Amazon Simple Workflow Service

Developer Guide

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Amazon Simple Workflow Service: Developer Guide

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What is Amazon Simple Workflow Service?

The Amazon Simple Workflow Service (Amazon SWF) makes it easy to build applications that coordinate work across distributed components. In Amazon SWF, a task represents a logical unit of work that is performed by a component of your application. Coordinating tasks across the application involves managing intertask dependencies, scheduling, and concurrency in accordance with the logical flow of the application. Amazon SWF gives you full control over implementing tasks and coordinating them without worrying about underlying complexities such as tracking their progress and maintaining their state.

When using Amazon SWF, you implement workers to perform tasks. These workers can run either on cloud infrastructure, such as Amazon Elastic Compute Cloud (Amazon EC2), or on your own premises. You can create tasks that are long-running, or that may fail, time out, or require restarts—or that may complete with varying throughput and latency. Amazon SWF stores tasks and assigns them to workers when they are ready, tracks their progress, and maintains their state, including details on their completion. To coordinate tasks, you write a program that gets the latest state of each task from Amazon SWF and uses it to initiate subsequent tasks. Amazon SWF maintains an application's execution state durably so that the application is resilient to failures in individual components. With Amazon SWF, you can implement, deploy, scale, and modify these application components independently.

Amazon SWF offers capabilities to support a variety of application requirements. It is suitable for a range of use cases that require coordination of tasks, including media processing, web application back-ends, business process workflows, and analytics pipelines.

Development Options

You have a number of options for implementing your workflow solutions with the Amazon Simple Workflow Service.

Topics

AWS SDKs

Amazon SWF is supported by the AWS SDKs for Java, .NET, Node.js, PHP, PHP version 2, Python and Ruby, providing a convenient way to use the Amazon SWF HTTP API in the programming language of your choice.

You can develop deciders, activities, or workflow starters using the API exposed by these libraries. Additionally, you can access visibility operations through these libraries so you can develop your own Amazon SWF monitoring and reporting tools.

To download any of the AWS SDKs, go to https://aws.amazon.com/code.

For detailed information about the Amazon SWF methods in each SDK, refer to the language-specific reference documentation for the SDK you are using.

Here is a list of the available AWS SDK documentation.

- AWS Java Developer Guide | Amazon SWF
- AWS SDK for Java API Reference
- AWS SDK for .NET API Reference
- AWS SDK for JavaScript in Node.js API Reference
- AWS SDK for PHP API Reference
- AWS SDK for Python (Boto) API Reference
- AWS SDK for Ruby API Reference

AWS Flow Framework

The AWS Flow Framework is an enhanced SDK for writing distributed, asynchronous programs that can run as workflows on Amazon SWF. It is available for the Java and Ruby programming languages, and it provides classes that simplify writing complex distributed programs.

With the AWS Flow Framework, you use preconfigured types to map the definition of your workflow directly to methods in your program.

The AWS Flow Framework supports standard object-oriented concepts, such as exception-based error handling, which makes it easier to implement complex workflows. Programs written with the AWS Flow Framework can be created, executed, and debugged entirely within your preferred editor or IDE. For more information, see the AWS Flow Framework website.

Here are links to the AWS Flow Framework documentation:

- AWS Flow Framework for Java Developer Guide
- AWS Flow Framework for Java Reference
- AWS Flow Framework for Ruby Developer Guide
- AWS Flow Framework for Ruby API Reference

AWS Flow Framework Sample Code

In addition to the code snippets that appear in the AWS Flow Framework documentation, you can obtain full, downloadable code samples at the following locations:

- AWS Flow Framework Recipes
- AWS Flow Framework Samples for Amazon SWF

HTTP Service API

Amazon SWF provides service operations that are accessible through HTTP requests. You can use these operations to communicate directly with Amazon SWF, and you can use them to develop your own libraries in any language that can communicate with Amazon SWF through HTTP.

You can develop deciders, activity workers, or workflow starters by using the service API. You can also access visibility operations through the API to develop your own monitoring and reporting tools.

For information about how to use the API, see Making HTTP Requests to Amazon SWF (p. 81). For detailed information about API operations, go to the *Amazon Simple Workflow Service API Reference*.

Development Environments

You will need to set up a development environment appropriate to the programming language that you will use. For example, if you intend to develop for Amazon SWF with Java, you will need to install a Java development environment, such as the AWS SDK for Java, on each of your development workstations. If you use the Eclipse IDE for Java development, you might consider also installing the AWS Toolkit for Eclipse. The Toolkit is an Eclipse plug-in that adds features that are helpful for AWS development.

If your programming language requires a run-time environment, you need to set up that environment on each computer on which these processes run.

Introduction to Amazon SWF

A growing number of applications are relying on asynchronous and distributed processing. The scalability of such applications is the primary motivation for using this approach. By designing autonomous distributed components, developers have the flexibility to deploy and scale out parts of the application independently if the load on the application increases. Another motivation is the availability of cloud services. As application developers start taking advantage of cloud computing, they have a need to combine their existing on-premises assets with additional cloud-based assets. Yet another motivation for the asynchronous and distributed approach is the inherent distributed nature of the process being modeled by the application; for example, the automation of an order fulfillment business process may span several systems and human tasks.

Developing such applications can be complicated. It requires that you coordinate the execution of multiple distributed components and deal with the increased latencies and unreliability inherent in remote communication. To accomplish this, you would typically need to write complicated infrastructure involving message queues and databases, along with the complex logic to synchronize them.

The Amazon Simple Workflow Service (Amazon SWF) makes it easier to develop asynchronous and distributed applications by providing a programming model and infrastructure for coordinating distributed components and maintaining their execution state in a reliable way. By relying on Amazon SWF, you are freed to focus on building the aspects of your application that differentiate it.

Simple Workflow Concepts

The basic concepts necessary for understanding Amazon SWF workflows are introduced below and are explained further in the subsequent sections of this guide. The following discussion is a high-level overview of the structure and components of a workflow.

The fundamental concept in Amazon SWF is the *workflow*. A workflow is a set of *activities* that carry out some objective, together with logic that coordinates the activities. For example, a workflow could receive a customer order and take whatever actions are necessary to fulfill it. Each workflow runs in an AWS resource called a *domain*, which controls the workflow's scope. An AWS account can have multiple domains, each of which can contain multiple workflows, but workflows in different domains cannot interact.

When designing an Amazon SWF workflow, you precisely define each of the required activities. You then register each activity with Amazon SWF as an activity type. When you register the activity, you provide information such as a name and version, and some timeout values based on how long you expect the activity to take. For example, a customer may have an expectation that an order will ship within 24 hours. Such expectations would inform the timeout values that you specify when registering your activities.

In the process of carrying out the workflow, some activities may need to be performed more than once, perhaps with varying inputs. For example, in a customer-order workflow, you might have an activity that handles purchased items. If the customer purchases multiple items, then this activity would have to run multiple times. Amazon SWF has the concept of an *activity task* that represents one invocation of an activity. In our example, the processing of each item would be represented by a single activity task.

An *activity worker* is a program that receives activity tasks, performs them, and provides results back. Note that the task itself might actually be performed by a person, in which case the person would use the activity worker software for the receipt and disposition of the task. An example might be a statistical analyst, who receives sets of data, analyzes them, and then sends back the analysis.

Activity tasks—and the activity workers that perform them—can run synchronously or asynchronously. They can be distributed across multiple computers, potentially in different geographic regions, or they can all run on the same computer. Different activity workers can be written in different programming languages and run on different operating systems. For example, one activity worker might be running on a desktop computer in Asia, whereas a different activity worker might be running on a hand-held computer device in North America.

The coordination logic in a workflow is contained in a software program called a *decider*. The decider schedules activity tasks, provides input data to the activity workers, processes events that arrive while the workflow is in progress, and ultimately ends (or closes) the workflow when the objective has been completed.

The role of the Amazon SWF service is to function as a reliable central hub through which data is exchanged between the decider, the activity workers, and other relevant entities such as the person administering the workflow. Amazon SWF also maintains the state of each workflow execution, which saves your application from having to store the state in a durable way.

The decider directs the workflow by receiving decision tasks from Amazon SWF and responding back to Amazon SWF with decisions. A decision represents an action or set of actions which are the next steps in the workflow. A typical decision would be to schedule an activity task. Decisions can also be used to set timers to delay the execution of an activity task, to request cancellation of activity tasks already in progress, and to complete or close the workflow.

The mechanism by which both the activity workers and the decider receive their tasks (activity tasks and decision tasks respectively) is by polling the Amazon SWF service.

Amazon SWF informs the decider of the state of the workflow by including with each decision task, a copy of the current workflow execution history. The workflow execution history is composed of events, where an event represents a significant change in the state of the workflow execution. Examples of events would be the completion of a task, notification that a task has timed out, or the expiration of a timer that was set earlier in the workflow execution. The history is a complete, consistent, and authoritative record of the workflow's progress.

A user must have authorized AWS access keys to run workflows in your account. However, access keys provide full access to all of the resources in your account and are difficult to revoke, so they are not appropriate for all applications. Amazon SWF access control uses AWS Identity and Access Management (IAM), which allows you to provide access to AWS resources in a controlled and limited way that does not expose your access keys. For example, you can allow a user to access your account, but only to run certain workflows in a particular domain.

Workflow Execution

Bringing together the ideas discussed in the preceding sections, here is an overview of the steps to develop and run a workflow in Amazon SWF:

1. Write activity workers that implement the processing steps in your workflow.

2. Write a decider to implement the coordination logic of your workflow.
3. Register your activities and workflow with Amazon SWF.

   You can do this step programmatically or by using the AWS Management Console.
4. Start your activity workers and decider.

   These actors can run on any computing device that can access an Amazon SWF endpoint. For example, you could use compute instances in the cloud, such as Amazon Elastic Compute Cloud (Amazon EC2); servers in your data center; or even a mobile device, to host a decider or activity worker. Once started, the decider and activity workers should start polling Amazon SWF for tasks.
5. Start one or more executions of your workflow.

   Executions can be initiated either programmatically or via the AWS Management Console.

   Each execution runs independently and you can provide each with its own set of input data. When an execution is started, Amazon SWF schedules the initial decision task. In response, your decider begins generating decisions which initiate activity tasks. Execution continues until your decider makes a decision to close the execution.
6. View workflow executions using the AWS Management Console.

   You can filter and view complete details of running as well as completed executions. For example, you can select an open execution to see which tasks have completed and what their results were.

Getting Set Up with Amazon SWF

Topics

This section discusses the prerequisites for developing with the Amazon Simple Workflow Service (Amazon SWF) and the development options that are available. The first step in using any AWS service is to sign up for an AWS account, discussed in detail in the following section. Once your account is set up, you have the option of developing for Amazon SWF in any of the programming languages supported by AWS. For Java and Ruby developers, the AWS Flow Framework is also available. AWS Identity and Access Management enables you to grant individuals other than the AWS account owner access to Amazon SWF resources.

AWS Account and Access Keys

To access Amazon SWF, you will need to sign up for an AWS account.

To sign up for an AWS account

1. Open https://aws.amazon.com/, and then choose **Create an AWS Account**.
2. Follow the online instructions.

   Part of the sign-up procedure involves receiving a phone call and entering a PIN using the phone keypad.

To get your access key ID and secret access key

Access keys consist of an access key ID and secret access key, which are used to sign programmatic requests that you make to AWS. If you don't have access keys, you can create them by using the AWS Management Console. We recommend that you use IAM access keys instead of AWS root account access keys. IAM lets you securely control access to AWS services and resources in your AWS account.

> **Note**
> To create access keys, you must have permissions to perform the required IAM actions. For more information, see Granting IAM User Permission to Manage Password Policy and Credentials in the *IAM User Guide*.

1. Open the IAM console.
2. In the navigation pane, choose **Users**.
3. Choose your IAM user name (not the check box).
4. Choose the **Security Credentials** tab and then choose **Create Access Key**.
5. To see your access key, choose **Show User Security Credentials**. Your credentials will look something like this:
   - Access Key ID: AKIAIOSFODNN7EXAMPLE
   - Secret Access Key: wJalrXUtnFEMI/K7MDENG/bPxRfiCYEXAMPLEKEY
6. Choose **Download Credentials**, and store the keys in a secure location.

   Your secret key will no longer be available through the AWS Management Console; you will have the only copy. Keep it confidential in order to protect your account, and never email it. Do not share it outside your organization, even if an inquiry appears to come from AWS or Amazon.com. No one who legitimately represents Amazon will ever ask you for your secret key.

Related topics

- What Is IAM? in the *IAM User Guide*
- AWS Security Credentials in *AWS General Reference*

Endpoints

To reduce latency and to store data in a location that meets your requirements, Amazon SWF provides endpoints in different regions.

Each endpoint in Amazon SWF is completely independent; any domains, workflows and activities you have registered in one region do not share any data or attributes with those in another. In other words, when you register an Amazon SWF domain, workflow or activity, it exists *only within the region you registered it in*. For example, you could register a domain named `SWF-Flows-1` in two different regions, but they will share no data or attributes with each other—each acts as a completely independent domain.

For a list of Amazon SWF endpoints, see Regions and Endpoints.

Tutorial: A Subscription Workflow with Amazon SWF and Amazon SNS

This section provides a tutorial that describes how to create an Amazon SWF workflow application that consists of a set of four activities that operate sequentially. It also covers:

- Setting *default* and *execution-time* workflow and activity options.
- Polling Amazon SWF for decision and activity tasks.
- Passing data between the activities and the workflow with Amazon SWF.
- Waiting for *human tasks* and reporting heartbeats to Amazon SWF from an activity task.
- Using Amazon SNS to create a topic, subscribe a user to it, and publish messages to subscribed endpoints.

You can use Amazon Simple Workflow Service (Amazon SWF) and Amazon Simple Notification Service (Amazon SNS) together to emulate a "human task" workflow—one in which a human worker is required to perform some action and then communicate with Amazon SWF to launch the next activity in the workflow.

Because Amazon SWF is a cloud-based web service, communication with Amazon SWF can originate from anywhere a connection to the Internet is available. In this case, we will use Amazon SNS to communicate with the user by either email, an SMS text message, or both.

This tutorial uses the AWS SDK for Ruby to access Amazon SWF and Amazon SNS, but there are many development options available, including the AWS Flow Framework for Ruby, which provides easier coordination and communication with Amazon SWF.

Note
This tutorial uses version 1 of the AWS SDK for Ruby. The SDK for Ruby continues to work, but we recommend that you use the AWS Flow Framework for Java as an alternative.

For a complete list of Amazon SWF development options, see Development Options (p. 1).

In this section:

- About the Workflow (p. 10)
- Prerequisites (p. 10)
- Download the Source Code (p. 10)
- Tutorial Steps (p. 10)

About the Workflow

The workflow that we will be developing consists of four major steps:

1. Get a subscription address (email or SMS) from the user.
2. Create an SNS topic and subscribe the provided endpoints to the topic.
3. Wait for the user to confirm the subscription.
4. If the user confirms, publish a congratulatory message to the topic.

These steps include activities that are completely automated (steps 2 and 4), and others that require the workflow to wait for a human to provide some data to the activity before the workflow can progress (steps 1 and 3).

Because each step relies on data that is generated by the previous step (you must have an endpoint before subscribing it to a topic, and you must have a topic subscription before you can wait for confirmation, etc.) This tutorial will also cover how to provide activity results upon completion, and how to pass input to a task that is being scheduled. Amazon SWF handles coordination and delivery of information between the activities and the workflow, and vice-versa.

We're also using both keyboard input and Amazon SNS to handle communication between Amazon SWF and the human who is providing data to the workflow. In practice, you can use many different techniques to communicate with human users, but Amazon SNS provides a very easy way to use email or text messages to notify the user about events in the workflow.

Prerequisites

To follow along with this tutorial, you will need the following:

- Amazon Web Services (AWS) account
- Ruby interpreter
- AWS SDK for Ruby

If you already have these set up, you're ready to continue. If you don't want to run the example, you can still follow the tutorial—much of the content in this tutorial applies to using Amazon SWF and Amazon SNS regardless of what development options (p. 1) you are using.

Download the Source Code

You can download the complete source code for this tutorial from: https://s3.amazonaws.com/codesamples/ruby/swf_sns_sample.zip

Note
Even if you intend to type in (or cut and paste) the code from this tutorial directly into your own source files, having the downloaded source code available to compare your own code with can help identify and solve issues if you run into any along the way.

Tutorial Steps

This tutorial is divided into the following steps:

Subscription Workflow Tutorial Part 1: Using Amazon SWF with the AWS SDK for Ruby

Topics

Include the AWS SDK for Ruby

Begin by creating a file called `utils.rb`. The code in this file will obtain, or create if necessary, the Amazon SWF domain used by both the workflow and activities code and will provide a place to put code that is common to all of our classes.

First, we need to include the `aws-sdk-v1` library in our code, so that we can use the features provided by the SDK for Ruby.

```
require 'aws-sdk-v1'
```

This gives us access to the AWS namespace, which provides the ability to set global session-related values, such as your AWS credentials and region, and also provides access to the AWS service APIs.

Configuring the AWS Session

We'll configure the AWS Session by setting our AWS credentials (which are needed for accessing AWS services) and the AWS region to use.

There are a number of ways to set AWS credentials in the AWS SDK for Ruby: by setting them in environment variables (AWS_ACCESS_KEY_ID and AWS_SECRET_ACCESS_KEY) or by setting them with AWS.config. We'll use the latter method, loading them from a YAML configuration file, called `aws-config.txt`, that looks like this.

```
---
:access_key_id: REPLACE_WITH_ACCESS_KEY_ID
:secret_access_key: REPLACE_WITH_SECRET_ACCESS_KEY
```

Create this file now, replacing the strings beginning with *REPLACE_WITH_* with your AWS access key ID and secret access key. For information about your AWS access keys, see How Do I Get Security Credentials? in the *Amazon Web Services General Reference*.

We also need to set the AWS region to use. Because we'll be using the Short Message Service (SMS) to send text messages to the user's phone with Amazon SNS, we need to make sure that we're using region **us-east-1**. *It is currently the only region that supports SMS*.

Note
If you don't have access to **us-east-1**, or don't care about running the demo with SMS messaging enabled, feel free to use any region you wish to. You can remove the SMS functionality from the sample and use email as the sole endpoint to subscribe to the Amazon SNS topic.
For more information about sending SMS messages, see Sending and Receiving SMS Notifications Using Amazon SNS in the *Amazon Simple Notification Service Developer Guide*.

We'll now add some code to `utils.rb` to load the config file, get the user's credentials, then provide both the credentials and region to AWS.config.

```
require 'yaml'

# Load the user's credentials from a file, if it exists.
begin
  config_file = File.open('aws-config.txt') { |f| f.read }
rescue
  puts "No config file! Hope you set your AWS credentials in the environment..."
end

if config_file.nil?
  options = { }
else
  options = YAML.load(config_file)
end

# SMS Messaging (which can be used by Amazon SNS) is available only in the
# `us-east-1` region.
$SMS_REGION = 'us-east-1'
options[:region] = $SMS_REGION

# Now, set the options
AWS.config = options
```

Registering an Amazon SWF Domain

To use Amazon SWF, you need to set up a *domain*: a named entity that will hold your workflows and activities. You can have many Amazon SWF domains registered, but they must all have unique names within your AWS account, and workflows cannot interact across domains: All of the workflows and activities for your application must be in the same domain to interact with one another.

Because we'll be using the same domain throughout our application, we'll create a function in `utils.rb` called `init_domain`, that will retrieve the Amazon SWF domain named *SWFSampleDomain*.

Once you have registered a domain, you can reuse it for many workflow executions. However, *it is an error to try to register a domain that already exists*, so our code will first check to see if the domain exists, and will use the existing domain if it can be found. If the domain can't be found, we'll create it.

To work with Amazon SWF domains in the SDK for Ruby, use AWS::SimpleWorkflow.domains, which returns a DomainCollection that can be used to both enumerate and register domains:

- To check to see if a domain is already registered, you can look at the list provided by AWS::Simpleworkflow.domains.registered.
- To register a new domain, use AWS::Simpleworkflow.domains.register.

Here is the code for `init_domain` in `utils.rb`.

```
# Registers the domain that the workflow will run in.
def init_domain
  domain_name = 'SWFSampleDomain'
  domain = nil
  swf = AWS::SimpleWorkflow.new

  # First, check to see if the domain already exists and is registered.
  swf.domains.registered.each do | d |
    if(d.name == domain_name)
      domain = d
      break
    end
  end

  if domain.nil?
    # Register the domain for one day.
    domain = swf.domains.create(
      domain_name, 1, { :description => "#{domain_name} domain" })
  end

  return domain
end
```

Next Steps

That's it for `utils.rb`. Next, we'll create the workflow and starter code in Subscription Workflow Tutorial Part 2: Implementing the Workflow (p. 13).

Subscription Workflow Tutorial Part 2: Implementing the Workflow

Up until now, our code has been pretty generic. This is the part where we begin to really define what our workflow does, and what activities we'll need to implement it.

Topics

Designing the Workflow

If you recall, the initial idea for this workflow consisted of the following steps:

1. Get a subscription address (email or SMS) from the user.
2. Create an SNS topic and subscribe the provided endpoints to the topic.
3. Wait for the user to confirm the subscription.
4. If the user confirms, publish a congratulatory message to the topic.

We can think of each step in our workflow as an *activity* that it must perform. Our *workflow* is responsible for scheduling each activity at the appropriate time, and coordinating data transfer between activities.

For this workflow, we'll create a separate activity for each of these steps, naming them descriptively:

1. get_contact_activity
2. subscribe_topic_activity
3. wait_for_confirmation_activity
4. send_result_activity

These activities will be executed in order, and data from each step will be used in the subsequent step.

We could design our application so that all of the code exists in one source file, but this runs contrary to the way that Amazon SWF was designed. It is designed for workflows that can span the entire Internet in scope, so let's at least break the application up into two separate executables:

- `swf_sns_workflow.rb` - Contains the workflow and workflow starter.
- `swf_sns_activities.rb` - Contains the activities and activities starter.

The workflow and activity implementations can be run in separate windows, separate computers, or even different parts of the world. Because Amazon SWF is keeping track of the details of your workflows and activities, your workflow can coordinate scheduling and data transfer of your activities no matter where they are running.

Setting up our Workflow Code

We'll begin by creating a file called `swf_sns_workflow.rb`. In this file, declare a class called **SampleWorkflow**. Here is the class declaration and its constructor, the `initialize` method.

```
require_relative 'utils.rb'

# SampleWorkflow - the main workflow for the SWF/SNS Sample
#
# See the file called `README.md` for a description of what this file does.
class SampleWorkflow

  attr_accessor :name

  def initialize(task_list)

    # the domain to look for decision tasks in.
    @domain = init_domain

    # the task list is used to poll for decision tasks.
    @task_list = task_list

    # The list of activities to run, in order. These name/version hashes can be
    # passed directly to AWS::SimpleWorkflow::DecisionTask#schedule_activity_task.
    @activity_list = [
      { :name => 'get_contact_activity', :version => 'v1' },
      { :name => 'subscribe_topic_activity', :version => 'v1' },
      { :name => 'wait_for_confirmation_activity', :version => 'v1' },
      { :name => 'send_result_activity', :version => 'v1' },
    ].reverse! # reverse the order... we're treating this like a stack.

    register_workflow
  end
```

As you can see, we are keeping the following class instance data:

- `domain` - The domain name retrieved from `init_domain` in `utils.rb`.

- `task_list` - The task list passed in to `initialize`.
- `activity_list` - The activity list, which has the names and versions of the activities we'll run.

The domain name, activity name, and activity version are enough for Amazon SWF to positively identify an activity type, so that is all of the data we need to keep about our activities in order to schedule them.

The task list will be used by the workflow's *decider* code to poll for decision tasks and schedule activities.

At the end of this function, we call a method we haven't yet defined: `register_workflow`. We'll define this method next.

Registering the Workflow

To use a workflow type, we must first register it. Like an activity type, a workflow type is identified by its domain, name, and version. Also, like both domains and activity types, you cannot re-register an existing workflow type. If you need to change anything about a workflow type, you must provide it with a new version, which essentially creates a new type.

Here is the code for `register_workflow`, which is used to either retrieve the existing workflow type we registered on a previous run or to register the workflow if it has not yet been registered.

```
 # Registers the workflow
 def register_workflow
   workflow_name = 'swf-sns-workflow'
   @workflow_type = nil

   # a default value...
   workflow_version = '1'

   # Check to see if this workflow type already exists. If so, use it.
   @domain.workflow_types.each do | a |
     if (a.name == workflow_name) && (a.version == workflow_version)
       @workflow_type = a
     end
   end

   if @workflow_type.nil?
     options =  {
       :default_child_policy => :terminate,
       :default_task_start_to_close_timeout => 3600,
       :default_execution_start_to_close_timeout => 24 * 3600 }

     puts "registering workflow: #{workflow_name}, #{workflow_version},
#{options.inspect}"
     @workflow_type = @domain.workflow_types.register(workflow_name, workflow_version,
options)
   end

   puts "** registered workflow: #{workflow_name}"
 end
```

First, we check to see if the workflow name and version is already registered by iterating through the domain's workflow_types collection. If we find a match, we'll use the workflow type that was already registered.

If we don't find a match, then a new workflow type is registered (by calling register on the same `workflow_types` collection that we were searching for the workflow in) with the name 'swf-sns-workflow', version '1', and the following options.

```
     options =  {
        :default_child_policy => :terminate,
        :default_task_start_to_close_timeout => 3600,
        :default_execution_start_to_close_timeout => 24 * 3600 }
```

Options passed in during registration are used to set *default behavior* for our workflow type, so we don't need to set these values every time we start a new workflow execution.

Here, we just set some timeout values: the maximum time it can take from the time a task starts to when it closes (one hour), and the maximum time it can take for the workflow execution to complete (24 hours). If either of these times are exceeded, the task or workflow will timeout.

For more information about timeout values, see Amazon SWF Timeout Types (p. 124).

Polling for Decisions

At the heart of every workflow execution there is a *decider*. The decider's responsibility is for managing the execution of the workflow itself. The decider receives *decision tasks* and responds to them, either by scheduling new activities, cancelling and restarting activities, or by setting the state of the workflow execution as complete, cancelled, or failed.

The decider uses the workflow execution's *task list* name to receive decision tasks to respond to. To poll for decision tasks, call poll on the domain's decision_tasks collection to loop over available decision tasks. You can then check for new events in the decision task by iterating over its new_events collection.

The returned events are AWS::SimpleWorkflow::HistoryEvent objects, and you can get the type of the event by using the returned event's event_type member. For a list and description of history event types, see HistoryEvent in the *Amazon Simple Workflow Service API Reference*.

Here is the beginning of the decision task poller's logic. A new method in our workflow class called `poll_for_decisions`.

```
  def poll_for_decisions
    # first, poll for decision tasks...
    @domain.decision_tasks.poll(@task_list) do | task |
      task.new_events.each do | event |
        case event.event_type
```

We'll now branch the execution of our decider based on the `event_type` that is received. The first one we are likely to receive is **WorkflowExecutionStarted**. When this event is received, it means that Amazon SWF is signaling to your decider that it should begin the workflow execution. We'll begin by scheduling the first activity by calling schedule_activity_task on the task we received while polling.

We'll pass it the first activity we declared in our activity list, which, because we reversed the list so we can use it like a stack, occupies the `last` position on the list. The "activities" we defined are just maps consisting of a name and version number, but this is all that Amazon SWF needs to identify the activity for scheduling, assuming that the activity has already been registered.

```
          when 'WorkflowExecutionStarted'
            # schedule the last activity on the (reversed, remember?) list to
            # begin the workflow.
            puts "** scheduling activity task: #{@activity_list.last[:name]}"

            task.schedule_activity_task( @activity_list.last,
              { :task_list => "#{@task_list}-activities" } )
```

When we schedule an activity, Amazon SWF sends an *activity task* to the activity task list that we pass in while scheduling it, signaling the task to begin. We'll deal with activity tasks in Subscription Workflow Tutorial Part 3: Implementing the Activities (p. 19), but it is worth noting that we don't execute the task here. We only tell Amazon SWF that it should be *scheduled*.

The next activity that we'll need to address is the **ActivityTaskCompleted** event, which occurs when Amazon SWF has received an activity completed response from an activity task.

```
        when 'ActivityTaskCompleted'
          # we are running the activities in strict sequential order, and
          # using the results of the previous activity as input for the next
          # activity.
          last_activity = @activity_list.pop

          if(@activity_list.empty?)
            puts "!! All activities complete! Sending complete_workflow_execution..."
            task.complete_workflow_execution
            return true;
          else
            # schedule the next activity, passing any results from the
            # previous activity. Results will be received in the activity
            # task.
            puts "** scheduling activity task: #{@activity_list.last[:name]}"
            if event.attributes.has_key?('result')
              task.schedule_activity_task(
                @activity_list.last,
                { :input => event.attributes[:result],
                  :task_list => "#{@task_list}-activities" } )
            else
              task.schedule_activity_task(
                @activity_list.last, { :task_list => "#{@task_list}-activities" } )
            end
          end
```

Since we are executing our tasks in a linear fashion, and only one activity is executing at once, we'll take this opportunity to pop the completed task from the `activity_list` stack. If this results in an empty list, then we know that our workflow is complete. In this case, we signal to Amazon SWF that our workflow is complete by calling complete_workflow_execution on the task.

In the event that the list still has entries, we'll schedule the next activity on the list (again, in the last position). This time, however, we'll look to see if the previous activity returned any result data to Amazon SWF upon completion, which is provided to the workflow in the event's attributes, in the optional `result` key. If the activity generated a result, we'll pass it as the `input` option to the next scheduled activity, along with the activity task list.

By retrieving the `result` values of completed activities, and by setting the `input` values of scheduled activities, we can pass data from one activity to the next, or we can use data from an activity to change behavior in our decider based on the results from an activity.

For the purposes of this tutorial, these two event types are the most important in defining the behavior of our workflow. However, an activity can generate events other than **ActivityTaskCompleted**. We'll wrap up our decider code by providing demonstration handler code for the **ActivityTaskTimedOut** and **ActivityTaskFailed** events, and for the **WorkflowExecutionCompleted** event, which will be generated when Amazon SWF processes the `complete_workflow_execution` call that we make when we run out of activities to run.

```
        when 'ActivityTaskTimedOut'
          puts "!! Failing workflow execution! (timed out activity)"
          task.fail_workflow_execution
          return false

        when 'ActivityTaskFailed'
          puts "!! Failing workflow execution! (failed activity)"
          task.fail_workflow_execution
          return false

        when 'WorkflowExecutionCompleted'
```

```
            puts "## Yesss, workflow execution completed!"
            task.workflow_execution.terminate
            return false
        end
      end
    end
  end
```

Starting the Workflow Execution

Before any decision tasks will be generated for the workflow to poll for, we need to start the workflow execution.

To start the workflow execution, call start_execution on your registered workflow type (AWS::SimpleWorkflow::WorkflowType). We'll define a small wrapper around this to make use of the `workflow_type` instance member that we retrieved in the class constructor.

```
  def start_execution
    workflow_execution = @workflow_type.start_execution( {
      :task_list => @task_list } )
    poll_for_decisions
  end
end
```

Once the workflow is executing, decision events will begin to appear on the workflow's task list, which is passed as a workflow execution option in start_execution.

Unlike options that are provided when the workflow type is registered, options that are passed to `start_execution` are not considered to be part of the workflow type. You are free to change these per workflow execution without changing the workflow's version.

Since we'd like the workflow to begin executing when we run the file, add some code that instantiates the class and then calls the `start_execution` method that we just defined.

```
if __FILE__ == $0
  require 'securerandom'

  # Use a different task list name every time we start a new workflow execution.
  #
  # This avoids issues if our pollers re-start before SWF considers them closed,
  # causing the pollers to get events from previously-run executions.
  task_list = SecureRandom.uuid

  # Let the user start the activity worker first...

  puts ""
  puts "Amazon SWF Example"
  puts "------------------"
  puts ""
  puts "Start the activity worker, preferably in a separate command-line window, with"
  puts "the following command:"
  puts ""
  puts "> ruby swf_sns_activities.rb #{task_list}-activities"
  puts ""
  puts "You can copy & paste it if you like, just don't copy the '>' character."
  puts ""
  puts "Press return when you're ready..."

  i = gets

  # Now, start the workflow.
  puts "Starting workflow execution."
  sample_workflow = SampleWorkflow.new(task_list)
  sample_workflow.start_execution
end
```

To avoid any task list naming conflicts, we'll use `SecureRandom.uuid` to generate a random UUID that we can use as the task list name, guaranteeing that a different task list name is used for each workflow execution.

> **Note**
> Task lists are used to record events about a workflow execution, so if you use the same task list for multiple executions of the same workflow type, you might get events that were generated during a previous execution, especially if you are running them in near succession to each other, which is often the case when trying out new code or running tests.

To avoid the issue of having to deal with artifacts from previous executions, we can use a new task list for each execution, specifying it when we begin the workflow execution.

There is also a bit of code here to provide instructions for the person running it (probably you), and to provide the "activity" version of the task list. The decider uses this task list name to schedule activities for the workflow, and the activities implementation will listen for activity events on this task list name to know when to begin the scheduled activities and to provide updates about the activity execution.

The code also waits for the user to start running the activities starter *before* it starts the workflow execution, so the activities starter will be ready to respond when activity tasks begin appearing on the provided task list.

Next Steps

We've completed the workflow implementation. Next, we'll define the activities and an activities starter, in Subscription Workflow Tutorial Part 3: Implementing the Activities (p. 19).

Subscription Workflow Tutorial Part 3: Implementing the Activities

We'll now implement each of the activities in our workflow, beginning with a base class that provides some common features for the activity code.

Topics

Defining a Basic Activity Type

When designing the workflow, we identified the following activities:

- `get_contact_activity`

- `subscribe_topic_activity`
- `wait_for_confirmation_activity`
- `send_result_activity`

We'll implement each of these activities now. Since our activities will share some features, let's do a little groundwork and create some common code they can share. We'll call it **BasicActivity**, and define it in a new file called `basic_activity.rb`.

