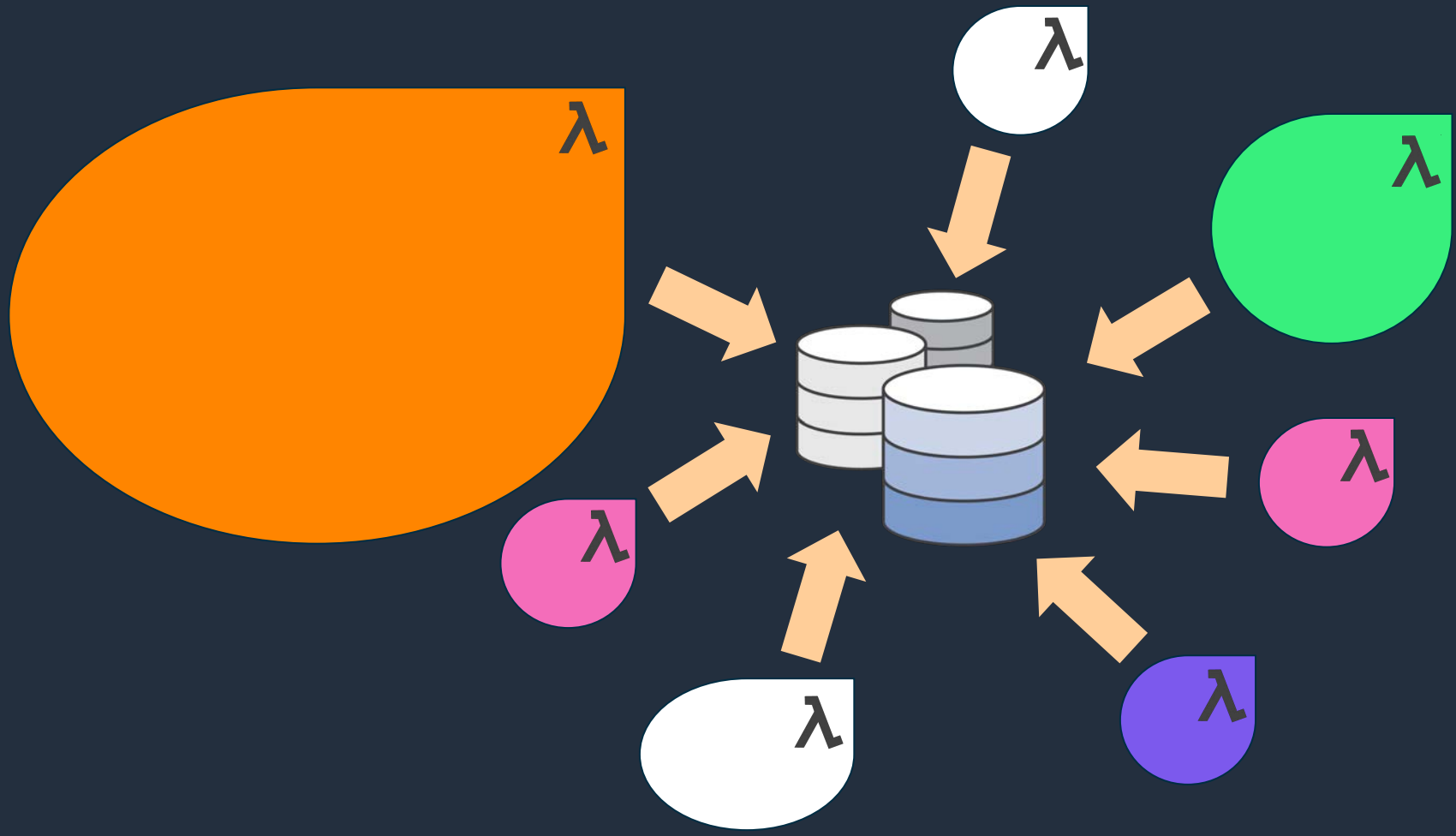
Coordination by method call



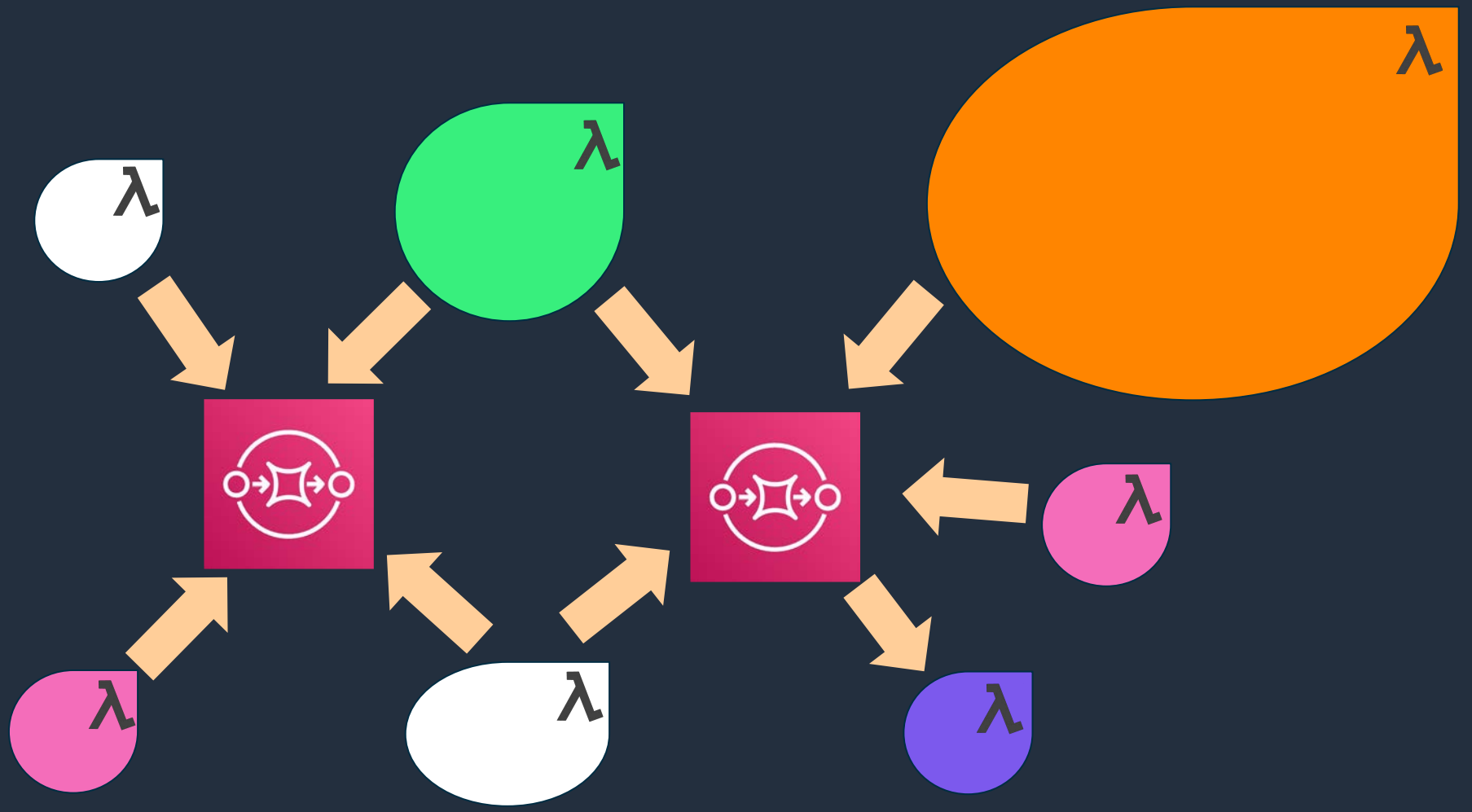
Coordination by function chaining



Coordination by database

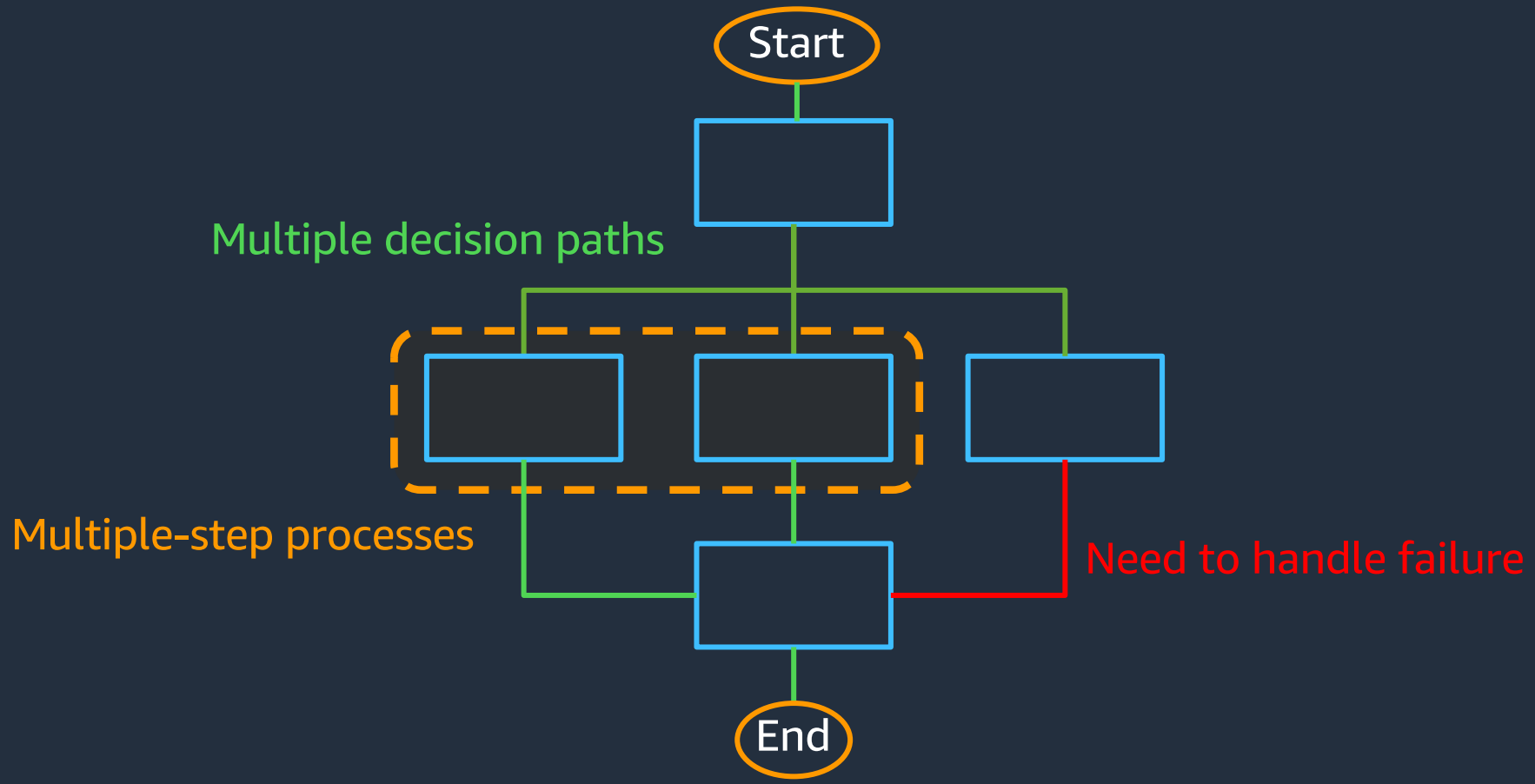


Coordination by queues



How to orchestrate?

Business workflow is rarely sequential start to finish



What is AWS Step Functions?

What is AWS Step Functions?

A serverless workflow orchestration service offered by AWS.

A workflow built on AWS Step Functions...

...is built using a state machine.

...is composed of steps called states.

...moves from one state to another via a state transition.

...is written using Amazon States Language or ASL (think of it as the workflow assembly language).

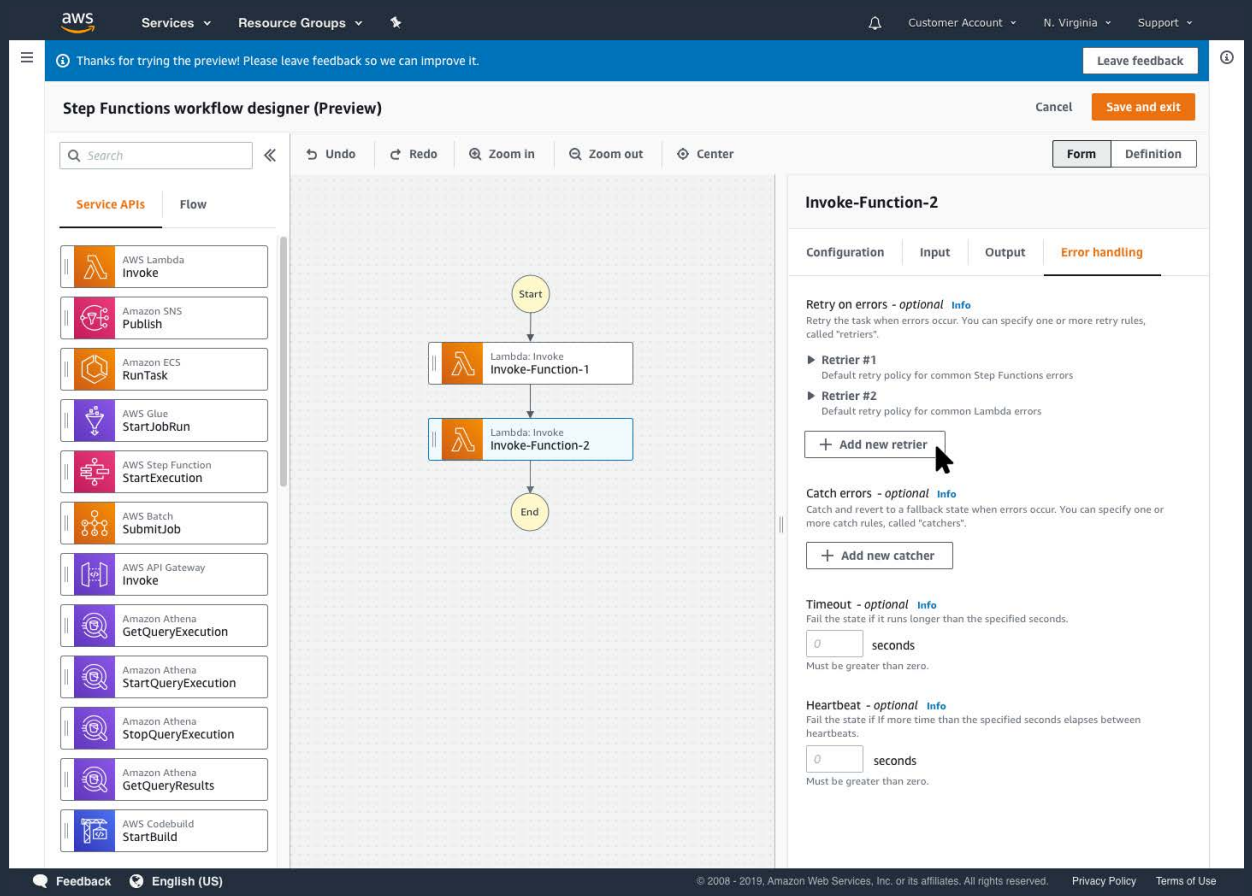
...can be used to orchestrate multiple AWS services.

AWS Step Functions

The workflows you build with Step Functions are called state machines, and each step of your workflow is called a state.

When you execute your state machine, each move from one state to the next is called a state transition.

