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Basic

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Connect IoT - Basic Configuration Tutorial

Estimated time to read: 15 minutes

Starting with this Basic Configuration, it will provide a structure to build the Connect IoT business logic and the connection to a device. The protocol chosen for this example is OPC-UA. We have used a simple simulator to mimic the behavior of a machine. The tutorial will be cumulative, so the basic will just focus on the MES configuration and connecting to the machine.

 **Note**

During this tutorial, the **Automation Manager** will be running in console mode to easily highlight the most important events as they occur, of course in a production setting this will not be the method used to run Connect IoT.

Installation

All information regarding Connect IoT Installation can be found here: [Connect IoT Installation](#)

Initial Configurations

Configurations

There are several configuration entries that need to be set for this scenario. All the Configurations for IoT can be found in the Administration menu and by navigating to the `/Cmf/System/Configuration/ConnectIoT` configuration section.

Configuration	Description
RepositoryType	Directory (folder location) or NPM repository
RepositoryLocation	Repository Location
ProtocolPackageNameFilter	A name filter to select which packages exist in the repository regarding protocols
RepositoryToken	Used for NPM authentication

Table: Connect IoT configuration entries

These configurations will impact the available packages and versions when creating the **Automation Protocol**, **Automation Driver Definition** and **Automation Manager** later on. Here is an example of these configurations:

Entries (5)

PATH	NAME	VALUE
/Cmf/System/Configuration/ConnectIoT/RepositoryLocation/	RepositoryLocation	/opt/connectiot
/Cmf/System/Configuration/ConnectIoT/RepositoryToken/	RepositoryToken	
/Cmf/System/Configuration/ConnectIoT/ProtocolPackageNameFilter/	ProtocolPackageNameFilter	@criticalmanufacturing/connect-iot-driver.*
/Cmf/System/Configuration/ConnectIoT/RepositoryType/	RepositoryType	Directory

Enable Connect IoT for Entity

One of the great advantages of coupling the Connect IoT configuration with the MES, is the process context the MES provides. In order to create that link, the MES needs to know what entities are going to be used for Connect IoT. Some of the most common examples a Resource, Area or Site, but of course you can link to whichever entity that makes sense for your use case.

In this case, we will choose a **Resource**, so that we can mimic the operation of an equipment on the shop floor.

Go to **Administration > Entity Type**, select the **Resource**, select **Edit** and set the **Connect IoT Enabled** option to **true**.



Edit Entity Type

Enable Version Creation:

Flags

Unique Name Required:

Replicate to ODS:

History Enabled:

Partitioned:

Visible in Business Data:

Connect IoT Enabled:

Enable Attributes:

Enable Operation Attributes:

System Managed State Models:

Allow Multiple State Models:

Allow Barcode IDs:

Comments:

Connect IoT User

Simultaneously, the MES user must be specifically set as enabled to use Connect IoT. This setting can be changed by going to **Administration > Security > Users**, selecting the user that should have permissions to run Connect IoT, selecting **Edit**, and setting the value for the **Integration User** option to **true**.

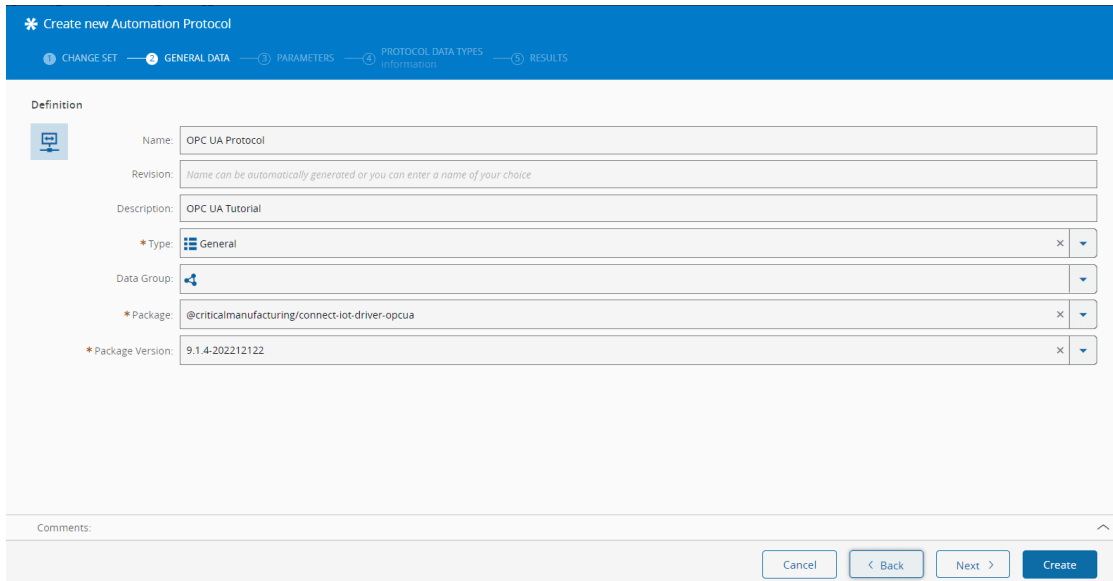
Create Automation Protocol

The first step of our integration will be to create the Connect IoT configuration entities.

Go to **Business Data > Automation Protocol**, select **New**.

1. Select the **Create** button to create a new **Change Set** or select an existing one. If you are creating a new one, enter the name, type, and select the **Create** button.
2. In the General Data step, provide:
 - A name that represents the Automation Protocol - **OPC UA**

- A description
- The type (for classification purposes)
- @criticalmanufacturing/connect-iot-driver-opcua as the package name.
 - The dropdown list uses the package repository and only shows the protocol packages that are filtered by the value set in the /Cmf/System/Configuration/ConnectIoT/ProtocolPackageNameFilter configuration
 - In this dropdown you will see all packages that are available for use
- The package version
- Select **Next**



Create new Automation Protocol

1 CHANGE SET — 2 GENERAL DATA — 3 PARAMETERS — 4 PROTOCOL DATA TYPES (Information) — 5 RESULTS

Definition

Name: OPC UA Protocol

Revision: *Name can be automatically generated or you can enter a name of your choice*

Description: OPC UA Tutorial

* Type: General

Data Group:

* Package: @criticalmanufacturing/connect-iot-driver-opcua

* Package Version: 9.1.4-202212122

Comments:

Cancel < Back Next > Create

3. Set the default values for the OPC UA protocol parameters
4. These values can be individually overridden by the **Automation Controller** workflows. In this step we will only define what are the default values for all automation controller workflow logic that will use this protocol.
5. Note that the parameters and some default values are automatically set. This values can be overridden at any point while creating the **Automation Protocol**.
6. Select **Next**.
7. Select **Create**

Edit new Automation Protocol

GENERAL DATA **PARAMETERS** PROTOCOL DATA TYPES

Parameters		Parameter Info
Connection Mode	Client	
Address		
Address Mask	opc.tcp://(.*)?(.*)?/?	
Application Name	ConnectIoTuaServer	
Application URI	urn:ConnectIoTuaServer	
Allow Anonymous	true	
Username		
Password		
Security Policy	None	
Security Mode	None	

Comments:

Cancel Edit

Info

The next steps, while not interactive, provide information regarding the protocol.

We now have an entity in MES that represents the OPC UA communication protocol and that will be requested by the Automation Monitor when used on a Connect IoT deployment. The package and respective version will be requested from the repository by the monitor, which will then requests the manager to execute the package.

Create Automation Driver Definition

Go to **Business Data > Automation Driver Definition**, select **New**.

1. Select or create an existing **ChangeSet**. Select **Next**.
2. In the General Data step, provide:
 - A name that represents the **Automation Driver Definition**
 - A description
 - The type (for classification and reporting purposes)
 - The name of the previously created **Automation Protocol**
 - The **Resource** as the entity type for the new **Automation Driver Definition**
 - This list shows all entities that that are configured with the Connect IoT enabled flag set to **true**.