As with the other source files, we'll include `utils.rb` to access the `init_domain` function to set up the sample domain.

```
require_relative 'utils.rb'
```

Next, we'll declare the basic activity class and some common data that we'll be interested in for each activity. We'll save the activity's AWS::SimpleWorkflow::ActivityType instance, *name*, and *results* in attributes of the class.

```
class BasicActivity

  attr_accessor :activity_type
  attr_accessor :name
  attr_accessor :results
```

These attributes access instance data that's defined in the class' `initialize` method, which takes an activity *name*, and an optional *version* and map of *options* to be used when registering the activity with Amazon SWF.

```
  def initialize(name, version = 'v1', options = nil)

    @activity_type = nil
    @name = name
    @results = nil

    # get the domain to use for activity tasks.
    @domain = init_domain

    # Check to see if this activity type already exists.
    @domain.activity_types.each do | a |
      if (a.name == @name) && (a.version == version)
        @activity_type = a
      end
    end

    if @activity_type.nil?
      # If no options were specified, use some reasonable defaults.
      if options.nil?
        options = {
          # All timeouts are in seconds.
          :default_task_heartbeat_timeout => 900,
          :default_task_schedule_to_start_timeout => 120,
          :default_task_schedule_to_close_timeout => 3800,
          :default_task_start_to_close_timeout => 3600 }
      end
      @activity_type = @domain.activity_types.register(@name, version, options)
    end
  end
```

As with workflow type registration, if an activity type is already registered, we can retrieve it by looking at the domain's activity_types collection. If the activity can't be found, it will be registered.

Also, as with workflow types, you can set *default options* that are stored with your activity type when you register it.

The last thing our basic activity gets is a consistent way to run it. We'll define a `do_activity` method that takes an activity task. As shown, we can use the passed-in activity task to receive data via its `input` instance attribute.

```
    def do_activity(task)
      @results = task.input # may be nil
      return true
    end
  end
```

That wraps up the **BasicActivity** class. Now we'll use it to make defining our activities simple and consistent.

Defining GetContactActivity

The first activity that is run during a workflow execution is `get_contact_activity`, which retrieves the user's Amazon SNS topic subscription information.

Create a new file called `get_contact_activity.rb`, and require both `yaml`, which we'll use to prepare a string for passing to Amazon SWF, and `basic_activity.rb`, which we'll use as the basis for this **GetContactActivity** class.

```
  require 'yaml'
  require_relative 'basic_activity.rb'

  # **GetContactActivity** provides a prompt for the user to enter contact
  # information. When the user successfully enters contact information, the
  # activity is complete.
  class GetContactActivity < BasicActivity
```

Since we put the activity registration code in **BasicActivity**, the `initialize` method for **GetContactActivity** is pretty simple. We simply call the base class constructor with the activity name, `get_contact_activity`. This is all that is required to register our activity.

```
    # initialize the activity
    def initialize
      super('get_contact_activity')
    end
```

We'll now define the `do_activity` method, which prompts for the user's email and/or phone number.

```
    def do_activity(task)
      puts ""
      puts "Please enter either an email address or SMS message (mobile phone) number to"
      puts "receive SNS notifications. You can also enter both to use both address types."
      puts ""
      puts "If you enter a phone number, it must be able to receive SMS messages, and
 must"
      puts "be 11 digits (such as 12065550101 to represent the number 1-206-555-0101)."

      input_confirmed = false
      while !input_confirmed
        puts ""
        print "Email: "
        email = $stdin.gets.strip
        print "Phone: "
        phone = $stdin.gets.strip

        puts ""
        if (email == '') && (phone == '')
          print "You provided no subscription information. Quit? (y/n)"
           confirmation = $stdin.gets.strip.downcase
           if confirmation == 'y'
             return false
           end
        else
           puts "You entered:"
           puts "  email: #{email}"
           puts "  phone: #{phone}"
           print "\nIs this correct? (y/n): "
           confirmation = $stdin.gets.strip.downcase
           if confirmation == 'y'
             input_confirmed = true
           end
        end
      end

      # make sure that @results is a single string. YAML makes this easy.
      @results = { :email => email, :sms => phone }.to_yaml
      return true
    end
  end
```

At the end of `do_activity`, we take the email and phone number retrieved from the user, place it in a map and then use `to_yaml` to convert the entire map to a YAML string. There's an important reason for this: any results that you pass to Amazon SWF when you complete an activity must be *string data only*. Ruby's ability to easily convert objects to YAML strings and then back again into objects is, thankfully, well-suited for this purpose.

That's the end of the `get_contact_activity` implementation. This data will be used next in the `subscribe_topic_activity` implementation.

Defining SubscribeTopicActivity

We'll now delve into Amazon SNS and create an activity that uses the information generated by `get_contact_activity` to subscribe the user to an Amazon SNS topic.

Create a new file called `subscribe_topic_activity.rb`, add the same requirements that we used for `get_contact_activity`, declare your class, and provide its `initialize` method.

```
require 'yaml'
require_relative 'basic_activity.rb'

# **SubscribeTopicActivity** sends an SMS / email message to the user, asking for
# confirmation.  When this action has been taken, the activity is complete.
class SubscribeTopicActivity < BasicActivity

  def initialize
    super('subscribe_topic_activity')
  end
```

Now that we have the code in place to get the activity set up and registered, we will add some code to create an Amazon SNS topic. To do so, we'll use the AWS::SNS::Client object's create_topic method.

Add the `create_topic` method to your class, which takes a passed-in Amazon SNS client object.

```
    def create_topic(sns_client)
      topic_arn = sns_client.create_topic(:name => 'SWF_Sample_Topic')[:topic_arn]

      if topic_arn != nil
        # For an SMS notification, setting `DisplayName` is *required*. Note that
        # only the *first 10 characters* of the DisplayName will be shown on the
        # SMS message sent to the user, so choose your DisplayName wisely!
        sns_client.set_topic_attributes( {
          :topic_arn => topic_arn,
          :attribute_name => 'DisplayName',
          :attribute_value => 'SWFSample' } )
      else
        @results = {
          :reason => "Couldn't create SNS topic", :detail => "" }.to_yaml
        return nil
      end

      return topic_arn
    end
```

Once we have the topic's Amazon Resource Name (ARN), we can use it with the Amazon SNS client's set_topic_attributes method to set the topic's *DisplayName*, which is required for sending SMS messages with Amazon SNS.

Lastly, we'll define the `do_activity` method. We'll start by collecting any data that was passed via the `input` option when the activity was scheduled. As previously mentioned, this must be passed as a string, which we created using `to_yaml`. When retrieving it, we'll use `YAML.load` to turn the data into Ruby objects.

Here's the beginning of `do_activity`, in which we retrieve the input data.

```
    def do_activity(task)
      activity_data = {
        :topic_arn => nil,
        :email => { :endpoint => nil, :subscription_arn => nil },
        :sms => { :endpoint => nil, :subscription_arn => nil },
      }

      if task.input != nil
        input = YAML.load(task.input)
        activity_data[:email][:endpoint] = input[:email]
        activity_data[:sms][:endpoint] = input[:sms]
      else
        @results = { :reason => "Didn't receive any input!", :detail => "" }.to_yaml
        puts("  #{@results.inspect}")
        return false
      end

      # Create an SNS client. This is used to interact with the service. Set the
      # region to $SMS_REGION, which is a region that supports SMS notifications
      # (defined in the file `utils.rb`).
      sns_client = AWS::SNS::Client.new(
        :config => AWS.config.with(:region => $SMS_REGION))
```

If we didn't receive any input, there isn't much to do, so we'll just fail the activity.

Assuming that everything is fine, however, we'll continue filling in our `do_activity` method, get an Amazon SNS client with the AWS SDK for Ruby, and pass it to our `create_topic` method to create the Amazon SNS topic.

```
      # Create the topic and get the ARN
      activity_data[:topic_arn] = create_topic(sns_client)

      if activity_data[:topic_arn].nil?
        return false
      end
```

There are a couple of things worth noting here:

- We use AWS.config.with to set the region for our Amazon SNS client. Because we want to send SMS messages, we use the SMS-enabled region that we declared in `utils.rb`.
- We save the topic's ARN in our `activity_data` map. This is part of the data that will be passed to the *next* activity in our workflow.

Finally, this activity subscribes the user to the Amazon SNS topic, using the passed-in endpoints (email and SMS). We don't require the user to enter *both* endpoints, but we do need at least one.

```
      # Subscribe the user to the topic, using either or both endpoints.
      [:email, :sms].each do | x |
        ep = activity_data[x][:endpoint]
        # don't try to subscribe an empty endpoint
        if (ep != nil && ep != "")
          response = sns_client.subscribe( {
            :topic_arn => activity_data[:topic_arn],
            :protocol => x.to_s, :endpoint => ep } )
          activity_data[x][:subscription_arn] = response[:subscription_arn]
        end
      end
```

AWS::SNS::Client.subscribe takes the topic ARN, the *protocol* (which, cleverly, we disguised as the `activity_data` map key for the corresponding endpoint).

Finally, we re-package the information for the next activity in YAML format, so that we can send it back to Amazon SWF.

```
      # if at least one subscription arn is set, consider this a success.
      if (activity_data[:email][:subscription_arn] != nil) or (activity_data[:sms]
[:subscription_arn] != nil)
        @results = activity_data.to_yaml
      else
        @results = { :reason => "Couldn't subscribe to SNS topic", :detail => "" }.to_yaml
        puts("  #{@results.inspect}")
        return false
      end
      return true
    end
  end
```

That completes the implementation of the `subscribe_topic_activity`. Next, we'll define `wait_for_confirmation_activity`.

Defining WaitForConfirmationActivity

Once a user is subscribed to an Amazon SNS topic, he or she will still need to confirm the subscription request. In this case, we'll be waiting for the user to confirm by either email or an SMS message.

The activity that waits for the user to confirm the subscription is called `wait_for_confirmation_activity`, and we'll define it here. To begin, create a new file called `wait_for_confirmation_activity.rb` and set it up as we've set up the previous activities.

```
require 'yaml'
require_relative 'basic_activity.rb'

# **WaitForConfirmationActivity** waits for the user to confirm the SNS
# subscription.  When this action has been taken, the activity is complete. It
# might also time out...
class WaitForConfirmationActivity < BasicActivity

  # Initialize the class
  def initialize
    super('wait_for_confirmation_activity')
  end
```

Next, we'll begin defining the `do_activity` method and retrieve any input data into a local variable called `subscription_data`.

```
  def do_activity(task)
    if task.input.nil?
      @results = { :reason => "Didn't receive any input!", :detail => "" }.to_yaml
      return false
    end

    subscription_data = YAML.load(task.input)
```

Now that we have the topic ARN, we can retrieve the topic by creating a new instance of AWS::SNS::Topic and pass it the ARN.

```
    topic = AWS::SNS::Topic.new(subscription_data[:topic_arn])

    if topic.nil?
      @results = {
        :reason => "Couldn't get SWF topic ARN",
        :detail => "Topic ARN: #{topic.arn}" }.to_yaml
      return false
    end
```

Now, we'll check the topic to see if the user has confirmed the subscription using one of the endpoints. We'll only require that one endpoint has been confirmed to consider the activity a success.

An Amazon SNS topic maintains a list of the subscriptions for that topic, and we can check whether or not the user has confirmed a particular subscription by checking to see if the subscription's ARN is set to anything other than `PendingConfirmation`.

```
    # loop until we get some indication that a subscription was confirmed.
    subscription_confirmed = false
    while(!subscription_confirmed)
      topic.subscriptions.each do | sub |
        if subscription_data[sub.protocol.to_sym][:endpoint] == sub.endpoint
          # this is one of the endpoints we're interested in. Is it subscribed?
          if sub.arn != 'PendingConfirmation'
            subscription_data[sub.protocol.to_sym][:subscription_arn] = sub.arn
            puts "Topic subscription confirmed for (#{sub.protocol}: #{sub.endpoint})"
            @results = subscription_data.to_yaml
            return true
          else
            puts "Topic subscription still pending for (#{sub.protocol}:
#{sub.endpoint})"
          end
        end
      end
```

If we get an ARN for the subscription, we'll save it in the activity's result data, convert it to YAML, and return true from `do_activity`, which signals that the activity completed successfully.

Since waiting for a subscription to be confirmed might take a while, we'll occasionally call `record_heartbeat` on the activity task. This signals to Amazon SWF that the activity is still processing, and can also be used to provide updates about the progress of the activity (if you are doing something, like processing files, that you can report progress for).

```
        task.record_heartbeat!(
          { :details => "#{topic.num_subscriptions_confirmed} confirmed,
#{topic.num_subscriptions_pending} pending" })
        # sleep a bit.
        sleep(4.0)
      end
```

This ends our `while` loop. If we somehow get out of the while loop without success, we'll report failure and finish the `do_activity` method.

```
      if (subscription_confirmed == false)
        @results = {
          :reason => "No subscriptions could be confirmed",
          :detail => "#{topic.num_subscriptions_confirmed} confirmed,
#{topic.num_subscriptions_pending} pending" }.to_yaml
        return false
      end
    end
  end
```

That ends the implementation of `wait_for_confirmation_activity`. We have only one more activity to define: `send_result_activity`.

Defining SendResultActivity

If the workflow has progressed this far, we've successfully subscribed the user to an Amazon SNS topic and the user has confirmed the subscription.

Our last activity, `send_result_activity`, sends the user a confirmation of the successful topic subscription, using the topic that the user subscribed to and the endpoint that the user confirmed the subscription with.

Create a new file called `send_result_activity.rb` and set it up as we've set up all the activities so far.

```
  require 'yaml'
  require_relative 'basic_activity.rb'

  # **SendResultActivity** sends the result of the activity to the screen, and, if
  # the user successfully registered using SNS, to the user using the SNS contact
  # information collected.
  class SendResultActivity < BasicActivity

    def initialize
      super('send_result_activity')
    end
```

Our `do_activity` method begins similarly, as well, getting the input data from the workflow, converting it from YAML, and then using the topic ARN to create an AWS::SNS::Topic instance.

```
    def do_activity(task)
      if task.input.nil?
```

```
        @results = { :reason => "Didn't receive any input!", :detail => "" }
        return false
      end

      input = YAML.load(task.input)

      # get the topic, so we publish a message to it.
      topic = AWS::SNS::Topic.new(input[:topic_arn])

      if topic.nil?
        @results = {
          :reason => "Couldn't get SWF topic",
          :detail => "Topic ARN: #{topic.arn}" }
        return false
      end
```

Once we have the topic, we'll publish a message to it (and echo it to the screen, as well).

```
      @results = "Thanks, you've successfully confirmed registration, and your workflow is
complete!"

      # send the message via SNS, and also print it on the screen.
      topic.publish(@results)
      puts(@results)

      return true
    end
  end
```

Publishing to an Amazon SNS topic sends the message that you supply to *all* of the subscribed and confirmed endpoints that exist for that topic. So, if the user confirmed with *both* an email and an SMS number, he or she will receive two confirmation messages, one at each endpoint.

Next Steps

That completes the implementation of `send_result_activity`. Now, we'll tie all these activities together in an activities application that handles the activity tasks and can launch activities in response, as described in Subscription Workflow Tutorial Part 4: Implementing the Activities Task Poller (p. 27).

Subscription Workflow Tutorial Part 4: Implementing the Activities Task Poller

In Amazon SWF, activity tasks for a running workflow execution appear on the *activity task list*, which is provided when you schedule an activity in the workflow.

We'll implement a basic activity poller to handle these tasks for our workflow, and use it to launch our activities when Amazon SWF places a task on the activity task list to start the activity.

To begin, create a new file called `swf_sns_activities.rb`. We'll use it to:

- Instantiate the activity classes that we created.
- Register each activity with Amazon SWF.
- Poll for activities and call `do_activity` for each activity when its name appears on the activity task list.

In `swf_sns_activities.rb`, add the following statements to require each of the activity classes we defined.

```
require_relative 'get_contact_activity.rb'
require_relative 'subscribe_topic_activity.rb'
require_relative 'wait_for_confirmation_activity.rb'
require_relative 'send_result_activity.rb'
```

Now, we'll create the class and provide some initialization code.

```
class ActivitiesPoller

  def initialize(domain, task_list)
    @domain = domain
    @task_list = task_list
    @activities = {}

    # These are the activities we'll run
    activity_list = [
      GetContactActivity,
      SubscribeTopicActivity,
      WaitForConfirmationActivity,
      SendResultActivity ]

    activity_list.each do | activity_class |
      activity_obj = activity_class.new
      puts "** initialized and registered activity: #{activity_obj.name}"
      # add it to the hash
      @activities[activity_obj.name.to_sym] = activity_obj
    end
  end
```

In addition to saving the passed in *domain* and *task list*, this code instantiates each of the activity classes we created. Because each class registers its associated activity (refer to `basic_activity.rb` if you need to review that code), this is enough to let Amazon SWF know about all of the activities we'll be running.

For each activity instantiated, we store it on a map using the activity name (such as `get_contact_activity`) as the key, so we can easily look these up in the activity poller code, which we'll define next.

Create a new method called `poll_for_activities` and call poll on the activity_tasks held by the domain to get activity tasks.

```
  def poll_for_activities
    @domain.activity_tasks.poll(@task_list) do | task |
      activity_name = task.activity_type.name
```

We can get the activity name from the task's activity_type member. Next, we'll use the activity name associated with this task to look up the class to run `do_activity` on, passing it the task (which includes any input data that should be transferred to the activity).

```
      # find the task on the activities list, and run it.
      if @activities.key?(activity_name.to_sym)
        activity = @activities[activity_name.to_sym]
        puts "** Starting activity task: #{activity_name}"
        if activity.do_activity(task)
          puts "++ Activity task completed: #{activity_name}"
          task.complete!({ :result => activity.results })
          # if this is the final activity, stop polling.
          if activity_name == 'send_result_activity'
             return true
          end
        else
```

```
          puts "-- Activity task failed: #{activity_name}"
          task.fail!(
            { :reason => activity.results[:reason],
              :details => activity.results[:detail] } )
        end
      else
        puts "couldn't find key in @activities list: #{activity_name}"
        puts "contents: #{@activities.keys}"
      end
    end
  end
end
```

The code just waits for `do_activity` to complete, and then calls either complete! or fail! on the task based on the return code.

> **Note**
> This code exits from the poller once the final activity has been launched, since it has completed its mission and has launched all of the activities. In your own Amazon SWF code, if your activities might be run again, you may want to keep the activity poller running indefinitely.

That's the end of the code for our **ActivitiesPoller** class, but we'll add a little more code at the end of the file to allow the user to run it from the command-line.

```
if __FILE__ == $0
  if ARGV.count < 1
    puts "You must supply a task-list name to use!"
    exit
  end
  poller = ActivitiesPoller.new(init_domain, ARGV[0])
  poller.poll_for_activities
  puts "All done!"
end
```

If the user runs the file from the command line (passing it an activity task list as the first argument), this code will instantiate the poller class and start it polling for activities. Once the poller completes (after it has launched the final activity), we just print a message and exit.

That's it for the activities poller. All that's left for you to do is to run the code and see how it works, in Subscription Workflow Tutorial: Running the Workflow (p. 29).

Subscription Workflow Tutorial: Running the Workflow

Now that you've completed the implementation of your workflow, activities, and the workflow and activity pollers, you're ready to run the workflow.

If you haven't done so already, you'll need to provide your AWS access keys in the `aws-config.txt` file as described in Configuring the AWS Session (p. 11) in Part 1 of the tutorial.

Now, go to your command line and change to the directory where the tutorial source files are located. You should have the following files:

```
.
|-- aws-config.txt
|-- basic_activity.rb
|-- get_contact_activity.rb
|-- send_result_activity.rb
|-- subscribe_topic_activity.rb
|-- swf_sns_activities.rb
|-- swf_sns_workflow.rb
|-- utils.rb
`-- wait_for_confirmation_activity.rb
```

Now, start the workflow with the following command.

```
ruby swf_sns_workflow.rb
```

This will begin the workflow, and should print out a message with a line that you can copy and paste into a separate command-line window (or even on another computer, if you've copied the tutorial source files onto it).

```
Amazon SWF Example
------------------

Start the activity worker, preferably in a separate command-line window, with
the following command:

> ruby swf_sns_activities.rb 87097e76-7c0c-41c7-817b-92527bb0ea85-activities

You can copy & paste it if you like, just don't copy the '>' character.

Press return when you're ready...
```

The workflow code will wait patiently for you to start the activity poller in a separate window.

Open a new command-line window, change to the directory where the source files are located again, and then use the command provided by the `swf_sns_workflow.rb` file to start the activity poller. For example, if you received the preceding output, you would type (or paste) the following.

```
ruby swf_sns_activities.rb 87097e76-7c0c-41c7-817b-92527bb0ea85-activities
```

Once you begin running your activity poller, it will start to output information about activities registration.

```
** initialized and registered activity: get_contact_activity
** initialized and registered activity: subscribe_topic_activity
** initialized and registered activity: wait_for_confirmation_activity
** initialized and registered activity: send_result_activity
```

You can now return to your original command-line window, and press return to start your workflow execution. It will register the workflow and schedule the first activity.

```
Starting workflow execution.
** registered workflow: swf-sns-workflow
** scheduling activity task: get_contact_activity
```

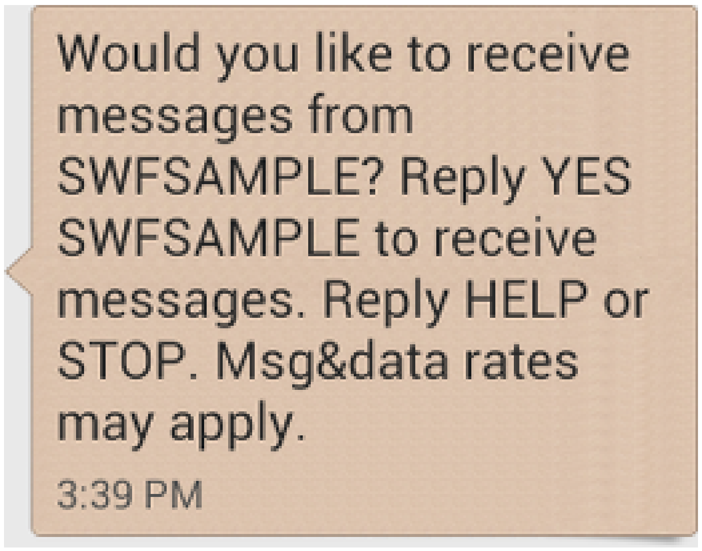
Go back to the other window, where your activity poller is running. The result of the first running activity is displayed, providing a prompt for you to enter your email or SMS phone number. Enter either, or both, of these pieces of data, and then confirm your text entry.

```
activity task received: <AWS::SimpleWorkflow::ActivityTask>
** Starting activity task: get_contact_activity
```

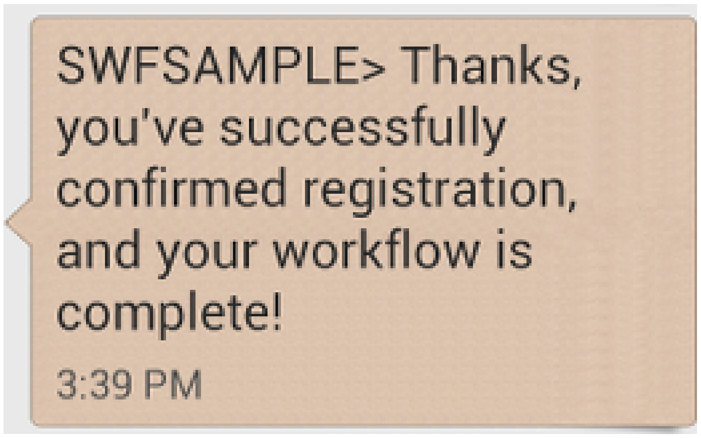
```
Please enter either an email address or SMS message (mobile phone) number to
receive Amazon SNS notifications. You can also enter both to use both address types.

If you enter a phone number, it must be able to receive SMS messages, and must
be 11 digits (such as 12065550101 to represent the number 1-206-555-0101).

Email: me@example.com
Phone: 12065550101

You entered:
  email: me@example.com
  phone: 12065550101

Is this correct? (y/n): y
```

> **Note**
> The phone number provided is fictitious, and is used only for illustrative purposes. Use your own phone number and email address here!

Soon after entering this information, you should receive an email or text message from Amazon SNS, asking you to confirm your topic subscription. If you entered an SMS number, you will see something like the following appear on your phone.


Would you like to receive messages from SWFSAMPLE? Reply YES SWFSAMPLE to receive messages. Reply HELP or STOP. Msg&data rates may apply.
3:39 PM

If you reply to this message with `YES`, you'll get the response that we provided in `send_result_activity`.


SWFSAMPLE> Thanks, you've successfully confirmed registration, and your workflow is complete!
3:39 PM

While all of this was happening, did you see what was happening in your command-line window? Both the workflow and activity pollers have been hard at work.

Here's the output from the workflow poller.

```
** scheduling activity task: subscribe_topic_activity
** scheduling activity task: wait_for_confirmation_activity
** scheduling activity task: send_result_activity
!! All activities complete! Sending complete_workflow_execution...
```

Here's the output from the activity poller, which was happening at the same time in another command-line window.

```
++ Activity task completed: get_contact_activity
** Starting activity task: subscribe_topic_activity
++ Activity task completed: subscribe_topic_activity
** Starting activity task: wait_for_confirmation_activity
Topic subscription still pending for (email: me@example.com)
Topic subscription confirmed for (sms: 12065550101)
++ Activity task completed: wait_for_confirmation_activity
** Starting activity task: send_result_activity
Thanks, you've successfully confirmed registration, and your workflow is complete!
++ Activity task completed: send_result_activity
All done!
```

Congratulations, your workflow is complete, and so is this tutorial!

You may want to re-run the workflow again to see how timeouts work, or to enter different data. Just remember that once you subscribe to a topic, *you're still subscribed until you unsubscribe*. Re-running the workflow before unsubscribing to topics will probably result in automatic success, since the `wait_for_confirmation_activity` will see that your subscription is already confirmed.

To unsubscribe from the Amazon SNS topic

- Respond in the negative (send `STOP`) to the text message.
- Choose the unsubscribe link that you received in your email.

You're now ready to re-subscribe to the topic again.

Where Do I Go from Here?

This tutorial has covered a lot of ground, but there's still much more you can learn about the AWS SDK for Ruby, Amazon SWF, or Amazon SNS. For more information and many more examples, see the official documentation for each:

- AWS SDK for Ruby Documentation
- Amazon Simple Notification Service Documentation
- Amazon Simple Workflow Service Documentation

Basic Concepts in Amazon SWF

The concepts in this chapter provide an overview of the Amazon Simple Workflow Service and describe its major features. While some examples of the use of Amazon SWF are provided in the topics within this chapter, refer to the section titled Using the Amazon SWF API (p. 81) for more concrete examples of implementing the features described here.

Topics

Amazon SWF Workflows

Topics

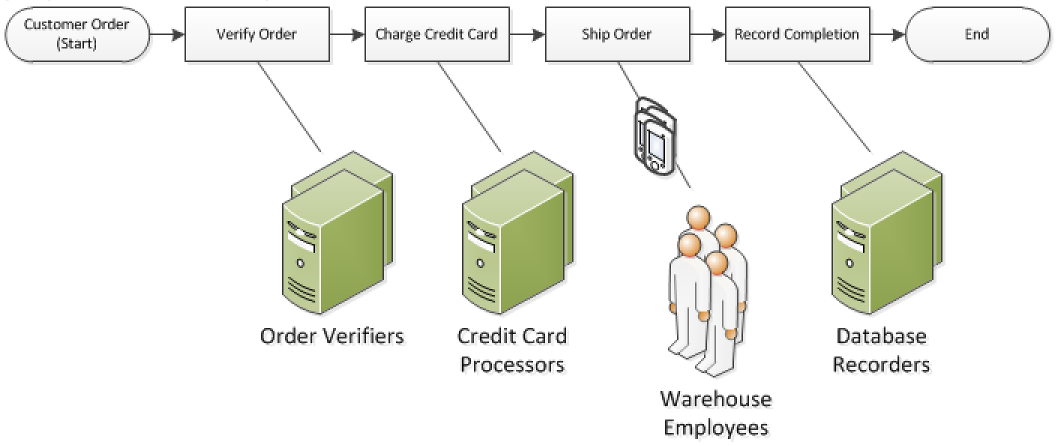
What is a Workflow?

Using the Amazon Simple Workflow Service (Amazon SWF), you can implement distributed, asynchronous applications as *workflows*. Workflows coordinate and manage the execution of activities that can be run asynchronously across multiple computing devices and that can feature both sequential and parallel processing.

When designing a workflow, you analyze your application to identify its component *tasks*. In Amazon SWF, these tasks are represented by *activities*. The order in which activities are performed is determined by the workflow's coordination logic.

A Simple Workflow Example: an E-Commerce Application

For example, the following figure shows a simple e-commerce order-processing workflow involving both people and automated processes.



This workflow starts when a customer places an order. It includes four *tasks*:

1. Verify the order.
2. If the order is valid, charge the customer.
3. If the payment is made, ship the order.
4. If the order is shipped, save the order details.

The tasks in this workflow are *sequential*: an order must be verified before a credit card can be charged; a credit card must be charged successfully before an order can be shipped; and an order must be shipped before it can be recorded. Even so, because Amazon SWF supports distributed processes, these tasks can be carried out in different locations. If the tasks are programmatic in nature, they can also be written in different programming languages or using different tools.

In addition to sequential processing of tasks, Amazon SWF also supports workflows with parallel processing of tasks. Parallel tasks are performed at the same time, and may be carried out independently by different applications or human workers. Your workflow makes decisions about how to proceed once one or more of the parallel tasks have been completed.

Workflow Registration and Execution

After the coordination logic and the activities have been designed, you register these components as workflow and activity types with Amazon SWF. During registration, you specify for each type a name, a version, and some default configuration values.

Only registered workflow and activity types can be used with Amazon SWF. In the e-commerce example, you would register the CustomerOrder workflow type and the VerifyOrder, ChargeCreditCard, ShipOrder, and RecordCompletion activity types.

After registering your workflow type, you can run it as often you like. A *workflow execution* is a running instance of a workflow. In the e-commerce example, a new workflow execution is started with each customer order.

A workflow execution can be started by any process or application, even another workflow execution. In the e-commerce example, what type of application initiates the workflow depends on how the customer places the order. The workflow could be initiated by a web site or mobile application or by a customer service representative using an internal company application.

With Amazon SWF, you can associate an identifier—called a `workflowId`—with your workflow executions, so you can integrate your existing business identifiers into your workflow. In the e-commerce example, each workflow execution might be identified using the customer invoice number.

In addition to the identifier that you provide, Amazon SWF associates a unique system-generated identifier—a `runId`—with each workflow execution. Amazon SWF allows only one workflow execution with this identifier to run at any given time; although you can have multiple workflows executions of the same workflow type, each workflow execution has a distinct `runId`.

See Also

- Amazon SWF Workflow History (p. 35)

Amazon SWF Workflow History

The progress of every workflow execution is recorded in its workflow history, which Amazon SWF maintains. The workflow history is a detailed, complete, and consistent record of every event that occurred since the workflow execution started. An event represents a discrete change in your workflow execution's state, such as a new activity being scheduled or a running activity being completed. The workflow history contains every event that causes the execution state of the workflow execution to change, such as scheduled and completed activities, task timeouts, and signals.

Operations that do not change the state of the workflow execution do not typically appear in the workflow history. For example, the workflow history does not show poll attempts or the use of visibility operations.

The workflow history has several key benefits:

- It enables applications to be stateless, because all information about a workflow execution is stored in its workflow history.
- For each workflow execution, the history provides a record of which activities were scheduled, their current status, and their results. The workflow execution uses this information to determine next steps.
- The history provides a detailed audit trail that you can use to monitor running workflow executions and verify completed workflow executions.

The following is a conceptual view of the e-commerce workflow history:

```
Invoice0001

Start Workflow Execution

Schedule Verify Order
Start Verify Order Activity
Complete Verify Order Activity
```

```
Schedule Charge Credit Card
Start Charge Credit Card Activity
Complete Charge Credit Card Activity

Schedule Ship Order
Start Ship Order Activity
```

In the preceding example, the order is waiting to ship. In the following example, the order is complete. Because the workflow history is cumulative, the newer events are appended:

```
Invoice0001

Start Workflow Execution

Schedule Verify Order
Start Verify Order Activity
Complete Verify Order Activity

Schedule Charge Credit Card
Start Charge Credit Card Activity
Complete Charge Credit Card Activity

Schedule Ship Order
Start Ship Order Activity

Complete Ship Order Activity

Schedule Record Order Completion
Start Record Order Completion Activity
Complete Record Order Completion Activity

Close Workflow
```

Programmatically, the events in the workflow execution history are represented as JavaScript Object Notation (JSON) objects. The history itself is a JSON array of these objects. Each event has the following:

- A type, such as WorkflowExecutionStarted or ActivityTaskCompleted
- A timestamp in Unix time format
- An ID that uniquely identifies the event

In addition, each type of event has a distinct set of descriptive attributes that are appropriate to that type. For example, the `ActivityTaskCompleted` event has attributes that contain the IDs for the events that correspond to the time that the activity task was scheduled and when it was started, as well as an attribute that holds result data.

You can obtain a copy of the current state of the workflow execution history by using the GetWorkflowExecutionHistory action. In addition, as part of the interaction between Amazon SWF and the decider for your workflow, the decider periodically receives copies of the history.

Below is a section of an example workflow execution history in JSON format.

```
[  {
       "eventId": 11,
       "eventTimestamp": 1326671603.102,
       "eventType": "WorkflowExecutionTimedOut",
       "workflowExecutionTimedOutEventAttributes": {
          "childPolicy": "TERMINATE",
          "timeoutType": "START_TO_CLOSE"
       }
   }, {
       "decisionTaskScheduledEventAttributes": {
          "startToCloseTimeout": "600",
          "taskList": {
             "name": "specialTaskList"
          }
       },
       "eventId": 10,
       "eventTimestamp": 1326670566.124,
       "eventType": "DecisionTaskScheduled"
   }, {
       "activityTaskTimedOutEventAttributes": {
          "details": "Waiting for confirmation",
          "scheduledEventId": 8,
          "startedEventId": 0,
          "timeoutType": "SCHEDULE_TO_START"
       },
       "eventId": 9,
       "eventTimestamp": 1326670566.124,
       "eventType": "ActivityTaskTimedOut"
   }, {
       "activityTaskScheduledEventAttributes": {
          "activityId": "verification-27",
          "activityType": {
             "name": "activityVerify",
             "version": "1.0"
          },
          "control": "digital music",
          "decisionTaskCompletedEventId": 7,
          "heartbeatTimeout": "120",
          "input": "5634-0056-4367-0923,12/12,437",
          "scheduleToCloseTimeout": "900",
          "scheduleToStartTimeout": "300",
          "startToCloseTimeout": "600",
          "taskList": {
             "name": "specialTaskList"
          }
       },
       "eventId": 8,
       "eventTimestamp": 1326670266.115,
       "eventType": "ActivityTaskScheduled"
   }, {
       "decisionTaskCompletedEventAttributes": {
          "executionContext": "Black Friday",
          "scheduledEventId": 5,
          "startedEventId": 6
       },
       "eventId": 7,
       "eventTimestamp": 1326670266.103,
       "eventType": "DecisionTaskCompleted"
   }, {
       "decisionTaskStartedEventAttributes": {
          "identity": "Decider01",
          "scheduledEventId": 5
       },
       "eventId": 6,
       "eventTimestamp": 1326670161.497,
       "eventType": "DecisionTaskStarted"
   }, {
       "decisionTaskScheduledEventAttributes": {
          "startToCloseTimeout": "600",
          "taskList": {
             "name": "specialTaskList"
          }
       },
       "eventId": 5,
       "eventTimestamp": 1326668752.66,
       "eventType": "DecisionTaskScheduled"
   }, {
       "decisionTaskTimedOutEventAttributes": {
          "scheduledEventId": 2,
          "startedEventId": 3,
          "timeoutType": "START_TO_CLOSE"
       },
       "eventId": 4,
       "eventTimestamp": 1326668752.66,
       "eventType": "DecisionTaskTimedOut"
   }, {
       "decisionTaskStartedEventAttributes": {
          "identity": "Decider01",
          "scheduledEventId": 2
       },
       "eventId": 3,
       "eventTimestamp": 1326668152.648,
       "eventType": "DecisionTaskStarted"
   }, {
       "decisionTaskScheduledEventAttributes": {
          "startToCloseTimeout": "600",
          "taskList": {
             "name": "specialTaskList"
          }
       },
       "eventId": 2,
       "eventTimestamp": 1326668003.094,
       "eventType": "DecisionTaskScheduled"
   }
]
```

For a detailed list of the different types of events that can appear in the workflow execution history, see the HistoryEvent data type in the *Amazon Simple Workflow Service API Reference*.

