IoT Device Simulator

Implementation Guide

aws
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Create and simulate hundreds of virtual connected devices without having to configure and manage physical devices

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Amazon Web Services (AWS) provides many services to help customers build serverless IoT applications that gather, process, analyze, and act on connected device data, without having to manage any infrastructure. With AWS, customers can also build a secure, agile, and scalable backend for their IoT applications. This eliminates the need for customers to develop and manage their own backend resources and can help reduce costs and increase productivity and innovation. However, it is costly and can be a challenge to test IoT applications and backend services without a large pool of physical, connected devices.

IoT Device Simulator is designed to help customers more easily test device integration and IoT backend services, without the need for physical devices. This solution provides a web-based graphical user interface (GUI) that allows customers to create and simulate hundreds of connected devices, without having to configure and manage physical devices, or develop time-consuming scripts. This solution is designed to work out-of-the-box, or you can use this solution as a reference implementation to build a custom simulation engine for your specific use case.

IoT Device Simulator provides a web interface that lets users launch fleets of virtually connected devices from a user-defined template and then simulate them to publish data at regular intervals to AWS IoT. You can also monitor devices from the simulator or observe how backend services are processing the data.

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

The guide is intended for IT infrastructure architects, administrators, and DevOps professionals who have practical experience with IoT devices, and the AWS Cloud.

Note
This solution is designed to simulate device data for testing. It is not recommended for use in production environments.
Cost

You are responsible for the cost of the AWS services used while running this solution. As of November 2021, the estimated cost for running the IoT Device Simulator solution using the 100 automotive demo device types in a single simulation, sending a message every two seconds in the US East (N. Virginia) Region is $3.05 per month for a simulation running six hours per day, $6.11 per month for a simulation running 12 hours per day, and $12.22 per month for a simulation running 24 hours per day. This includes estimated charges for Amazon API Gateway, AWS Lambda, AWS Step Functions, Amazon DynamoDB, and AWS IoT Core.

The following table provides an example cost breakdown to run 100 device simulations per month in the US East (N. Virginia) Region.

<table>
<thead>
<tr>
<th>AWS service</th>
<th>6 hours per day</th>
<th>12 hours per day</th>
<th>24 hours per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon API Gateway</td>
<td>$0.000105</td>
<td>$0.000105</td>
<td>$0.000105</td>
</tr>
<tr>
<td>AWS Step Functions</td>
<td>$0.02</td>
<td>$0.04</td>
<td>$0.08</td>
</tr>
<tr>
<td>AWS Lambda</td>
<td>$2.70</td>
<td>$5.40</td>
<td>$10.80</td>
</tr>
<tr>
<td>Amazon DynamoDB</td>
<td>$0.01</td>
<td>$0.02</td>
<td>$0.04</td>
</tr>
<tr>
<td>AWS IoT Core messaging</td>
<td>$0.32</td>
<td>$0.65</td>
<td>$1.30</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>$3.05</strong>*</td>
<td><strong>$6.11</strong>*</td>
<td><strong>$12.22</strong>*</td>
</tr>
</tbody>
</table>

*Cost to run 100 device simulations per month.

We recommend creating a budget through AWS Cost Explorer to help manage costs. Prices are subject to change. For full details, refer to the pricing webpage for each AWS service you will be using in this solution.
Architecture overview

Deploying this solution with the default parameters builds the following environment in the AWS Cloud.

- **Figure 1: IoT Device Simulator architecture**

1. **Amazon CloudFront** to serve the web interface content from an Amazon Simple Storage Service (Amazon S3) bucket.
2. The Amazon S3 bucket hosts the web interface.
3. **Amazon Cognito** user pool authenticates the API requests.
4. An **Amazon API Gateway** provides the solution's API layer.
5. **AWS Lambda** serves as the solution's microservices and routes API requests.
6. **Amazon DynamoDB** stores simulation and device type information.
7. **AWS Step Functions** include an AWS Lambda simulator function to simulate devices and send messages.
8. An Amazon S3 bucket stores pre-defined routes that are used for the automotive demo (p. 16).
9. **AWS IoT Core** serves as the endpoint to which messages are sent.
10. **Amazon Location Service** provides the map display showing the location of automotive devices for the automotive demo.

