

Introduction to IoT-Build your Own Basic IoT App

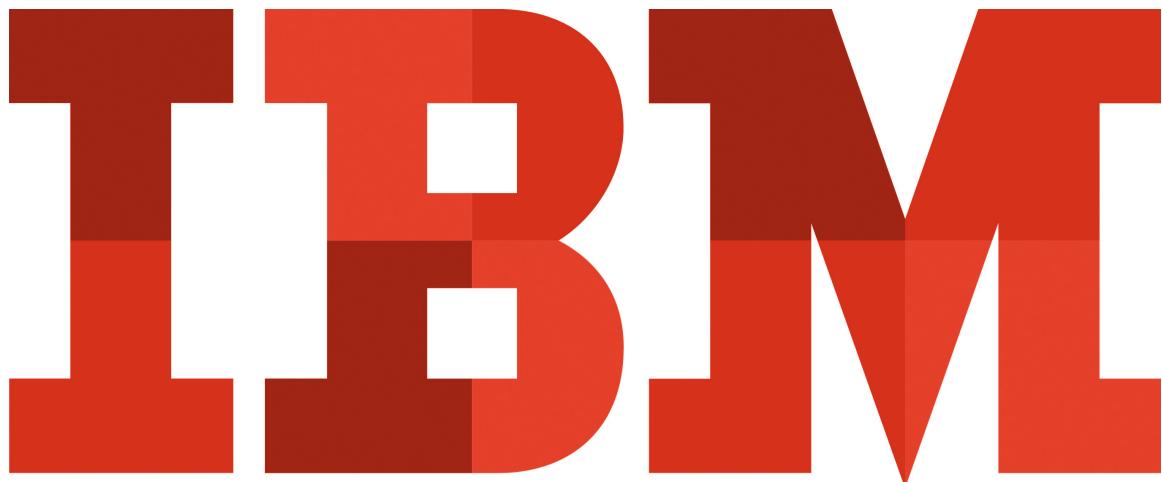
IWT-2862 InterConnect Hands-On Lab

Download this PDF and Node-RED flows at

<https://github.com/johnwalicki/Interconnect-IoT-Labs>

Authors:

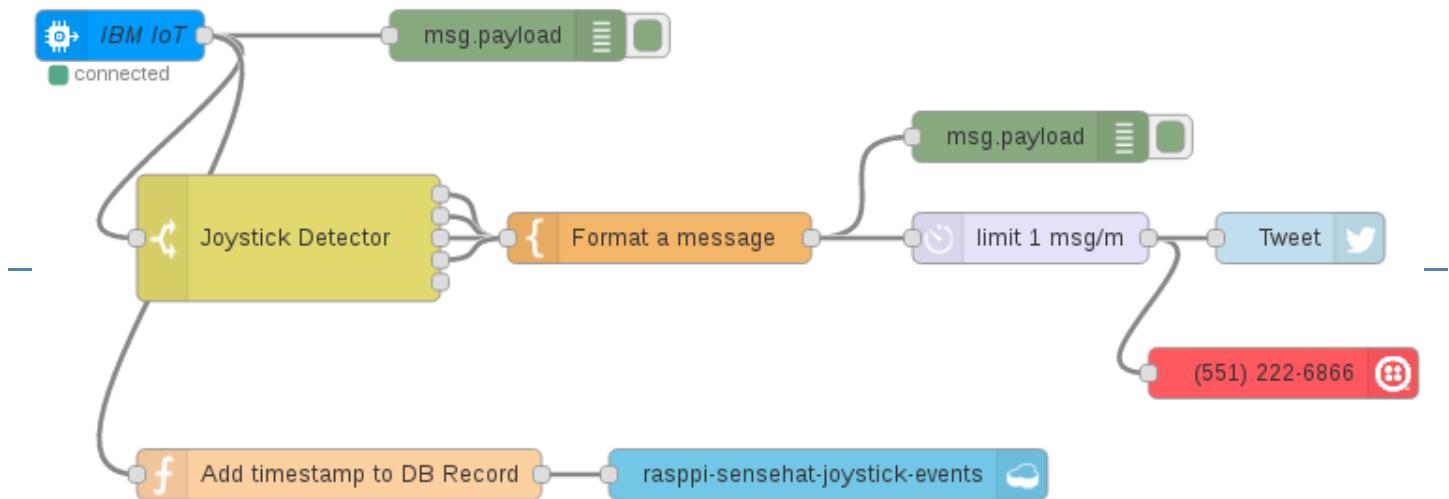
John Walicki | walicki@us.ibm.com | @johnwalicki



Topics covered: Raspberry Pi, Node-RED, Watson Internet of Things Platform, SenseHAT, Twitter, Sentiment and Weather Company Data for IBM Bluemix.

In this lab, we will unbox and set up a Raspberry Pi and Raspberry Pi SenseHAT and connect to the IBM Bluemix and Watson IoT Platform. We will query the temperature via the SenseHAT and send data to the Watson IoT platform. Watson IoT Platform will report the temperature and alert maintenance of a high temperature. Using Node-RED, running on the Raspberry Pi and in Bluemix, the application will analyze the sentiment of a Twitter feed. The sentiment scores will be sent via Watson's Internet of Things Platform service from a Node-RED application hosted on IBM Bluemix to the local Raspberry Pi. The SenseHAT LED display will flash a color corresponding to the sentiment. We will retrieve outside weather data and display it on a LED screen connected to the SenseHAT.

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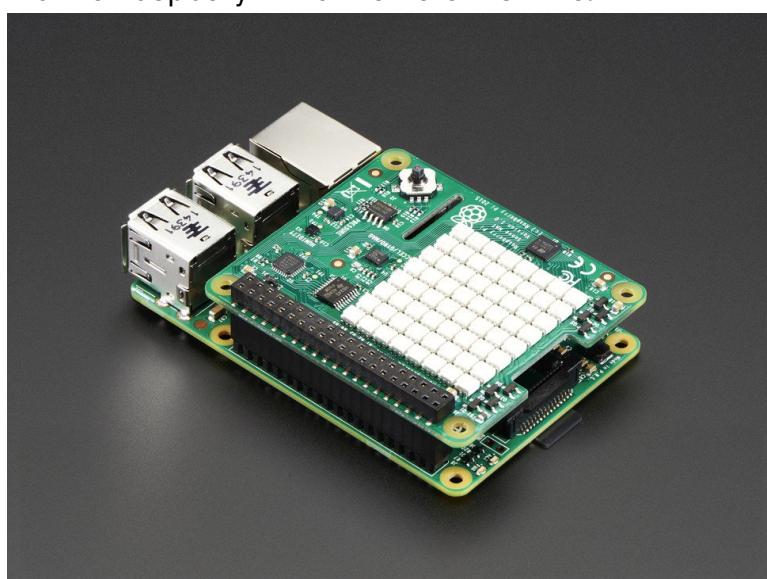
Lesson 1 – Raspberry Pi Set Up

Step 1 - Unbox the Raspberry Pi and Raspberry Pi SenseHAT

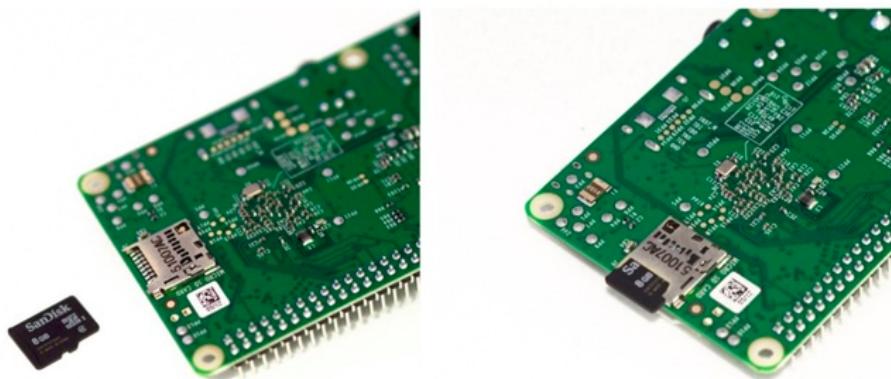


Step 2 – Connect the Raspberry Pi SenseHAT to the Raspberry Pi

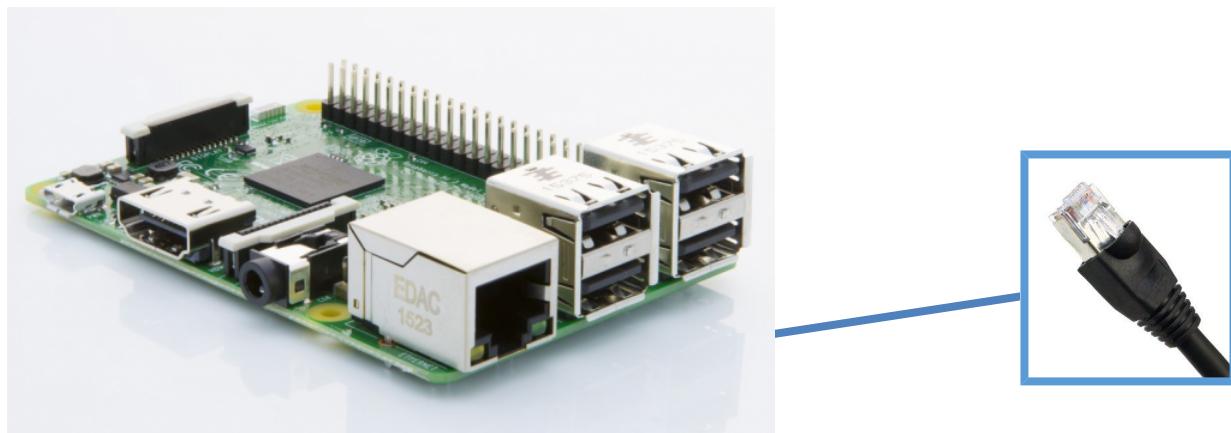
Connect your SenseHAT to the Raspberry Pi via the 40 GPIO Pins.



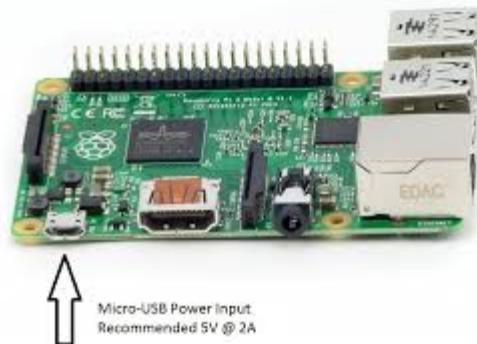
Step 3 – Insert the Raspbian Linux microSD card into the Raspberry Pi



Step 4 – Connect the Ethernet cable to the Raspberry Pi



Step 5 - Power the Raspberry Pi via a microUSB Cable or 5v microUSB Power supply



Step 6 – Allow the Raspberry Pi to boot

The Raspberry Pi will display a red light if it is powered. After around 2 minutes, the IP addresses (Ethernet wired and WiFi) will scroll across the LED of the SenseHAT. The IP addresses will scroll for a few minutes and then turn off.