Amazon SWF stores the complete history of all workflow executions for a configurable number of days after the execution closes. This period, which is known as the workflow history retention period, is specified when you register a *Domain* for your workflow. Domains are discussed in greater detail later in this section.

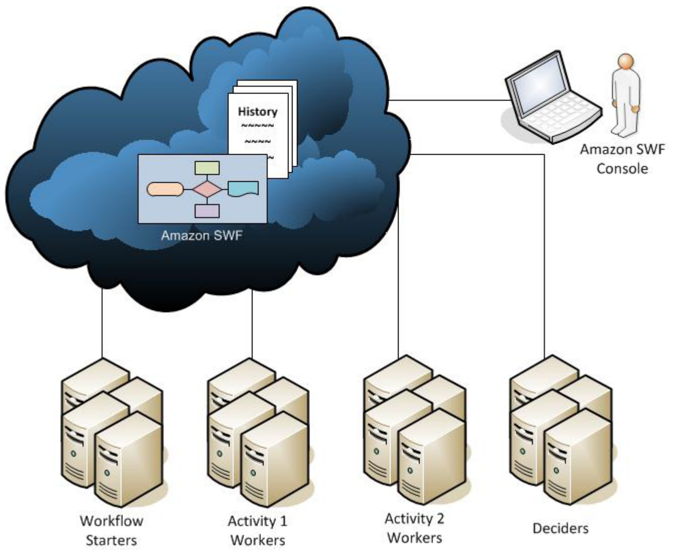
Amazon SWF Actors

Topics

What is an Actor in Amazon SWF?

In the course of its operations, Amazon SWF interacts with a number of different types of programmatic *actors*. Actors can be workflow starters (p. 39), deciders (p. 39), or activity workers (p. 40). These actors communicate with Amazon SWF through its API. You can develop these actors in any programming language.

The following diagram shows the Amazon SWF architecture, including Amazon SWF and its actors.



Workflow Starters

A workflow starter is any application that can initiate workflow executions. In the e-commerce example, one workflow starter could be the website at which the customer places an order. Another workflow starter could be a mobile application or system used by a customer service representative to place the order on behalf of the customer.

Deciders

A decider is an implementation of a workflow's coordination logic. Deciders control the flow of activity tasks in a workflow execution. Whenever a change occurs during a workflow execution, such as the completion of an activity task, the client polls for decision tasks and passes them to a decider using the entire workflow history up to that point in time. When the decider receives the decision task from Amazon SWF, it analyzes the workflow execution history to determine the next appropriate steps in the workflow execution. The decider communicates these steps back to Amazon SWF using *decisions*. A decision is an Amazon SWF data type that can represent various next actions. For a list of the possible decisions, go to Decision in the Amazon Simple Workflow Service API Reference.

Here is an example of a decision in JSON format, the format in which it is transmitted to Amazon SWF. This decision schedules a new activity task.

```
{
   "decisionType" : "ScheduleActivityTask",
   "scheduleActivityTaskDecisionAttributes" : {
      "activityType" : {
         "name" : "activityVerify",
         "version" : "1.0"
      },
      "activityId" : "verification-27",
      "control" : "digital music",
      "input" : "5634-0056-4367-0923,12/12,437",
      "scheduleToCloseTimeout" : "900",
      "taskList" : {
         "name": "specialTaskList"
      },
      "scheduleToStartTimeout" : "300",
      "startToCloseTimeout" : "600",
      "heartbeatTimeout" : "120"
```

```
    }
}
```

A decider receives a decision task when the workflow execution starts and each time a state change occurs in the workflow execution. Deciders continue to move the workflow execution forward by receiving decision tasks and responding to Amazon SWF with more decisions until the decider determines that the workflow execution is complete. It then responds with a decision to close the workflow execution. After the workflow execution closes, Amazon SWF will not schedule additional tasks for that execution.

In the e-commerce example, the decider determines if each step was performed correctly, and then either schedules the next step or manages any error conditions.

A decider represents a single computer process or thread. Multiple deciders can process tasks for the same workflow type.

Activity Workers

An activity worker is a process or thread that performs the *activity tasks* that are part of your workflow. The activity task represents one of the tasks that you identified in your application.

To use an activity task in your workflow, you must register it using either the Amazon SWF console or the RegisterActivityType action.

Each activity worker polls Amazon SWF for new tasks that are appropriate for that activity worker to perform; certain tasks can be performed only by certain activity workers. After receiving a task, the activity worker processes the task to completion and then reports to Amazon SWF that the task was completed and provides the result. The activity worker then polls for a new task. The activity workers associated with a workflow execution continue in this way, processing tasks until the workflow execution itself is complete. In the e-commerce example, activity workers are independent processes and applications used by people, such as credit card processors and warehouse employees, that perform individual steps in the process.

An activity worker represents a single computer process (or thread). Multiple activity workers can process tasks of the same activity type.

Data Exchange Between Actors

Input data can be provided to a workflow execution when it is started. Similarly, input data can be provided to activity workers when they schedule activity tasks. When an activity task is complete, the activity worker can return results to Amazon SWF. Similarly, a decider can report the results of a workflow execution when the execution is complete. Each actor can send data to, and receive data from, Amazon SWF through strings, the form of which is user-defined. Depending on the size and sensitivity of the data, you can pass data directly or pass a pointer to data stored on another system or service (such as Amazon S3 or DynamoDB). Both the data passed directly and the pointers to other data stores are recorded in the workflow execution history; however, Amazon SWF does not copy or cache any of the data from external stores as part of the history.

Because Amazon SWF maintains the complete execution state of each workflow execution, including the inputs and the results of tasks, all actors can be stateless. As a result, workflow processing is highly scalable. As the load on your system grows, you can simply add more actors to increase capacity.

Amazon SWF Tasks

Amazon SWF interacts with activity workers and deciders by providing them with work assignments known as tasks. There are three types of tasks in Amazon SWF:

- **Activity task**. An *Activity* task tells an activity worker to perform its function, such as to check inventory or charge a credit card. The activity task contains all the information that the activity worker needs to perform its function.
- **Lambda task**. A *Lambda* task is similar to an Activity task, but executes a Lambda function instead of a traditional Amazon SWF activity. For more information about how to define a Lambda task, see AWS Lambda Tasks (p. 92).
- **Decision task**. A *Decision* task tells a decider that the state of the workflow execution has changed so that the decider can determine the next activity that needs to be performed. The decision task contains the current workflow history.

Amazon SWF schedules a decision task when the workflow starts and whenever the state of the workflow changes, such as when an activity task completes. Each decision task contains a paginated view of the entire workflow execution history. The decider analyzes the workflow execution history and responds back to Amazon SWF with a set of decisions that specify what should occur next in the workflow execution. Essentially, every decision task gives the decider an opportunity to assess the workflow and provide direction back to Amazon SWF.

To ensure that no conflicting decisions are processed, Amazon SWF assigns each decision task to exactly one decider and allows only one decision task at a time to be active in a workflow execution.

The following table shows the relationship between the different constructs related to workflows and deciders.

Logical Design	Registered As	Performed By	Receives & Performs	Generates
Workflow	Workflow Type	Decider	Decision Tasks	Decisions

When an activity worker has completed the activity task, it reports to Amazon SWF that the task was completed, and it includes any relevant results that were generated. Amazon SWF updates the workflow execution history with an event that indicates the task completed and then schedules a decision task to transmit the updated history to the decider.

Amazon SWF assigns each activity task to exactly one activity worker. Once the task is assigned, no other activity worker can claim or perform that task.

The following table shows the relationship between the different constructs related to activities.

Logical Design	Registered As	Performed By	Receives & Performs	Generates
Activity	Activity Type	Activity Worker	Activity Tasks	Results Data

Amazon SWF Domains

Domains provide a way of scoping Amazon SWF resources within your AWS account. All the components of a workflow, such as the workflow type and activity types, must be specified to be in a domain. It is possible to have more than one workflow in a domain; however, workflows in different domains cannot interact with each other.

When setting up a new workflow, before you set up any of the other workflow components you need to register a domain if you have not already done so.

When you register a domain, you specify a *workflow history retention period*. This period is the length of time that Amazon SWF will continue to retain information about the workflow execution after the workflow execution is complete.

Amazon SWF Object Identifiers

The following list describes how Amazon SWF objects, such as workflow executions, are uniquely identified.

- **Workflow Type:** A registered workflow type is identified by its domain, name, and version. Workflow types are specified in the call to `RegisterWorkflowType`.
- **Activity Type:** A registered activity type is identified by its domain, name, and version. Activity types are specified in the call to `RegisterActivityType`.
- **Decision Tasks and Activity Tasks:** Each decision task and activity task is identified by a unique task token. The task token is generated by Amazon SWF and is returned with other information about the task in the response from `PollForDecisionTask` or `PollForActivityTask`. Although the token is most commonly used by the process that received the task, that process could pass the token to another process, which could then report the completion or failure of the task.
- **Workflow Execution:** A single execution of a workflow is identified by the domain, workflow ID, and run ID. The first two are parameters that are passed to StartWorkflowExecution. The run ID is returned by `StartWorkflowExecution`.

Amazon SWF Task Lists

Task lists provide a way of organizing the various tasks associated with a workflow. You can think of task lists as similar to dynamic queues. When a task is scheduled in Amazon SWF, you can specify a queue (task list) to put it in. Similarly, when you poll Amazon SWF for a task you say which queue (task list) to get the task from.

Task lists provide a flexible mechanism to route tasks to workers as your use case necessitates. Task lists are dynamic in that you don't need to register a task list or explicitly create it through an action: simply scheduling a task creates the task list if it doesn't already exist.

There are separate lists for *activity* tasks and *decision* tasks. A task is always scheduled on only one task list; tasks are not shared across lists. Furthermore, like activities and workflows, task lists are scoped to a particular AWS region and Amazon SWF domain.

Topics

Decision Task Lists

Each workflow execution is associated with a specific decision task list. When a workflow type is registered (RegisterWorkflowType action), you can specify a default task list for executions of that workflow type. When the workflow starter initiates the workflow execution (`StartWorkflowExecution` action), it has the option of specifying a different task list for that workflow execution.

When a decider polls for a new decision task (`PollForDecisionTask` action), the decider specifies a decision task list to draw from. A single decider could serve multiple workflow executions by calling

`PollForDecisionTask` multiple times, using a different task list in each call, where each task list is specific to a particular workflow execution. Alternatively, the decider could poll a single decision task list that provides decision tasks for multiple workflow executions. You could also have multiple deciders serving a single workflow execution by having all of them poll the task list for that workflow execution.

Activity Task Lists

A single activity task list can contain tasks of different activity types. Tasks are scheduled on the task list in order. Amazon SWF returns the tasks from the list in order on a best effort basis. Under some circumstances, the tasks may not come off the list in order.

When an activity type is registered (RegisterActivityType action), you can specify a default task list for that activity type. By default, activity tasks of this type will be scheduled on the specified task list; however, when the decider schedules an activity task (ScheduleActivityTask decision), the decider can optionally specify a different task list on which to schedule the task. If the decider does not specify a task list, the default task list is used. As a result, you can place activity tasks on specific task lists according to attributes of the task. For example, you could place all instances of an activity task for a given credit card type on a particular task list.

Task Routing

When an activity worker polls for a new task (PollForActivityTask action), it can specify an activity task list to draw from. If it does, the activity worker will accept tasks only from that list. In this way, you can ensure that certain tasks get assigned only to particular activity workers. For example, you might create a task list that holds tasks that require the use of a high-performance computer. Only activity workers running on the appropriate hardware would poll that task list. Another example would be to create a task list for a particular geographic region. You could then ensure that only workers deployed in that region would pick up those tasks. Or you could create a task list for high-priority orders and always check that list first.

Assigning particular tasks to particular activity workers in this way is called *task routing*. Task routing is optional; if you do not specify a task list when scheduling an activity task, the task is automatically placed on the default task list.

Amazon SWF Workflow Execution Closure

Once you start a workflow execution, it is open. An open workflow execution could be closed as completed, canceled, failed, or timed out. It could also be continued as a new execution, or it could be terminated. A workflow execution could be closed by the decider, by the person administering the workflow, or by Amazon SWF.

If the decider determines that the activities of the workflow have finished, it should close the workflow execution as completed by using the RespondDecisionTaskCompleted action and pass the CompleteWorkflowExecution decision.

Alternatively, a decider might close the workflow execution as canceled or failed. In order to cancel the execution, the decider should use the `RespondDecisionTaskCompleted` action and pass the CancelWorkflowExecution decision.

A decider should fail the workflow execution if it enters a state outside the realm of normal completion. In order to fail the execution, the decider should use the `RespondDecisionTaskCompleted` action and pass the FailWorkflowExecution decision.

Amazon SWF monitors workflow executions to ensure that they do not exceed any user-specified timeout settings. If a workflow execution times out, Amazon SWF automatically closes it. For more information about timeout values, see the Amazon SWF Timeout Types (p. 124) section.

A decider might also close the execution and logically continue it as a new execution using the `RespondDecisionTaskCompleted` action and passing the ContinueAsNewWorkflowExecution decision. This is a useful strategy for long-running workflow executions for which the history may grow too large over time.

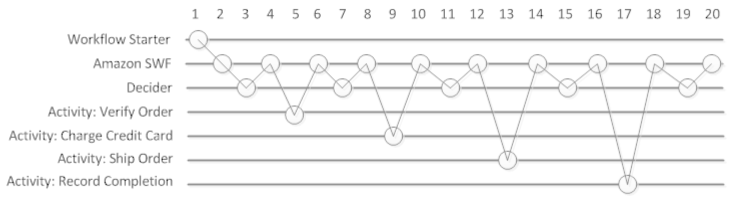
Finally, you could terminate workflow executions directly from the Amazon SWF console or programmatically by using the TerminateWorkflowExecution API. Termination forces closure of the workflow execution. Cancellation is preferred over termination, because your deciders can manage closure of the workflow execution.

Amazon SWF would terminate a workflow execution if the execution exceeds certain service-defined limits. Amazon SWF would also terminate a child workflow if the parent workflow has terminated and the applicable child policy indicates that the child workflow should also be terminated.

Life Cycle of an Amazon SWF Workflow Execution

From the start of a workflow execution to its completion, Amazon SWF interacts with actors by assigning them appropriate tasks, either activity tasks or decision tasks.

The following diagram shows the life cycle of an order-processing workflow execution from the perspective of components that act on it.



The following table explains each task in the preceding image.

Workflow Execution Life Cycle

Description	Action, Decision, or Event
1) The workflow starter calls the appropriate Amazon SWF action to start the workflow execution for an order, providing the order information.	StartWorkflowExecution action.
2) Amazon SWF receives the start workflow execution request and then schedules the first decision task.	WorkflowExecutionStarted event and DecisionTaskScheduled event.
3) The decider receives the task from Amazon SWF, reviews the history, applies the coordination logic to determine that no previous activities	PollForDecisionTask action. RespondDecisionTaskCompleted action with ScheduleActivityTask decision.

Description	Action, Decision, or Event
occurred, makes a decision to schedule the Verify Order activity with the information the activity worker needs to process the task, and returns the decision to Amazon SWF.	
4) Amazon SWF receives the decision, schedules the Verify Order activity task, and waits for the activity task to complete or time out.	ActivityTaskScheduled event.
5) An activity worker that can perform the Verify Order activity receives the task, performs it, and returns the results to Amazon SWF.	`PollForActivityTask` action and `RespondActivityTaskCompleted` action.
6) Amazon SWF receives the results of the Verify Order activity, adds them to the workflow history, and schedules a decision task.	ActivityTaskCompleted event and DecisionTaskScheduled event.
7) The decider receives the task from Amazon SWF, reviews the history, applies the coordination logic, makes a decision to schedule a ChargeCreditCard activity task with the information the activity worker needs to process the task, and returns the decision to Amazon SWF.	PollForDecisionTask action. RespondDecisionTaskCompleted action with ScheduleActivityTask decision.
8) Amazon SWF receives the decision, schedules the ChargeCreditCard activity task, and waits for it to complete or time out.	DecisionTaskCompleted event and ActivityTaskScheduled event.

Description	Action, Decision, or Event
9) An activity worker that can perform the ChargeCreditCard activity receives the task, performs it, and returns the results to Amazon SWF.	`PollForActivityTask` and `RespondActivityTaskCompleted` action.
10) Amazon SWF receives the results of the ChargeCreditCard activity task, adds them to the workflow history, and schedules a decision task.	ActivityTaskCompleted event and DecisionTaskScheduled event.
11) The decider receives the task from Amazon SWF, reviews the history, applies the coordination logic, makes a decision to schedule a ShipOrder activity task with the information the activity worker needs to perform the task, and returns the decision to Amazon SWF.	PollForDecisionTask action. RespondDecisionTaskCompleted with ScheduleActivityTask decision.
12) Amazon SWF receives the decision, schedules a ShipOrder activity task, and waits for it to complete or time out.	DecisionTaskCompleted event and ActivityTaskScheduled event.
13) An activity worker that can perform the ShipOrder activity receives the task, performs it, and returns the results to Amazon SWF.	`PollForActivityTask` action and `RespondActivityTaskCompleted` action.
14) Amazon SWF receives the results of the ShipOrder activity task, adds them to the workflow history, and schedules a decision task.	ActivityTaskCompleted event and DecisionTaskScheduled event.

Description	Action, Decision, or Event
15) The decider receives the task from Amazon SWF, reviews the history, applies the coordination logic, makes a decision to schedule a RecordCompletion activity task with the information the activity worker needs to perform the task, and returns the decision to Amazon SWF.	PollForDecisionTask action. RespondDecisionTaskCompleted action with ScheduleActivityTask decision.
16) Amazon SWF receives the decision, schedules a RecordCompletion activity task, and waits for it to complete or time out.	DecisionTaskCompleted event and ActivityTaskScheduled event.
17) An activity worker that can perform the RecordCompletion activity receives the task, performs it, and returns the results to Amazon SWF.	`PollForActivityTask` action and `RespondActivityTaskCompleted` action.
18) Amazon SWF receives the results of the RecordCompletion activity task, adds them to the workflow history, and schedules a decision task.	ActivityTaskCompleted event and DecisionTaskScheduled event.
19) The decider receives the task from Amazon SWF, reviews the history, applies the coordination logic, makes a decision to close the workflow execution and returns the decision along with any results to Amazon SWF.	PollForDecisionTask action. RespondDecisionTaskCompleted action with CompleteWorkflowExecution decision
20) Amazon SWF closes the workflow execution and archives the history for future reference.	WorkflowExecutionCompleted event.

Polling for Tasks in Amazon SWF

Deciders and activity workers communicate with Amazon SWF using *long polling*. The decider or activity worker periodically initiates communication with Amazon SWF, notifying Amazon SWF of its availability to accept a task, and then specifies a task list to get tasks from.

If a task is available on the specified task list, Amazon SWF returns it immediately in the response. If no task is available, Amazon SWF holds the TCP connection open for up to 60 seconds so that, if a task becomes available during that time, it can be returned in the same connection. If no task becomes available within 60 seconds, it returns an empty response and closes the connection. (An empty response is a Task structure in which the value of taskToken is an empty string.) If this happens, the decider or activity worker should poll again.

Long polling works well for high-volume task processing. Deciders and activity workers can manage their own capacity, and is easy to use when the deciders and activity workers are behind a firewall.

For more information, see Polling for Decision Tasks (p. 100) and Polling for Activity Tasks (p. 96).

Using IAM to Manage Access to Amazon SWF Resources

Every actor that accesses an Amazon SWF resource—deciders, activity workers, workflow administrators—must have authorized AWS access keys. An actor can access resources by using the account's access keys. However, access keys provide unrestricted access to all of the account's resources and are difficult to revoke, so they are not appropriate for all applications.

Amazon SWF uses AWS Identity and Access Management (IAM) to provide controlled access to resources. IAM provides a flexible way to manage access to an account's AWS resources without exposing the access keys. With IAM, you create one or more *users* that are associated with the AWS account. Each user has a separate set of IAM access keys that provide access to the account's resources. You then attach an *IAM policy* to the user—or a group that includes the user—to specify which resources the user can access. The policy can be much more granular than simply specifying whether to allow or deny account access. You could, for example, create a policy that allows a user to access an account, but only for a specified set of domains.

A further advantage of IAM is that you can revoke IAM access without affecting your access keys. In fact, periodically *rotating access keys*—revoking users' IAM access keys and issuing new ones—is a security best practice.

This topic discusses the details of how to use IAM to provide controlled access to Amazon SWF resources. It assumes that you are generally familiar with IAM, which is described in detail in the following documents.

- AWS Identity and Access Management (IAM)
- Using Identity and Access Management

Basic Principles

Amazon SWF access control is based primarily on two types of permissions:

- Resource permissions: Which Amazon SWF resources a user can access.

  You can express resource permissions only for domains.
- API permissions: Which Amazon SWF actions a user can call.

The simplest approach is to grant full account access—call any Amazon SWF action in any domain—or deny access entirely. However, IAM supports a more granular approach to access control that is often more useful. For example, you could:

- Allow a user to call any Amazon SWF action without restrictions, but only in a specified domain. You could use such a policy to allow workflow applications that are under development to use any action, but only a "sandbox" domain.
- Allow a user to access any domain, but constrain how they use the API. You could use such a policy to allow an "auditor" application to call the API in any domain, but allow only read access.
- Allow a user to call only a limited set of actions in certain domains. You could use such a policy to allow a workflow starter to call only the `StartWorkflowExecution` action in a specified domain.

Amazon SWF access control is based on the following principles:

- Access control decisions are based only on IAM policies; all policy auditing and manipulation is done through IAM.
- The access control model uses a deny-by-default policy; any access that is not explicitly allowed is denied.
- You control access to Amazon SWF resources by attaching appropriate IAM policies to the workflow's actors.
- Resource permissions can be expressed only for domains.
- You can further constrain the usage of some actions by applying conditions to one or more parameters.
- If you grant permission to use RespondDecisionTaskCompleted, you can express permissions for the list of decisions included in that action.

  Each of the decisions has one or more parameters, much like a regular API call. To allow for policies to be as readable as possible, you can express permissions on decisions as if they were actual API calls, including applying conditions to some parameters. These types of permissions are called *pseudo API* permissions.

For a summary of which regular and pseudo API parameters can be constrained by using conditions, see API Summary (p. 55).

Amazon SWF IAM Policies

An IAM policy contains one or more **Statement** elements, each of which contains a set of elements that define the policy. For a complete list of elements and a general discussion of how to construct policies, see The Access Policy Language. Amazon SWF access control is based on the following elements:

Effect

  [Required] The effect of the statement: **deny** or **allow**.

  Note
  You must explicitly allow access; IAM denies access by default.

Resource

  [Required] The resource—an entity in an AWS service that a user can interact with—that the statement applies to.

  You can express resource permissions only for domains. For example, a policy can allow access to only certain domains in your account. To express permissions for a domain, set **Resource** to the domain's Amazon Resource Name (ARN), which has the format "arn:aws:swf:*Region*:*AccountID*:/domain/*DomainName*". *Region* is the AWS region, *AccountID* is the account ID with no dashes, and *DomainName* is the domain name.

Action

[Required] The action that the statement applies to, which you refer to by using the following format: *serviceId*:*action*. For Amazon SWF, set *serviceID* to `swf`. For example, `swf:StartWorkflowExecution` refers to the StartWorkflowExecution action, and is used to control which users are allowed to start workflows.

If you grant permission to use RespondDecisionTaskCompleted, you can also control access to the included list of decisions by using **Action** to express permissions for the pseudo API. Because IAM denies access by default, a decider's decision must be explicitly allowed or it will not be accepted. You can use a '*' value to allow all decisions.

Condition

[Optional] Expresses a constraint on one or more of an action's parameters, which restricts the allowed values.

Amazon SWF actions often have a wide scope, which you can reduce by using IAM conditions. For example, to limit which task lists the PollForActivityTask action is allowed to access, you include a **Condition** and use the `swf:taskList.name` key to specify the allowable lists.

You can express constraints for the following entities.

- The workflow type. The name and version have separate keys.
- The activity type. The name and version have separate keys.
- Task lists.
- Tags. You can specify multiple tags for some actions. In that case, each tag has a separate key.

Note
For Amazon SWF, the values are all strings so you constrain a parameter by using a string operator such as `StringEquals`, which restricts the parameter to a specified string. However, the regular string comparison operators such as `StringEquals` require all requests to include the parameter. If you do not include the parameter explicitly, and there is no default value such as the default task list provided during type registration, access will be denied. It is often useful to treat conditions as optional, so that you can call an action without necessarily including the associated parameter. For example, you might want to allow a decider to specify a set of RespondDecisionTaskCompleted decisions, but also allow it to specify only one of them for any particular call. In that case, you constrain the appropriate parameters by using a `StringEqualsIfExists` operator, which allows access if the parameter satisfies the condition, but does not deny access if the parameter is absent.

For a complete list of constrainable parameters and the associated keys, see API Summary (p. 55).

The following section provides examples of how to construct Amazon SWF policies. For details, see String Conditions.

Amazon SWF Policy Examples

A workflow consists of multiple actors—activities, deciders, and so on. You can control access for each actor by attaching an appropriate IAM policy. This section provides some examples. The following shows the simplest case:

```
{
   "Version": "2012-10-17",
   "Statement" : [ {
      "Effect" : "Allow",
      "Action" : "swf:*",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/*"
   } ]
}
```

If you attach this policy to an actor, it has full account access across all regions. You can use wildcards to have a single value represent multiple resources, actions, or regions.

- The first '*' wildcard in the **Resource** value (...:swf:*:123...) indicates that the resource permissions apply to all regions. To restrict permissions to a single region, replace the '*' with the appropriate region string, such as us-east-1.
- The second '*' wildcard in the **Resource** value (/domain/*) allows the actor to access any of the account's domains in the specified regions.
- The '*' wildcard in the **Action** value allows the actor to call any Amazon SWF action.

For details on how to use wildcards, see Element Descriptions

The following sections show examples of policies that grant permissions in a more granular way.

Domain Permissions

If you want to restrict a department's workflows to a particular domain, you can use something like:

```
{
   "Version": "2012-10-17",
   "Statement": [ {
      "Effect" : "Allow",
      "Action" : "swf:*",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/department1"
   } ]
}
```

If you attach this policy to an actor, it can call any action, but only for the department1 domain.

If you want an actor to have access to more than one domain, you can express permission for each domain separately, as follows:

```
{
   "Version": "2012-10-17",
   "Statement": [
      {
         "Effect" : "Allow",
         "Action" : "swf:*",
         "Resource" : "arn:aws:swf:*:123456789012:/domain/department1"
      }, {
         "Effect" : "Allow",
         "Action" : "swf:*",
         "Resource" : "arn:aws:swf:*:123456789012:/domain/department2"
      }
   ]
}
```

If you attach this policy to an actor, it can use any Amazon SWF action in the "department1" and "department2" domains. You can also sometimes use wildcards to represent multiple domains.

API Permissions and Constraints

You control which actions an actor can use with the **Action** element. Optionally, you can constrain the action's allowable parameter values by using a **Condition** element.

If you want to restrict an actor to only certain actions, you can use something like the following:

```
{
   "Version": "2012-10-17",
   "Statement": [ {
      "Effect" : "Allow",
      "Action" : "swf:StartWorkflowExecution",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/department2"
   } ]
}
```

If you attach this policy to an actor, it can call `StartWorkflowExecution` to start workflows in the "department2" domain. It cannot use any other actions or start workflows in any other domains.

You can further restrict which workflows an actor can start by constraining one or more of the `StartWorkflowExecution` parameter values, as follows:

```
{
   "Version": "2012-10-17",
   "Statement": [
      {
         "Effect" : "Allow",
         "Action" : "swf:StartWorkflowExecution",
         "Resource" : "arn:aws:swf:*:123456789012:/domain/department1",
         "Condition" : {
            "StringEquals" : {
               "swf:workflowType.name" : "workflow1",
               "swf:workflowType.version" : "version2"
            }
         }
      }
   ]
}
```

This policy constrains the `StartWorkflowExecution` action's **name** and **version** parameters. If you attach the policy to an actor, it can run only "version2" of "workflow1" in the "department1" domain and both parameters must be included in the request.

You can constrain a parameter without requiring it to be included in a request by using a `StringEqualsIfExists` operator, as follows:

```
{
   "Version": "2012-10-17",
   "Statement" : [ {
      "Effect" : "Allow",
      "Action" : "swf:StartWorkflowExecution",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/some_domain",
      "Condition" : {
         "StringEqualsIfExists" : { "swf:taskList.name" : "task_list_name" }
      }
   } ]
}
```

This policy allows an actor to optionally specify a task list when starting a workflow execution.

You can constrain a list of tags for some actions. In that case, each tag has a separate key, so you use `swf:tagList.member.0` to constrain the first tag in the list, `swf:tagList.member.1` to constrain the second tag in the list, and so on, up to a maximum of 5. However, you must be careful how you constrain tag lists. For instance, here is an example of a policy that is *not* recommended:

```
{
   "Version": "2012-10-17",
   "Statement" : [ {
      "Effect" : "Allow",
      "Action" : "swf:StartWorkflowExecution",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/some_domain",
      "Condition" : {
         "StringEqualsIfExists" : {
            "swf:tagList.member.0" : "some_ok_tag", "another_ok_tag"
         }
      }
   } ]
}
```

This policy allows you to optionally specify either "some_ok_tag" or "another_ok_tag". However, this policy constrains only the first element of the tag list. The list could have additional elements with arbitrary values that would all be allowed because this policy does not apply any conditions to `swf:tagList.member.1`, `swf:tagList.member.2`, and so on .

One way to address this issue is to disallow the use of tag lists. The following policy ensures that only "some_ok_tag" or "another_ok_tag" are allowed by requiring the list to have only one element.

```
{
   "Version": "2012-10-17",
   "Statement" : [ {
      "Effect" : "Allow",
      "Action" : "swf:StartWorkflowExecution",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/some_domain",
      "Condition" : {
         "StringEqualsIfExists" : {
            "swf:tagList.member.0" : "some_ok_tag", "another_ok_tag"
         },
         "Null" : { "swf:tagList.member.1" : "true" }
      }
   } ]
}
```

Pseudo API Permissions and Constraints

If you want to restrict the decisions available to `RespondDecisionTaskCompleted`, you must first allow the actor to call `RespondDecisionTaskCompleted`. You can then express permissions for the appropriate pseudo API members by using the same syntax as for the regular API, as follows:

```
{
   "Version": "2012-10-17",
   "Statement" : [
      {
         "Resource" : "arn:aws:swf:*:123456789012:/domain/*",
         "Action" : "swf:RespondDecisionTaskCompleted",
         "Effect" : "Allow"
      }, {
         "Resource" : "*",
         "Action" : "swf:ScheduleActivityTask",
         "Effect" : "Allow",
         "Condition" : {
            "StringEquals" : { "swf:activityType.name" : "SomeActivityType" }
         }
      }
   ]
}
```

If you attach this policy to an actor, the first `Statement` element allows the actor to call `RespondDecisionTaskCompleted`. The second element allows the actor to use the `ScheduleActivityTask` decision to direct Amazon SWF to schedule an activity task. To allow all decisions, replace "swf:ScheduleActivityTask" with "swf:*".

You can use Condition operators to constrain parameters just as with the regular API. The `StringEquals` operator in this Condition allows `RespondDecisionTaskCompleted` to schedule an activity task for the "SomeActivityType" activity, and it must schedule that task. If you want to allow `RespondDecisionTaskCompleted` to use a parameter value but not require it to do so, you can instead use the `StringEqualsIfExists` operator.

Service Model Limitations on IAM Policies

You must consider service model constraints when creating IAM policies. It is possible to create a syntactically valid IAM policy that represents an invalid Amazon SWF request; a request that is allowed in terms of access control can still fail because it is an invalid request.

For instance, the following policy for ListOpenWorkflowExecutions is *not* recommended:

```

{
   "Version": "2012-10-17",
   "Statement" : [ {
      "Effect" : "Allow",
      "Action" : "swf:ListOpenWorkflowExecutions",
      "Resource" : "arn:aws:swf:*:123456789012:/domain/domain_name",
      "Condition" : {
         "StringEquals" : {
            "swf:typeFilter.name" : "workflow_name",
            "swf:typeFilter.version" : "workflow_version",
            "swf:tagFilter.tag" : "some_tag"
         }
      }
   } ]
}
```

The Amazon SWF service model does not allow the `typeFilter` and `tagFilter` parameters to be used in the same `ListOpenWorkflowExecutions` request. The policy therefore allows calls that the service will reject—by throwing `ValidationException`—as an invalid request.

API Summary

This section briefly describes how you can use IAM policies to control how an actor can use each API and pseudo API to access Amazon SWF resources.

- For all actions except `RegisterDomain` and `ListDomains`, you can allow or deny access to any or all of an account's domains by expressing permissions for the domain resource.

- You can allow or deny permission for any member of the regular API and, if you grant permission to call RespondDecisionTaskCompleted, any member of the pseudo API.
- You can use a Condition to constrain some parameters' allowable values.

The following sections list the parameters that can be constrained for each member of the regular and pseudo API and provide the associated key, and note any limitations on how you can control domain access.

