ST-DiscoveryKit-WatsonIoT-Workshop

STMicroelectronics Discovery Kit IoT Node and IBM Watson Hands-On Workshop

ST Discovery Kit IoT Node and IBM Watson Hands-On Workshop:

Learn how to connect your next IoT design to the Cloud using IBM Watson IoT Platform and the ST Discovery Kit IoT node. The IoT Discovery Kit features an ultra-low-power STM32L4 Cortex® -M4 MCU, wireless connectivity and an array of sensors to showcase cloud connectivity features. Presenters: STMicroelectronics team with John Walicki, IBM

This hands-on workshop will show you how to integrate sensors, wireless connectivity (WiFi, NFC, BLE, SubGHz), a low-power microcontroller and sensor libraries into your next IoT design. You'll then learn to connect the Discovery Kit to IBM Cloud and Watson IoT Platform to create a new application in minutes using Node-RED.

The hands-on training is a working session – please bring your laptop. Note: Administrator rights is needed for software and driver installation. ST will provide the required STM32 development boards and software. SPACE IS LIMITED FOR THIS SESSION – FIRST COME, FIRST SEATED. Must be present and stay for training to receive free kit.

Learning Objectives:

In this workshop, you will learn how to:

- Learn about the STM32L4 Discovery Kit IoT node, low-power wireless, BLE, NFC, SubGHz, Wi-Fi development board.
- Send Discovery Kit data to Watson IoT Quickstart
- Create an IoT Starter Kit application running in IBM Cloud
- Launch the Watson IoT Starter application
- Open the Watson IoT Platform so that you can send/receive data from the Discovery IoT device
- Create a Discovery IoT device type and device
- Configure the Node-RED visual programming editor
- Secure your Node-RED Editor in IBM Cloud
- Install additional Node-RED nodes
- Import a prebuilt flow from GitHub
- Create a new Node-RED flow and configure IoT Nodes

- Output the ST Microelectronics Discovery Kit IoT node temperature and humidity data
- Work with JSON data and observe the sensor results in the Debug sidebar
- Create a Node-RED Dashboard
- Experiment with Chart types
- Plot Real Time sensor data
- Trigger alerts when the real-time sensor data exceeds a threshold value
- Create a Node-RED flow that uses the Cloudant node
- Format a time series database record
- View Cloudant databases
- Read datasets from a Cloudant database
- Create a chart of historical data
- Set up a new Watson Studio Project
- Create a Jupyter Notebook
- Read data from a Cloudant DB into Spark
- Calculate the Average, Standard Deviation, and Find the Min/Max

Prerequisites

This tutorial can be completed using an IBM Cloud Lite account.

- Create an IBM Cloud account
- Log into IBM Cloud

Part 1 - ST Micro Discovery Kit IoT Node and Watson IoT Quickstart

- Instructions : Review Slides 5 to 13

Part 2 - Create an Internet of Things Platform Starter application

- Instructions : Create an Internet of Things Platform Starter application

Part 3 - Create a Watson IoT Platform Device Type and Device

- Instructions : Create a Watson IoT Platform Device Type and Device

Part 4 - Node-RED Set up and Configuration in IBM Cloud

- Instructions : Node-RED Set up and Configuration in IBM Cloud

Part 5 - Receive Discovery Kit Environmental Sensor Data in Node-RED

- Instructions : Receive Discovery Kit Environmental Sensor Data in Node-RED

Part 6 - Node-RED Dashboard Charts - Plot Environmental Sensor Data

- Instructions : Node-RED Dashboard Charts - Plot Environmental Sensor Data

Part 7 - Store Data in Cloud Storage for Historical Data Analytics

- Instructions : Store Data in Cloud Storage for Historical Data Analytics

Part 8 - Node-RED Charts of Historical Sensor Data

- Instructions : Node-RED Charts of Historical Sensor Data

Part 9 - Watson Studio Set up and Configuration in IBM Cloud

- Instructions : Watson Studio Set up and Configuration in IBM Cloud

Part 10 - Discovery Insights via Jupyter Notebook in Watson Studio

- Instructions : Watson Studio Jupyter Notebook

References:

- Download link to TrueStudio
- Download link to the IBM Watson IoT examples that are buildable in TrueStudio

Quick links :
Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

Create an Internet of Things Platform Starter application

In this tutorial you will learn how to create a Watson IoT Platform Starter application that can be used to connect IoT devices and simulated IoT devices to the Watson IoT Platform. The **Internet of Things Platform Starter** is designed with pre-assembled services that work together. The Internet of Things Platform Starter includes a Node-RED Node.js web server, Cloudant database to store the sensor data, and the IoT platform service so you can connect devices.

Learning objectives

After completing this tutorial you will be able to:

- Create an IoT Starter Kit application running in IBM Cloud
- Launch the Watson IoT Starter application
- Open the Watson IoT Platform so that you can send data from IoT devices and device simulators

Prerequisites

This tutorial can be completed using an IBM Cloud Lite account.

- Create an IBM Cloud account
- Log into IBM Cloud

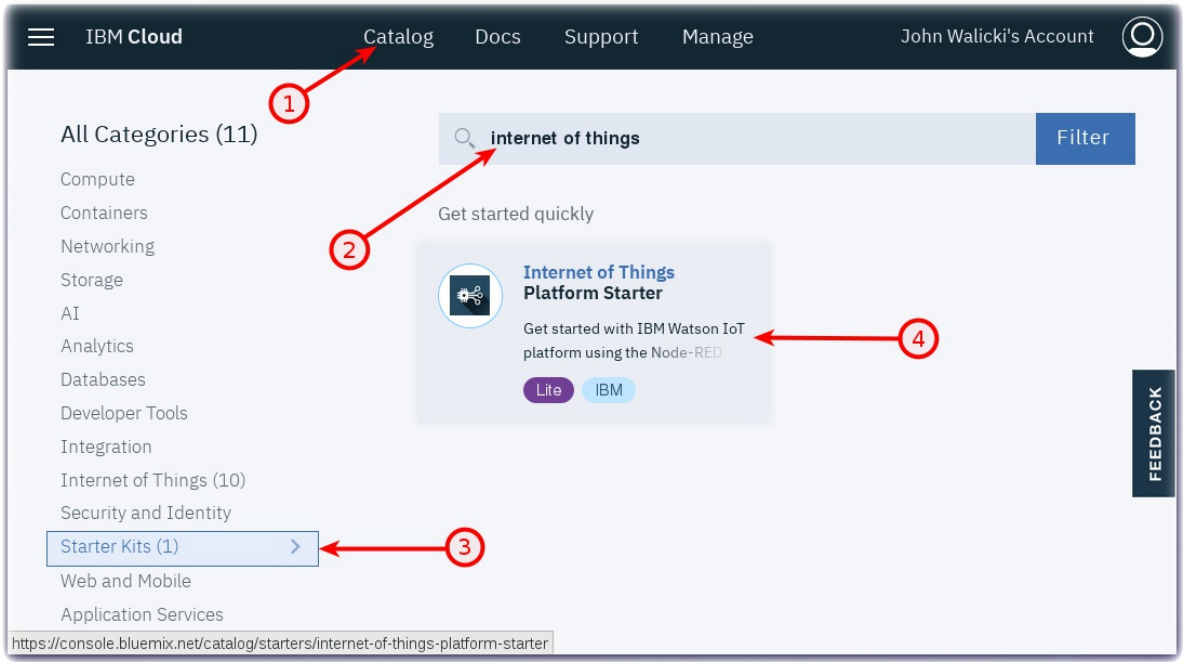
Estimated time

You can complete this task in no more than 20 minutes.

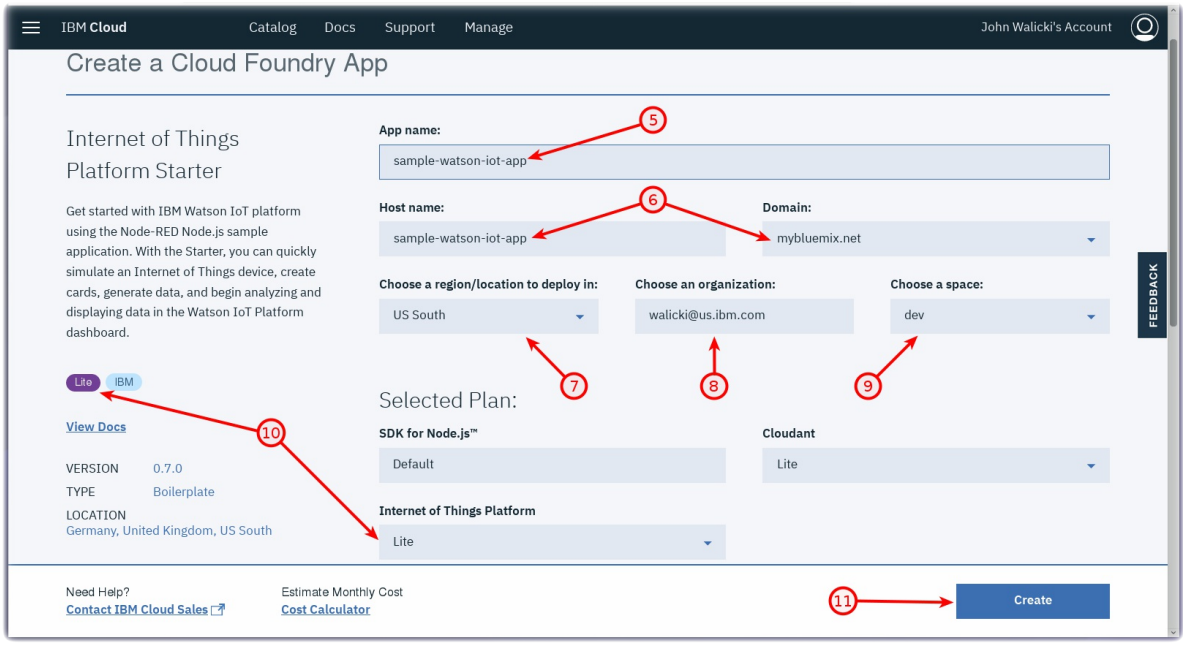
Step 1 - Create a Watson IoT Starter Application

Follow these steps to create a Watson IoT Platform Starter application in IBM Cloud.

- Create an IBM Cloud account and log into IBM Cloud
- Click on the Catalog (1) and search for **internet of things** (2)
- Under **Starter Kits** (3) click on **Internet of Things Platform Starter** (4)



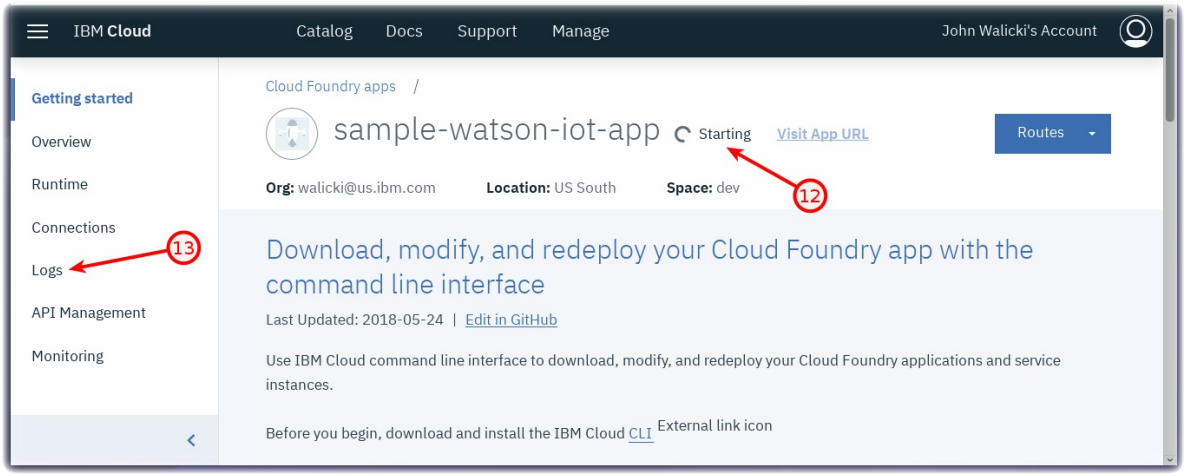
- Enter a **unique name** for your application (5). For example, *stmicro-discoverykit-yourname*. This name will be part of the **application URL** (6)
  - *Note:* In case the name is not unique you will receive an error message and can enter another name.
- The **Region** (7), **Organization** (8) and **Space** (9) will be prepopulated with valid options for your IBM Cloud account. If you have a Lite account then accept the defaults. If you have a trial or paid account, or belong to additional organizations, then you may choose to deploy in to any region, organization and space available to you.
- The IoT Starter application can be provisioned in the IBM Cloud *Lite* plan (10)
- Click on the **Create** button (11)



Step 2 - Launch the IoT Starter Application

The Internet of Things Starter application will be provisioned in the IBM Cloud region that was specified. This is called staging an application. It can take a few minutes for this process to complete.

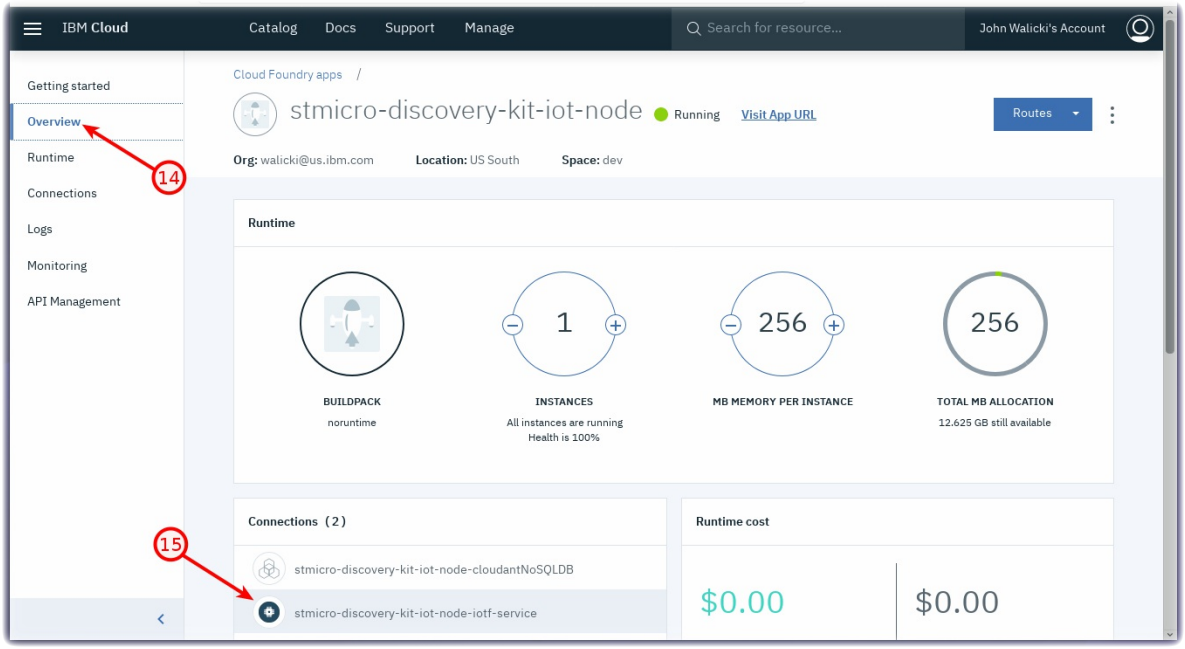
- Wait for the application to provision and start (12)
    - *Note:* While you wait, you can click on the Logs tab and review the activity logs from the platform and Node.js runtime.
    - Click on **Logs** (13) in the left navigation menu.
    - Scroll to the bottom to check the latest DevOps messages.



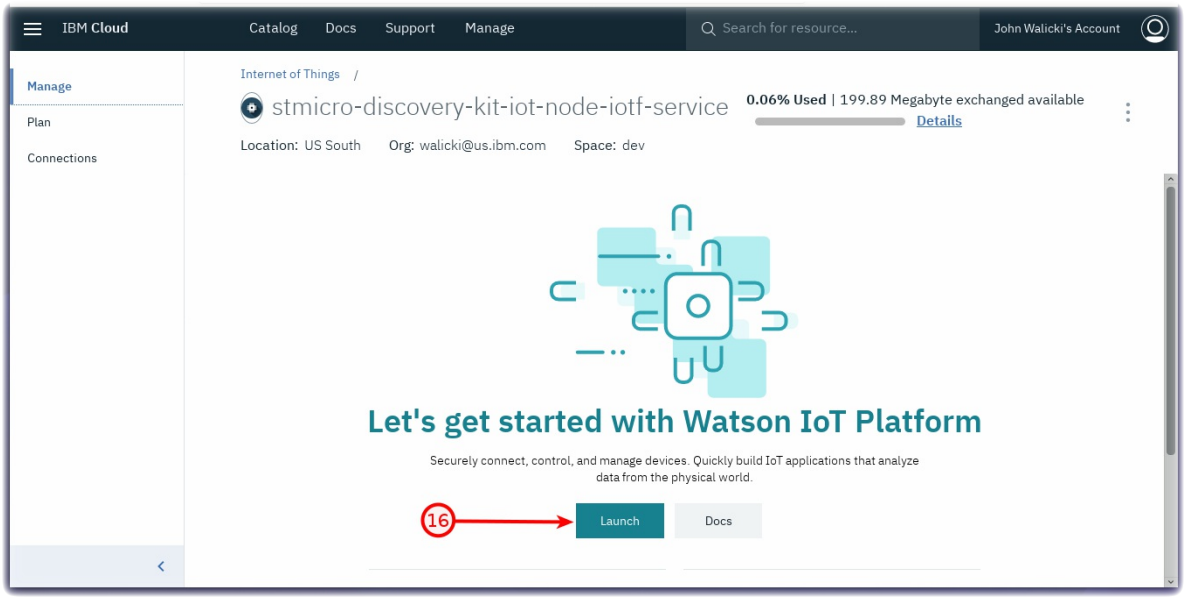
Step 3 - Launch the Watson IoT platform

Return to the IBM Cloud Application Details page.

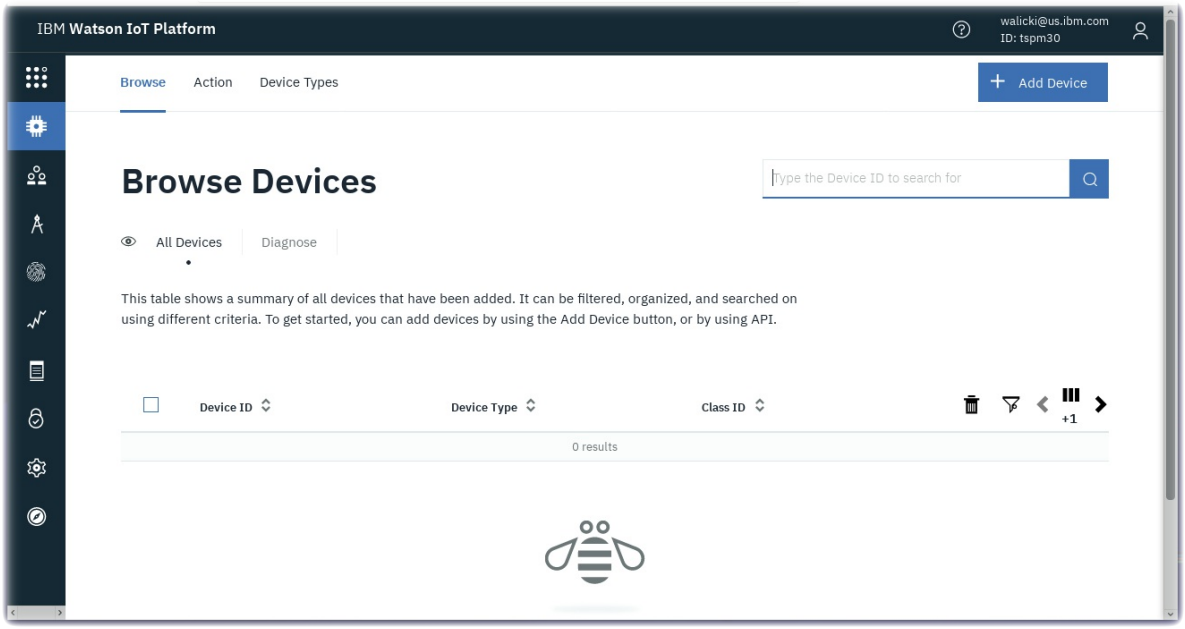
- Click on the **Overview** item (14) in the left navigation menu.
- Click on your *iotf-service* (15) in the **Connections** tile.



- The **Internet of Things** service landing page will open. Click on the **Launch** (16) button.



- The **Watson IoT Platform** service will open in a new browser tab and you can create an IoT device.



Congratulations - You have completed the creation of a Watson Internet of Things Platform Starter application in IBM Cloud.

Continue to the next step - Device Types and Devices

Quick links :

Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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Registering a new device to the Watson IoT Platform

Lab Objectives

This Lab will show you how to register your ST Microelectronics Discovery Kit IoT Node with the IBM Watson Internet of Things Platform. In the lab you will learn:

- How to define a device type and register a device in the Watson IoT Platform

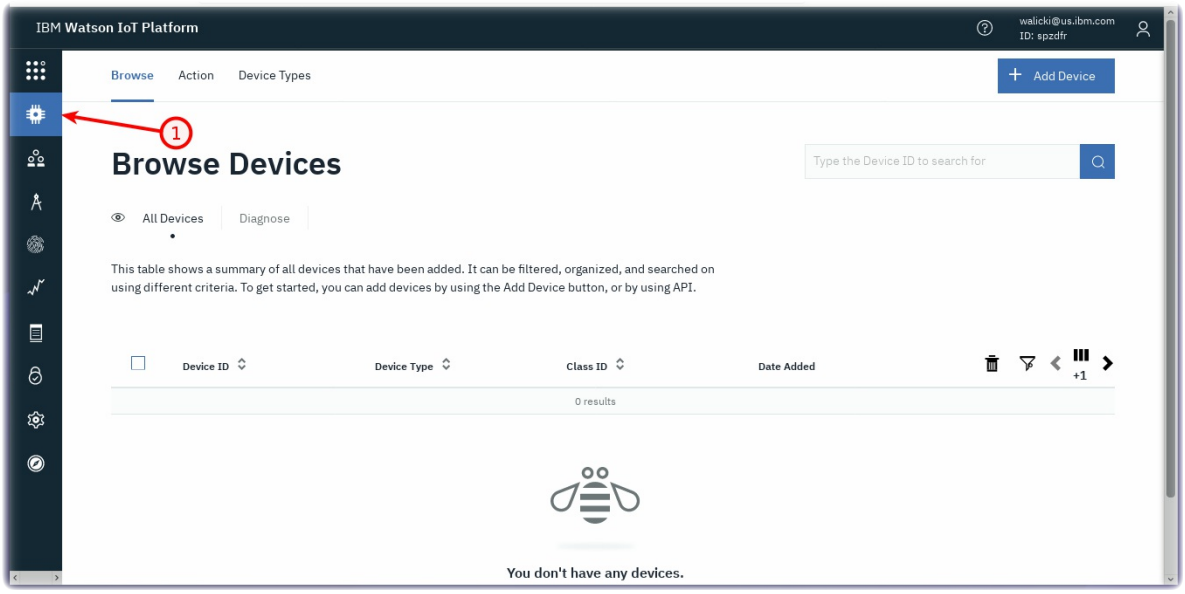
Introduction

Before you can connect a device to the Watson IoT Platform you need to define how the device will connect to the platform and also register the device to generate an access token for the device. This will be used to verify the device identity.

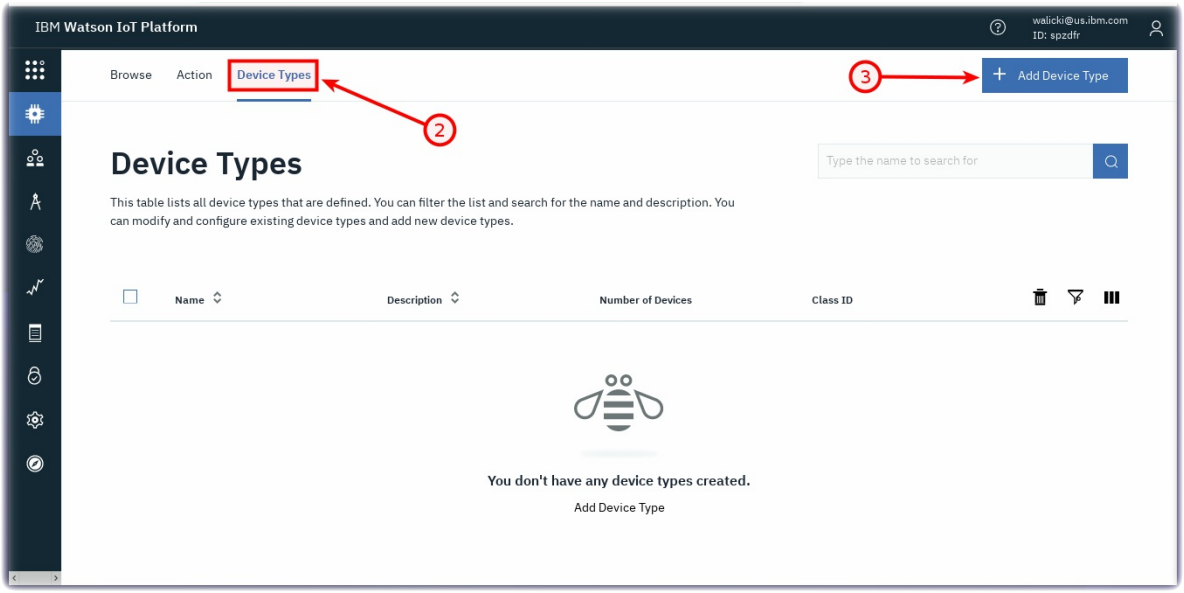
You need to decide how you want to group devices, by function, by hardware type, etc. Each device registered on the platform must be registered against a device type. There are no restrictions about how devices are grouped and the device types, for this workshop we will create a device type representing the ST Microelectronics Discovery Kit IoT Node devices.