Write down the IP address

Step 7 – Connect to the Raspberry Pi with a Terminal Client

In order to perform advanced configuration of the Raspberry Pi either a monitor and keyboard, or a Secure Shell (SSH) connection is required. On OSX and Linux there are default programs that can do this - Screen and SSH respectively. However on Windows no default exists, however PuTTY is light weight and easy to install and can be used to SSH into the Raspberry Pi.

For Windows Users:

- o PuTTY is installed on the lab laptops
- o or Visit the [PuTTY download page](#)
- o Under the "For Windows on Intel x86" heading, click on the "putty.exe" link to download the latest release version to your computer.



- o Double-click putty.exe on your computer to launch PuTTY
- o Enter IP address of the Gateway
- o You can login with the username **pi** and the password **raspberry**

For Mac and Linux Users:

- o Open a Terminal
- o Type **\$ ssh pi@<<IP Address>>** Replace <<IP Address>> with the IP address of your gateway
- o Enter **raspberry** as password

Step 8 – Open a Browser and enter <http://<ip-address>:1880>

The Node-RED graphical programming tool will open in your browser.

Lesson 2 - Send data from the Raspberry Pi to Watson IoT

The Raspberry Pi Raspbian image provided in the InterConnect Conference lab has a program installed and running that is automatically sending the CPU temperature of your Raspberry Pi to the IBM Watson IoT Platform QuickStart. In the terminal window, enter the **following two commands marked below in bold** and copy the device ID it reports.

```
pi@raspberrypi:~ $ sudo service iot restart  
pi@raspberrypi:~ $ service iot getdeviceid
```

The device ID is **b827eb6effa7**

For Real-time visualization of the data, visit

<http://quickstart.internetofthings.ibmcloud.com/?deviceId=b827eb6effa7>

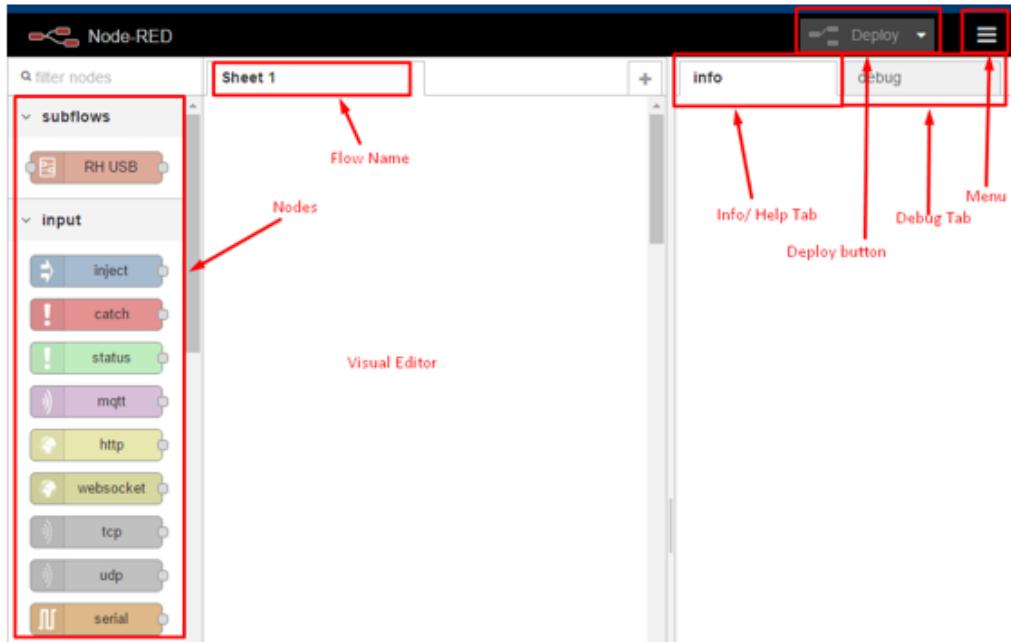
Open a browser tab to <http://quickstart.internetofthings.ibmcloud.com/?deviceId=<device id>>

The screenshot shows a Mozilla Firefox window titled "IBM Watson IoT Platform – Mozilla Firefox: IBM Edition". The address bar shows the URL <https://quickstart.internetofthings.ibmcloud.com/#/device/b827eb6effa7/sensor/>. The main content area is titled "Quickstart" and displays a line graph for the sensor "status.cpuTemp" over time. The graph shows a fluctuating line between approximately 47.8 and 49.4. Below the graph is a table of sensor data with columns: Event, Datapoint, Value, and Time Received. The table contains four rows of data. To the right of the graph, there is a sidebar with the heading "I've seen my data, what next?". It includes links to "IBM Bluemix" and "Click here for more details.", "SIGN UP" and "LOG IN" buttons, and three numbered steps: "Go to your Bluemix account", "Create an app using the Internet of Things Starter from the Catalog", and "Import the flow for your device into the Node-RED flow editor".

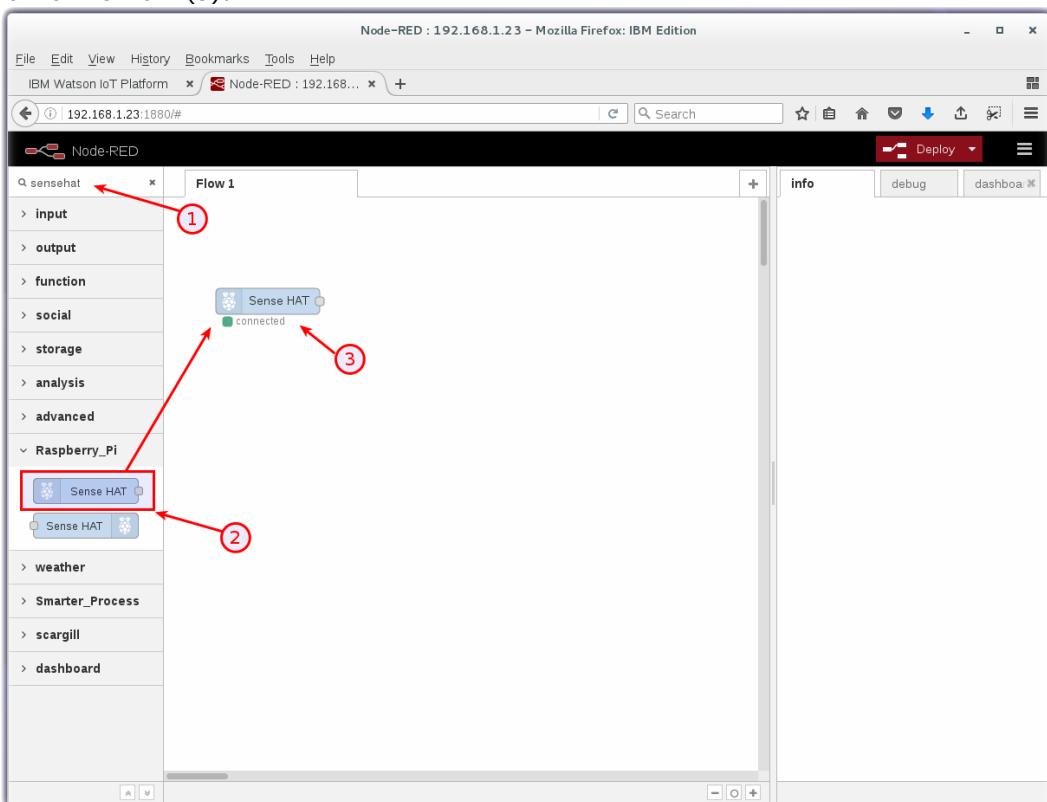
Event	Datapoint	Value	Time Received
status	myName	myPi	Oct 20, 2016 10:05:52 PM
status	cputemp	48.31	Oct 20, 2016 10:05:52 PM
status	cpubad	0.01	Oct 20, 2016 10:05:52 PM
status	sine	0.38	Oct 20, 2016 10:05:52 PM

Sending SenseHAT data to IBM Watson IoT Platform Quickstart

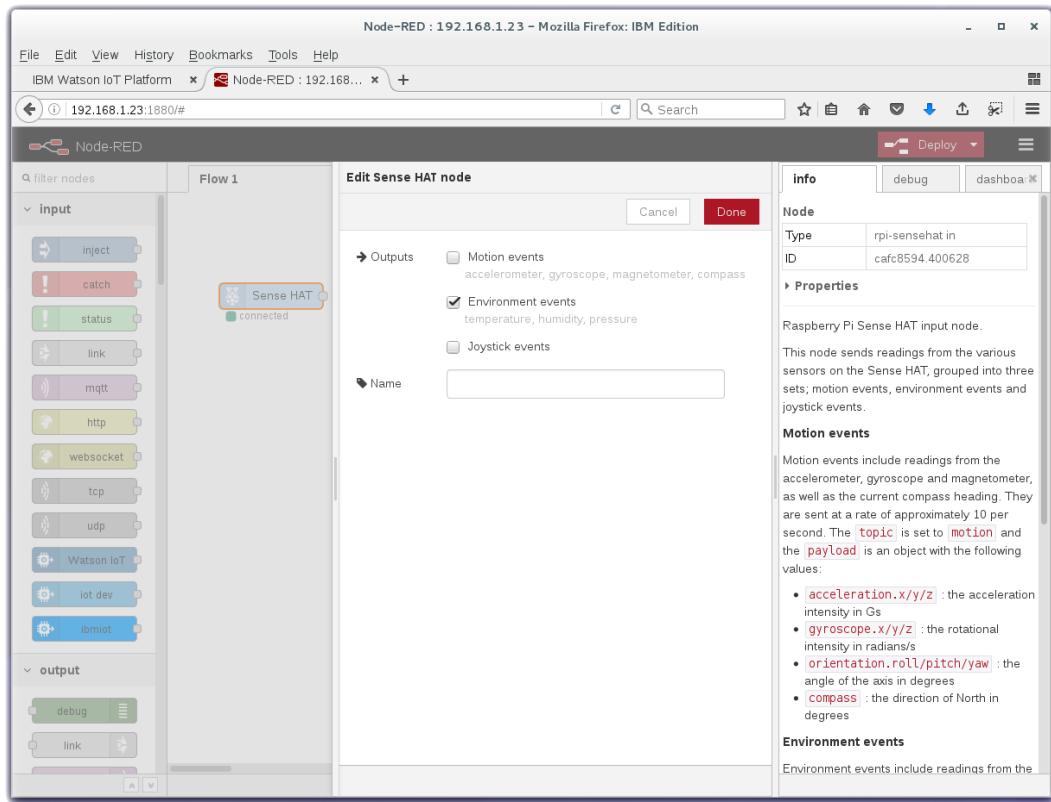
Now that we have sent the Raspberry Pi CPU temperature to Watson IoT, let's also send SenseHAT environmental sensor readings by using Node-RED. Create a new flow to program the rest of the exercises by clicking on the + button in the upper right corner of the Node-RED interface to open a Flow 1.