Regular API

This section lists the regular API members, and briefly describes the parameters that can be constrained and the associated keys. It also notes any limitations on how you can control domain access.

CountClosedWorkflowExecutions

- **tagFilter.tag**: String constraint. The key is `swf:tagFilter.tag`
- **typeFilter.name**: String constraint. The key is `swf:typeFilter.name`.
- **typeFilter.version**: String constraint. The key is `swf:typeFilter.version`.

Note
`CountClosedWorkflowExecutions` requires **typeFilter** and **tagFilter** to be mutually exclusive.

CountOpenWorkflowExecutions

- **tagFilter.tag**: String constraint. The key is `swf:tagFilter.tag`
- **typeFilter.name**: String constraint. The key is `swf:typeFilter.name`.
- **typeFilter.version**: String constraint. The key is `swf:typeFilter.version`.

Note
`CountOpenWorkflowExecutions` requires **typeFilter** and **tagFilter** to be mutually exclusive.

CountPendingActivityTasks

- **taskList.name**: String constraint. The key is `swf:taskList.name`.

CountPendingDecisionTasks

- **taskList.name**: String constraint. The key is `swf:taskList.name`.

DeprecateActivityType

- **activityType.name**: string constraint. The key is `swf:activityType.name`.
- **activityType.version**: String constraint. The key is `swf:activityType.version`.

DeprecateDomain

- You cannot constrain this action's parameters.

DeprecateWorkflowType

- **workflowType.name**: String constraint. The key is `swf:workflowType.name`.
- **workflowType.version**: String constraint. The key is `swf:workflowType.version`.

DescribeActivityType

- **activityType.name**: string constraint. The key is `swf:activityType.name`.
- **activityType.version**: String constraint. The key is `swf:activityType.version`.

DescribeDomain

- You cannot constrain this action's parameters.

DescribeWorkflowExecution

- You cannot constrain this action's parameters.

DescribeWorkflowType

- **workflowType.name**: String constraint. The key is `swf:workflowType.name`.
- **workflowType.version**: String constraint. The key is `swf:workflowType.version`.

GetWorkflowExecutionHistory

- You cannot constrain this action's parameters.

ListActivityTypes

- You cannot constrain this action's parameters.

ListClosedWorkflowExecutions

- **tagFilter.tag**: String constraint. The key is `swf:tagFilter.tag`
- **typeFilter.name**: String constraint. The key is `swf:typeFilter.name`.
- **typeFilter.version**: String constraint. The key is `swf:typeFilter.version`.

Note
`ListClosedWorkflowExecutions` requires **typeFilter** and **tagFilter** to be mutually exclusive.

ListDomains

- You cannot constrain this action's parameters.

ListOpenWorkflowExecutions

- **tagFilter.tag**: String constraint. The key is `swf:tagFilter.tag`
- **typeFilter.name**: String constraint. The key is `swf:typeFilter.name`.
- **typeFilter.version**: String constraint. The key is `swf:typeFilter.version`.

Note
`ListOpenWorkflowExecutions` requires **typeFilter** and **tagFilter** to be mutually exclusive.

ListWorkflowTypes

- You cannot constrain this action's parameters.

PollForActivityTask

- **taskList.name**: String constraint. The key is `swf:taskList.name`.

PollForDecisionTask

- **taskList.name**: String constraint. The key is `swf:taskList.name`.

RecordActivityTaskHeartbeat

- You cannot constrain this action's parameters.

RegisterActivityType

- **defaultTaskList.name**: String constraint. The key is `swf:defaultTaskList.name`.
- **name**: String constraint. The key is `swf:name`.
- **version**: String constraint. The key is `swf:version`.

RegisterDomain

- **name**: The name of the domain being registered is available as the resource of this action.

RegisterWorkflowType

- **defaultTaskList.name**: String constraint. The key is `swf:defaultTaskList.name`.
- **name**: String constraint. The key is `swf:name`.
- **version**: String constraint. The key is `swf:version`.

RequestCancelWorkflowExecution

- You cannot constrain this action's parameters.

RespondActivityTaskCanceled

- You cannot constrain this action's parameters.

RespondActivityTaskCompleted

- You cannot constrain this action's parameters.

RespondActivityTaskFailed

- You cannot constrain this action's parameters.

RespondDecisionTaskCompleted

- **decisions.member.N**: Restricted indirectly through pseudo API permissions. For details, see Pseudo API (p. 59).

SignalWorkflowExecution

- You cannot constrain this action's parameters.

StartWorkflowExecution

- **tagList.member.0**: String constraint. The key is `swf:tagList.member.0`
- **tagList.member.1**: String constraint. The key is `swf:tagList.member.1`
- **tagList.member.2**: String constraint. The key is `swf:tagList.member.2`
- **tagList.member.3**: String constraint. The key is `swf:tagList.member.3`
- **tagList.member.4**: String constraint. The key is `swf:tagList.member.4`
- **taskList.name**: String constraint. The key is `swf:taskList.name`.
- **workflowType.name**: String constraint. The key is `swf:workflowType.name`.
- **workflowType.version**: String constraint. The key is `swf:workflowType.version`.

> **Note**
> You cannot constrain more than five tags.

TerminateWorkflowExecution

- You cannot constrain this action's parameters.

Pseudo API

This section lists the members of the pseudo API, which represent the decisions included in RespondDecisionTaskCompleted. If you have granted permission to use `RespondDecisionTaskCompleted`, your policy can express permissions for the members of this API in the same way as the regular API. You can further restrict some members of the pseudo-API by setting conditions on one or more parameters. This section lists the pseudo API members, and briefly describes the parameters that can be constrained and the associated keys.

> **Note**
> The `aws:SourceIP`, `aws:UserAgent`, and `aws:SecureTransport` keys are not available for the pseudo API. If your intended security policy requires these keys to control access to the pseudo API, you can use them with the `RespondDecisionTaskCompleted` action.

`CancelTimer`

- You cannot constrain this action's parameters.

`CancelWorkflowExecution`

- You cannot constrain this action's parameters.

`CompleteWorkflowExecution`

- You cannot constrain this action's parameters.

`ContinueAsNewWorkflowExecution`

- **tagList.member.0**: String constraint. The key is `swf:tagList.member.0`
- **tagList.member.1**: String constraint. The key is `swf:tagList.member.1`
- **tagList.member.2**: String constraint. The key is `swf:tagList.member.2`
- **tagList.member.3**: String constraint. The key is `swf:tagList.member.3`

- **tagList.member.4**: String constraint. The key is `swf:tagList.member.4`
- **taskList.name**: String constraint. The key is `swf:taskList.name`.
- **workflowTypeVersion**: String constraint. The key is `swf:workflowTypeVersion`.

> **Note**
> You cannot constrain more than five tags.

`FailWorkflowExecution`

- You cannot constrain this action's parameters.

`RecordMarker`

- You cannot constrain this action's parameters.

`RequestCancelActivityTask`

- You cannot constrain this action's parameters.

`RequestCancelExternalWorkflowExecution`

- You cannot constrain this action's parameters.

`ScheduleActivityTask`

- **activityType.name**: String constraint. The key is `swf:activityType.name`.
- **activityType.version**: String constraint. The key is `swf:activityType.version`.
- **taskList.name**: String constraint. The key is `swf:taskList.name`.

`SignalExternalWorkflowExecution`

- You cannot constrain this action's parameters.

`StartChildWorkflowExecution`

- **tagList.member.0**: String constraint. The key is `swf:tagList.member.0`
- **tagList.member.1**: String constraint. The key is `swf:tagList.member.1`
- **tagList.member.2**: String constraint. The key is `swf:tagList.member.2`
- **tagList.member.3**: String constraint. The key is `swf:tagList.member.3`
- **tagList.member.4**: String constraint. The key is `swf:tagList.member.4`
- **taskList.name**:String constraint. The key is `swf:taskList.name`.
- **workflowType.name**: String constraint. The key is `swf:workflowType.name`.
- **workflowType.version**: String constraint. The key is `swf:workflowType.version`.

> **Note**
> You cannot constrain more than five tags.

`StartTimer`

- You cannot constrain this action's parameters.

Advanced Concepts in Amazon SWF

Topics

The e-commerce example in the Basic Concepts in Amazon SWF (p. 33) section represents a simplified workflow scenario. In reality, you are likely to want your workflow to do concurrent tasks (send an order confirmation email while authorizing a credit card), record major events (all items are packed), update the order with changes (add or remove an item), and make other more advanced decisions as part of your workflow execution. This section describes advanced workflow features that you can use to construct robust and sophisticated workflows.

Versioning

Business needs often require you to have different implementations or variations of the same workflow or activity running simultaneously. For example, you might want to test a new implementation of a workflow while another one is in production. You might also want to run two different implementations with two different feature sets, such as a basic and premium implementation. Versioning enables you to run multiple implementations of workflows and activities concurrently, for any purpose that meets your requirements.

Workflow and activity types have a version associated with them which is specified at registration time. Version is a free-form string and you can choose your own versioning scheme. In order to create a new version of a registered type, you should register it with the same name and a different version. Amazon SWF Task Lists (p. 42), described earlier, can further help you to implement versioning. Consider a situation in which you have long-running workflow executions of a given type already in progress, and circumstances require that you revise the workflow, such as to add a new feature. You could implement the new feature by creating new versions of activity types and workers, and a new decider. Then you could launch executions of the new workflow version using a different set of task lists. This way, you could have executions of workflows of different versions running simultaneously without affecting each other.

Signals

Signals enable you to inject information into a running workflow execution. In some scenarios, you might want to add information to a running workflow execution to let it know that something has changed or to inform it of an external event. Any process can send a signal to an open workflow execution. For example, one workflow execution might signal another.

To use signals, define the signal name and data to be passed to the signal—if any. Then, program the decider to recognize the signal event (WorkflowExecutionSignaled) in the history and process it appropriately. When a process wants to signal a workflow execution, it makes a call to Amazon SWF (using the SignalWorkflowExecution action or, in the case of a decider, using the SignalExternalWorkflowExecution decision) that specifies the identifier for the target workflow execution, the signal name, and the signal data. Amazon SWF then receives the signal, records it in the history of the target workflow execution, and schedules a decision task for it. When the decider receives the decision task, it also receives the signal inside the workflow execution history. The decider can then take appropriate actions based on the signal and its data.

Some applications for signals include the following:

- Pausing workflow executions from progressing until a signal is received (e.g., waiting for an inventory shipment).
- Providing information to a workflow execution that might affect the logic of how deciders make decisions. This is useful for workflows affected by external events (e.g., trying to finish the sale of a stock after the market closes).
- Updating a workflow execution when you anticipate that changes might occur (e.g., changing order quantities after an order is placed and before it ships).

For cases in which a workflow should be canceled—for example, the order itself was canceled by the customer—the `RequestCancelWorkflowExecution` action should be used rather than sending a signal to the workflow.

Child Workflows

Complicated workflows can be broken into smaller, more manageable, and potentially reusable components by using child workflows. A child workflow is a workflow execution that is initiated by another (parent) workflow execution. To initiate a child workflow, the decider for the parent workflow uses the `StartChildWorkflowExecution` decision. Input data specified with this decision is made available to the child workflow through its history.

The attributes for the `StartChildWorkflowExecution` decision also specify the *child policy*, that is, how Amazon SWF should handle the situation in which the parent workflow execution terminates before the child workflow execution. There are three possible values:

- TERMINATE: Amazon SWF will terminate the child executions.
- REQUEST_CANCEL: Amazon SWF will attempt to cancel the child execution by placing a `WorkflowExecutionCancelRequested` event in the child's workflow execution history.
- ABANDON: Amazon SWF will take no action; the child executions will continue to run.

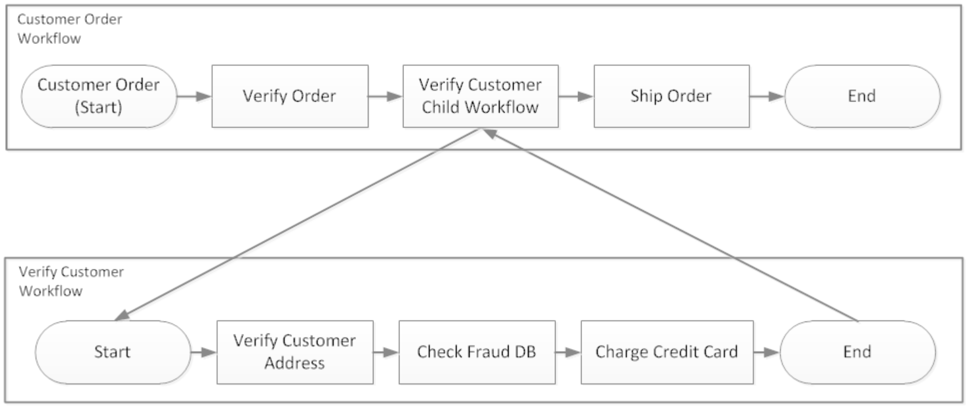
After the child workflow execution starts, it runs like a regular execution. When it completes, Amazon SWF records the completion, along with its results, in the parent workflow execution's workflow history. Examples of child workflows include the following:

- Credit card processing child workflow used by workflows in different websites

- Email child workflow that verifies the customer email address, checks the opt-out list, sends the email, and verifies that it didn't bounce or fail.
- Database storage and retrieval child workflow that combines connection, setup, transaction, and verification.
- Source code compilation child workflow that combines building, packaging, and verification.

In the e-commerce example, you might want to make the Charge Credit Card activity a child workflow. To do this, you could register a new Verify Customer workflow, register the Verify Customer Address and Check Fraud DB activities, and define coordination logic for the tasks. Then, a decider in the Customer Order workflow can initiate a Verify Customer child workflow by scheduling the `StartChildWorkflowExecution` decision that specifies this workflow type.

The following figure shows a customer order workflow that includes a new Verify Customer child workflow, which checks the customer address, checks the fraud database, and charges the credit card.



Multiple workflows could create child workflow executions using the same workflow type. For example, the Verify Customer child workflow could also be used in other parts of an organization. The events for a child workflow are contained in its own workflow history and are not included in the parent's workflow history.

Because child workflows are simply workflow executions that are initiated by a decider, they could also be started as normal stand-alone workflows executions.

Markers

At times, you might want to record information in the workflow history of a workflow execution that is specific to your use case. Markers enable you to record information in the workflow execution history that you can use for any custom or scenario-specific purpose.

To use markers, a decider uses the RecordMarker decision, names the marker, attaches desired data to the decision, and notifies Amazon SWF using the `RespondDecisionTaskCompleted` action. Amazon SWF receives the request, records the marker in the workflow history, and enacts any other decisions in the request. From that point on, deciders can see the marker in the workflow history and use it in any way that you program.

Examples of markers include the following:

- A counter that counts the number of loops in a recursive workflow.
- Progress of the workflow execution based on the results of activities.
- Information summarized from earlier workflow history events.

In the e-commerce example, you might add an activity that checks the inventory every day and increments the count in a marker each time. Then, you could add decision logic that emails the customer or notifies a manager when the count exceeds five, without having to review the entire history.

Tags

Amazon SWF enables you to associate tags with workflow executions and later query for workflow executions based on these tags. Tagging enables you to filter the listing of the executions when you use the visibility operations. By carefully selecting the tags you assign to an execution, you can use them to help provide meaningful listings.

For example, suppose you run several fulfillment centers. Proper tagging could enable you to list the processes occurring in a specific fulfillment center. Or, to take another example, if a customer is converting different types of media files, tagging could enable you to show the processing differences used for converting video, audio, and image files.

Amazon SWF supports tagging a workflow execution with up to five tags. Each tag is a free-form string and may be up to 256 characters in length. If you want to use tags, you must assign them when you start a workflow execution. You cannot add tags to a workflow execution after it has been started, nor may you edit or remove tags that have been assigned to a workflow execution.

Using the Amazon SWF Console

The Amazon Simple Workflow Service (Amazon SWF) console provides an alternative way to configure, initiate, and manage workflow executions.

With the Amazon SWF console, you can:

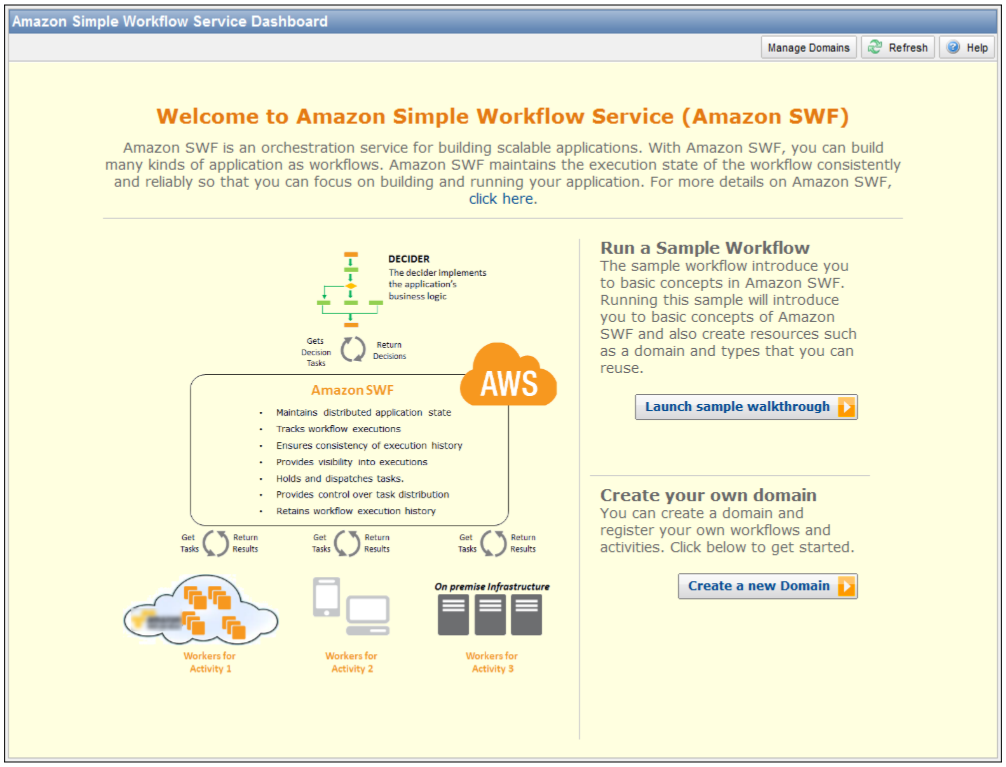
- Register workflow domains.
- Register workflow types.
- Register activity types.
- Initiate workflow executions.
- View information about pending tasks.
- View running workflow executions.
- Cancel, terminate, and send signals to running workflow executions.
- Restart closed workflow executions.

The Amazon SWF console is part of the larger AWS Console experience, which you can access by signing in at https://aws.amazon.com/. The sign-in link is located in the upper-right corner of the page.

Topics

Amazon Simple Workflow Service Dashboard

The following image shows the **Amazon Simple Workflow Service Dashboard** area of the Amazon SWF console as it looks when no domains are registered.



Amazon Simple Workflow Service Dashboard

Manage Domains | Refresh | Help

Welcome to Amazon Simple Workflow Service (Amazon SWF)

Amazon SWF is an orchestration service for building scalable applications. With Amazon SWF, you can build many kinds of application as workflows. Amazon SWF maintains the execution state of the workflow consistently and reliably so that you can focus on building and running your application. For more details on Amazon SWF, click here.

DECIDER
The decider implements the application's business logic
Gets Decision Tasks
Return Decisions
AWS
Amazon SWF
Maintains distributed application state
Tracks workflow executions
Ensures consistency of execution history
Provides visibility into executions
Holds and dispatches tasks.
Provides control over task distribution
Retains workflow execution history
Get Tasks
Return Results
Get Tasks
Return Results
Get Tasks
Return Results
On premise Infrastructure
Workers for Activity 1
Workers for Activity 2
Workers for Activity 3

Run a Sample Workflow

The sample workflow introduce you to basic concepts in Amazon SWF. Running this sample will introduce you to basic concepts of Amazon SWF and also create resources such as a domain and types that you can reuse.

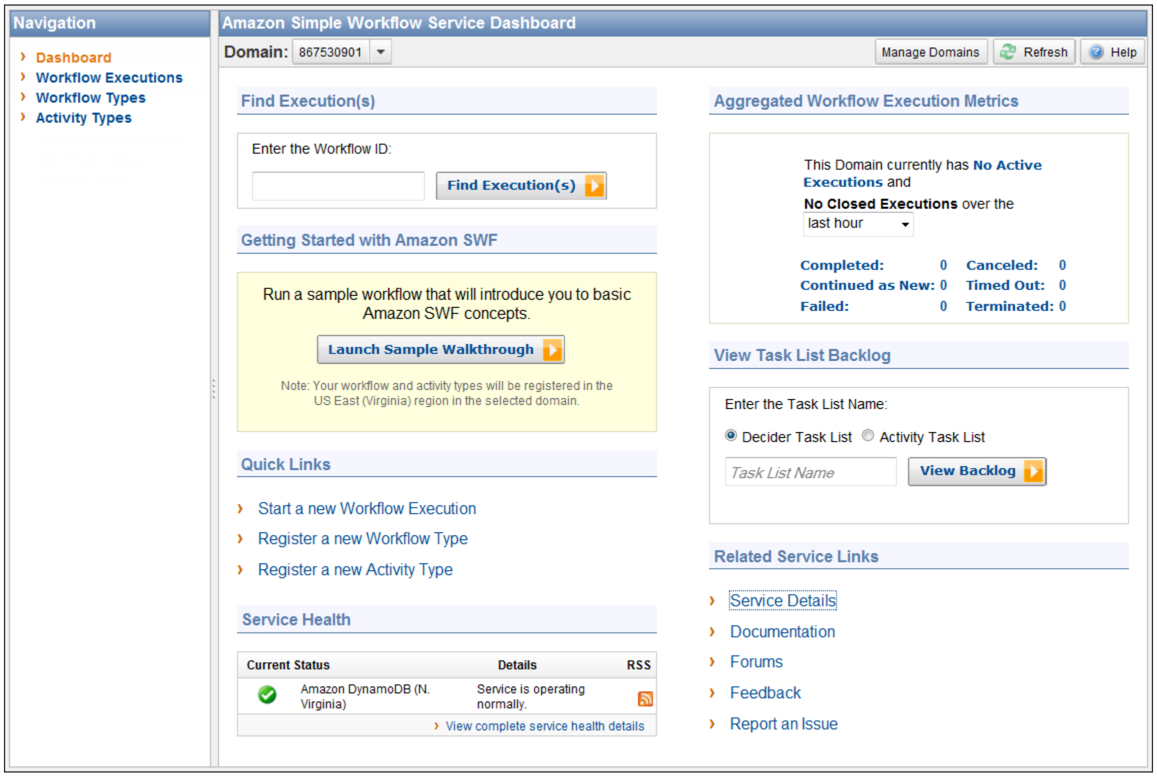
Launch sample walkthrough

Create your own domain

You can create a domain and register your own workflows and activities. Click below to get started.

Create a new Domain

When at least one domain is registered, the **Amazon Simple Workflow Service Dashboard** displays full functionality.



Navigation

- Dashboard
- Workflow Executions
- Workflow Types
- Activity Types

Amazon Simple Workflow Service Dashboard

Domain: 867530901

Manage Domains | Refresh | Help

Find Execution(s)

Enter the Workflow ID:

Find Execution(s)

Getting Started with Amazon SWF

Run a sample workflow that will introduce you to basic Amazon SWF concepts.

Launch Sample Walkthrough

Note: Your workflow and activity types will be registered in the US East (Virginia) region in the selected domain.

Quick Links

- Start a new Workflow Execution
- Register a new Workflow Type
- Register a new Activity Type

Service Health

Current Status		Details	RSS
✓	Amazon DynamoDB (N. Virginia)	Service is operating normally.	

View complete service health details

Aggregated Workflow Execution Metrics

This Domain currently has **No Active Executions** and **No Closed Executions** over the last hour

Completed:	0	**Canceled:**	0
Continued as New:	0	**Timed Out:**	0
Failed:	0	**Terminated:**	0

View Task List Backlog

Enter the Task List Name:

(● Decider Task List) ○ Activity Task List

Task List Name | View Backlog

Related Service Links

- Service Details
- Documentation
- Forums
- Feedback
- Report an Issue

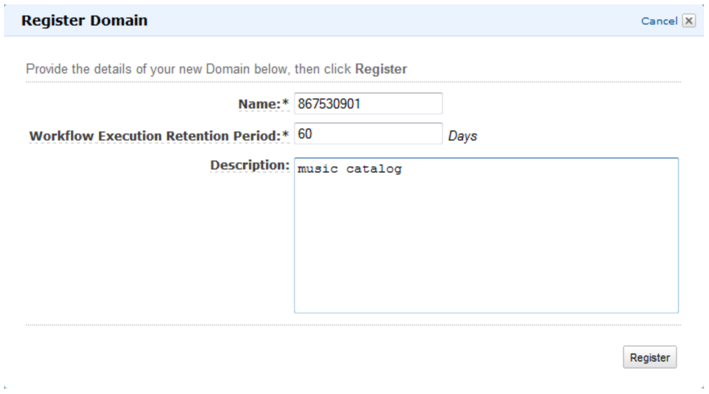
Registering an Amazon SWF Domain

Until at least one domain is registered, domain registration is the only functionality available from the console.

To register an Amazon SWF domain using the console

1. If no domains have been registered, in the center of the main pane, choose **Register a New Domain**.

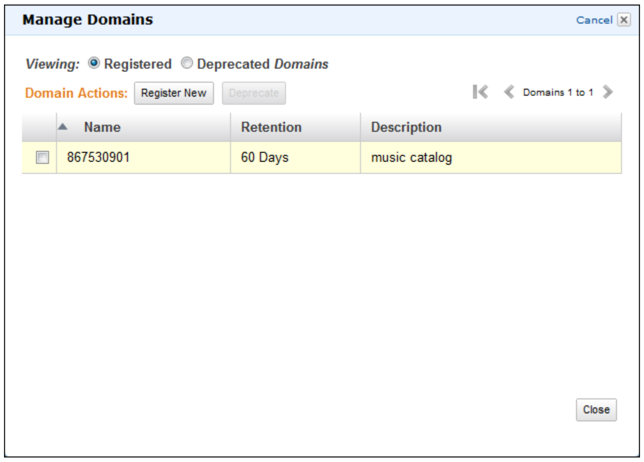
   If at least one domain is registered, in the dashboard view, choose the **Manage Domains** button, and then in the **Manage Domains** dialog box, choose **Register New**.
2. In the **Register Domain** dialog box, enter a Name, Retention Period, and Description. These values correspond to the similarly-named parameters in the **RegisterDomain** action.



Provide the details of your new Domain below, then click Register

Name:*	867530901
Workflow Execution Retention Period:*	60 Days
Description:	music catalog

3. Choose **Register**.
4. After the domain is registered, the console displays the **Manage Domains** dialog box.



Viewing: [✓ Registered] Deprecated Domains

Domain Actions:

Name	Retention	Description
867530901	60 Days	music catalog

Registering a Workflow Type

You can register workflow types using the Amazon Simple Workflow console. You are not able to register a workflow type until at least one domain is registered.

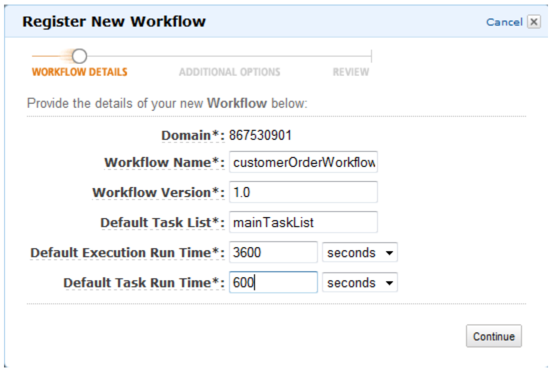
To register an Amazon SWF workflow type using the console

1. In the **Amazon Simple Workflow Service Dashboard**, under **Quick Links**, choose **Register New Workflow Type**.

In the **Workflow Details** dialog box, enter the following information.

- Domain
- Workflow Name
- Workflow Version
- Default Task List
- Default Execution Run Time
- Default Task Run Time

Fields marked with an asterisk ("*") are required.

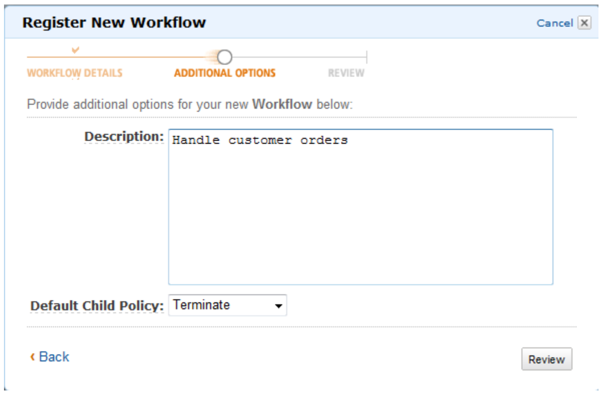


Provide the details of your new **Workflow** below:

Domain*:	867530901	
Workflow Name*:	customerOrderWorkflow	
Workflow Version*:	1.0	
Default Task List*:	mainTaskList	
Default Execution Run Time*:	3600	seconds
Default Task Run Time*:	600	seconds

Choose **Continue**.

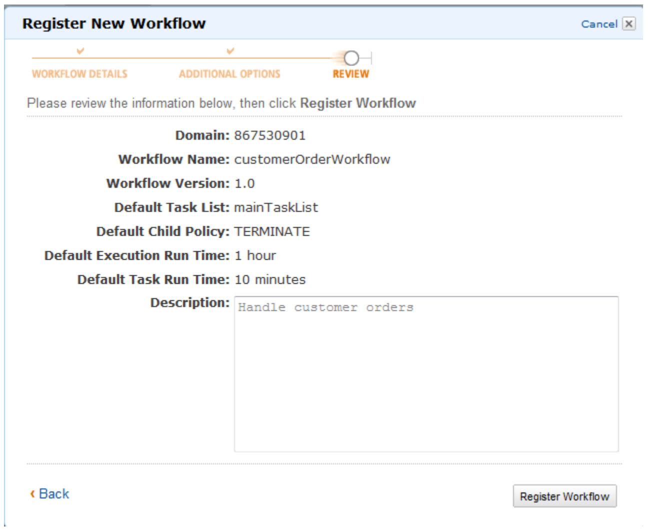
2. In the **Additional Options** dialog box, enter a **Description** and specify a **Default Child Policy**. Choose **Review**.



Provide additional options for your new **Workflow** below:

Description:	Handle customer orders
Default Child Policy:	Terminate

3. In the **Review** dialog box, review the information that you entered in the previous dialog boxes. If the information is correct, choose **Register Workflow**. Otherwise, choose **Back** to change the information.


Register New Workflow

Please review the information below, then click **Register Workflow**

Domain:	867530901
Workflow Name:	customerOrderWorkflow
Workflow Version:	1.0
Default Task List:	mainTaskList
Default Child Policy:	TERMINATE
Default Execution Run Time:	1 hour
Default Task Run Time:	10 minutes
Description:	Handle customer orders

Registering an Activity Type

You can register activity types using the Amazon Simple Workflow Service console. You are not able to register an activity type until at least one domain is registered.

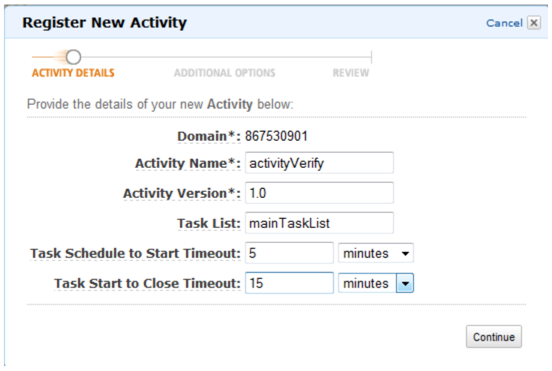
To register an Amazon SWF activity type using the console

1. In the **Amazon Simple Workflow Service Dashboard**, under **Quick Links**, choose **Register New Activity Type**.

   In the **Activity Details** dialog box, enter the following information.

   - Domain
   - Activity Name
   - Activity Version
   - Default Task List
   - Task Schedule to Start Timeout
   - Task Start to Close Timeout

   Fields marked with an asterisk ("*") are required.

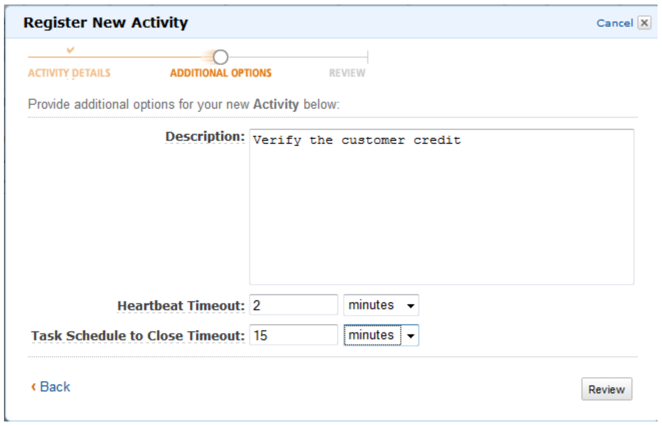

Register New Activity

Provide the details of your new **Activity** below:

Domain*:	867530901	
Activity Name*:	activityVerify	
Activity Version*:	1.0	
Task List:	mainTaskList	
Task Schedule to Start Timeout:	5	minutes
Task Start to Close Timeout:	15	minutes

   Choose **Continue**.

2. In the **Additional Options** dialog box, enter a **Description** and specify a **Heartbeat Timeout** and a **Task Schedule to Close Timeout**. Choose **Review**.



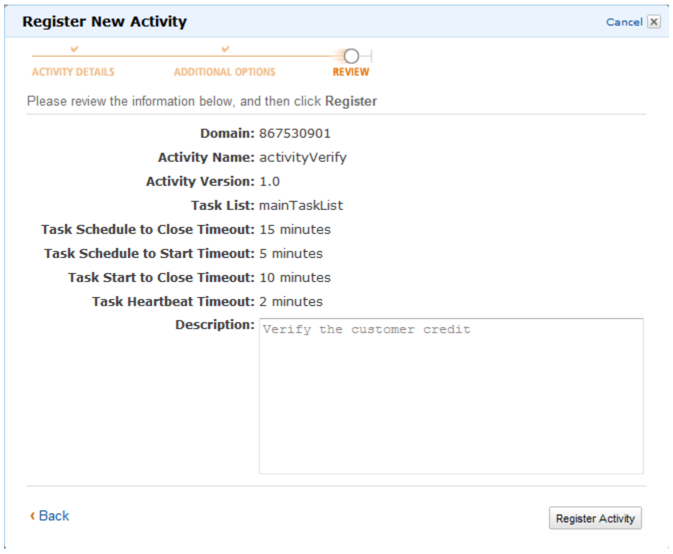
Provide additional options for your new Activity below:

Description: Verify the customer credit

Heartbeat Timeout: 2 minutes

Task Schedule to Close Timeout: 15 minutes

3. In the **Review** dialog box, review the information that you entered in the previous dialog boxes. If the information is correct, choose **Register Activity**. Otherwise, choose **Back** to change the information.