You can reuse components, easily edit the sequence of steps or swap out the code called by task states as your needs change.



AWS STEP FUNCTIONS WORKFLOW STUDIO

Step Functions benefits

Build and update apps quickly

AWS Step Functions lets you build visual workflows that enable fast translation of business requirements into technical requirements. You can build applications in a matter of minutes, and when needs change, you can swap or reorganize components without customizing any code.

Write less code

AWS Step Functions manages the logic of your application for you, and implements basic primitives such as branching, parallel execution, and timeouts. This removes extra code that may be repeated in your microservices and functions.

Improve resiliency

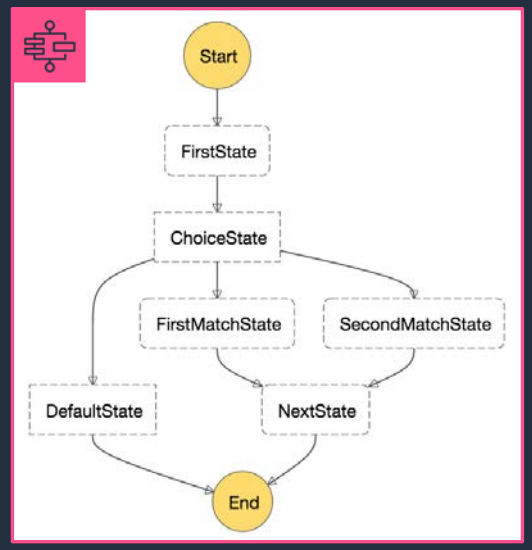
AWS Step Functions manages state, checkpoints and restarts for you to make sure that your application executes in order and as expected. Built-in try/catch, retry and rollback capabilities deal with errors and exceptions automatically.

