CESMII
THE SMART MANUFACTURING INSTITUTE

Application Note

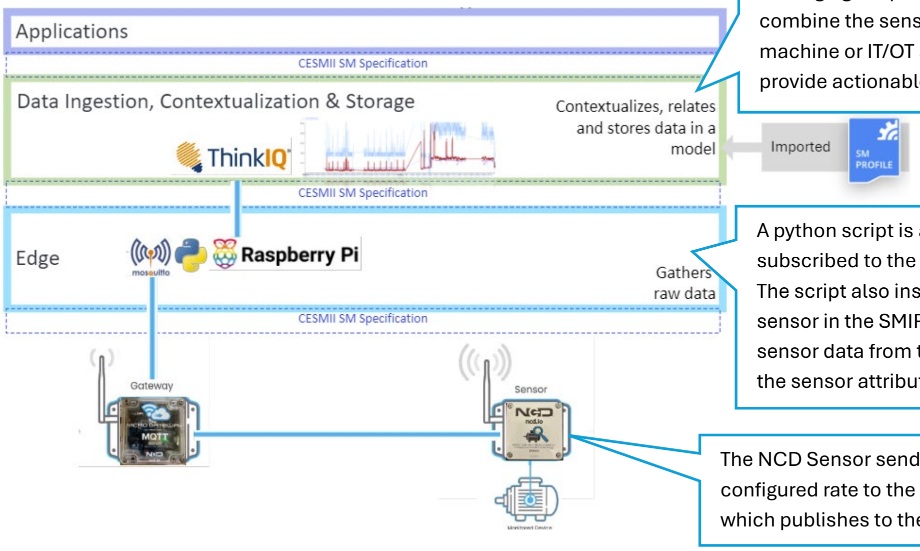
Seamless Integration with Wireless Sensors to SMIP

Summary

Connecting machines or equipment to an IIoT platform can be a major hurdle to obtaining the data you need for Digital Transformation. Since a majority of manufacturers are adding sensors to their equipment for more insights, there should be an easier way. Therefore, this is a guide to seamlessly & quickly connect a National Control Device (NCD) Wireless Sensor via the MQTT Gateway to ThinkIQ as the Smart Manufacturing Innovation Platform (SMIP).

Data Flow Architecture

With this Edge, Platform, and Application solution, the data flow during execution is detailed below.



In the SMIP, Trends show the real-time data for users to gain insights. Further, other Applications leveraging GraphQL queries can combine the sensor data with other machine or IT/OT software data to provide actionable information.

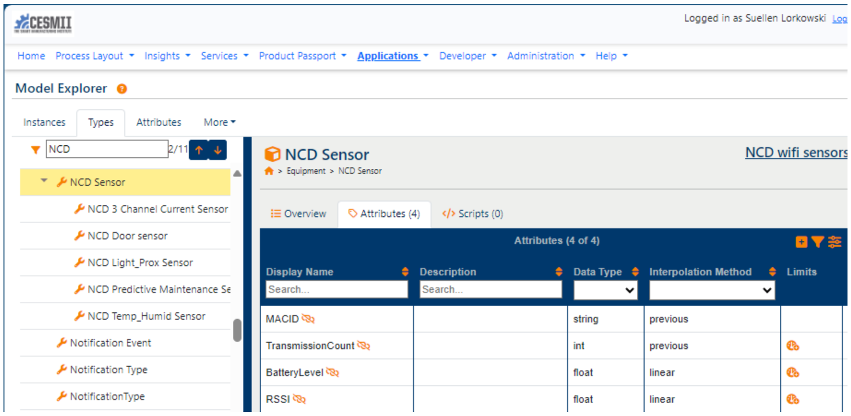
A python script is an MQTT Client subscribed to the MQTT Broker Topic. The script also instantiates the sensor in the SMIP and pushes sensor data from the broker topic to the sensor attributes.

The NCD Sensor sends data at a configured rate to the MQTT Gateway, which publishes to the MQTT Broker.

Quick Start

These are the abbreviated steps to set up this solution.