**Note**

AWS CloudFormation resources are created from AWS Cloud Development Kit (CDK) constructs.
Solution components

AWS Step Functions workflow

An AWS Step Functions state machine runs the device simulator. The state machine consists of an AWS Lambda function which provides the logic to create the device messages and send them to the IoT endpoint. An architecture diagram of the workflow and a complete walkthrough can be found in the AWS Step Functions workflow (p. 15) section.

Device Simulator microservices

The IoT Device Simulator microservices are a series of AWS Lambda functions that provide the business logic and data access layer for all device simulation operations. This includes create, read, update, and delete (CRUD) operations for the Amazon DynamoDB simulation and device type tables, as well as starting the step functions workflow. Each Lambda function assumes an AWS Identity and Access Management (IAM) role with least privilege access (minimum permissions necessary) to perform its designated functions.

Web interface

The solution includes an intuitive web interface which is hosted in Amazon S3 and used to simulate the devices. You can use the interface to create and manage simulations and device types, and start device simulations to simulate devices and send messages to the AWS IoT endpoint.

The interface is designed to simulate devices that publish to an AWS IoT endpoint at regular intervals in order to test backend integration.

Note
Device creation and starting and stopping device simulations are routed through the Amazon API Gateway.

Routes bucket

The solution includes an IoT device simulator automotive demo. An Amazon S3 bucket is used to host the pre-defined routes for the automotive demo. The routes are used to provide a pathway for the simulated vehicle to follow. For more details about these routes, refer to Routes (p. 16) in this guide.
Security

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

IAM Roles

AWS Identity and Access Management (IAM) roles allow customers to assign granular access policies and permissions to services and users on the AWS Cloud. This solution creates IAM roles that grant the solution’s AWS Lambda functions access to read and write to Amazon DynamoDB, publish to an IoT endpoint, read from the Amazon S3 bucket used to host routes, and start the AWS Step Functions state machine.

AWS IoT Core policies

AWS IoT Core policies allow you to control access to the AWS IoT data plane. The AWS IoT data plane consists of operations that allow you to connect to the AWS IoT message broker and send and receive MQ Telemetry Transport (MQTT) messages. The IoT Device Simulator solution creates an AWS IoT policy which allows the web interface to connect to AWS IoT Core, subscribe, and receive MQTT messages.

Amazon CloudFront

This solution deploys a web interface hosted in an Amazon Simple Storage Service (Amazon S3) bucket. To help reduce latency and improve security, this solution includes an AWS CloudFormation distribution with an origin access identity, which is a CloudFront user that provides public access to the solution’s website bucket contents. For more information, refer to Restricting Access to Amazon S3 Content by Using an Origin Access Identity in the Amazon CloudFront Developer Guide.

Amazon API Gateway

This solution deploys an Amazon API Gateway REST API and uses the default API endpoint and Secure Sockets Layer (SSL) certificate. The default API endpoint supports only the TLSv1 protocol. To use a later version of Transport Layer Security (TLS), use your own domain name and custom SSL certificate. For more information, refer to Choosing a minimum TLS version for a custom domain in API Gateway in the Amazon API Gateway Developer Guide.
Design considerations

Updating the solution

This implementation guide contains information about how to set up and configure IoT Device Simulator version 3.0.0. You cannot update version 2.x or earlier versions of this solution to version 3 using the AWS CloudFormation console due to changes with how resources are deployed. To use version 3, you must launch a new stack using version 3.0.0 of the AWS CloudFormation template. You can uninstall your previous version of this solution.

**Note**
- If you have device types saved in a previous version of this solution, we recommend recreating these types using the web interface.