Step 1 - Add a new device type for Discovery Kit IoT Node device

- Navigate into the **Devices** section (1) of the console

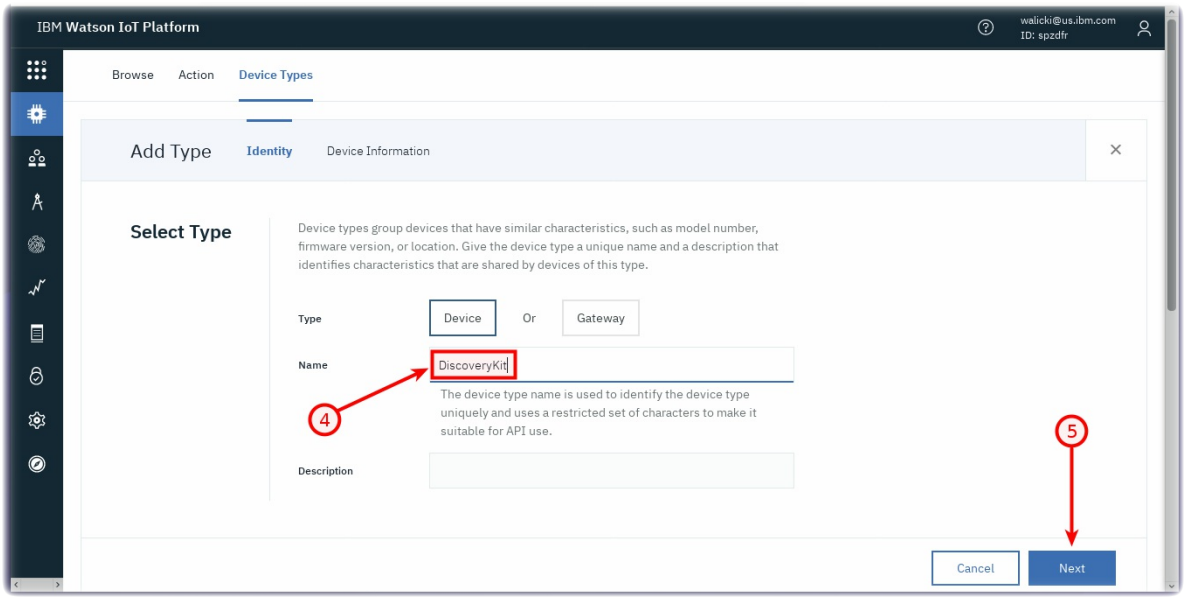


- Select the **Device Types** section (2). Press the **+ Add Device Type** (3) button

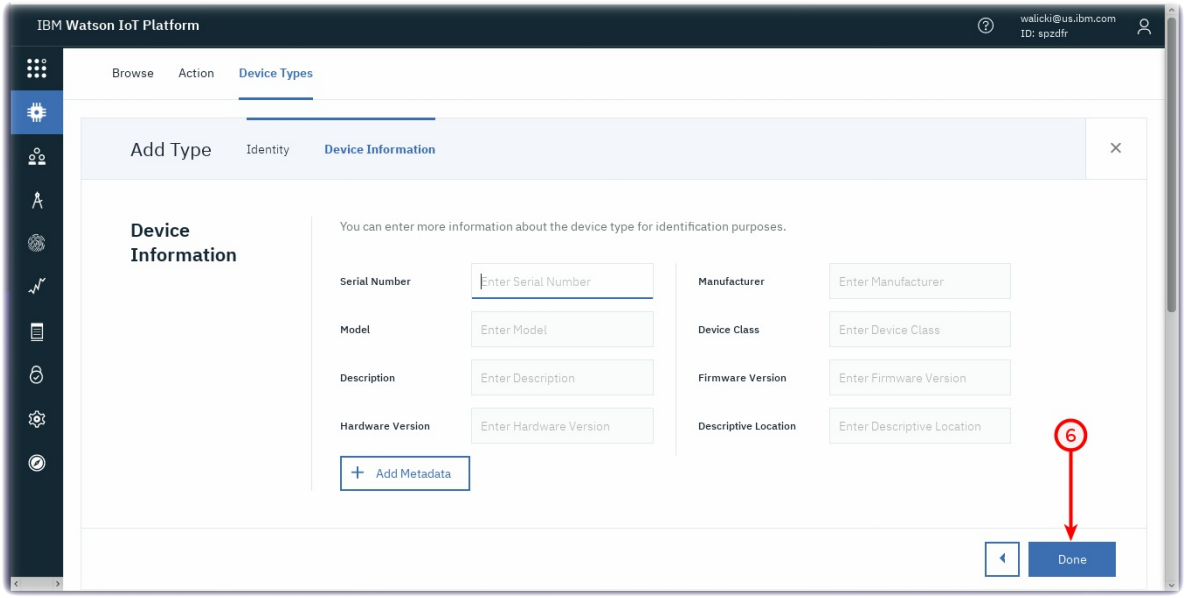


- Enter the following:
  - Type : Ensure **Device** is selected (NOT Gateway)
  - Name : Enter **DiscoveryKit** (4)

- Press the **Next** button (5)



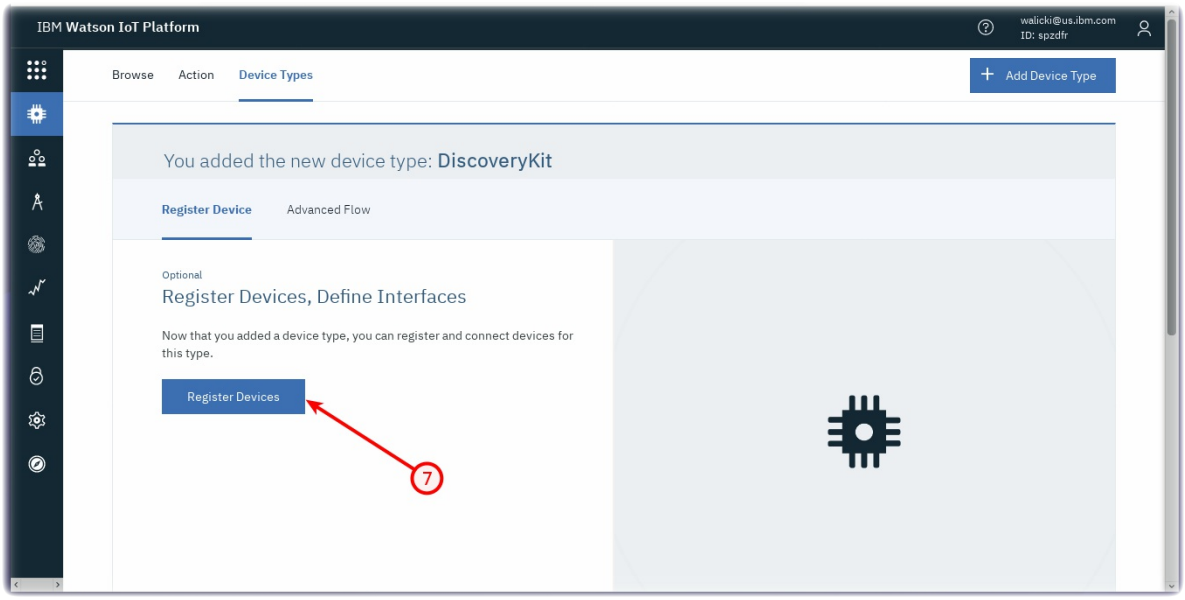
- Press the **Done** button (6)



Step 2 - Register a new DiscoveryKit device in the IoT Platform

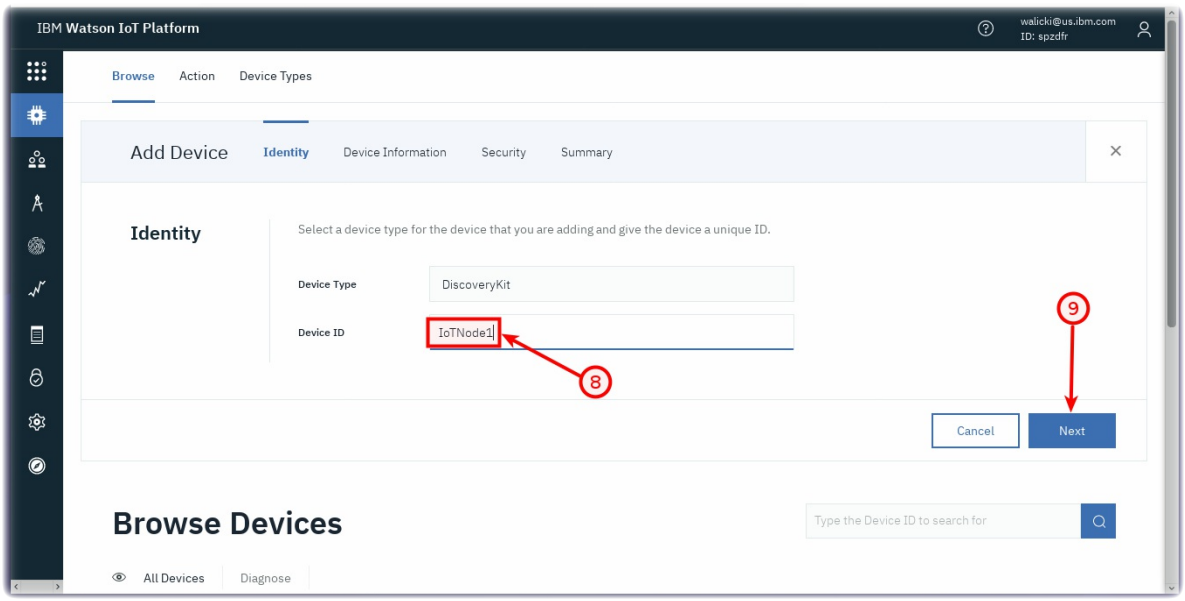
You now have the opportunity to register a device.

- Press **Register Devices** (7)

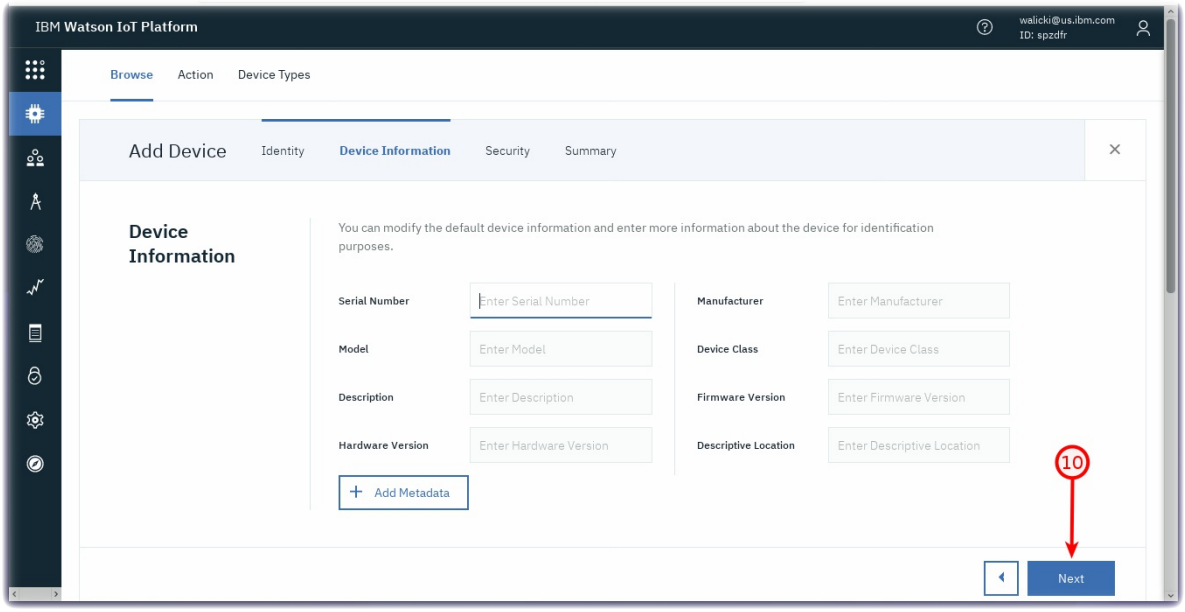


- The DiscoveryKit device type should be pre-selected. You now need to enter a unique device ID. You can choose how you want to identify devices. For the workshop, use a simple format, such as **IoTNode1**. (8)

- Press **Next** button (9)



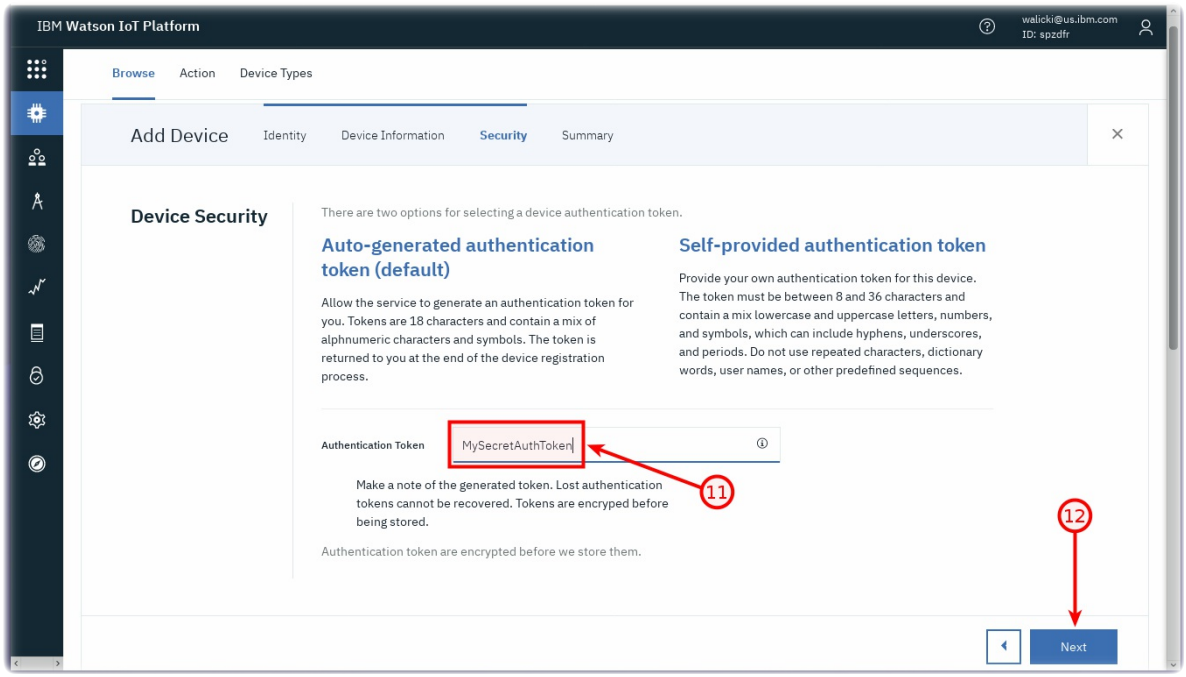
- Press **Next** button (10)



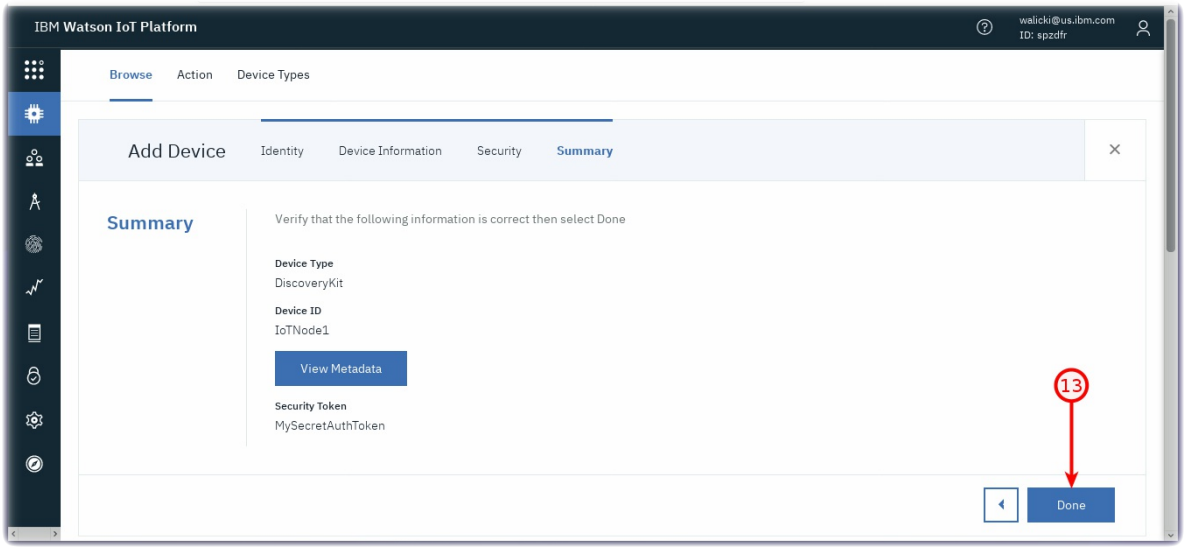
- You will be prompted to provide a token (11)

- Each time you connect the device the token will need to be presented to the server. Once the device is registered there is no way to recover a token. You will need to delete and reregister the device if the token is lost or forgotten.

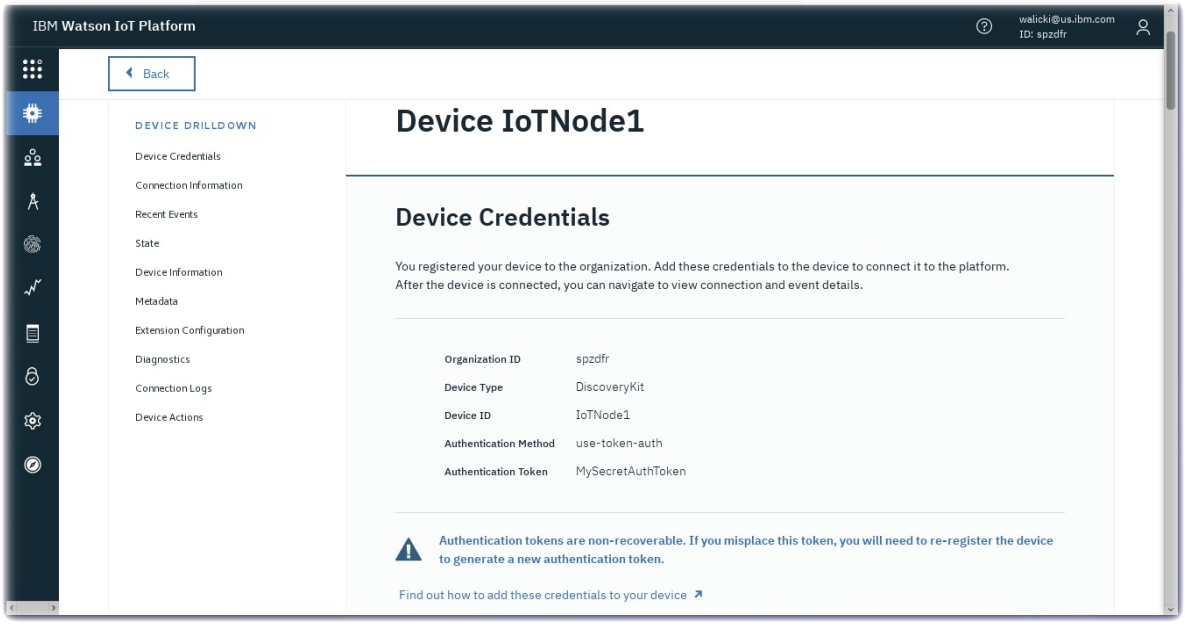
- Enter a **token** for your device (11) then press **Next** (12).



- You will see a summary of the device. Press **Done** to complete the device registration.



- You are now shown a **Device Credentials** page - this is the last chance you get to see the token. Once you leave this page the token can not be recovered. Write down the Org, Device Type, Device ID and Authentication Token. You might even consider taking a screen shot.



Step 3 - Reprogram the ST Microelectronics Discovery Kit IoT Node

Instead of sending the ST Microelectronics Discovery Kit IoT Node sensor data to Quickstart, we can now reprogram the board to send data to your secure Watson IoT Platform instance. If you have not yet powered the ST Microelectronics Discovery Kit IoT Node, connect it to your laptop using a MicroUSB cable. Start the terminal program to access the program running on the ST Microelectronics Discovery Kit IoT Node.

- Press the **Black Reset** on the ST Microelectronics Discovery Kit IoT Node
- Let it reconnect to the WiFi network
- When the program prompts, Enter **y** to update the device credentials

```
Do you want to update your way to register, or the device credentials? (y/n)
```

- When the program prompts, Enter **2** to specify a simple registered device.

```
Enter Registration Mode (1 - Quickstart, 2 - Simple):
```

- The program then prompts for your Org, DeviceType, DeviceId and Auth Token. You might want to type the string into a text editor to avoid typos and mistakes, then copy / paste the string into the program as hidden text. In the example case:

```
OrgId=spzdfr;DeviceType=DiscoveryKit;DeviceId=IoTNode1;Token=MySecret
```

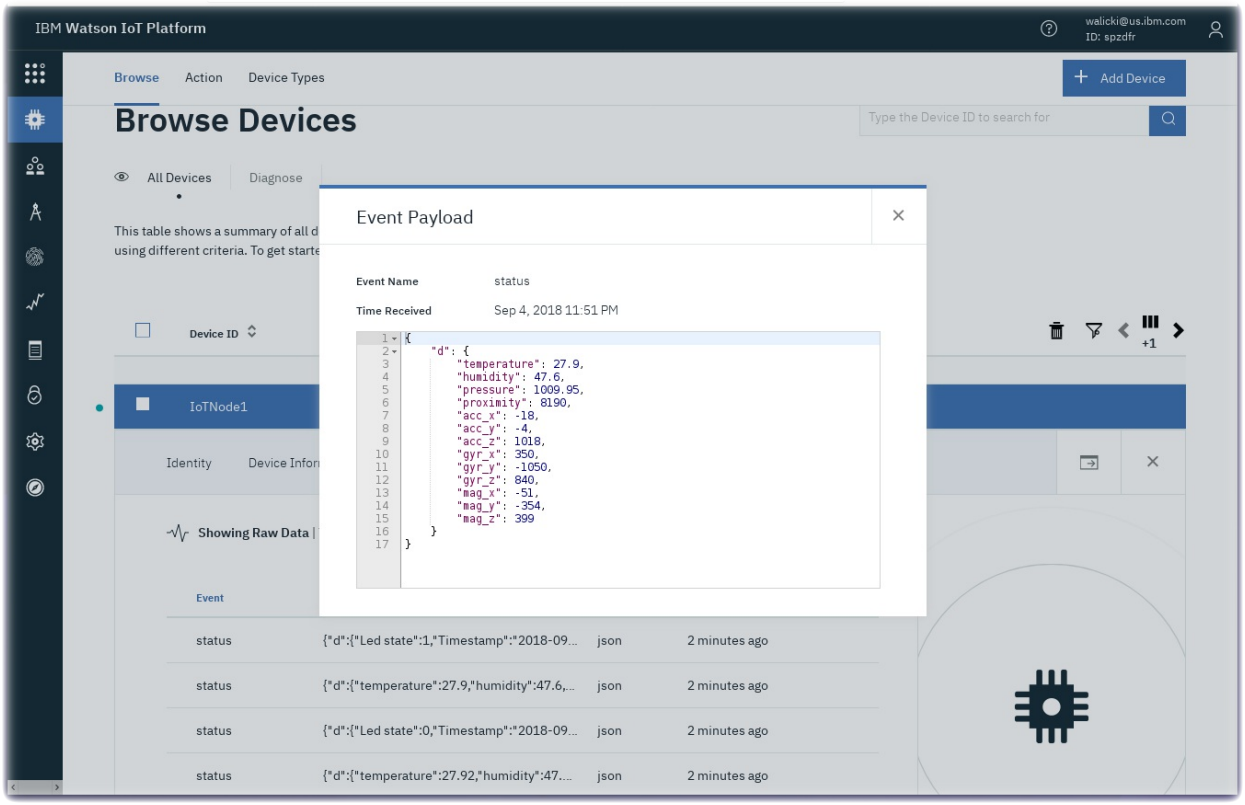
- The program will connect via MQTT to Watson IoT Platform.
- To send data, press the Blue **user** button. The application publishes the current sensor values.
- On double button push, the application enters in a loop and publishes sensor values automatically every second.
- For comparison, a full execution of the program is included below:

```
******************************************************************************
***   STM32 IoT Discovery kit for STM32L475/STM32F413/STM32F769 MCU    ***
***   X-CUBE-WATSON-X Cloud Connectivity Demonstration                ***
***   FW version 1.0.1 - Jul 26 2018, 11:10:45                        ***
******************************************************************************

*** Board personalization ***

*** WIFI connection ***

Push the User button (Blue) within the next 5 seconds if you want to update the WiFi netwo

Initializing the WiFi module
Module initialized successfully: Inventek eS-WiFi ISM43362-M3G-L44-SPI C3.5.2.3.BETA9
Retrieving the WiFi module MAC address: c4:7f:51:03:f1:a9

Connecting to AP: stmiot32  Attempt 1/3 ...
Connected to AP stmiot32
```

```
Mac address: c4:7f:51:03:f1:a9
Retrieving the IP address.
IP address: 192.168.1.236
Do you want to update your way to register, or the device credentials? (y/n)

Enter Registration Mode (1 - Quickstart, 2 - Simple):
You have selected the Simple registration mode.

Enter the Bluemix connection string of your device: (template: OrgId=xxx;DeviceType=xxx;De
connection string: --->
SimpleReg;OrgId=spzdfr;DeviceType=DiscoveryKit;DeviceId=IoTNode1;Token=MySecret
<---
Setting the RTC from the network time.
Configuring the RTC from Date: Tue, 04 Sep 2018 03:55:15 GMT
Device Client Connected to spzdfr.messaging.internetofthings.ibmcloud.com in registered mo

--------- Callback following our request to become a managed device ---------
Status :: 200
requestId : A27FD802-C29A8-4FA28-A0DAA-9F755DA3126B
Payload is : {"reqId":"A27FD802-C29A8-4FA28-A0DAA-9F755DA3126B","rc":200}
------------------------------------------------------------------------------

You can see your published data at https://spzdfr.internetofthings.ibmcloud.com
Sign in. Open a session with the "spzdfr" organization (next to your account name)
Select the device dashboard and click on the "IoTNode1" device to get its information and

When user button is pushed shortly, application publishes the sensor values, a 0/1 toggle
On double button push, application enters in a loop and publishes automatically every seco

Enter the sensor values publication loop.
publishing sensor data
publishing sensor data
publishing sensor data
```

Discovery Kit IoT Node Environmental Sensor data in Watson IoT platform

Confirm in Watson IoT Platform that ST Microelectronics Discovery Kit IoT Node environmental sensor data is arriving successfully.



