Industrial Machine Connectivity (IMC) Kit

Physical-Greenfield Deployment User Guide

**Introduction:**

The physical greenfield deployment is intended to demonstrate the capabilities of the IMC kit in an environment where the end user does not have existing edge-based asset modeling software (such as Ignition or KepServer). It is deployed onto physical hardware. After deployment, the physical hardware will run Greengrass software and edge-based asset modeling software (Ignition). The IMC kit supports the following OEM devices:

1. **Lenovo**
   1. Model: ThinkCentre M90n IoT
   2. Architecture: Intel® Celeron® 4205U (x86)
   3. URL: <https://www.lenovo.com/us/en/desktops-and-all-in-ones/thinkcentre/m-series-tiny/ThinkCentre-M90n-IoT/p/thinkcentre-m90n-iot>
2. **ADLINK** 
   1. Model: MXE-211
   2. Architecture: Intel Atom® Processor E3900 (x86)
   3. <https://www.adlinktech.com/Products/Industrial_IoT_and_Cloud_solutions/IoTGateway/MXE-210_Series?lang=en>
3. **OnLogic**
   1. Model: Karbon 300 Compact Rugged Computer
   2. Architecture: Intel Atom® E3930 or E3950 processors
   3. URL: <https://onlogic.com/k300/>
4. **Advantech** 
   1. Model: UNO-2372G
   2. Architecture: Intel Atom E3845/Celeron® J1900 Quad-Core Processors
   3. URL: <https://www.advantech.com/products/1-2mlj9a/uno-2372g/mod_f4ff5680-f016-44bd-bff0-e5eddfd82237>
5. **MOXA**
   1. Model: MC-1112-E4-T
   2. Architecture: Intel Atom® Processor E3845 processor
   3. URL: <https://www.moxa.com/en/products/industrial-computing/x86-computers/mc-1100-series/mc-1121-e4-t>

This deployment mode does not come with a configured set of project tags similar to the virtual deployment but does come with a set of device simulations that can be configured to represent a project tag structure similar to the virtual deployment tag structure (or your own structure entirely). This deployment can be configured to work with a physical PLC test harness. Currently Inductive Automation’s Ignition Server (<https://inductiveautomation.com/ignition/>) is the only supported edge software application for the physical greenfield deployment.

**Deployment Options:**

There are several options for the virtual deployment configuration which depend on 2 configuration choices:

1. Data Flow option - There are 3 options for data flow:
   1. Option 1
   2. Option 2a
   3. Option 2b
2. Ignition Server Tag Hierarchy Source
   1. Cirrus Link Module - This option is based on the Cirrus Link MQTT Transmission Module implementing the SparkplugB MQTT spec to publish birth certificates when a node or device is created within the Ignition Designer UI dashboard. The AMC runs automatically without a manual step with this option and results in assets provisioned within AWS IoT SiteWise.
   2. Ignition File Export - This option is based on exporting a JSON tag hierarchy definition file from Ignition Server and uploading it into an S3 bucket. Once the file is uploaded to the S3 bucket, the AMC runs automatically, resulting in assets provisioned within AWS IoT SiteWise.

Depending on the choices of these 2 configuration options, there are a total of 6 deployment modes:

## Physical Greenfield Option 1 Cirrus Link Module

## Physical Greenfield Option 1 Ignition File Export

## Physical Greenfield Option 2a Cirrus Link Module

## Physical Greenfield Option 2a Ignition File Export

## Physical Greenfield Option 2b Cirrus Link Module

## Physical Greenfield Option 2b Ignition File Export

**Get Started**

1. Ensure that you are preparing pre-requisite resources and launching the CloudFormation stack in one of the 3 supported regions for the IMC kit:
   1. us-east-1
   2. us-west-2
   3. eu-west-1
2. Complete the setup steps defined in the Pre-Requisites section below.
3. Select one of the 6 deployment modes from the list above and proceed to the appropriate section that details the deployment steps for the mode you selected in the list above. Each deployment mode has the following sections:
   1. CloudFormation stack launch
   2. Post deployment steps
   3. Troubleshooting - Refer to this section to troubleshoot IMC stack launch and operation.
4. Physical Greenfield Cleanup - Refer to this section to cleanup AWS resources launched for the IMC kit.
5. Physical Greenfield FAQ - Refer to this section for FAQs regarding IMC kit.

The physical-greenfield deployment has the following sections:

1. Pre-Requisites
2. CloudFormation stack launch
3. Post deployment steps
4. Troubleshooting
5. Physical Greenfield Cleanup
6. Physical Greenfield FAQ

## Pre-Requisites

* **AWS account with SSO enabled & User created:**
  + **Enable AWS SSO**
    - Navigate to the SSO service in the AWS console
    - A screenshot of a cell phone

      Description automatically generatedClick “Enable AWS SSO”
    - A screenshot of a cell phone

      Description automatically generatedIf you don’t have an AWS organization set up for your account (required for AWS SSO usage), you’ll be prompted to set one up. Click “Create AWS organization”.
    - For extra documentation, visit AWS:
      * <https://docs.aws.amazon.com/singlesignon/latest/userguide/getting-started.html>
  + **Create a Group:**
    - Navigate to the SSO service in the AWS console
    - Click on “Groups” in the left-hand navbar
    - A screenshot of a cell phone

      Description automatically generatedIf none exist, click the blue “Create group” button
    - A screenshot of a cell phone

      Description automatically generatedFill out the required fields, then click “Create”
  + **Create an SSO user:**
    - Navigate to the SSO service in the AWS console
    - Click on “Users” in the left-hand navbar
    - A screenshot of a cell phone

      Description automatically generatedClick the blue “Add user” button
    - A screenshot of a cell phone

      Description automatically generatedFill out the required fields
    - Click “Next: Groups”
    - A screenshot of a cell phone