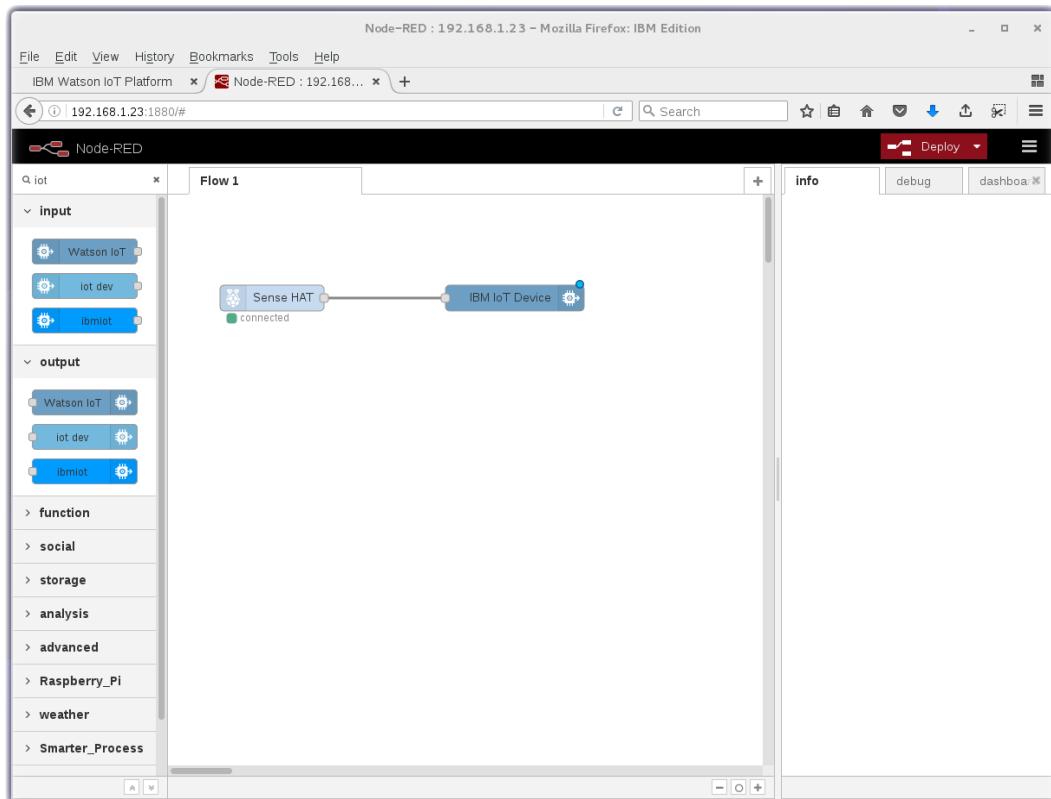
- Find a SenseHAT node by searching in the filter node box (1). Drag the SenseHAT node (2) from the palette onto the flow (3).



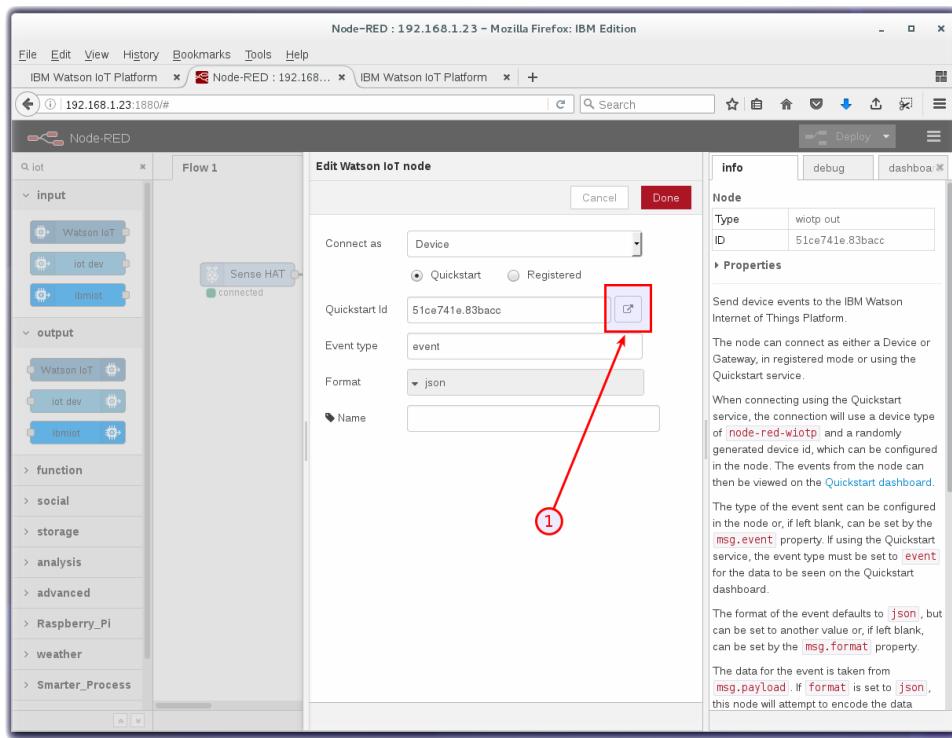
- Double click on the SenseHAT node on the Flow and select the “Environment events” checkbox and press the Done button.



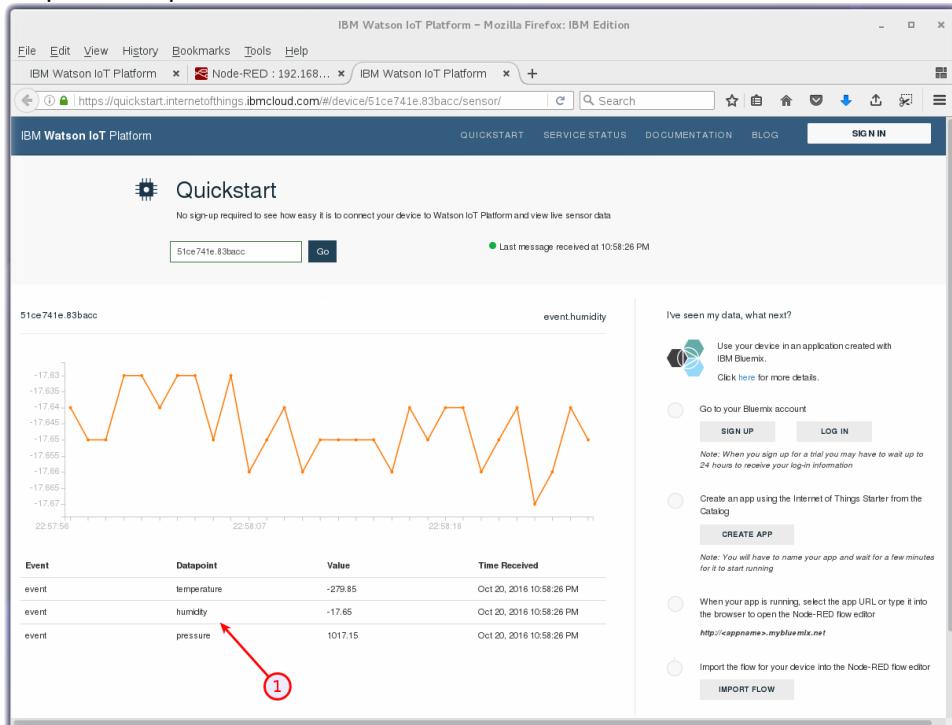
- Search for a Watson IoT output node on the palette and drag it onto the flow. Wire it to the SenseHAT node by dragging your mouse from one node point to the other. A wire will connect the two nodes.



- Click the Deploy  button on the top of menu bar to deploy the Node-RED flow.
- Doubleclick on the IBM IoT Device node and then click on the box (1) to the right of the Quickstart Id. A new browser tab will open. **Note the unique Quickstart Id**. This Id will be used in Lesson 4 and 5.

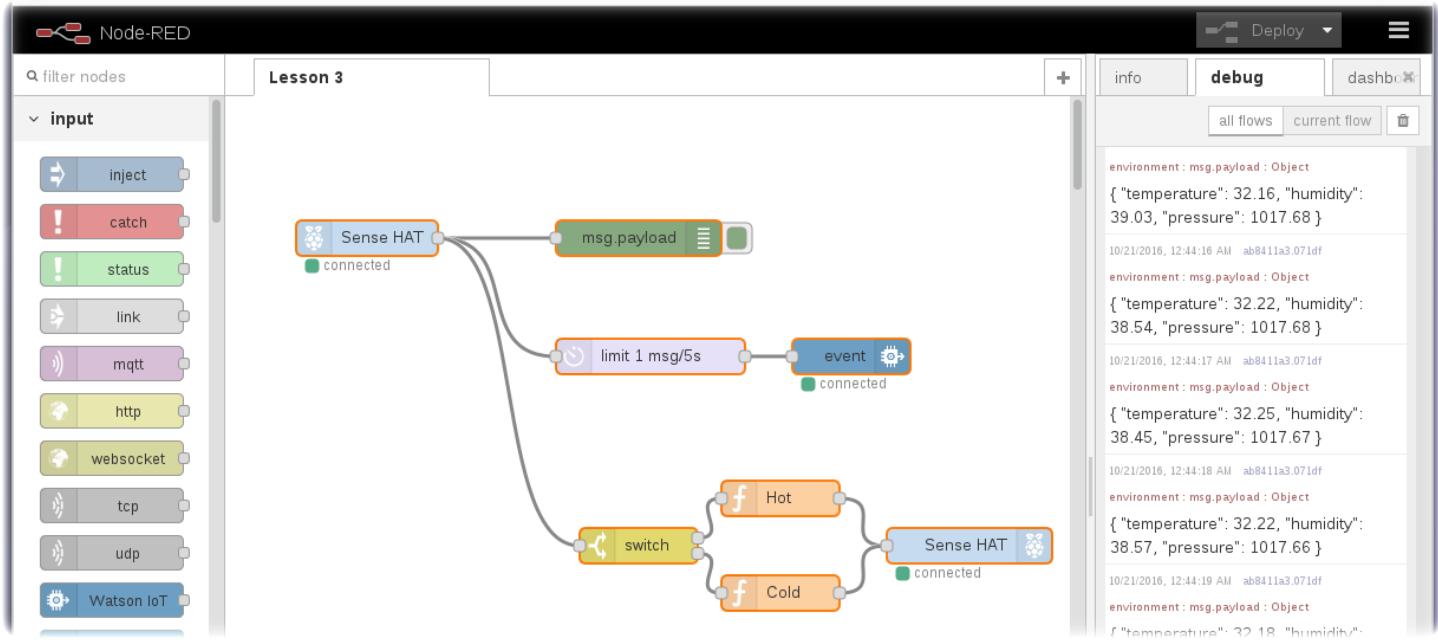


- Room temperature, humidity and air pressure sensor data from the SenseHAT is now being sent to the Watson IoT Platform and is being plotted in the Quickstart landing page. You can click (1) on any of the three datapoints to plot them.