Congratulations : Your board is sending data securely to Watson IoT Platform using TLS encrypted MQTT packets and server certificates.

Continue to the next step - Node-RED Setup

Quick links :

Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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Node-RED Set up and Configuration in IBM Cloud

Lab Objectives

In this lab you will set up Node-RED in your Watson IoT Starter application created at the end of Part 2. You will learn:

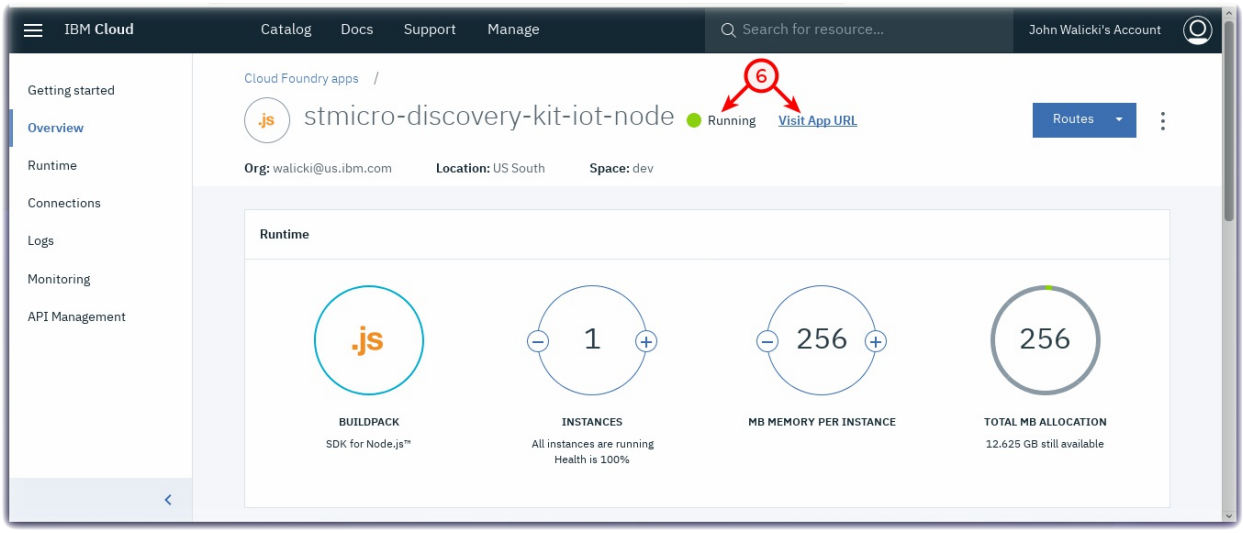
- Node-RED Visual Programming
- How to secure your Node-RED Editor in IBM Cloud
- How to install additional Node-RED nodes
- How to import a prebuilt flow from GitHub

Introduction

Node-RED is an open-source
Node.js application that provides a visual programming editor that makes it easy to wire together flows.

Step 1 - Node-RED Visual Programming

Recall that in Part 2, you created a IoT Starter Application. Once the Green **Running** icon appears, click the **View App URL** button (6)

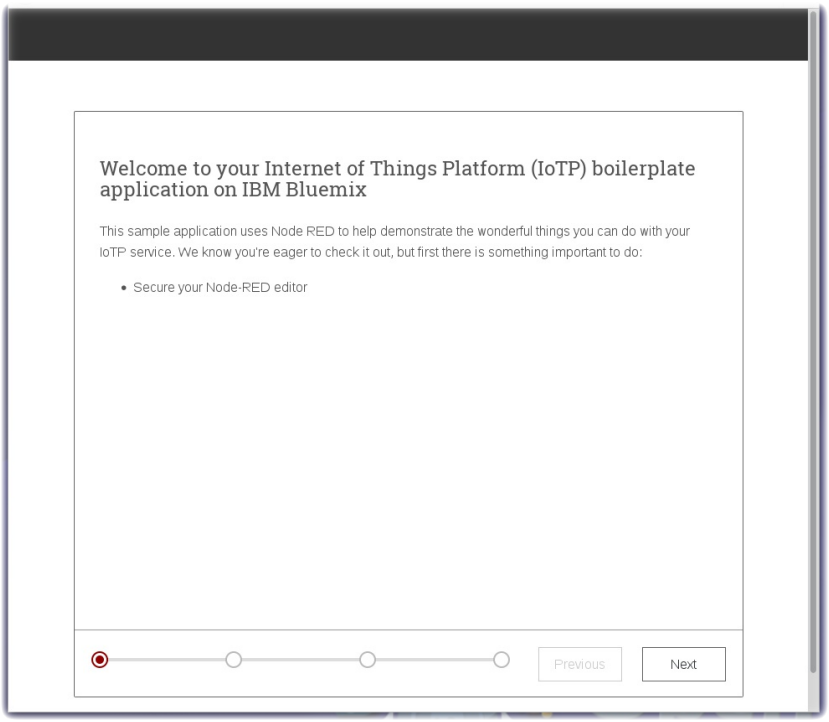


Step 2 - How to secure your Node-RED Editor in IBM Cloud

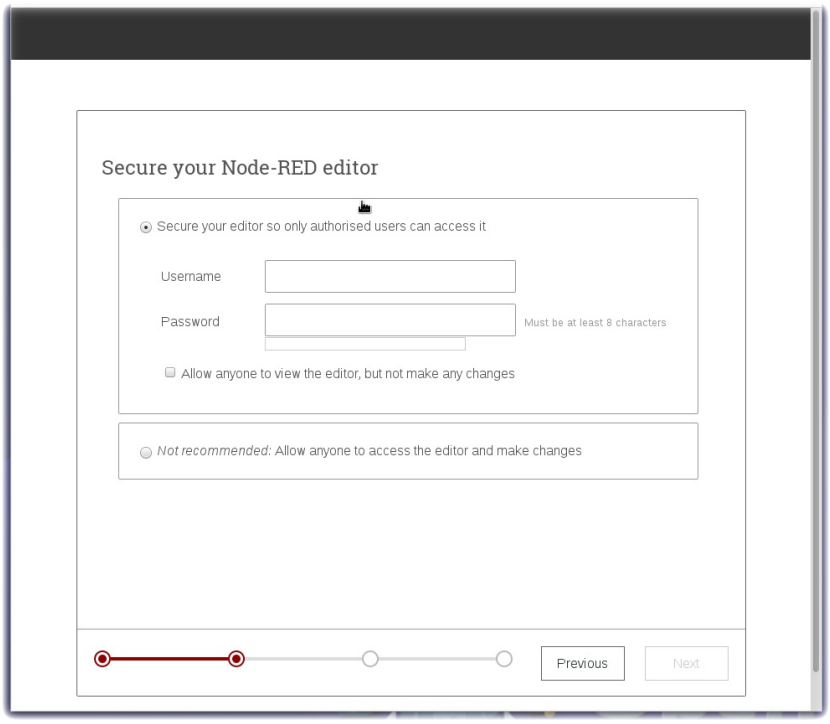
A new browser tab will open to the Node-RED start page. Node-RED is an open-source Node.js application that provides a visual programming editor that makes it easy to wire together flows.

Several panels will help you set up Node-RED in your Watson IoT Starter application.

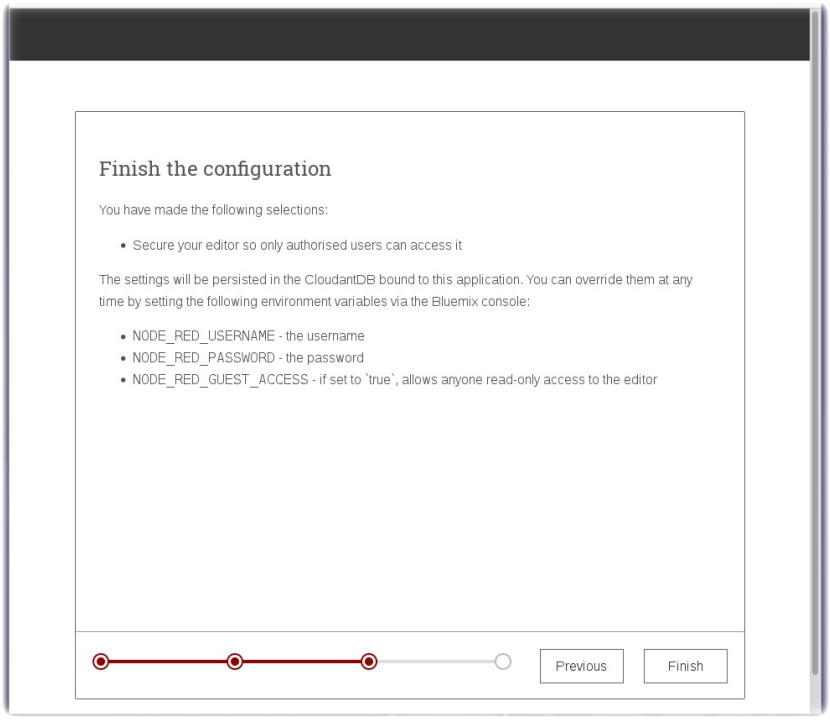
- Welcome to Node-RED and IoT Platform. Click the **Next** button to proceed. Step 1 of 4



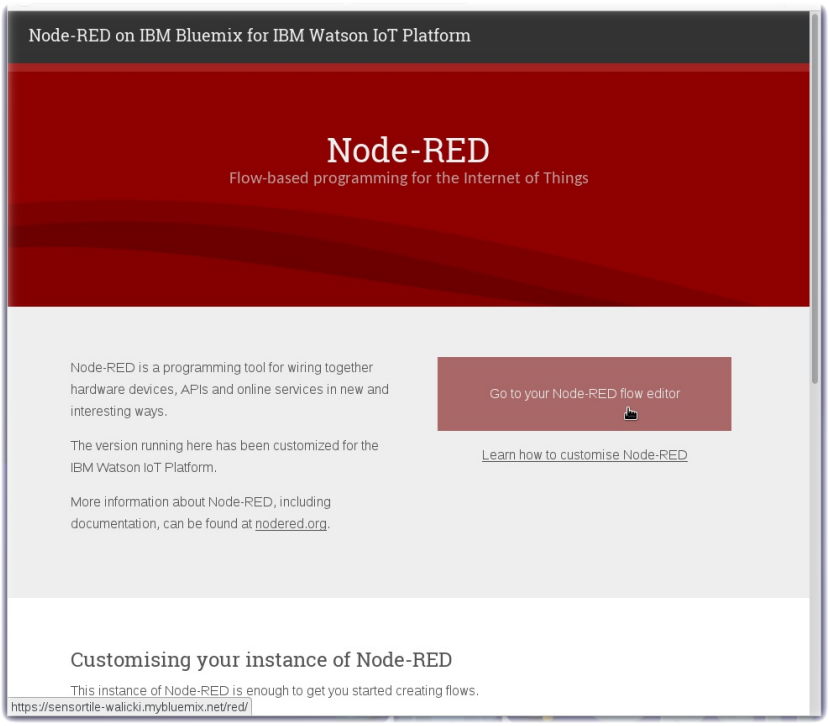
- Secure your Node-RED editor by setting a username / password. Remember your username / password. Click the **Next** button to proceed. Step 2 of 4



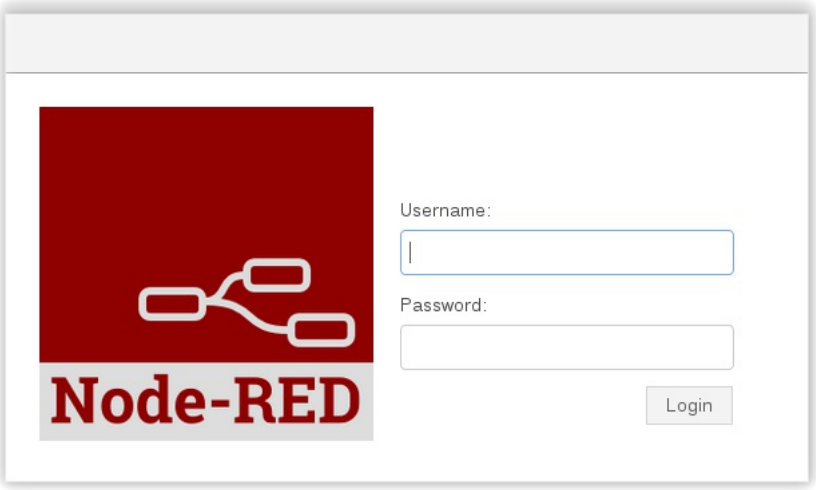
- If you forget, you can reset the username / password in the Cloudant DB or by setting IBM Cloud environment variables. Click the **Finish** button to proceed. Step 3 of 4



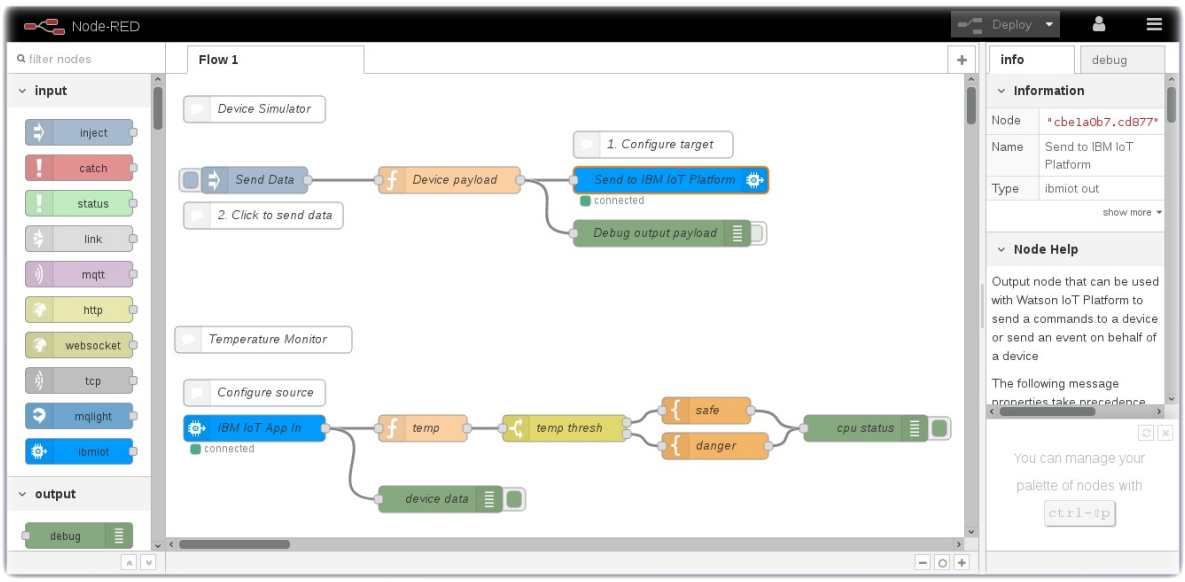
- Click the **Go to your Node-RED flow editor** button to launch the Node-RED flow editor. Step 4 of 4



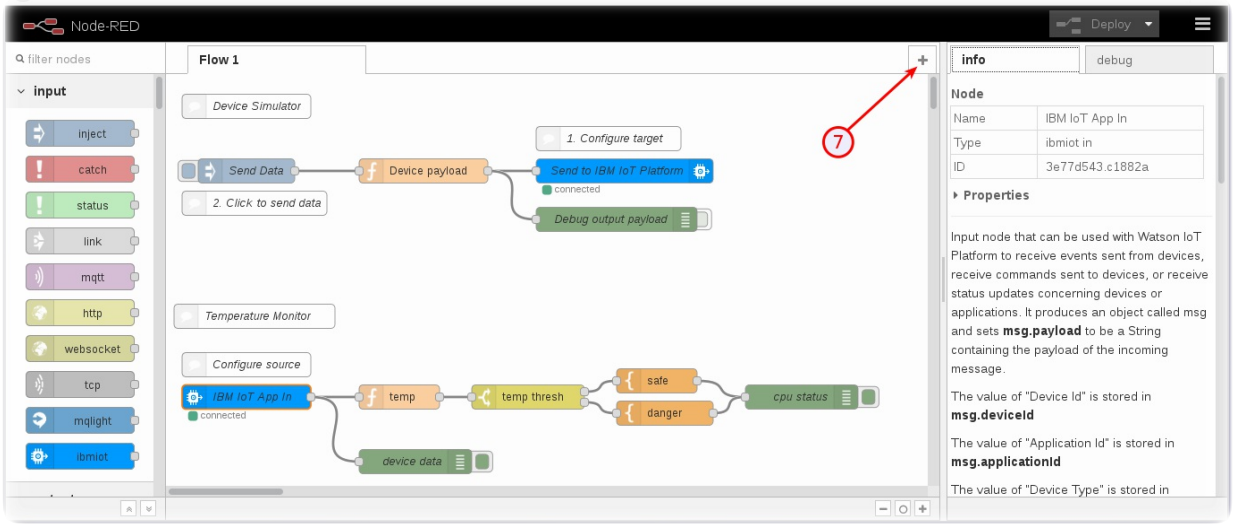
- **Sign in** with your new username and password credentials.



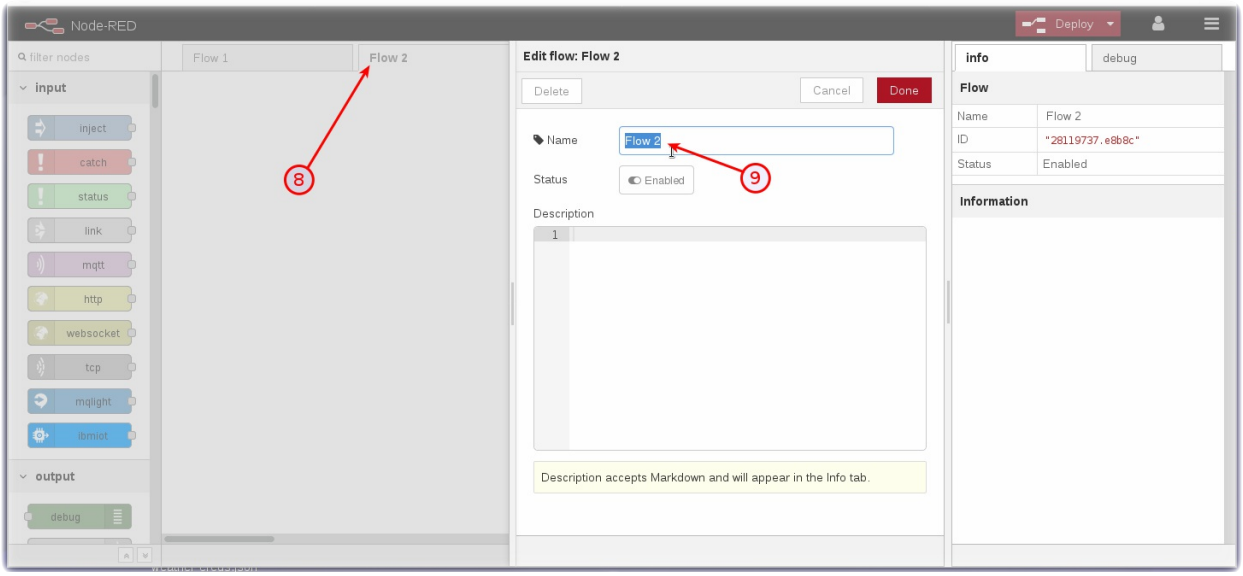
- The **Node-RED Visual Programming Editor** will open with a default flow. On the left side is a **palette of nodes** that you can drag onto the flow. You can **wire nodes together** to create a program.



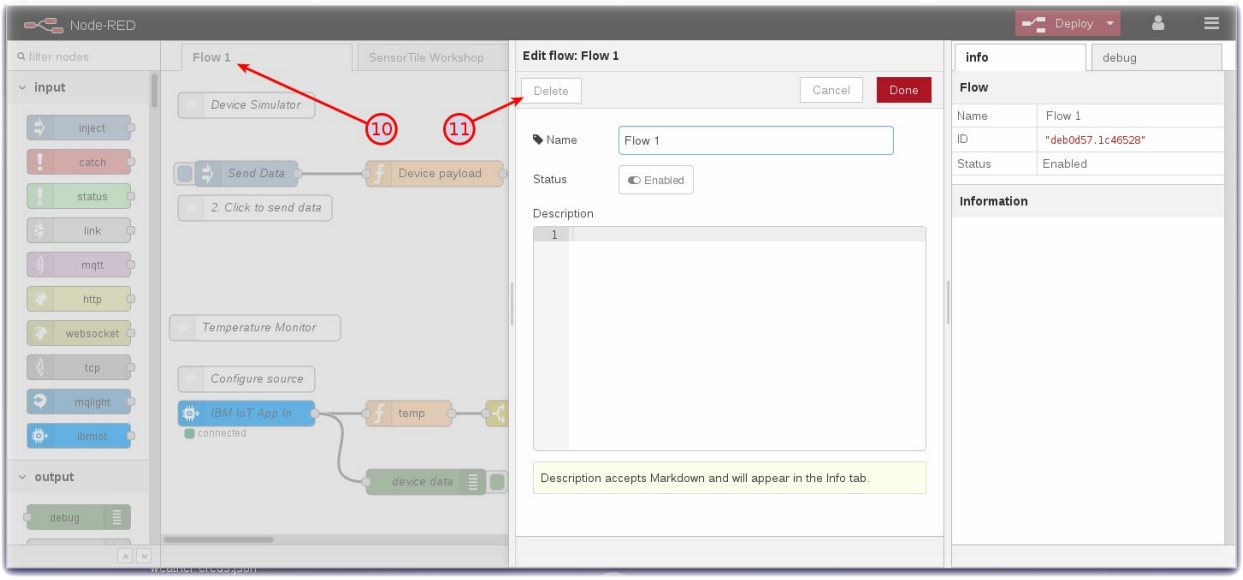
- The **Node-RED Visual Programming Editor** will open with a default flow.
- On the left side is a **palette of nodes** that you can drag onto the flow.
- You can **wire nodes together** to create a program.
- The sample IoT Starter flow is not applicable to this workshop and can be deleted.