Visual workflows

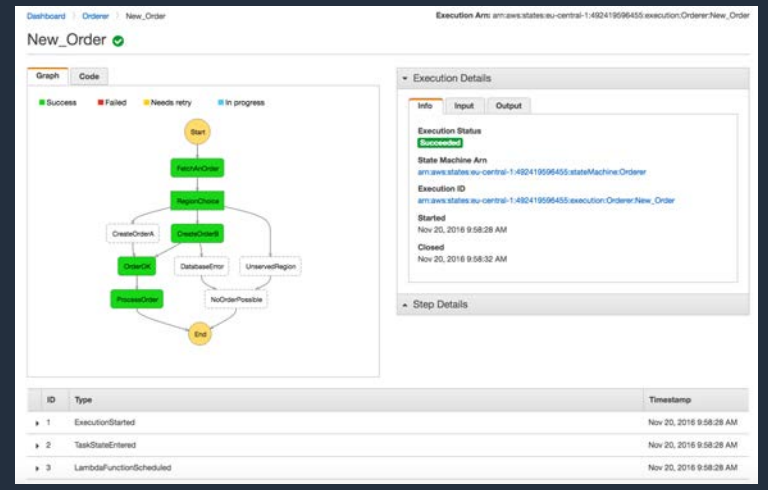
Define

- Drag-and-drop with Workflow Studio
- JSON (Amazon States Language)
- CDK **(**TypeScript, JavaScript, Python, Java, C#)
- Data Science SDK (Python)

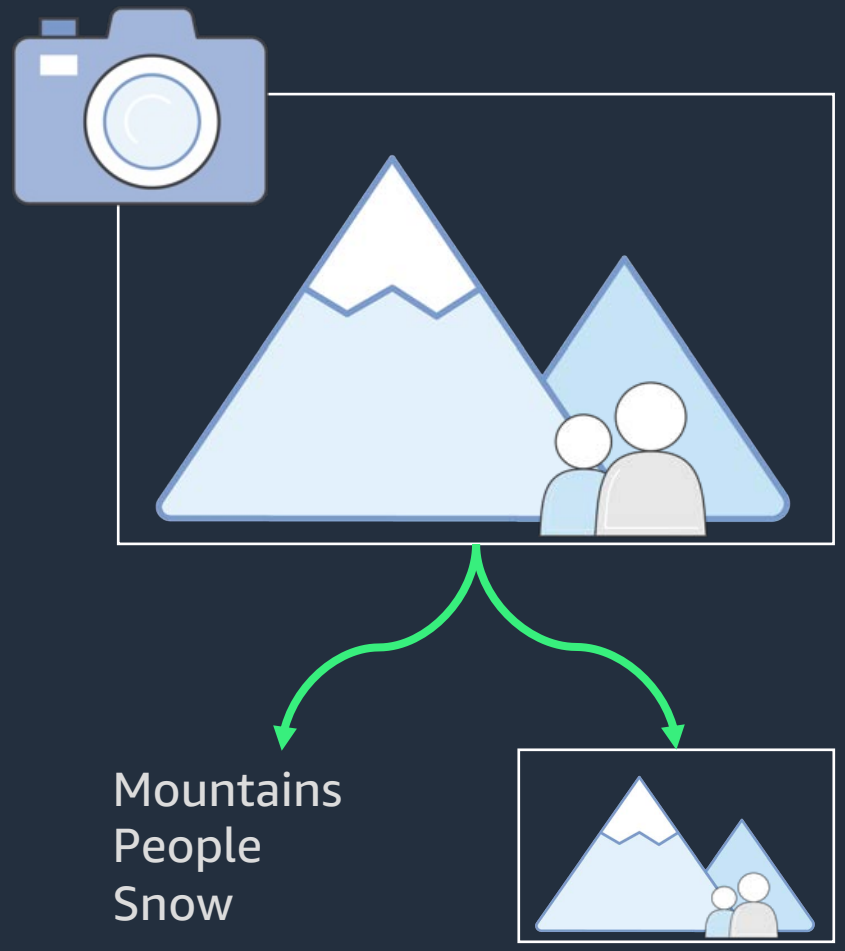
Visualize



Execute and monitor

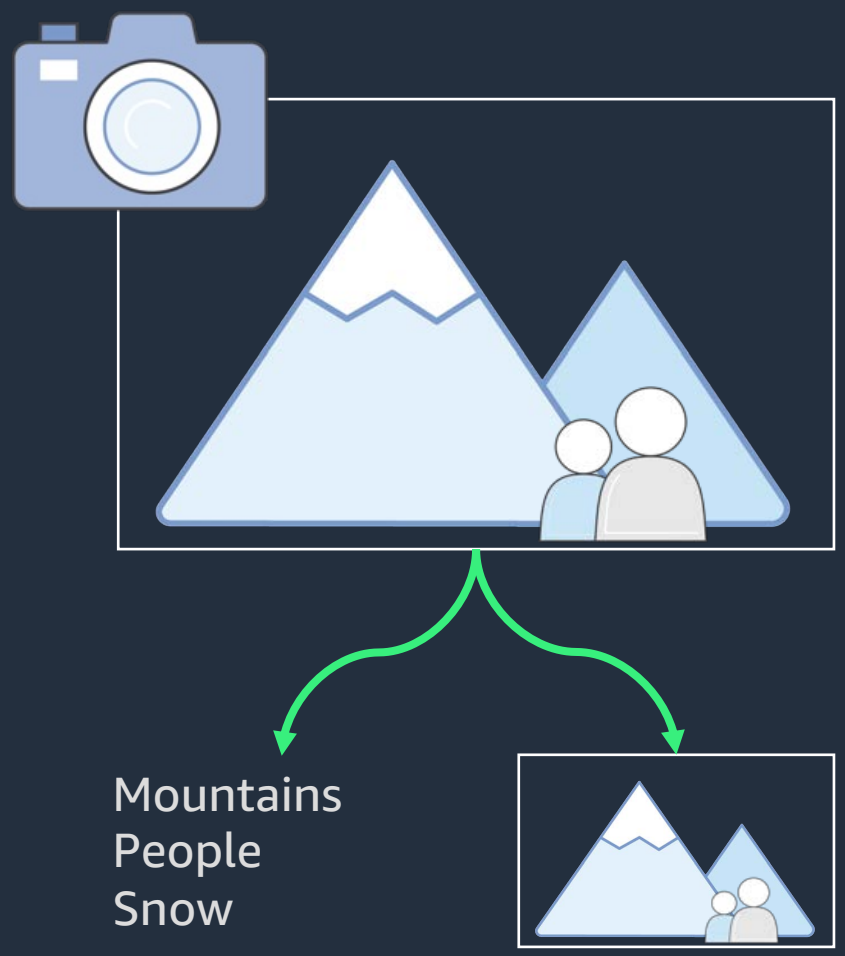


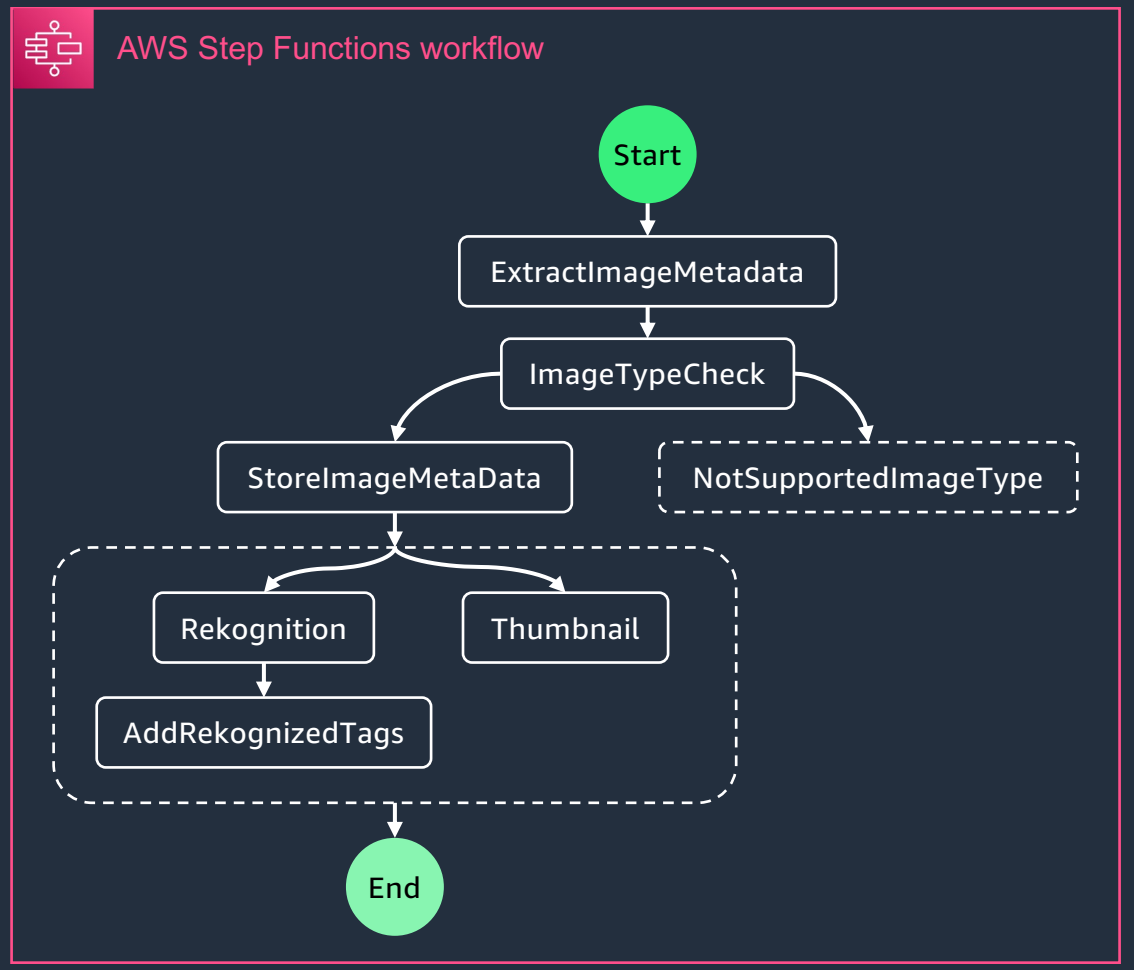
An image processing workflow



1. Make a thumbnail
2. Identify features
3. Store image metadata

Build workflows using eight state types





Amazon States Language (ASL)