Lesson 3 – Local Node-RED Temperature Alert

To practice with Node-RED visual programming, we might want to limit the amount of sensor data that is sent to Watson IoT Quickstart to 1 msg / 5 secs. It is also interesting to watch the SenseHAT environmental data by reporting it to a debug node before it is sent to Quickstart. Depending on the temperature, display if the room is hot or cold by changing the SenseHAT LEDs to red / green.



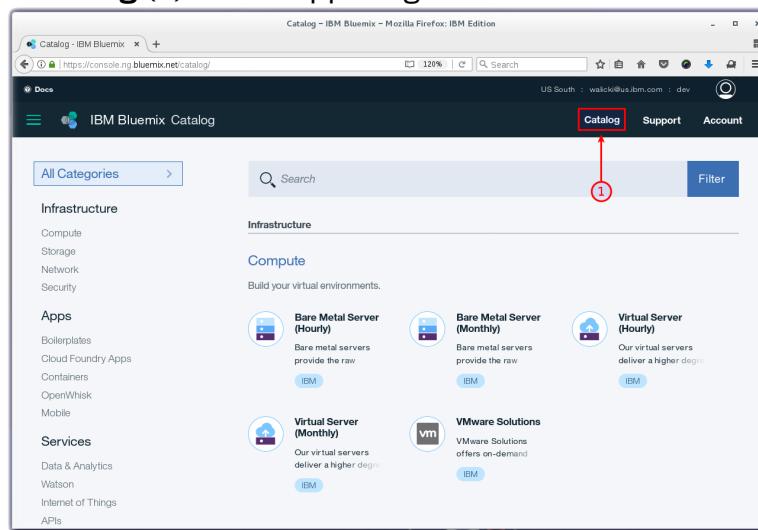
To create the above program, follow the URL below and download the Lesson3.flow. The text is a Node-RED representation of the above graphical flow. You can copy it from the browser to the clipboard and paste it in your Node-RED browser tab. From the **Node-RED menu, select Import → Clipboard, paste the flow and press the red Import button**. Finally press the Deploy button.

This flow is available at : <https://github.com/johnwalicki/Interconnect-IoT-Labs>

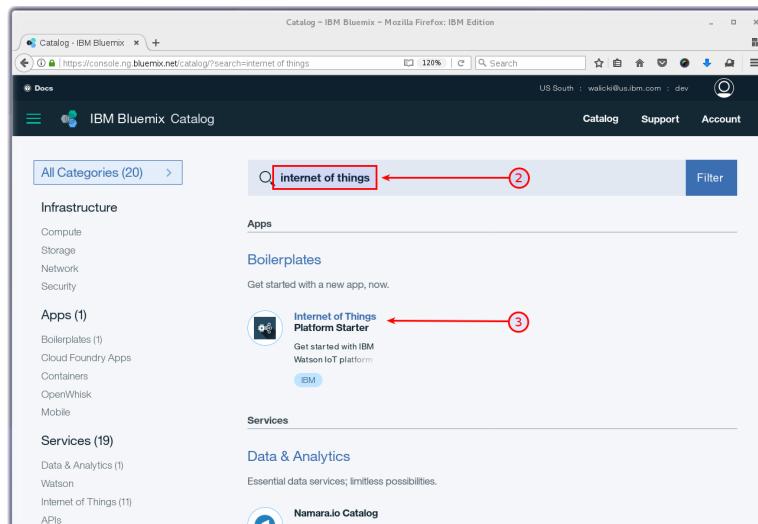
Lesson 4 - Send sensor data to a Bluemix Application

Quickstart is a fast way to send and see sensor data on the Watson IoT Platform. The next step is to create a Bluemix Watson IoT application that receives the Raspberry Pi sensor data via the Quickstart service and takes actions on it.

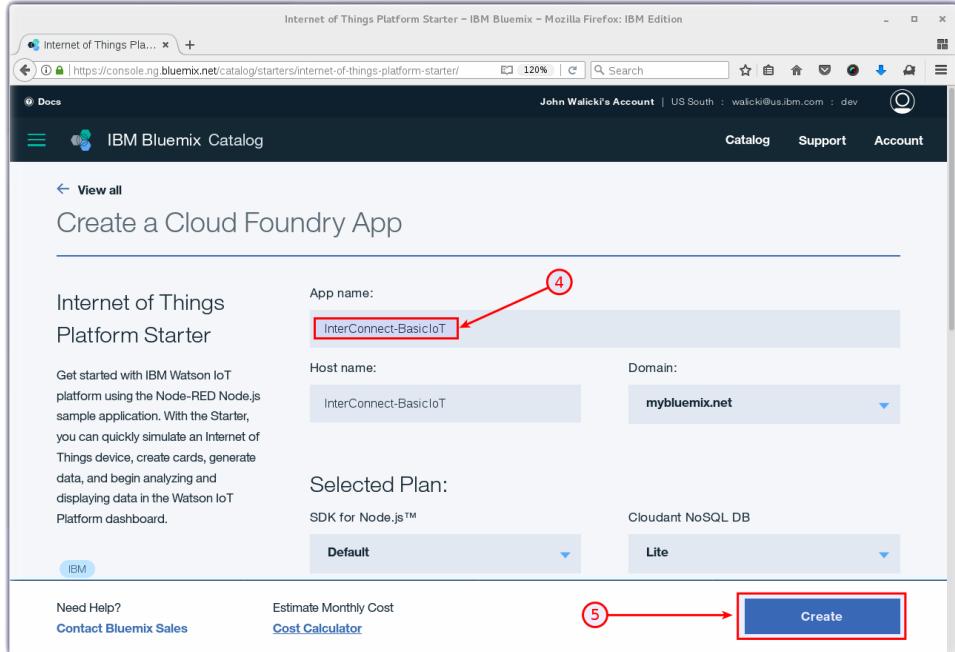
- If you do not yet have a Bluemix account, visit <http://bluemix.net/registration> and enter the requested information. Check your email to confirm the Bluemix account creation.
- See the lab instructor for a promocode to extend your 30 day free trial.
- Login into http://bluemix.net with your new account userid and password.
- Click on the word **Catalog** (1) on the upper right side.



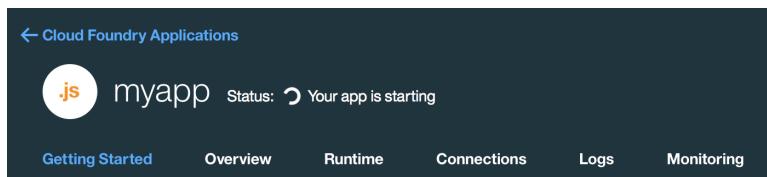
- Search for **Internet of Things Platform Starter** (2) – The boilerplates are designed with pre-assembled services that work together. The Internet of Things Platform Starter (3) includes a Node-RED Node.js web server, Cloudant database to store sensor data, and the IoT platform service so you can connect devices



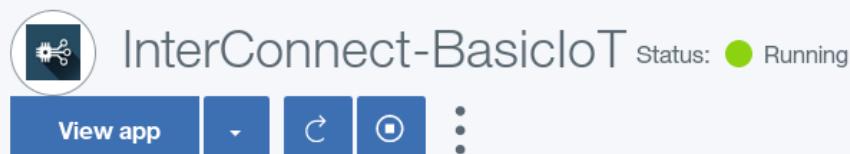
- Name your application something unique (4). If you choose **myapp**, your application will be located at <http://myapp.mybluemix.net>. There can only be one “**myapp**” application registered in IBM Bluemix. You can try adding your initials in front of the host if the host you choose is already taken by someone else. Click on **Create** (5) to create the application instance.



- IBM Bluemix will create an application in your account based on the services in the boilerplate. This is called staging an application. It can take a few minutes for this process to complete. While you wait, you can click on the **Logs** tab and see activity logs from the platform and Node.js runtime.

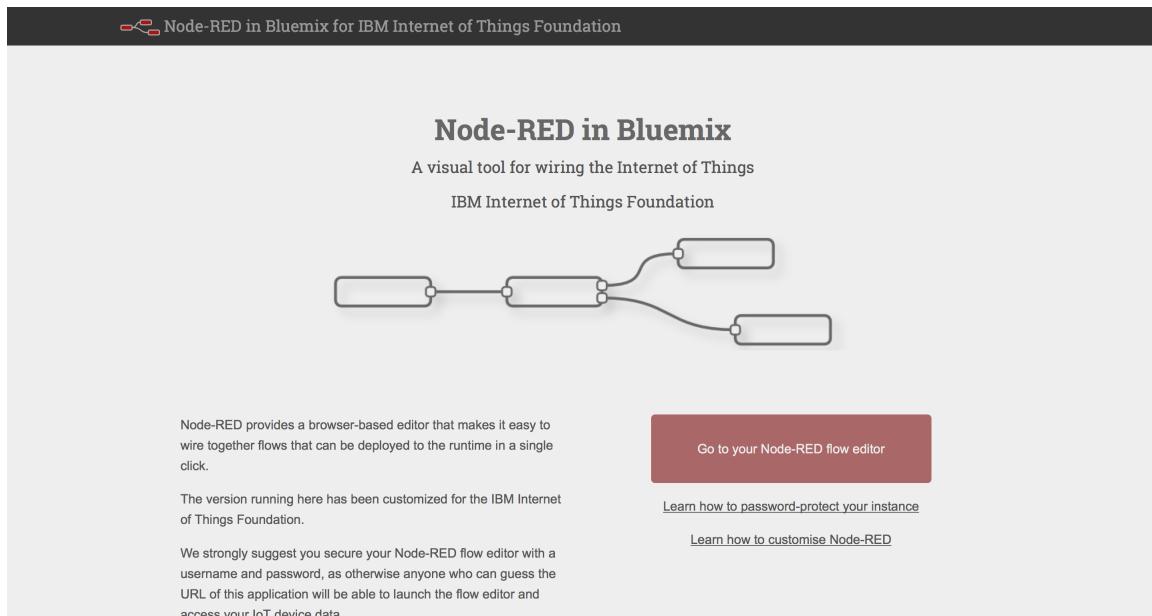


- You may need to press the **Dashboard** link and then re-enter your application.