- Click the **+** icon (7) to add a new tab. Double Click on the **Flow 2** tab header (8).
- Rename this tab from **Flow 2** to Receive Discovery Kit Data (9)

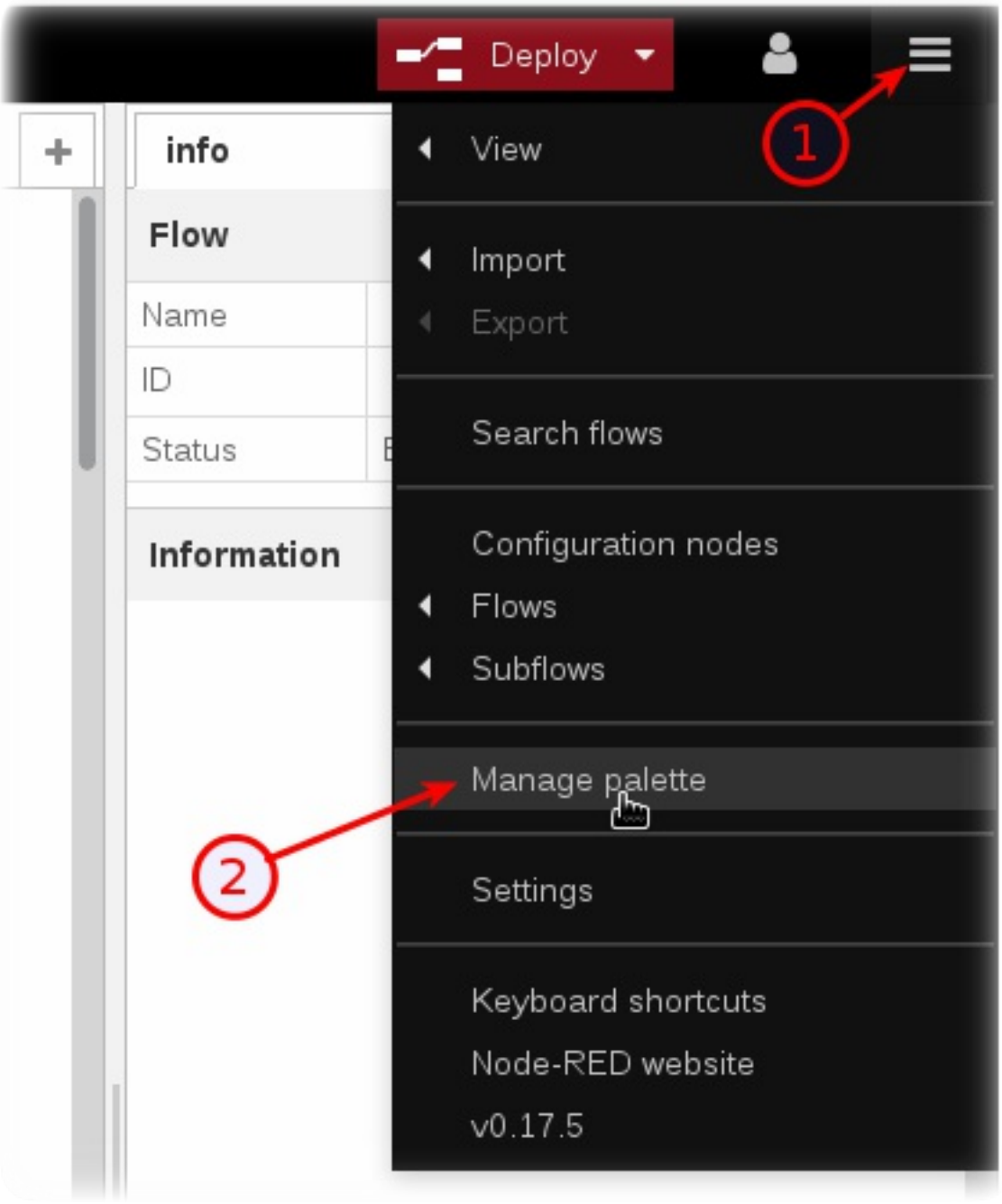


- Double Click on the **Flow 1** tab header (10). Press the **Delete** button. (11)

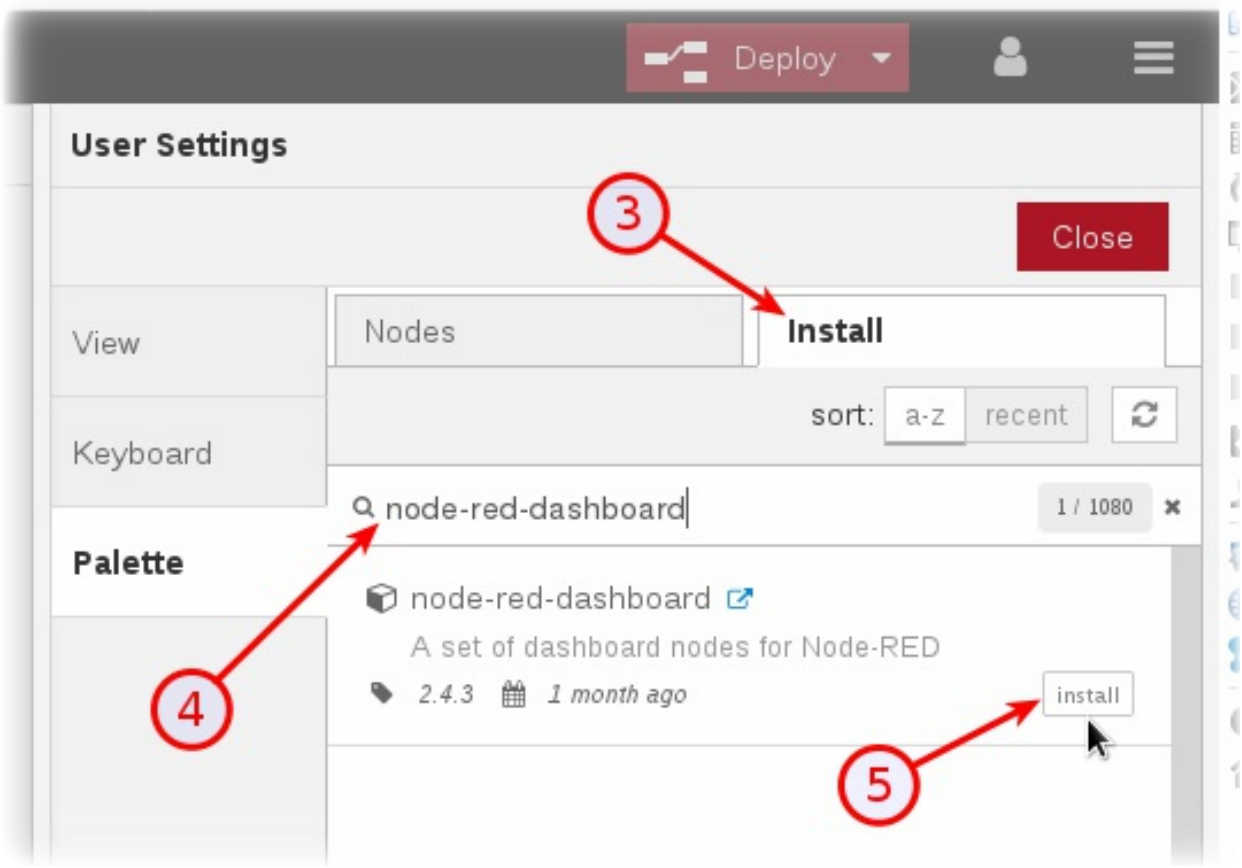


Step 3 - How to install additional Node-RED nodes

- The IoT Starter Application deployed into IBM Cloud includes just a small subset of Node-RED nodes. The Node-RED palette can be extended with over one thousand additional nodes for different devices and functionality. These NPM nodes can be browsed at http://flows.nodered.org
- In this Step, you will add the **Node-RED Dashboard** nodes to your Internet of Things Starter Application.
- Click on the Node-RED **Menu** (1) in the upper right corner, then **Manage palette** (2)



- Turn to the **Install** tab (3), type **node-red-dashboard** (4) and press the **Install** button (5).

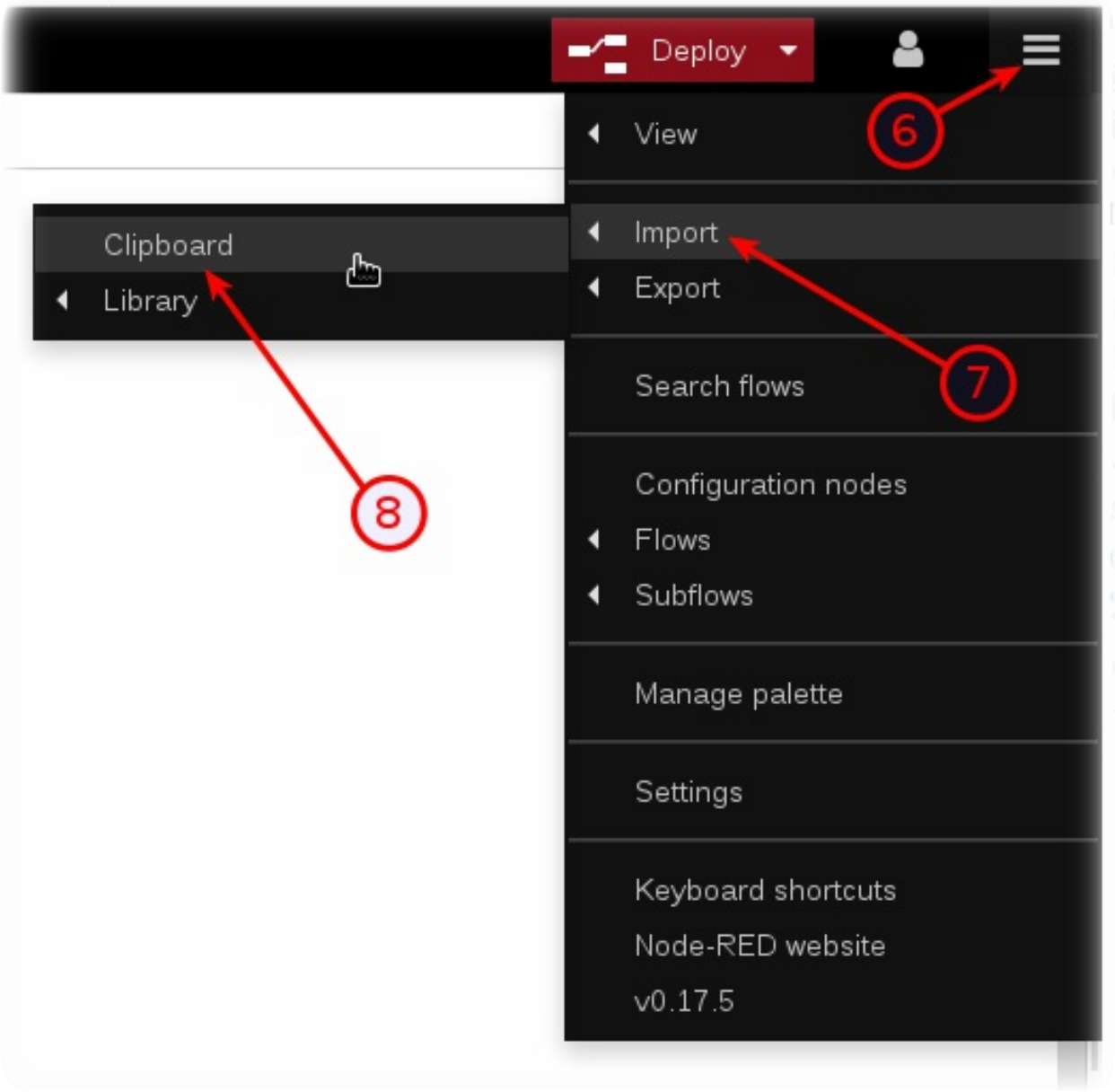


- Press the **Install** button in the next dialog.

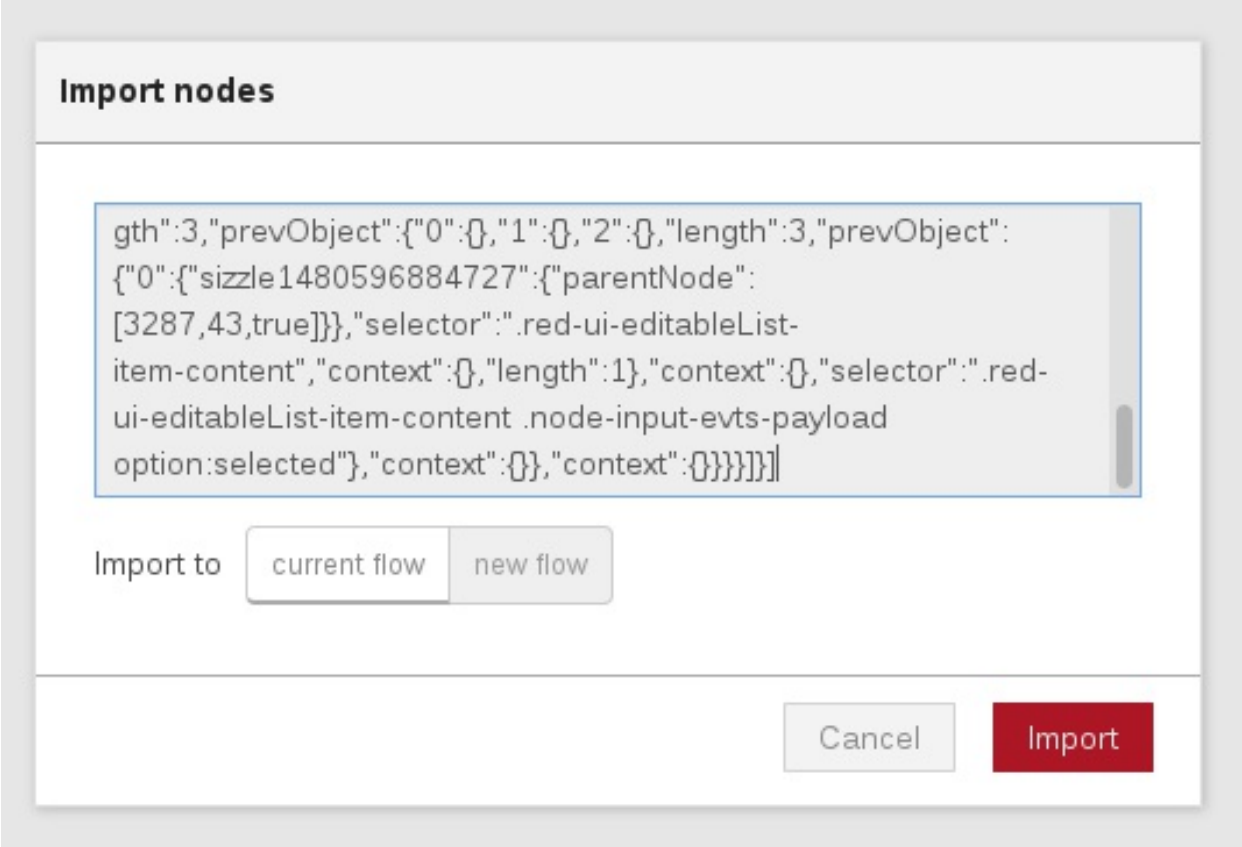
Step 4 - How to import a prebuilt flow from GitHub

In this step, you will **learn** how to Import a prebuilt flow from GitHub

- Since configuring Node-RED nodes and wiring them together requires many steps to document in screenshots, there is an easier way to build a flow by importing a prebuilt flow into your IoT Starter Application.
- Not here in Step 4, but in several sections below, there will be a **Get the Code** link.
- When instructed in those later sections, open the Get the Code github URL, mark or Ctrl-A to select all of the text, and copy the text for the flow to your Clipboard.
- Click on the Node-RED Menu (6), then Import (7), then Clipboard (8).



- Paste the text of the flow into the **Import nodes** dialog and press the red **Import** button. This is an example of how to paste flows into your Node-RED editor. Don't type the text in the screenshot!



- The new flow will be imported into a new tab in the Node-RED Editor.
- Click the **Deploy** button on the top of menu bar to deploy the Node-RED flow.

Congratulations - Node-RED is configured

Continue to the next step - Sensor Data

Quick links :
Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

---

Receive Device Environmental Sensor Data in Node-RED

Lab Objectives

In this lab you will build a flow that receives Device environmental temperature and humidity sensor data. You will learn:

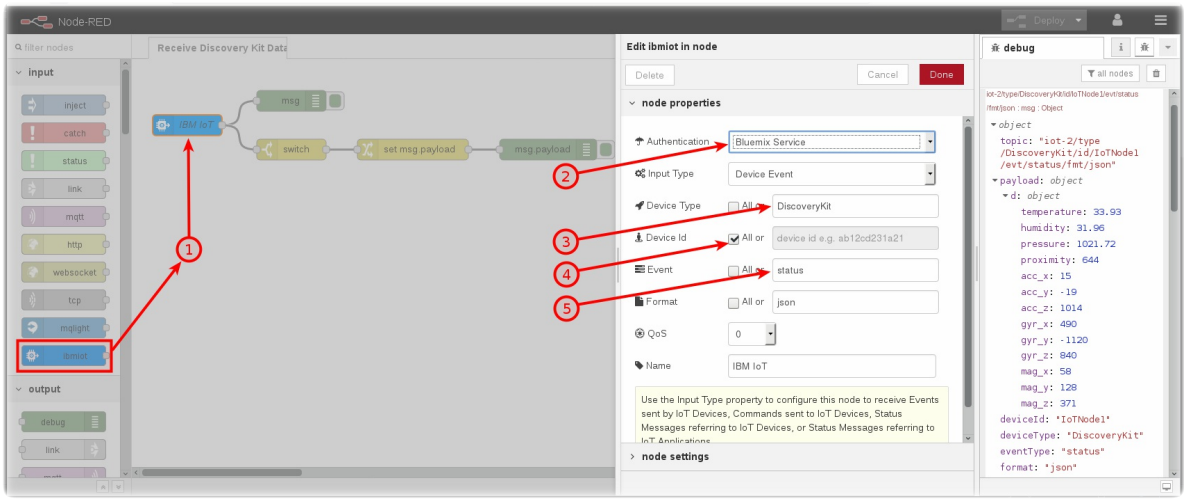
- How to create a new Node-RED flow and configure IoT Nodes
- How to output the Device environmental temperature and humidity data.
- How to work with JSON data and observe the sensor results in the Debug sidebar.

Introduction

In just a few nodes, Node-RED can receive the data that was transmitted from the device over MQTT to Watson IoT Platform. This simple exercise will be the foundation for the next several sections that plot the data in a dashboard, trigger Real Time threshold alerts, store the data in Cloud Storage and allow for data analytics and anomaly detection.

Step 1 - Configure an IoT in Node

- From the Input category of the left Node-RED palette, select an **ibmiot node** and drag it onto your Node-RED flow (1).
- Double-click on the IBM IoT node. An **Edit ibmiot in node** sidebar will open.
- Configure the Authentication dropdown to **Bluemix Service** (2).
- Uncheck All and set the Device Type to **DiscoveryKit** (3).
- Check All Device Ids (4)
- Uncheck All and set the Event to **status** (5).
- Click on the red **Done** button.

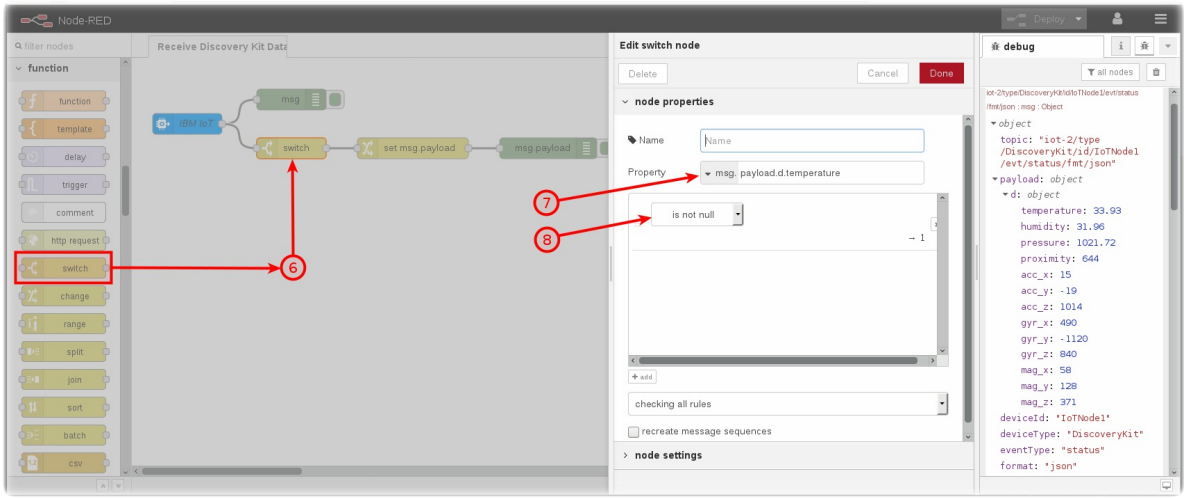


Step 2 - Extract the Temperature from the JSON Object

- Recall that the environmental sensor data was transmitted in a JSON object

```
{ "d": {"temperature":T,"humidity":H,"pressure":B,"proximity":D,"acc_x":X,"acc_y":Y,"a
```

- Node-RED passes data from node to node in a *msg.payload* JSON object.
- The **Switch** node can be used to test if the msg.payload.d.temperature is not null.
- From the Function category of the left Node-RED palette, select a **Switch** node and drag it onto your Node-RED flow (6).
- Double-click on the Switch node. An **Edit switch node** sidebar will open.
- Set the "Property" field to *payload.d.temperature* (7).
- From the dropdown, select **is not null** (8)
- Click on the red **Done** button.



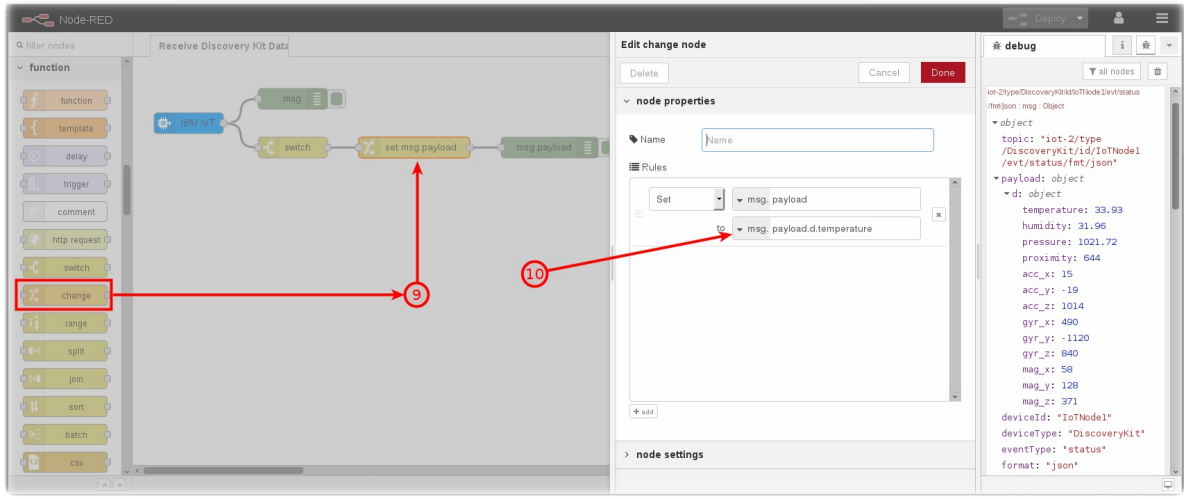
- The **Change** node can be used to extract a particular value so that it can be directly output or manipulated (for instance in a Dashboard chart which we will take advantage of in the next section).

- From the Function category of the left Node-RED palette, select a **Change** node and drag it onto your Node-RED flow (9).

- Double-click on the Change node. An **Edit change node** sidebar will open.

- Configure the "to" AZ dropdown to msg. and set it to *payload.d.temperature* (10).

- Click on the red **Done** button.

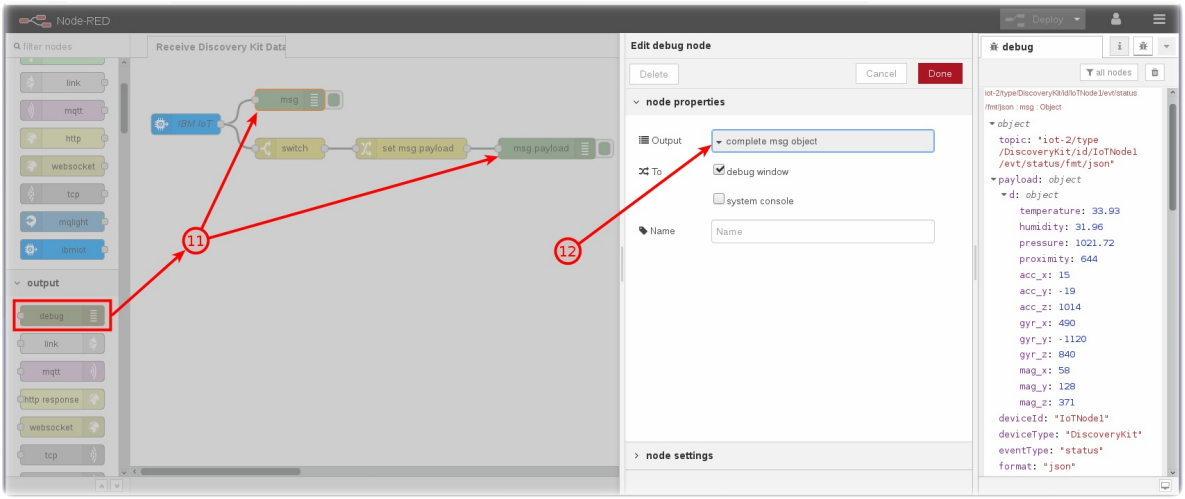


Step 3 - Node-RED Debug Nodes

- Debug nodes can be used to print out JSON object values and help you validate your program.
- From the Output category of the left Node-RED palette, drag two **debug nodes** onto your

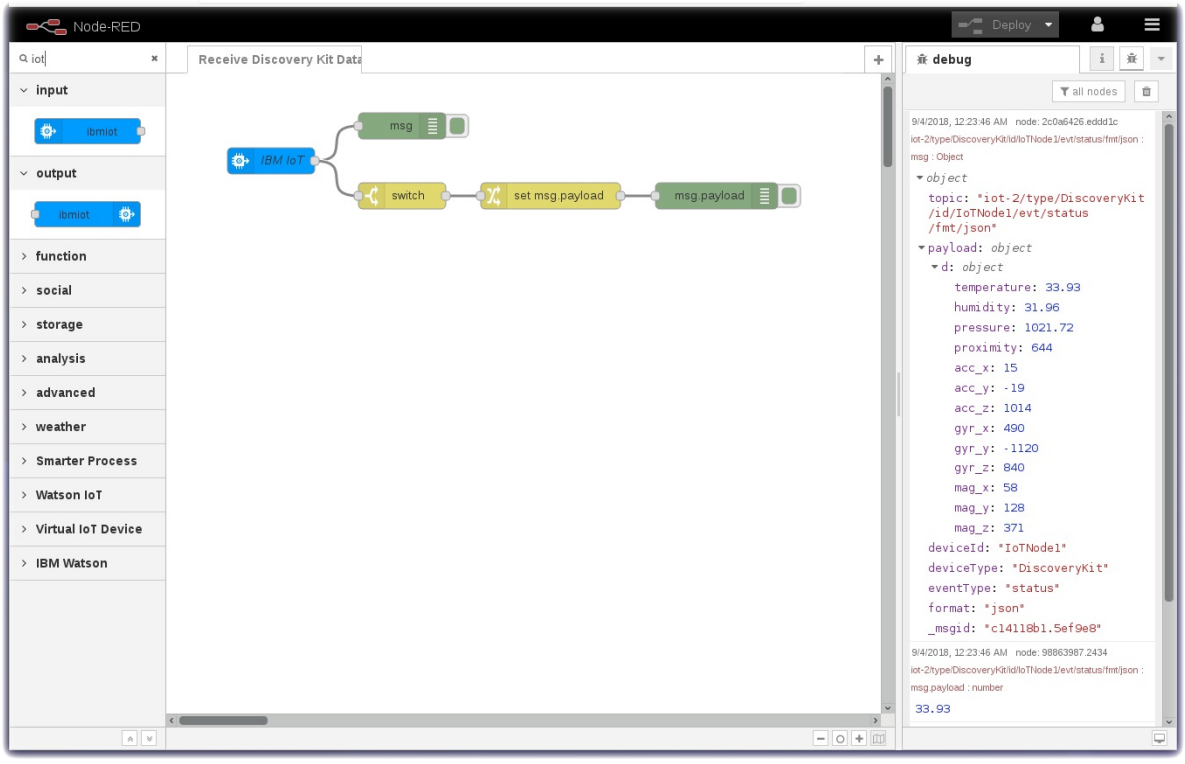
Node-RED flow (11).