1. Check if the NCD Sensor Type exists in the SMIP Instance.



Attributes (4 of 4)

Display Name	Description	Data Type	Interpolation Method	Limits
Search...	Search...			
MACID		string	previous	
TransmissionCount		int	previous	●
BatteryLevel		float	linear	●
RSSI		float	linear	●

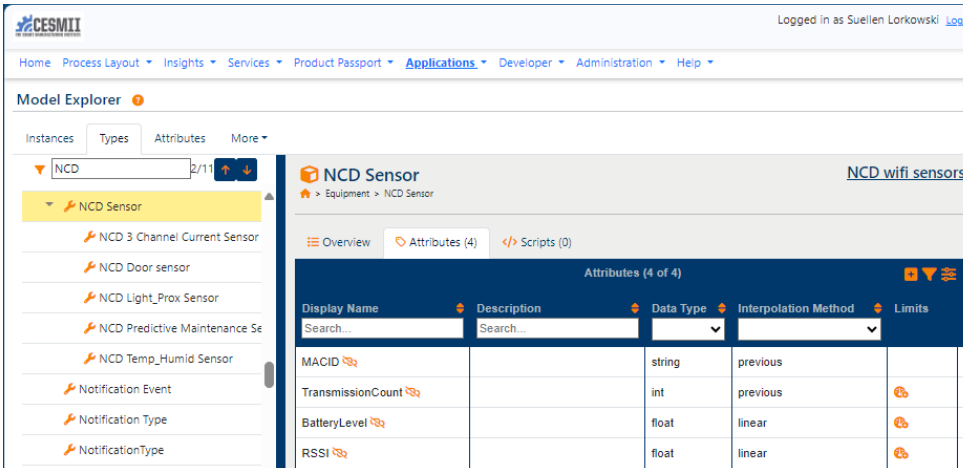
   a. If not, import the NCD wifi sensors Library attached in the Detailed Steps section.

2. Configure the NCD.io MQTT Gateway, then connect the Sensor to the Gateway.
3. On the Raspberry Pi or any computer, start an MQTT Broker and adapt the python script to reflect the MQTT Broker Address and SMIP instance. Then, run the start.sh script and switch the sensor on to automatically create the model and start collecting data. (Note: once everything is running, you can create a Service for better reliability.)

Detailed Steps

For more detailed instructions on this configuration, follow these steps.

1. **SMIP (Smart Manufacturing Innovation Platform)**
    a. If this is your first time using the SMIP, please watch this video as a good starting point Quick Start 2: Platform Type Modeling
    b. Check if the NCD Sensor Type exists in the SMIP Instance. This is the type (or template) that will be copied when a sensor instance (real sensor) is created in the model. If this type already exists, skip to Step 1d below.



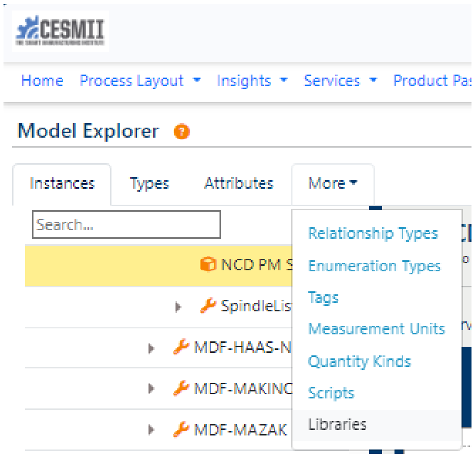
Attributes (4 of 4)

Display Name	Description	Data Type	Interpolation Method	Limits
Search...	Search...			
MACID		string	previous	
TransmissionCount		int	previous	
BatteryLevel		float	linear	
RSSI		float	linear	