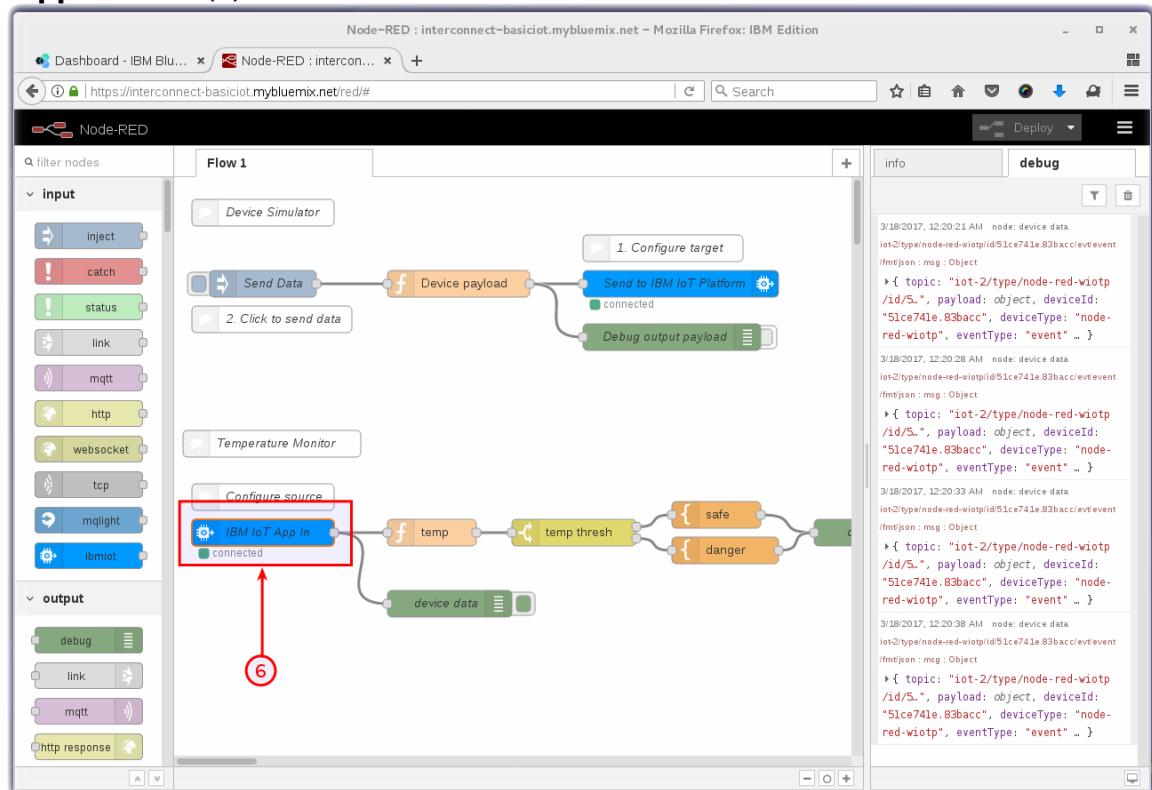


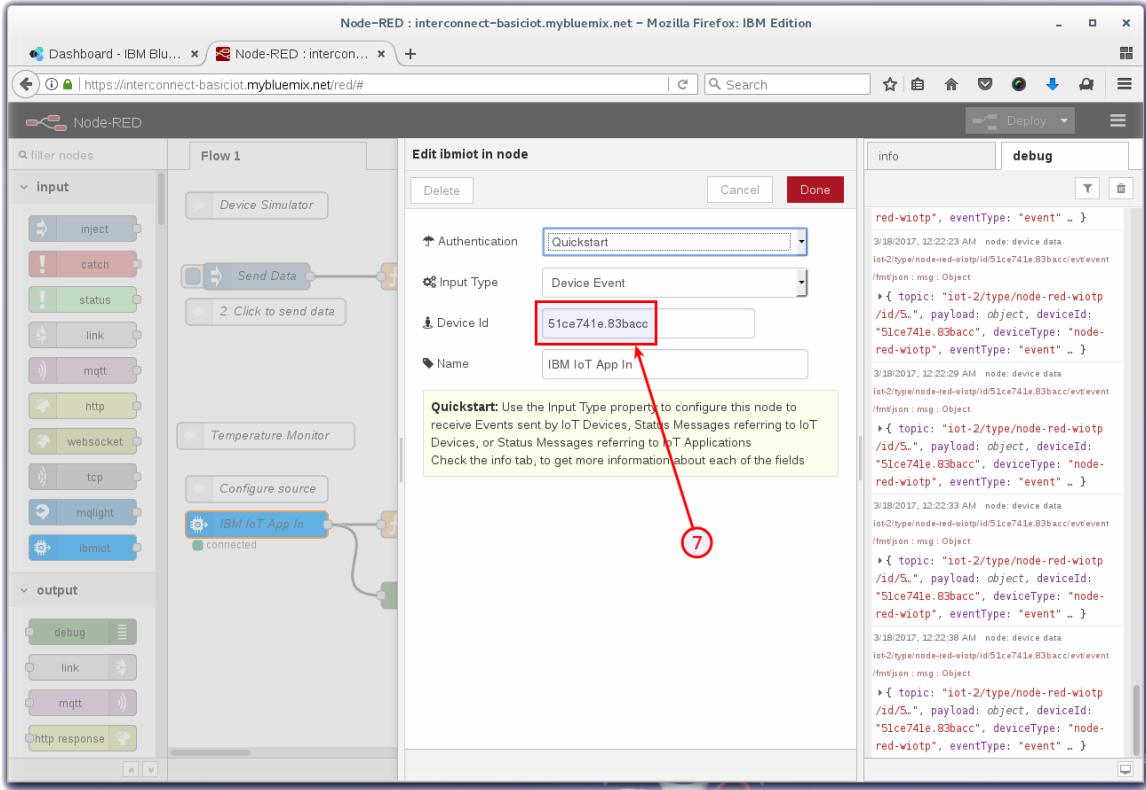
- Open your application by pressing the **View App** button.

- A new browser tab will open to the Node-RED start page. Node-RED is an open-sourced Node.js application that provides a visual editor that makes it easy to wire together flows. Click on the red button **Go to your Node-RED flow editor** to launch the editor.



- The IoT Starter app has a default flow that can be modified. To receive the Raspberry Pi SenseHAT data from your **Quickstart ID** within our new Bluemix application, click on the **IBM IoT App In** node (6).





- Authentication by default is set to Quickstart. Provide the Device Id (7) from the local Node-RED Watson IoT node in Lesson 2. You can Copy and Paste the Device Id between browser tabs.
- Click on the “temp” Function node. Fix up the temp function so that it extracts the **msg.payload.d.temperature** value that is being sent from the Raspberry Pi SenseHAT.

Edit function node

Name: temp

Function:

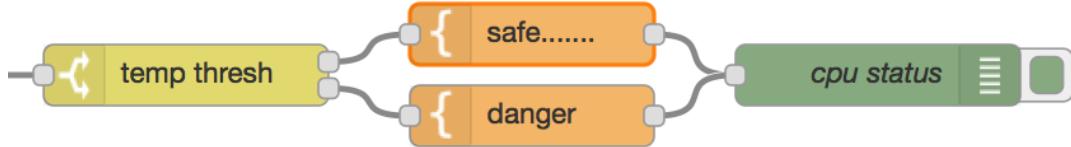
```
1 return {payload:msg.payload.d.temperature};
```

info debug

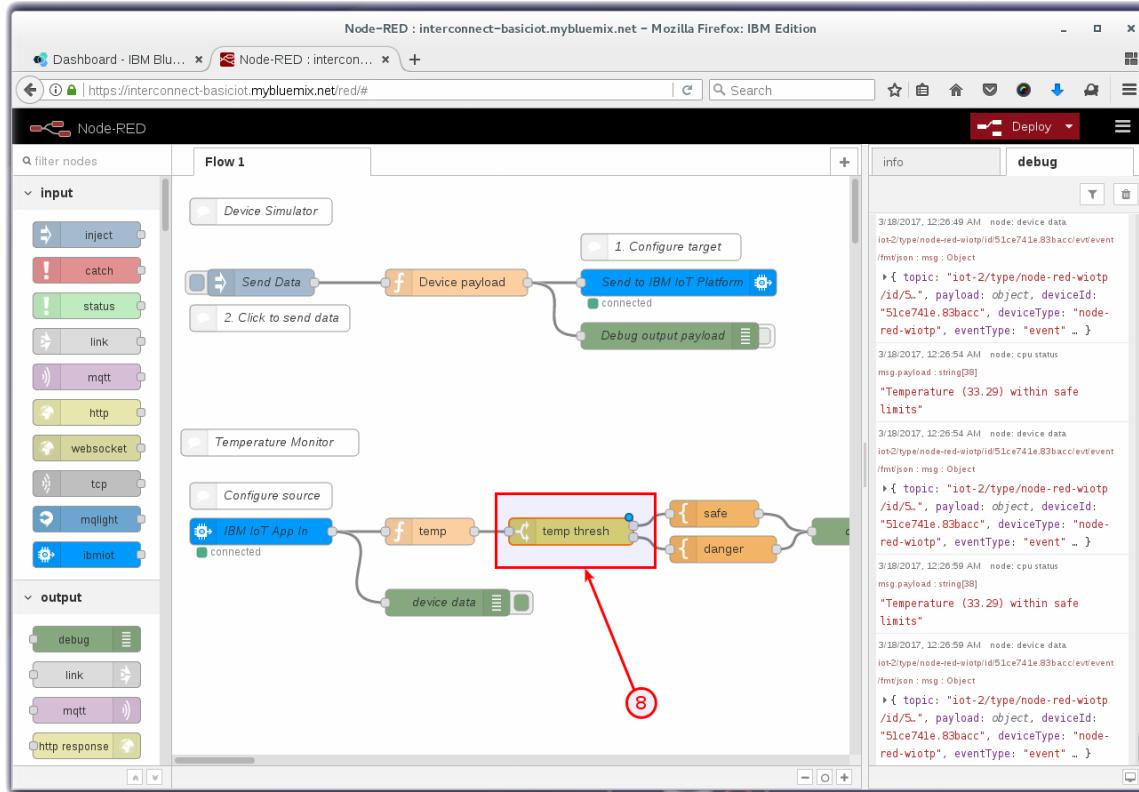
all flows current flow

```
iot-2/type/node-red-wiotp/id/51ce741e.83bacc/evt/event
/fmt/json : msg : Object
{
  "topic": "iot-2/type/node-red-wiotp
  /id/51ce741e.83bacc/evt/event/fmt/json",
  "payload": {
    "d": {
      "temperature": 32.92,
      "humidity": 37.36,
      "pressure": 1016.68
    },
    "deviceId": "51ce741e.83bacc",
    "deviceType": "node-red-wiotp",
    "eventType": "event",
    "format": "json",
    "_msgid": "e9d06dc5.162f9"
  }
}
```

- The yellow node is called a node. You can program logic using a switch node and split a flow into two or more flows based on a property's value. In this example, if the temperature is less than or equal to 30°C, it is considered “safe” and continues with the flow to the template labeled safe. If the temperature is greater than 30°C, it is considered “danger[ous]” and continues with the flow to the template labeled danger.



- Set the temp threshold calibrated to your SenseHAT by clicking on the temp thresh node (8).