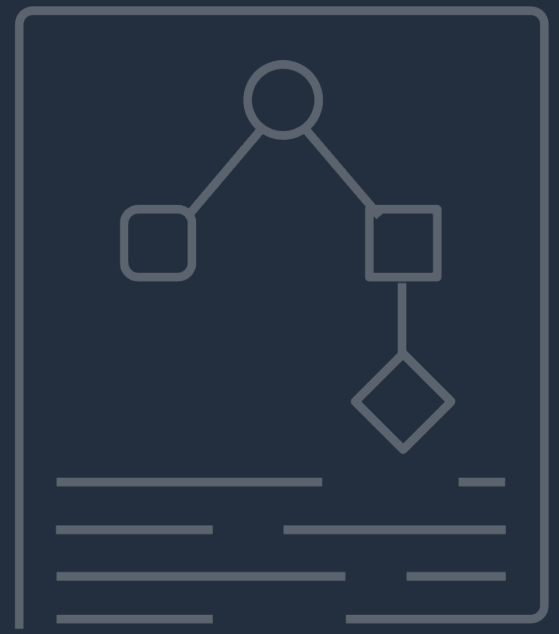
```
{
  "Comment": "An example of the Amazon States Language using a choice state.",
  "StartAt": "FirstState",
  "States": {
    "FirstState": {
      "Type": "Task",
      "Resource": "arn:aws:lambda:us-east-1:123456789012:function:FUNCTION_NAME",
      "Next": "ChoiceState"
    },
    "ChoiceState": {
      "Type" : "Choice",
      "Choices": [ {
        "Variable": "$.foo",
        "NumericEquals": 1,
        "Next": "FirstMatchState"
      },
      {
        "Variable": "$.foo",
        "NumericEquals": 2,
        "Next": "SecondMatchState"
      } ],
    ...
  }
}
```

https://states-language.net/spec.html/

States

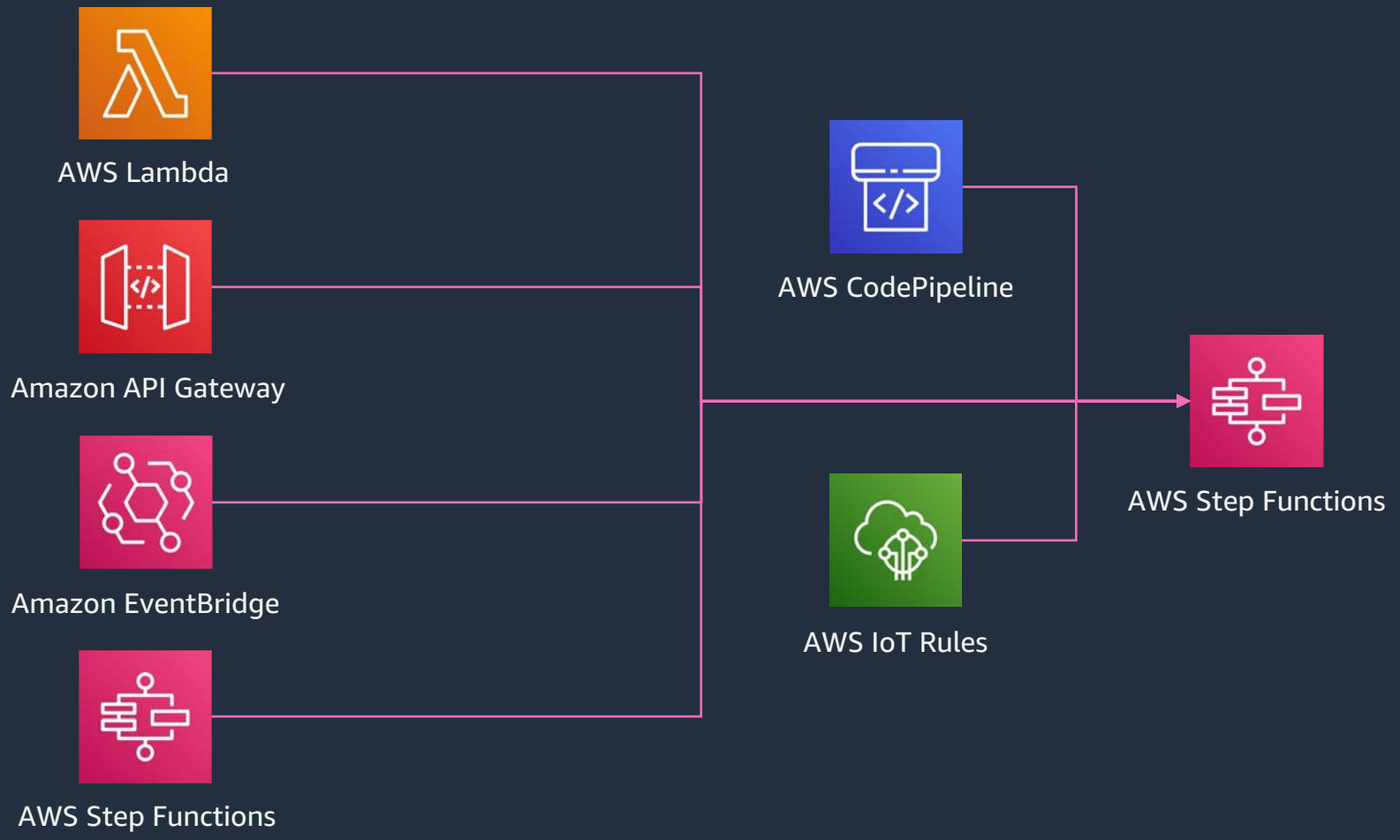
State types

Task	Execute work
Choice	Add branching logic
Wait	Add a timed delay
Parallel	Execute branches in parallel
Map	Process each of an input array's items with a state machine
Pass	Pass input to output
Succeed	Signal a successful execution and stop
Fail	Signal a failed execution and stop



Integrations

Triggers



Integration types

Optimized integrations

- Customized by Step Functions to provide additional functionality and UI elements in Workflow Studio.
- Support for 17 AWS services.
- No performance benefit over SDK integrations.

```
arn:aws:states:::serviceName:apiAction.[serviceIntegrationPattern]
```

SDK integrations

- Use standard AWS API calls directly in your workflows.
- Write less custom code: reduces need for Lambda functions.
- Support for over 200 AWS services and over 10,000 API actions.

```
arn:aws:states:::aws-sdk:serviceName:apiAction.[serviceIntegrationPattern]
```

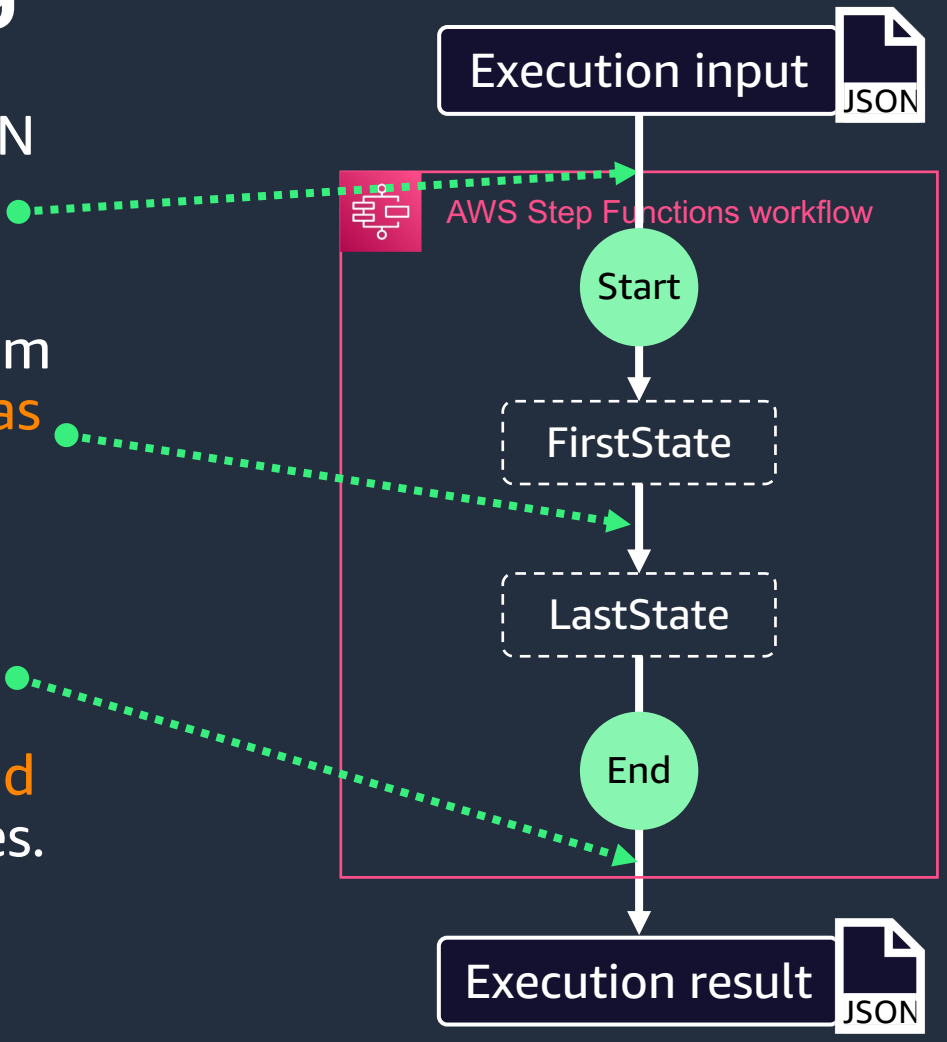
Service integration patterns

Request Response	Step Functions will wait for an HTTP response and then progress to the next state. Step Functions will not wait for a job to complete.
Run a Job (.sync)	Call a service and have Step Functions wait for a job to complete.
Wait for callback	Call a service with a task token and have Step Functions wait until that token is returned with a payload.