*** Create New Automation Driver Definition**

1 CHANGE SET — 2 **GENERAL DATA** — 3 PROPERTIES — 4 EVENTS — 5 EVENT PROPERTIES — 6 COMMANDS — 7 COMMAND PARAMETERS

Definition

Name: Oven DD
 Revision: *Name can be automatically generated or you can enter a name of your choice*
 Description: Oven DD Tutorial
 * Type: General
 Data Group:
 * Automation Protocol: OPC UA Protocol [A.1]
 * Entity Type: Resource

Comments:

Cancel < Back **Next >**

3. Select **Next** until the Driver Definition is created, since we will not create any additional properties, events or commands.

Notice, that we are not configuring any properties, events or commands. For now this is ok, we are just getting acquainted with the GUI and our goal will be just to connect to the OPC-UA Server.

Create Automation Controller

Go to **Business Data > Automation Controller**, select **New**.

1. In the General Data step, provide:

- A name
- A description
- The type (for classification purposes)
- The scope of this controller (which in this case should be Connect IoT)
- Controller package version
 - This is the version of the controller that will be executed.
 - The versions used in the **Automation Controller** and on the **Automation Protocol** must be compatible.
- The **Resource** as the entity type for the new **Automation Controller**.
- Select **Next**.

Create New Automation Controller

1 CHANGE SET — 2 GENERAL DATA — 3 DRIVERS DEFINITIONS — 4 TASKS

Definition

Name: Oven Controller

Revision: *Name can be automatically generated or you can enter a name of your choice*

Description:

* Type: General

* Scope: Connect IoT

* Version: 9.1.3-202211253

Entity Type: Resource

Comments:

Cancel < Back Next >

2. In the Drivers Definition step, add a new driver definition by selecting + and providing:

- A friendly name.
- The previously created **Automation Driver Definition**.
- A color to identify the tasks that will be associated to a specific driver definition.

Note

The color code helps you to identify the tasks related to each driver/machine/resource, so it is a good practice to assign a different color to every driver.

- Select **Next**.

Create New Automation Controller

1 CHANGE SET — 2 GENERAL DATA — 3 DRIVERS DEFINITIONS — 4 TASKS

Drivers Definitions + [trash] [up] [down] **Driver Details**

OPC Server
Oven DD

* Name: OPC Server

* Driver Definition: Oven DD [A.1]

Color: [blue]

Driver definition info

Description:

Type: General

Protocol: OPC UA [A]

Entity Type: Resource

Comments:

Cancel < Back Next >

3. In the Task step, select the task packages relevant for the integration itself and available in the workflow designer. For this tutorial, Core Tasks is enough.

- Core tasks: default selection, can't be unselected.
- Critical Manufacturing and Factory Automation tasks are available to every type of workflows.
- All protocols from the drivers under this controller are available to be selected in this task package list (these tasks are listed on the protocol `package.json` file).

- Select Create

✦ Create New Automation Controller

1 CHANGE SET — 2 GENERAL DATA — 3 DRIVERS DEFINITIONS — 4 TASKS

PACKAGES	CORE TASKS	Selected Tasks (44)
<input checked="" type="checkbox"/> Core Tasks Version 9.1.3-202211253	<input type="checkbox"/> Arithmetic Operation	<input type="checkbox"/> Arithmetic Operation
<input type="checkbox"/> Critical Manufacturing Tasks Version 9.1.3-202211253	<input type="checkbox"/> Switch	<input type="checkbox"/> Switch
<input type="checkbox"/> Factory Automation Tasks Version 9.1.3-202211253	<input type="checkbox"/> Store Data	<input type="checkbox"/> Store Data
<input type="checkbox"/> OPC-UA Tasks Version 9.1.3-202211253	<input type="checkbox"/> Retrieve Data	<input type="checkbox"/> Retrieve Data
<input type="checkbox"/> ASM OIB Tasks Version 9.1.3-202211253	<input type="checkbox"/> Expression Evaluator	<input type="checkbox"/> Expression Evaluator
<input type="checkbox"/> File Drivers Tasks Version 9.1.3-202211253	<input type="checkbox"/> On System Event	<input type="checkbox"/> On System Event
<input type="checkbox"/> SECS/GEM Tasks Version 9.1.3-202211253	<input type="checkbox"/> Log Message	<input type="checkbox"/> Log Message
		<input type="checkbox"/> Timer

Comments: ^

Cancel
< Back
Create

📌 **Note**

Since it is easier to activate packages than to deactivate them due to possible usage in multiple workflow pages, it is advisable to use as many packages as possible for a smoother workflow development. Also, if we had customization, the tasks regarding that customization would appear in this list.

As seen above, a workflow page is automatically created, called `Setup`, containing two tasks:

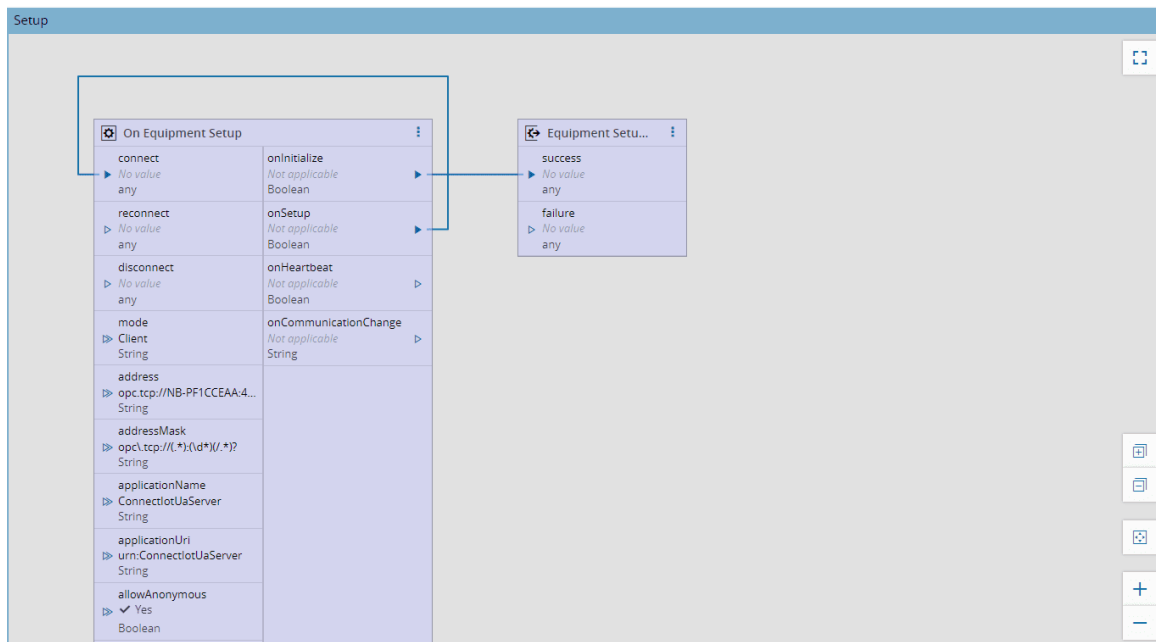
- `On Equipment Setup`
- `Equipment Setup Result`

Note that they are assuming the color set for the driver definition in this controller. As the workflow logic can get increasingly complex, with a vast number of tasks and links between them, it can become difficult to find the task you are looking for. You can change the line style to make it easier to do this and you can see how to do it in the [Workflow Designer](#) page.

These are driver related tasks regarding communication configuration and initialization. Let's link them as shown below:

- Link the `onInitialize` output directly to the `connect` input;
- Link the `onSetup` output to the `success` input.

When the connection between the controller and the driver processes is established, the `onInitialize` event is triggered. By linking it to the `connect` input, it indicates the driver process to start configuration and connection to the equipment.