- Double-click on one of them. An **Edit debug node** sidebar will open.
- Configure the Output to print the *complete msg object* (12).
- Click on the red **Done** button.



Step 4 - Wire the Node-RED nodes together

- Wire the Node-RED nodes together by click / dragging your mouse from nodelet to nodelet as show in the screenshot.
- Click on the red **Deploy** button in the upper right corner.
- Observe the DiscoveryKit IoT Node sensor data in the **debug** tab of the Node-RED right sidebar. You can expand the twisties to expose the JSON object information. Hover over a debug message in the right sidebar and the node that generated the message will be outlined in orange.



Congratulations - Your Node-RED flow is receiving sensor data from the Discovery Kit board.

Continue to the next step - Node-RED Charts

Quick links :
Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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Node-RED Dashboard Charts - Plot Environmental Sensor Data

Lab Objectives

In this lab you will import Node-RED flows which create Dashboard Charts. After learning about Node-RED Dashboard Charts, you will be able to display temperature and humidity graphs of the Device environmental sensors. You will learn:

- How to create a Node-RED Dashboard
- Experiment with Chart types
- Plot Real Time sensor data
- Trigger alerts when the real-time sensor data exceeds a threshold value

Introduction

In this section you will learn about Node-RED Dashboard Charts and then create a chart to graph the sensor data arriving from the device.

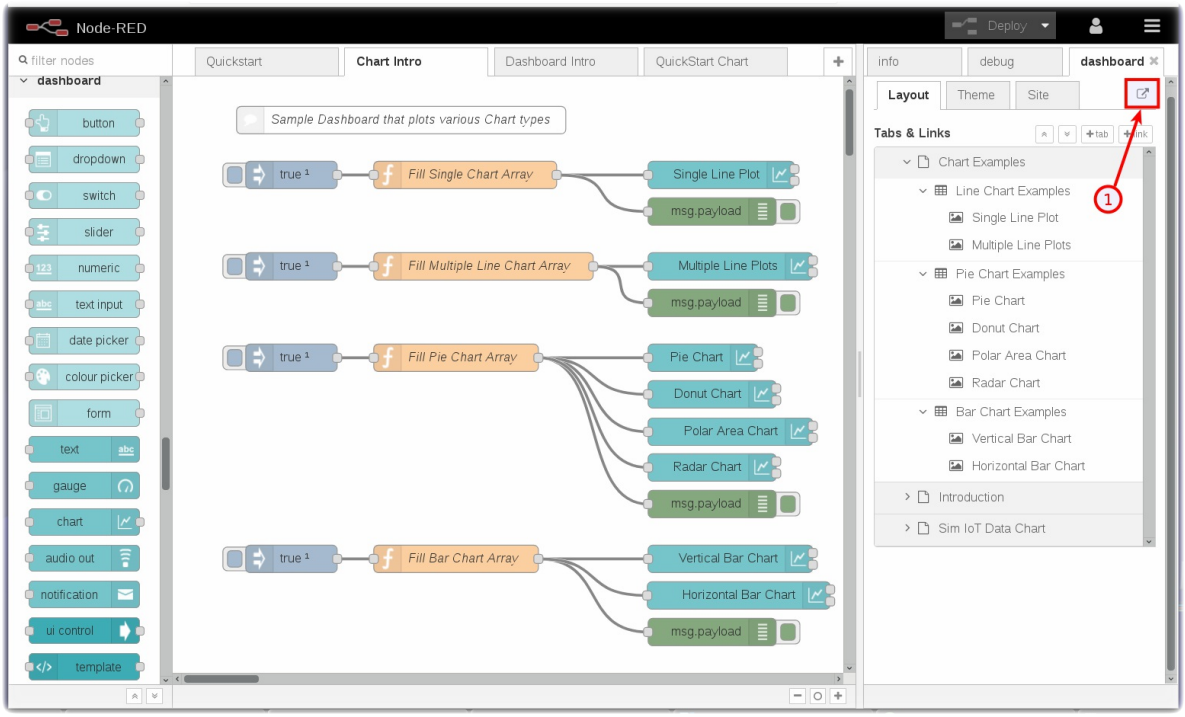
Step 1 - Import the Node-RED Dashboard Chart Flows

Open the “Get the Code” github URL listed below, mark or Ctrl-A to select all of the text, and copy the text for the flow to your Clipboard. Recall from a previous section, click on the Node-RED Menu, then Import, then Clipboard. Paste the text of the flow into the Import nodes dialog and press the red Import button. Finally, click on the red **Deploy** button in the upper right corner.

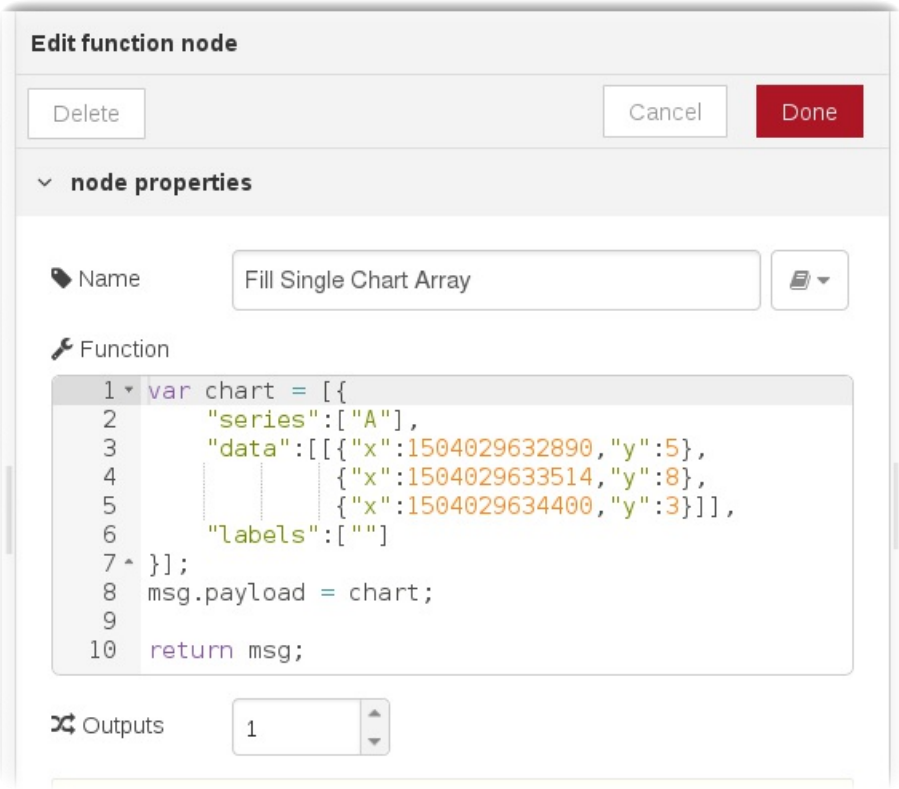
Get the Code: Node-RED Dashboard Charts

Step 2 - Learn about various Node-RED Dashboard Chart types

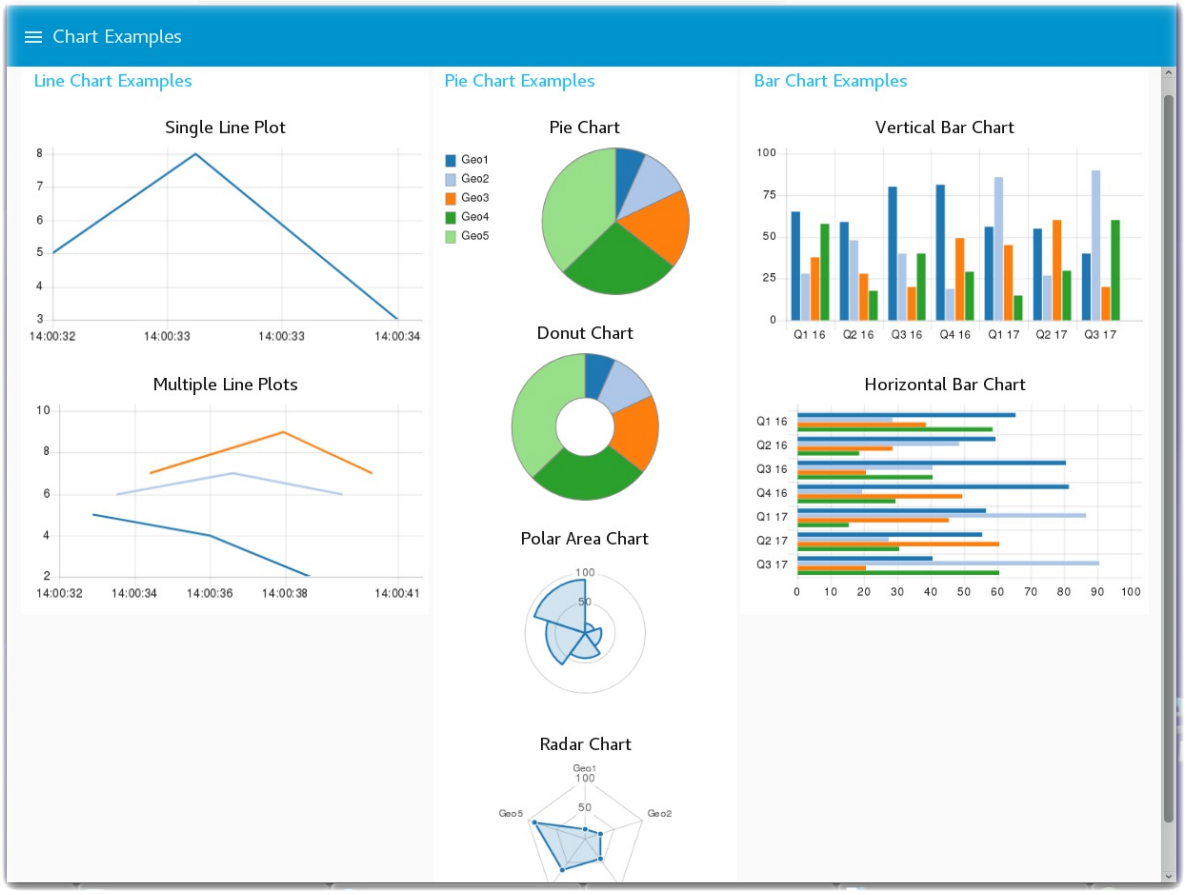
- You might have noticed that the flow import in the prior step actually created three tabs. These are called Node-RED flows.
- The **Chart Intro** flow introduces you to the various Node-RED Dashboard Chart types that are available. You can create Line charts, various Pie chart styles – Pie, Donut, Polar Area, Radar - and vertical and horizontal Bar charts.



- For illustration, the **Fill Single Chart Array** function node above fills an array of static sample data and sends the data to the **Chart** node to visualize.

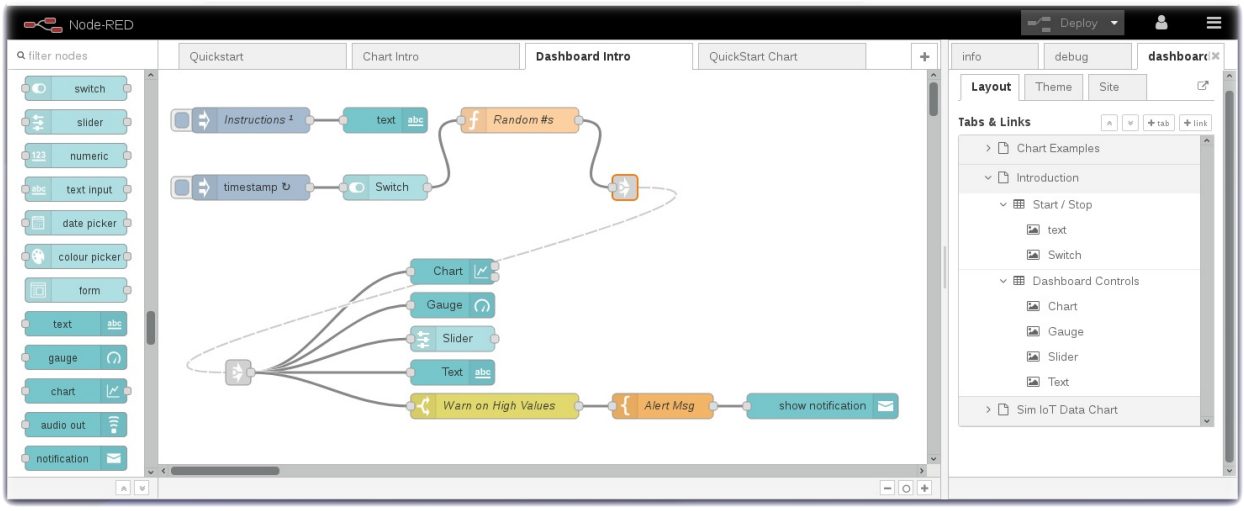


- The Node-RED flow is not nearly as interesting as the charts that it renders. To launch the Node-RED Dashboard, in the Node-RED sidebar, turn to the **dashboard** tab and click on the **Launch** button (1) [See two pictures above].

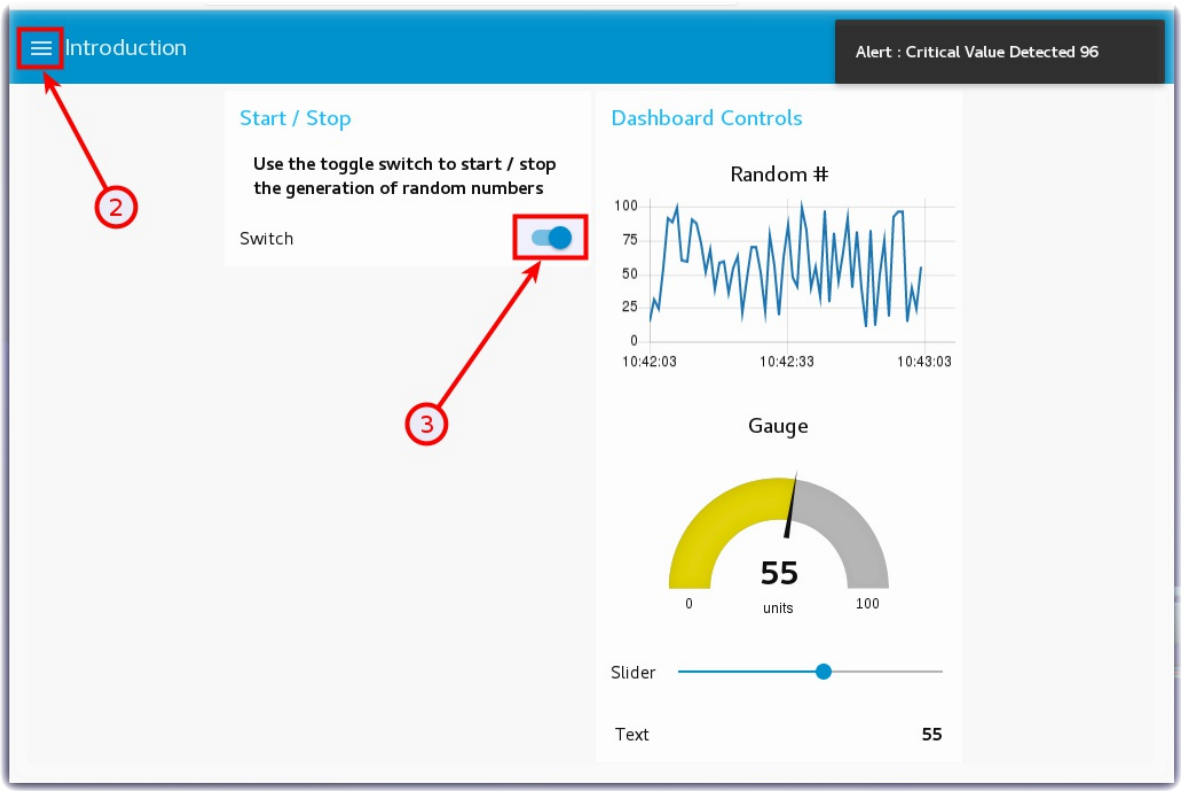


Step 3 – Generating and Displaying data in Node-RED Dashboards

The next Node-RED flow - **Dashboard Intro** - uses a variety of UI widgets to display data in the Node-RED Dashboard. There is a Switch node that turns On/Off a random number generator function node. The simple random numbers are sent to a line Chart node, a Gauge node, a Slider node, a Text node and, if the number exceeds a threshold, will display an alert notification message.



- Turn to the Node-RED Dashboard browser tab that you launched in Step 2, click on the menu tab (2) in the upper left corner, and select the Introduction tab.
- On the Introduction dashboard, turn on the **Switch** (3) to start the data visualization.
- Experiment with / observe the Dashboard controls.



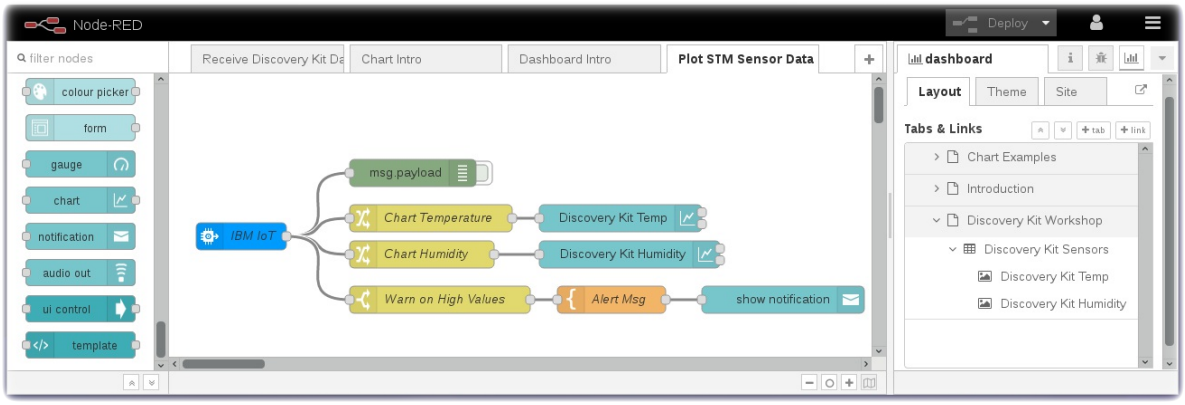
Step 4 - Plot Device Environmental Sensor Data

Now that you have learned about Node-RED Dashboard and Chart types, you are ready to plot the real-time device environmental sensor data.

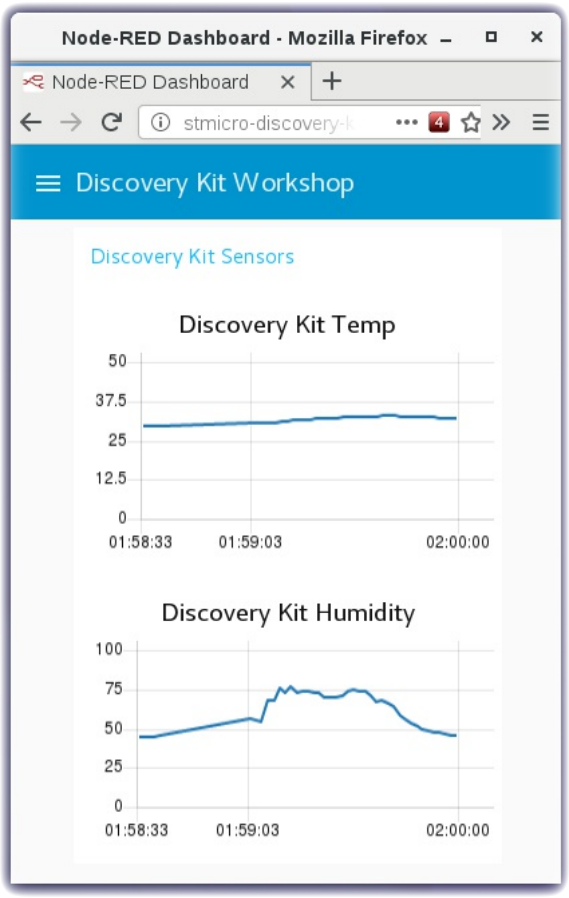
- Turn to the next flow - **Plot STM Sensor Data**
- The **IBM IoT** node is already configured to receive *status* Device Events from the

DiscoveryKit Device Type.

- The **Change** nodes extract the `msg.payload.d.temperature` and `msg.payload.d.humidity` values from the JSON object sent over MQTT from the device environmental sensor to Watson IoT Platform.
- The environmental sensor values are sent to two charts to plot Temperature and Humidity.



- Turn to the Node-RED Dashboard browser tab that you launched in Step 2, click on the tab in the upper left corner, and select the **Discovery Kit Workshop** tab.

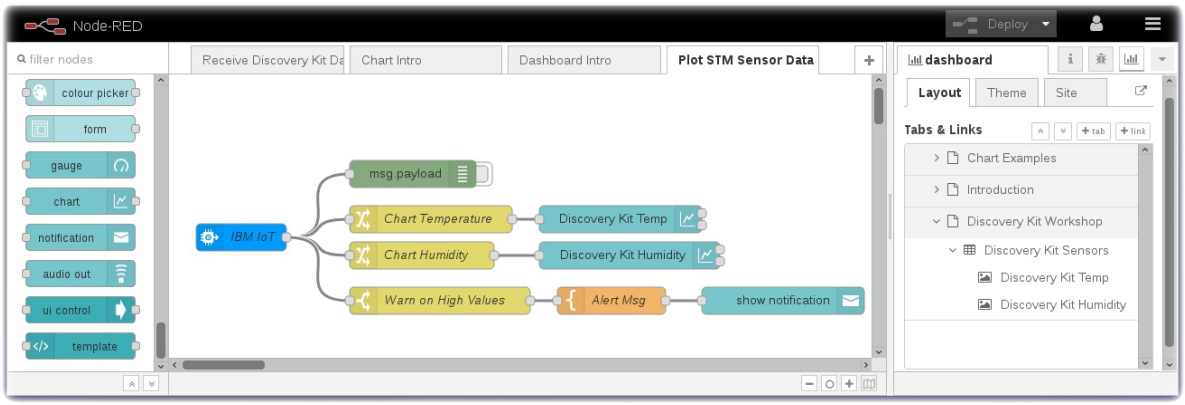


Step 5 - Trigger Alerts when Real-Time Sensor Data Exceeds a Threshold Value

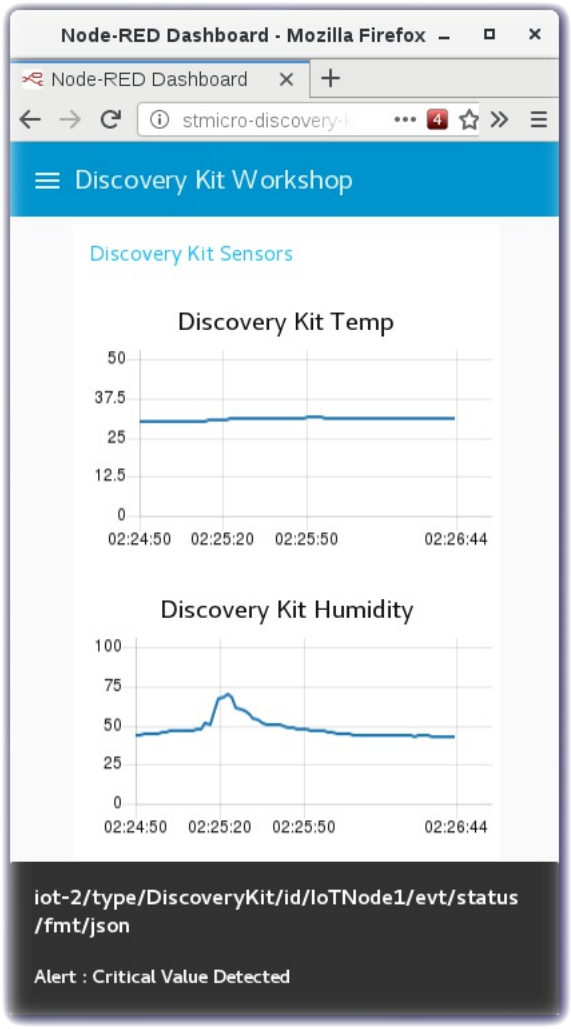
Often IoT devices and sensors are deployed so that alerts can be triggered when the real time

sensor data exceeds a threshold value. In this last Step, the flow checks the temperature values and, if the temperature exceeds the threshold, triggers a Node-RED Dashboard notification.

- In the prior step, the flow included three nodes that have not yet been discussed.
- A **Switch** node is configured to *Warn on High Values* by testing if `msg.payload.d.temperature` is greater than 30C.
- A **Template** node is configured to construct a sentence `Alert : Critical Value Detected {{payload.d.temperature}}`
- The Alert message is sent to a **Node-RED Dashboard Notification** node to display in the browser.
- This flow could be extended to call a **Twilio** node to send a SMS message. It could raise an alarm in another system by triggering a REST API call to the manufacturing production operations systems.



- Return to the Node-RED Dashboard **Discovery Kit Workshop** tab and increase the temperature of your Discovery Kit sensor above 30C.