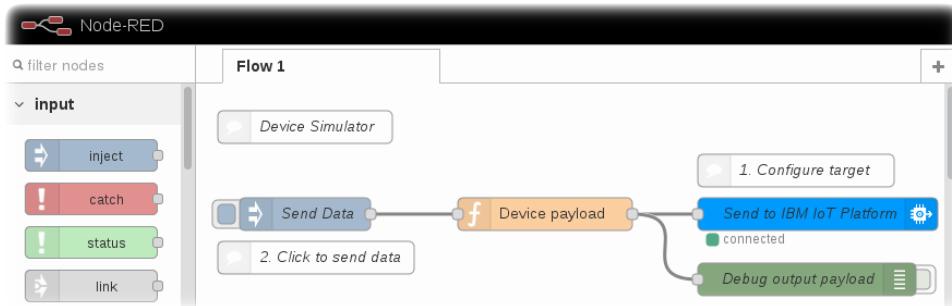
- Click on the button in the top right of the screen to save and deploy your changes.
- Click on the debug tab in the right-hand pane. Every 5 second, the SenseHAT emits a device event to the Watson IoT platform with temperature and other data. The Node-RED application subscribes to these events and the IBM IoT In node triggers the flow with the temperature data in the message. When the debug nodes are processed, contents of the message object are in the debug tab. Adding debug nodes can be helpful when something doesn't work right and you want to see the values being passed around. The Quickstart sensor data should appear in the debug tab and the Temperature is reported as Critical or Safe within our Bluemix Watson IoT application.

Lesson 5 – Send Twitter Feed Sentiment Alerts to a Raspberry Pi

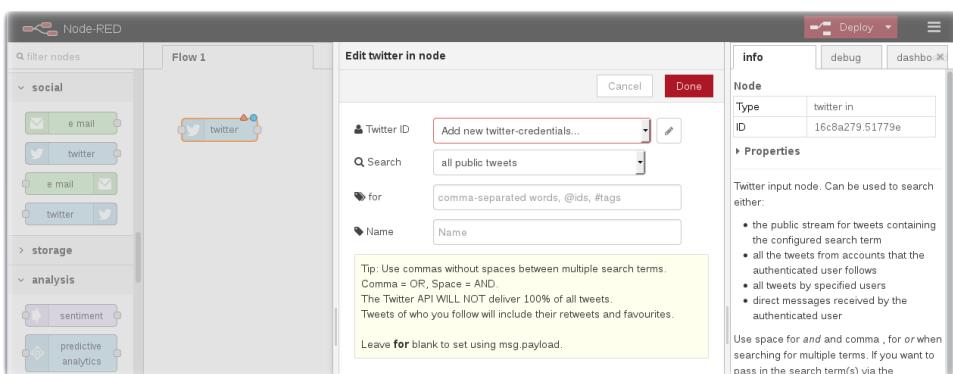
Until this point, the lessons have sent data **from** the Raspberry Pi **to** Watson IoT. Lesson 5 will send command data to the Raspberry Pi. Recall that in Lesson 3, the SenseHat LED red/green alert colors were set if the temperature exceeded a threshold value inside the switch statement. In this section, we will connect a Twitter account and analyze the Twitter feed using the Watson Sentiment API. The Sentiment score of the tweets will be sent to the Raspberry Pi and the SenseHat LED will display a range of sentiment colors.

Warning: These modifications will require changes on both the Bluemix Node-RED and on the local Node-RED flows. Be careful as you make changes in the two browser tabs. It is easy to become disoriented by which flow you are editing.

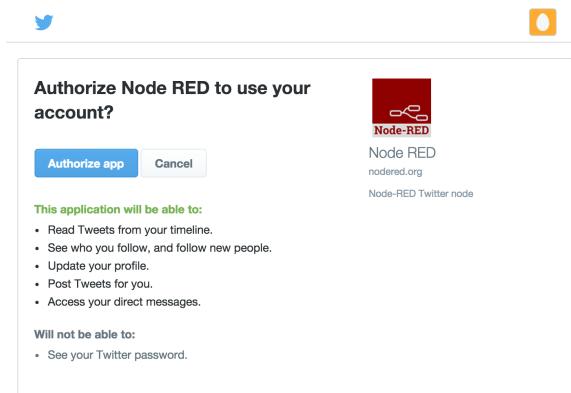
1. Let's start the modifications on the Bluemix Watson IoT Application side. Recall that the default flow for a Watson IoT Starter Application looks like this.



2. The “Device Simulator” and “2. Click to send data” comment nodes and “Send Data” inject nodes can be deleted and will be replaced by a Twitter input node.
3. Sign up for a Twitter account at <http://twitter.com>
If you already have a Twitter account, proceed to step 4.
4. Add a input node from the palette “social” section. Click on the twitter node and then click on the “Add new twitter-credentials...” pencil button.



- Authenticate with Twitter. The account you sign in with will be used to receive tweets.



- Return back to the node configuration. The settings for the Twitter node should have your username set. Click **Add**.

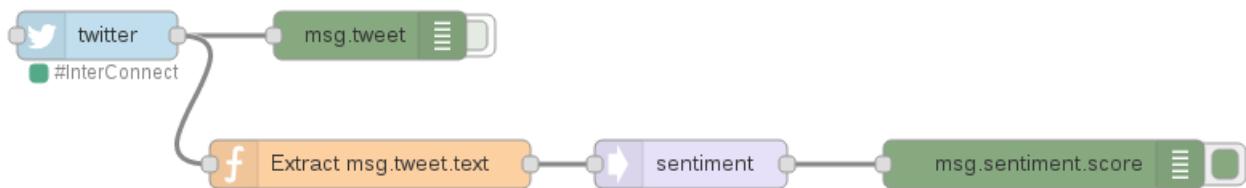


- Configure the twitter feed to “Search all public tweets” for your favorite #hashtag. You might want to analyze the sentiment of your local sports team – NCAA or College Basketball for instance – or the InterConnect Conference hashtag - #InterConnect
Be aware that there is a Twitter API rate limit to the number of tweets your application can receive. Following politics or trending topics might exceed your Twitter API limit and your application will pause until tomorrow.

- Confirm that the Bluemix application is receiving tweets by wiring the Twitter node to a Debug node that prints out msg(tweet). Press the Deploy button.



- Pass the Twitter messages to a function that extracts the msg(tweet.text) Wire the function node to the Watson Sentiment node for analysis. Wire the Sentiment node to a Debug node which reports the sentiment. Press the Deploy button. A score greater than zero is positive and less than zero is negative.



10. Recall that the default IoT Starter application sends simulated data that the default “Device payload” function generates. This function must be modified to send the sentiment score to the Raspberry Pi. The Raspberry Pi local Node-RED flow will set the color of the SenseHat LED display based on the sentiment of the tweets. If you double click on the “Device payload” function, select all of the javascript code and delete it. Replace it with this function.

Quickstart can only accept JSON events.

Example JSON device event: {"d":{"myName":"RaspberryPi", "temperature":989}}

```
// Create MQTT message in JSON
msg = {
  payload: JSON.stringify(
    {
      d:{
        "sentiment" : msg.sentiment.score
      }
    }
  );
}
return msg;
```

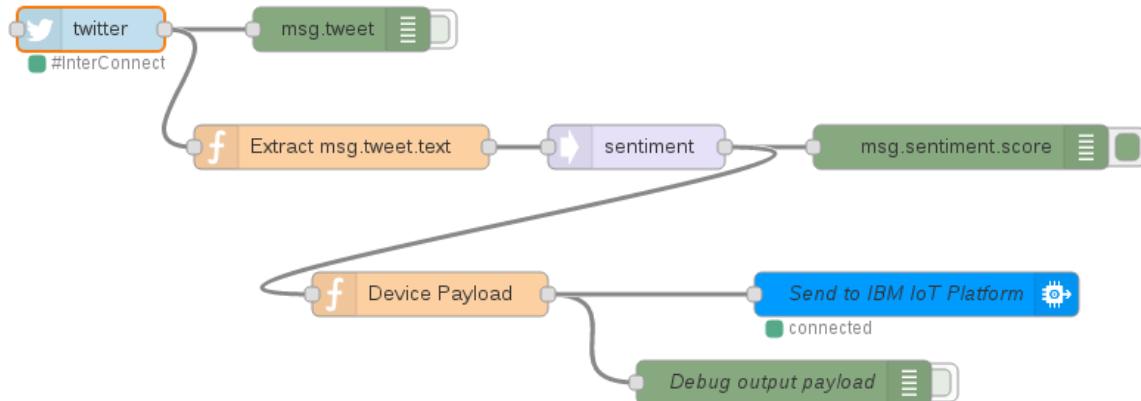
This flow is available at <https://github.com/johnwalicki/Interconnect-IoT-Labs>

11. The **Send to IBM IoT Platform** node needs to be configured to send the data to your Quickstart Id.

Click on the Send to IBM IoT Platform node and paste in the **Quickstart Device Id** from Lesson 2 and Lesson 4.

12. Remember to  Deploy this flow.

13. The new flow might look like this:



Receiving Bluemix Sentiment Score Alerts on a Raspberry Pi

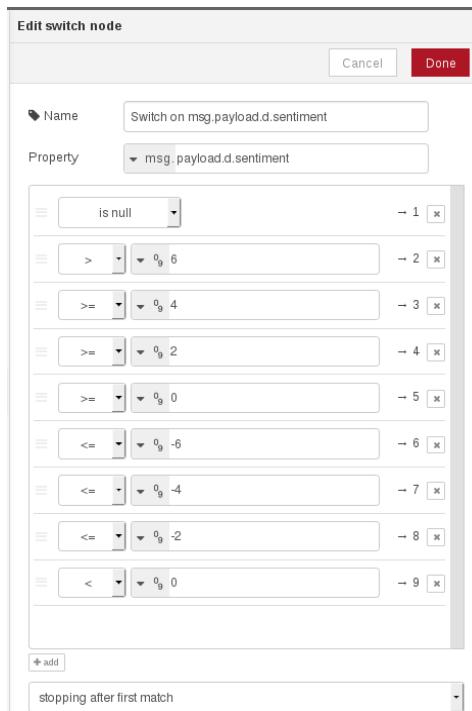
The local Raspberry Pi half of Lesson 5 will receive MQTT messages from your Bluemix application and act on the sentiment scores from a twitter feed. The Raspberry Pi SenseHat LED will display different colors depending on the sentiment.

A switch node and a series of function nodes will set the color to be sent to the Raspberry Pi SenseHat LED display. An alternative technique could implement the switch statement in a single function node and set the color, but the resulting picture (below) would be boring and not as snazzy in a workshop lab.

1. On the local Node-RED browser tab, a new Lesson 5 flow will be added. Create a new flow (press the + sign)
2. Drag a **IBM IoT** input node from the palette onto your flow.
3. Double Click on the IBM IoT Node to configure it with your Quickstart device ID from Lesson 2 and 5
4. Drag a Debug node and wire it to the IBM IoT Node. Click on Deploy to verify the flow is receiving sentiment scores.



5. Drag a **switch** node to your flow. Double click on the switch node and press the “+ add” button nine (9) times. Click on “stopping after the first match” and set the ranges as displayed in the figure below.