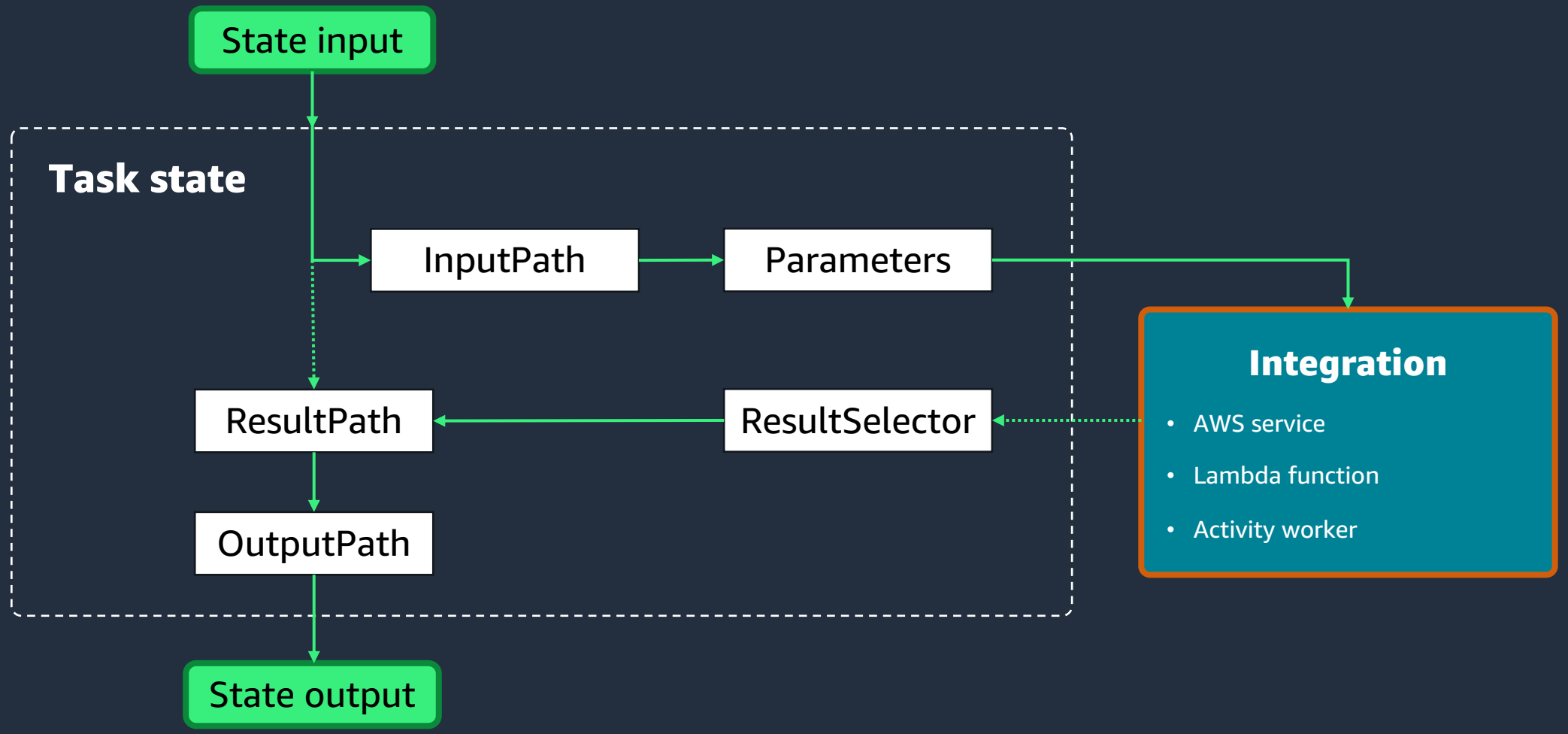
State machine data

Input and output processing

- A Step Functions execution receives a JSON text as input and passes that input to the first state in the workflow.
- Individual states receive JSON as input from the previous state and usually pass JSON as output to the next state.
- The output of the workflow's last state becomes the result of the Step Functions execution.
- ASL provides tools to filter, manipulate and transform input and output between states.



Anatomy of a state

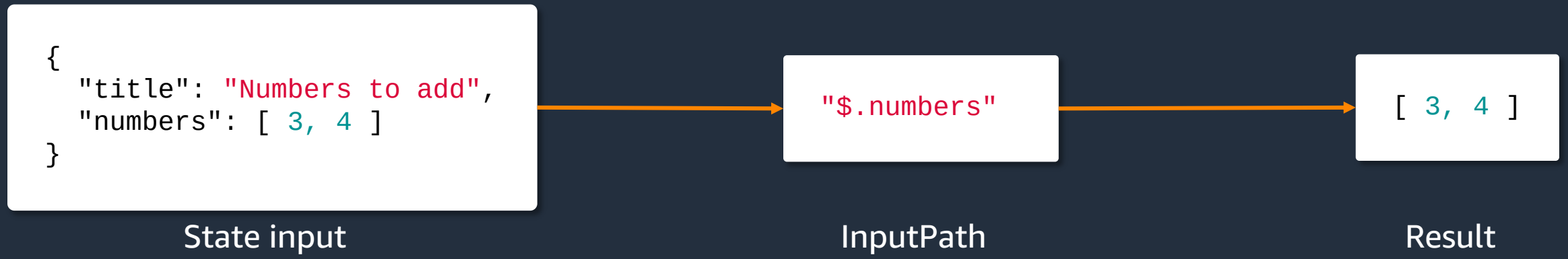


InputPath

Use the InputPath filter to select a portion of the JSON state input to use. Specify which part of the JSON to use with a JSONPath expression.

If not provided, state gets raw input, as-is.

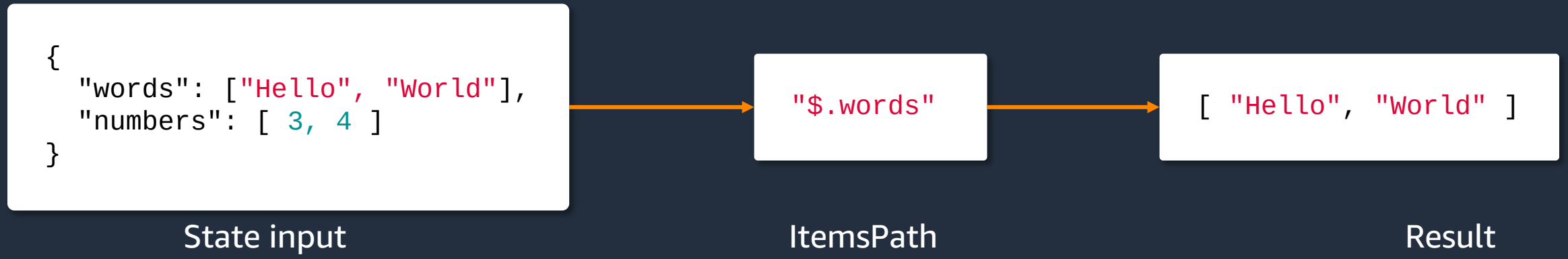
If null, state gets an empty JSON {}.



ItemsPath

Use ItemsPath field in a Map state to select an array in the input. Specify which part of the JSON to use with a JSONPath expression.

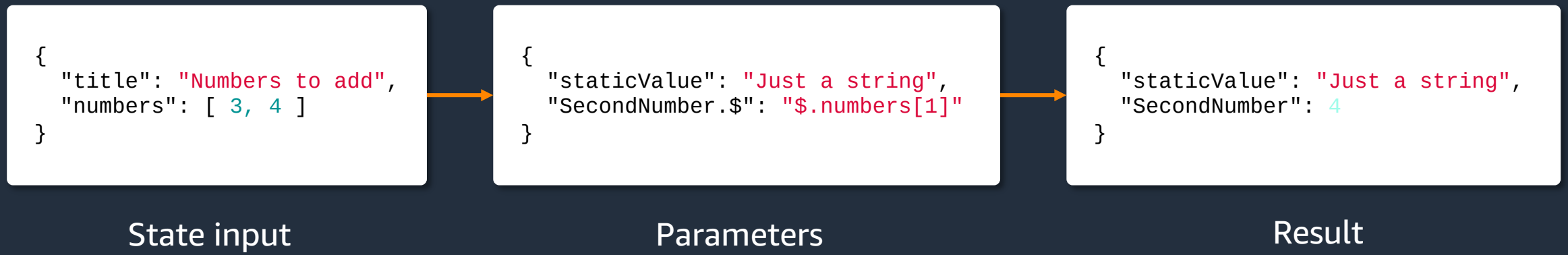
If not provided, state gets entire JSON.