      Description automatically generatedSelect a group, then click the blue “Add user” button
* **EC2 SSH Key Pair:** If you do not already have an EC2 SSH Key Pair available (pem file format), create one in the region you are launching the CloudFormation stack,

EC2 SSH Key Pair Documentation:<https://docs.aws.amazon.com/AWSEC2/latest/UserGuide/ec2-key-pairs.html>

* **Create IoT SiteWise Service-linked Role Using the AWS CLI:** 
  + Run the following command from the AWS CLI:
    - aws iam create-service-linked-role --aws-service-name iotsitewise.amazonaws.com --description "Service-linked role to support IoT SiteWise"
  + Service-Linked-Role Documentation: <https://docs.aws.amazon.com/iot-sitewise/latest/userguide/using-service-linked-roles.html>
* **Connect to your physical hardware running Ubuntu 18.04, make sure it is connected to the internet, and configure the AWS CLI:**
  + You may achieve this however you please – either via an SSH command or a connection to the device with a keyboard and monitor
  + Ensure you have the ability to connect to the internet
  + Configure the AWS CLI on the hardware to communicate with the AWS account you plan to deploy in: <https://docs.aws.amazon.com/cli/latest/userguide/cli-chap-configure.html>
* **The directory structure of the physical hardware running Ubuntu 18.04 must look like the following:**

home/

ubuntu

Deployment Modes:

## Physical Greenfield Option 1 Cirrus Link Module

## Physical Greenfield Option 1 Ignition File Export

## Physical Greenfield Option 2a Cirrus Link Module

## Physical Greenfield Option 2a Ignition File Export

## Physical Greenfield Option 2b Cirrus Link Module

## Physical Greenfield Option 2b Ignition File Export

## Physical Greenfield Option 1 Cirrus Link Module

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 1”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 1”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

**Option 1**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption1] physical-greenfield-option1.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option1.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield1and2a]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option1.sh physicalgreenfieldoption1-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption1/PhysicalGreenfieldOption1Core.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption1 [Hardware-IP] PhysicalGreenfieldOption1/PhysicalGreenfieldOption1Device.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Download the Ignition Designer software
      1. In your browser of choice, visit the following URL: http://<hardwarePrivateIP>:8088
      2. On the top right corner of the screen, click “Get Designer”
      3. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.
   3. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
3. Trigger a node “birth” message
   1. Using the steps in 2.b, connect to your Ignition server
   2. A screenshot of a cell phone

      Description automatically generatedA birth message is triggered by launching the Ignition Designer, navigating to the tag browser 🡪 tag providers 🡪 MQTT Transmission 🡪 Transmission Control 🡪 clicking the “Refresh” button.
   3. This action triggers the IMC kit’s AMC, which creates the models and assets that represent the Ignition hierarchy in SiteWise.
4. Accept SiteWise Certificate in Ignition: To enable the SiteWise to ingest data over OPC UA from Ignition’s OPC UA server, you must accept the certificate presented by the SiteWise connector within Ignition.
   1. Get the private IP address of the physical hardware, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
   2. Once the Ignition Web UI is open, you should see a gear like icon on the left labeled 'Config'. Click that, and it may ask you to log in. The default credentials are:
      1. Username: admin
      2. Password: password
         1. If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.
   3. Navigate to "OPC UA -> Security -> Server" and wait for the quarantined certificate to appear (from AWS IoT SiteWise Gateway). You should see a single entry under 'Quarantined Certificates' named something like 'AWS IoT SiteWise Gateway Client'.
      1. Click “Trust” to accept the certificate. At this point, the SiteWise connector will start consuming data over OPC UA from Ignition and this data will be sent up to the AWS IoT SiteWise in the cloud.
5. Update the SiteWise Gateway
   1. Navigate to AWS IoT SiteWise console and select Ingest🡪Gateways
   2. Select the gateway created during the stack launch.
      1. Naming convention: [name\_of\_stack]\_Automated\_Gateway
   3. Click “Edit” in the Source Configuration for Automated Gateway Config” section
   4. Click “Save” at the bottom. No changes are necessary. This action simply activates the SiteWise gateway to ensure data flows from the OPC UA server.
6. Validate Incoming PLC Data
   1. Now that you've trusted the certificate, go back to the AWS IoT SiteWise console.
   2. In the SiteWise console, click the icon on the left side of the page, select build🡪assets
   3. In the asset tree on the left, drill down to an asset (i.e. Hauloff or Conveyor), select it and then select “Measurements” tab for that asset.
   4. Verify that the values in the “Latest value” column are updating. This indicates that the Ignition simulation of those virtual devices and sensors is properly sending data through to the SiteWise connector in Greengrass and up to AWS IoT SiteWise in the AWS cloud.

### View SiteWise Portal Data

**Log in to SiteWise Monitor Portal**

1. For a more visual display of the data, navigate to the SiteWise console, select the icon on the left and select Monitor🡪 Portals.
2. Select the hyperlinked "name" of the Portal most recently added (the topmost on the list).
3. Add yourself as an administrator of the Portal by clicking “Assign Users” in the Portal Administrators section
4. Once you are listed as a Portal Administrator, click the hyperlinked URL in the Portal details section under the “URL” column. This URL should have the format <https://[XXXXX....XXXXXX].app.iotsitewise.aws>.
5. Log in with the credentials (username and password) you just created for your administrator account.

**View Data in SiteWise Monitor Portal**

1. Select “Dashboards” tab on the left-hand side, then select the newly created dashboard hyperlink under the “Name” column of the Dashboards page.
   1. Data should be flowing into the line charts for the asset measurement properties
2. You can also see data for individual assets by navigating to the “Asset Library” tab on the left and selecting an asset from the asset tree. Once an asset is selected, you can view its properties.