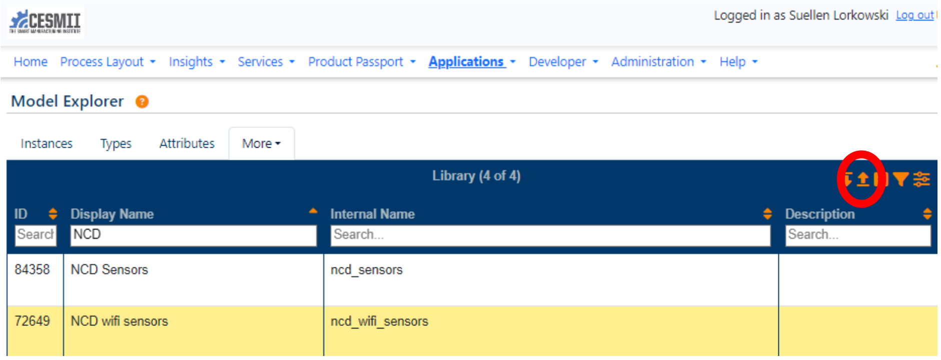
    c. If this type doesn't exist, import the Library (json file) below using the following steps:

demo_cesmii_thinkiq_net_ncd_wifi_sensors

        i. Save this Library to your computer.
        ii. In Model Explorer, select More > Libraries.



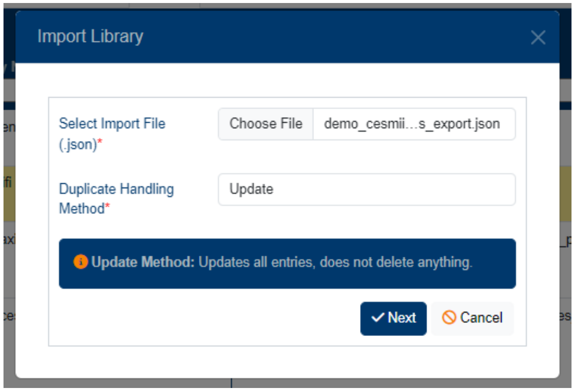
iii. Once in Libraries window, click on orange "up" arrow in the upper right corner to import it.



Library (4 of 4)

ID	Display Name	Internal Name	Description
Search	NCD	Search...	Search...
84358	NCD Sensors	ncd_sensors	
72649	NCD wifi sensors	ncd_wifi_sensors	

iv. In the Import Library pop up, Choose the File that was saved in Step a and use the Update Method.


Import Library

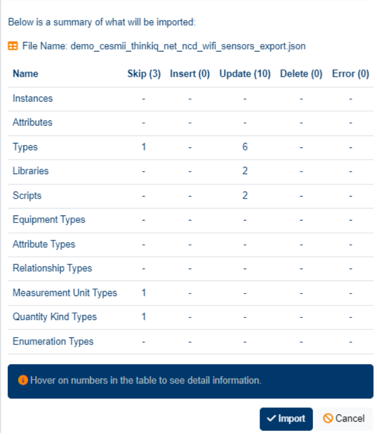
Select Import File (.json)*: Choose File demo_cesmii...s_export.json

Duplicate Handling Method*: Update

Update Method: Updates all entries, does not delete anything.

Loading options:
Skip – skips importing existing entries
Update – updates all entries, does not delete anything
Newer – updates entries to whichever has the most recent timestamp
Replace – replaces all entries, deletes entries not in the imported library

v. Select Next to see the Summary. Then, click Import. To double check it imported, go to Step 1b.



Below is a summary of what will be imported:

File Name: demo_cesmii_thinkiq_net_ncd_wifi_sensors_export.json

Name	Skip (3)	Insert (0)	Update (10)	Delete (0)	Error (0)
Instances	-	-	-	-	-
Attributes	-	-	-	-	-
Types	1	-	6	-	-
Libraries	-	-	2	-	-
Scripts	-	-	2	-	-
Equipment Types	-	-	-	-	-
Attribute Types	-	-	-	-	-
Relationship Types	-	-	-	-	-
Measurement Unit Types	1	-	-	-	-
Quantity Kind Types	1	-	-	-	-
Enumeration Types	-	-	-	-	-

Hover on numbers in the table to see detail information.