Parameters

Use the Parameters fields to create a collection of key-value pairs that are passed as input to an AWS service integration.

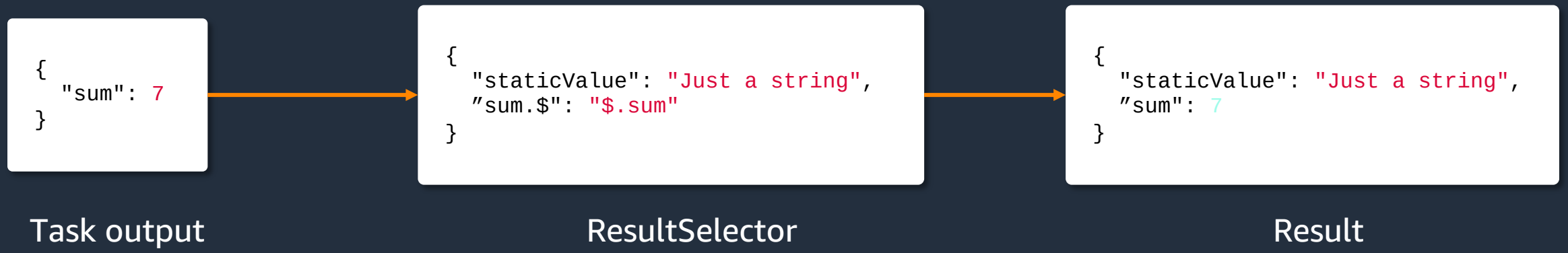
The values can be static, or they can be selected from the filtered input using a JSONPath expression. When the value is selected with a JSONPath expression, the key name must end in ".$".



ResultSelector

Use the ResultSelector filter to construct a new JSON object using parts of the task result.

The values can be static, or they can be selected from the task result using a JSONPath expression. When the value is selected with a JSONPath expression, the key name must end in ".$".



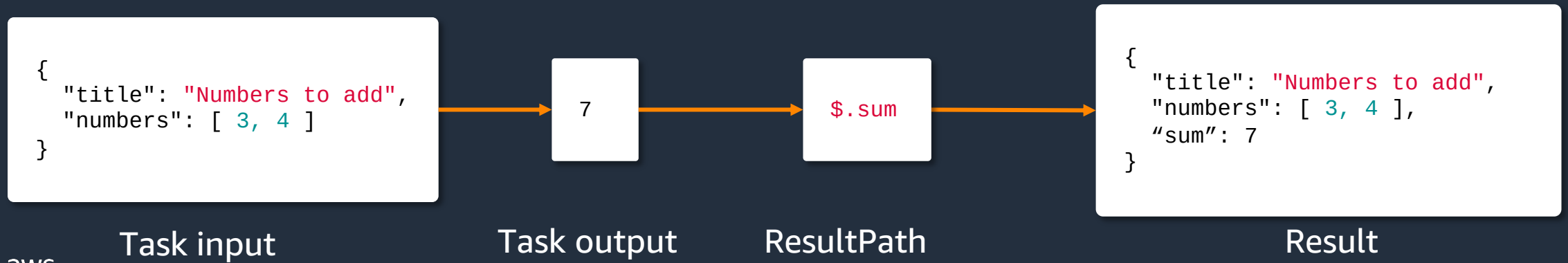
ResultPath

Use ResultPath to add the result into the original state input. The specified path indicates where to add the result.

If unspecified or $, the result becomes the output and the input is discarded.

If null, state's input becomes state's output and task's output is discarded.

If a JSONPath expression, the result will be inserted into the state input.



OutputPath

Use OutputPath to filter the final result before it becomes the state's output

Context object

```
{
  "Execution": {
    "Id": "arn:aws:states:us-east-1:123456789012:execution:stateMachineName:executionName",
    "Input": {
      "key": "value"
    },
    "Name": "executionName",
    "RoleArn": "arn:aws:iam::123456789012:role...",
    "StartTime": "2019-03-26T20:14:13.192Z"
  },
  "State": {
    "EnteredTime": "2019-03-26T20:14:13.192Z",
    "Name": "Test",
    "RetryCount": 3
  },
  "StateMachine": {
    "Id": "arn:aws:states:us-east-1:123456789012:stateMachine:stateMachineName",
    "Name": "name"
  },
  "Task": {
    "Token": "h7XRiCdLtd/83p1E0dMccoxlzFhglsdkzpK9mBVKZsp7d9yrT1W"
  }
}
```

```
"Map": {
  "Item": {
    "Index": "Number",
    "Value": "String"
  }
}
```

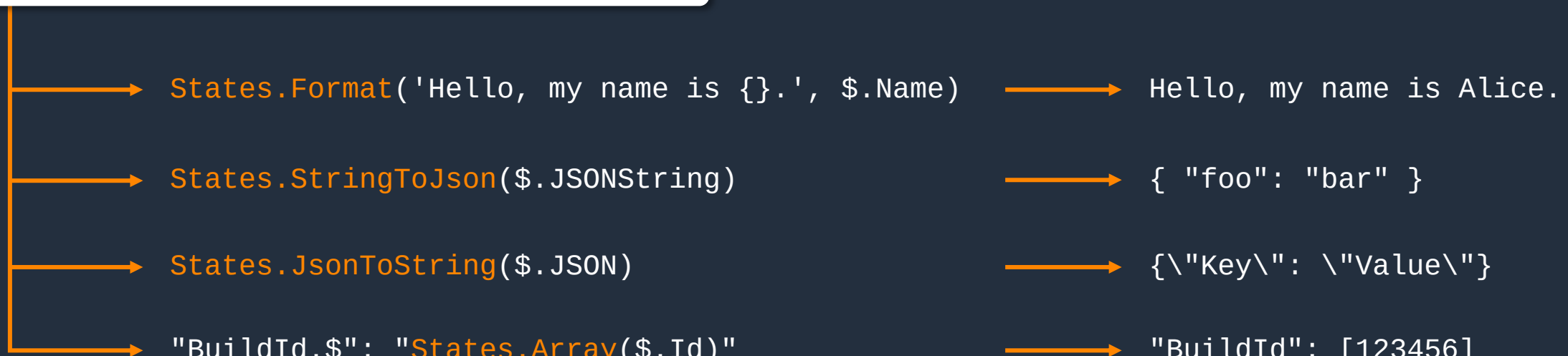
`$$.Execution.Id`

Accessible from anywhere in the state machine via context object:

- Execution metadata
- State machine input

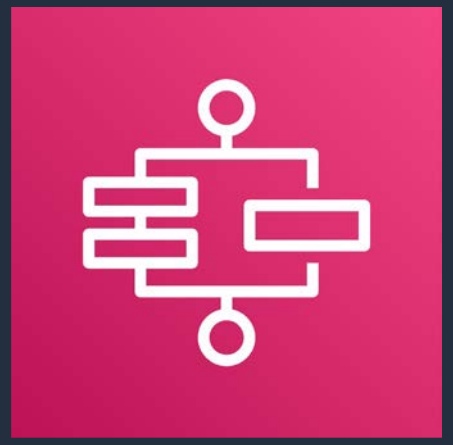
Intrinsic functions

```
{
    "Name": "Alice",
    "JSONString": "{\"foo\": \"bar\"}",
    "JSON": {"Key": "Value"},
    "Array": 12345
}
```

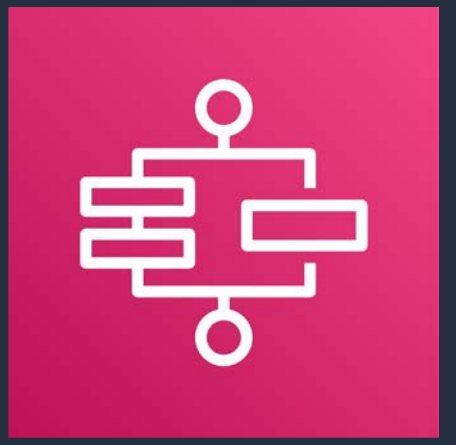


Workflow types

Workflow types



STANDARD



EXPRESS WORKFLOWS

Which one is right for my customer use case?