Simulation limits

A simulation is limited to running up to 100 devices, however, multiple simulations can be run concurrently. The number of simulations that can be run concurrently is limited by the number of AWS Lambda concurrently running. For more information on AWS Lambda service quotas, refer to Lambda quotas in the *AWS Lambda Developer Guide*.

Amazon Cognito limits

This solution uses Amazon Cognito user pools to manage users. Amazon Cognito sends an email every time you create a user, change a password, or reset a password. Amazon Cognito limits the number of emails sent daily per user pool to 50. For customers who plan to use this solution for a large number of users, we recommend using Amazon Simple Email Service (Amazon SES) for these emails. For more information, refer to Authorizing Amazon Cognito to Send Amazon SES Email on Your Behalf in the *Amazon Cognito Developer Guide*.

Regional deployments

This solution uses Amazon Location Service, which is not currently available in all AWS Regions. You must launch this solution in an AWS Region where Amazon Location Service is available. For the most current availability by Region, refer to the *AWS Regional Services List*. 
AWS CloudFormation template

To automate deployment, this solution uses the following AWS CloudFormation template, which you can download before deployment.

**View Template**

**iot-device-simulator.template**: Use this template to launch the solution and all associated components. The default configuration deploys Amazon Simple Storage Service (Amazon S3) buckets, an AWS CloudFormation distribution, an Amazon Cognito user pool, an Amazon API Gateway REST API, AWS Lambda functions, an AWS Step Functions state machine, Amazon DynamoDB tables, and an Amazon Location Service map and place index. You can customize the template to meet your specific needs.

**Note**

AWS CloudFormation resources are created from AWS Cloud Development Kit (CDK) constructs.
Automated deployment

**Time to deploy:** Approximately 10 minutes

**Deployment overview**

**Important**

You cannot update version 2.x or earlier versions of this solution to version 3 using the AWS CloudFormation console due to changes with how resources are deployed. To use version 3, you must launch a new stack using version 3.0.0 of the AWS CloudFormation template. You can uninstall your previous version of this solution.

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

**Step 1. Launch the stack**

- Launch the AWS CloudFormation template into your AWS account.
- Review the template parameters and enter or adjust the default values as needed.

**Step 2. Sign in to the web interface**

**Step 3. Create the device types**

- Create device types which your devices will represent.

**Step 4. Create the simulations**

- Create simulations to define the simulation you want to run.

**Step 5. Run and manage the simulations**

- Start one or more simulations.
- View simulation details and the messages of a simulation if it is currently running.

---

**Step 1. Launch the stack**

**Important**

This solution includes an option to send anonymous operational metrics to AWS. We use this data to better understand how customers use this solution and related services and products. AWS owns the data gathered through this survey. Data collection is subject to the [AWS Privacy Policy](#).

To opt out of this feature, download the template, modify the AWS CloudFormation mapping section, and then use the AWS CloudFormation console to upload your template and deploy the solution. For more information, refer to the [Collection of operational metrics](#) section in this guide.

This automated AWS CloudFormation template deploys IoT Device Simulator in the AWS Cloud.

**Note**

You are responsible for the cost of the AWS services used while running this solution. For more details, refer to the [Cost](#) section in this guide, and refer to the pricing webpage for each AWS service used in this solution.
1. Sign in to the AWS Management Console and select the button to launch the `iot-device-simulator.template` AWS CloudFormation template.

Alternatively, you can download the template as a starting point for your own implementation.

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

   **Note**
   This solution uses Amazon Location Service, which is not currently available in all AWS Regions. You must launch this solution in an AWS Region where Amazon Location Service is available. For the most current availability by Region, refer to the AWS Regional Services List.

3. On the **Create stack** page, verify that the correct template URL is in the **Amazon S3 URL** text box and choose **Next**.