### Troubleshooting

**Quarantined certificate in Ignition doesn't show up, or data doesn’t show up for Option 1 deployments**

First, verify that the Ignition trial period (2 hours) has not expired. If that action does not remediate the issue, repeat the process of refreshing the SiteWise Gateway:

1. Navigate to the AWS IoT SiteWise console and select Ingest 🡪 Gateways
2. Select the gateway created during the stack launch:
   1. Naming convention: [name\_of\_stack]\_Automated\_Gateway
3. Click “Edit” in the Source Configuration for Automated Gateway Config section
4. Click “Save” at the bottom. No changes are necessary. This action simply activates the SiteWise gateway to ensure data flows from the OPC UA server.
5. If it hasn’t already been done, look for and accept the quarantined certificate in Ignition.

## Physical Greenfield Option 1 Ignition File Export

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 1”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 1”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Select “IgnitionFileExport”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

**Option 1**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption1] physical-greenfield-option1.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option1.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield1and2a]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option1.sh physicalgreenfieldoption1-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption1/PhysicalGreenfieldOption1Core.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption1 [Hardware-IP] PhysicalGreenfieldOption1/PhysicalGreenfieldOption1Device.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Download the Ignition Designer software
      1. In your browser of choice, visit the following URL: http://<hardwarePrivateIP>:8088
      2. On the top right corner of the screen, click “Get Designer”
      3. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
3. Export the JSON file that describes your project hierarchy in Ignition.
   1. Follow the steps in 2.b to connect to your Ignition server via the Ignition Designer
   2. A screenshot of a cell phone

      Description automatically generatedIn the Tag Browser, under “Tag Providers” select “default” and click export.
4. Upload the JSON file from step 1 into the following S3 bucket created during deployment to trigger the AMC and creation of models and assets in SiteWise:
   1. [name\_of\_stack]-[amcincomingresource]-[hash]
      1. Upon dropping the JSON file in this S3 bucket, an S3 event trigger will automatically invoke the AMC Lambda function
   2. Wait for the AMC to complete creating your models and assets in SiteWise
5. Accept SiteWise Certificate in Ignition: To enable the SiteWise to ingest data over OPC UA from Ignition’s OPC UA server, you must accept the certificate presented by the SiteWise connector within Ignition.
   1. Get the private IP address of the physical hardware, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
   2. Once the Ignition Web UI is open, you should see a gear like icon on the left labeled 'Config'. Click that, and it may ask you to log in. The default credentials are:
      1. Username: admin
      2. Password: password
         1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. Navigate to "OPC UA -> Security -> Server" and wait for the quarantined certificate to appear (from AWS IoT SiteWise Gateway). You should see a single entry under 'Quarantined Certificates' named something like 'AWS IoT SiteWise Gateway Client'.
      1. Click “Trust” to accept the certificate. At this point, the SiteWise connector will start consuming data over OPC UA from Ignition and this data will be sent up to the AWS IoT SiteWise in the cloud.
6. Update the SiteWise Gateway
   1. Navigate to AWS IoT SiteWise console and select Ingest🡪Gateways
   2. Select the gateway created during the stack launch.
      1. Naming convention: [name\_of\_stack]\_Automated\_Gateway
   3. Click “Edit” in the Source Configuration for Automated Gateway Config” section
   4. Click “Save” at the bottom. No changes are necessary. This action simply activates the SiteWise gateway to ensure data flows from the OPC UA server.
7. Validate Incoming PLC Data
   1. Now that you've trusted the certificate, go back to the AWS IoT SiteWise console.
   2. In the SiteWise console, click the icon on the left side of the page, select build🡪assets
   3. In the asset tree on the left, drill down to an asset (i.e. Hauloff or Conveyor), select it and then select “Measurements” tab for that asset.
   4. Verify that the values in the “Latest value” column are updating. This indicates that the Ignition simulation of those virtual devices and sensors is properly sending data through to the SiteWise connector in Greengrass and up to AWS IoT SiteWise in the AWS cloud.

### View SiteWise Portal Data

**Log in to SiteWise Monitor Portal**

1. For a more visual display of the data, navigate to the SiteWise console, select the icon on the left and select Monitor🡪 Portals.
2. Select the hyperlinked "name" of the Portal most recently added (the topmost on the list).
3. Add yourself as an administrator of the Portal by clicking “Assign Users” in the Portal Administrators section
4. Once you are listed as a Portal Administrator, click the hyperlinked URL in the Portal details section under the “URL” column. This URL should have the format <https://[XXXXX....XXXXXX].app.iotsitewise.aws>.
5. Log in with the credentials (username and password) you just created for your administrator account.

**View Data in SiteWise Monitor Portal**

1. Select “Dashboards” tab on the left-hand side, then select the newly created dashboard hyperlink under the “Name” column of the Dashboards page.
   1. Data should be flowing into the line charts for the asset measurement properties
2. You can also see data for individual assets by navigating to the “Asset Library” tab on the left and selecting an asset from the asset tree. Once an asset is selected, you can view its properties.

### Troubleshooting

**Models and assets weren’t created in SiteWise**

Check the Lambda function responsible for creating the models and assets in SiteWise for errors:

1. In the AWS lambda console, navigate to the function named [name\_of\_stack]-AssetModelIngestionLambdaResource-[hash]
2. Hit the “Monitoring” tab
3. Click “View logs in CloudWatch”
4. Click into the most recent Log Stream and find the error message

**Quarantined certificate in Ignition doesn't show up, or data doesn’t show up for Option 1 deployments**

First, verify that the Ignition trial period (2 hours) has not expired. If that action does not remediate the issue, repeat the process of refreshing the SiteWise Gateway:

1. Navigate to the AWS IoT SiteWise console and select Ingest 🡪 Gateways
2. Select the gateway created during the stack launch:
   1. Naming convention: [name\_of\_stack]\_Automated\_Gateway
3. Click “Edit” in the Source Configuration for Automated Gateway Config section
4. Click “Save” at the bottom. No changes are necessary. This action simply activates the SiteWise gateway to ensure data flows from the OPC UA server.
5. If it hasn’t already been done, look for and accept the quarantined certificate in Ignition.