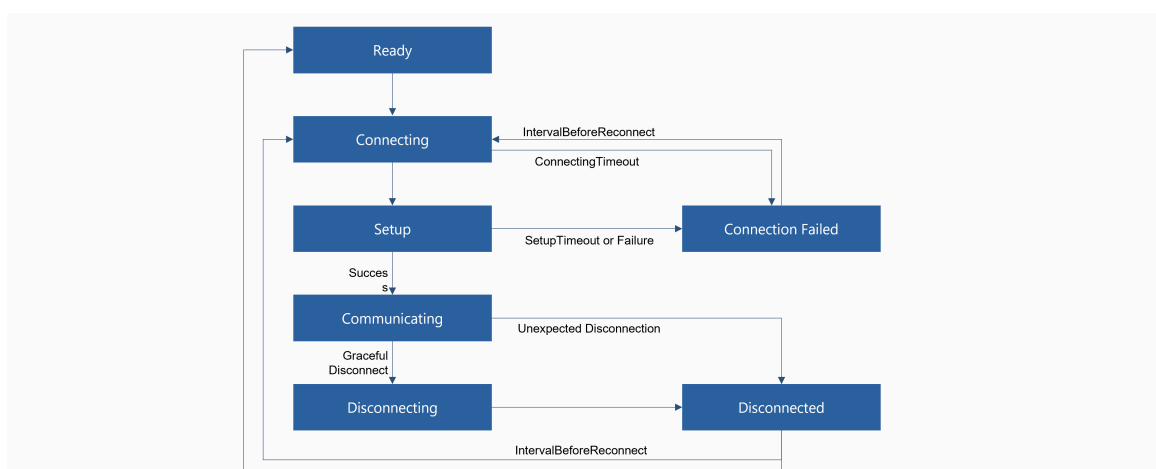
In the `On Equipment Setup` task:

- Select the three dots and select `Settings`.
- Select the `Communication Parameters` step
- Set the device address on the `Address` Parameter - i.e `opc.tcp://localhost:48011` - The address will be provided by the `UaCPPServer` described in the **Equipment Simulator Tests** section, feel free to leave it empty and fill it later.
- Select `OK`

All information regarding `On Equipment Setup` Task can be found here: [On Equipment Setup](#)

Communication Workflow

The communication between the controller and the driver processes follows a state model, creating a workflow of communication. The goal is to ensure stable communication when the process reaches communicating state. If it doesn't achieve stable communication, the process enters into a retry loop until it connects successfully.



State	Description
-------	-------------

State	Description
Ready	Connection is ready to be established
Connecting	Action was received to start the connection, when <code>Connect</code> is activated, and starts to establish the connection
Setup	When the connection to the device is successful, and the <code>onSetup</code> output is sent (if this property is not changed then it goes to the next state (Connecting Failed))
Connecting Failed	When the connection failed after the defined time out, transitioning from Connecting to Connecting Failed When <code>setupTimeout</code> or setup failure, transitioning from Setup to Connecting Failure
Communicating	When the <code>onSetup</code> event outputs a successful connection, the device is now with a stable communication
Disconnecting	When the automation is disconnected with a graceful disconnect
Disconnected	The result of disconnecting process or of an unexpected disconnection

Table: Communication States

Create Automation Manager

Go to `Business Data > Automation Manager`, select `New`.

In the General Data step, provide:

- A name
- A description
- The type (for classification or reporting purposes)
- A unique name as the **Automation Manager** ID, which will be referred to when performing the installation


Warning

Do not use spaces in the name to facilitate the command line usage

- Select `Create`

Edit Automation Manager

Definition

 Name: Oven Manager 01

Description:

* Type: x ▾

* Monitor Version: x ▾

* Manager Version: x ▾

Automation Manager ID: OvenManager01

Comments:

Runtime

As a summary, this is what was configured:

- An **Automation Protocol**: OPC UA
- An **Automation Driver Definition**: Oven DD
- An **Automation Controller**: Oven Controller, linked to the driver definition, and with the address of the protocol server
- An **Automation Manager**: Oven Manager 01.

Now we need to export the configuration to a runtime scenario.

1. Start with downloading the Automation Manager by going to the Automation Manager and selecting **Download** from the top ribbon.

Info

The users that are available for selection are the ones that have the property `Integration User` set to `true`.

2. After downloading the file (in `.zip` format), extract the files within the zip folder.

Note

While development is ongoing, it is recommended that the Automation Manager runs in console mode, so you can have immediate information on the status of the manager without the need of going through service logs, as well as to enable quick start and stop control over the application. When the development has ended, and ready to be in production, the Automation Manager can be executed as service.

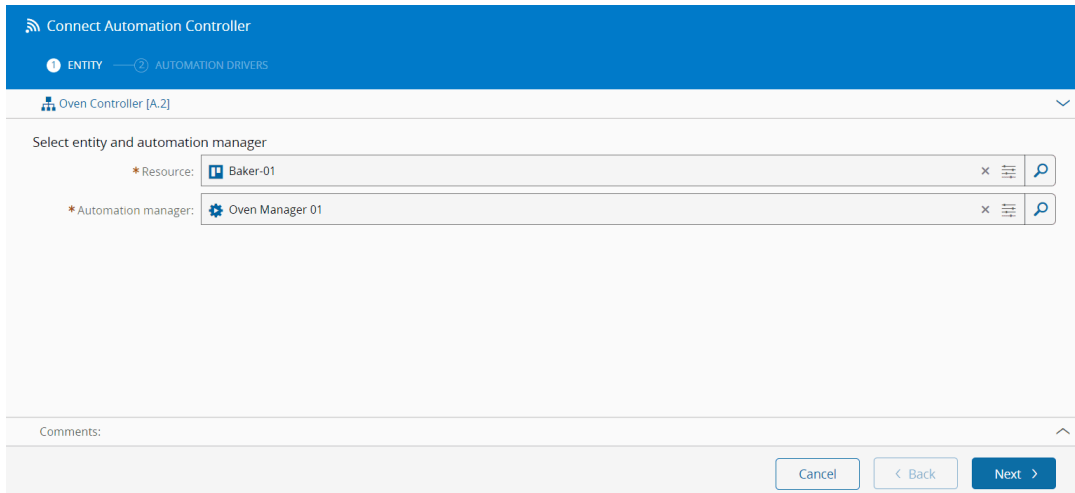
Note

Running the Automation Manager as a service and using the console mode simultaneously might not work for some protocols.

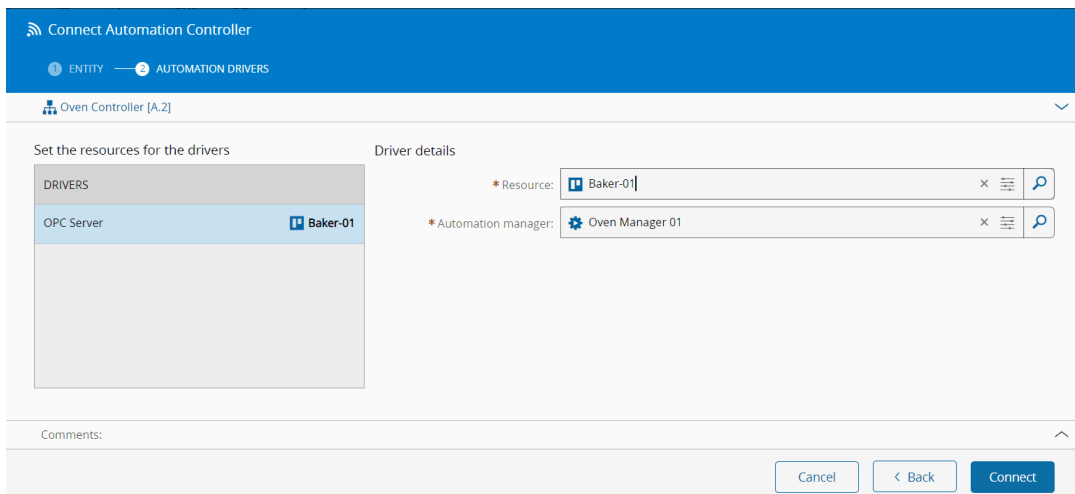
3. To start the Automation Manager, go to the Scripts folder of the extracted files and run `startConsole.bat`.