Quick links :

Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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Store Data in Cloud Storage for Historical Data Analytics

Lab Objectives

In this lab you will store the device environmental sensor data in a Cloudant database in IBM Cloud. You will learn:

- How to create a Node-RED flow that uses the Cloudant node
- How to format a time series database record
- How to view Cloudant databases

Introduction

While real-time charts of sensor data and threshold alerts are useful, the power of IoT becomes significant when data analytics techniques, Machine Learning and AI are applied to the IoT historical datasets. The first and necessary step toward data analytics is storing the incoming data in a Cloud data storage database for later statistical modelling.

Step 1 - Import the Node-RED Cloudant Storage Flow

Open the “Get the Code” github URL listed below, mark or Ctrl-A to select all of the text, and copy the text for the flow to your Clipboard. Recall from a previous section, click on the Node-RED Menu, then Import, then Clipboard. Paste the text of the flow into the Import nodes dialog and press the red Import button.

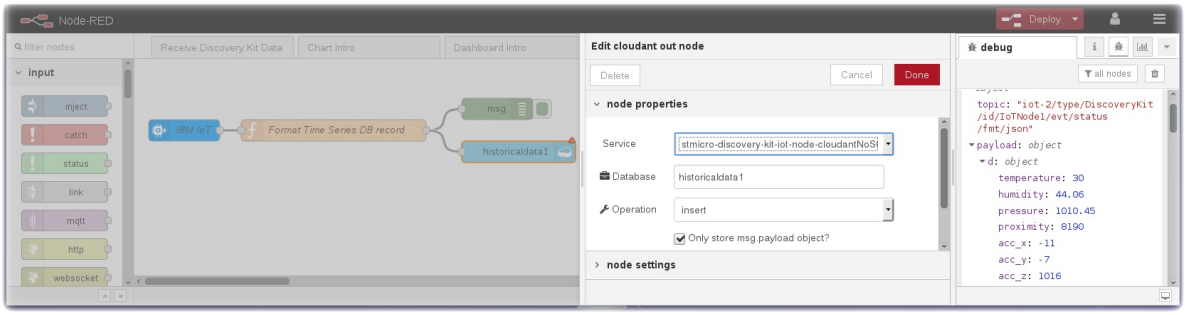
Get the Code: Node-RED Cloud Storage Flow

Step 2 - Store IoT Sensor Data with Node-RED

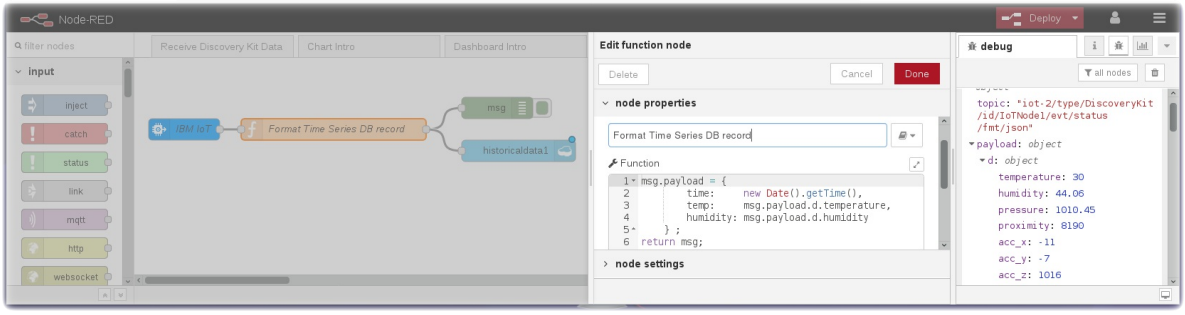
In this Step you will use Node-RED to store IoT Sensor data from the ST Microelectronics Discovery Kit IoT Node environmental sensors in a Cloudant database.

- When the flow is imported there will be a misconfigured Cloudant node – indicated by a red triangle.

- To associate the **Cloudant** database node with your IBM Cloud instance, click on the historical data Cloudant node and press the red Done button. The red error triangle will turn blue.



- The *Format Time Series DB Record* function node recasts the Discovery Kit JSON object. As required by any time series dataset, the Node-RED function node adds a timestamp to the record before writing it to the Cloudant storage. Note in the screenshot, the debug sidebar shows a `msg.payload` that includes the Epoch timestamp (milliseconds since Jan 1 1970)

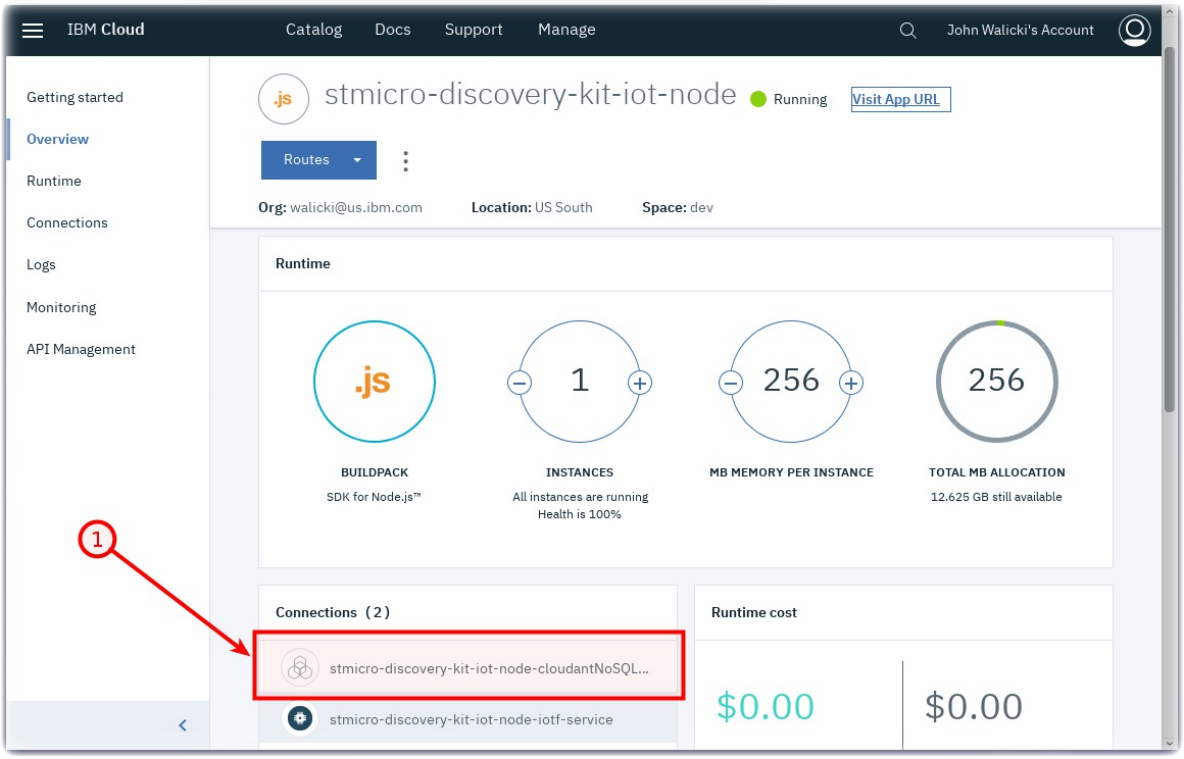


- Click the **Deploy** button on the top of menu bar to deploy the Node-RED flow.

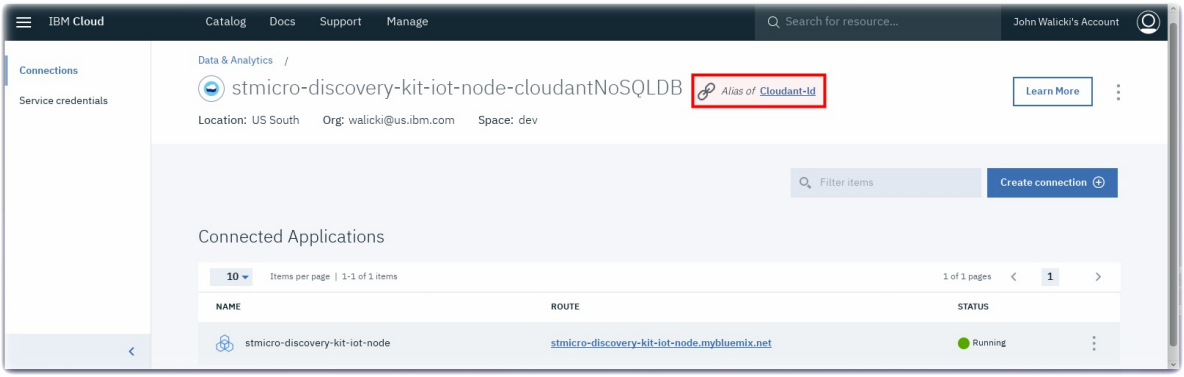
- The device environmental sensor data is now being recorded in a Cloudant database.

Step 3 - Observe Sensor Data being added to the Cloudant database

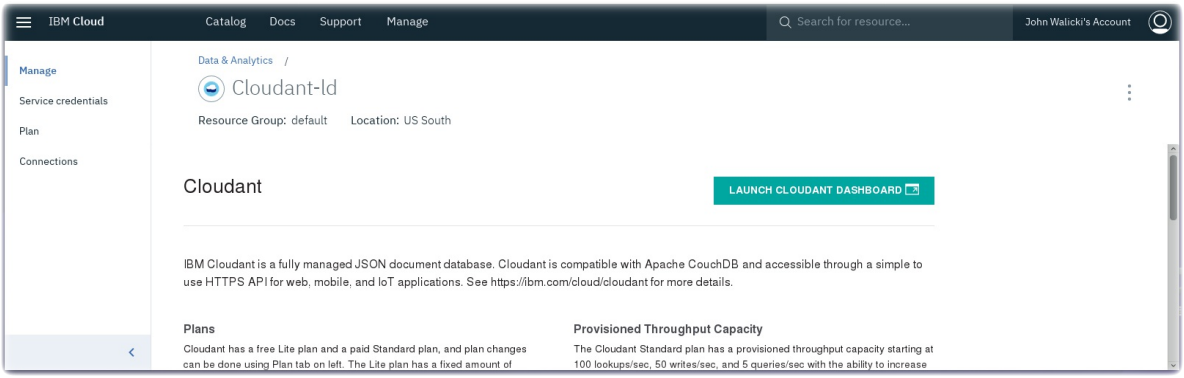
- Return to the IBM Cloud dashboard and your IoT Starter application. **Click** on the cloudantNoSQLDB (1) service connection.



- Click on the *Alias of Cloudant-NNN* link

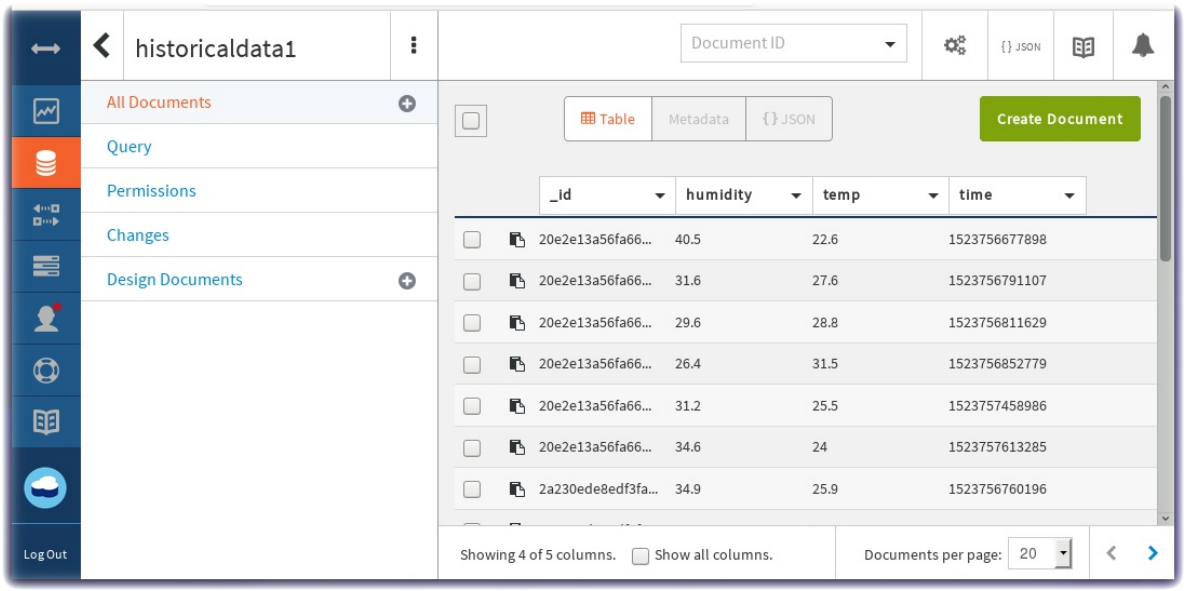


- Read about the Cloudant Storage service and press the **Launch** button.



- The IoT Sensor device data is stored in the Cloudant service.

- Click on historicaldata1 and then observe the **table** view of temperature, humidity and timestamp data.



Quick links :

Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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Node-RED Charts of Historical Sensor Data

Lab Objectives

In this lab you will read the historical sensor data from a Cloud storage database and create a graph of prior readings. You will learn:

- How to read datasets from a Cloudant database
- How to create a chart of historical data

Introduction

The previous section stored the Device environment sensor data into a Cloudant DB. This section will read the historical sensor data from a Cloud storage database and create a graph of prior readings.

Step 1 - Import the Node-RED Historian Chart Flow

- Open the “Get the Code” github URL listed below, mark or Ctrl-A to select all of the text, and copy the text for the flow to your Clipboard. Recall from a previous section, click on the Node-RED Menu, then Import, then Clipboard. Paste the text of the flow into the Import nodes dialog and press the red Import button.

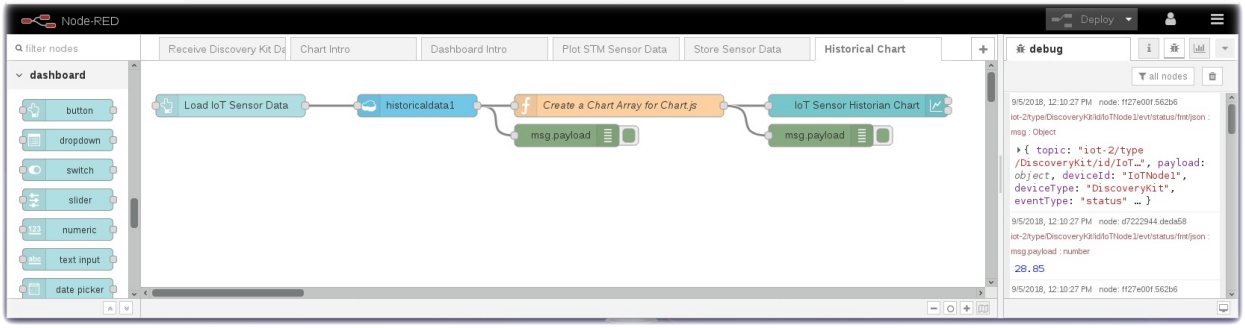
Get the Code: Node-RED Historian Chart Flow

- Click on the **Cloudant** node on the Historical Chart flow to confirm that it is configured to your IoT Platform Cloudant service instance.
- Click the **Deploy** button on the top of menu bar to deploy the Node-RED flow.

Step 2 - Graph Historical IoT Sensor data stored in a

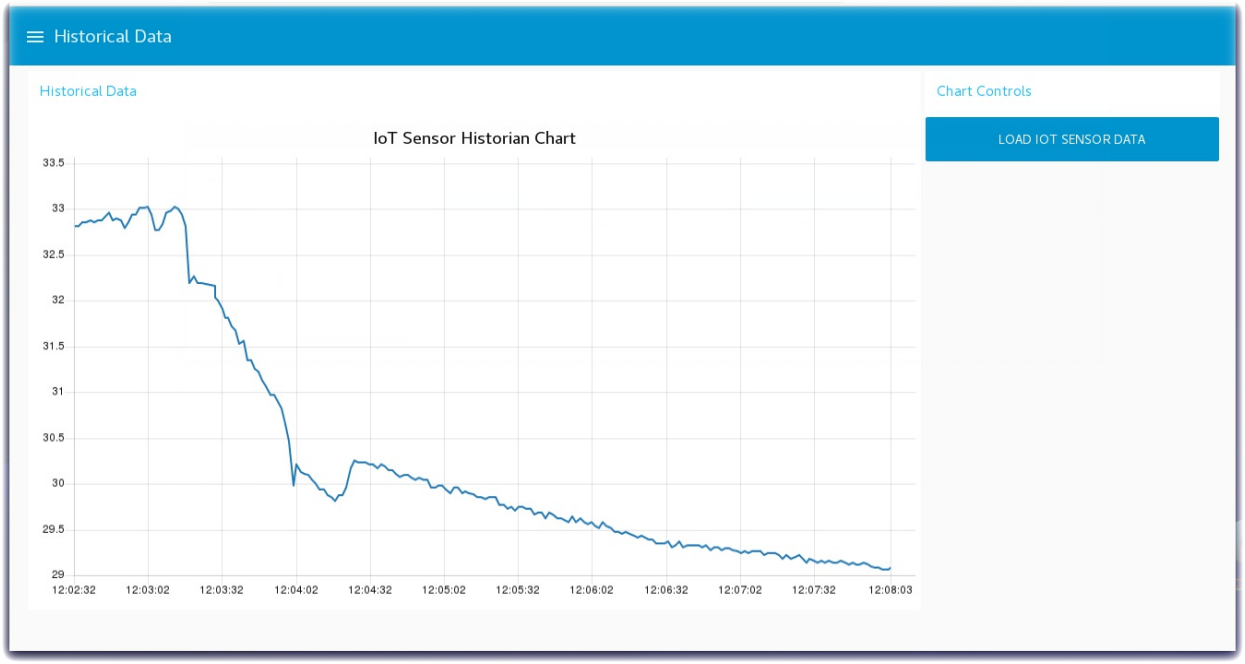
database using Node-RED

- The Historical Chart flow reads the IoT Sensor Device data from the Cloudant database and formats it into a Chart array before sending the data to a Node-RED Chart node.



Step 3 - Historian Charts of Device Environmental Sensor data

- Turn to the Node-RED Dashboard browser tab, click on the menu tab in the upper left corner, and select the Historical Data tab.
- On the Historical Data dashboard, click on the **LOAD DISCOVERY KIT DATA** button to start the data visualization.
- The button will trigger the read of the historian DB records created in the previous section.
- In the *Create a Chart Array for Chart.js* function node the time series temperature data from the Device Environmental sensor is formatted into a Chart Array and sorted chronologically.
- The Chart Array is passed to the Node-RED Chart node to render the graph.



Watson Studio Set up and Configuration in IBM Cloud

Lab Objectives

In this lab you will set up Watson Studio with a new Project. You will learn:

- Watson Studio
- How to set up a new Watson Studio Project
- How to create a Jupyter Notebook

Introduction

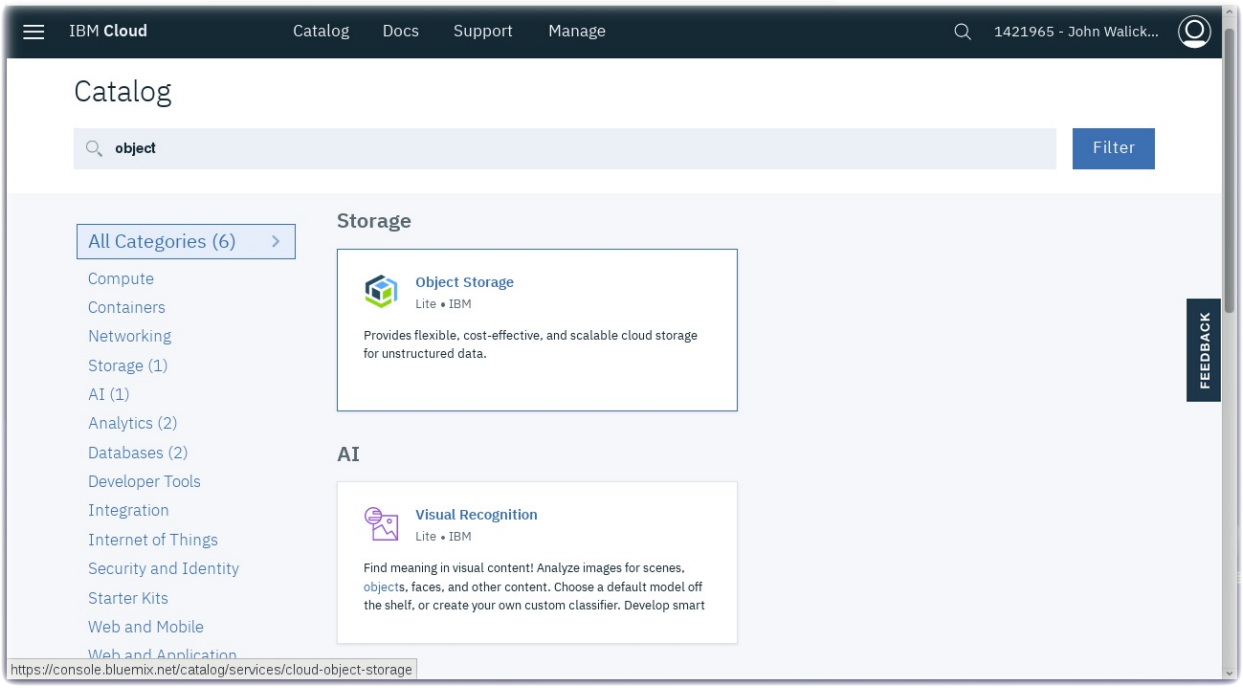
Watson Studio accelerates the machine and deep learning workflows required to infuse AI into your business to drive innovation. It provides a suite of tools for data scientists, application developers and subject matter experts, allowing them to collaboratively connect to data, wrangle that data and use it to build, train and deploy models at scale. Successful AI projects require a combination of algorithms + data + team, and a very powerful compute infrastructure.

- Learn more from the Experts - Introducing IBM Watson Studio

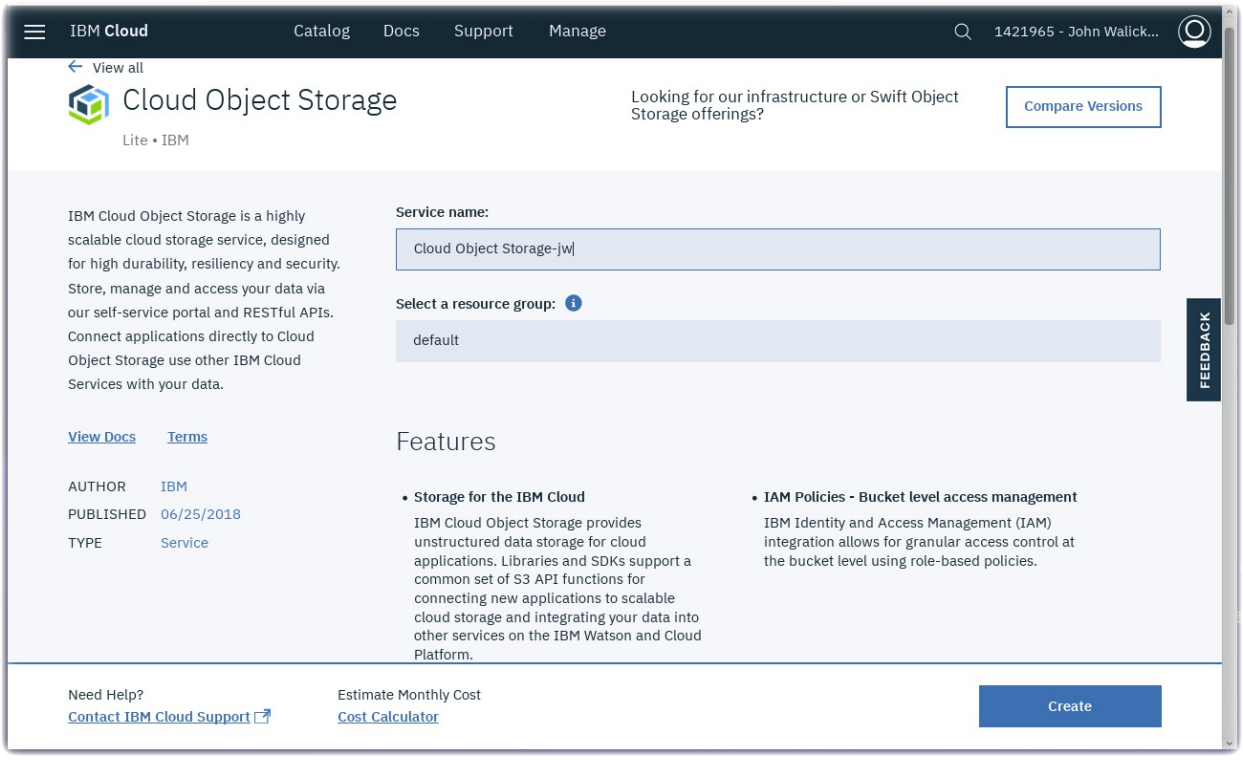
Step 1 - Watson Studio Setup

Create Cloud Object Storage

- Create a Cloud Object Storage instance by visiting the IBM Cloud Catalog
- Search on **Object** in the IBM Cloud Catalog
- Click on the **Object Storage** service tile