## Physical Greenfield Option 2a Cirrus Link Module

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2a”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2a”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Select “IgnitionCirrusLink”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

\*\*Note – for Option 2a deployments, models and assets are not required to collect data.

**Option 2a**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption2a] physical-greenfield-option2a.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option2a.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield1and2a]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option2a.sh physicalgreenfieldoption1-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption2a/PhysicalGreenfieldOption2aCore.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption2a [Hardware-IP] PhysicalGreenfieldOption2a/PhysicalGreenfieldOption1Device.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Download the Ignition Designer software
      1. In your browser of choice, visit the following URL: http://<hardwarePrivateIP>:8088
      2. On the top right corner of the screen, click “Get Designer”
      3. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
3. Trigger an MQTT node “birth” message
   1. Note for AWS/SME: a birth message is triggered by launching the Ignition Designer, navigating to the tag browser 🡪 tag providers 🡪 MQTT Transmission 🡪 Transmission Control 🡪 clicking the “Refresh” button.
   2. This action triggers the IMC kit’s AMC, which creates the models and assets that represent the Ignition hierarchy in SiteWise.
      1. \*\* Not required to collect data for this deployment option
4. Validate Incoming PLC Data in IoT Core
   1. Navigate to the AWS IoT Core console.
   2. Select “Test” from the navbar on the left.
   3. Subscribe to the topic: “spBv1.0/AWS Smart Factory/DDATA/#”
   4. Verify that messages are coming in from this topic.
5. Validate Incoming PLC Data in S3
   1. Navigate to the S3 console.
   2. Search for the bucket: “[stack\_name\_here]-imcs3bucket-[hash]
   3. Click into the bucket and confirm that a directory inside the bucket called “mqtt” exists.

### Troubleshooting

**Models and assets weren’t created in SiteWise**

Check the Lambda function responsible for creating the models and assets in SiteWise for errors:

1. In the AWS lambda console, navigate to the function named [name\_of\_stack]-AssetModelIngestionLambdaResource-[hash]
2. Hit the “Monitoring” tab
3. Click “View logs in CloudWatch”
4. Click into the most recent Log Stream and find the error message

**Data via the MQTT Transmission module doesn’t show up in IoT Cloud**

1. Get the public IP address of that instance, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
2. Open the Ignition Web UI is open, you should see a gear like icon on the left labeled ‘Config’. Click that, and it will ask you to log in. The default credentials are:
   1. Username: admin
   2. Password: password
      1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
3. Navigate to “MQTT Transmission -> Settings -> Server” and confirm that the connectivity shows 1 of 1. If it doesn’t, click edit and:
   1. Make sure the URL is in the format: ssl://[your\_aws\_account\_iot\_endpoint]:8883
   2. Download the .tar.gz file that represents the non-GreenGrass IoT thing from the following S3 bucket location:
      1. Bucket Name: [stack\_name]-devicesbucketresource-hash
      2. Key Name: [name\_for\_edge\_device\_parameter]/[name\_for\_edge\_device\_parameter]Device.tar.gz
   3. Expand the tarball
   4. Replace the CA Certificate File with “root.ca.pem” from the tarball package
   5. Replace the Client Certificate File with the “.pem” file from the tarball package
   6. Replace the Client Private Key File with the “.private” file from the tarball package
   7. Hit “Save Changes”, and make sure that the connectivity says “1 of 1”.

## Physical Greenfield Option 2a Ignition File Export

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2a”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2a”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Select “IgnitionFileExport”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

\*\*Note – for Option 2a deployments, models and assets are not required to collect data.

**Option 2a**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption2a] physical-greenfield-option2a.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option2a.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield1and2a]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option2a.sh physicalgreenfieldoption1-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption2a/PhysicalGreenfieldOption2aCore.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption2a [Hardware-IP] PhysicalGreenfieldOption2a/PhysicalGreenfieldOption1Device.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Download the Ignition Designer software
      1. In your browser of choice, visit the following URL: http://<hardwarePrivateIP>:8088
      2. On the top right corner of the screen, click “Get Designer”
      3. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
3. Export the JSON file that describes your project hierarchy in Ignition.
   1. Download the Ignition Designer software
      1. Navigate to the EC2 console and retrieve the public IP address of the EC2 instance running Ignition for the IMC Kit
         1. The end of the EC2’s instance should contain “Ignition”
      2. In your browser of choice, visit the following URL: http://<ignition\_ec2\_IP>:8088
      3. On the top right corner of the screen, click “Get Designer”
      4. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: <http://[ignition_ec2_public_ip]:8088>
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. A screenshot of a cell phone

      Description automatically generatedIn the Tag Browser, under “Tag Providers” select “default” and click export.
4. Upload the JSON file from step 1 into the following S3 bucket created during deployment to trigger the AMC and creation of models and assets in SiteWise:
   1. [name\_of\_stack]-[amcincomingresource]-[hash]
      1. This action triggers the IMC kit’s AMC, which creates the models and assets that represent the Ignition hierarchy in SiteWise.
         1. \*\* Not required to collect data for this deployment option
   2. Wait for the AMC to complete creating your models and assets in SiteWise
5. Validate Incoming PLC Data in IoT Core
   1. Navigate to the AWS IoT Core console.
   2. Select “Test” from the navbar on the left.
   3. Subscribe to the topic: “spBv1.0/AWS Smart Factory/DDATA/#”
   4. Verify that messages are coming in from this topic.
6. Validate Incoming PLC Data in S3
   1. Navigate to the S3 console.
   2. Search for the bucket: “[stack\_name\_here]-imcs3bucket-[hash]
   3. Click into the bucket and confirm that a directory inside the bucket called “mqtt” exists.