4. Now you have a running Automation Manager that does not contain any controller or driver yet. To do this, we need to create an instance in the Manager on the MES GUI.

- Go to **Business Data > Automation Controller**, select the created **Automation Controller**, open the Details view and select **Connect**.
- You must provide an appropriate **Resource** and the Automation Manager this instance will be associated to. Choose the **Resource** and select the **Automation Manager** created above.
- Select **Next**.

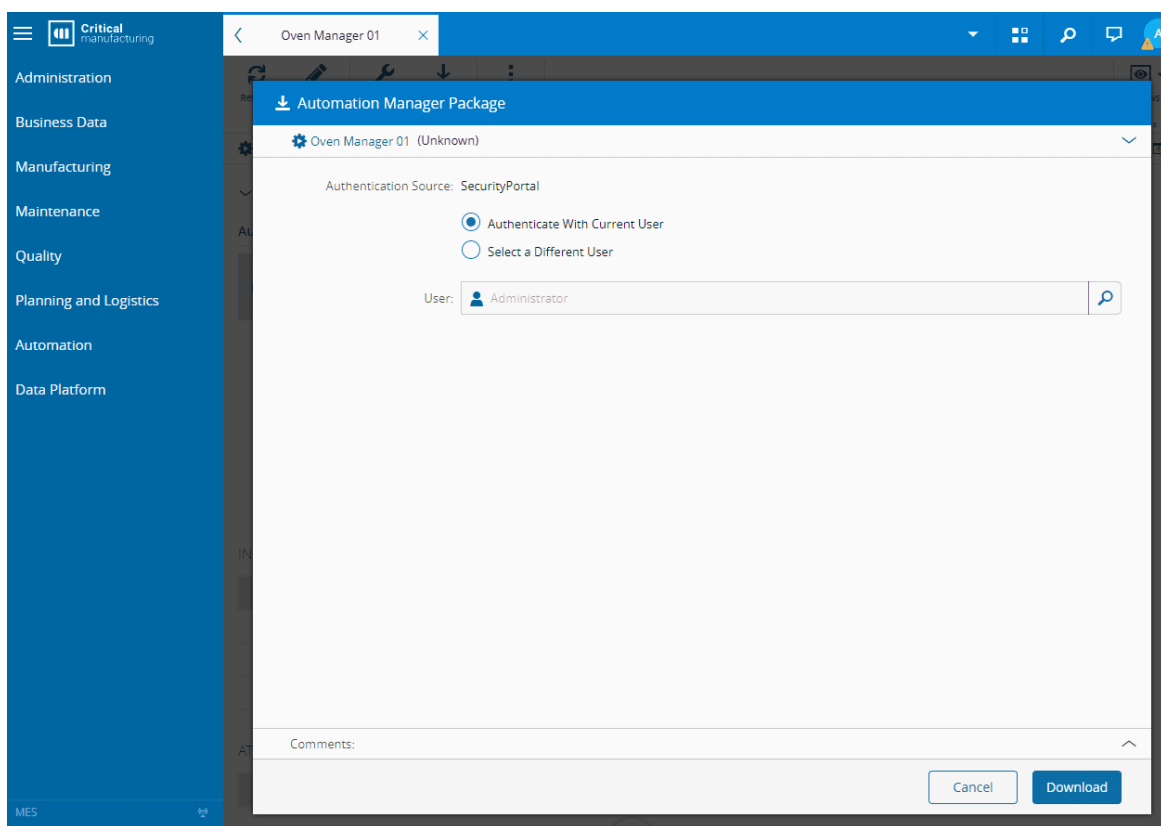
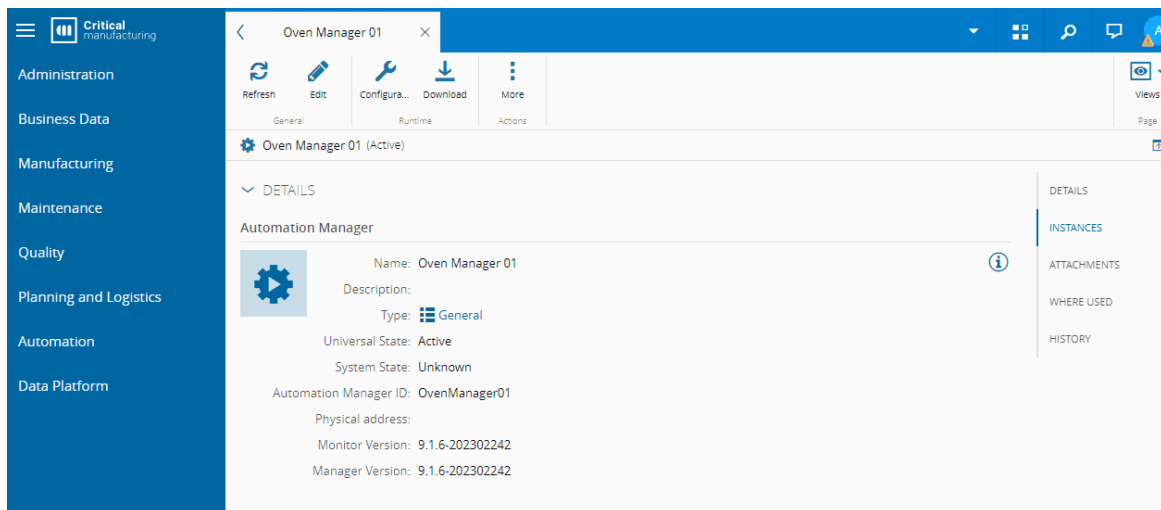


- In the Automation Drivers step select the **Automation Driver Definition** and choose the same **Resource** chosen before.

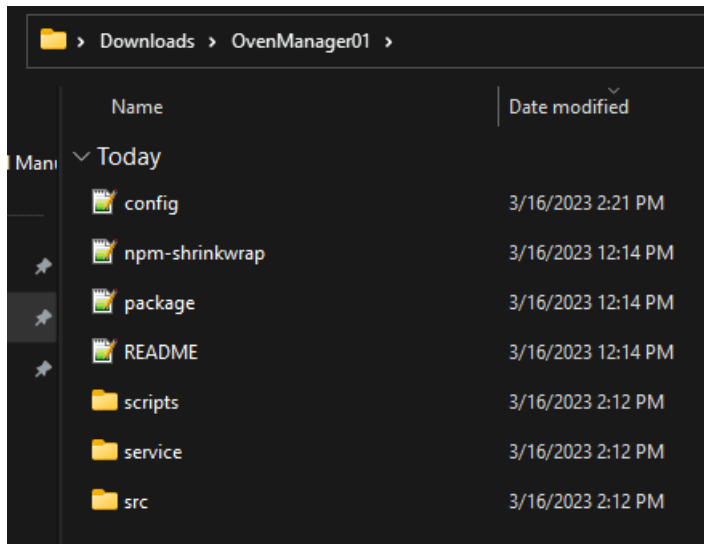


You now have a structure to build the Connect IoT business logic, and its device connection.

Now let's try to run the program. For this scenario, in order to decrease complexity, we are not deploying the Automation Manager through the DevOpsCenter in a containerized installation, but running it as an executable. In the Automation Manager download the zip package.



It will now download a zip file, you can extract it. Here we will have everything we need to run the application.