4. On the **Specify stack details** page, assign a name to your solution stack. For information about naming character limitations, refer to IAM and STS Limits in the AWS Identity and Access Management User Guide.

5. Under **Parameters**, review the parameters for this solution template and modify them as necessary. This solution uses the following default value.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>User email</td>
<td><code>&lt;Requires input&gt;</code></td>
<td>The email used to sign in to the IoT Device Simulator web interface.</td>
</tr>
</tbody>
</table>

6. Choose **Next**.

7. On the **Configure stack options** page, choose **Next**.

8. On the **Review** page, review and confirm the settings. Check the boxes acknowledging that the template creates AWS Identity and Access Management (IAM) resources.

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

   You can view the status of the stack in the AWS CloudFormation Console in the Status column. You should receive a CREATE_COMPLETE status in approximately 10 minutes.

   **Note**
   In addition to the primary AWS Lambda functions (microservices and simulator), this solution also includes the custom resources helper Lambda function, which runs only during initial configuration or when resources are updated or deleted. When you run this solution, you will notice both Lambda functions in the AWS console. Only the microservices and simulator functions are regularly active. However, you must not delete the custom resource helper function, as it is necessary to manage associated resources.

---

**Step 2. Sign in to the web interface**

After the AWS CloudFormation stack is created, the resources for the web interface are deployed. You should also receive an email containing the URL for the web interface, your admin credentials, and a temporary password. Use the following procedure to sign in to the web interface for the first time.
1. Open the email, note your username and temporary password, and select the URL link.
2. On the IoT Device Simulator sign in page, enter the username and temporary password.
3. On the Change password page, enter a new password.

   **Note**  
   Password requirements: minimum of 12 characters, requiring at least one upper case character, one number, and one symbol.

After you sign in to the web interface, follow the remaining steps to create the device types, simulations, and other activities.

### Step 3. Create the device types

Use the following procedure to define your device types.

1. Navigate to the **Device Types** page.
2. Choose **Add Device Type**.

On this page, you can either manually add device types or import your device types by uploading a JSON file containing the necessary attributes. To view the structure for the JSON, refer to the Device Type JSON structure section.

![Create Device Type](image)

**Figure 2: Web interface - create a device type**

Use the following procedure to manually create a device type.

1. On the **Create Device Type** page, take the following actions:
   1. In the **Device type name** field, enter a name.
   2. In the **Topic** field, enter the topic where the device type will publish to.
3. Under **Message payload**, choose **Add Attribute**.

You will define the payload of the device type which will serve as a template for the messages that devices of the device type will send.

4. In the **Add attribute** dialog box, enter an attribute name and complete the additional data fields as needed. You can specify multiple attributes with different data types to structure your payload.

![Figure 3: Web Interface – add an attribute](image)

**Note**

The fields are dynamic based on the Attribute data type that you select.

5. Choose **Save**.

2. Enter additional attributes, as needed.

3. Choose **Save**.

---

**Step 4. Create the simulations**

Use the following procedure to define the simulations to run.

1. Navigate to the **Simulations** page.

2. Choose **Add Simulation**

3. On the **Create Simulation** page, take the following actions:
Step 5. Run and manage the simulations

Use the following procedure to run one or more simulations.

1. Navigate to the Simulations page.
2. On the Simulations page, select the checkbox for the simulations you want to run.
3. Choose Start Simulations to run one or more simulations.

View the simulations

Use the following procedure to view simulations from the Simulations page.

1. Select the View button that corresponds to the simulation you want to view. This will take you to the Simulation Details page.
2. If the simulation is running, you will be able to view the incoming messages in the Messages section.

Figure 4: Web interface - create a simulation

1. In the Simulation name field, enter a name.
2. In the Select a device type drop-down menu, select the device type you want to simulate. To select more than one device type, choose Add type.
3. In the Number of devices drop-down menu, select the number of devices you want to simulate.
4. In the Data transmission interval field, enter the interval time that the devices will send data.
   