Standard workflows

- IT automation
- Report generation
- Order processing
- Payment and billing processing
- ML model training
- ETL and big data orchestration (AWS Glue, Amazon EMR)
- Media processing (video, image, audio)

Express workflows

- Event driven microservices orchestration
- High volume data processing
- IoT data ingestion
- Order / cart validation
- Payment reconciliation

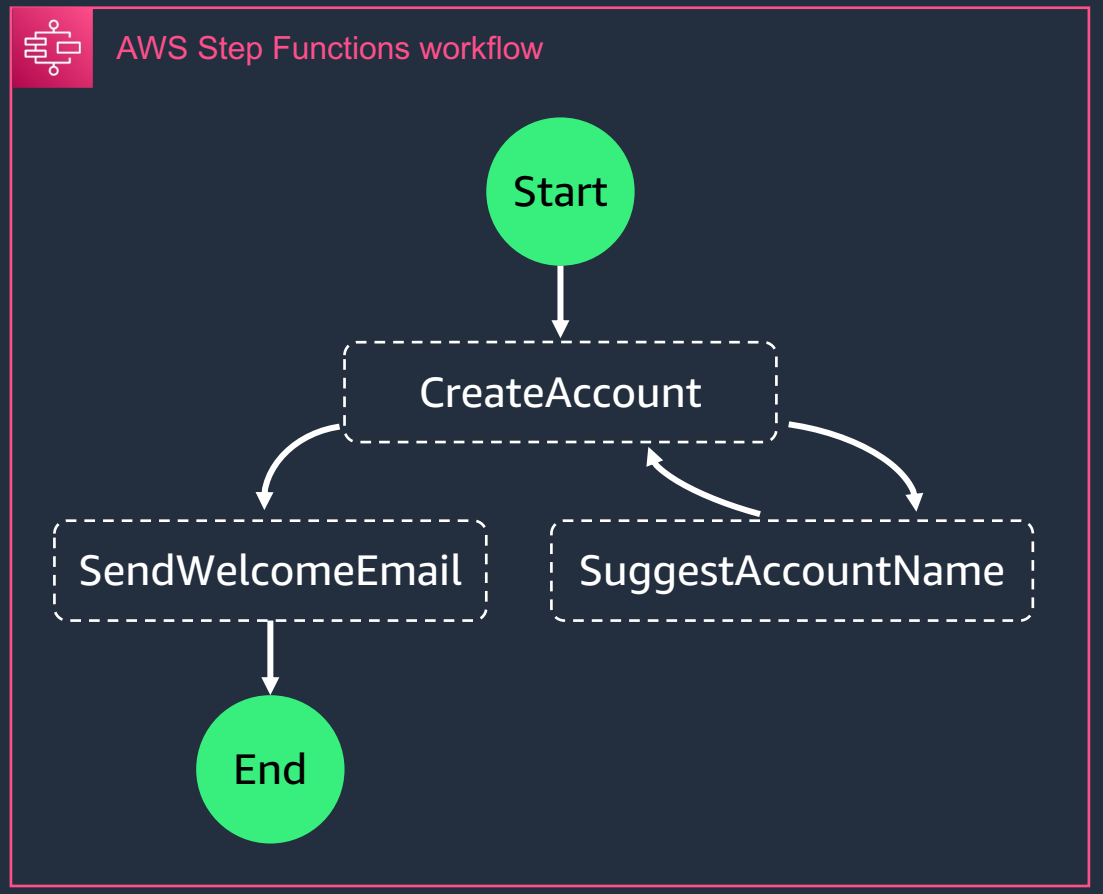
Standard vs. express workflows

	Standard	Express
Maximum duration	365 days	5 minutes
Execution start rate	Over 2,000 per second	Over 100,000 per second
State transition rate	Over 4,000 per second per account	Nearly unlimited
Executions	Executions persisted for 90 days in Step Functions, with tooling for visual debugging in the console, and have ARNs. Optionally sent to CloudWatch Logs.	Executions logs are only sent to CloudWatch Logs.

Workflow patterns

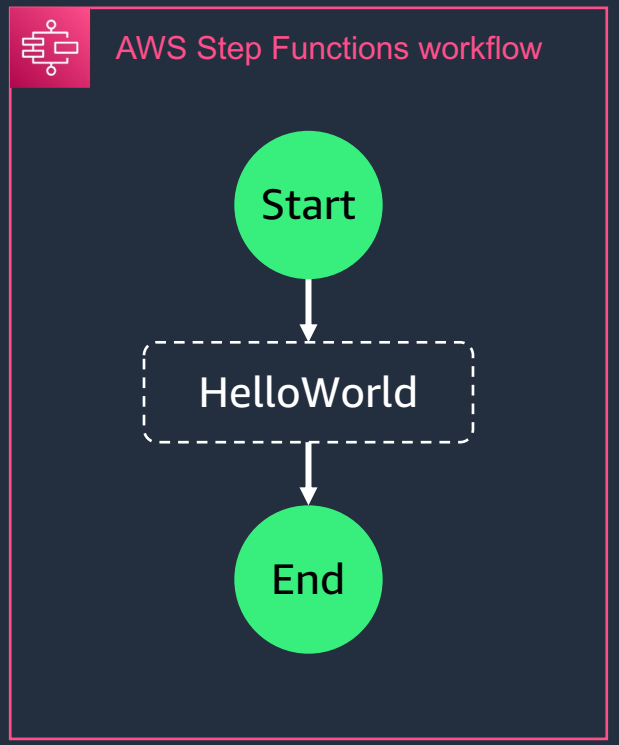
Error handling - Catch

```
"CreateAccount": {
  "Type": "Task",
  ...
  "Catch": [
    {
      "ErrorEquals": ["AccountAlreadyExistsError"],
      "Next": "SuggestAccountName"
    }
  ]
}
```

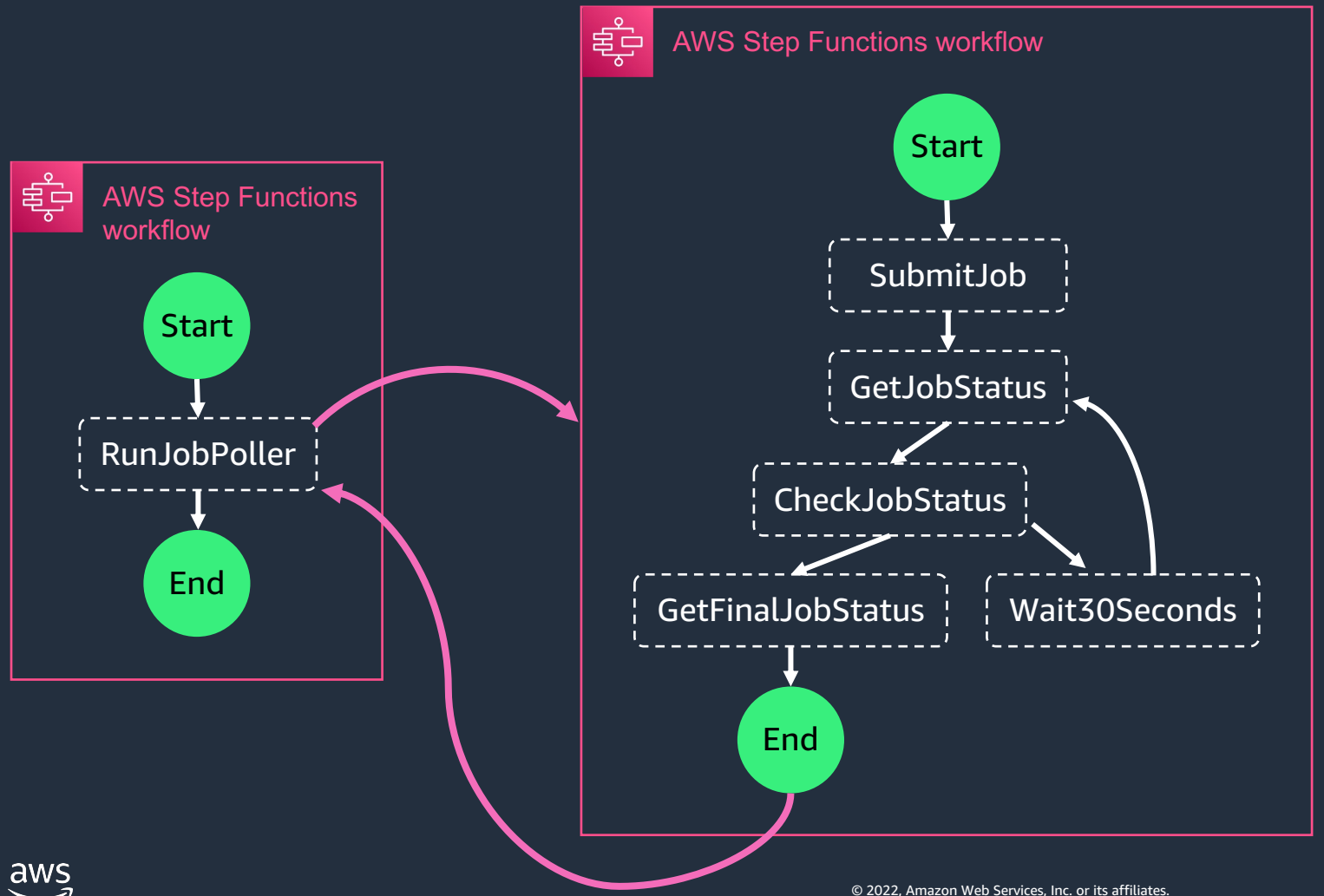


Error handling - Retry

```
"HelloWorld": {
  "Type": "Task",
  …
    "Retry": [
       {
        "ErrorEquals": ["States.TaskFailed"],
        "IntervalSeconds": 1,
        "MaxAttempts": 2,
        "BackoffRate": 2.0
        },
    …
}
```



Nested “child” workflows



- Easily build complex workflows with libraries of state machines.
- Swap and reorganize workflow modules without customizing code.
- Simplifies development and deployment.