Please review the information below, and then click Register

Domain: 867530901
Activity Name: activityVerify
Activity Version: 1.0
Task List: mainTaskList
Task Schedule to Close Timeout: 15 minutes
Task Schedule to Start Timeout: 5 minutes
Task Start to Close Timeout: 10 minutes
Task Heartbeat Timeout: 2 minutes
Description: Verify the customer credit

Starting a Workflow Execution

You can start a workflow execution from the Amazon Simple Workflow Service console. You are not able to start a workflow execution until you have registered at least one workflow type.

To start a workflow execution using the console

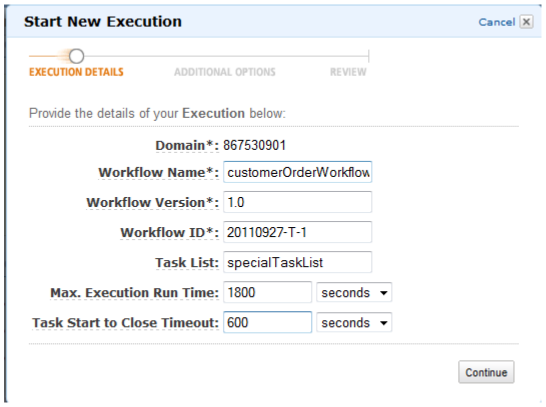
1. In the **Amazon Simple Workflow Service Dashboard**, under **Quick Links**, choose **Start a New Workflow Execution**.

   In the **Execution Details** dialog box, enter the following information.

   - Domain
   - Workflow Name
   - Workflow Version
   - Workflow ID

- Task List
- Maximum Execution Run Time
- Task Start to Close Timeout

Fields marked with an asterisk ("*") are required.



Start New Execution

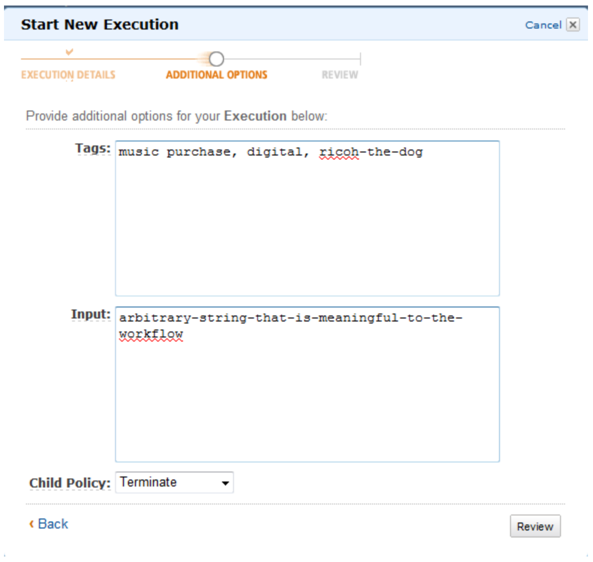
Provide the details of your Execution below:

Domain*:	867530901
Workflow Name*:	customerOrderWorkflow
Workflow Version*:	1.0
Workflow ID*:	20110927-T-1
Task List:	specialTaskList
Max. Execution Run Time:	1800 seconds
Task Start to Close Timeout:	600 seconds

Choose **Continue**.

2. In the **Additional Options** dialog box, specify:

   - A set of **Tags** to associate with the workflow execution. You can use these tags to query information about your workflow executions.
   - An **Input** string that is meaningful to the execution. This string is not interpreted by Amazon SWF.
   - A **Child Policy**.

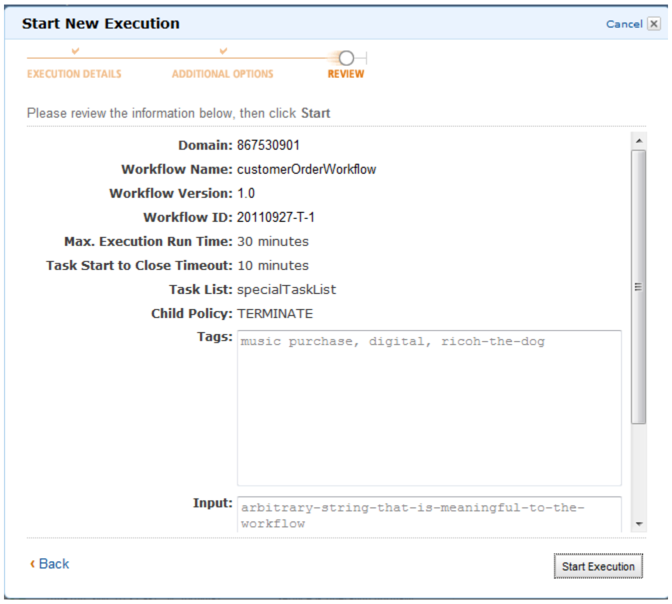


Start New Execution

Provide additional options for your Execution below:

Tags:	music purchase, digital, ricoh-the-dog
Input:	arbitrary-string-that-is-meaningful-to-the-workflow
Child Policy:	Terminate

3. In the **Review** dialog box, review the information that you entered in the previous dialog boxes. If the information is correct, choose **Start Execution**. Otherwise, choose **Back** to change the information.



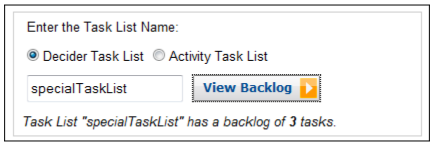
Please review the information below, then click Start

Domain:	867530901
Workflow Name:	customerOrderWorkflow
Workflow Version:	1.0
Workflow ID:	20110927-T-1
Max. Execution Run Time:	30 minutes
Task Start to Close Timeout:	10 minutes
Task List:	specialTaskList
Child Policy:	TERMINATE
Tags:	music purchase, digital, ricoh-the-dog
Input:	arbitrary-string-that-is-meaningful-to-the-workflow

Viewing Pending Tasks

From the Amazon Simple Workflow Service Dashboard, you can view the number of pending tasks that are associated with a particular task list.

1. Select whether the task list is a **Decider Task List** or **Activity Task List**.
2. Enter the task list name in the text box.
3. Choose **View Backlog**.


Enter the Task List Name:

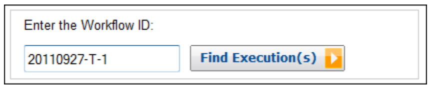
[✓ Decider Task List] Activity Task List

specialTaskList

Task List "specialTaskList" has a backlog of 3 tasks.

Managing Your Workflow Executions

The **My Workflow Executions** view in the Amazon SWF console provides functionality for managing your workflow executions both those that are currently running, and those that are closed. To access this view, choose the **Find Execution(s)** button in the Amazon SWF Dashboard.


Enter the Workflow ID:

20110927-T-1

If you first enter a workflow ID, the console will display executions with that workflow ID. Otherwise, if you choose **Find Execution(s)**, the **My Workflow Executions** view will enable you to query for workflow executions based on when they were started, whether they are still running, and their associated metadata. For a given query, you can select from any one of the following types of metadata:

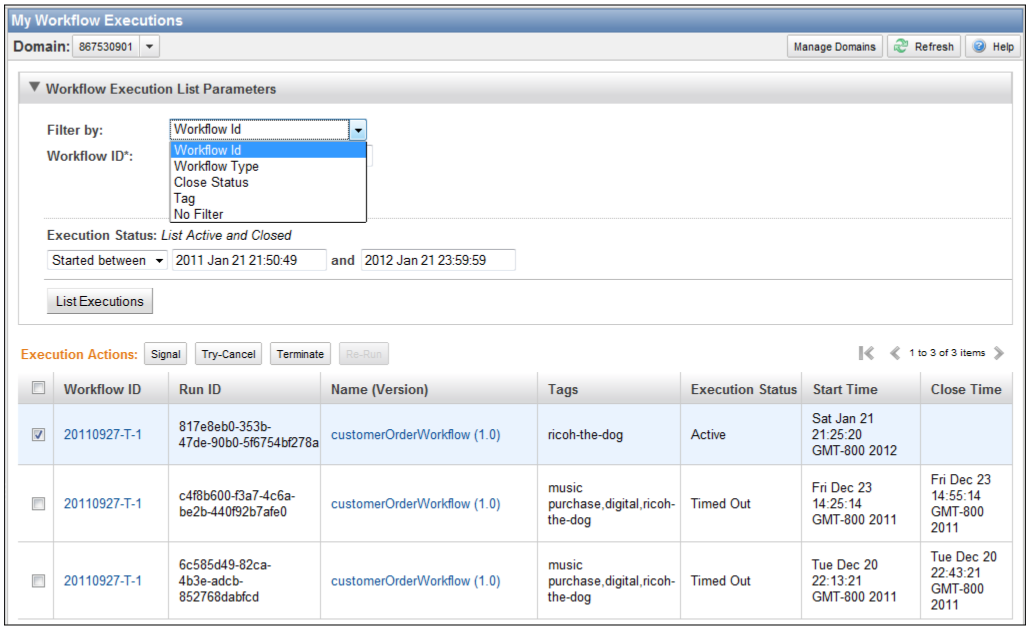
- Workflow ID

- Workflow Type
- Tags
- Close Status

If the workflow execution is closed, the close status is one of the following values, which indicate the circumstance in which the workflow execution closed:

- Completed
- Failed
- Canceled
- Timed Out
- Continued as New

Note
You must select a domain from the **Domain** drop-down list before you can enumerate workflow executions.



Domain: 867530901

Filter by: Workflow Id

Workflow ID*:

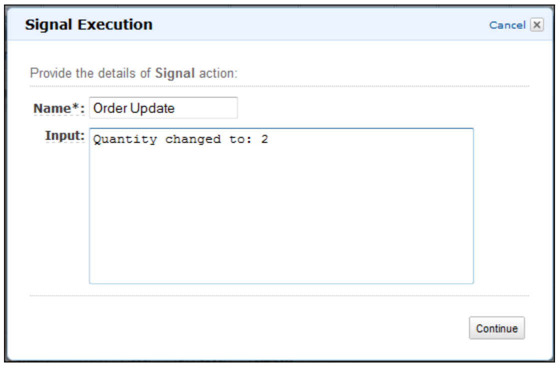
Execution Status: *List Active and Closed*

Started between 2011 Jan 21 21:50:49 and 2012 Jan 21 23:59:59

	Workflow ID	Run ID	Name (Version)	Tags	Execution Status	Start Time	Close Time
✓	20110927-T-1	817e8eb0-353b-47de-90b0-5f6754bf278a	customerOrderWorkflow (1.0)	ricoh-the-dog	Active	Sat Jan 21 21:25:20 GMT-800 2012	
	20110927-T-1	c4f8b600-f3a7-4c6a-be2b-440f92b7afe0	customerOrderWorkflow (1.0)	music purchase,digital,ricoh-the-dog	Timed Out	Fri Dec 23 14:25:14 GMT-800 2011	Fri Dec 23 14:55:14 GMT-800 2011
	20110927-T-1	6c585d49-82ca-4b3e-adcb-852768dabfcd	customerOrderWorkflow (1.0)	music purchase,digital,ricoh-the-dog	Timed Out	Tue Dec 20 22:13:21 GMT-800 2011	Tue Dec 20 22:43:21 GMT-800 2011

After enumerating a list of workflow executions, you can perform the following operations.

- Signal a workflow execution—that is, send a running workflow execution additional data.

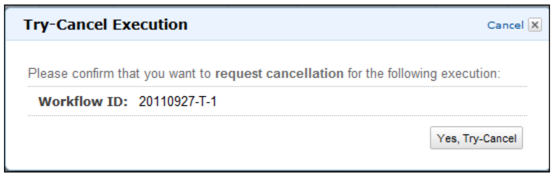


Provide the details of **Signal** action:

Name*: Order Update

Input:
```
Quantity changed to: 2
```

- Try to cancel a workflow execution. It is preferable to cancel a workflow execution rather than terminate it. Canceling provides the workflow execution an opportunity to perform any clean-up tasks and then close properly.

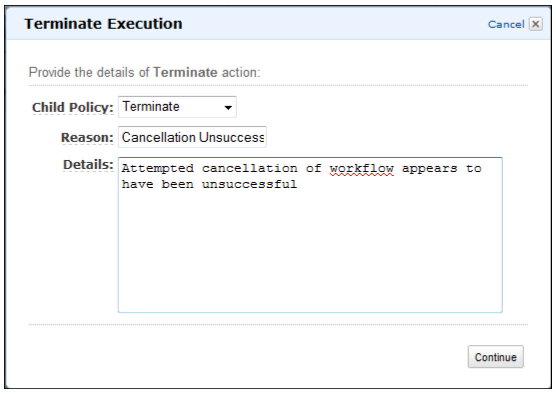


Try-Cancel Execution

Please confirm that you want to **request cancellation** for the following execution:

Workflow ID: 20110927-T-1

- Terminate a workflow execution. Note that it is preferable to cancel a workflow execution rather than terminate it.



Terminate Execution

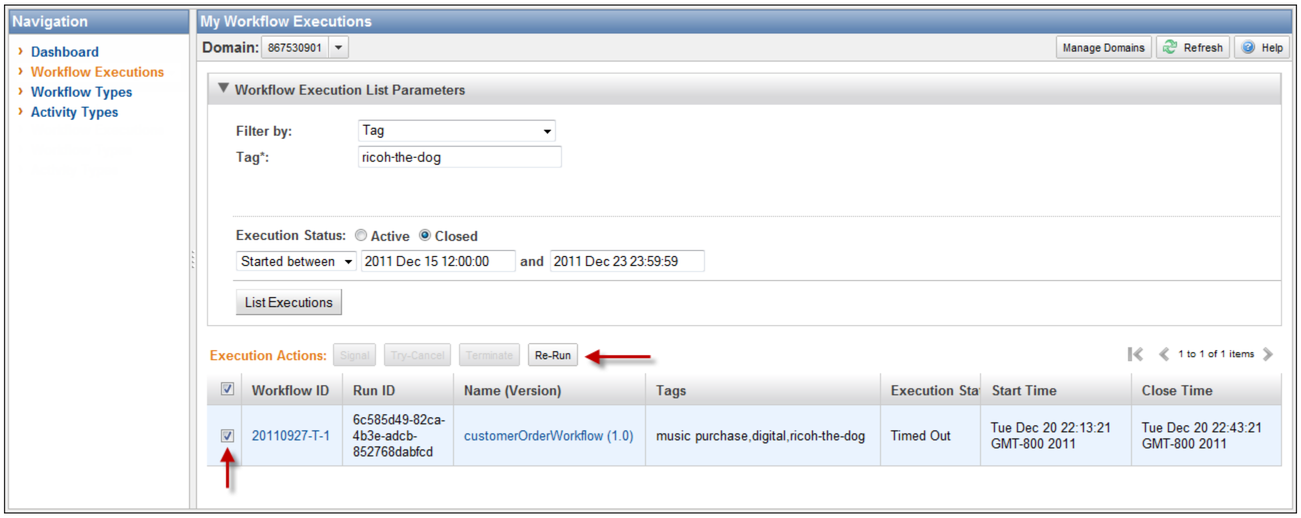
Provide the details of **Terminate** action:

Child Policy: Terminate

Reason: Cancellation Unsuccess

Details: Attempted cancellation of workflow appears to have been unsuccessful

- Re-run a closed workflow execution.



Domain: 867530901

Filter by: Tag

Tag*: ricoh-the-dog

Execution Status: Active [✓ Closed]

Started between 2011 Dec 15 12:00:00 and 2011 Dec 23 23:59:59

✓	Workflow ID	Run ID	Name (Version)	Tags	Execution Sta	Start Time	Close Time
✓	20110927-T-1	6c585d49-82ca-4b3e-adcb-852768dabfcd	customerOrderWorkflow (1.0)	music purchase,digital,ricoh-the-dog	Timed Out	Tue Dec 20 22:13:21 GMT-800 2011	Tue Dec 20 22:43:21 GMT-800 2011

To re-run a closed workflow execution

1. In the list of workflow executions, select the closed execution to re-run. When you select a closed execution, the **Re-Run** button becomes enabled. Choose **Re-Run**.

   The **Re-Run Execution** sequence of dialog boxes appears.
2. In the **Execution Details** dialog box, specify the following information. The dialog box has the information from the original execution already filled in.

   - Domain
   - Workflow Name

- Workflow Version
- Workflow ID

By choosing the **Advanced Options** link, you can specify the following additional options.

- Task List
- Maximum Execution Run Time
- Task Start to Close Timeout

Choose **Continue**

3. In the **Additional Options** dialog box, specify an input string for the execution. By choosing the **Advanced Options** link, you can specify **Tags** to associate with this run or the workflow execution as well as change the executions **Child Policy**. As with the previous dialog box, the information from the original execution is already filled in.

   Choose **Review**.
4. In the **Review** dialog box, verify that all the information is correct. If the information is correct, choose **Re-Run Execution**. Otherwise, choose **Back** to change the information.

Viewing Amazon SWF Metrics for CloudWatch using the AWS Management Console

Amazon CloudWatch provides a number of viewable metrics for Amazon SWF workflows and activities. You can view the metrics and set alarms for your Amazon SWF workflow executions using the AWS Management Console. *You must be logged in to the console to proceed.*

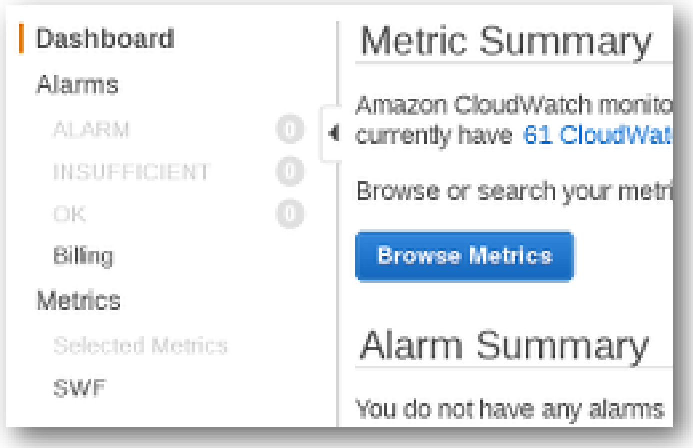
For a description of each of the available metrics, see Amazon SWF Metrics for CloudWatch (p. 114).

Topics

Viewing Metrics

To view your metrics for Amazon SWF

1. Sign in to the AWS Management Console and open the CloudWatch console at https://console.aws.amazon.com/cloudwatch/.
2. In the navigation pane, under **Metrics**, choose **SWF**.



Metric Summary

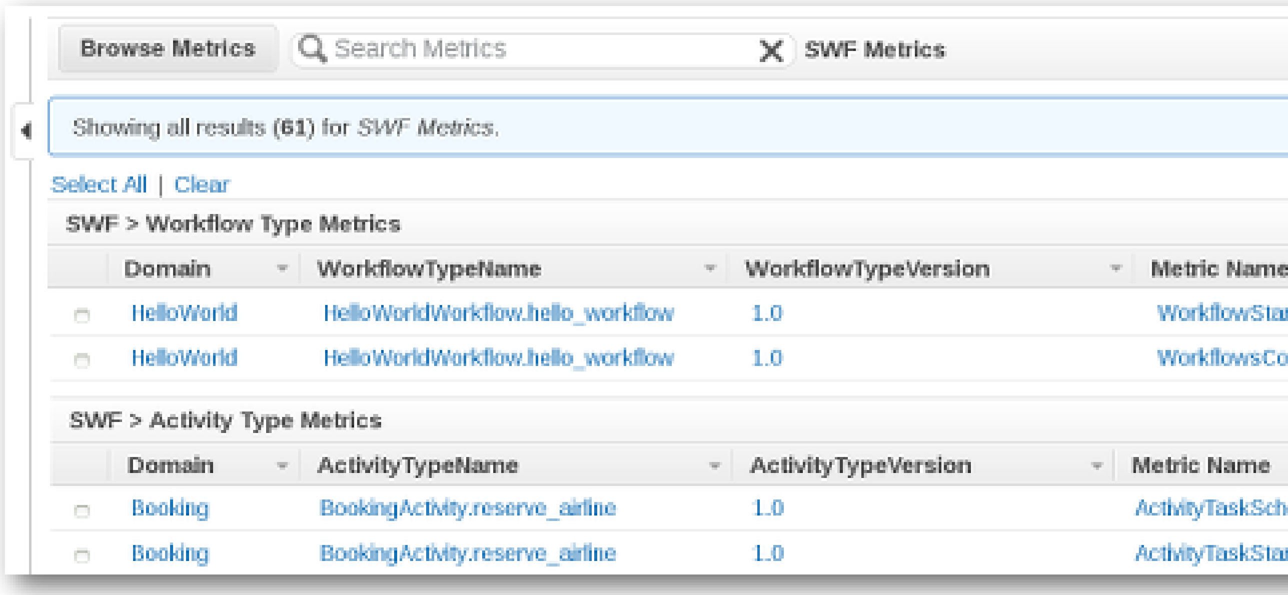
Amazon CloudWatch monito
currently have 61 CloudWat

Browse or search your metri

Alarm Summary

You do not have any alarms

If you have run any workflow executions recently, you will see two lists of metrics presented: **Workflow Type Metrics** and **Activity Type Metrics**.



Showing all results (61) for *SWF Metrics*.

SWF > Workflow Type Metrics

	Domain	WorkflowTypeName	WorkflowTypeVersion	Metric Name
▢	HelloWorld	HelloWorldWorkflow.hello_workflow	1.0	WorkflowSta
▢	HelloWorld	HelloWorldWorkflow.hello_workflow	1.0	WorkflowsCo

SWF > Activity Type Metrics

	Domain	ActivityTypeName	ActivityTypeVersion	Metric Name
▢	Booking	BookingActivity.reserve_airline	1.0	ActivityTaskSch
▢	Booking	BookingActivity.reserve_airline	1.0	ActivityTaskSta

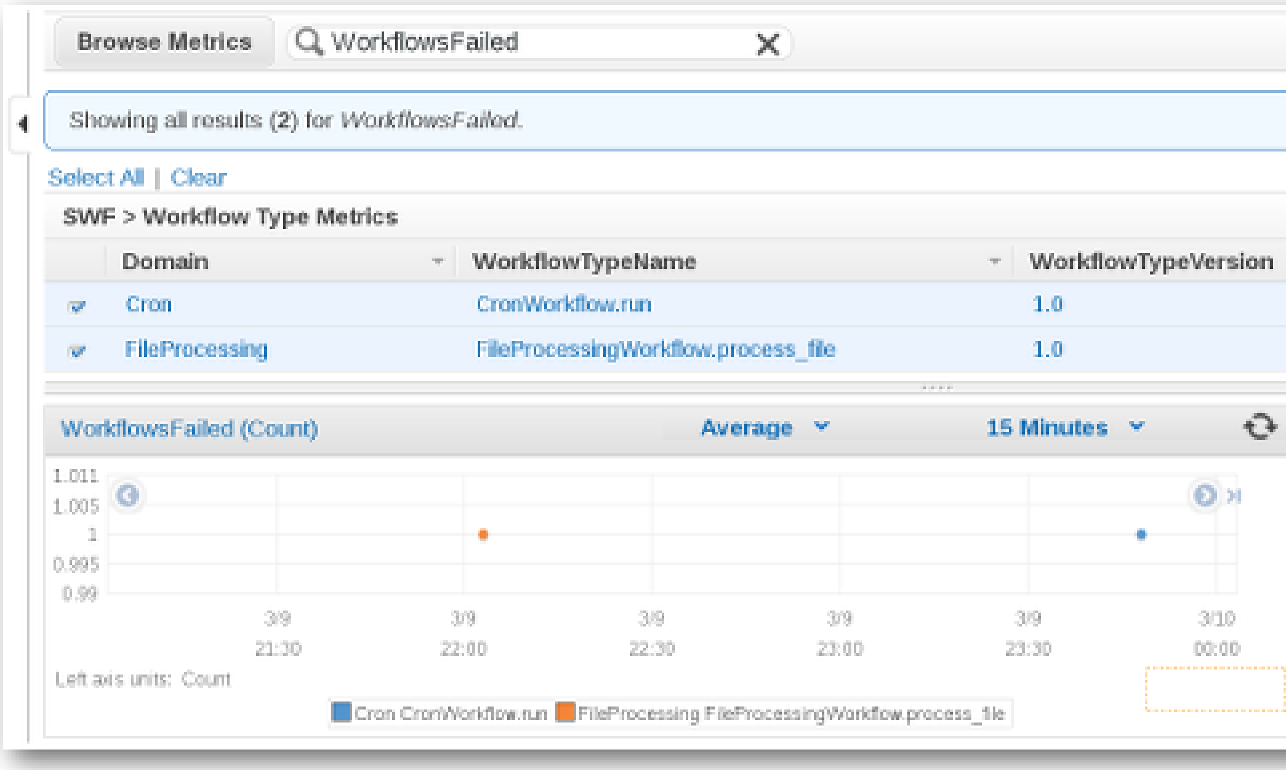
Note
Initially you might only see the **Workflow Type Metrics**; **Activity Type Metrics** are presented in the same view, but you may need to scroll down to see them.

Up to 50 of the most recent metrics will be shown at a time, divided among workflow and activity metrics.

You can use the interactive headings above each column in the list to sort your metrics using any of the provided dimensions. For workflows, the dimensions are **Domain**, **WorkflowTypeName**, **WorkflowTypeVersion**, and **Metric Name**. For activities, the dimensions are **Domain**, **ActivityTypeName**, **ActivityTypeVersion**, and **Metric Name**.

The various types of metrics are described in Amazon SWF Metrics for CloudWatch (p. 114).

You can view graphs for metrics by choosing the boxes next to the metric row in the list, and change the graph parameters using the **Time Range** controls to the right of the graph view.



Browse Metrics | WorkflowsFailed

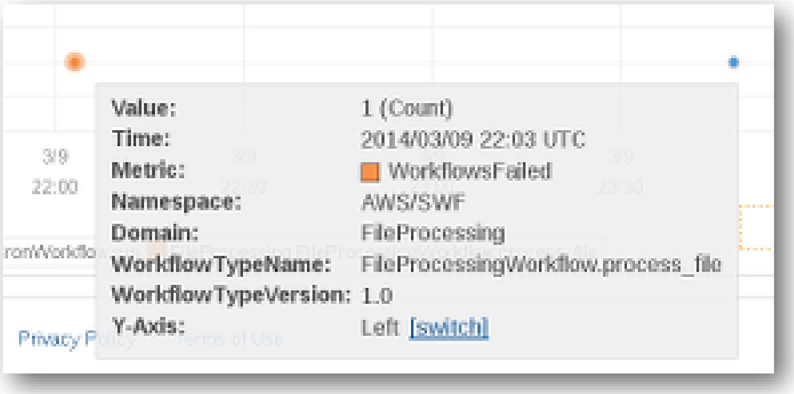
Showing all results (2) for *WorkflowsFailed.*

Select All | Clear

SWF > Workflow Type Metrics

	Domain	WorkflowTypeName	WorkflowTypeVersion
✓	Cron	CronWorkflow.run	1.0
✓	FileProcessing	FileProcessingWorkflow.process_file	1.0

For details about any point on the graph, place your cursor over the graph point. A detail of the point's dimensions will be shown.



Value:	1 (Count)
Time:	2014/03/09 22:03 UTC
Metric:	🟧 WorkflowsFailed
Namespace:	AWS/SWF
Domain:	FileProcessing
WorkflowTypeName:	FileProcessingWorkflow.process_file
WorkflowTypeVersion:	1.0
Y-Axis:	Left [switch]

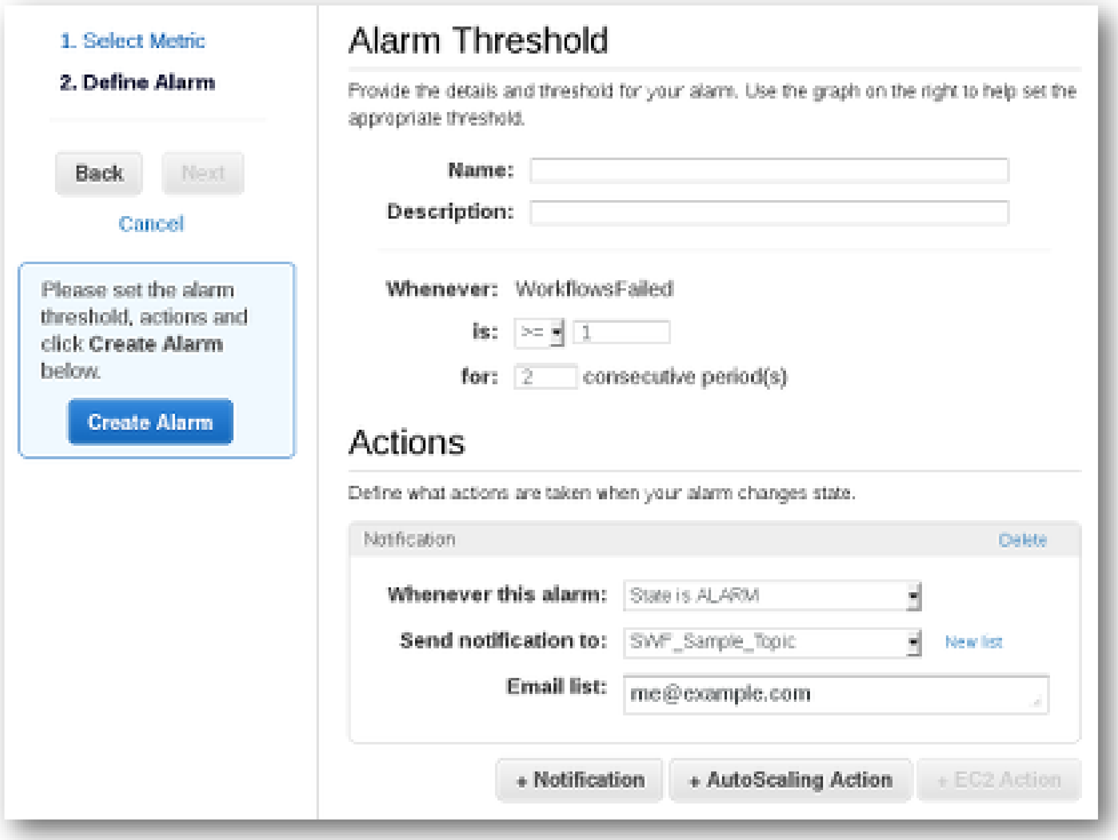
For more information about working with CloudWatch metrics, see Viewing, Graphing, and Publishing Metrics in the *Amazon CloudWatch User Guide*.

Setting Alarms

You can use CloudWatch alarms to perform actions such as notifying you when an alarm threshold is reached. For example, you can set an alarm to send a notification to an SNS topic or to send an email when the **WorkflowsFailed** metric rises above a certain threshold.

To set an alarm on any of your metrics

1. Choose a single metric by choosing its box.
2. To the right of the graph, in the **Tools** controls, choose **Create Alarm**.
3. On the **Define Alarm** screen, enter the alarm threshold value, period parameters, and actions to take.



Alarm Threshold

Provide the details and threshold for your alarm. Use the graph on the right to help set the appropriate threshold.

Please set the alarm threshold, actions and click **Create Alarm** below.

Name:
Description:
Whenever: WorkflowsFailed
is: >= 1
for: 2 consecutive period(s)

Actions

Define what actions are taken when your alarm changes state.

Notification
Whenever this alarm: State is ALARM
Send notification to: SWF_Sample_Topic
Email list: me@example.com

For more information about setting and using CloudWatch alarms, see Creating Amazon CloudWatch Alarms in the *Amazon CloudWatch User Guide*.

Using the AWS CLI with Amazon Simple Workflow Service

Many of the features of Amazon Simple Workflow Service can be accessed from the AWS CLI. The AWS CLI provides an alternative to using Amazon SWF with the AWS Management Console or in some cases, to programming with the Amazon SWF API and the AWS Flow Framework.

For example, you can use the AWS CLI to register a new workflow type:

```
aws swf register-workflow-type --domain MyDomain --name "MySimpleWorkflow" --workflow-
version "v1"
```

You can also list your registered workflow types:

```
aws swf list-workflow-types --domain MyDomain --registration-status REGISTERED
```

The following shows an example of the default output in JSON:

```
{
    "typeInfos": [
        {
            "status": "REGISTERED",
            "creationDate": 1377471607.752,
            "workflowType": {
                "version": "v1",
                "name": "MySimpleWorkflow"
            }
        },
        {
            "status": "REGISTERED",
            "creationDate": 1371454149.598,
            "description": "MyDomain subscribe workflow",
            "workflowType": {
                "version": "v3",
                "name": "subscribe"
            }
        }
    ]
}
```

The Amazon SWF commands in AWS CLI provide the ability to start and manage workflow executions, poll for activity tasks, record task heartbeats, and more! For a complete list of Amazon SWF commands, with descriptions of the available arguments and examples showing their use, see Amazon SWF commands in the *AWS Command Line Interface Reference*.

The AWS CLI commands follow the Amazon SWF API closely, so you can use the AWS CLI to learn about the underlying Amazon SWF API. You can also use your existing API knowledge to prototype code or perform Amazon SWF actions on the command line.

To learn more about the AWS CLI, see the AWS Command Line Interface User Guide.

Using the Amazon SWF API

In addition to using the AWS SDKs that are described in Development Options (p. 1), you can use the HTTP API directly.

To use the API, you send HTTP requests to the SWF endpoint that matches the region that you want to use for your domains, workflows and activities. For more information about making HTTP requests for Amazon SWF, see Making HTTP Requests to Amazon SWF (p. 81).

This section provides basic information about using the HTTP API to develop your workflows with Amazon SWF. More advanced features, such as using timers, logging with CloudTrail and tagging your workflows are provided in the section, Using Advanced Features of Amazon SWF (p. 110).

Topics

Making HTTP Requests to Amazon SWF

If you don't use one of the AWS SDKs, you can perform Amazon Simple Workflow Service (Amazon SWF) operations over HTTP using the POST request method. The POST method requires that you specify the operation in the header of the request and provide the data for the operation in JSON format in the body of the request.