The config file is key to all the configuration, feel free to take a look at what is there and all the variations, you can also look at [IoT Runtime Components Configuration](#) for more details. The configuration in the Automation Manager will be the one used by the running process and can be updated. Nevertheless it will only be changed after a restart of the application.

```

config.json
1  {
2    "id": "OvenManager01",
3    "cache": "${temp}/ConnectIoT/Cache",
4    "hostName": "localhost",
5    "monitorApplication": "${pwd}/monitor.js",
6    "repository": {
7      "type": "Directory",
8      "settings": {
9        "path": "/opt/connectiot"
10     }
11  },
12  "system": {
13    "tenantName": "MES",
14    "address": "192.168.1.1",
15    "port": 443,
16    "timeout": 120000,
17    "useSsl": true,
18    "isLoadBalancingEnabled": false,
19    "authentication": {
20      "type": "SecurityPortal"

```

Note

If you are using an MES installation in containers, the path that is in the config RepositoryLocation is not the same as the one in the config of the Connect IoT application. The path in the MES will be the perspective from the MES, whereas the one you download is from the perspective of your local application.

For example, in this MES installation the path is /opt/connectiot, which is the container mount. In your config under repository change the path to what is applicable in your use case, the one used in this tutorial was `\\wsl.localhost/Ubuntu/mes/iot-repository`. In order to diagnose this problem look out for the error `error: Failed to resolve package`.

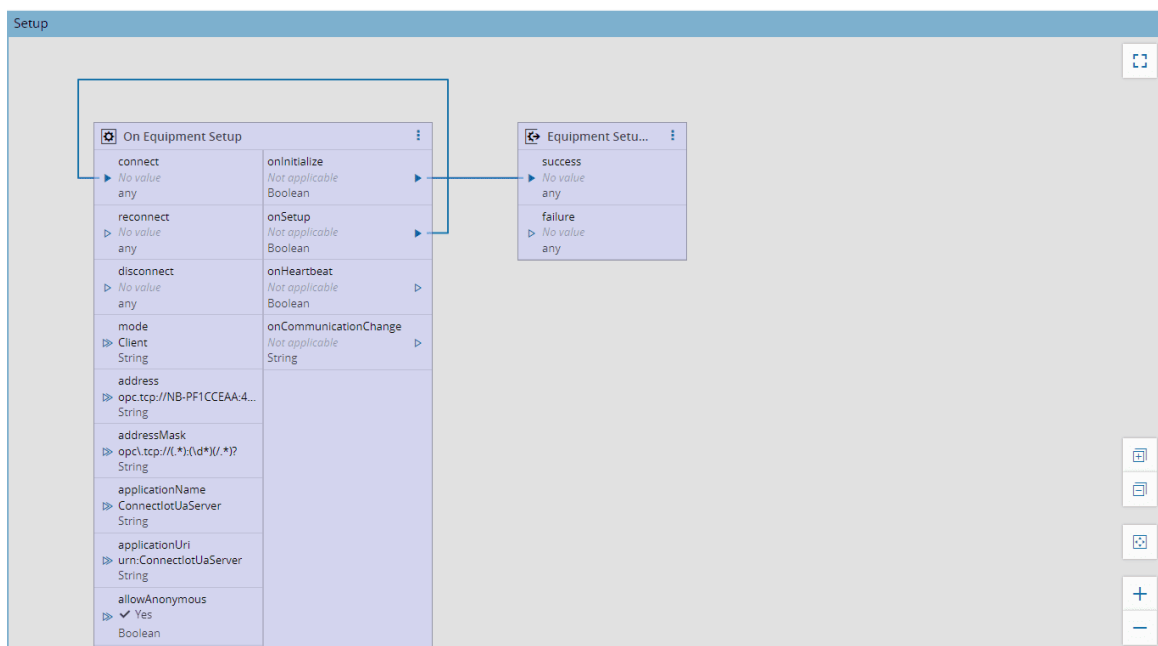
Let's start by running the StartConsole in the `scripts` folder.

```

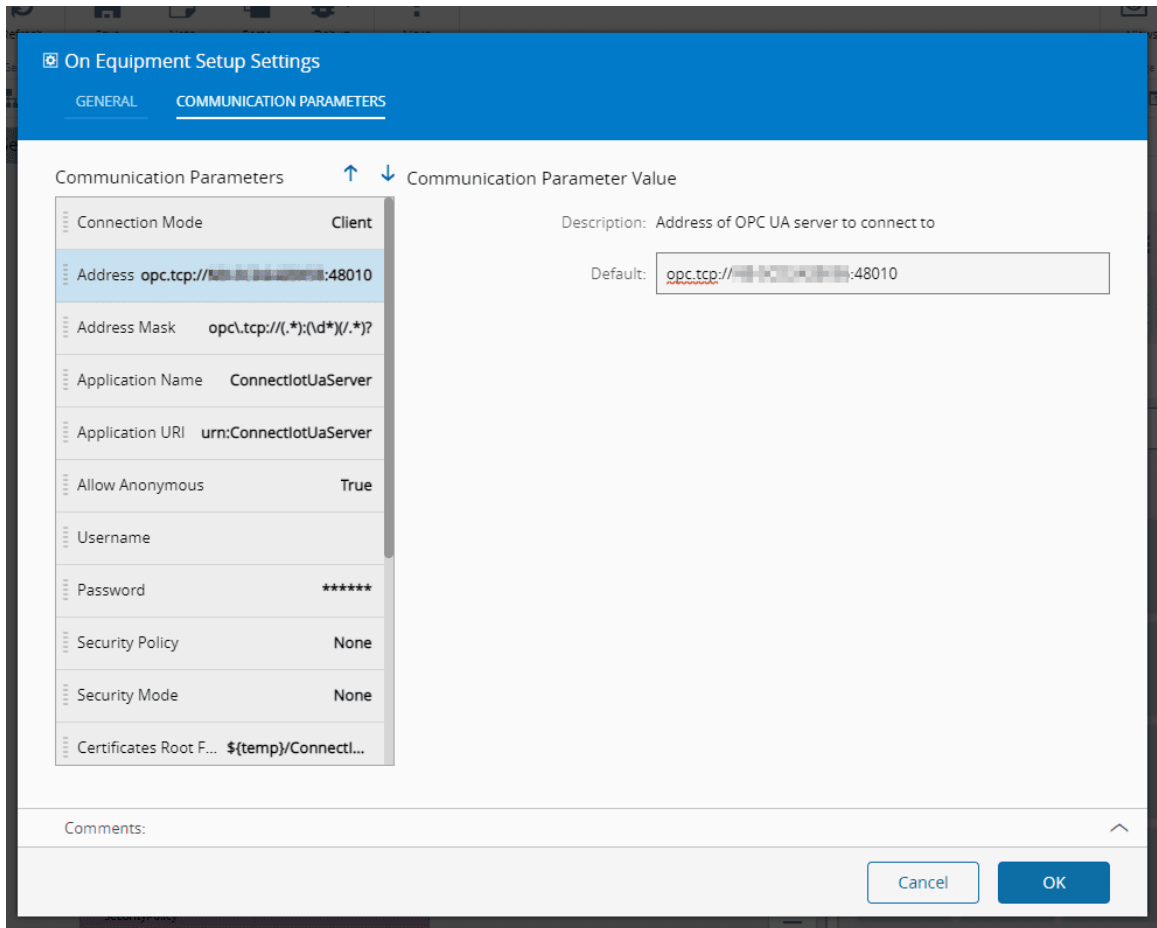
2023-03-16 14:39:11.923 info: Connecting to server ''
2023-03-16 14:39:11.924 error: Unable to connect to server ': Invalid endpoint url
2023-03-16 14:39:11.924 info: Communication state changed Connecting -> ConnectingFailed
2023-03-16 14:39:16.925 info: Reconnecting to device
2023-03-16 14:39:16.925 info: Received Communication State change from driver: Connecting
2023-03-16 14:39:16.925 info: Communication state changed ConnectingFailed -> Connecting
2023-03-16 14:39:16.926 info: Received Communication State change from driver: ConnectingFailed
2023-03-16 14:39:16.925 info: Connecting to server ''
2023-03-16 14:39:16.926 error: Unable to connect to server ': Invalid endpoint url
2023-03-16 14:39:16.926 info: Communication state changed Connecting -> ConnectingFailed

```

The output of the console is very helpful and informs us to what the process is doing and also to troubleshoot. Looking at the error message we can see that we have a connection loop, because it is failing with `error: Unable to connect to server : Invalid endpoint url`. Remember we are trying to connect to an OPC-UA server, so we need to specify the OPC Server address. For this tutorial we are going to have the address hardcoded in the Automation Controller, but in normal scenarios you want to be more dynamic.