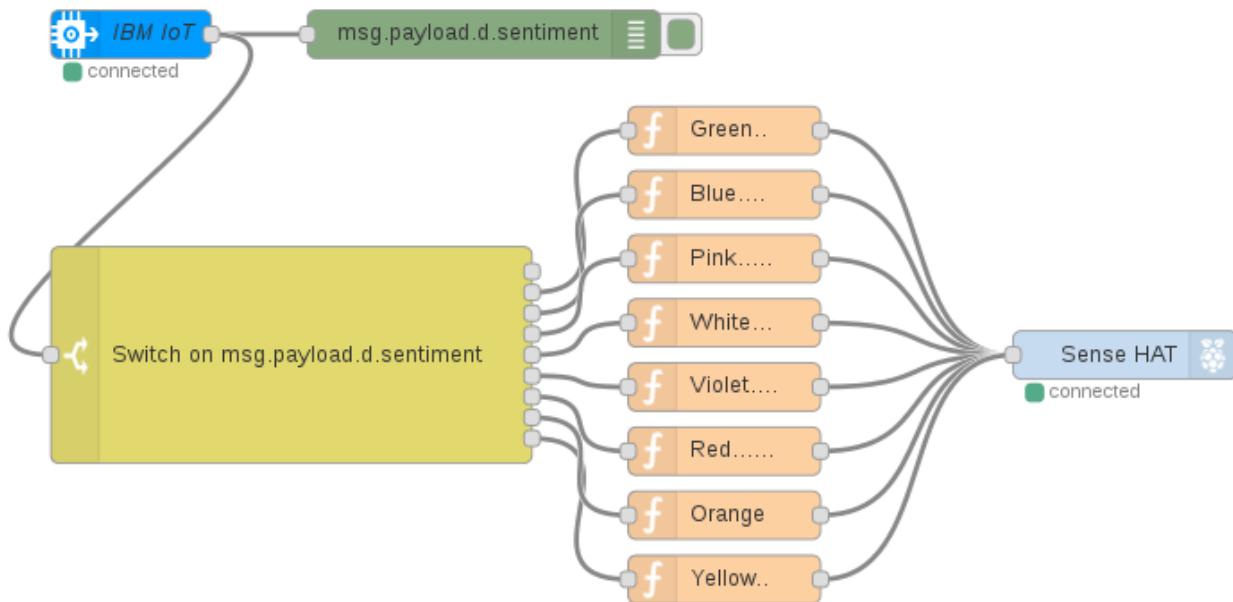


6. Drag eight (8) Function nodes to your flow and configure them to send, respectively; green, blue, pink, white, violet, red, orange, yellow color patterns to the SenseHat LED.

```
msg.payload = "*,* ,green";  
return msg;
```

7. Drag a Sense HAT Sense HAT output node to your flow.

8. Wire the nodes like this illustration.



9. This flow is available at <https://github.com/johnwalicki/Interconnect-IoT-Labs>

10. Menu → Import → Clipboard the paste into Node-RED

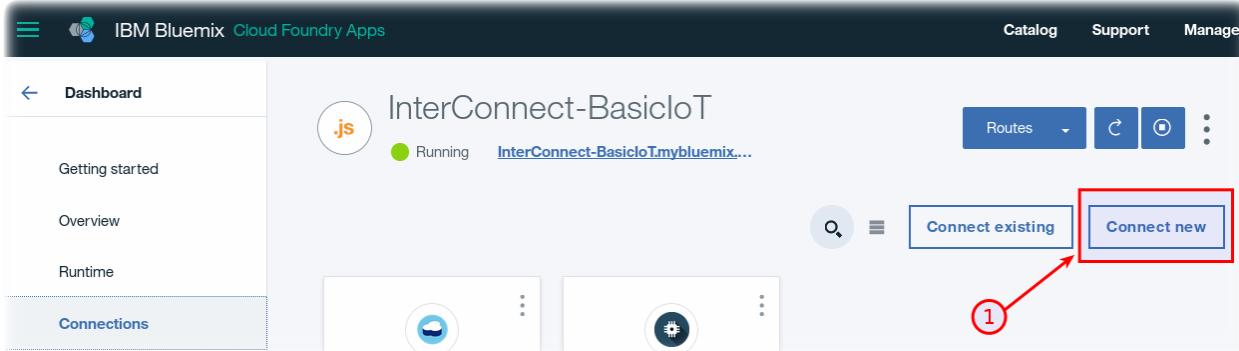
11. Click on Deploy to save and deploy your changes

Note: If your LED display starts blinking RED / GREEN, it is possible you didn't disable part of the Lesson 3 flow. Turn to that flow and delete the output wire to the SenseHat node. Don't delete the entire flow however. You might still want to send environmental sensor data to Watson IoT Platform.

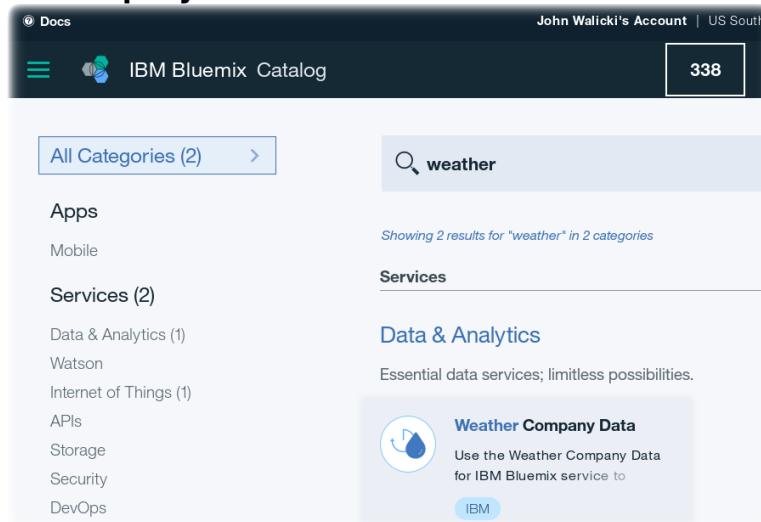
Lesson 6 - Send Weather Alerts to a Raspberry Pi

In this section, we will display the temperature of your favorite home town. The outside temperature will be retrieved via the **Weather Company Data for IBM Bluemix** service.

1. Return to the **Connections** tab of your Internet of Things Starter Application
2. Click on the **Connect New** button (1) of your Node-RED application in IBM Bluemix.



3. Select the **Weather Company Data for IBM Bluemix** under the Data & Analytics category.

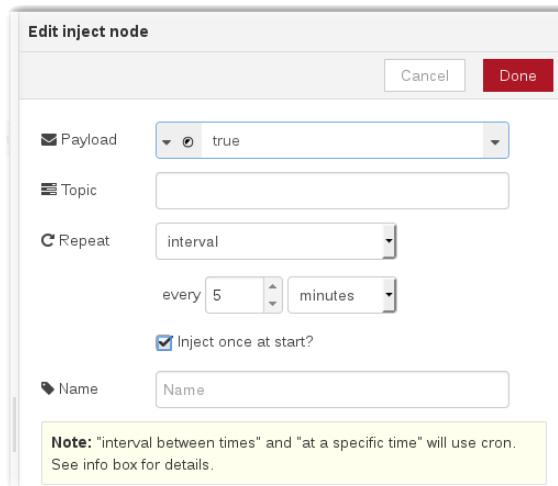


4. Click **Create** to add the service to your application.

- When prompted to restage the application, click **Restage** to restart the application and update the environment with the credentials to the Weather service.
- When the application has restarted, a third service tile will appear in the **Connections** tab.

The screenshot shows the IBM Bluemix Cloud Foundry Apps dashboard. The top navigation bar includes 'Docs', 'IBM Bluemix Cloud Foundry Apps', '209 Trial Days Remaining', 'John Walicki's Account | US South : walicki : dev', 'Catalog', 'Support', and 'Manage'. Below the navigation is a sidebar with links: 'Dashboard', 'Getting started', 'Overview', 'Runtime', 'Connections' (which is selected), 'Logs', and 'Monitoring'. The main area displays the 'InterConnect-BasicIoT' application. It shows three service tiles: 'InterConnect-BasicIoT-c...' (Cloudant NoSQL DB Lite), 'InterConnect-BasicIoT-i...' (Internet of Things Platform iotf-service-free), and 'Weather Company Data-zj' (Weather Company Data Free-v2). The 'Weather Company Data-zj' tile is highlighted with a blue border. Below each tile are 'View credentials' and 'Docs' buttons. To the right of the tiles are 'Routes', 'Connect existing', and 'Connect new' buttons.

- Return to your Node-RED application flows on Bluemix and add a new flow tab by clicking the +. Name the flow **Weather**
- Add a node as shown below. This will trigger the flow once at startup, and then every 5 minutes.





9. Add a node as shown below.

Edit weather insights node

<input type="button" value="Cancel"/>	<input type="button" value="Done"/>
Name	Get Current Weather
Service	Current Observations
Location	40.9793,-74.1165
Units	Imperial (English)
Language	en-US

Look up the Geocode of your home town and enter the Longitude,Latitude in the Location field. Do not enter any spaces. Note the – minus symbol / negative sign if you live in the western hemisphere.

10. Add a node as shown below.

Edit function node

<input type="button" value="Cancel"/>	<input type="button" value="Done"/>
Name	Construct IoT MQTT payload
Function	<pre>1 return { 2 payload: { 3 d: { 4 temp: msg.observation.temp 5 } 6 } 7 };</pre>

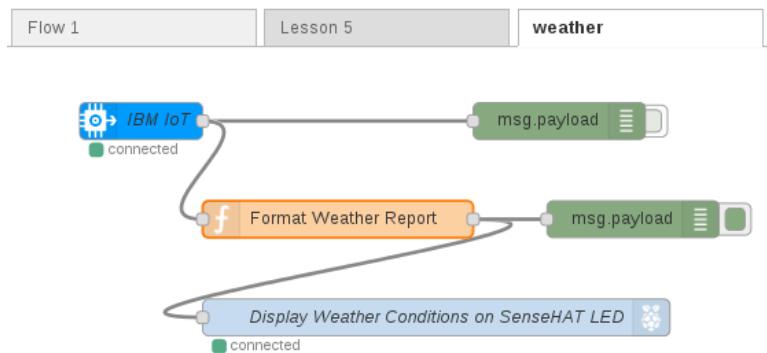
This will format the temperature in a MQTT message payload, for use in step #11. If the weather condition changes every 5 minutes, the value will be sent to the Raspberry Pi for display on the SenseHAT LED

11. On IBM Bluemix, connect the nodes together as shown below.



Get the Code:
<https://github.com/johnwalciki/Interconnect-IoT-Labs>

12.On the Raspberry Pi, connect the nodes together as shown.



Get the Code:
<https://github.com/johnwalciki/Interconnect-IoT-Labs>

13.Click on Deploy to save and deploy your changes.

14.**Note:** You will need to **disable** the SenseHAT output nodes created in Lesson 3 and Lesson 5 so that those flows do not overwrite the LED. The LED should display the outside temperature and will update the temperature from the Weather service every 5 minutes.