HTTP Header Contents

Amazon SWF requires the following information in the header of an HTTP request:

- `host` The Amazon SWF endpoint.
- `x-amz-date` You must provide the time stamp in either the HTTP `Date` header or the AWS `x-amz-date header` (some HTTP client libraries don't let you set the `Date` header). When an `x-amz-date` header is present, the system ignores any `Date` header when authenticating the request.

  The date must be specified in one of the following three formats, as specified in the HTTP/1.1 RFC:
  - Sun, 06 Nov 1994 08:49:37 GMT (RFC 822, updated by RFC 1123)
  - Sunday, 06-Nov-94 08:49:37 GMT (RFC 850, obsoleted by RFC 1036)
  - Sun Nov 6 08:49:37 1994 (ANSI C's asctime() format)
- `x-amzn-authorization` The signed request parameters in the format:

  ```
  AWS3 AWSAccessKeyId=####,Algorithm=HmacSHA256, [,SignedHeaders=Header1;Header2;...]
  Signature=S(StringToSign)
  ```

  AWS3 - This is an AWS implementation-specific tag that denotes the authentication version used to sign the request (currently, for Amazon SWF this value is always `AWS3`).

  AWSAccessKeyId - Your AWS Access Key ID.

  Algorithm - The algorithm used to create the HMAC-SHA value of the string-to-sign, such as `HmacSHA256` or `HmacSHA1`.

  Signature - Base64(Algorithm(StringToSign, SigningKey)). For details see Calculating the HMAC-SHA Signature for Amazon SWF (p. 84)

  SignedHeaders - Optional. If present, must contain a list of all the HTTP Headers used in the Canonicalized HttpHeaders calculation. A single semicolon character (;) (ASCII character 59) must be used as the delimiter for list values.
- `x-amz-target` The destination service of the request and the operation for the data, in the format

  ```
  com.amazonaws.swf.service.model.SimpleWorkflowService. + <action>
  ```

  For example, `com.amazonaws.swf.service.model.SimpleWorkflowService.RegisterDomain`
- `content-type` The type needs to specify JSON and the character set, as `application/json; charset=UTF-8`

The following is an example header for an HTTP request to create a domain.

```
POST http://swf.us-east-1.amazonaws.com/ HTTP/1.1
Host: swf.us-east-1.amazonaws.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.2.25) Gecko/20111212
 Firefox/3.6.25 ( .NET CLR 3.5.30729; .NET4.0E)
Accept: application/json, text/javascript, */*
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Content-Type: application/json; charset=UTF-8
```

```
X-Requested-With: XMLHttpRequest
X-Amz-Date: Fri, 13 Jan 2012 18:42:12 GMT
X-Amz-Target: com.amazonaws.swf.service.model.SimpleWorkflowService.RegisterDomain
Content-Encoding: amz-1.0
X-Amzn-Authorization: AWS3
 AWSAccessKeyId=AKIAIOSFODNN7EXAMPLE,Algorithm=HmacSHA256,SignedHeaders=Host;X-Amz-Date;X-
Amz-Target;Content-Encoding,Signature=tzjkF55lxAxPhzp/BRGFYQRQRq6CqrM254dTDE/EncI=
Referer: http://swf.us-east-1.amazonaws.com/explorer/index.html
Content-Length: 91
Pragma: no-cache
Cache-Control: no-cache

{"name": "867530902",
 "description": "music",
 "workflowExecutionRetentionPeriodInDays": "60"}
```

Here is an example of the corresponding HTTP response.

```
HTTP/1.1 200 OK
Content-Length: 0
Content-Type: application/json
x-amzn-RequestId: 4ec4ac3f-3e16-11e1-9b11-7182192d0b57
```

HTTP Body Content

The body of an HTTP request contains the data for the operation specified in the header of the HTTP request. Use the JSON data format to convey data values and data structure, simultaneously. Elements can be nested within other elements using bracket notation. For example, the following shows a request to list all workflow executions that started between two specified points in time—using Unix Time notation.

```
{
 "domain": "867530901",
 "startTimeFilter":
 {
   "oldestDate": 1325376070,
  "latestDate": 1356998399
 },
 "tagFilter":
 {
   "tag": "music purchase"
 }
}
```

Sample Amazon SWF JSON Request and Response

The following example shows a request to Amazon SWF for a description of the domain that we created previously. Then it shows the Amazon SWF response.

HTTP POST Request:

```

POST http://swf.us-east-1.amazonaws.com/ HTTP/1.1
Host: swf.us-east-1.amazonaws.com
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US; rv:1.9.2.25) Gecko/20111212
 Firefox/3.6.25 ( .NET CLR 3.5.30729; .NET4.0E)
Accept: application/json, text/javascript, */*
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
```

```
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 115
Connection: keep-alive
Content-Type: application/json; charset=UTF-8
X-Requested-With: XMLHttpRequest
X-Amz-Date: Sun, 15 Jan 2012 03:13:33 GMT
X-Amz-Target: com.amazonaws.swf.service.model.SimpleWorkflowService.DescribeDomain
Content-Encoding: amz-1.0
X-Amzn-Authorization: AWS3
 AWSAccessKeyId=AKIAIOSFODNN7EXAMPLE,Algorithm=HmacSHA256,SignedHeaders=Host;X-Amz-Date;X-
Amz-Target;Content-Encoding,Signature=IFJtq3M366CHqMlTpyqYqd9z0ChCoKDC5SCJBsLifu4=
Referer: http://swf.us-east-1.amazonaws.com/explorer/index.html
Content-Length: 21
Pragma: no-cache
Cache-Control: no-cache

{"name": "867530901"}
```

Amazon SWF Response:

```
HTTP/1.1 200 OK
Content-Length: 137
Content-Type: application/json
x-amzn-RequestId: e86a6779-3f26-11e1-9a27-0760db01a4a8

{"configuration":
  {"workflowExecutionRetentionPeriodInDays": "60"},
 "domainInfo":
  {"description": "music",
   "name": "867530901",
   "status": "REGISTERED"}
}
```

Notice the protocol (`HTTP/1.1`) is followed by a status code (`200`). A code value of `200` indicates a successful operation.

Amazon SWF does not serialize null values. If your JSON parser is set to serialize null values for requests, Amazon SWF ignores them.

Calculating the HMAC-SHA Signature for Amazon SWF

Every request to Amazon SWF must be authenticated. The AWS SDKs automatically sign your requests and manage your token-based authentication. However, if you want to write your own HTTP `POST` requests, you need to create an `x-amzn-authorization` value for the HTTP `POST Header` content as part of your request authentication.

For more information about formatting headers, see HTTP Header Contents (p. 82). For the AWS SDK for Java implementation of AWS Version 3 signing, see the AWSSigner.java class.

Creating a Request Signature

Before you create an HMAC-SHA request signature, you must get your AWS credentials (the Access Key ID and the Secret Key).

Important
You can use either SHA1 or SHA256 to sign your requests. However, make sure that you use the same method throughout the signing process. The method you choose must match the value of the `Algorithm` name in the HTTP header.

To create the request signature

1. Create a canonical form of the HTTP request headers. The canonical form of the HTTP header includes the following:

   - `host`
   - Any header element starting with `x-amz-`

   For more information about the included headers, see HTTP Header Contents (p. 82).

   1. For each header name-value pair, convert the header name (but not the header value) to lowercase.
   2. Build a map of the header name to comma-separated header values.

      ```
      x-amz-example: value1
      x-amz-example: value2  =>  x-amz-example:value1,value2
      ```

      For more information, see Section 4.2 of RFC 2616.
   3. For each header name-value pair, convert the name-value pair into a string in the format `headerName:headerValue`. Trim any whitespace from the beginning and end of both `headerName` and `headerValue`, with no spaces on each side of the colon.

      ```
      x-amz-example1:value1,value2
      x-amz-example2:value3
      ```
   4. Insert a new line (`U+000A`) after each converted string, including the last string.
   5. Sort the collection of converted strings alphabetically, by header name.
2. Create a string-to-sign value that includes the following items:

   - Line `1`: The HTTP method (`POST`), followed by a newline.
   - Line `2`: The request URI (`/`), followed by a newline.
   - Line `3`: An empty string followed by a newline.

     Note
     Typically, the query string appears here, but Amazon SWF doesn't use a query string.
   - Lines `4-n`: The string representing the canonicalized request headers that you computed in Step 1, followed by a newline. This newline creates a blank line between the headers and the body of the HTTP request. For more information, see RFC 2616.
   - The request body, *not* followed by a newline.
3. Compute the SHA256 or SHA1 digest of the string-to-sign value. Use the same SHA method throughout the process.
4. Compute and Base64-encode the HMAC-SHA using either a SHA256 or a SHA1 digest (depending on the method you used) of the value resulting from the previous step and the temporary secret access key from the AWS Security Token Service using the `GetSessionToken` API action.

   Note
   Amazon SWF expects an equals sign (`=`) at the end of the Base64-encoded HMAC-SHA value. If your Base64 encoding routine doesn't include the appended equals sign, append one to the end of the value.

   For more information about using temporary security credentials with Amazon SWF and other AWS services, see AWS Services That Work with IAM in the *IAM User Guide*.
5. Place the resulting value as the value for the `Signature` name in the `x-amzn-authorization` header of the HTTP request to Amazon SWF.

6. Amazon SWF verifies the request and performs the specified operation.

List of Amazon SWF Actions by Category

This section lists the reference topics for Amazon SWF actions in the Amazon SWF application programming interface (API). These are listed by *functional category*.

For an *alphabetic* list of actions, see the Amazon Simple Workflow Service API Reference.

Topics

Actions Related to Activities

Activity workers use **PollForActivityTask** to get new activity tasks. After a worker receives an activity task from Amazon SWF, it performs the task and responds using **RespondActivityTaskCompleted** if successful or **RespondActivityTaskFailed** if unsuccessful.

The following are actions that are performed by activity workers.

- PollForActivityTask
- RespondActivityTaskCompleted
- RespondActivityTaskFailed
- RespondActivityTaskCanceled
- RecordActivityTaskHeartbeat

Actions Related to Deciders

Deciders use **PollForDecisionTask** to get decision tasks. After a decider receives a decision task from Amazon SWF, it examines its workflow execution history and decides what to do next. It calls **RespondDecisionTaskCompleted** to complete the decision task and provides zero or more next decisions.

The following are actions that are performed by deciders.

- PollForDecisionTask
- RespondDecisionTaskCompleted

Actions Related to Workflow Executions

The following actions operate on a workflow execution.

- RequestCancelWorkflowExecution

- StartWorkflowExecution
- SignalWorkflowExecution
- TerminateWorkflowExecution

Actions Related to Administration

Although you can perform administrative tasks from the Amazon SWF console, you can use the actions in this section to automate functions or build your own administrative tools.

Activity Management

- RegisterActivityType
- DeprecateActivityType

Workflow Management

- RegisterWorkflowType
- DeprecateWorkflowType

Domain Management

These actions allow you to register and deprecate Amazon SWF domains.

- RegisterDomain
- DeprecateDomain

For more information and examples of these domain management actions, see Registering a Domain with Amazon SWF (p. 89).

Workflow Execution Management

- RequestCancelWorkflowExecution
- TerminateWorkflowExecution

Visibility Actions

Although you can perform visibility actions from the Amazon SWF console, you can use the actions in this section to build your own console or administrative tools.

Activity Visibility

- ListActivityTypes
- DescribeActivityType

Workflow Visibility

- ListWorkflowTypes

- DescribeWorkflowType

Workflow Execution Visibility

- DescribeWorkflowExecution
- ListOpenWorkflowExecutions
- ListClosedWorkflowExecutions
- CountOpenWorkflowExecutions
- CountClosedWorkflowExecutions
- GetWorkflowExecutionHistory

Domain Visibility

- ListDomains
- DescribeDomain

Task List Visibility

- CountPendingActivityTasks
- CountPendingDecisionTasks

Creating a Basic Workflow in Amazon SWF

Creating a basic sequential workflow involves the following stages.

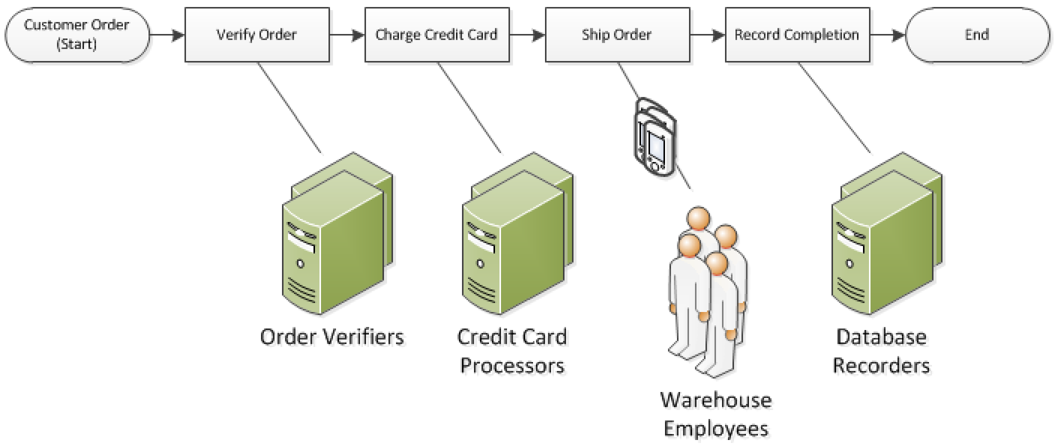
- Modeling a workflow, registering its type, and registering its activity types
- Developing and launching activity workers that perform activity tasks
- Developing and launching deciders that use the workflow history to determine what to do next
- Developing and launching workflow starters, that is, applications that start workflow executions

Modeling Your Workflow and Its Activities

To use Amazon SWF, model the logical steps in your application as activities. An activity represents a single logical step or task in your workflow. For example, authorizing a credit card is an activity that involves providing a credit card number and other information, and receiving an approval code or a message that the card was declined.

In addition to defining activities, you also need to define the coordination logic that handles decision points. For example, the coordination logic might schedule a different follow-up activity depending on whether the credit card was approved or declined.

The following figure shows an example of a sequential customer order workflow with four activities (Verify Order, Charge Credit Card, Ship Order, and Record Completion).



Registering a Domain with Amazon SWF

Your workflow and activity types and the workflow execution itself are all scoped to a *domain*. Domains isolate a set of types, executions, and task lists from others within the same account.

You can register a domain by using the AWS Management Console or by using the `RegisterDomain` action in the Amazon SWF API. The following example uses the API.

```
https://swf.us-east-1.amazonaws.com
RegisterDomain
{
  "name" : "867530901",
  "description" : "music",
  "workflowExecutionRetentionPeriodInDays" : "60"
}
```

The parameters are specified in JavaScript Object Notation (JSON) format. Here, the retention period is set to 60 days. During the retention period, all information about the workflow execution is available through visibility operations using either the AWS Management Console or the Amazon SWF API.

After registering the domain, you should register the workflow type and the activity types used by the workflow. You need to register the domain first because a registered domain name is part of the required information for registering workflow and activity types.

See Also

- RegisterDomain in the *Amazon Simple Workflow Service API Reference*

Setting Timeout Values in Amazon SWF

Topics

Limits on Timeout Values

Timeout values are always declared in seconds, and can be set to any number of seconds up to a year (31536000 seconds)—the maximum execution limit for any workflow or activity. The special value "NONE" is used to set a timeout parameter to "no timeout", or infinite, but the maximum limit of a year still applies.

Workflow Execution and Decision Task Timeouts

You can set timeout values for your Workflow and Decision tasks when registering the workflow type. For example:

```
https://swf.us-east-1.amazonaws.com
RegisterWorkflowType
{
  "domain": "867530901",
  "name": "customerOrderWorkflow",
  "version": "1.0",
  "description": "Handle customer orders",
  "defaultTaskStartToCloseTimeout": "600",
  "defaultExecutionStartToCloseTimeout": "3600",
  "defaultTaskList": { "name": "mainTaskList" },
  "defaultChildPolicy": "TERMINATE"
}
```

This workflow type registration sets the defaultTaskStartToCLoseTimeout to 600 seconds (10 minutes), and defaultExecutionStartToCloseTimeout to 3600 seconds (1 hour).

For more information about workflow type registration, see Registering a Workflow Type with Amazon SWF (p. 91), and RegisterWorkflowType in the *Amazon Simple Workflow Service API Reference*.

You can override the value set for `defaultExecutionStartToCloseTimeout` by specifying executionStartToCloseTimeout in StartWorkflowExecution.

Activity Task Timeouts

You can set timeout values for your activity tasks when registering the activity type. For example:

```
https://swf.us-east-1.amazonaws.com
RegisterActivityType
{
  "domain": "867530901",
  "name": "activityVerify",
  "version": "1.0",
  "description": "Verify the customer credit",
  "defaultTaskStartToCloseTimeout": "600",
  "defaultTaskHeartbeatTimeout": "120",
  "defaultTaskList": { "name": "mainTaskList" },
  "defaultTaskScheduleToStartTimeout": "1800",
  "defaultTaskScheduleToCloseTimeout": "5400"
}
```

This activity type registration sets the defaultTaskStartToCloseTimeout to 600 seconds (10 minutes), the defaultTaskHeartbeatTimeout to 120 seconds (2 minutes), the defaultTaskScheduleToStartTimeout to 1800 seconds (30 minutes) and defaultTaskScheduleToCloseTimeout to 5400 seconds (1.5 hours).

For more information about activity type registration, see Registering an Activity Type with Amazon SWF (p. 91), and RegisterActivityType in the *Amazon Simple Workflow Service API Reference*.

You can override the value set for `defaultTaskStartToCloseTimeout` by specifying taskStartToCloseTimeout in StartWorkflowExecution.

See Also

- Amazon SWF Timeout Types (p. 124)

Registering a Workflow Type with Amazon SWF

The example discussed in this section registers a workflow type using the Amazon SWF API. The name and version that you specify during registration form a unique identifier for the workflow type. The specified domain must have already been registered using the RegisterDomain API.

The timeout parameters in the following example are duration values specified in seconds. For the `defaultTaskStartToCloseTimeout` parameter, you can use the duration specifier "NONE" to indicate no timeout. However, you cannot specify a value of "NONE" for `defaultExecutionStartToCloseTimeout`; there is a one-year maximum limit on the time that a workflow execution can run. Exceeding this limit always causes the workflow execution to time out. If you specify a value for `defaultExecutionStartToCloseTimeout` that is greater than one year, the registration will fail.

```
https://swf.us-east-1.amazonaws.com
RegisterWorkflowType
{
  "domain" : "867530901",
  "name" : "customerOrderWorkflow",
  "version" : "1.0",
  "description" : "Handle customer orders",
  "defaultTaskStartToCloseTimeout" : "600",
  "defaultExecutionStartToCloseTimeout" : "3600",
  "defaultTaskList" : { "name": "mainTaskList" },
  "defaultChildPolicy" : "TERMINATE"
}
```

See Also

- RegisterWorkflowType in the *Amazon Simple Workflow Service API Reference*

Registering an Activity Type with Amazon SWF

The following example registers an activity type by using the Amazon SWF API. The name and version that you specify during registration form a unique identifier for the activity type within the domain. The specified domain must have already been registered using the `RegisterDomain` action.

The timeout parameters in this example are duration values specified in seconds. You can use the duration specifier "NONE" to indicate no timeout.

```
https://swf.us-east-1.amazonaws.com
RegisterActivityType
{
  "domain" : "867530901",
  "name" : "activityVerify",
  "version" : "1.0",
  "description" : "Verify the customer credit",
  "defaultTaskStartToCloseTimeout" : "600",
  "defaultTaskHeartbeatTimeout" : "120",
  "defaultTaskList" : { "name" : "mainTaskList" },
  "defaultTaskScheduleToStartTimeout" : "1800",
  "defaultTaskScheduleToCloseTimeout" : "5400"
}
```

See Also

- RegisterActivityType in the *Amazon Simple Workflow Service API Reference*

AWS Lambda Tasks

Topics

About AWS Lambda

AWS Lambda is a fully managed compute service that runs your code in response to events generated by custom code or from various AWS services such as Amazon S3, DynamoDB, Amazon Kinesis, Amazon SNS, and Amazon Cognito. For more information about Lambda, see the AWS Lambda Developer Guide.

Amazon Simple Workflow Service provides a Lambda task so that you can run Lambda functions in place of, or alongside traditional Amazon SWF activities.

Important
Your AWS account will be charged for Lambda executions (requests) executed by Amazon SWF on your behalf. For details about Lambda pricing, see http://aws.amazon.com/lambda/pricing/.

Benefits and Limitations of using Lambda Tasks

There are a number of benefits of using Lambda tasks in place of a traditional Amazon SWF activity:

- Lambda tasks don't need to be registered or versioned like Amazon SWF activity types.
- You can use any existing Lambda functions that you've already defined in your workflows.
- Lambda functions are called directly by Amazon SWF; there is no need for you to implement a worker program to execute them as you must do with traditional activities.
- Lambda provides you with metrics and logs for tracking and analyzing your function executions.

There are also a number of limitations regarding Lambda tasks that you should be aware of:

- Lambda tasks can only be run in AWS regions that provide support for Lambda. See Lambda Regions and Endpoints in the *Amazon Web Services General Reference* for details about the currently-supported regions for Lambda.
- Lambda tasks are currently supported only by the base SWF HTTP API and in the AWS Flow Framework for Java. There is currently no support for Lambda tasks in the AWS Flow Framework for Ruby.

Using Lambda tasks in your workflows

To use Lambda tasks in your Amazon SWF workflows, you will need to:

1. Set up IAM roles to provide Amazon SWF with permission to invoke Lambda functions.
2. Attach the IAM roles to your workflows.
3. Call your Lambda function during a workflow execution.

Set up an IAM role

Before you can invoke Lambda functions from Amazon SWF you must provide an IAM role that provides access to Lambda from Amazon SWF. You can either:

- choose a pre-defined role, *AWSLambdaRole*, to give your workflows permission to invoke any Lambda function associated with your account.
- define your own policy and associated role to give workflows permission to invoke particular Lambda functions, specified by their Amazon Resource Names (ARNs).

Providing Amazon SWF with access to invoke any Lambda role

You can use the pre-defined role, *AWSLambdaRole*, to give your Amazon SWF workflows the ability to invoke any Lambda function associated with your account.

To use AWSLambdaRole to give Amazon SWF access to invoke Lambda functions

1. Open the Amazon IAM console.
2. Choose **Roles**, then **Create New Role**.
3. Give your role a name, such as `swf-lambda` and choose **Next Step**.
4. Under **AWS Service Roles**, choose **Amazon SWF**, and choose **Next Step**.
5. On the **Attach Policy** screen, choose **AWSLambdaRole** from the list.
6. Choose **Next Step** and then **Create Role** once you've reviewed the role.

Defining an IAM role to provide access to invoke a specific Lambda function

If you want to provide access to invoke a specific Lambda function from your workflow, you will need to define your own IAM policy.

To create an IAM policy to provide access to a particular Lambda function

1. Open the Amazon IAM console.
2. Choose **Policies**, then **Create Policy**.
3. Choose **Copy an AWS Managed Policy** and select **AWSLambdaRole** from the list. A policy will be generated for you. Optionally edit its name and description to suit your needs.
4. In the *Resource* field of the **Policy Document**, add the ARN of your Lambda function(s). For example:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": [
        "lambda:InvokeFunction"
      ],
      "Resource": [
        "arn:aws:lambda:us-east-1:111111000000:function:hello_lambda_function"
      ]
    }
  ]
}
```

> **Note**
> For a complete description of how to specify resources in an IAM role, see Overview of IAM Policies in *Using IAM*.

5. Choose **Create Policy** to finish creating your policy.

You can then select this policy when creating a new IAM role, and use that role to give invoke access to your Amazon SWF workflows. This procedure is very similar to creating a role with the *AWSLambdaRole* policy. instead, choose your own policy when creating the role.

To create a Amazon SWF role using your Lambda policy

1. Open the Amazon IAM console.
2. Choose **Roles**, then **Create New Role**.
3. Give your role a name, such as **`swf-lambda-function`** and choose **Next Step**.
4. Under **AWS Service Roles**, choose **Amazon SWF**, and choose **Next Step**.
5. On the **Attach Policy** screen, choose your Lambda function-specific policy from the list.
6. Choose **Next Step** and then **Create Role** once you've reviewed the role.

Attach the IAM role to your workflow

Once you've defined your IAM role, you will need to attach it to the workflow that will be using it to call the Lambda functions you provided Amazon SWF with access to.

There are two places where you can attach the role to your workflow:

- During workflow type registration. This role then may be used as the default Lambda role for every execution of that workflow type.
- When starting a workflow execution. This role will be used only during this workflow's execution (and throughout the entire execution).

To provide a default Lambda role for a workflow type

- When calling RegisterWorkflowType, set the defaultLambdaRole field to the ARN of the role that you defined.

To provide a Lambda role to be used during a workflow execution

- When calling StartWorkflowExecution, set the lambdaRole field to the ARN of the role that you defined.

> **Note**
> if the account calling RegisterWorkflowType or StartWorkflowExecution doesn't have permission to use the given role, then the call will fail with an OperationNotPermittedFault.

Call your Lambda function from a Amazon SWF workflow

You can use the ScheduleLambdaFunctionDecisionAttributes data type to identify the Lambda function to call during a workflow execution.

During a call to RespondDecisionTaskCompleted, provide a ScheduleLambdaFunctionDecisionAttributes to your decisions list. For example:

```
{
  "decisions": [{
    "ScheduleLambdaFunctionDecisionAttributes": {
      "id": "lambdaTaskId",
      "name": "myLambdaFunctionName",
      "input": "inputToLambdaFunction",
      "startToCloseTimeout": "30"
    },
  }],
}
```

Set the following parameters:

- *id* with an identifier for the Lambda task. This must be a string from 1-256 characters and must not contain the characters : (colon), / (slash), | (vertical bar), nor any control characters (\u0000 - \u001f and \u007f - \u009f), nor the literal string `arn`.
- *name* with the name of your Lambda function. Your Amazon SWF workflow must be provided with an IAM role that gives it access to call the Lambda function. The name provided must follow the constraints for the FunctionName parameter as described in the Lambda Invoke action.
- *input* with optional input data for the function. If set, this must follow the constraints for the ClientContext parameter as described in the Lambda Invoke action.
- *startToCloseTimeout* with an optional maximum period, in seconds, that the function can take to execute before the task fails with a timeout exception. The value NONE can be used to specify unlimited duration.

For more information, see Implementing AWS Lambda Tasks

Developing an Activity Worker in Amazon SWF

An activity worker provides the implementation of one or more activity types. An activity worker communicates with Amazon SWF to receive activity tasks and perform them. You can have a fleet of multiple activity workers performing activity tasks of the same activity type.

Amazon SWF makes an activity task available to activity workers when the decider schedules the activity task. When a decider schedules an activity task, it provides the data (which you determine) that the activity worker needs to perform the activity task. Amazon SWF inserts this data into the activity task before sending it to the activity worker.

Activity workers are managed by you. They can be written in any language. A worker can be run anywhere, as long as it can communicate with Amazon SWF through the API. Because Amazon SWF provides all the information needed to perform an activity task, all activity workers can be stateless. Statelessness enables your workflows to be highly scalable; to handle increased capacity requirements, simply add more activity workers.

This section explains how to implement an activity worker. The activity workers should repeatedly do the following.

1. Poll Amazon SWF for an activity task.

2. Begin performing the task.
3. Periodically report a heartbeat to Amazon SWF if the task is long-lived.
4. Report that the task completed or failed and return the results to Amazon SWF.

Topics

Polling for Activity Tasks

To perform activity tasks, each activity worker must poll Amazon SWF by periodically calling the `PollForActivityTask` action.

In the following example, the activity worker **`ChargeCreditCardWorker01`** polls for a task on the task list, **`ChargeCreditCard-v0.1`**. If no activity tasks are available, after 60 seconds, Amazon SWF sends back an empty response. An empty response is a `Task` structure in which the value of the `taskToken` is an empty string.

```
https://swf.us-east-1.amazonaws.com
PollForActivityTask
{
  "domain" : "867530901",
  "taskList" : { "name": "ChargeCreditCard-v0.1" },
  "identity" : "ChargeCreditCardWorker01"
}
```

If an activity task becomes available, Amazon SWF returns it to the activity worker. The task contains the data that the decider specifies when it schedules the activity.

After an activity worker receives an activity task, it is ready to perform the work. The next section provides information about performing an activity task.

Performing the Activity Task

After receiving an activity task, the activity worker is ready to perform it.

To perform an activity task

1. Program your activity worker to interpret the content in the input field of the task. This field contains the data specified by the decider when the task was scheduled.
2. Program the activity worker to begin processing the data and executing your logic.

The next section describes how to program your activity workers to provide status updates to Amazon SWF for long running activities.

Reporting Activity Task Heartbeats

If a heartbeat timeout was registered with the activity type, then the activity worker must record a heartbeat before the heartbeat timeout is exceeded. If an activity task does not provide a heartbeat within the timeout, the task times out, Amazon SWF closes it and schedules a new decision task to inform a decider of the timeout. The decider can then reschedule the activity task or take another action.

If, after timing out, the activity worker attempts to contact Amazon SWF, such as by calling `RespondActivityTaskCompleted`, Amazon SWF will return an `UnknownResource` fault.

This section describes how to provide an activity heartbeat.

To record an activity task heartbeat, program your activity worker to call the `RecordActivityTaskHeartbeat` action. This action also provides a string field that you can use to store free-form data to quantify progress in whatever way works for your application.

In this example, the activity worker reports heartbeat to Amazon SWF and uses the details field to report that the activity task is 40 percent complete. To report heartbeat, the activity worker must specify the task token of the activity task.

```
https://swf.us-east-1.amazonaws.com
RecordActivityTaskHeartbeat
{
  "taskToken" : "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "details" : "40"
}
```

This action does not in itself create an event in the workflow execution history; however, if the task times out, the workflow execution history will contain a `ActivityTaskTimedOut` event that contains the information from the last heartbeat generated by the activity worker.

Completing or Failing an Activity Task

After executing a task, the activity worker should report whether the activity task completed or failed.

Completing an Activity Task

To complete an activity task, program the activity worker to call the `RespondActivityTaskCompleted` action after it successfully completes an activity task, specifying the task token.

In this example, the activity worker indicates that the task completed successfully.

```
https://swf.us-east-1.amazonaws.com
RespondActivityTaskCompleted
{
  "taskToken": "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "results": "40"
}
```

When the activity completes, Amazon SWF schedules a new decision task for the workflow execution with which the activity is associated.

Program the activity worker to poll for another activity task after it has completed the task at hand. This creates a loop where the activity worker continuously polls for and completes tasks.

If the activity does not respond within the *StartToCloseTimeout* period, or if *ScheduleToCloseTimeout* has been exceeded, Amazon SWF times out the activity task and schedules a decision task. This enables a decider to take an appropriate action, such as rescheduling the task.

For example, if an Amazon EC2 instance is executing an activity task and the instance fails before the task is complete, the decider receives a timeout event in the workflow execution history. If the activity task is using a heartbeat, the decider receives the event when the task fails to deliver the next heartbeat after the Amazon EC2 instance fails. If not, the decider eventually receives the event when the activity task fails to complete before it hits one of its overall timeout values. It is then up to the decider to re-assign the task or take some other action.

Failing an Activity Task

If an activity worker cannot perform an activity task for some reason, but it can still communicate with Amazon SWF, you can program it to fail the task.

To program an activity worker to fail an activity task, program the activity worker to call the `RespondActivityTaskFailed` action that specifies the task token of the task.

```
https://swf.us-east-1.amazonaws.com
RespondActivityTaskFailed
{
  "taskToken" : "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "reason" : "CC-Invalid",
  "details" : "Credit Card Number Checksum Failed"
}
```

As the developer, you define the values that are stored in the reason and details fields. These are free-form strings; you can use any error code conventions that serve your application. Amazon SWF does not process these values. However, Amazon SWF may display these values in the console.

When an activity task is failed, Amazon SWF schedules a decision task for the workflow execution with which the activity task is associated to inform the decider of the failure. Program your decider to handle failed activities, such as by rescheduling the activity or failing the workflow execution, depending on the nature of the failure.

Launching Activity Workers

To launch activity workers, package your logic into an executable that you can use on your activity worker platform. For example, you might package your activity code as a Java executable that you can run on both Linux and Windows servers.

Once launched, your workers start polling for tasks. Until the decider schedules activity tasks, though, these polls time out with no tasks and your workers just continue polling.

Because polls are outbound requests, activity worker can run on any network that has access to the Amazon SWF endpoint.

You can launch as many activity workers as you like. As the decider schedules activity tasks, Amazon SWF automatically distributes the activity tasks to the polling activity workers.

Developing Deciders in Amazon SWF

A decider is an implementation of the coordination logic of your workflow type that runs during the execution of your workflow. You can run multiple deciders for a single workflow type.

Because the execution state for a workflow execution is stored in its workflow history, deciders can be stateless. Amazon SWF maintains the workflow execution history and provides it to a decider with each decision task. This enables you to dynamically add and remove deciders as necessary, which makes the processing of your workflows highly scalable. As the load on your system grows, you simply add more deciders to handle the increased capacity. Note, however, that there can be only one decision task open at any time for a given workflow execution.

Every time a state change occurs for a workflow execution, Amazon SWF schedules a decision task. Each time a decider receives a decision task, it does the following:

- Interprets the workflow execution history provided with the decision task
- Applies the coordination logic based on the workflow execution history and makes decisions on what to do next. Each decision is represented by a Decision structure
- Completes the decision task and provides a list of decisions to Amazon SWF.

This section describes how to develop a decider, which involves:

- Programming your decider to poll for decision tasks
- Programming your decider to interpret the workflow execution history and make decisions
- Programming your decider to respond to a decision task.

The examples in this section show how you might program a decider for the e-commerce example workflow.

You can implement the decider in any language that you like and run it anywhere, as long as it can communicate with Amazon SWF through its service API.

Topics

Defining Coordination Logic

The first thing to do when developing a decider is to define the coordination logic. In the e-commerce example, coordination logic that schedules each activity after the previous activity completes might look similar to the following:

```
IF lastEvent = "StartWorkflowInstance"
 addToDecisions ScheduleVerifyOrderActivity

ELSIF lastEvent = "CompleteVerifyOrderActivity"
 addToDecisions ScheduleChargeCreditCardActivity

ELSIF lastEvent = "CompleteChargeCreditCardActivity"
 addToDecisions ScheduleCompleteShipOrderActivity

ELSIF lastEvent = "CompleteShipOrderActivity"
 addToDecisions ScheduleRecordOrderCompletion

ELSIF lastEvent = "CompleteRecordOrderCompletion"
 addToDecisions CloseWorkflow

ENDIF
```

The decider applies the coordination logic to the workflow execution history, and creates a list of decisions when completing the decision task using the `RespondDecisionTaskCompleted` action.

Polling for Decision Tasks

Each decider polls for decision tasks. The decision tasks contain the information that the decider uses to generate decisions such as scheduling activity tasks. To poll for decision tasks, the decider uses the `PollForDecisionTask` action.

In this example, the decider polls for a decision task, specifying the **`customerOrderWorkflow-0.1`** tasklist.