In the settings of the `On Equipment Setup` task, provide an address to your OPC-UA Server. If you don't have an OPC-UA server refer to the next chapter on Equipment Simulator Tests.

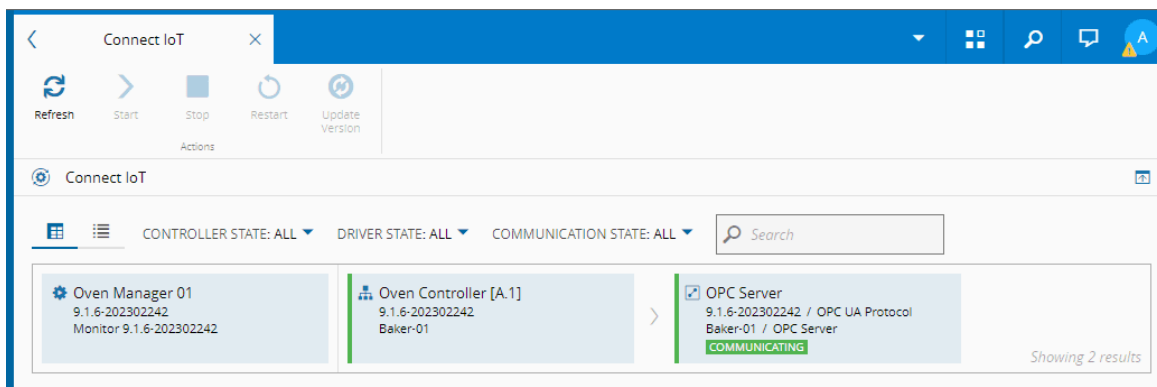


Select ok and save your changes in the Automation Controller. Going back to the application you can see that after saving in the MES it automatically sent the change to your Automation Manager running as is know able to connect.

```

2023-03-16 14:54:50.167 info: Reporting device setup result for Driver 'OPC Server', result='true'
2023-03-16 14:54:50.169 debug: Updating 'AutomationDriverInstance/2303151030560000001' instance to (Communicating)
2023-03-16 14:54:50.169 info: Received Communication State change from driver: Communicating
2023-03-16 14:54:50.137 info: Device connected and ready to be setup
2023-03-16 14:54:50.168 info: Reporting Setup Result (success='true')
2023-03-16 14:54:50.168 info: Device successfully setup
2023-03-16 14:54:50.169 info: Communication state changed Setup -> Communicating
2023-03-16 14:54:50.280 info: Updated 'AutomationDriverInstance/2303151030560000001' instance to (Communicating)
2023-03-16 14:54:50.280 info: DriverInstance Communication State updated in MES to Communicating
  
```

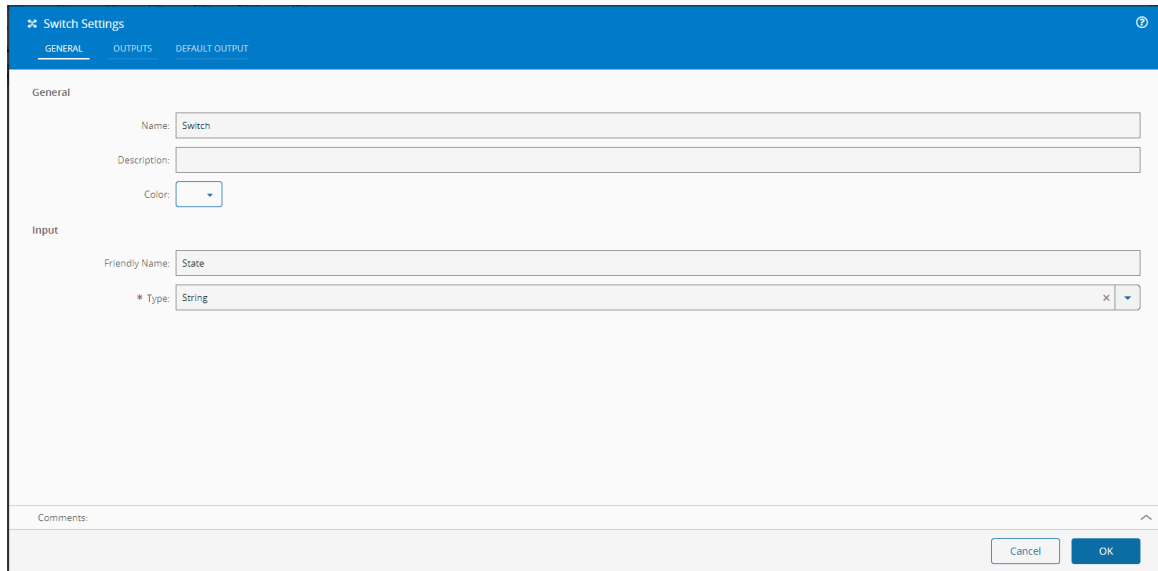
The MES GUI can also provide feedback of the status of the communication. Selecting **Automation > ConnectIoT**, you have a global vision of all the communications.



We are connected to the machine, in this case an OPC Server.

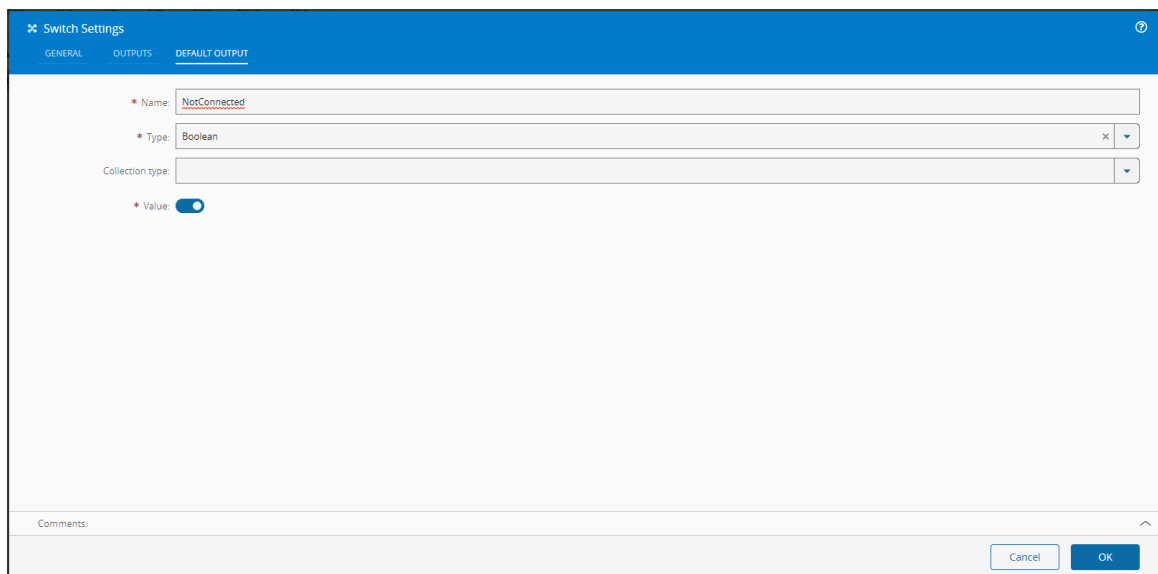
Let's finish this basic training by, logging a message saying "`* Great Tutorial ***`" when the machine is on the state communicating.