### Troubleshooting

**Models and assets weren’t created in SiteWise**

Check the Lambda function responsible for creating the models and assets in SiteWise for errors:

1. In the AWS lambda console, navigate to the function named [name\_of\_stack]-AssetModelIngestionLambdaResource-[hash]
2. Hit the “Monitoring” tab
3. Click “View logs in CloudWatch”
4. Click into the most recent Log Stream and find the error message

**Data via the MQTT Transmission module doesn’t show up in IoT Cloud**

1. Get the public IP address of that instance, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
2. Open the Ignition Web UI is open, you should see a gear like icon on the left labeled ‘Config’. Click that, and it will ask you to log in. The default credentials are:
   1. Username: admin
   2. Password: password
      1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
3. Navigate to “MQTT Transmission -> Settings -> Server” and confirm that the connectivity shows 1 of 1. If it doesn’t, click edit and:
   1. Make sure the URL is in the format: ssl://[your\_aws\_account\_iot\_endpoint]:8883
   2. Download the .tar.gz file that represents the non-GreenGrass IoT thing from the following S3 bucket location:
      1. Bucket Name: [stack\_name]-devicesbucketresource-hash
      2. Key Name: [name\_for\_edge\_device\_parameter]/[name\_for\_edge\_device\_parameter]Device.tar.gz
   3. Expand the tarball
   4. Replace the CA Certificate File with “root.ca.pem” from the tarball package
   5. Replace the Client Certificate File with the “.pem” file from the tarball package
   6. Replace the Client Private Key File with the “.private” file from the tarball package
   7. Hit “Save Changes”, and make sure that the connectivity says “1 of 1”.

## Physical Greenfield Option 2b Cirrus Link Module

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2b”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2b”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Select “IgnitionCirrusLink”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

\*\*Note – for Option 2b deployments, models and assets are not required to collect data.

**Option 2b**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption2b] physical-greenfield-option2b.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option2b.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield2b]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option2b.sh physicalgreenfieldoption2b-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption2b/PhysicalGreenfieldOption2bCore.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption2b [Hardware-IP] PhysicalGreenfieldOption2b/PhysicalGreenfieldOption2bDevice.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Download the Ignition Designer software
      1. In your browser of choice, visit the following URL: http://<hardwarePrivateIP>:8088
      2. On the top right corner of the screen, click “Get Designer”
      3. Install the Ignition Designer for your operating system
   2. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   3. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
3. Trigger a node “birth” message
   1. Using the steps in 2.b, connect to your Ignition server
   2. A screenshot of a cell phone

      Description automatically generatedA birth message is triggered by launching the Ignition Designer, navigating to the tag browser 🡪 tag providers 🡪 MQTT Transmission 🡪 Transmission Control 🡪 clicking the “Refresh” button.
   3. This action triggers the IMC kit’s AMC, which creates the models and assets that represent the Ignition hierarchy in SiteWise.
      1. \*\* Not required to collect data for this deployment option
4. Validate Incoming PLC Data in IoT Core
   1. Navigate to the AWS IoT Core console.
   2. Select “Test” from the navbar on the left.
   3. Subscribe to the topic: “spBv1.0/AWS Smart Factory/DDATA/#”
   4. Verify that messages are coming in from this topic.
5. Validate Incoming PLC Data in S3
   1. Navigate to the S3 console.
   2. Search for the bucket: “[stack\_name\_here]-imcs3bucket-[hash]
   3. Click into the bucket and confirm that a directory inside the bucket called “mqtt” exists.

### Troubleshooting

**Models and assets weren’t created in SiteWise**

Check the Lambda function responsible for creating the models and assets in SiteWise for errors:

1. In the AWS lambda console, navigate to the function named [name\_of\_stack]-AssetModelIngestionLambdaResource-[hash]
2. Hit the “Monitoring” tab
3. Click “View logs in CloudWatch”
4. Click into the most recent Log Stream and find the error message

**Data via the MQTT Transmission module doesn’t show up in IoT Cloud**

1. Get the public IP address of that instance, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
2. Open the Ignition Web UI is open, you should see a gear like icon on the left labeled ‘Config’. Click that, and it will ask you to log in. The default credentials are:
   1. Username: admin
   2. Password: password
      1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
3. Navigate to “MQTT Transmission -> Settings -> Server” and confirm that the connectivity shows 1 of 1. If it doesn’t, click edit and:
   1. Make sure the URL is in the format: ssl://[greengrass\_ec2\_private\_ip\_address]:8883
   2. Download the .tar.gz file that represents the GreenGrass IoT thing from the following S3 bucket location:
      1. Bucket Name: [stack\_name]-devicesbucketresource-hash
      2. Key Name: [name\_for\_edge\_device\_parameter]/[name\_for\_edge\_device\_parameter]Device.tar.gz
   3. Expand the tarball
   4. Retrieve the GreenGrass group CA certificate by running the following command, replacing the sections in red with their correstponding CloudFormation template outputs found in the “NESTED” stack:
      1. wget -O root.ca.pem <https://$RESTAPIID.execute-api.$REGION.amazonaws.com/api/deploygg/$EDGEDEVICEID>
   5. Replace the Client Certificate File with the “.pem” file from the tarball package
   6. Replace the Client Certificate File with the “.private” file from the tarball package
   7. Replace the CA Certificate File with the “root.ca.pem” file retrieved from step d.
   8. Check the “show advanced properties” box
   9. Make sure the client ID reads: [name\_for\_edge\_device\_parameter]Device
4. Hit “Save Changes”, and make sure that the connectivity says “1 of 1”.

## Physical Greenfield Option 2b Ignition File Export

Open up the AWS Console and navigate to the CloudFormation console. Create a new stack and select “with new resources (standard)”).