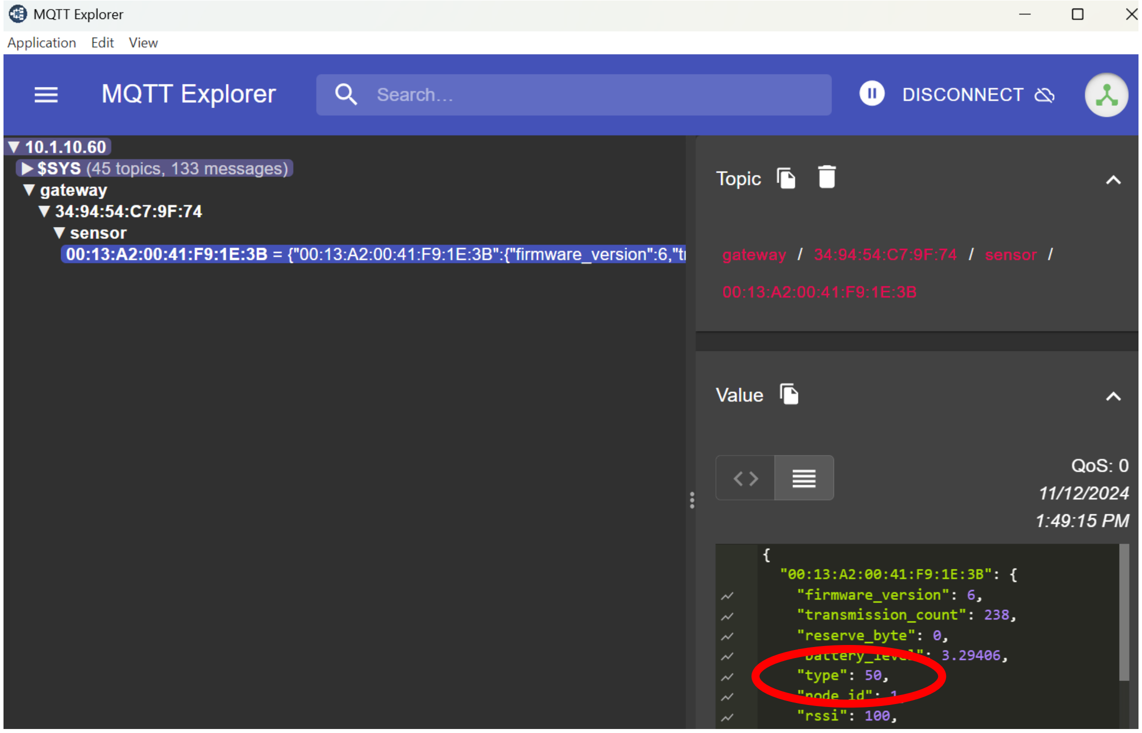
d. Now that we have a type (or template), we can configure the sensors, since the script will use this to create the model when the sensor publishes data.

2. **NCD (National Control Devices) Sensor & Gateway**

   a. Follow the Wi-FI Micro Gateway Setup for MQTT found here [MQTT Gateway - Wi-Fi Micro Gateway for MQTT - NCD Store]. These instructions include Sensor Setup and Installation.

   b. If Gateway light is anything but solid green, go to [Troubleshooting.]

   c. Once the Gateway light is solid green (connected to both wireless & MQTT), use an MQTT client, like MQTT Explorer, to ensure data is being published by the Gateway. (see below) Notice the sensor type value. We'll use that in the next step.

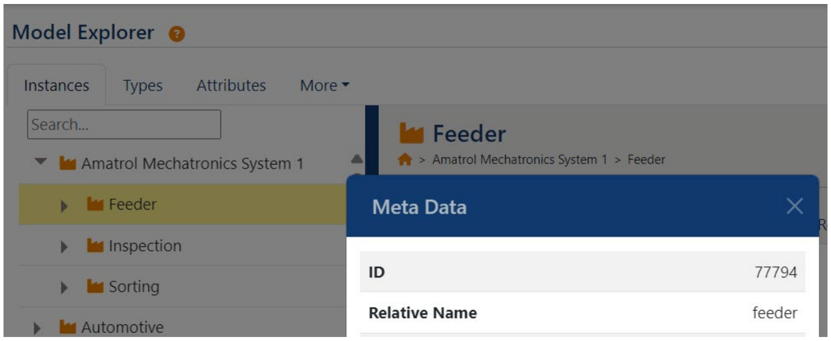


```
▼ 10.1.10.60
  ▶ $SYS (45 topics, 133 messages)
  ▼ gateway
    ▼ 34:94:54:C7:9F:74
      ▼ sensor
        00:13:A2:00:41:F9:1E:3B = {"00:13:A2:00:41:F9:1E:3B":{"firmware_version":6,"t
```

gateway / 34:94:54:C7:9F:74 / sensor / 00:13:A2:00:41:F9:1E:3B

```
{
  "00:13:A2:00:41:F9:1E:3B": {
    "firmware_version": 6,
    "transmission_count": 238,
    "reserve_byte": 0,
    "battery_level": 3.29406,
    "type": 50,
    "node_id": 1,
    "rssi": 100,
```