```
https://swf.us-east-1.amazonaws.com
PollForDecisionTask
{
  "domain": "867530901",
  "taskList": {"name": "customerOrderWorkflow-v0.1"},
  "identity": "Decider01",
  "maximumPageSize": 50,
  "reverseOrder": true
}
```

If a decision task is available from the task list specified, Amazon SWF returns it immediately. If no decision task is available, Amazon SWF holds the connection open for up to 60 seconds, and returns a task as soon as it becomes available. If no task becomes available, Amazon SWF returns an empty response. An empty response is a `Task` structure in which the value of `taskToken` is an empty string. Make sure to program your decider to poll for another task if it receives an empty response.

If a decision task is available, Amazon SWF returns a response that contains the decision task as well as a paginated view of the workflow execution history.

In this example, the type of the most recent event indicates the workflow execution started and the input element contains the information needed to perform the first task.

```
{
  "events": [
    {
      "decisionTaskStartedEventAttributes": {
        "identity": "Decider01",
        "scheduledEventId": 2
      },
      "eventId": 3,
      "eventTimestamp": 1326593394.566,
      "eventType": "DecisionTaskStarted"
    }, {
      "decisionTaskScheduledEventAttributes": {
        "startToCloseTimeout": "600",
        "taskList": { "name": "specialTaskList" }
      },
      "eventId": 2,
      "eventTimestamp": 1326592619.474,
      "eventType": "DecisionTaskScheduled"
    }, {
      "eventId": 1,
      "eventTimestamp": 1326592619.474,
      "eventType": "WorkflowExecutionStarted",
      "workflowExecutionStartedEventAttributes": {
        "childPolicy" : "TERMINATE",
        "executionStartToCloseTimeout" : "3600",
        "input" : "data-used-decider-for-first-task",
        "parentInitiatedEventId": 0,
        "tagList" : ["music purchase", "digital", "ricoh-the-dog"],
        "taskList": { "name": "specialTaskList" },
        "taskStartToCloseTimeout": "600",
        "workflowType": {
          "name": "customerOrderWorkflow",
          "version": "1.0"
        }
      }
    }
  ],
  ...
}
```

After receiving the workflow execution history, the decider interprets history and makes decisions based on its coordination logic.

Because the number of workflow history events for a single workflow execution might be large, the result returned might be split up across a number of pages. To retrieve subsequent pages, make additional calls to `PollForDecisionTask` using the *nextPageToken* returned by the initial call. Note that you do *not* call `GetWorkflowExecutionHistory` with this *nextPageToken*. Instead, call `PollForDecisionTask` again.

Applying the Coordination Logic

After the decider receives a decision task, program it to interpret the workflow execution history to determine what has happened so far. Based on this, it should generate a list of decisions.

In the e-commerce example, we are concerned only with the last event in the workflow history, so we define the following logic.

```
IF lastEvent = "StartWorkflowInstance"
 addToDecisions ScheduleVerifyOrderActivity

ELSIF lastEvent = "CompleteVerifyOrderActivity"
 addToDecisions ScheduleChargeCreditCardActivity

ELSIF lastEvent = "CompleteChargeCreditCardActivity"
 addToDecisions ScheduleCompleteShipOrderActivity

ELSIF lastEvent = "CompleteShipOrderActivity"
 addToDecisions ScheduleRecordOrderCompletion

ELSIF lastEvent = "CompleteRecordOrderCompletion"
 addToDecisions CloseWorkflow

ENDIF
```

If the lastEvent is `CompleteVerifyOrderActivity`, you would add the `ScheduleChargeCreditCardActivity` activity to the list of decisions.

After the decider determines the decision(s) to make, it can respond to Amazon SWF with appropriate decisions.

Responding with Decisions

After interpreting the workflow history and generating a list of decisions, the decider is ready to respond back to Amazon SWF with those decisions.

Program your decider to extract the data that it needs from the workflow execution history, then create decisions that specify the next appropriate actions for the workflow. The decider transmits these decision back to Amazon SWF using the `RespondDecisionTaskCompleted` action. See the *Amazon Simple Workflow Service API Reference* for a list of the available decision types.

In the e-commerce example, when the decider responds with the set of decisions that it generated, it also includes the credit card input from the workflow execution history. The activity worker then has the information it needs to perform the activity task.

When all activities in the workflow execution are complete, the decider closes the workflow execution.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken" : "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions" : [
    {
      "decisionType" :"ScheduleActivityTask",
      "scheduleActivityTaskDecisionAttributes" : {
        "control" :"OPTIONAL_DATA_FOR_DECIDER",
        "activityType" : {
          "name" :"ScheduleChargeCreditCardActivity",
          "version" :"1.1"
        },
        "activityId" :"3e2e6e55-e7c4-beef-feed-aa815722b7be",
        "scheduleToCloseTimeout" :"360",
        "taskList" : { "name" :"CC_TASKS" },
        "scheduleToStartTimeout" :"60",
        "startToCloseTimeout" :"300",
        "heartbeatTimeout" :"60",
        "input" : "4321-0001-0002-1234: 0212 : 234"
      }
    }
  ]
}
```

Closing a Workflow Execution

When the decider determines that the business process is complete, that is, that there are no more activities to perform, the decider generates a decision to close the workflow execution.

To close a workflow execution, program your decider to interpret the events in the workflow history to determine what has happened in the execution so far and see if the workflow execution should be closed.

If the workflow has completed successfully, then close the workflow execution by calling `RespondDecisionTaskCompleted` with the `CompleteWorkflowExecution` decision. Alternatively, you can fail an erroneous execution using the `FailWorkflowExecution` decision.

In the e-commerce example, the decider reviews the history and based on the coordination logic adds a decision to close the workflow execution to its list of decisions, and initiates a `RespondDecisionTaskCompleted` action with a close workflow decision.

> **Note**
> There are some cases where closing a workflow execution fails. For example, if a signal is received while the decider is closing the workflow execution, the close decision will fail. To handle this possibility, ensure that the decider continues polling for decision tasks. Also, ensure that the decider that receives the next decision task responds to the event—in this case, a signal—that prevented the execution from closing.

You might also support cancellation of workflow executions. This could be especially useful for long running workflows. To support cancellation, your decider should handle the `WorkflowExecutionCancelRequested` event in the history. This event indicates that cancellation of the execution has been requested. Your decider should perform appropriate clean-up actions, such as canceling ongoing activity tasks, and closing the workflow calling the `RespondDecisionTaskCompleted` action with the `CancelWorkflowExecution` decision.

The following example calls `RespondDecisionTaskCompleted` to specify that the current workflow execution is canceled.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken" : "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions" : [
    {
      "decisionType":"CancelWorkflowExecution",
      "CancelWorkflowExecutionAttributes":{
        "Details": "Customer canceled order"
      }
    }
  ]
}
```

Amazon SWF checks to ensure that the decision to close or cancel the workflow execution is the last decision sent by the decider. That is, it isn't valid to have a set of decisions in which there are decisions after the one that closes the workflow.

Launching Deciders

After completing decider development, you are ready to launch one or more deciders.

To launch deciders, package your coordination logic into an executable that you can use on your decider platform. For example, you might package your decider code as a Java executable that you can run on both Linux and Windows computers.

Once launched, your deciders should start polling Amazon SWF for tasks. Until you start workflow executions and Amazon SWF schedules decision tasks, these polls will time out and get empty responses. An empty response is a `Task` structure in which the value of `taskToken` is an empty string. Your deciders should simply continue to poll.

Amazon SWF ensures that only one decision task can be active for a workflow execution at any time. This prevents issues such as conflicting decisions. Additionally, Amazon SWF ensures that a single decision task is assigned to a single decider, regardless of the number of deciders that are running.

If something occurs that generates a decision task while a decider is processing another decision task, Amazon SWF queues the new task until the current task completes. After the current task completes, Amazon SWF makes the new decision task available. Also, decision tasks are batched in the sense that, if multiple activities complete while a decider is processing a decision task, Amazon SWF will create only a single new decision task to account for the multiple task completions. However, each task completion will receive an individual event in the workflow execution history.

Because polls are outbound requests, deciders can run on any network that has access to the Amazon SWF endpoint.

In order for workflow executions to progress, one or more deciders must be running. You can launch as many deciders as you like. Amazon SWF supports multiple deciders polling on the same task list.

Starting Workflow Executions with Amazon SWF

You can start a workflow execution of a registered workflow type from any application using the `StartWorkflowExecution` action. When you start the execution you associate an identifier, called the `workflowId`, with it. The `workflowId` can be any string that is appropriate for your application, such as the order number in an order processing application. You cannot use the same `workflowId` for multiple open workflow executions within the same domain. For example, if you start two workflow executions with the `workflowId` **`Customer Order 01`**, the second workflow execution will not start and the request will fail. You can, however, reuse the `workflowId` of a closed execution. Amazon SWF also associates a unique system generated identifier, called the `runId`, with each workflow execution.

After the workflow and activity types are registered, start the workflow by calling the `StartWorkflowExecution` action. The value of the `input` parameter can be any string specified by the application that is starting the workflow. The `executionStartToCloseTimeout` is the length of time in seconds that the workflow execution can consume from start to close. Exceeding this limit causes the workflow execution to time out. Unlike some of the other timeout parameters in Amazon SWF, you cannot specify a value of "NONE" for this timeout; there is a one-year maximum limit on the time that a workflow execution can run. Similarly, the *taskStartToCloseTimeout* is the length of time in seconds that a decision task associated with this workflow execution can take before timing out.

```
https://swf.us-east-1.amazonaws.com
StartWorkflowExecution
{
  "domain" : "867530901",
  "workflowId" : "20110927-T-1",
  "workflowType" : {
    "name" : "customerOrderWorkflow", "version" : "1.1"
  },
  "taskList" : { "name" : "specialTaskList" },
  "input" : "arbitrary-string-that-is-meaningful-to-the-workflow",
  "executionStartToCloseTimeout" : "1800",
  "tagList" : [ "music purchase", "digital", "ricoh-the-dog" ],
  "taskStartToCloseTimeout" : "1800",
  "childPolicy" : "TERMINATE"
}
```

If the `StartWorkflowExecution` action is successful, Amazon SWF returns the `runId` for the workflow execution. The `runId` uniquely identifies this workflow execution from any other workflow executions currently running under Amazon SWF. Save the `runId` in case you later need to specify this workflow execution in a call to Amazon SWF. For example, you would use the `runId` if you later needed to send a signal to the workflow execution.

```
{"runId": "9ba33198-4b18-4792-9c15-7181fb3a8852"}
```

Setting Task Priority

By default, tasks on a task list are delivered based upon their *arrival time*: tasks that are scheduled first are generally run first, as far as possible. By setting an optional *task priority*, you can give priority to certain tasks: Amazon SWF will attempt to deliver higher-priority tasks on a task list before those with lower priority.

You can set task priorities for both workflows and activities. A workflow's task priority does not affect the priority of any activity tasks it schedules, nor does it affect any child workflows it starts. The default priority for an activity or workflow is set (either by you or by Amazon SWF) during registration, and the registered task priority is always used unless it is overridden while scheduling the activity or starting a workflow execution.

Task priority values can range from "-2147483648" to "2147483647", with higher numbers indicating higher priority. If you don't set the task priority for an activity or workflow, it will be assigned a priority of zero ("0").

Topics

Setting Task Priority for Workflows

You can set the task priority for a workflow when you register it or start it. The task priority that is set when the workflow type is registered is used as the default for any workflow executions of that type, unless it is overridden when starting the workflow execution.

To register a workflow type with a default task priority, set the *defaultTaskPriority* option when using the RegisterWorkflowType action:

```
{
  "domain": "867530901",
  "name": "expeditedOrderWorkflow",
  "version": "1.0",
  "description": "Expedited customer orders workflow",
  "defaultTaskStartToCloseTimeout": "600",
  "defaultExecutionStartToCloseTimeout": "3600",
  "defaultTaskList": {"name": "mainTaskList"},
  "defaultTaskPriority": "10",
  "defaultChildPolicy": "TERMINATE"
}
```

You can override a workflow type's registered task priority when you start a workflow execution with StartWorkflowExecution:

```
{
  "childPolicy": "TERMINATE",
  "domain": "867530901",
  "executionStartToCloseTimeout": "1800",
  "input": "arbitrary-string-that-is-meaningful-to-the-workflow",
  "tagList": ["music purchase", "digital", "ricoh-the-dog"],
  "taskList": {"name": "specialTaskList"},
  "taskPriority": "-20",
  "taskStartToCloseTimeout": "600",
  "workflowId": "20110927-T-1",
  "workflowType": {"name": "customerOrderWorkflow", "version": "1.0"},
}
```

You can also override the registered task priority when starting a child workflow or when continuing a workflow as new, such as when responding to a decision with RespondDecisionTaskCompleted.

To set a child workflow's task priority, provide the value in `startChildWorkflowExecutionDecisionAttributes`:

```
{
  "taskToken": "AAAAKgAAAAEAAAAAAAAAA...",
  "decisions": [
    {
      "decisionType": "StartChildWorkflowExecution",
      "startChildWorkflowExecutionDecisionAttributes": {
        "childPolicy": "TERMINATE",
        "control": "digital music",
        "executionStartToCloseTimeout": "900",
        "input": "201412-Smith-011x",
        "taskList": {"name": "specialTaskList"},
        "taskPriority": "5",
        "taskStartToCloseTimeout": "600",
        "workflowId": "verification-workflow",
        "workflowType": {
          "name": "MyChildWorkflow",
          "version": "1.0"
        }
      }
    }
  ]
}
```

When continuing a workflow as new, set the task priority in `continueAsNewWorkflowExecutionDecisionAttributes`:

```
{
  "taskToken": "AAAAKgAAAAEAAAAAAAAAAA...",
  "decisions": [
    {
      "decisionType": "ContinueAsNewWorkflowExecution",
      "continueAsNewWorkflowExecutionDecisionAttributes": {
        "childPolicy": "TERMINATE",
        "executionStartToCloseTimeout": "1800",
        "input": "5634-0056-4367-0923,12/12,437",
        "taskList": {"name": "specialTaskList"},
        "taskStartToCloseTimeout": "600",
        "taskPriority": "100",
        "workflowTypeVersion": "1.0"
      }
    }
  ]
}
```

Setting Task Priority for Activities

You can set the task priority for an activity either when registering it or when scheduling it. The task priority that is set when registering an activity type is used as the default priority when the activity is run, unless it is overridden when scheduling the activity.

To set task priority when registering an activity type, set the *defaultTaskPriority* option when using the RegisterActivityType action:

```
{
  "defaultTaskHeartbeatTimeout": "120",
  "defaultTaskList": {"name": "mainTaskList"},
  "defaultTaskPriority": "10",
  "defaultTaskScheduleToCloseTimeout": "900",
  "defaultTaskScheduleToStartTimeout": "300",
  "defaultTaskStartToCloseTimeout": "600",
  "description": "Verify the customer credit card",
  "domain": "867530901",
  "name": "activityVerify",
  "version": "1.0"
}
```

To schedule a task with a task priority, use the *taskPriority* option when scheduling the activity with the RespondDecisionTaskCompleted action:

```
{
  "taskToken": "AAAAKgAAAAEAAAAAAAAAAA...",
  "decisions": [
    {
      "decisionType": "ScheduleActivityTask",
      "scheduleActivityTaskDecisionAttributes": {
        "activityId": "verify-account",
        "activityType": {
            "name": "activityVerify",
            "version": "1.0"
        },
        "control": "digital music",
        "input": "abab-101",
        "taskList": {"name": "mainTaskList"},
        "taskPriority": "15"
      }
    }
  ]
}
```

Actions that Return Task Priority Information

You can get information about the set task priority (or set default task priority) from the following Amazon SWF actions:

- DescribeActivityType returns the *defaultTaskPriority* of the activity type in the `configuration` section of the response.
- DescribeWorkflowExecution returns the *taskPriority* of the workflow execution in the `executionConfiguration` section of the response.
- DescribeWorkflowType returns the *defaultTaskPriority* of the workflow type in the `configuration` section of the response.
- GetWorkflowExecutionHistory and PollForDecisionTask provide task priority information in the `activityTaskScheduledEventAttributes`, `decisionTaskScheduledEventAttributes`, `workflowExecutionContinuedAsNewEventAttributes`, and `workflowExecutionStartedEventAttributes` sections of the response.

Handling Errors in Amazon SWF

There are a number of different types of errors that can occur during the course of a workflow execution.

Topics

Validation Errors

Validation errors occur when a request to Amazon SWF fails because it is not properly formed or it contains invalid data. In this context, a request could be an action such as `DescribeDomain` or it could be a decision such as `StartTimer`. If the request is an action, Amazon SWF returns an error code in the response. Check this error code as it may provide information about what aspect of the request caused the failure. For example, one or more of the arguments passed with the request might be invalid. For a list of common error codes, go to the topic for the action in the *Amazon Simple Workflow Service API Reference*.

If the request that failed is a decision, an appropriate event will be listed in the workflow execution history. For example, if the `StartTimer` decision failed, you would see a `StartTimerFailed` event in the history. The decider should check for these events when it receives the history in response to `PollForDecisionTask` or `GetWorkflowExecutionHistory`. Below is a list of possible decision failure events that can occur when the decision is not correctly formed or contains invalid data.

Errors in Enacting Actions or Decisions

Even if the request is properly formed, errors may occur when Amazon SWF attempts to carry out the request. In these cases, one of the following events in the history will indicate that an error occurred. Look at the `reason` field of the event to determine the cause of failure.

- CancelTimerFailed
- RequestCancelActivityTaskFailed
- RequestCancelExternalWorkflowExecutionFailed
- ScheduleActivityTaskFailed
- SignalExternalWorkflowExecutionFailed
- StartChildWorkflowExecutionFailed
- StartTimerFailed

Timeouts

Deciders, activity workers, and workflow executions all operate within the constraints of timeout periods. In this type of error, a task or a child workflow times out. An event will appear in the history that describes the timeout. The decider should handle this event by, for example, rescheduling the task or restarting the child workflow. For more information about timeouts, see Amazon SWF Timeout Types (p. 124)

- ActivityTaskTimedOut
- ChildWorkflowExecutionTimedOut
- DecisionTaskTimedOut
- WorkflowExecutionTimedOut

Errors raised by user code

Examples of this type of error condition are activity task failures and child-workflow failures. As with timeout errors, Amazon SWF adds an appropriate event to the workflow execution history. The decider should handle this event, possibly by rescheduling the task or restarting the child workflow.

- ActivityTaskFailed
- ChildWorkflowExecutionFailed

Errors related to closing a workflow execution

Deciders may also see the following events if they attempt to close a workflow that has a pending decision task.

- FailWorkflowExecutionFailed

- CompleteWorkFlowExecutionFailed
- ContinueAsNewWorkflowExecutionFailed
- CancelWorkflowExecutionFailed

For more information about any of the events listed above, see History Event in the Amazon SWF API Reference.

Using Advanced Features of Amazon SWF

Topics

Logging Amazon Simple Workflow Service API Calls with AWS CloudTrail

Amazon SWF is integrated with AWS CloudTrail, a service that captures API calls made by or on behalf of Amazon SWF and delivers the log files to an Amazon S3 bucket that you specify. The API calls can be made indirectly by using the Amazon SWF console or directly by using the Amazon SWF API. Using the information collected by CloudTrail, you can determine what request was made to Amazon SWF, the source IP address from which the request was made, who made the request, when it was made, and so on. To learn more about CloudTrail, including how to configure and enable it, see the *AWS CloudTrail User Guide*.

Amazon SWF Information in CloudTrail

When CloudTrail logging is enabled, calls made to Amazon SWF actions are tracked in log files. Amazon SWF records are written together with any other AWS service records in a log file. CloudTrail determines when to create and write to a new file based on a specified time period and file size.

The following actions are supported:

- DeprecateActivityType
- DeprecateDomain
- DeprecateWorkflowType
- RegisterActivityType
- RegisterDomain
- RegisterWorkflowType

Every log entry contains information about who generated the request. The user identity information in the log helps you determine whether the request was made with root or IAM user credentials, with temporary security credentials for a role or federated user, or by another AWS service. For more information, see the userIdentity element in the *CloudTrail Event Reference*.

You can store your log files in your bucket for as long as you want, but you can also define Amazon S3 lifecycle rules to archive or delete log files automatically. By default, your log files are encrypted using Amazon S3 server-side encryption.

You can choose to have CloudTrail publish Amazon SNS notifications when new log files are delivered if you want to take quick action upon log file delivery. For more information, see Configuring Amazon SNS Notifications.

You can also aggregate log files from multiple AWS regions and multiple AWS accounts into a single Amazon S3 bucket. For more information, see Aggregating CloudTrail Log Files to a Single Amazon S3 Bucket.

Example Amazon SWF Log File Entries

CloudTrail log files can contain one or more log entries where each entry is made up of multiple JSON-formatted events. A log entry represents a single request from any source and includes information about the requested action, any parameters, the date and time of the action, and so on. The log entries are not guaranteed to be in any particular order. That is, they are not an ordered stack trace of the public API calls.

DeprecateActivityType

Here is an example of a CloudTrail log for DeprecateActivityType:

```
{
  "eventVersion": "1.01",
  "eventID": "0f65b038-58ff-4d26-b1c7-eedff8db994b",
  "eventTime": "2014-05-07T22:45:36Z",
  "requestParameters": {
    "domain": "swf-example-domain",
    "activityType": {
      "version": "1.0",
      "name": "swf-example-activityType"
    }
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "DeprecateActivityType",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "4e1a8e94-d639-11e3-9a1c-4dbc5d9f1a49",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

DeprecateDomain

Here is an example of a CloudTrail log for DeprecateDomain:

```
{
  "eventVersion": "1.01",
  "eventID": "a2be5766-3d3a-4bd3-8b88-4f3582cb52bc",
  "eventTime": "2014-05-07T22:46:00Z",
  "requestParameters": {
    "name": "swf-example-domain"
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "DeprecateDomain",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "5c95ae06-d639-11e3-8836-a37995ed01ed",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

DeprecateWorkflowType

Here is an example of a CloudTrail log for DeprecateWorkflowType:

```
{
  "eventVersion": "1.01",
  "eventID": "ff6f4e8e-2401-4c1a-956a-f36dab55b22b",
  "eventTime": "2014-05-07T22:45:36Z",
  "requestParameters": {
    "domain": "swf-example-domain",
    "workflowType": {
      "version": "1.0",
      "name": "swf-example-workflowType"
    }
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "DeprecateWorkflowType",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "4df29420-d639-11e3-8836-a37995ed01ed",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

RegisterActivityType

Here is an example of a CloudTrail log for RegisterActivityType:

```
{
  "eventVersion": "1.01",
  "eventID": "d4a99e9e-a980-4e7a-9d84-7b00806ab70f",
  "eventTime": "2014-05-07T22:03:38Z",
  "requestParameters": {
    "domain": "swf-example-domain",
    "defaultTaskScheduleToStartTimeout": "60",
    "name": "swf-example-activityType",
    "defaultTaskStartToCloseTimeout": "120",
    "defaultTaskScheduleToCloseTimeout": "180",
    "version": "1.0",
    "defaultTaskList": {
      "name": "swf-tasklist"
    },
    "description": "integration test"
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "RegisterActivityType",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "71811de3-d633-11e3-accd-9dbdf860ac2b",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

RegisterDomain

Here is an example of a CloudTrail log for RegisterDomain:

```
{
  "eventVersion": "1.01",
  "eventID": "e7e3c104-e748-4eda-90b5-827d44f4e459",
  "eventTime": "2014-05-07T22:03:38Z",
  "requestParameters": {
    "name": "swf-example-domain",
    "workflowExecutionRetentionPeriodInDays": "7",
    "description": "integration test domain"
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "RegisterDomain",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "7133729f-d633-11e3-860e-45859b92f1b2",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

RegisterWorkflowType

Here is an example of a CloudTrail log for RegisterWorkflowType:

```
{
  "eventVersion": "1.01",
  "eventID": "31d2b900-a0c1-41a9-a09b-d5c8a57087eb",
  "eventTime": "2014-05-07T22:03:38Z",
  "requestParameters": {
    "defaultExecutionStartToCloseTimeout": "180",
    "domain": "swf-example-domain",
    "name": "swf-example-workflowType",
    "defaultChildPolicy": "TERMINATE",
    "defaultTaskStartToCloseTimeout": "NONE",
    "version": "1.0",
    "defaultTaskList": {
      "name": "swf-tasklist"
    }
  },
  "responseElements": null,
  "awsRegion": "us-east-1",
  "eventName": "RegisterWorkflowType",
  "userIdentity": {
    "accessKeyId": "AKIAIOSFODNN7EXAMPLE",
    "type": "Root",
    "arn": "arn:aws:iam::244806523816:root",
    "principalId": "244806523816",
    "accountId": "244806523816"
  },
  "eventSource": "swf.amazonaws.com",
  "requestID": "71577518-d633-11e3-842e-67638fa0222f",
  "userAgent": "aws-sdk-java/unknown-version Linux/2.6.18-164.el5 Java_HotSpot(TM)_64-
Bit_Server_VM/24.45-b08",
  "sourceIPAddress": "10.61.88.189"
}
```

Amazon SWF Metrics for CloudWatch

Amazon SWF now provides metrics for CloudWatch that you can use to track your workflows and activities and set alarms on threshold values that you choose. You can view metrics using the AWS Management Console. For more information, see Viewing Amazon SWF Metrics for CloudWatch using the AWS Management Console (p. 75).

Topics

- Workflow Metrics (p. 115)
- Activity Metrics (p. 116)

Metrics that Report a Time Interval

Some of the Amazon SWF metrics for CloudWatch are *time intervals*, always measured in milliseconds. These metrics generally correspond to stages of your workflow execution for which you can set workflow and activity timeouts, and have similar names.

For example, the **DecisionTaskStartToCloseTime** metric measures the time it took for the decision task to complete after it began executing, which is the same time period for which you can set a **DecisionTaskStartToCloseTimeout** value.

For a diagram of each of these workflow stages and to learn when they occur over the workflow and activity lifecycles, see Amazon SWF Timeout Types (p. 124).

Metrics that Report a Count

Some of the Amazon SWF metrics for CloudWatch report results as a *count*. For example, **WorkflowsCanceled**, records a result as either *one* or *zero*, indicating whether or not the workflow was canceled. A value of zero does not indicate that the metric was not reported, only that the condition described by the metric did not occur.

For count metrics, minimum and maximum will always be either zero or one, but average will be a value ranging from zero to one.

Workflow Metrics

The `AWS/SWF` namespace includes the following metrics for Amazon SWF workflows:

Metric	Description
DecisionTaskScheduleToStartTime	The time interval, in milliseconds, between the time that the decision task was scheduled and the time it was picked up by a worker and started.
DecisionTaskStartToCloseTime	The time interval, in milliseconds, between the time that the decision task was started and the time it was closed.
DecisionTasksCompleted	The count of decision tasks that have been completed.
StartedDecisionTasksTimedOutOnClose	The count of decision tasks that started but timed out on closing.
WorkflowStartToCloseTime	The time, in milliseconds, between the time the workflow started and the time it closed.
WorkflowsCanceled	The count of workflows that were canceled.
WorkflowsCompleted	The count of workflows that completed.
WorkflowsContinuedAsNew	The count of workflows that continued as new.
WorkflowsFailed	the count of workflows that failed.
WorkflowsTerminated	the count of workflows that were terminated.

Metric	Description
WorkflowsTimedOut	The count of workflows that timed out, for any reason.

Dimensions for Amazon SWF Workflow Metrics

Dimension	Description
Domain	The Amazon SWF domain that the workflow is running in.
WorkflowTypeName	The name of the workflow type for this workflow execution.
WorkflowTypeVersion	The version of the workflow type for this workflow execution.

Activity Metrics

The `AWS/SWF` namespace includes the following metrics for Amazon SWF activities:

Metric	Description
ActivityTaskScheduleToCloseTime	The time interval, in milliseconds, between the time when the activity was scheduled to when it closed.
ActivityTaskScheduleToStartTime	The time interval, in milliseconds, between the time when the activity task was scheduled and when it started.
ActivityTaskStartToCloseTime	The time interval, in milliseconds, between the time when the activity task started and when it was closed.
ActivityTasksCanceled	The count of activity tasks that were canceled.
ActivityTasksCompleted	The count of activity tasks that completed.
ActivityTasksFailed	The count of activity tasks that failed.
ScheduledActivityTasksTimedOutOnClose	The count of activity tasks that were scheduled but timed out on close.
ScheduledActivityTasksTimedOutOnStart	The count of activity tasks that were scheduled but timed out on start.
StartedActivityTasksTimedOutOnClose	The count of activity tasks that were started but timed out on close.
StartedActivityTasksTimedOutOnHeartbeat	The count of activity tasks that were started but timed out due to a heartbeat timeout.

Dimensions for Amazon SWF Activity Metrics

Dimension	Description
Domain	The Amazon SWF domain that the activity is running in.

Dimension	Description
ActivityTypeName	The name of the activity type.
ActivityTypeVersion	The version of the activity type

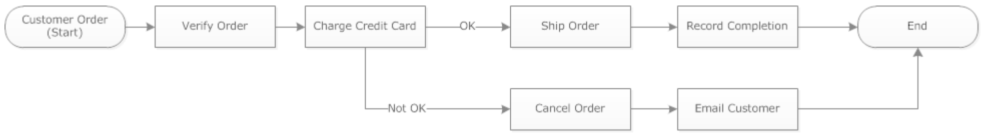
Implementing Exclusive Choice with Amazon Simple Workflow Service

In some scenarios, you might want to schedule a different set of activities based on the outcome of a previous activity. The exclusive choice pattern enables you to create flexible workflows that meet the complex requirements of your application.

The Amazon Simple Workflow Service (Amazon SWF) does not have a specific exclusive choice action. To use exclusive choice, you simply write your decider logic to make different decisions based on the results of the previous activity. Some applications for exclusive choice include the following:

- Performing cleanup activities if the results of a previous activity were unsuccessful
- Scheduling different activities based on whether the customer purchased a basic or advanced plan
- Performing different customer authentication activities based on the customer's ordering history

In the e-commerce example, you might use exclusive choice to either ship or cancel an order based on the outcome of charging the credit card. In the following figure, the decider schedules the Ship Order and Record Completion activity tasks if the credit card is successfully charged. Otherwise, it schedules the Cancel Order and Email Customer activity tasks.



The decider schedules the `ShipOrder` activity if the credit card is successfully charged. Otherwise, the decider schedules the `CancelOrder` activity.

In this case, program the decider to interpret the history and determine whether the credit card was successfully charged. To do this, you might have logic similar to the following

```
IF lastEvent = "WorkflowExecutionStarted"
 addToDecisions ScheduleActivityTask(ActivityType = "VerifyOrderActivity")

ELSIF lastEvent = "ActivityTaskCompleted"
     AND ActivityType = "VerifyOrderActivity"
 addToDecisions ScheduleActivityTask(ActivityType = "ChargeCreditCardActivity")

#Successful Credit Card Charge Activities
ELSIF lastEvent = "ActivityTaskCompleted"
      AND ActivityType = "ChargeCreditCardActivity"
  addToDecisions ScheduleActivityTask(ActivityType = "ShipOrderActivity")

ELSIF lastEvent = "ActivityTaskCompleted"
     AND ActivityType = "ShipOrderActivity"
  addToDecisions ScheduleActivityTask(ActivityType = "RecordOrderCompletionActivity")

ELSIF lastEvent = "ActivityTaskCompleted"
     AND ActivityType = "RecordOrderCompletionActivity"
 addToDecisions CompleteWorkflowExecution

#Unsuccessful Credit Card Charge Activities
ELSIF lastEvent = "ActivityTaskFailed"
      AND ActivityType = "ChargeCreditCardActivity"
  addToDecisions ScheduleActivityTask(ActivityType = "CancelOrderActivity")

ELSIF lastEvent = "ActivityTaskCompleted"
     AND ActivityType = "CancelOrderActivity"
 addToDecisions ScheduleActivityTask(ActivityType = "EmailCustomerActivity")

ELSIF lastEvent = "ActivityTaskCompleted"
     AND ActivityType = "EmailCustomerActivity"
 addToDecisions CompleteWorkflowExecution

ENDIF
```

If the credit card was successfully charged, the decider should respond with `RespondDecisionTaskCompleted` to schedule the `ShipOrder` activity.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken": "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions":[
      {
          "decisionType":"ScheduleActivityTask",
          "scheduleActivityTaskDecisionAttributes":{
              "control":"OPTIONAL_DATA_FOR_DECIDER",
              "activityType":{
                  "name":"ShipOrder",
                  "version":"2.4"
              },
              "activityId":"3e2e6e55-e7c4-fee-deed-aa815722b7be",
              "scheduleToCloseTimeout":"3600",
              "taskList":{
                  "name":"SHIPPING"
              },
              "scheduleToStartTimeout":"600",
              "startToCloseTimeout":"3600",
              "heartbeatTimeout":"300",
              "input": "123 Main Street, Anytown, United States"
          }
      }
  ]
}
```

If the credit card was not successfully charged, the decider should respond with `RespondDecisionTaskCompleted` to schedule the `CancelOrder` activity.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken": "12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions":[
      {
          "decisionType":"ScheduleActivityTask",
          "scheduleActivityTaskDecisionAttributes":{
              "control":"OPTIONAL_DATA_FOR_DECIDER",
              "activityType":{
                  "name":"CancelOrder",
                  "version":"2.4"
              },
              "activityId":"3e2e6e55-e7c4-fee-deed-aa815722b7be",
              "scheduleToCloseTimeout":"3600",
              "taskList":{
                  "name":"CANCELLATIONS"
              },
              "scheduleToStartTimeout":"600",
              "startToCloseTimeout":"3600",
              "heartbeatTimeout":"300",
              "input": "Out of Stock"
          }
      }
  ]
}
```

If Amazon SWF is able to validate the data in the `RespondDecisionTaskCompleted` action, Amazon SWF returns a successful HTTP response similar to the following.

```

HTTP/1.1 200 OK
Content-Length: 11
Content-Type: application/json
x-amzn-RequestId: 93cec6f7-0747-11e1-b533-79b402604df1
```

Amazon Simple Workflow Service Timers

A timer enables you to notify your decider when a certain amount of time has elapsed. When responding to a decision task, the decider has the option to respond with a `StartTimer` decision. This decision specifies an amount of time after which the timer should fire. After the specified time has elapsed, Amazon SWF will add a `TimerFired` event to the workflow execution history and schedule a decision task. The decider can then use this information to inform further decisions. One common application for a timer is to delay the execution of an activity task. For example, a customer might want to take delayed delivery of an item.