Use cases

Use cases for AWS Step Functions

Data processing

IT and security automation

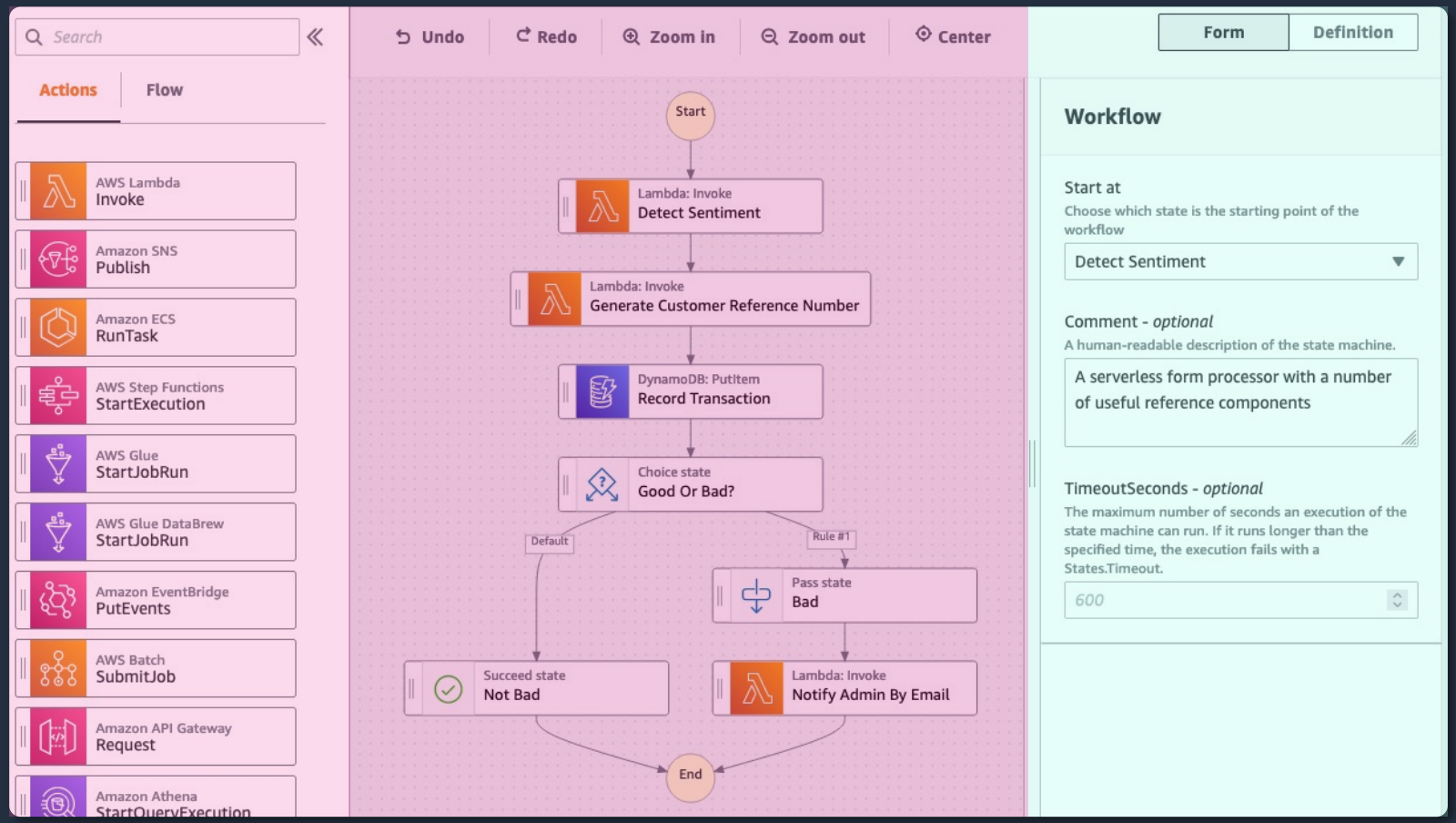
Machine learning

Microservice orchestration

Developer tooling

Workflow Studio

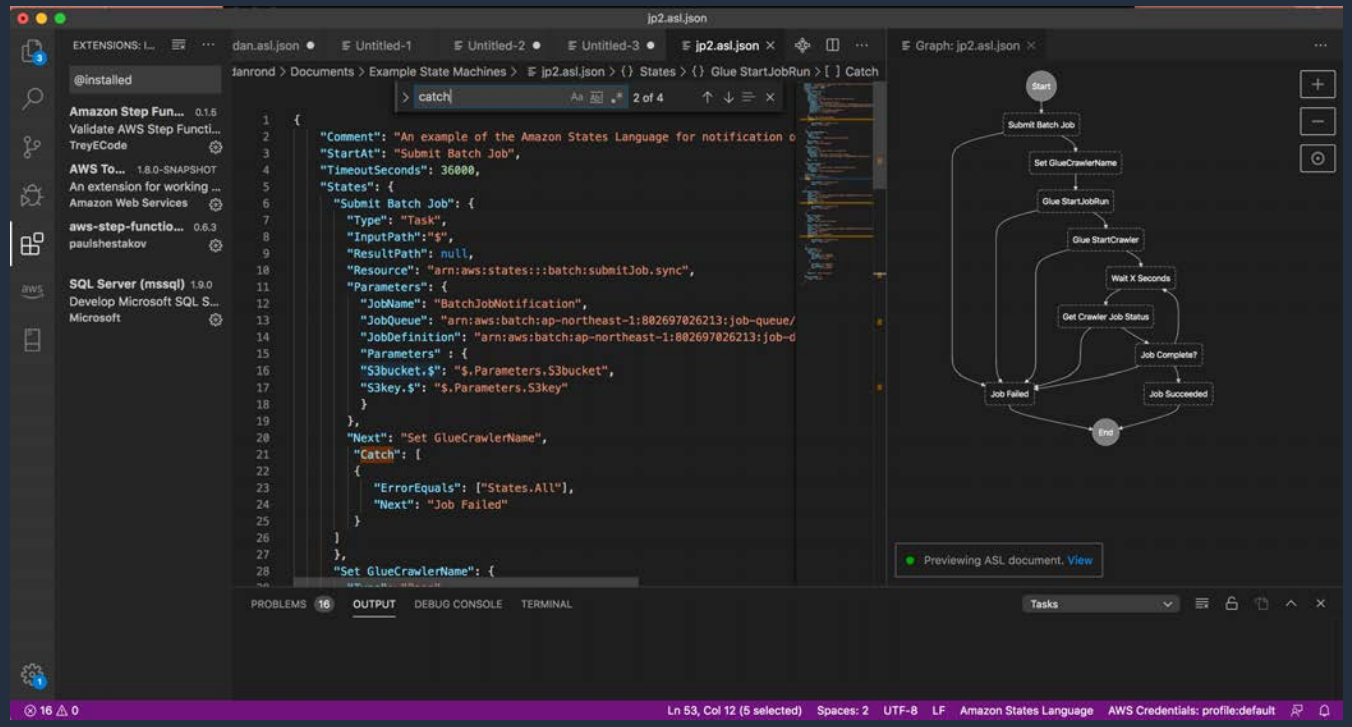
- Low-code visual workflow designer
- Rapid prototyping and experimentation
- Generates and validates ASL template
- Export ASL for local development and infrastructure as code integration



AWS Toolkit for Visual Studio Code

Local development platform

- Build state machines locally
- Workflow visualization
- State machine linting
- Code snippets and IntelliSense



Your Choice for Infrastructure as Code

AWS CloudFormation

DECLARATIVE

IMPERATIVE

AWS Serverless Application Model

- Declarative / template based
- JSON / YAML

AWS Serverless Application Model

AWS Cloud Development Kit

AWS Cloud Development Kit

- Imperative
- Author state machines in TypeScript, JavaScript, Python, Java, C#

Step Functions Local

- A downloadable version of Step Functions that lets you develop and test applications using a version of Step Functions running in your own development environment.
- Local mocking of all optimized and SDK service integrations.
- Available as a JAR package and as a Docker image.

```
java -jar StepFunctionsLocal.jar || docker run -p 8083:8083 amazon/aws-stepfunctions-local

aws stepfunctions --endpoint-url http://localhost:8083 command
```

Best practices

Best practices

- Choose the right workflow type.
- Use timeouts to avoid stuck executions.
- Use Amazon S3 to pass large payloads.
- Avoid reaching history quota.
- Handle Lambda service exceptions.

In closing

Useful resources

Serverless lens

https://docs.aws.amazon.com/wellarchitected/latest/serverless-applications-lens/welcome.html

Serverless Land

https://serverlessland.com/

Use cases

https://aws.amazon.com/step-functions/use-cases/

Customer testimonials

https://aws.amazon.com/step-functions/customer-testimonials/

re:Invent sessions

https://www.youtube.com/watch?v=2zCvMcZTr1E

https://www.youtube.com/watch?v=z1rIfyP1LGg

Thank you!

Oskar Neumann
Solutions Architect