Go back to the Automation Controller Workflow and add a task `Switch`.



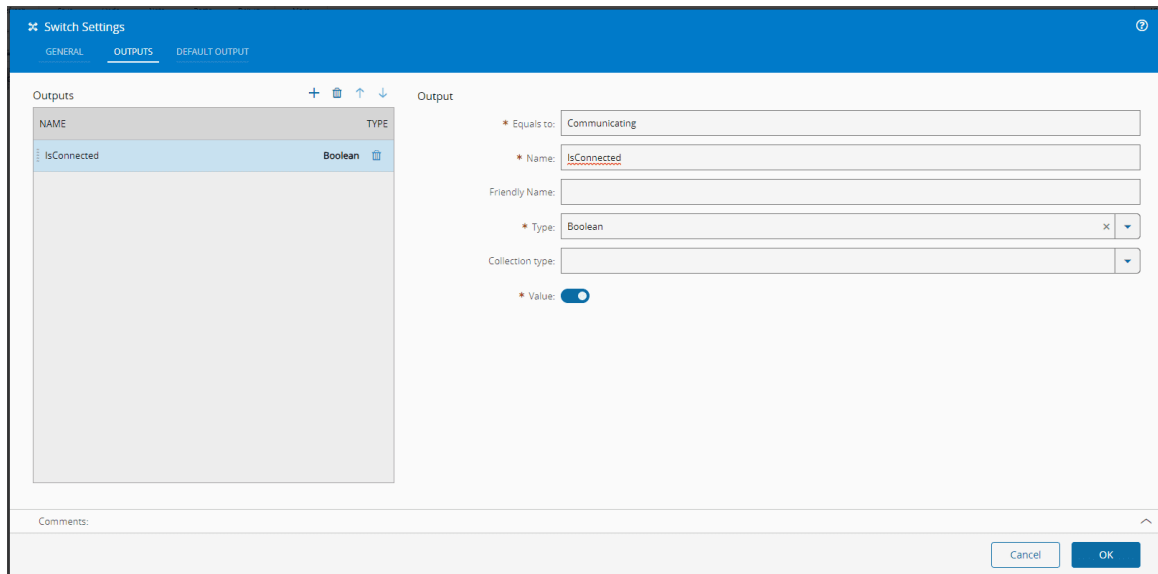
The screenshot shows the 'Switch Settings' dialog box with the 'GENERAL' tab selected. The 'Name' field is set to 'Switch'. The 'Description' field is empty. The 'Color' field has a dropdown arrow. Under the 'Input' section, the 'Friendly Name' is 'State' and the '* Type' is 'String'. There is a 'Comments' field at the bottom and 'Cancel' and 'OK' buttons.

In the `Default Output` we will add a Name - `NotConnected` with type `String`. If the input `State` has no match, the default output will emit.

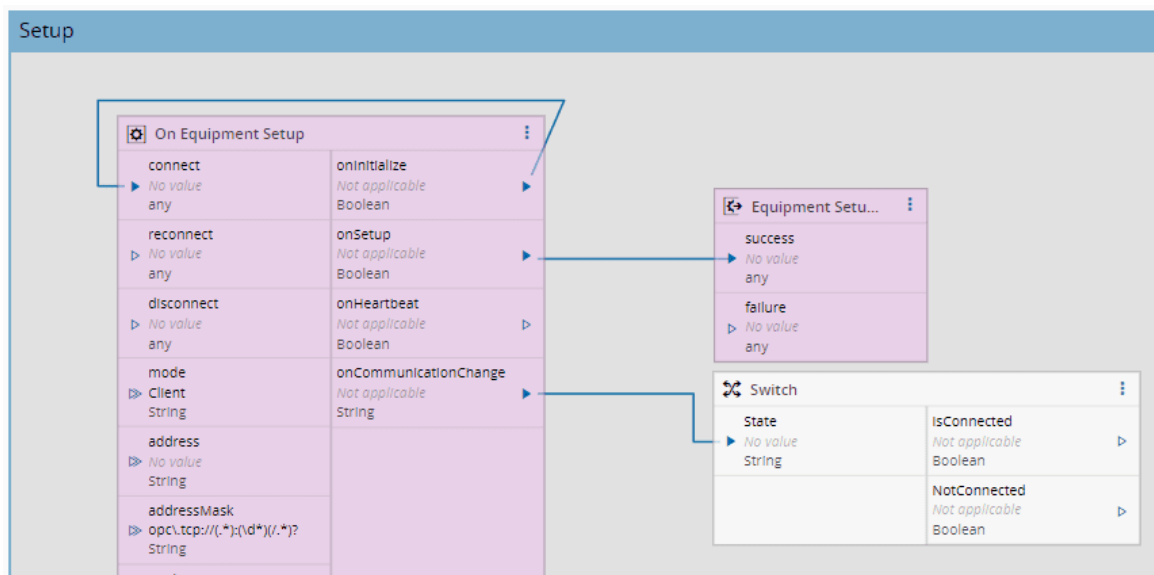


The screenshot shows the 'Switch Settings' dialog box with the 'DEFAULT OUTPUT' tab selected. The '* Name' field is 'NotConnected'. The '* Type' is 'Boolean'. The 'Collection type' field is empty. The '* Value' is a toggle switch that is currently turned on. There is a 'Comments' field at the bottom and 'Cancel' and 'OK' buttons.

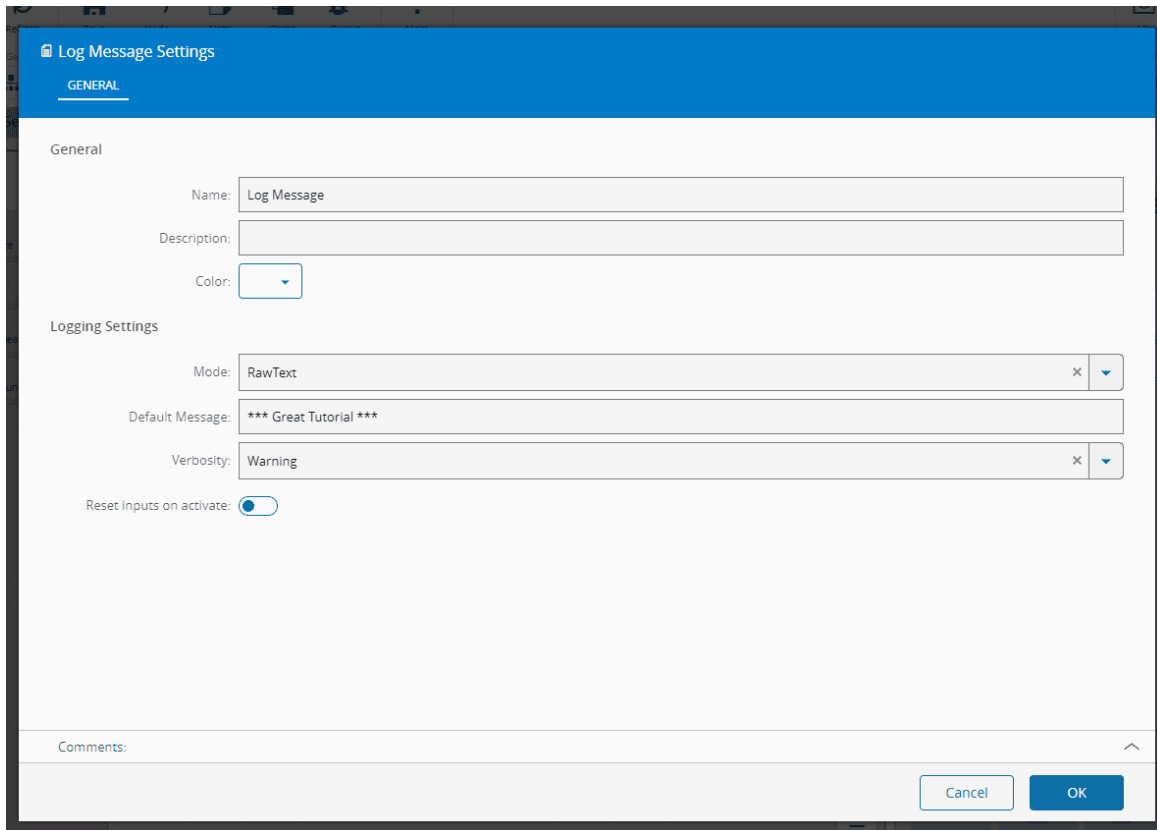
In the outputs, we add an `IsConnected` output, and in this output we will say, that if the `State` is equal to `Communicating`, it will emit `true`.