### CloudFormation stack launch

**Step 1: Specify templates**

* Pre-Requisite:
  1. Select “Template is ready”
* Specify Template (Choose one of the below):
  1. Template Source: Leave as default – “Amazon S3 URL”. Most users will want to use the “IMC-main.template.yaml” CloudFormation main template that’s in the AWS Quick Start S3 bucket. The full S3 URL for the main template is:
     1. Main Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-main.template.yaml
     2. This template launches the solution in a new VPC. Note, only 5 VPCs per account are permitted.
  2. Alternatively, launch the “IMC-workload.template.yaml” Cloudformation template. The workload template launches the solution in your default VPC.
     1. Workload Template S3 URL: https://aws-quickstart.s3.amazonaws.com/quickstart-aws-industrial-machine-connectivity/templates/IMC-workload.template.yaml
* Click Next to proceed to Step 2 of the CloudFormation stack launch (Specify stack details)

**Step 2 – Specify Stack Details (if using main template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters
  + Network Configuration
    - VPC CIDR: Defaults to 10.0.0.0/16. Change if desired
    - Public subnet 1 CIDR: Defaults to 10.0.128.0/20. Change if desired
    - VPC Tenancy: Defaults to non-dedicated. Change if desired
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2b”.
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Select the Asset Model Converter (AMC) Driver: Leave as default “IgnitionCirrusLink”.
    - User Public IP Address: For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Input any IP address in the format “x.x.x.x”.

**Step 2: Specify stack details (if using workload template)**

* Stack Name:
  + Stack Name: Give the stack a unique name such as “IMC-Phys” . Make sure the name is no longer than 10 characters. If you don’t adhere to this character limit, your stack deployment may fail due to resource name lengths.
* Parameters:
  + Edge Deployment Configuration
    - Name for the edge device**:** You may leave as default or, if desired, you may specify a new name for the edge device. This name will be the name of the Greengrass group that gets created with this stack.
    - Type of Deployment (Virtual or Physical):Physical
    - Deployment Flow: Select “Option 2b”
  + Amazon EC2 Configuration
    - SSH Key Name: For physical deployments, the EC2 Key Pair won’t be used, but one needs to be selected for the stack to deploy properly. If you haven’t, navigate to the EC2 service in the AWS console and create an EC2 key pair. Select the key pair when deploying the stack.
    - VPC ID: Find your default VPC ID and copy it into this field.
    - Greengrass EC2 Instance Type**:** (default: t3.small) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - Ignition EC2 Instance Types: (default: t3.large) For physical deployments, an EC2 instance won’t be created, but this field must be filled in during the creation of the stack. Leave as the default value.
    - EC2 Subnet: Find the VPC Subnet associated with availability zone [your\_region\_here]a in your account and use that value in this field.
    - CIDR range for Ignition/Greengrass: This value is irrelevant and not used in the Physical deployment. Leave as the default 0.0.0.0/0. Ignition and Greengrass will be on the same device.
  + AWS Quick Start Configuration
    - QuickStart S3 Bucket Name: aws-quickstart
    - QuickStart S3 Key Prefix: quickstart-aws-industrial-machine-connectivity/
    - QuickStart S3 Bucket Region: Suggested to leave as default “us-east-1”
    - Select the Asset Model Converter (AMC) Driver: Select “IgnitionFileExport”.
    - User Public IP Address: Input your public IP address in the format “x.x.x.x” so the EC2 instance security groups allow access from your IP address.
  + Click “Next” to proceed to Step 3 “Configure stack options”

**Step 3: Configure stack options**

* You can accept all defaults
* Click “Next” to proceed to Step 4 “Review”

**Step 4: Review**

* Review and accept the acknowledgements at the bottom of the page
* Click “Create stack” to launch the CloudFormation stack.

**Stack Deployment**

Stack deployment will take approximately 5-10 minutes. You can track the progress of the stack launch by viewing the “Events” tab of the stack.

### Post Deployment Steps

Once the CloudFormation stack is completed, follow the steps to configure the IMC Kit to make it operational.

\*\*Note – for Option 2b deployments, models and assets are not required to collect data.

**Option 2b**

1. Retrieve and run the bootup script for the physical hardware device
   1. Open a terminal on the physical hardware
   2. Use the command line to become the root user in your terminal session:
      1. sudo su
   3. Use the command line to retrieve the deployment script from your stack’s S3 bucket, replacing the values in brackets with the corresponding output values from your CloudFormation stack (found on the AWS CloudFormation console, in the stack labeled “NESTED” in the output tab):
      1. aws s3api get-object --bucket [DependenciesBucket] --key [BootupScriptGreenfieldOption2b] physical-greenfield-option2b.sh
      2. \*\*You must have the AWS CLI configured to point to the AWS account you’re using for the IMC kit.
   4. Use the command line to make the file executable:
      1. chmod +x physical-greenfield-option2b.sh
   5. Retrieve (copy to your clipboard) the command from the “NESTED” CloudFormation output: [FullScriptParamsGreenfield2b]
   6. Replace [HardwareIP] with the physical device’s private IP address
   7. Use the command line to run the deployment script, which should resemble something like the following (but filled in with your stack-specific values):
      1. ./physical-greenfield-option2b.sh physicalgreenfieldoption2b-devicesbucketresource-1ifk8w3a77621 PhysicalGreenfieldOption2b/PhysicalGreenfieldOption2bCore.tar.gz 866prvj43g us-east-1 PhysicalGreenfieldOption2b [Hardware-IP] PhysicalGreenfieldOption2b/PhysicalGreenfieldOption2bDevice.tar.gz [a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com](http://a1zs31l2dkuqc-ats.iot.us-east-1.amazonaws.com/)
2. Download the Ignition Designer software
   1. Navigate to the Ec2 console and retrieve the public IP address of the EC2 instance running Ignition for the IMC kit
      1. The end of the Ec2’s instance should contain “Ignition”
   2. In your browser choice, visit the following URL: http://<ignition\_ec2\_IP>:8088
   3. On the top corner of the screen, click “Get Designer”
   4. Install the Ignition Designer for your operating system
3. Represent your data in Ignition by creating a project tag hierarchy. The source of this data can be physical PLCs, or simulated devices in Ignition.
   1. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: http://<reachableIgnitionIP>:8088
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   2. With the help of an OT professional or IMC Kit contact, represent your PLC data (simulated or real) in a hierarchy
4. Export the JSON file that describes your project hierarchy in Ignition.
   1. Open the Ignition Designer and connect to your Ignition server
      1. Launch the Designer
      2. Click “Add Designer”
      3. Click “Manually Add Gateway”
      4. Add a Gateway URL in the following format: <http://[ignition_ec2_public_ip]:8088>
      5. Under the Gateway tile you just added, click “Launch”
      6. Supply the username and password and click “Login”
         1. Username: admin
         2. Password: password
            1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
   2. A screenshot of a cell phone