   **Note**
   
   Data transmission interval is a key cost driver of AWS IoT Core messaging expense.
5. In the Data transmission duration field, enter the length of time that the simulation will run.
6. Choose Save.

 Step 5. Run and manage the simulations

Use the following procedure to run one or more simulations.

1. Navigate to the Simulations page.
2. On the Simulations page, select the checkbox for the simulations you want to run.
3. Choose Start Simulations to run one or more simulations.

View the simulations

Use the following procedure to view simulations from the Simulations page.

1. Select the View button that corresponds to the simulation you want to view. This will take you to the Simulation Details page.
2. If the simulation is running, you will be able to view the incoming messages in the Messages section.
Manage the device types

Device types are used to define the type of data your simulated IoT devices will send. The IoT Device Simulator provides a web interface to help you manage your device types, letting you view and edit your device types when needed. You can manage the device types from the Device Types page. On the Device Types page, you can:

- View your device types. A list of all device types associated with your account is displayed on this page.
- Review and update the details of a specific device type. To make updates, find the applicable device type and select Edit. The Device Type Edit page shows the device type definition details including the name, the data topic, and the message payload. To make updates, change the applicable values, and choose Save. You can remove existing attributes or add new attributes to the message payload.

Manage the simulations

Simulations define which devices will run, how long they will run, and at what intervals they will send messages to the IoT topic. You can create and delete simulations, view the simulation details, and view the messages a simulation is sending.

To manage your simulations, navigate to the Simulation page. A list of all simulations associated with your account are displayed.

- To start one or more simulations, select the checkbox next to the simulation you want to start, then choose Start simulations. Use the select all checkbox in the table header to select all simulations on the page.
- To stop simulations, choose Stop simulations.
- To delete a simulation, select the simulation you want to delete and choose Delete.
Additional Resources

AWS services

- AWS Lambda
- AWS Fargate
- Amazon Elastic Container Service
- Amazon DynamoDB
- Amazon Cognito
- Amazon CloudWatch
- Amazon Virtual Private Cloud
- AWS CloudFormation
- Amazon Simple Queue Service
- AWS IoT
- Amazon Simple Storage Service
- Amazon API Gateway
- AWS Identity and Access Management
- Amazon CloudFront
AWS Step Functions workflow

The following detailed breakdown shows the steps involved in the AWS Step Functions state machine when running a simulation.

1. The microservices AWS Lambda function receives the run simulation request and passes the simulation information to AWS Step Functions.
2. The device type information is retrieved from the corresponding DynamoDB table for each device type specified in the simulation.
3. The simulation and device type information are passed to the simulator AWS Lambda function.
4. The simulator AWS Lambda function creates messages and sends them to the AWS IoT Core endpoint. The AWS Lambda function restarts every 15 minutes until it has run for the specified duration.
5. Every 30 seconds, the simulator AWS Lambda function polls the simulator Amazon DynamoDB table to check if the simulation has been stopped externally.
6. When the simulation has finished, the corresponding simulation in the simulations Amazon DynamoDB table is updated.

Figure 5: Simulation workflow
Automotive demo

Routes

The solution includes an Amazon S3 bucket to store pre-defined routes for the automotive demo. The routes are used to define the path the vehicle will take, and some routes include random triggers that may arise throughout the route, such as high oil temperature. The route locations are defined in the stages. Each stage contains a start and end position. The automotive demo device will move along the stages based on various calculations, such as the speed of the device. The latitude and longitude of the device is reflective of which stage the device is currently navigating. The device location updates each time it moves between a stage. It may take multiple messages before a device moves from one stage to the next.