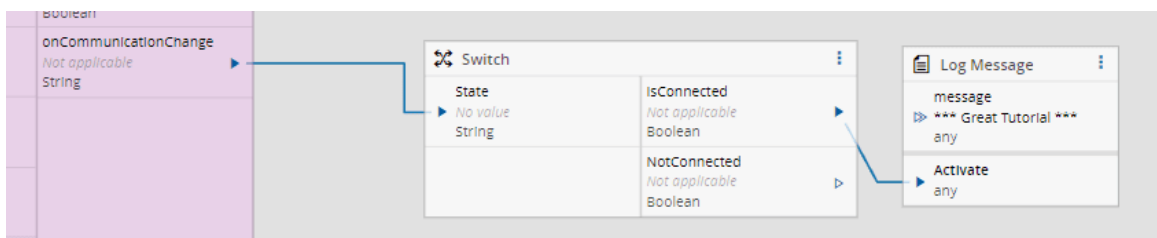
Now we can link it to the `onCommunicationChange` of the `OnEquipmentSetup`.



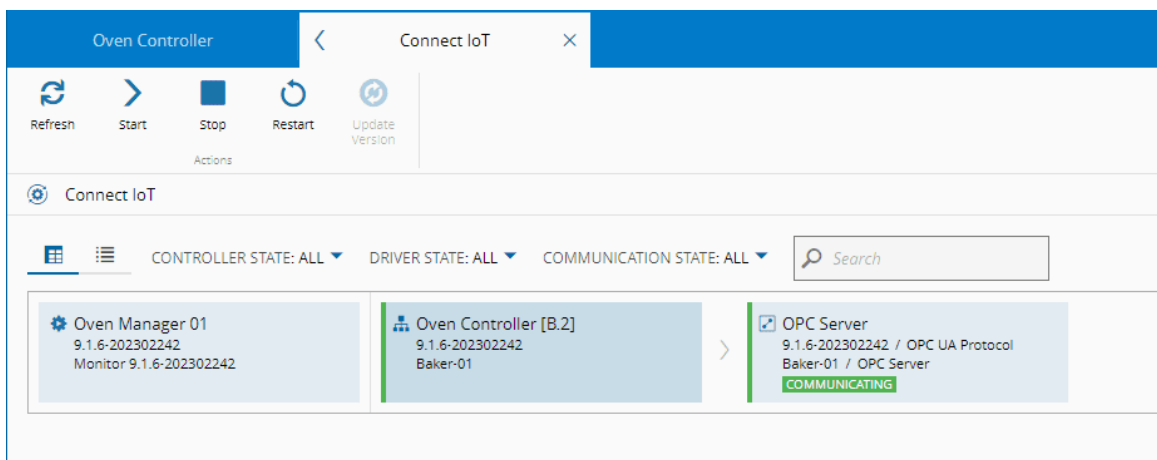
We will now add our log message. To do so, drag and drop a `Log Message` task. Here, we will add the message as our Default Message and change the verbosity to `Warning` so it's easier to spot in the console output.



Lets now finish the flow by connecting it to the `Switch` task.



In the `Automation > ConnectIoT` tab, in the `MES` system restart the controller. In this case we are restarting the application as we want to force it to connect again.



Going back to the console we can see the message now appearing after connecting.

```

2023-03-16 15:16:06.338 info: DriverInstance Communication State updated in MES to AttemptingToConnect
2023-03-16 15:16:06.338 debug: Updating 'AutomationDriverInstance/2303151030560000002' instance to (Communicating)
2023-03-16 15:16:06.413 info: Updated 'AutomationDriverInstance/2303151030560000002' instance to (Communicating)
2023-03-16 15:16:06.413 info: DriverInstance Communication State updated in MES to Communicating
2023-03-16 15:16:06.789 warn: [<<root>>|Setup|task_659|logMessage] *** Great Tutorial ***
2023-03-16 15:16:44.504 debug: Heartbeat received from Monitor
2023-03-16 15:16:44.503 debug: Sending Heartbeat the running processes

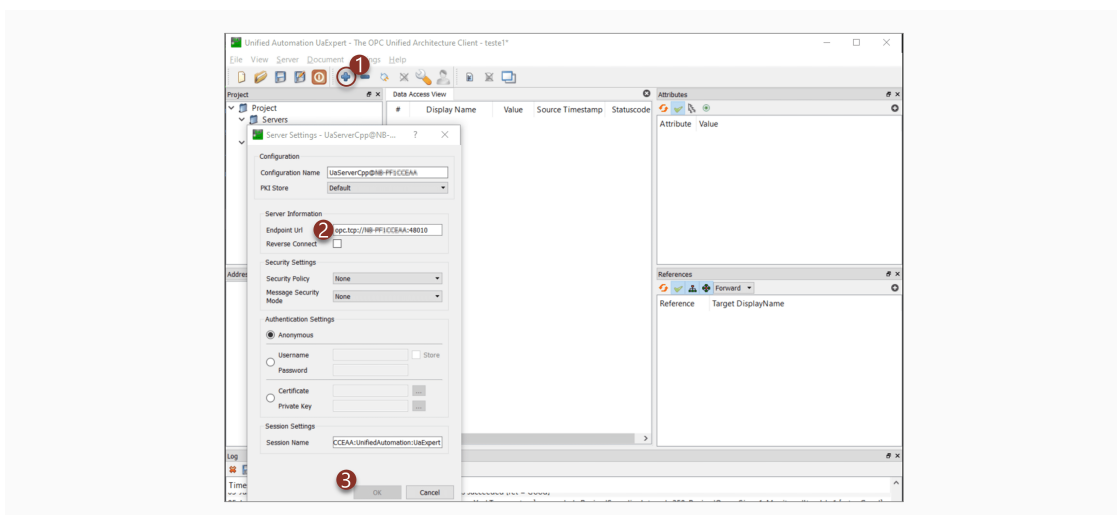
```

You now have a built structure using Connect IoT that can connect to an equipment, and this is the end of the basic configuration tutorial. The intermediate scenario configuration will be built upon this.

Equipment Simulator Tests

In order to test this integration tutorial, we can use a free OPC/UA server (to mimic the behavior of an equipment) available at <https://www.unified-automation.com/products/server-sdk/c-ua-server-sdk.html> as well as an OPC/UA client (to set the values of the server accordingly), available at <https://www.unified-automation.com/products/development-tools/uaexpert.html>.

1. Go to the websites listed above to download and install the UaCPPServer server software and Unified Automation UaExpert client software.
2. Start the server.
3. Run the UaExpert client. Add a server, set the Endpoint Url to the server displayed on UaCPPServer, and select **OK**.



The values given here are examples, replace it with yours.



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