      Description automatically generatedIn the Tag Browser, under “Tag Providers” select “default” and click export.
5. Upload the JSON file from step 1 into the following S3 bucket created during deployment to trigger the AMC and creation of models and assets in SiteWise:
   1. [name\_of\_stack]-[amcincomingresource]-[hash]
      1. Upon dropping the JSON file in this S3 bucket, an S3 event trigger will automatically invoke the AMC Lambda function
   2. Wait for the AMC to complete creating your models and assets in SiteWise
6. Validate Incoming PLC Data in IoT Core
   1. Navigate to the AWS IoT Core console.
   2. Select “Test” from the navbar on the left.
   3. Subscribe to the topic: “spBv1.0/AWS Smart Factory/DDATA/#”
   4. Verify that messages are coming in from this topic.
7. Validate Incoming PLC Data in S3
   1. Navigate to the S3 console.
   2. Search for the bucket: “[stack\_name\_here]-imcs3bucket-[hash]
   3. Click into the bucket and confirm that a directory inside the bucket called “mqtt” exists.

### Troubleshooting

**Models and assets weren’t created in SiteWise**

Check the Lambda function responsible for creating the models and assets in SiteWise for errors:

1. In the AWS lambda console, navigate to the function named [name\_of\_stack]-AssetModelIngestionLambdaResource-[hash]
2. Hit the “Monitoring” tab
3. Click “View logs in CloudWatch”
4. Click into the most recent Log Stream and find the error message

**Data via the MQTT Transmission module doesn’t show up in IoT Cloud**

1. Get the public IP address of that instance, and load a URL like this into your browser of choice: http://<hardwarePrivateIP>:8088
2. Open the Ignition Web UI is open, you should see a gear like icon on the left labeled ‘Config’. Click that, and it will ask you to log in. The default credentials are:
   1. Username: admin
   2. Password: password
      1. **If you haven’t already, it is recommended that you change your password once you’ve successfully logged into the Ignition web UI.**
3. Navigate to “MQTT Transmission -> Settings -> Server” and confirm that the connectivity shows 1 of 1. If it doesn’t, click edit and:
   1. Make sure the URL is in the format: ssl://[greengrass\_ec2\_private\_ip\_address]:8883
   2. Download the .tar.gz file that represents the GreenGrass IoT thing from the following S3 bucket location:
      1. Bucket Name: [stack\_name]-devicesbucketresource-hash
      2. Key Name: [name\_for\_edge\_device\_parameter]/[name\_for\_edge\_device\_parameter]Device.tar.gz
   3. Expand the tarball
   4. Retrieve the GreenGrass group CA certificate by running the following command, replacing the sections in red with their correstponding CloudFormation template outputs found in the “NESTED” stack:
      1. wget -O root.ca.pem <https://$RESTAPIID.execute-api.$REGION.amazonaws.com/api/deploygg/$EDGEDEVICEID>
   5. Replace the Client Certificate File with the “.pem” file from the tarball package
   6. Replace the Client Certificate File with the “.private” file from the tarball package
   7. Replace the CA Certificate File with the “root.ca.pem” file retrieved from step d.
   8. Check the “show advanced properties” box
   9. Make sure the client ID reads: [name\_for\_edge\_device\_parameter]Device
4. Hit “Save Changes”, and make sure that the connectivity says “1 of 1”.

## 

## Physical Greenfield Cleanup

**Follow these steps to clean up the IMC CloudFormation stack deployment:**

Cloud

1. Navigate to the CloudFormation console and delete the base stack (not the stack named "NESTED"), in order to clean up the account as much as possible. Most of the resources will be deleted, but the stack deletion will fail due to non-empty S3 buckets and potentially a deployed Greengrass group (for all Virtual options by default, and for all Physical deployments that have been completed on a piece of hardware. The steps required to delete a stack are:
   1. Empty the S3 buckets:
      1. Navigate to the S3 service in the AWS Console.
      2. In the search bar, enter your stack name.
      3. For each bucket that is associated with the stack (naming convention: [name\_of\_stack]-[bucket\_identifier]-unique hash), select the bucket, and click “Empty” under the search bar.
      4. Here are the following “bucket identifiers” that exist for each deployment:
         1. amcincomingresource
         2. amcoutputresource
         3. devicesbucketresource
         4. imcs3bucket
         5. lambdazipsbucket
   2. Force a reset of the GreenGrass group:
      1. Navigate to the GreenGrass console
      2. Select the GreenGrass group with the “Name for the Edge device” parameter name provided to the stack
      3. Under “Actions”, select “Reset Deployments”
      4. Check the box that asks if you want to force the reset
      5. Click “Reset Deployment”
   3. Navigate back to the CloudFormation console and once again delete the base stack.
      1. There is a main and nested stack. you must delete the main stack (the one that does **not** have “NESTED” in a gray box associated with it.
2. Other resources to clean up after stack deletion (if desired, for cleanliness): SiteWise Portal, SiteWise Gateway, SiteWise Models and Assets, QuickSight dataset.