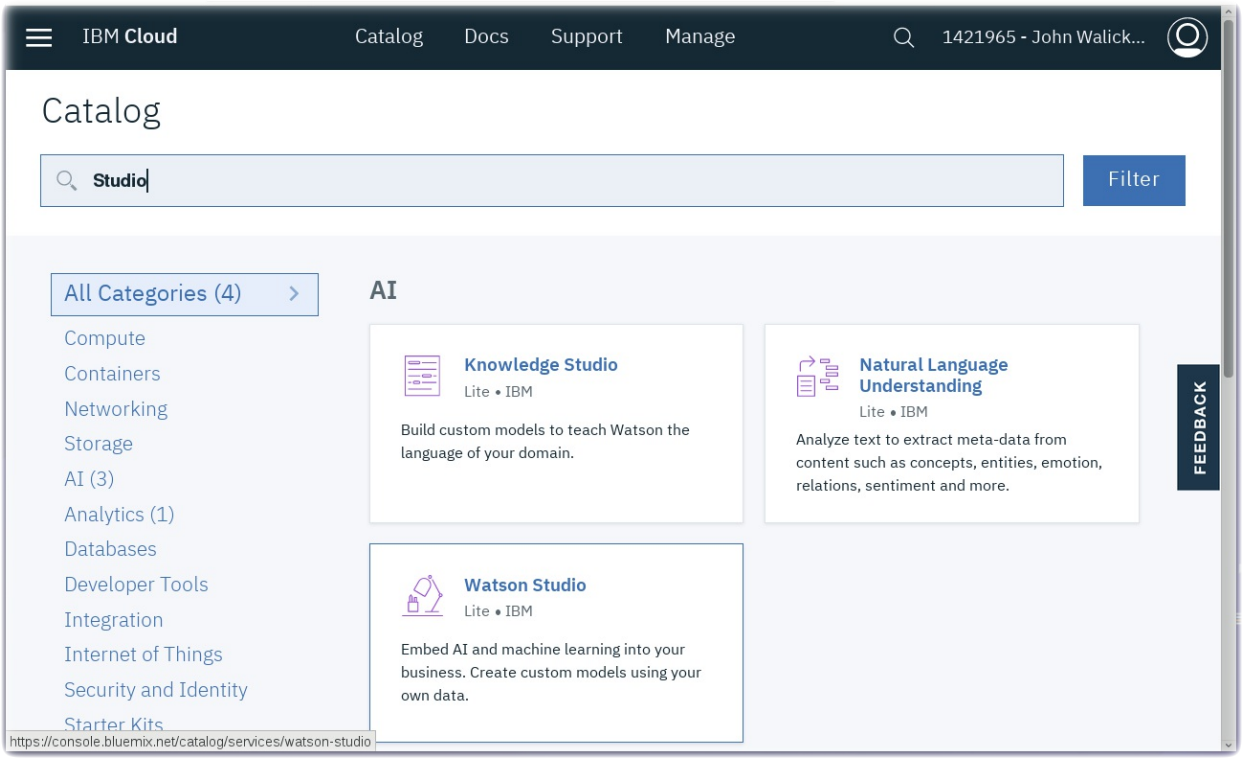


- Click on the **Create** button

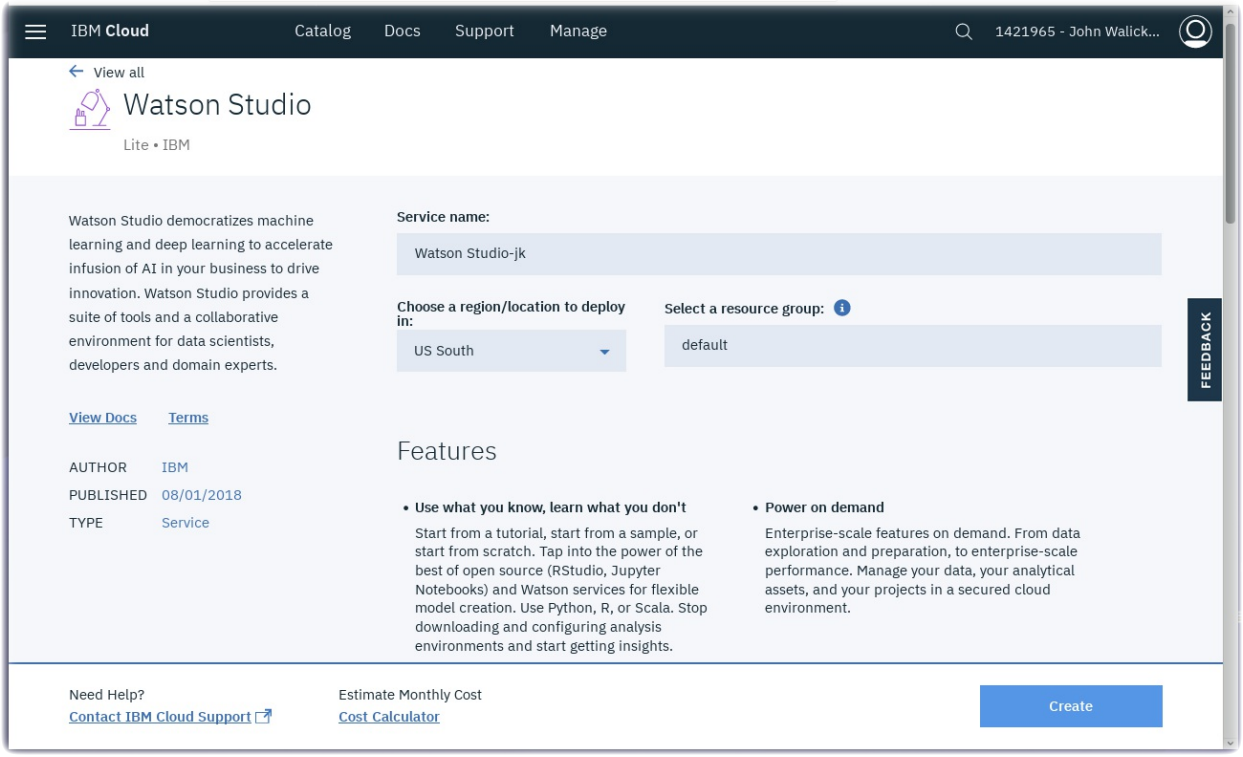


Create a Watson Studio service instance

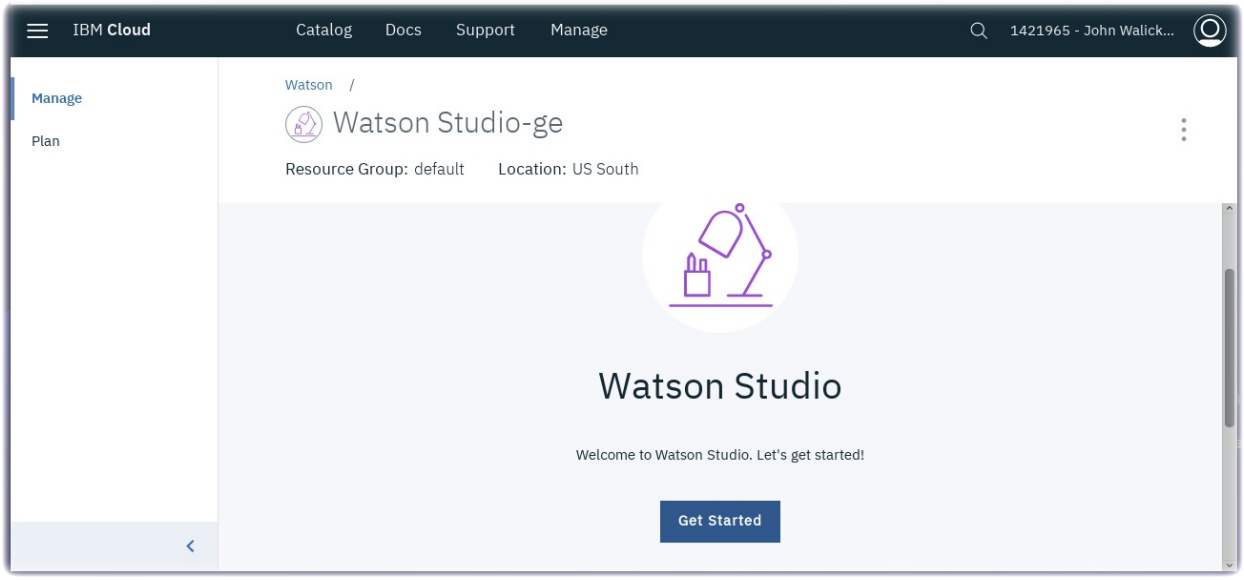
- Create a **Watson Studio** service instance from the IBM Cloud Catalog
- Search on **Studio** in the IBM Cloud Catalog



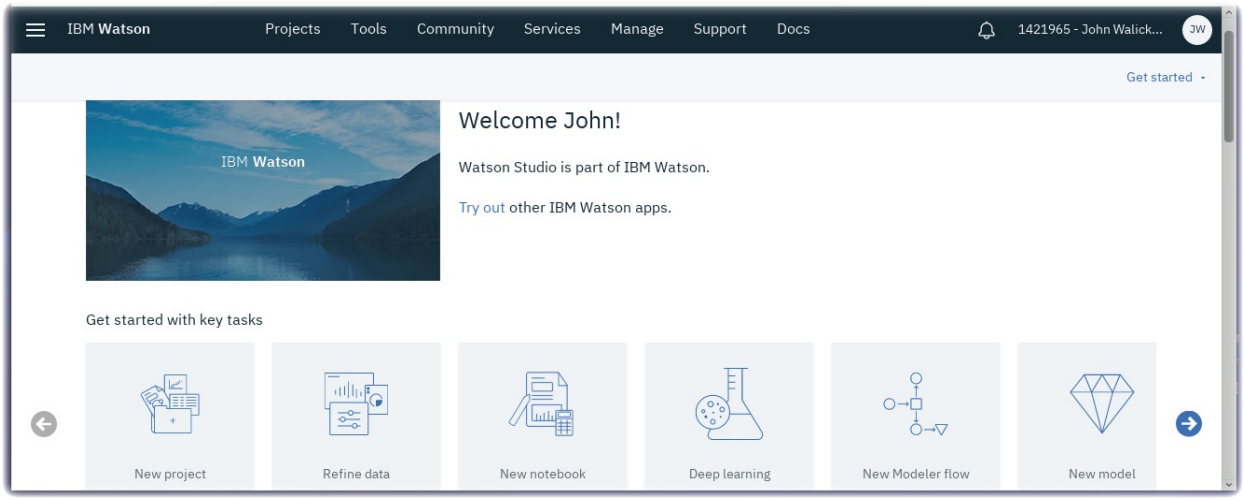
- Click on the **Watson Studio** service tile



- Click on the **Create** button
- After the Watson Studio service is created, click on **Get Started** or visit Watson Studio at http://dataplatform.ibm.com



- Login with your IBM Cloud account
- Walk through the introductory tutorial to learn about Watson Studio

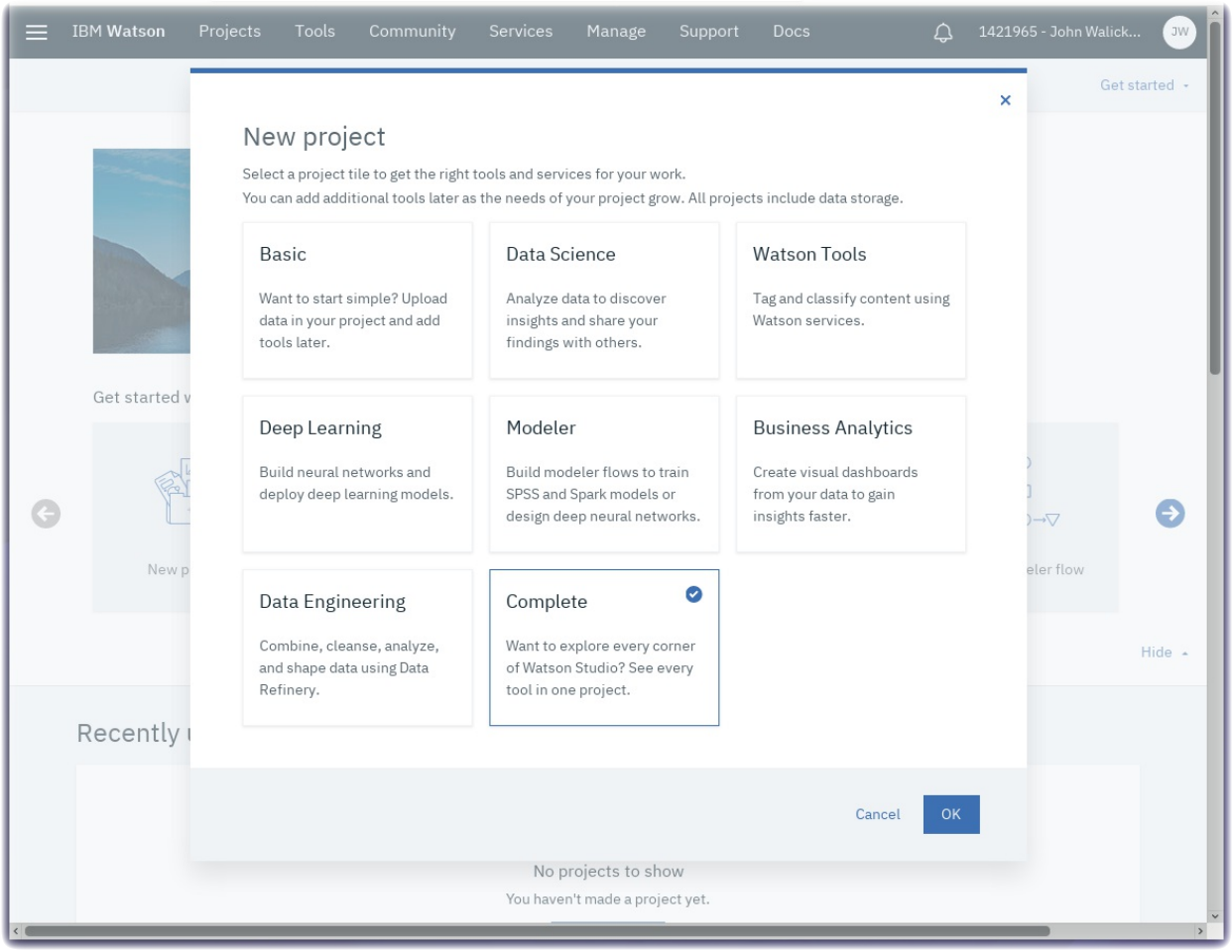


Step 2 - Create a New Project

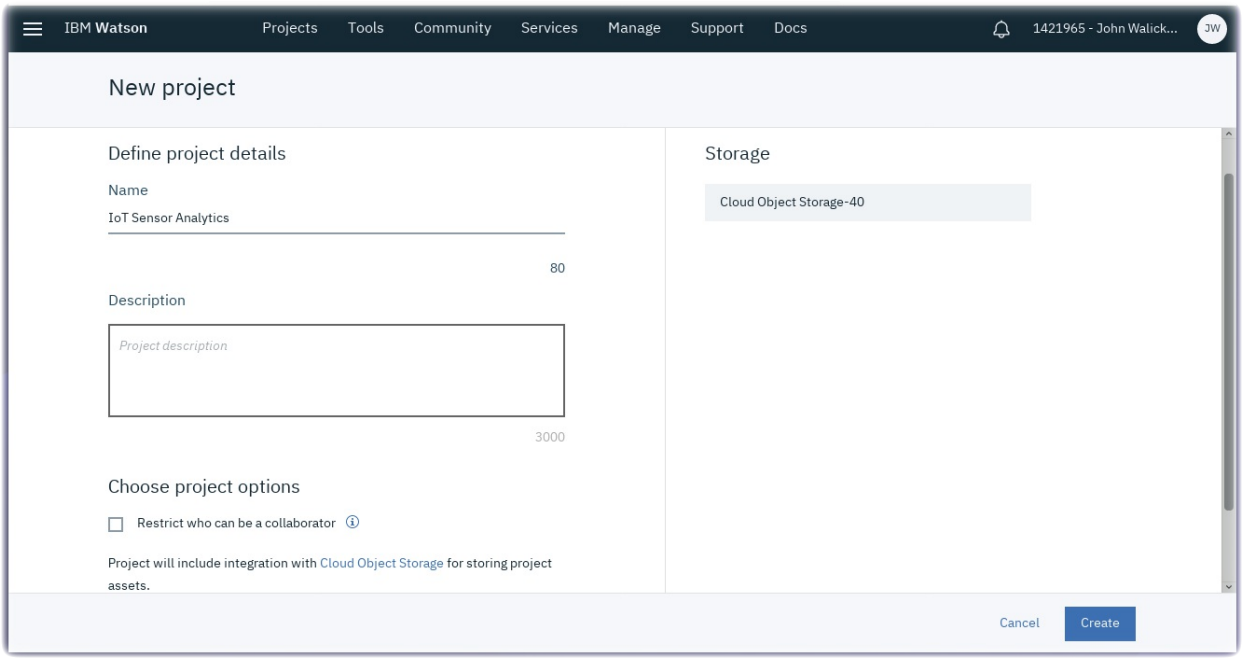
Projects are your workspace to organize your resources, such as assets like data, collaborators, and analytic tools like notebooks and models

Create a New Project

- Click on **New project**
- Select the **Complete** tile and press the **OK** button



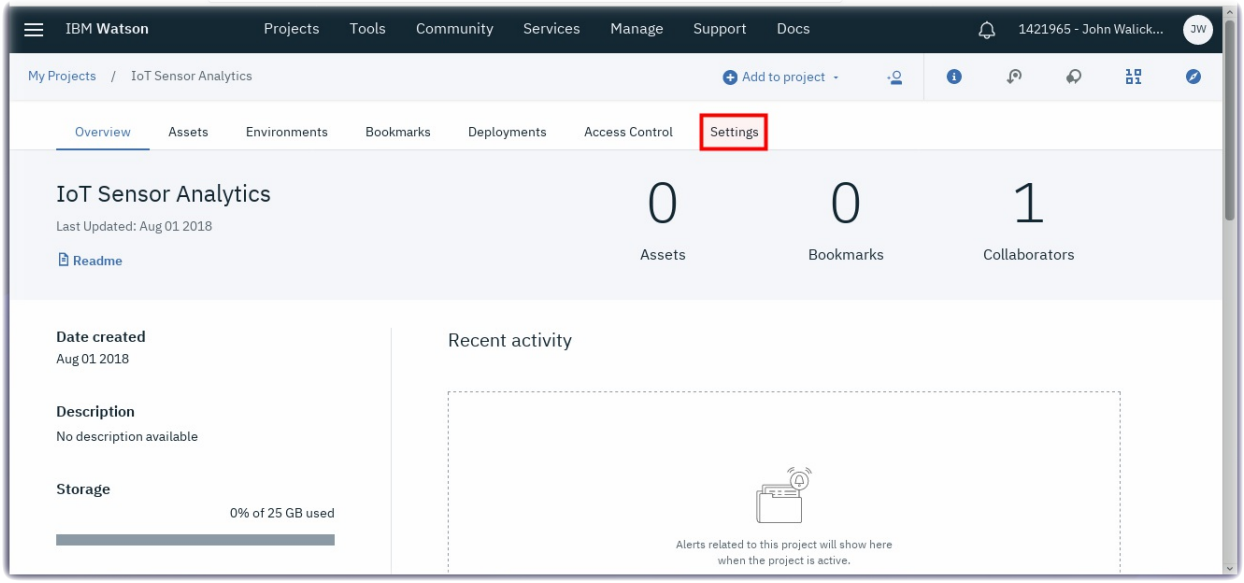
- Give your Project a name : **IoT Sensor Analytics**
- The Cloud Object Storage instance created in Step 1 should be prefilled
- Press the **Create** button



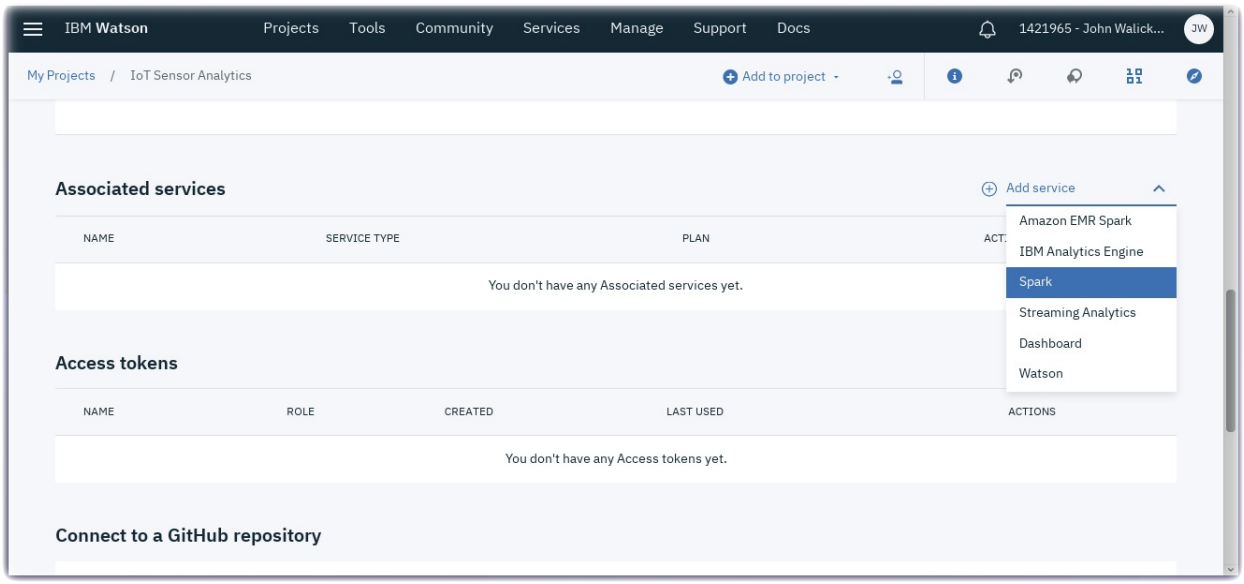
Add an Apache Spark Service

First add an Apache Spark service to the project.

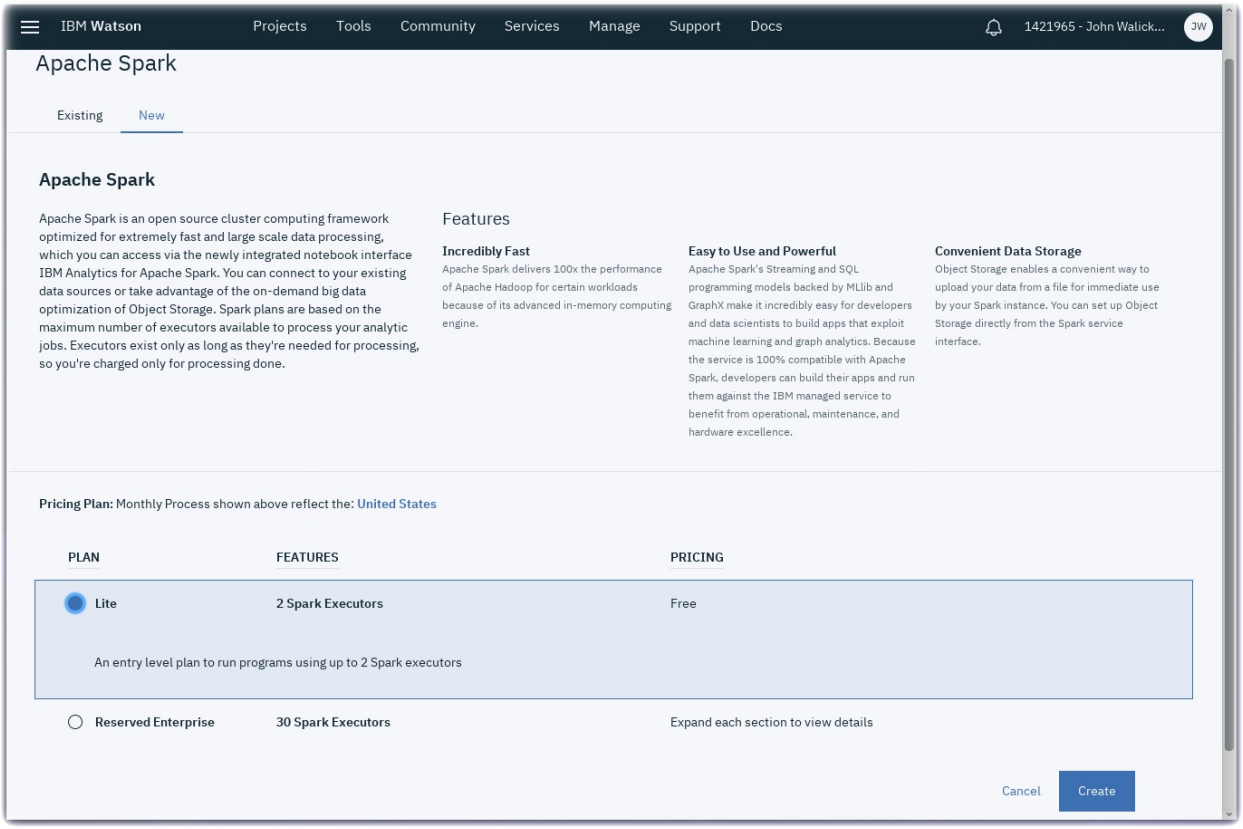
- Press the **Settings** tab



- Scroll down to the **Associated services** section and click on the **Add service** dropdown
- Select **Spark** from the dropdown



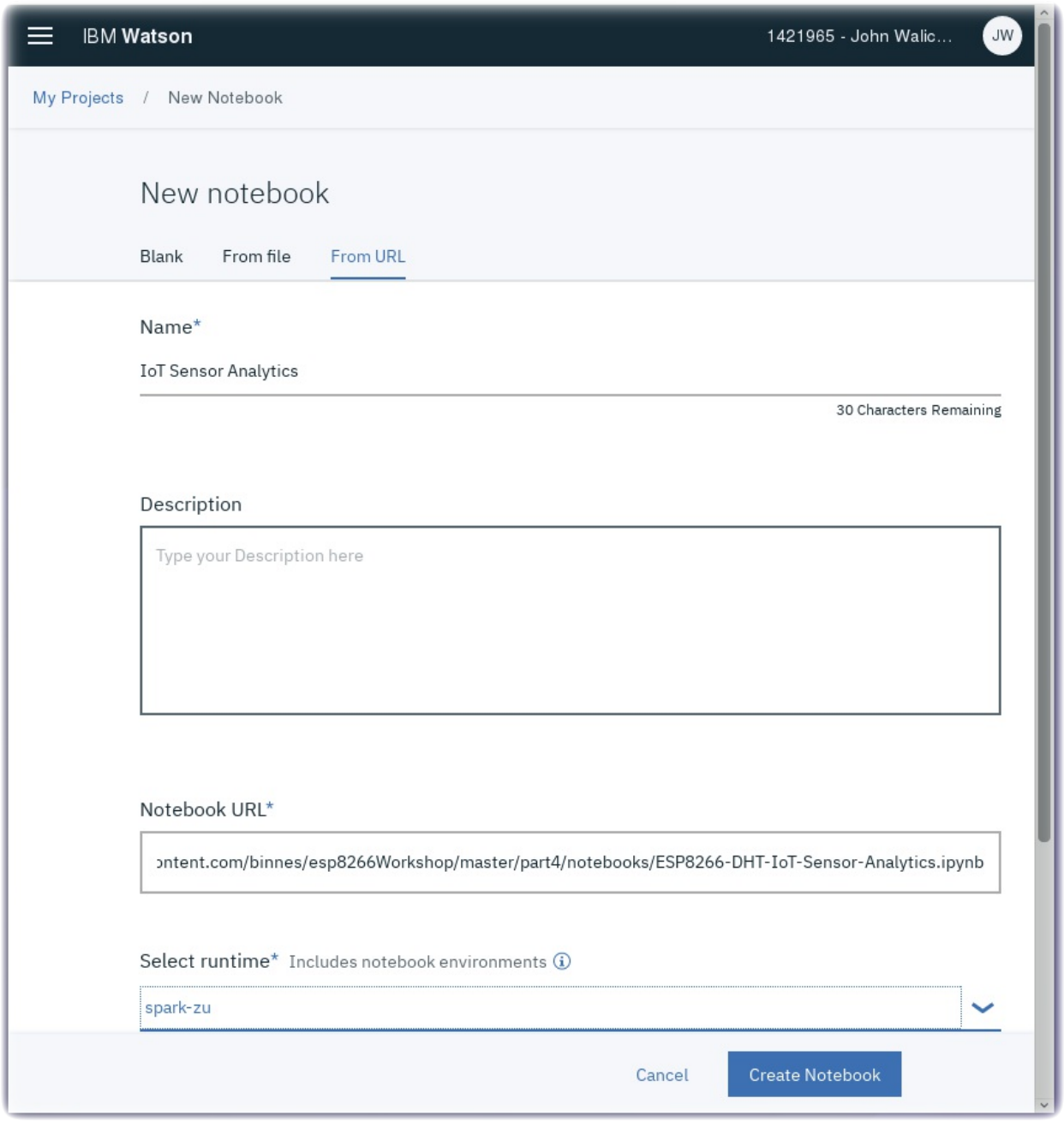
- In the **Apache Spark** service panel, select the **Lite** plan and press the **Create** button. Press the **Confirm** button.