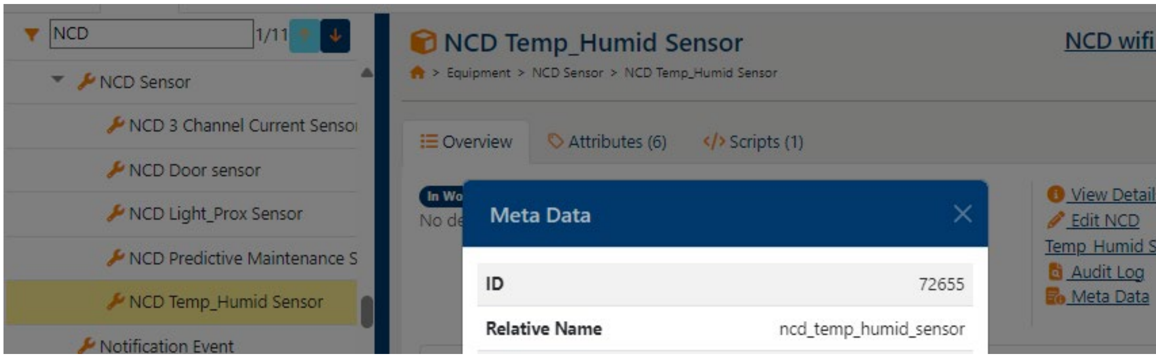
3. **Edge Device (Raspberry Pi, iPC, computer, etc)**
    a. Install and run as a service an MQTT Broker, like Mosquito, HiveMQ or your broker of choice. Eclipse Mosquitto, The Best Free Public MQTT Broker & MQTT Client by HiveMQ (Note: I had issues connecting to a Cloud Broker, so eventually chose a local broker.)
    b. Clone or copy the cesmii/NCD_Gateway Github to obtain the python script.
    c. Configure the config_demo.py script to match your set up:
        i. MQTT Broker Address
        ii. SMIP authenticator, which details how to connect to the SMIP. For more information, GraphQL-API/Docs/jwt.md at main · cesmii/GraphQL-API or Quick Start 7: Introduction to GraphQL
        iii. SMIP parent_equipment_id, which is the corresponding equipment instance to associate the sensor. This can be found by in the SMIP Model Explorer by clicking on the equipment, then select the Meta Data link.



ID	77794
Relative Name	feeder

iv. For machine_name_dict and machine_type_dict, does the sensor type list here match the sensor type from MQTT Explorer from Step 2c? For example, the NCD Temperature and Humidity Sensor is type 27, so if you have the same sensor, it should be 27. If this doesn't match, please go to the Troubleshooting. Section to update the script to your sensor type.

v. In the machine_id_dict, replace the IDs with Type IDs in your system. For example, NCD type 27 is the NCD Temperature and Humidity Sensor and has a SMIP Type ID 72655 in the script. In the SMIP, find the NCD Temp_Humid Sensor Type, choose Meta Data and ensure the ID here matches the script. If not, update the script with your IDs.



ID	72655
Relative Name	ncd_temp_humid_sensor

vi. Save the script.

d. Run the start.sh or start.bat script to start collecting data.