Running the automotive demo

The solution contains an automotive demo which simulates a connected vehicle. The automotive demo uses one of 18 defined routes that exist in an Amazon Simple Storage Service (Amazon S3) bucket that is created when the solution is launched. It then uses various calculations in the AWS Lambda simulator function to simulate data such as fuel consumption, vehicle speed, acceleration and more. With the automotive demo simulation, you will be able to view a map with the location of the running devices. To use the automotive demo, perform the following steps:

1. Create an Automotive Demo device type.
   1. Navigate to the Device Type page.
   2. Choose Create Device Type.
   3. Choose Automotive Demo.
   4. The payload is auto populated. Enter the rest of the fields such as Name and Topic.
   5. Choose Save.
2. Create a simulation.
   1. Navigate to the Simulations page.
   2. Choose Create Simulation.
   3. Change the Simulation Type field to Automotive.
   4. In the dropdown field for devices, you can view your automotive demo device types.
   5. Enter the required fields.
   6. Choose Save.
3. Run the simulation.
   1. Run the simulation from the Simulations page by checking the desired simulations, then choose Start Simulations.
   2. Alternatively, choose View next to the simulation you want to run, then choose Start to run the simulation.
4. View the simulation.
   1. Choose View next to the simulation you want to view.
   2. If the simulation is running, you can view a map with the locations of the devices, and up to 100 of the most recent messages sent to the IoT topic.
### Device type JSON structure

The structure of the JSON to import a device type should contain the following:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Yes</td>
<td>String</td>
<td>The name of the device type.</td>
</tr>
<tr>
<td>topic</td>
<td>Yes</td>
<td>String</td>
<td>The topic to which the device type sends its messages.</td>
</tr>
<tr>
<td>payload</td>
<td>Yes</td>
<td>Array of attribute objects</td>
<td>The payload of the device type. See the attribute structure table below to see valid payload contents.</td>
</tr>
</tbody>
</table>

General attribute parameters that are required in all attribute objects:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>Yes</td>
<td>String</td>
<td>The name of the attribute.</td>
</tr>
<tr>
<td>type</td>
<td>Yes</td>
<td>String</td>
<td>The type of attribute, must be one of the values listed in the attribute table below.</td>
</tr>
</tbody>
</table>

Parameters that are specific to each attribute:

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameters</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>id</td>
<td>Name</td>
<td>No</td>
<td>String</td>
<td>An alphabet to limit the characters that will be used in the ID.</td>
</tr>
<tr>
<td></td>
<td>charSet</td>
<td>No</td>
<td>String</td>
<td></td>
</tr>
<tr>
<td></td>
<td>length</td>
<td>No</td>
<td>Number</td>
<td>The length of the ID.</td>
</tr>
<tr>
<td></td>
<td>static</td>
<td>No</td>
<td>Boolean</td>
<td>If true, the value will only be generated once per simulation.</td>
</tr>
<tr>
<td>bool</td>
<td>Name</td>
<td>No</td>
<td>Type</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameters</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17
<table>
<thead>
<tr>
<th>Type</th>
<th>Parameters</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td>A default value to be used instead of generating a value.</td>
<td></td>
</tr>
<tr>
<td>decay</td>
<td>Name</td>
<td>Required</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>min</td>
<td>Yes</td>
<td>Number</td>
<td>The floor for the decay.</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>Yes</td>
<td>Number</td>
<td>The starting value for the decay.</td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td>The static value to be used.</td>
<td></td>
</tr>
<tr>
<td>float</td>
<td>Name</td>
<td>Required</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>min</td>
<td>Yes</td>
<td>Number</td>
<td>The minimum value to be generated.</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>Yes</td>
<td>Number</td>
<td>The maximum value to be generated.</td>
<td></td>
</tr>
<tr>
<td>precision</td>
<td>Yes</td>
<td>Number</td>
<td>The decimal precision of the float (for example, .01).</td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td>A default value to be used instead of generating a value.</td>
<td></td>
</tr>
<tr>
<td>int</td>
<td>Name</td>
<td>Required</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>min</td>
<td>Yes</td>
<td>Number</td>
<td>The minimum of the range from which a number will be generated.</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>Yes</td>
<td>Number</td>
<td>The maximum of the range form which a number will be generated.</td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td>A default value to be used rather than have one generated.</td>
<td></td>
</tr>
<tr>
<td>location</td>
<td>Name</td>
<td>Required</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>lat</td>
<td>Yes</td>
<td>Number</td>
<td>The center position latitude.</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Parameters</td>
<td>Required</td>
<td>Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>------------</td>
<td>----------</td>
<td>--------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>long</td>
<td>Yes</td>
<td>Number</td>
<td>The center position longitude.</td>
<td></td>
</tr>
<tr>
<td>radius</td>
<td>Yes</td>
<td>Number</td>
<td>The radius (in meters) from the center position for the random coordinates to be generated.</td>
<td></td>
</tr>
<tr>
<td>payload</td>
<td>Yes</td>
<td>Array</td>
<td>An array of attribute objects.</td>
<td></td>
</tr>
<tr>
<td>min</td>
<td>Yes</td>
<td>Number</td>
<td>The minimum length of the string.</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>Yes</td>
<td>Number</td>
<td>The maximum length of the string.</td>
<td></td>
</tr>
<tr>
<td>static</td>
<td>No</td>
<td>Boolean</td>
<td>If true, the value will be generated once per simulation.</td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>String</td>
<td>A default value to be used instead of generating a value.</td>
<td></td>
</tr>
<tr>
<td>min</td>
<td>Yes</td>
<td>Number</td>
<td>The minimum value.</td>
<td></td>
</tr>
<tr>
<td>max</td>
<td>Yes</td>
<td>Number</td>
<td>The maximum value.</td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td>A default value to be used instead of generating a value.</td>
<td></td>
</tr>
<tr>
<td>tsformat</td>
<td>Yes</td>
<td>String</td>
<td>The timestamp format to be used. Must be one of the following: default or unix.</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>Parameters</td>
<td>Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>default</td>
<td>No</td>
<td>Number</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A default value to be used instead of generating a value.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**pickOne**

<table>
<thead>
<tr>
<th>Type</th>
<th>Parameters</th>
<th>Required</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>arr</td>
<td>Yes</td>
<td>Array</td>
<td>Array</td>
<td>An array of strings from which a value will be chosen.</td>
</tr>
<tr>
<td>static</td>
<td>No</td>
<td>Boolean</td>
<td>Boolean</td>
<td>If true, the value will be generated only once per simulation.</td>
</tr>
</tbody>
</table>
Uninstall the solution

You can uninstall the IoT Device Simulator solution from the AWS Management Console or by using the AWS Command Line Interface. You must manually delete the Amazon S3 buckets, and Amazon DynamoDB tables created by this solution. AWS Solutions Implementations do not automatically delete these resources in case you have stored data to retain.

Using the AWS Management Console

1. Sign in to the AWS CloudFormation console.
2. Select this solution's installation stack.
3. Choose Delete.

Using AWS Command Line Interface

Determine whether the AWS Command Line Interface (AWS CLI) is available in your environment. For installation instructions, refer to What Is the AWS Command Line Interface in the AWS CLI User Guide. After confirming that the AWS CLI is available, run the following command.

```
$ aws cloudformation delete-stack --stack-name <installation-stack-name>
```

Deleting Amazon S3 bucket

This solution is configured to retain the solution-created Amazon S3 buckets if you decide to delete the AWS CloudFormation stack to prevent accidental data loss. After uninstalling the solution, you can manually delete the S3 buckets if you do not need to retain the data. Follow these steps to delete the Amazon S3 bucket.

1. Sign in to the Amazon S3 console.
2. Choose Buckets from the left navigation pane.
3. Locate the <stack-name> S3 buckets.
4. Select the S3 bucket and choose Delete.