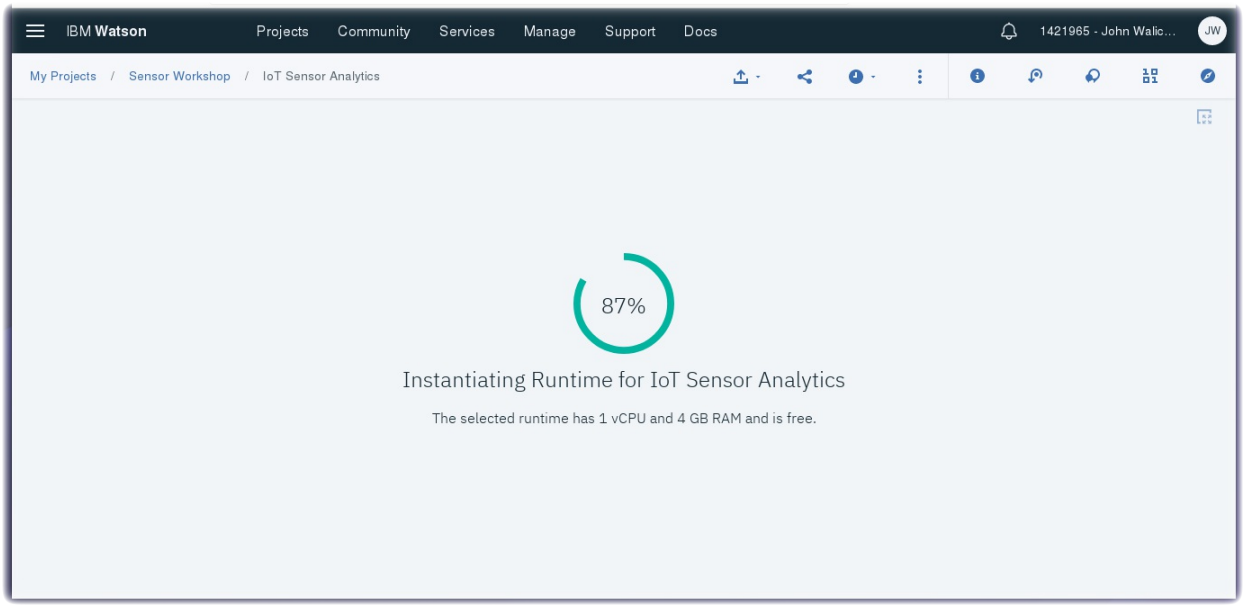
- Now an Apache Spark service has been added to your Project

Step 3 - Create a Notebook

- From the top menu, select **Tools**, and then **Notebook**
- Select **From URL**
- Give the notebook a name : **IoT Sensor Analytics**
- In the **Notebook URL** field, paste the following URL: https://raw.githubusercontent.com/binnes/esp8266Workshop/master/part4/notebooks/ESP8266-DHT-IoT-Sensor-Analytics.ipynb
- Scroll down to the **Select runtime** dropdown and choose your **Spark** runtime



- Click on **Create Notebook**



- Before running this notebook, an additional connector notebook needs to be installed.

Step 4 - Create an Apache Bahir Connector Notebook

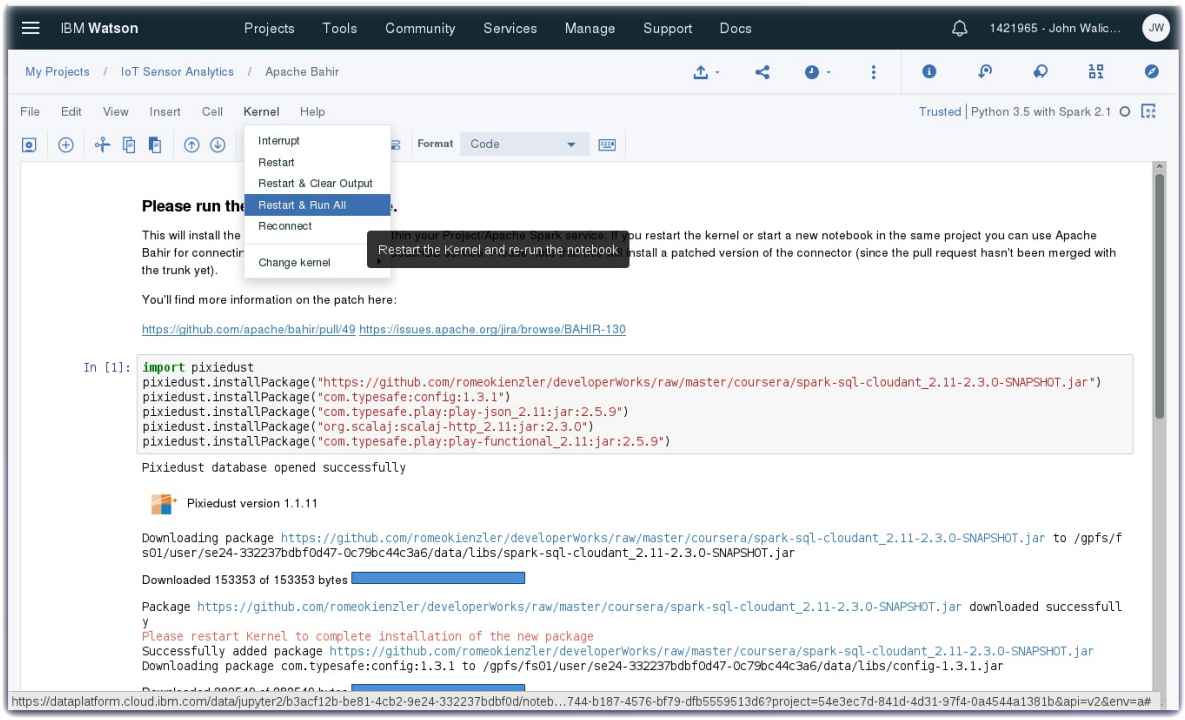
This will install the Apache Bahir connector within your Project/Apache Spark service. If you restart the kernel or start a new notebook in the same project you can use Apache Bahir for connecting to the Cloudant/Apache CouchDB service.

- From the top menu, select **Tools**, and then **Notebook**
- Select **From URL**
- Give the notebook a name: **Apache Bahir**
- In the **Notebook URL** field, paste the following URL: https://raw.githubusercontent.com/romeokienzler/developerWorks/master/coursera/bahir_setup.ipynb
- Scroll down to the **Select runtime** dropdown and choose your **Spark** runtime
- Click on **Create Notebook**

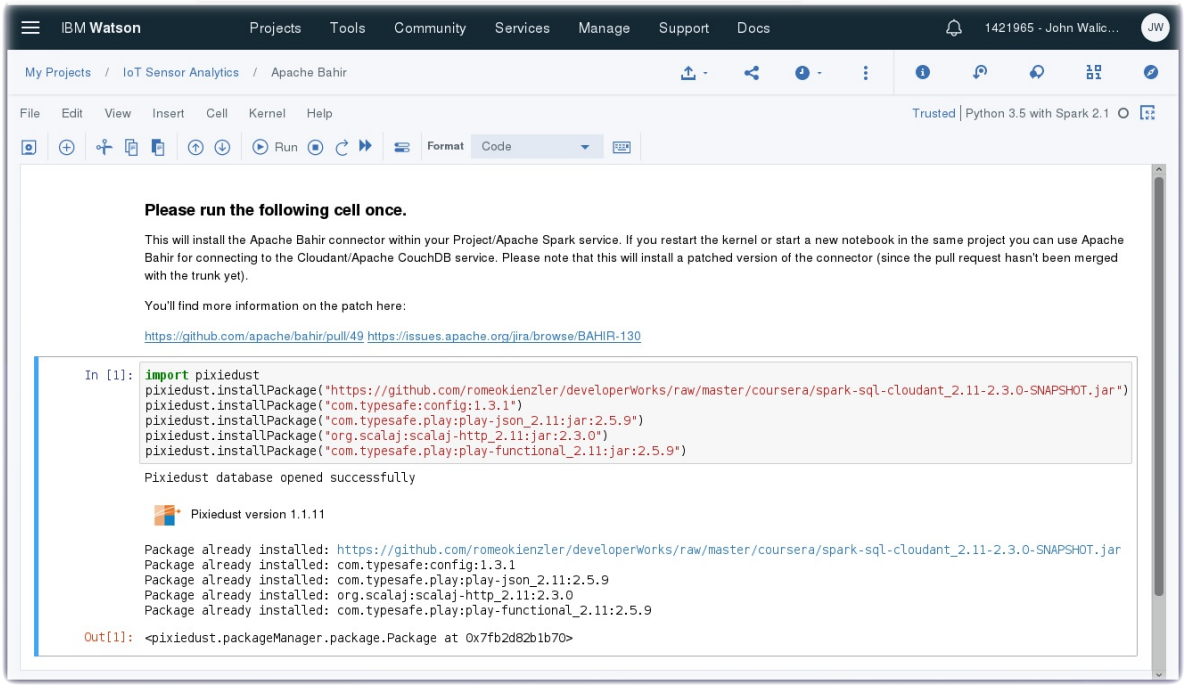
Apache Bahir Connector Initialization

- Once the Apache Bahir notebook loads, click on the **Kernel** menu and select **Restart & Run All** button

- Do this **Restart & Run All** step **twice** to complete the package installs



- The packages are successfully installed when the cell reports "Package already installed" messages



You are now ready to analyse the IoT sensor historical dataset using a Jupyter notebook and Spark. Proceed to the next Jupyter Notebook section.

Quick links :
Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data -

Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

Run a Jupyter Notebook in Watson Studio

Lab Objectives

In this lab you will read IoT data into a Watson Studio Project Jupyter Notebook and perform some analytics. You will learn:

- Jupyter Notebooks
- Read data from a Cloudant DB into Spark
- Calculate the Average, Standard Deviation, and Find the Min/Max

Introduction

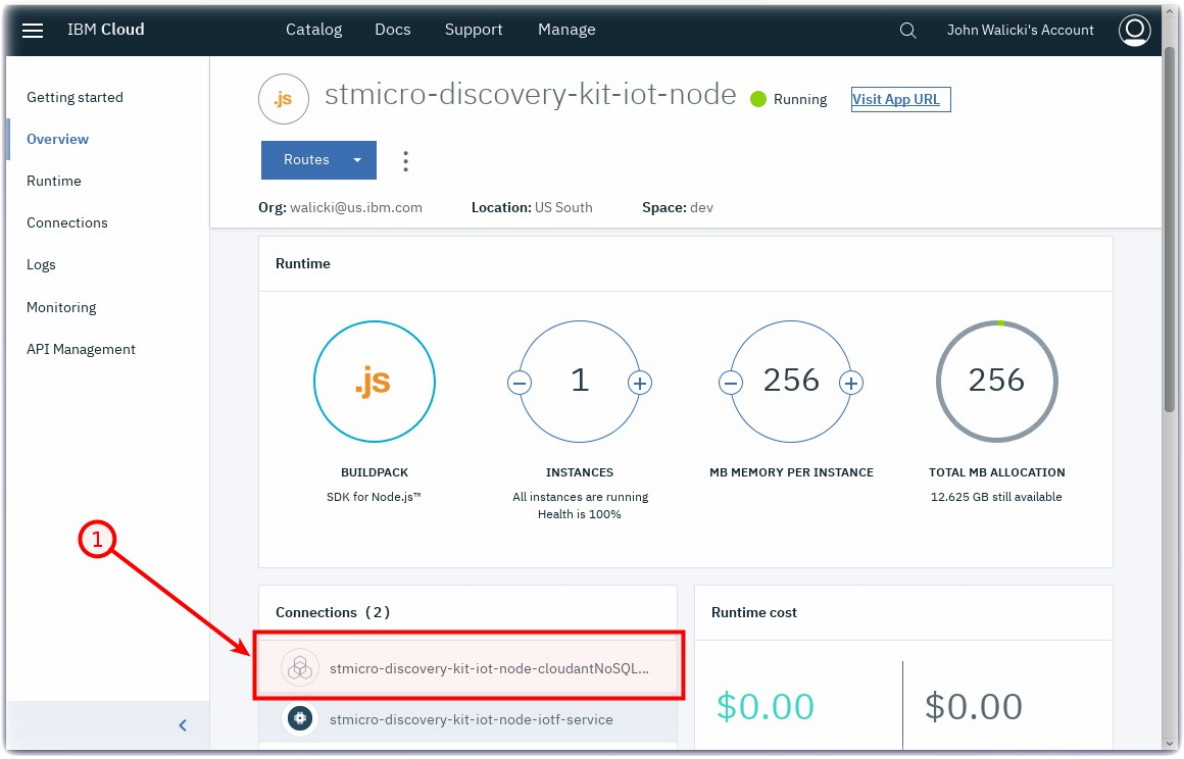
Jupyter Notebook is a web-based interactive computational environment for interactive data science and scientific computing. A Jupyter Notebook document is a JSON document, following a versioned schema, and containing an ordered list of input/output cells which can contain code, text (using Markdown), mathematics, plots and rich media, usually ending with the ".ipynb" extension. A Jupyter kernel is a program responsible for handling various types of request (code execution, code completions, inspection), and providing a reply.

Step 1 - Cloudant Credentials

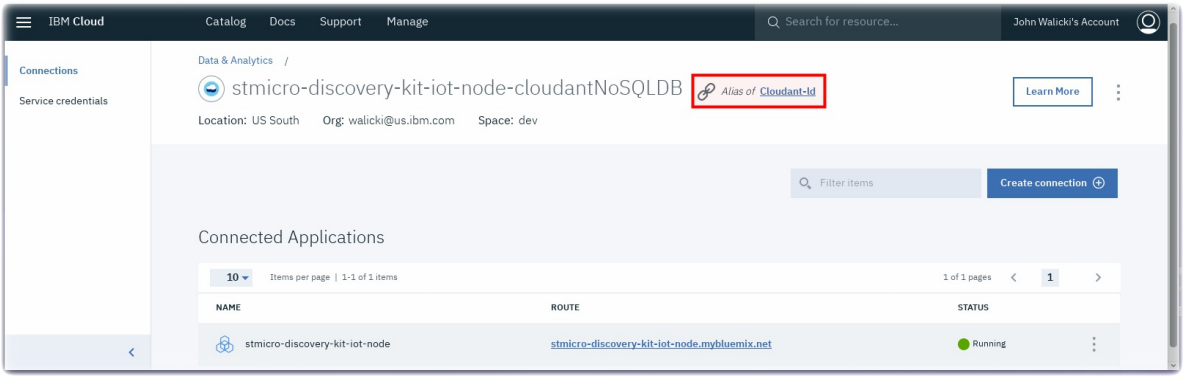
Before we can read the ST Microelectronics Discovery Kit IoT Node temperature and humidity data into a Jupyter notebook we need to create credentials to the Cloudant database created in the Store Data in Cloud Storage section.

- Open a new browser tab.

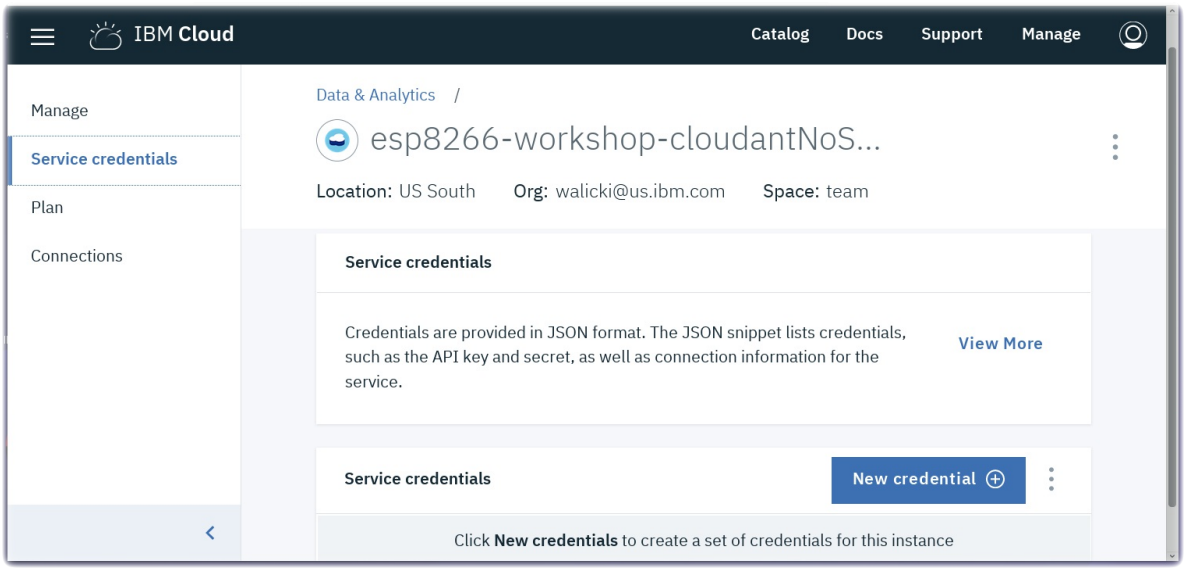
- Return to the IBM Cloud dashboard and your IoT Starter application. **Click** on the cloudantNoSQLDB service connection (1).



- Read about the Cloudant Storage service and click on the **Service credentials** menu item in the left menu bar.



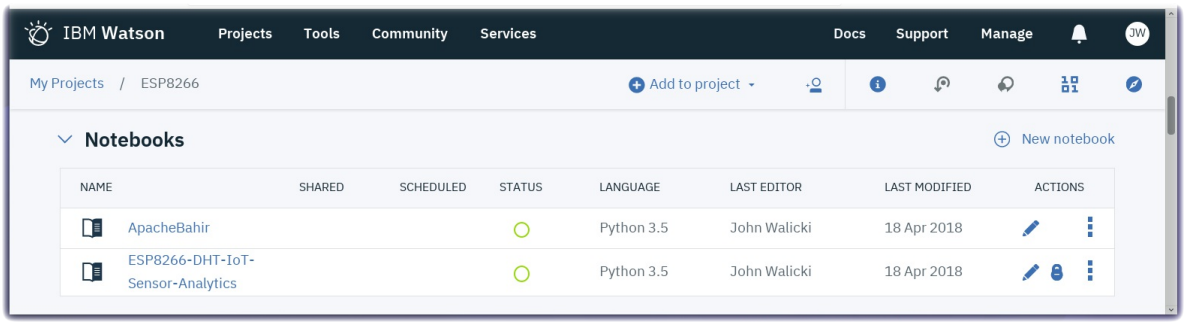
- Click on **New credential**



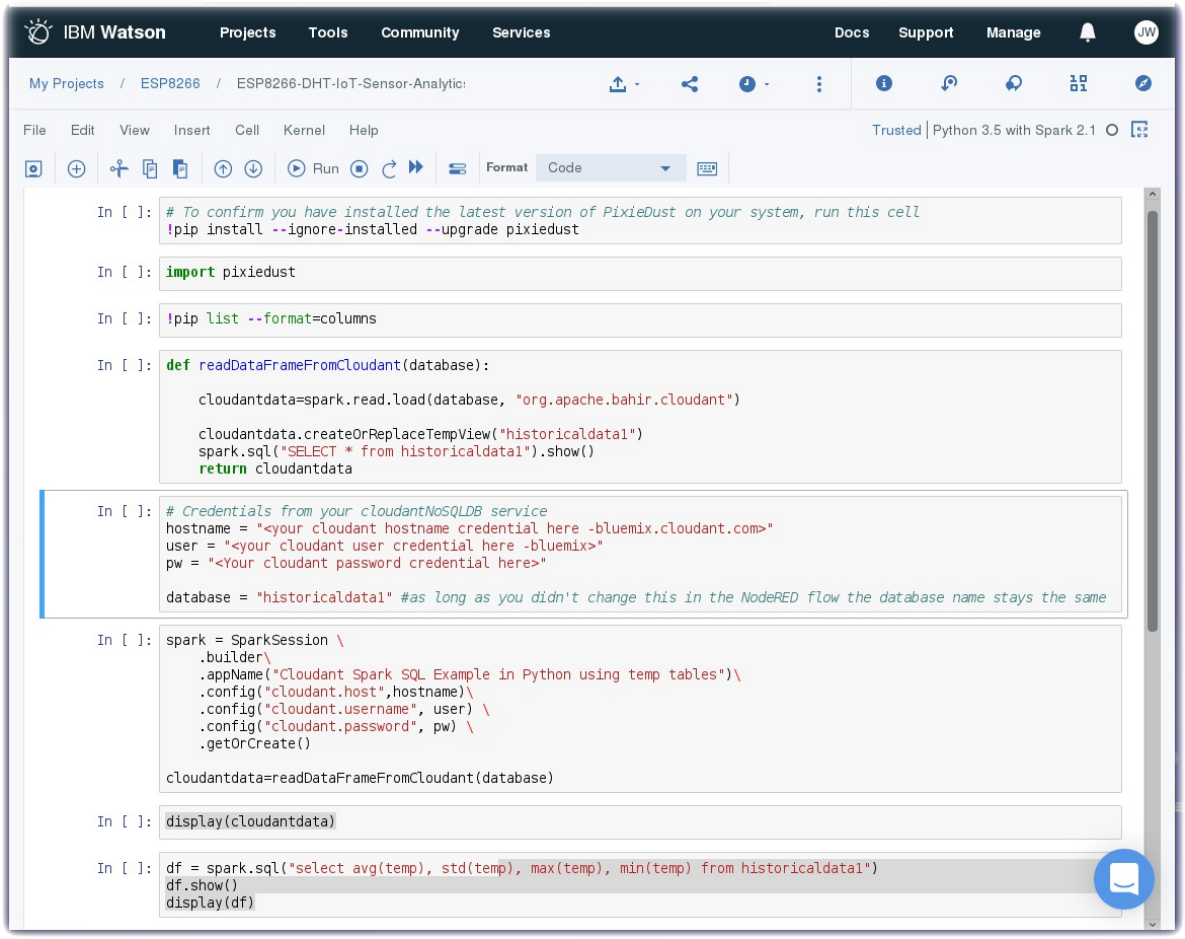
- Give your credential a name: **Credentials-DSX**
- Click on **Add**
- Expand the **View credentials** twistie
- The Cloudant hostname, user and password credentials will be displayed.
- Keep this browser tab open. You will use these credentials in the next Step.

Step 2 - Run a Jupyter Notebook

- Return to the Watson Studio browser tab and open the **STM Discovery Kit IoT Sensor Analytics** notebook.



- Make certain you are in **Edit** mode by clicking on the Pencil icon.
- You will now copy the Cloudant hostname, user and password credentials to your **STM Discovery Kit IoT Sensor Analytics** notebook cell 5



- Move the focus to the first cell.
- In the toolbar, click on the **Run** button to run each cell.
- Spark will calculate the Average, Standard Deviation, Max and Min of your DiscoveryKit IoT Historical data set.

Quick links :
Home - IoT Platform Starter - Device Types and Devices - Node-RED Setup - Sensor Data - Node-RED Charts - Store Data in Cloud Storage - Historical Charts - Watson Studio - Jupyter Notebooks

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