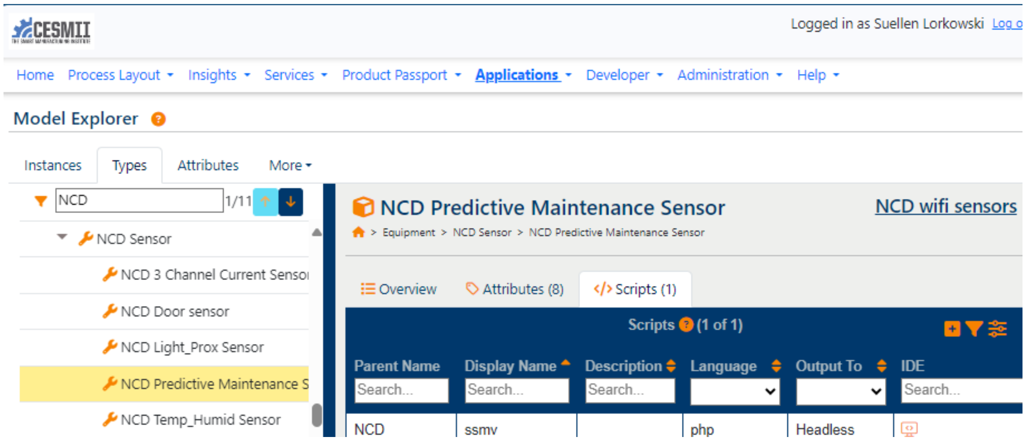
Troubleshooting

When things don't work as expected, look here for answers. This section is broken down into 3 parts for easier troubleshooting.

1. **SMIP**

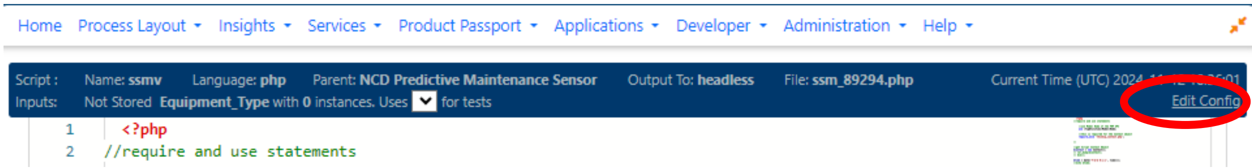
   a. On NCD Sensor Type children (particular sensor type), ensure the php Script is Not Scheduled. If it runs, then it will overwrite the sensor's data with random values every 5 seconds.

      i. Select Script tab, then click on "computer" icon.



Parent Name	Display Name	Description	Language	Output To	IDE
Search...	Search...	Search...			Search...
NCD	ssmv		php	Headless	

      ii. Choose Edit Config in the upper right corner, then change Scheduled from True to False.



Script : Name: **ssmv** Language: **php** Parent: **NCD Predictive Maintenance Sensor** Output To: **headless** File: **ssm_89294.php** Current Time (UTC) 2024

Inputs: Not Stored **Equipment_Type** with **0** instances. Uses for tests

```
<?php
//require and use statements
```

2. **NCD.io**
   a. Ensure correct frequency match between Gateway and Sensor. 2.4GHz sensors connect only to 2.4 gateways and 900MHz only connect 900.
   b. Gateway lights
      i. MQTT gateway setup problems - Hardware - NCD.io Community
      ii. Blue flashing = Set Up Mode (or not connect to WiFi in earlier version)
         1. Must be 2.4GHz network.
         2. Try a different WiFi network.
      iii. Red flashing = Refer to link above for 1,3,4 Red Flashes meaning.
      iv. Blue solid (earlier version) = Connect to WiFi, not to MQTT
         1. Connecting the MQTT Gateway to Mosquitto - NCD.io
      v. Green solid = Connected to both WiFi & MQTT, ready to send data
3. **Python script**
   a. If your Sensor Type doesn't match or exist the script, make the following changes:
      i. Config_demo.py
         1. For machine_name_dict and machine_type_dict, Match or Add Sensor Type to MQTT Explorer. For example, an earlier version

of ncd_temp_humid_sensor had type 1. The later version was 27, so I changed the 1 to a 27.

2. Ensure the machine_id_dict matches your SMIP Type.

ii. Gatewayutils.py

1. Line 144+, adapt sntype to match numbers or add your sensor type, like you did in Config_demo.py

iii. NCD_Definitions.py

1. Ensure attributes in each SMIP type match this script.

b. If sensor is not instantiated in the SMIP, ensure the

i. Parent ID is correct in the config_demo.py script.

ii. IDs listed in machine_id_dict in Config_demo.py match your SMIP.