Edge Hardware

1. Navigate to a terminal on the edge hardware. Become the root user using the “sudo su” command.
2. Stop and remove Ignition from hardware:
   1. cd /[path\_to\_Ignition\_download]/Ignition-AWS-Kit-MQTT-v4
   2. ./remove.sh
   3. cd ..
   4. rm device.tar.gz group.tar.gz opcclient.der Ignition-AWS-Kit-MQTT-v4.zip physical-greenfield-option<insert\_option\_here>.sh
   5. rm -rf Ignition-AWS-Kit-MQTT-v4
3. Stop and remove GreenGrass:
   1. apt remove aws-iot-greengrass-core
   2. rm -rf /greengrass
   3. rm -rf /var/sitewise

## Physical Greenfield FAQs

**Can I update a stack to a different deployment type (Physical, Virtual) or dataflow option (Option1, 2a, 2b)?**

* Updates are currently not supported. To achieve a different deployment type or dataflow type, you'll need to [deploy a new stack.](#_Physical_–_Greenfield) See the details on having more than one stack deployed in an account below, and then decide whether or not you’ll want to [delete your original stack](#_Physical_Greenfield_Cleanup_1) before re-creating another.

**Can I deploy multiple times in the same AWS account?**

Yes, you may deploy multiple stacks in the same account – but be wary of the following:

* For Option 1 deployments, SiteWise may receive data from multiple sources if there are, for example, two instances of Ignition that are publishing data onto the topic “/Tag Providers/default/Line1/CNC/Temperature”.
* If SiteWise models and assets exist in the Cloud from a previous deployment, a new deployment will not re-create the model/asset hierarchy. Instead, the Asset Model Converter operates by recognizing any “deltas” in the existing models/assets and the new deployment hierarchy. For example:
  + If the previously deployed hierarchy is identical to the newly deployed, nothing in SiteWise is changed.
  + If the newly deployed hierarchy has an identical structure to the previously deployed hierarchy **with additional nodes that follow the hierarchy pattern,** the new models/assets will be created in SiteWise**:**
    - Previous:
      * Line 1/CNC1/Temperature
    - New:
      * Line 1/CNC1/Temperature
      * Line 1/CNC2/Temperature
* If the newly deployed hierarchy has a different hierarchy than the previously deployed hierarchy altogether, the Asset Model Converter will not succeed in creating the new models and assets.
* Refer to the instructions in the appendix showing how to [add a line and device with tags](#_Add_a_line) to a project in Ignition using the Ignition Designer.

**Does any hardening of the OS occur during deployment?**

Yes. Fail2ban is installed and enabled on the device, which bans IPs that show the following malicious signs:

* Too many password failures
* Seeking for exploits

Additionally, shared memory on the device is secured via /etc/fstab.

**Can I re-run the AMC to create new models and assets?**

Yes. Follow these steps:

1. If any of the models/assets you want to create share a name with the models/assets created in the first pass of the AMC execution, you’ll need to delete the models and assets in SiteWise.
2. The second action you’ll need to take is clearing out the following DynamoDB tables associated with the initial IMC kit deployment:
   1. [stack-name]-asset-model-table
   2. [stack-name]-asset-table

Depending on your driver of choice, you’ll need to take the follow actions to re-run the AMC:

* IgnitionCirrusLink
  + Initiate a re-birth (NBIRTH,DBIRTH) MQTT message that represents the your project hierarchy.
    - Connect to your Ignition server in the Ignition Designer
    - A screenshot of a cell phone

      Description automatically generatedA birth message is triggered by launching the Ignition Designer, navigating to the tag browser 🡪 tag providers 🡪 MQTT Transmission 🡪 Transmission Control 🡪 clicking the “Refresh” button.
    - This action triggers the IMC kit’s AMC, which creates the models and assets that represent the Ignition hierarchy in SiteWise.
* IgnitionFileExport
  + Obtain your JSON file that represents the new hierarchy and drop it into the following S3 bucket:
    - [name\_of\_stack]-[amcincomingresource]-[hash]
* KepServerFileExport
  + Obtain your JSON file that represents the new hierarchy and drop it into the following S3 bucket:
    - [name\_of\_stack]-[amcincomingresource]-[hash]

**How do I add a QuickSight visual?**

Users may create Amazon QuickSight visuals for the data that is put in the S3 bucket via the Kinesis Data Firehose. Prior to creating these visuals, complete the following pre-requisite steps:

* Pre-Requisites
  + Open the AWS console and navigate to the QuickSight service console
  + If you have not previously used QuickSight, you will be asked to grant access to QuickSight. Refer to the Amazon QuickSight documentation for additional details:
    - <https://docs.aws.amazon.com/quicksight/latest/user/getting-started.html>
* Create a QuickSight visual
  + The data source will be the S3 bucket that receives data via the AWS IoT Core rule. The S3 bucket is named: [stack\_name\_here]-imcs3bucket-[hash]
  + Navigate to the Amazon QuickSight console home page and click “New analysis”, select “New dataset”, then select the Amazon S3 service icon.
  + Add details for the dataset:
    - Data source name: Provide a name for the IMC data set such as “IMC-QS-Dataset”
    - Manifest file: Leave the “URL” radio button selected for the “Upload a manifest file” text entry option and paste the S3 URL of the S3 bucket manifest file. The manifest file is located in the same S3 bucket where the data is stored (S3 bucket name: [stack\_name\_here]-imcs3bucket-[hash]). The manifest file is named “imcquicksightdata.json”. The S3 URL will follow this naming convention:
      * https:// [stack\_name\_here]-imcs3bucket-[hash].s3.amazonaws.com/imcquicksightdata.json