To delete the S3 bucket using AWS CLI, run the following command:

```
$ aws s3 rb s3://<bucket-name> --force
```

Deleting DynamoDB tables

This solution is configured to retain the solutions Amazon DynamoDB tables if you decide to delete the AWS CloudFormation stack to prevent accidental data loss. After uninstalling the solution, you can manually delete the Amazon DynamoDB tables if you do not need to retain the data. Follow these steps to delete the Amazon DynamoDB tables.
1. Sign in to the Amazon DynamoDB console.
2. Choose Tables from the left navigation pane.
3. Select the <stack-name> Amazon DynamoDB table you want to delete and choose Delete table.
Collection of operational metrics

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

- **Solution ID**: The AWS solution identifier
- **Unique ID (UUID)**: Randomly generated, unique identifier for each solution deployment
- **Timestamp**: Data-collection timestamp
- **Device Type Data**: The type of attributes used when defining a device type payload

Example data:

```json
{
    eventType: "create device type",
    uniquePayloadAttrs: ["string", "float", "sinusoidal"]
}
```

- **Simulation Creation Data**: The amount of devices, and the duration of the simulation

Example data:

```json
{
    eventType: "create simulation",
    duration: 120,
    numDevices: 70
}
```

- **Simulation Run Data**: The amount of devices, and the duration of the simulation

Example data:

```json
{
    eventType: "start simulation",
    duration: 120,
    numSimulations: 2,
    type: 'autoDemo'
}
```

Note that AWS will own the data gathered via this survey. Data collection will be subject to the AWS Privacy Policy. To opt out of this feature, complete the following steps before launching the AWS CloudFormation template.

1. Download the AWS CloudFormation template to your local hard drive.
2. Open the AWS CloudFormation template with a text editor.
3. Modify the AWS CloudFormation template mapping section from:

   ```text
   Solution:
   Config:
   SendAnonymousUsage: "Yes"
   ```

   to:

   ```text
   Solution:
   Config:
   ```
Solution:
Config:
  SendAnonymousUsage: "No"

4. Sign in to the AWS CloudFormation console.
5. Select Create stack.
6. On the Create stack page, Specify template section, select Upload a template file.
7. Under Upload a template file, choose Choose file and select the edited template from your local drive.
8. Choose Next and follow the steps in Launch the stack in the Automated Deployment section of this guide.
Source code

Visit our GitHub repository to download the source files for this solution and to share your customizations with others. The IoT Device Simulator templates are generated using the AWS Cloud Development Kit (CDK). Refer to the README.md file for additional information.
Contributors

The following individuals contributed to this document:

- George Lenz
- Ajay Swamy
## Revisions

<table>
<thead>
<tr>
<th>Date</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2018</td>
<td>Initial release</td>
</tr>
<tr>
<td>December 2018</td>
<td>Added information about the Amazon CloudFront distribution for the static website hosted in the Amazon S3 bucket</td>
</tr>
<tr>
<td>March 2019</td>
<td>Added information about Amazon DynamoDB on-demand, the Amazon ECS service-linked role, additional device type attributes and functionality, and managing device types, widgets, and users</td>
</tr>
<tr>
<td>December 2019</td>
<td>Added information on support for Node.js update</td>
</tr>
<tr>
<td>July 2020</td>
<td>Added cost considerations for Amazon ECS; updated information on support for Node.js update and AWS Lambda</td>
</tr>
<tr>
<td>November 2021</td>
<td>Release v3.0.0: Used AWS Cloud Development Kit to create the AWS CloudFormation template; migrated UI to React and simplified the UI; added the ability to import/export device types; changed simulator from running on Amazon ECS to AWS Lambda with AWS Step Functions; removed widgets and changed to a device type/simulation workflow to run devices; added Amazon Location Service as map provider; changed the UI and custom resource Lambda to Typescript; and aggregated automotive demo messages. For more information, refer to the CHANGELOG.md in the GitHub repository.</td>
</tr>
</tbody>
</table>
Notices

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AWS glossary

For the latest AWS terminology, see the AWS glossary in the AWS General Reference.