Amazon Simple Workflow Service Signals

Signals enable you to inform a workflow execution of external events and inject information into a workflow execution while it is running. Any program can send a signal to a running workflow execution by calling the `SignalWorkflowExecution` API. When a signal is received, Amazon SWF records it in the workflow execution's history as `WorkflowExecutionSignaled` event and alerts the decider by scheduling a decision task.

Note
An attempt to send a signal to a workflow execution that is not open results in `SignalWorkflowExecution` failing with `UnknownResourceFault`.

In this example, the workflow execution is sent a signal to cancel an order.

```
https://swf.us-east-1.amazonaws.com
SignalWorkflowExecution
{"domain": "867530901",
 "workflowId": "20110927-T-1",
 "runId": "f5ebbac6-941c-4342-ad69-dfd2f8be6689",
 "signalName": "CancelOrder",
 "input": "order 3553"}
```

If the workflow execution receives the signal, Amazon SWF returns a successful HTTP response similar to the following. Amazon SWF will generate a decision task to inform the decider to process the signal.

```
HTTP/1.1 200 OK
Content-Length: 0
Content-Type: application/json
x-amzn-RequestId: bf78ae15-3f0c-11e1-9914-a356b6ea8bdf
```

Sometimes you might want to wait for a signal. For example, a user could cancel an order by sending a signal, but only within one hour of placing the order. Amazon SWF does not have a primitive to enable a decider to wait for a signal from the service. Pause functionality needs to be implemented in the decider itself. In order to pause, the decider should start a timer, using the `StartTimer` decision, which specifies the duration for which the decider will wait for the signal while continuing to poll for decision tasks. When the decider receives a decision task, it should check the history to see if either the signal has been received or the timer has fired. If the signal has been received, then the decider should cancel the timer. However, if instead, the timer has fired, then it means that the signal did not arrive within the specified time. To summarize, in order to wait for a specific signal, do the following.

1. Create a timer for the amount of time the decider should wait.
2. When a decision task is received, check the history to see if the signal has arrived or if the timer has fired.
3. If a signal has arrived, cancel the timer using a `CancelTimer` decision and process the signal. Depending on the timing, the history may contain both `TimerFired` and `WorkflowExecutionSignaled` events. In such cases, you can rely on the relative order of the events in the history to determine which occurred first.
4. If the timer has fired, before a signal is received, then the decider has timed out waiting for the signal. You can fail the execution or do whatever other logic is appropriate to your use case.

Amazon Simple Workflow Service Activity Task Cancellation

Activity task cancellation enables the decider to end activities that no longer need to be performed. Amazon SWF uses a cooperative cancellation mechanism and does not forcibly interrupt running activity tasks. You must program your activity workers to handle cancellation requests.

The decider can decide to cancel an activity task while it is processing a decision task. To cancel an activity task, the decider uses the `RespondDecisionTaskCompleted` action with the `RequestCancelActivityTask` decision.

If the activity task has not yet been acquired by an activity worker, the service will cancel the task. Note that there is a potential race condition in that an activity worker could acquire the task at any time. If the task has already been assigned to an activity worker, then the activity worker will be requested to cancel the task.

In this example, the workflow execution is sent a signal to cancel the order.

```

https://swf.us-east-1.amazonaws.com
SignalWorkflowExecution
{"domain": "867530901",
 "workflowId": "20110927-T-1",
 "runId": "9ba33198-4b18-4792-9c15-7181fb3a8852",
 "signalName": "CancelOrder",
 "input": "order 3553"}
```

If the workflow execution receives the signal, Amazon SWF returns a successful HTTP response similar to the following. Amazon SWF will generate a decision task to inform the decider to process the signal.

```
HTTP/1.1 200 OK
Content-Length: 0
Content-Type: application/json
x-amzn-RequestId: 6c0373ce-074c-11e1-9083-8318c48dee96
```

When the decider processes the decision task and sees the signal in the history, the decider attempts to cancel the outstanding activity that has the `ShipOrderActivity0001` activity ID. The activity ID is provided in the workflow history from the schedule activity task event.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken":"12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions":[{
          "decisionType":"RequestCancelActivityTask",
          "RequestCancelActivityTaskDecisionAttributes":{
              "ActivityID":"ShipOrderActivity0001"
          }
      }
  ]
}
```

If Amazon SWF successfully receives the cancellation request, it returns a successful HTTP response similar to the following:

```
HTTP/1.1 200 OK
Content-Length: 0
Content-Type: application/json
x-amzn-RequestId: 6c0373ce-074c-11e1-9083-8318c48dee96
```

The cancellation attempt is recorded in the history as the `ActivityTaskCancelRequested` event.

If the task is successfully canceled—as indicated by an `ActivityTaskCanceled` event—program your decider to take the appropriate steps that should follow task cancellation such as closing the workflow execution.

If the activity task could not be canceled—for example, if the task completes, fails, or times out instead of canceling—your decider should accept the results of the activity or perform any cleanup or mitigation necessitated by your use case.

If the activity task has already been acquired by an activity worker, then the request to cancel is transmitted through the task-heartbeat mechanism. Activity workers can periodically use `RecordActivityTaskHeartbeat` to report to Amazon SWF that the task is still in progress.

Note that activity workers are not required to heartbeat, although it is recommended for long-running tasks. Task cancellation requires periodic heartbeat to be recorded; if the worker does not heartbeat, the task cannot be canceled.

If the decider requests a cancellation of the task, Amazon SWF sets the value of the `cancelRequest` object to true. The `cancelRequest` object is part of the `ActivityTaskStatus` object which is returned by the service in response to `RecordActivityTaskHeartbeat`.

Amazon SWF does not prevent the successful completion of an activity task whose cancellation has been requested; it is up to the activity to determine how to handle the cancellation request. Depending on your requirements, program the activity worker to either cancel the activity task or ignore the cancellation request.

If you want the activity worker to indicate that the work for the activity task was canceled, program it to respond with a `RespondActivityTaskCanceled`. If you want the activity worker to complete the task, program it to respond with a standard `RespondActivityTaskCompleted`.

When Amazon SWF receives the `RespondActivityTaskCompleted` or `RespondActivityTaskCanceled` request, it updates the workflow execution history and schedules a decision task to inform the decider.

Program the decider to process the decision task and return any additional decisions. If the activity task is successfully canceled, program the decider to perform the tasks needed to continue or close the workflow execution. If the activity task is not successfully canceled, program the decider to accept the results, ignore the results, or schedule any required cleanup.

Amazon Simple Workflow Service Markers

You can use markers to record events in the workflow execution history for application specific purposes. Markers are useful when you want to record custom information to help implement decider logic. For example, you could use a marker to count the number of loops in a recursive workflow.

In the following example, the decider completes a decision task and responds with a `RespondDecisionTaskCompleted` action that contains a `RecordMarker` decision.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "taskToken":"12342e17-80f6-FAKE-TASK-TOKEN32f0223",
  "decisions":[{
          "decisionType":"RecordMarker",
          "recordMarkerDecisionAttributes":{
              "markerName":"customer elected special shipping offer"
          }
      },
  ]
}
```

If Amazon SWF successfully records the marker, it returns a successful HTTP response similar to the following.

```
HTTP/1.1 200 OK
Content-Length: 0
Content-Type: application/json
x-amzn-RequestId: 6c0373ce-074c-11e1-9083-8318c48dee96
```

Recording a marker does not, by itself, initiate a decision task. To prevent the workflow execution from becoming stuck, something must occur that continues the execution of the workflow. For example, this might include the decider scheduling another activity task, the workflow execution receiving a signal, or a previously scheduled activity task completing.

Amazon Simple Workflow Service Tagging

As described in the section Tags (p. 64), you can associate up to five tags with a workflow execution when you start the execution using the `StartWorkflowExecution` action, `StartChildWorkflowExecution` decision, or `ContinueAsNewWorkflowExecution` decision. Tagging enables you to filter your results when you use visibility actions to list or count workflow executions.

To use tagging

1. Devise a tagging strategy. Think about your business requirements and create a list of tags that are meaningful to you. Determine which executions will get which tags. Even though an execution can be assigned a maximum of five tags, your tag library can have any number of tags. Because each tag can be any string value up to 256 characters in length, a tag can describe almost any business concept.
2. Tag an execution with up to five tags when you create it.
3. List or count the executions that are tagged with a particular tag by specifying the *tagFilter* parameter with the `ListOpenWorkflowExecutions`, `ListClosedWorkflowExecutions`, `CountOpenWorkflowExecutions`, and `CountClosedWorkflowExecutions` actions. The action will filter the executions based on the tags specified.

When you associate a tag with a workflow execution, it is permanently associated with that execution, and cannot be removed.

You can specify only one tag in the `tagFilter` parameter with `ListWorkflowExecutions`. Also, tag matching is case sensitive, and only exact matches return results.

Assume you have already set up two executions that are tagged as follows.

Execution Name	Assigned Tags
Execution-One	Consumer, 2011-February
Execution-Two	Wholesale, 2011-March

You can filter the list of executions returned by `ListOpenWorkflowExecutions` on the Consumer tag. The `oldestDate` and `latestDate` values are specified as Unix Time values.

```
https://swf.us-east-1.amazonaws.com
RespondDecisionTaskCompleted
{
  "domain":"867530901",
  "startTimeFilter":{
      "oldestDate":1262332800,
      "latestDate":1325348400
  },
  "tagFilter":{
    "tag":"Consumer"
    }
}
```

Amazon Simple Workflow Service Resources

This chapter provides additional resources and reference information that is useful when developing workflows with Amazon SWF.

Topics

Amazon SWF Timeout Types

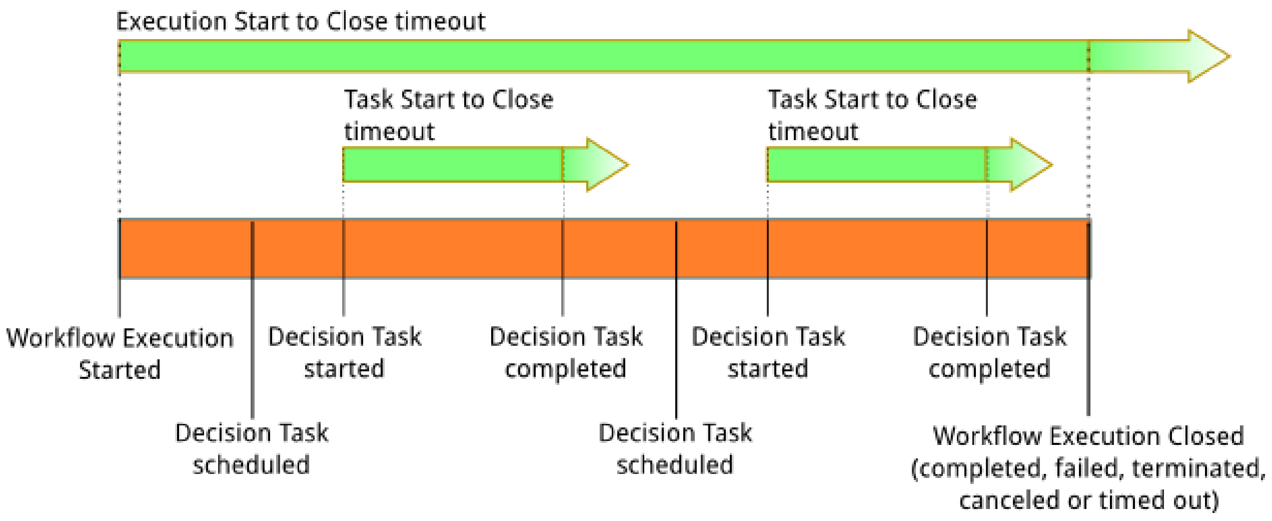
To ensure that workflow executions run correctly, Amazon SWF enables you to set different types of timeouts. Some timeouts specify how long the workflow can run in its entirety. Other timeouts specify how long activity tasks can take before being assigned to a worker and how long they can take to complete from the time they are scheduled. All timeouts in the Amazon SWF API are specified in seconds. Amazon SWF also supports the string "NONE" as a timeout value, which indicates no timeout.

For timeouts related to decision tasks and activity tasks, Amazon SWF adds an event to the workflow execution history. The attributes of the event provide information about what type of timeout occurred and which decision task or activity task was affected. Amazon SWF also schedules a decision task. When the decider receives the new decision task, it will see the timeout event in the history and take an appropriate action by calling the RespondDecisionTaskCompleted action.

A task is considered open from the time that it is scheduled until it is closed. Therefore a task is reported as open while a worker is processing it. A task is closed when a worker reports it as completed, canceled, or failed. A task may also be closed by Amazon SWF as the result of a timeout.

Timeouts in Workflow and Decision Tasks

The following diagram shows how workflow and decision timeouts are related to the lifetime of a workflow:

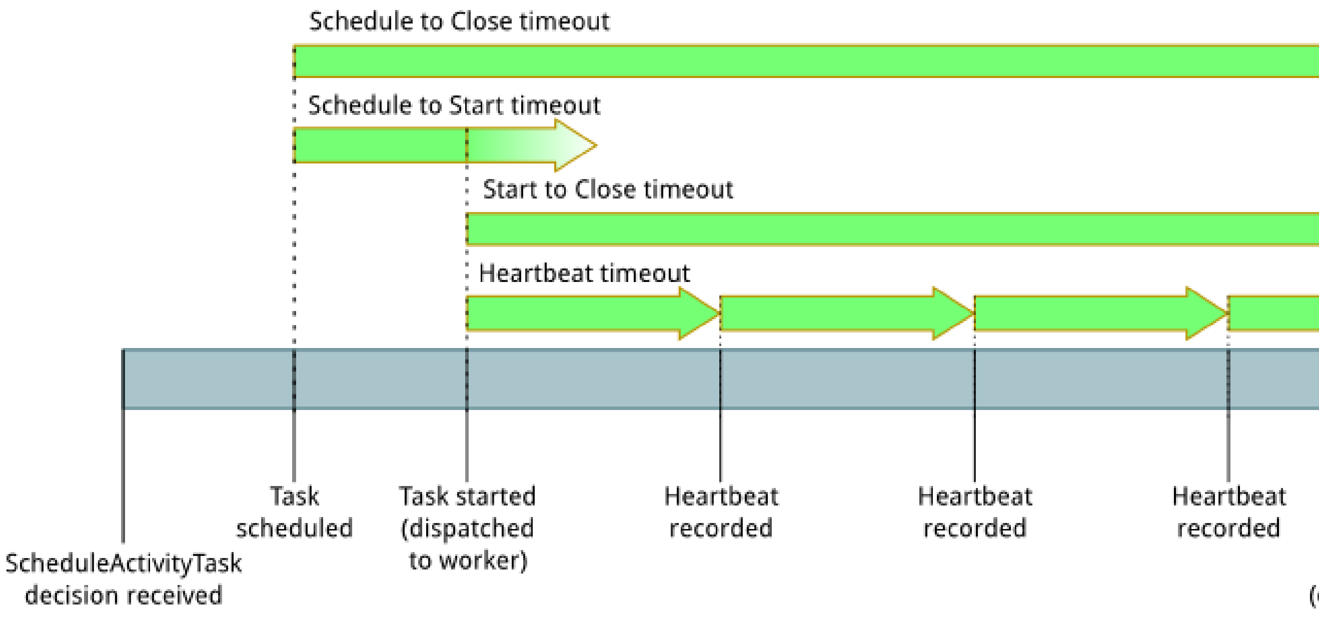

Execution Start to Close timeout
Task Start to Close timeout
Task Start to Close timeout
Workflow Execution Started
Decision Task scheduled
Decision Task started
Decision Task completed
Decision Task scheduled
Decision Task started
Decision Task completed
Workflow Execution Closed (completed, failed, terminated, canceled or timed out)

There are two timeout types that are relevant to workflow and decision tasks:

- **Workflow Start to Close (timeoutType: START_TO_CLOSE):** This timeout specifies the maximum time that a workflow execution can take to complete. It is set as a default during workflow registration, but it can be overridden with a different value when the workflow is started. If this timeout is exceeded, Amazon SWF closes the workflow execution and adds an event of type WorkflowExecutionTimedOut to the workflow execution history. In addition to the `timeoutType`, the event attributes specify the `childPolicy` that is in effect for this workflow execution. The child policy specifies how child workflow executions are handled if the parent workflow execution times out or otherwise terminates. For example, if the `childPolicy` is set to TERMINATE, then child workflow executions will be terminated. Once a workflow execution has timed out, you cannot take any action on it other than visibility calls.
- **Decision Task Start to Close (timeoutType: START_TO_CLOSE):** This timeout specifies the maximum time that the corresponding decider can take to complete a decision task. It is set during workflow type registration. If this timeout is exceeded, the task is marked as timed out in the workflow execution history, and Amazon SWF adds an event of type DecisionTaskTimedOut to the workflow history. The event attributes will include the IDs for the events that correspond to when this decision task was scheduled (`scheduledEventId`) and when it was started (`startedEventId`). In addition to adding the event, Amazon SWF also schedules a new decision task to alert the decider that this decision task timed out. After this timeout occurs, an attempt to complete the timed-out decision task using `RespondDecisionTaskCompleted` will fail.

Timeouts in Activity Tasks

The following diagram shows how timeouts are related to the lifetime of an activity task:


Schedule to Close timeout
Schedule to Start timeout
Start to Close timeout
Heartbeat timeout
Task scheduled
Task started (dispatched to worker)
Heartbeat recorded
Heartbeat recorded
Heartbeat recorded
ScheduleActivityTask decision received

There are four timeout types that are relevant to activity tasks:

- **Activity Task Start to Close (timeoutType: START_TO_CLOSE):** This timeout specifies the maximum time that an activity worker can take to process a task after the worker has received the task. Attempts to close a timed out activity task using RespondActivityTaskCanceled, RespondActivityTaskCompleted, and RespondActivityTaskFailed will fail.
- **Activity Task Heartbeat (timeoutType: HEARTBEAT):** This timeout specifies the maximum time that a task can run before providing its progress through the `RecordActivityTaskHeartbeat` action.
- **Activity Task Schedule to Start (timeoutType: SCHEDULE_TO_START):** This timeout specifies how long Amazon SWF waits before timing out the activity task if no workers are available to perform the task. Once timed out, the expired task will not be assigned to another worker.
- **Activity Task Schedule to Close (timeoutType: SCHEDULE_TO_CLOSE):** This timeout specifies how long the task can take from the time it is scheduled to the time it is complete. As a best practice, this value should not be greater than the sum of the task schedule-to-start timeout and the task start-to-close timeout.

Note
Each of the timeout types has a default value, which is generally set to NONE (infinite). The maximum time for any activity execution is limited to one year, however.

You set default values for these during activity type registration, but you can override them with new values when you schedule the activity task. When one of these timeouts occurs, Amazon SWF will add an event of type ActivityTaskTimedOut to the workflow history. The `timeoutType` value attribute of this event will specify which of these timeouts occurred. For each of the timeouts, the value of `timeoutType` is shown in parentheses. The event attributes will also include the IDs for the events that correspond to when the activity task was scheduled (`scheduledEventId`) and when it was started (`startedEventId`). In addition to adding the event, Amazon SWF also schedules a new decision task to alert the decider that the timeout occurred.

Amazon SWF Limits

Amazon SWF places limits on the sizes of certain workflow parameters, such as on the number of domains per account and on the size of the workflow execution history. These limits are designed to prevent erroneous workflows from consuming all of the resources of the system, but are not hard limits. If you find that your application is frequently exceeding these limits, you can request a service limit increase (p. 131).

Topics

General Account Limits for Amazon SWF

- **Maximum registered domains** – 100

  This limit includes both registered and deprecated domains.
- **Maximum workflow and activity types** – 10,000 each per domain

  This limit includes both registered and deprecated types.
- **API call limit** – Beyond infrequent spikes, applications may be throttled if they make a large number of API calls in a very short period of time.
- **Maximum request size** – 1 MB per request

  This is the *total* data size per Amazon SWF API request, including the request header and all other associated request data.

Limits on Workflow Executions

- **Maximum open workflow executions** – 100,000 per domain

  This count includes child workflow executions.
- **Maximum workflow execution time** – 1 year
- **Maximum workflow execution history size** – 25,000 events
- **Maximum child workflow executions** – 1,000 per workflow execution.
- **Workflow execution idle time limit** – 1 year (constrained by workflow execution time limit)

  You can configure workflow timeouts (p. 124) to cause a timeout event to occur if a particular stage of your workflow takes too long.
- **Workflow retention time limit** – 90 days

  After this time, the workflow history can no longer be retrieved or viewed. There is no further limit to the number of closed workflow executions that are retained by Amazon SWF.

If your use case requires you to go beyond these limits, you can use features Amazon SWF provides to continue executions and structure your applications using child workflow (p. 62) executions. If you find that you still need a limits increase, see Requesting a Limit Increase (p. 131).

Limits on Task Executions

- **Maximum pollers per task list** – 100 per host, per tasklist

  There are 10 hosts available, so the limit of pollers per task list is 1000 total. However, if a single host receives 101 pollers on a particular task list, a LimitExceededException will result.
- **Maximum task execution time** – 1 year (constrained by workflow execution time limit)

  You can configure activity timeouts (p. 124) to cause a timeout event to occur if a particular stage of your activity task (p. 40) execution takes too long.
- **Maximum time SWF will keep a task in the queue** – 1 year (constrained by workflow execution time limit)

  You can configure default activity timeouts (p. 124) during activity registration that will cause a timeout event to occur if a particular stage of your activity task (p. 40) execution takes too long. You can also override the default activity timeouts when you schedule an activity task in your decider code.
- **Maximum open activity tasks** – 1,000 per workflow execution.

  This limit includes both activity tasks that have been scheduled and those being processed by workers.
- **Maximum open timers** – 1,000 per workflow execution
- **Maximum input/result data size** – 32,000 characters

  This limit affects activity or workflow execution result data, input data when scheduling activity tasks or workflow executions, and input sent with a workflow execution signal (p. 62).
- **Maximum decisions in a decision task response** – varies

  Due to the 1 MB limit on the maximum API request size (p. 127), the number of decisions returned in a single call to RespondDecisionTaskCompleted will be limited according to the size of the data used by each decision, including the size of any input data provided to scheduled activity tasks or to workflow executions.

Amazon SWF throttling limits

In addition to the service limits described previously, certain Amazon SWF API calls and decision events are throttled to maintain service bandwidth, using a token bucket scheme. If your rate of requests consistently exceeds the rates that are listed here, you can request a throttle limit increase (p. 131).

Throttling limits are per account / region. Limits in *us-east-1* are slightly different than in other regions; refer to the section that corresponds to your region:

- Throttling limits for us-east-1 (p. 128)
- Throttling limits for other regions (p. 130)

Throttling limits for us-east-1

API limits

API name	Bucket size	Refill rate / s
CountClosedWorkflowExecutions	1000	1
CountOpenWorkflowExecutions	1000	1
CountPendingActivityTasks	100	1

API name	Bucket size	Refill rate / s
CountPendingDecisionTasks	100	1
DeprecateActivityType	100	1
DeprecateDomain	50	1
DeprecateWorkflowType	100	1
DescribeActivityType	1000	1
DescribeDomain	100	1
DescribeWorkflowExecution	1000	1
DescribeWorkflowType	1000	1
GetWorkflowExecutionHistory	1000	5
ListActivityTypes	100	1
ListClosedWorkflowExecutions	100	1
ListDomains	50	1
ListOpenWorkflowExecutions	100	1
ListWorkflowTypes	100	1
PollForActivityTask	1000	100
PollForDecisionTask	1000	142
RecordActivityTaskHeartbeat	1000	1
RegisterActivityType	100	1
RegisterDomain	50	1
RegisterWorkflowType	100	1
RequestCancelWorkflowExecution	1000	5
RespondActivityTaskCanceled	1000	100
RespondActivityTaskCompleted	1000	100
RespondActivityTaskFailed	1000	100
RespondDecisionTaskCompleted	1000	142
SignalWorkflowExecution	1000	5
StartWorkflowExecution	1000	25
TerminateWorkflowExecution	1000	10

Decision limits

Decision	Bucket size	Refill rate / s
RequestCancelExternalWorkflowExecution	100	10
ScheduleActivityTask	500	100
SignalExternalWorkflowExecution	100	10
StartChildWorkflowExecution	500	2
StartTimer	1000	142

Throttling limits for other regions

API limits

API name	Bucket size	Refill rate / s
CountClosedWorkflowExecutions	1000	1
CountOpenWorkflowExecutions	1000	1
CountPendingActivityTasks	100	1
CountPendingDecisionTasks	100	1
DeprecateActivityType	100	1
DeprecateDomain	50	1
DeprecateWorkflowType	100	1
DescribeActivityType	1000	1
DescribeDomain	100	1
DescribeWorkflowExecution	1000	1
DescribeWorkflowType	1000	1
GetWorkflowExecutionHistory	1000	5
ListActivityTypes	100	1
ListClosedWorkflowExecutions	100	1
ListDomains	50	1
ListOpenWorkflowExecutions	100	1
ListWorkflowTypes	100	1
PollForActivityTask	1000	10
PollForDecisionTask	1000	12
RecordActivityTaskHeartbeat	1000	1
RegisterActivityType	100	1

API name	Bucket size	Refill rate / s
RegisterDomain	50	1
RegisterWorkflowType	100	1
RequestCancelWorkflowExecution	1000	5
RespondActivityTaskCanceled	1000	10
RespondActivityTaskCompleted	1000	10
RespondActivityTaskFailed	1000	10
RespondDecisionTaskCompleted	1000	12
SignalWorkflowExecution	1000	5
StartWorkflowExecution	1000	2
TerminateWorkflowExecution	1000	10

Decision limits

Decision	Bucket size	Refill rate / s
RequestCancelExternalWorkflowExecution	100	10
ScheduleActivityTask	100	10
SignalExternalWorkflowExecution	100	10
StartChildWorkflowExecution	100	2
StartTimer	500	25

Requesting a Limit Increase

Use the **Support Center** page in the AWS Management Console to request a limit increase for resources provided by AWS Step Functions on a per-region basis. For more information, see To Request a Limit Increase in the *AWS General Reference*.

Amazon Simple Workflow Service Endpoints

A list of the current Amazon SWF Regions and Endpoints are provided in the *Amazon Web Services General Reference*, along with the endpoints for other services.

Amazon SWF domains and all related workflows and activities must exist within the same region to communicate with each other. Furthermore, any registered domains, workflows and activities within a region don't exist in other regions. For example, if you create a domain named "MySampleDomain" in both *us-east-1* and in *us-west-2*, they exist as *separate domains*: none of the workflows, task lists, activities, or data associated with your domains are shared across regions.

If you use other AWS resources in your workflows, such as Amazon EC2 instances, these must also exist in the same region as your Amazon SWF resources. The only exceptions to this are services that span regions, such as Amazon S3 and IAM. You can access these services from workflows that exist in any region that supports them.

Additional Documentation for the Amazon Simple Workflow Service

In addition to this Developer Guide, you may find the following documentation useful.

Topics

Amazon Simple Workflow Service API Reference

The Amazon Simple Workflow Service API Reference provides detailed information about the Amazon SWF HTTP API, including actions, request and response structures and error codes.

AWS Flow Framework Documentation

The AWS Flow Framework is a programming framework that simplifies the process of implementing distributed asynchronous applications that use Amazon SWF to manage their workflows and activities, so you can focus on implementing your workflow logic.

Each AWS Flow Framework is designed to work idiomatically in the language for which it is designed, so you can work naturally with your language of choice to implement workflows with all of the benefits of Amazon SWF.

There are AWS Flow Frameworks for the following languages:

Java

The AWS Flow Framework for Java Developer Guide provides information about how to obtain, set up and use the AWS Flow Framework for Java.

For a list of the classes, methods, and annotations used by the framework, refer to the AWS Flow Framework for Java API Reference.

Ruby

The AWS Flow Framework for Ruby Developer Guide provides information about how to obtain, set up and use the AWS Flow Framework for Ruby.

For a list of the classes and methods used by the framework, refer to the AWS Flow Framework for Ruby API Reference.

The aws-flow-ruby-samples project on GitHub provides code examples that demonstrate many of the features of the AWS Flow Framework for Ruby. You can use this code to learn more about the framework and as an aid for designing and implementing your own workflows.

AWS SDK Documentation

The AWS Software Development Kits (SDKs) provide access to Amazon SWF in many different programming languages. The SDKs follow the HTTP API closely, but also provide language-specific programming interfaces for some Amazon SWF features. You can find out more information about each SDK by visiting the following links.

Note
Only SDKs that have support for Amazon SWF at the time of writing are listed here. For a full list of the available AWS SDKs, visit the Tools for Amazon Web Services page.

Java

The AWS SDK for Java provides a Java API for AWS infrastructure services.

To view the available documentation, see the AWS SDK for Java Documentation page. You can also go directly to the Amazon SWF sections in the SDK reference by following these links:

- Class: AmazonSimpleWorkflowClient
- Class: AmazonSimpleWorkflowAsyncClient
- Interface: AmazonSimpleWorkflow
- Interface: AmazonSimpleWorkflowAsync

JavaScript

The AWS SDK for JavaScript allows developers to build libraries or applications that make use of AWS services using a simple and easy-to-use API available both in the browser or inside of Node.js applications on the server.

To view the available documentation, see the AWS SDK for JavaScript Documentation page. You can also go directly to the Amazon SWF section in the SDK reference by following this link:

- Class: AWS.SimpleWorkflow

.NET

The AWS SDK for .NET is a single, downloadable package that includes Visual Studio project templates, the AWS .NET library, C# code samples, and documentation. The AWS SDK for .NET makes it easier for Windows developers to build .NET applications for Amazon SWF and other services.

To view the available documentation, see the AWS SDK for .NET Documentation page. You can also go directly to the Amazon SWF sections in the SDK reference by following these links:

- Namespace: Amazon.SimpleWorkflow
- Namespace: Amazon.SimpleWorkflow.Model

PHP

The AWS SDK for PHP provides a PHP programming interface to Amazon SWF.

To view the available documentation, see the AWS SDK for PHP Documentation page. You can also go directly to the Amazon SWF section in the SDK reference by following this link:

- Class: SwfClient

Python

The AWS SDK for Python (Boto) provides a Python programming interface to Amazon SWF.

To view the available documentation, see the boto: A Python interface to Amazon Web Services page. You can also go directly to the Amazon SWF sections in the documentation by following these links:

- Amazon SWF Tutorial
- Amazon SWF Reference

Ruby

The AWS SDK for Ruby provides a Ruby programming interface to Amazon SWF.

To view the available documentation, see the AWS SDK for Ruby Documentation page. You can also go directly to the Amazon SWF section in the SDK reference by following this link:

- Class: AWS::SimpleWorkflow

AWS CLI Documentation

The AWS Command Line Interface (AWS CLI) is a unified tool to manage your AWS services. With just one tool to download and configure, you can control multiple AWS services from the command line and automate them through scripts.

For more information about the AWS CLI, see the AWS Command Line Interface page.

For an overview of the available commands for Amazon SWF, see swf in the *AWS Command Line Interface Reference*.

Web Resources for the Amazon Simple Workflow Service

There are a number of Web resources that you can use to learn more about Amazon SWF or to get help with using the service and developing workflows.

Topics

Amazon SWF Forum

The Amazon SWF forum provides a place for you to communicate with other Amazon SWF developers and members of the Amazon SWF development team at Amazon to ask questions and to get answers.

You can visit the forum at: Forum: Amazon Simple Workflow Service. *You must be signed in to your AWS account to view the forum.*

Amazon SWF FAQ

The Amazon SWF FAQ provide answers to frequently-asked questions about Amazon SWF, including an overview of common use cases, differences between Amazon SWF and other services, and more.

You can access the FAQ here: Amazon SWF FAQ.

Amazon SWF Videos

The Amazon Web Services channel on YouTube provides video training for all of Amazon's Web Services, including Amazon SWF.

Videos are updated frequently; for a full list of Amazon SWF-related videos, you can use the following query: *Simple Workflow* in Amazon Web Services

Amazon SWF Source Code and Samples

The source code for the AWS Flow Framework for Ruby is available on GitHub. You can use the following links to access it and its associated samples and recipes.

- AWS Flow Framework for Ruby
- AWS Flow Framework for Ruby Samples and Recipes

Amazon Simple Workflow Service Developer Guide History

The following table describes the important changes to the documentation since the last release of the *Amazon Simple Workflow Service Developer Guide*.

- **API version:** 2012-01-25
- **Latest documentation update:** June 5, 2017

Change	Description	Date Changed
Update	Cleaned up the code examples throughout this guide.	June 5, 2017
Update	Simplified and improved the organization and contents of this guide.	May 19, 2017
Update	Updates and link fixes.	May 16, 2017
Update	Updates and link fixes.	October 1, 2016
Lambda task support	You can specify Lambda tasks in addition to traditional Activity tasks in your workflows. For more information, see AWS Lambda Tasks (p. 92).	July 21, 2015
Support for setting task priority	Amazon SWF now includes support for setting the priority of tasks on a task list, and will attempt to deliver those with higher priority before tasks with lower priority. Information about how to set the task priority for workflows and for activities is provided in Setting Task Priority (p. 104).	December 17, 2014
Update	Added a new topic that describes how to log Amazon SWF API calls using CloudTrail: Logging Amazon Simple Workflow Service API Calls with AWS CloudTrail (p. 110).	May 8, 2014

Change	Description	Date Changed
Update	Two new topics related to CloudWatch metrics for Amazon SWF have been added: Amazon SWF Metrics for CloudWatch (p. 114), which provides a list and descriptions of the supported metrics, and Viewing Amazon SWF Metrics for CloudWatch using the AWS Management Console (p. 75), which provides information about how to view metrics and set alarms with the AWS Management Console.	April 28, 2014
Update	Added a new section: Amazon Simple Workflow Service Resources (p. 124). This section provides some service reference information and provides information about additional documentation, samples, code and other web resources for Amazon SWF developers.	March 19, 2014
Update	Added a workflow tutorial. See Tutorial: A Subscription Workflow with Amazon SWF and Amazon SNS (p. 9).	October 25, 2013
Update	Added AWS CLI information and example (p. 79).	August 26, 2013
Update	Updates and fixes.	August 1, 2013
Update	Updated the document to describe how to use IAM for access control.	February 22, 2013
Initial Release	This is the first release of the *Amazon Simple Workflow Service Developer Guide*.	October 16, 2012

AWS Glossary

For the latest AWS terminology, see the AWS Glossary in the *AWS General Reference*.