Lesson 7 Registered Watson IoT Platform Devices

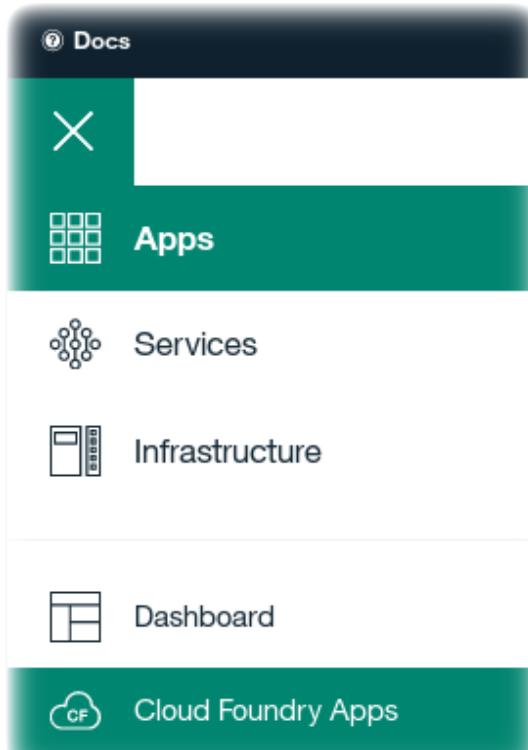
The IBM Watson IoT Platform is a fully managed, cloud-hosted service that makes it simple to derive value from Internet of Things (IoT) devices. When combined with the IBM Bluemix platform, Watson IoT provides simple, but powerful application access to IoT devices and data. You can rapidly compose analytics applications, visualization dashboards and mobile IoT apps. Create IoT applications that feed insights to your backend enterprise applications.

This section shows how one can setup an Watson IoT Organization and register devices in it. When you created the “Internet of Things Platform” Starter application in IBM Bluemix, a new Organization was created for you. This IBM Watson IoT Platform organization is a space used for connecting and managing devices to the IBM Watson IoT Platform, so that your applications can access their live and historical data.

1. Return to your Bluemix browser tab – <http://bluemix.net>
2. Click on the top left menu



3. Click on **Cloud Foundry Apps**



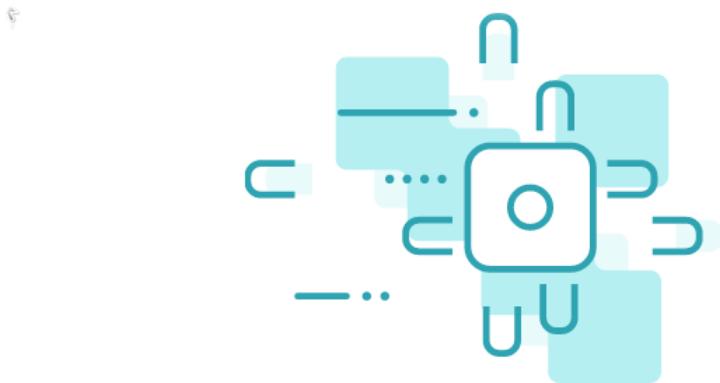
4. From the list of Cloud Foundry Applications, click on the left side of your Bluemix application to enter
5. Turn to the **Connections** tab (1)
6. Find the **Internet of Things Platform** tile (2) and click on it

The screenshot shows the IBM Bluemix Application Details interface. The left sidebar has 'Cloud Foundry' selected, with 'Connections' highlighted. The main area displays an application named 'InterConnect-Basicl...'. Below it, three service tiles are listed:

- InterConnect-BasiclT...**: Cloudant NoSQL DB Lite. Buttons: View credentials, Docs.
- InterConnect-BasiclT...**: Internet of Things Platform iotf-service-free. Buttons: View credentials, Docs.
- Weather Company Data...**: Weather Company Data Free-v2. Buttons: View credentials, Docs.

The 'InterConnect-BasiclT...' tile is highlighted with a blue border. The URL in the browser's address bar is: https://console.ng.bluemix.net/services/iotf-service/825268a8-18a6-4843-b98f-cee7897e5679?...f8-dd37e809eee3?panelId=connected-objects&bluemixUVVersion:v5&env_id=ibm:yp:us-south

7. Scroll down underneath the Welcome to Watson IoT Platform and press the **Launch** button.



Welcome to Watson IoT Platform

Securely connect, control, and manage devices. Quickly build IoT applications that analyze data from the physical world.

[Launch](#)

[Docs](#)

8. Click on the Devices chip logo.

A screenshot of the Watson IoT Platform dashboard. The top bar says "IBM Watson IoT Platform". The main area has a dark sidebar with three icons: a gear (highlighted with a red arrow), a lightbulb, and a person. The main content area is titled "Devices" and includes "Browse" and "Diagnose" buttons. Below that is a search bar with a "Device ID" placeholder.

9. Click on the **+ Add Device**

[+ Add Device](#)

10.Click on the **Create device type**

11.Create a gateway type

Create Gateway Type

General Information

Name

RaspberryPi

12.Name your gateway “RaspberryPi”

13.Press the **Next** button 3 times

14.Press the **Create** button

15.Now finally Add Device by pressing the **Next** button

16.Enter a Device ID name

Add Device

Device Info

Device ID is the only required information, however other fields are populated according to the attributes set in the selected device type. These values can be overridden, and attributes not set in the device type can be added.

Device ID

InterConnectSensehat

17.Press the **Next** button twice

18.**Provide a token** that you will remember

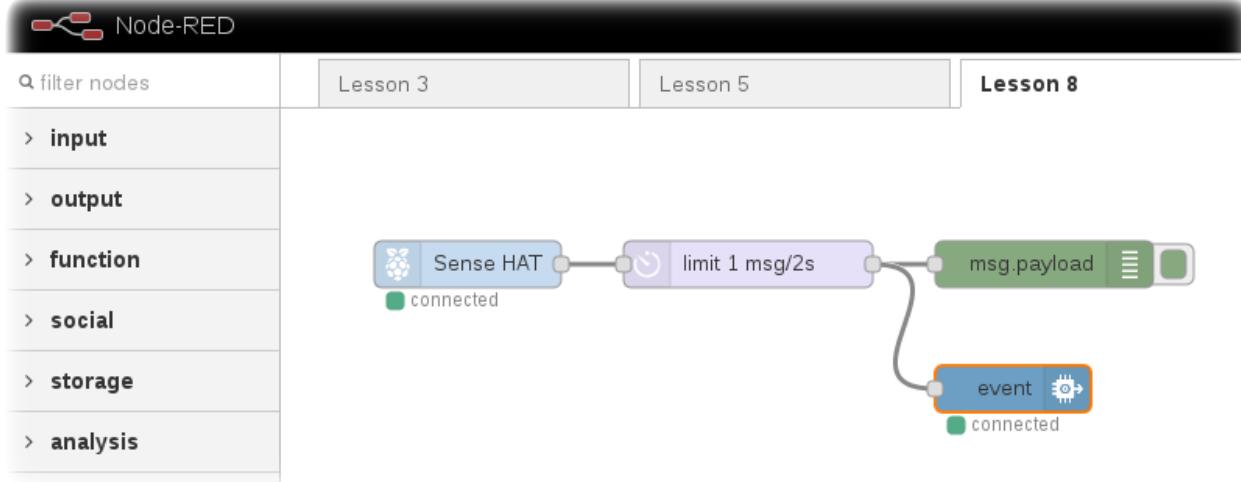
19.Press the **Next** button

20.Press the **Add** button

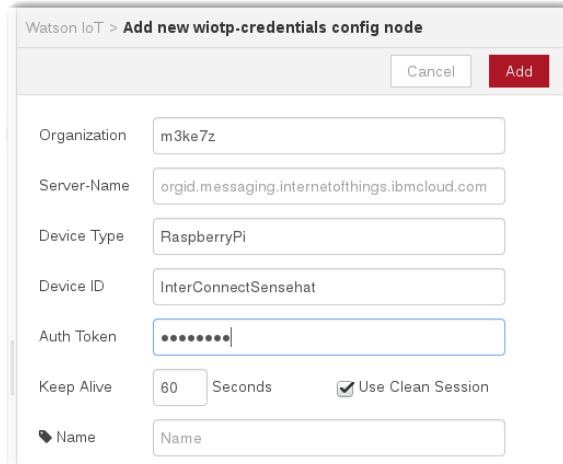
21.Take a screenshot of the **Device Credentials** summary page. **It is the only time that you will see the token.**

Lesson 8 Send SenseHAT Joystick data to Watson IoT

In this section, the Joystick data from the SenseHAT will be sent to the Watson IoT Platform registered device that was created in Lesson 7. Return to the local Node-RED browser tab and create a new flow by pressing the + sign. Name this flow “Lesson 8”



1. Drag a **SenseHat** node from the palette. Double click on it and only select the **Motion events** data.
2. There will be rapid motion data from the SenseHAT so limit the amount of data that is sent by adding a **delay** node. Set it to Limit to 1 msg per 2 seconds and check the “drop intermediate messages”
3. Drag a **Debug** node to the flow.
4. Press the **Deploy** button to observe the SenseHat data
5. Drag a **Watson IoT** output node from the palette onto your flow
6. Double Click on the Watson IoT Node to configure it with your WIoTP credentials
7. Enter all of the information from Lesson 7



8. Click on the Credentials pencil to enter your authentication token

9. Connect as a **Gateway**

The screenshot shows the 'Edit Watson IoT node' dialog box. At the top, there are 'Delete', 'Cancel', and 'Done' buttons. The 'Connect as' dropdown is set to 'Gateway'. The 'Credentials' dropdown is set to 'RaspberryPi/InterConnectSensehat'. The 'Device Type' field contains 'RaspberryPi'. The 'Device Id' field contains 'InterConnectSensehat'. The 'Event type' field contains 'event'. The 'Format' dropdown is set to 'json'. The 'QoS' dropdown has a value of '0'. The 'Name' field is empty.

10. Deploy the Flow

Visualizing Bluemix Watson IoT Application Sensor data

There are several ways to visualize the joystick data that is being sent from the Raspberry Pi SenseHAT to Watson IoT Platform. WIOTP has preconfigured dashboards called Boards that display Cards of the data.

1. Return to the Watson IoT Platform dashboard
2. You will find the Boards on the top of the list.
3. Click on the DEVICE-CENTRIC ANALYTICS card

The screenshot shows the 'All Boards' page of the Watson IoT Platform. On the left, there's a sidebar with various icons. In the center, under 'Your boards', there are two main sections: 'DEVICE-CENTRIC ANALYTICS' (containing 5 Cards) and 'RULE-CENTRIC ANALYTICS' (containing 6 Cards). Each section has a 'Sort By' dropdown set to 'Recently changed'. At the top right, there's a '+ Create New Board' button and a user profile with ID 'm3ke7z'.

4. You will see Device Info and Device Properties with the latest joystick data

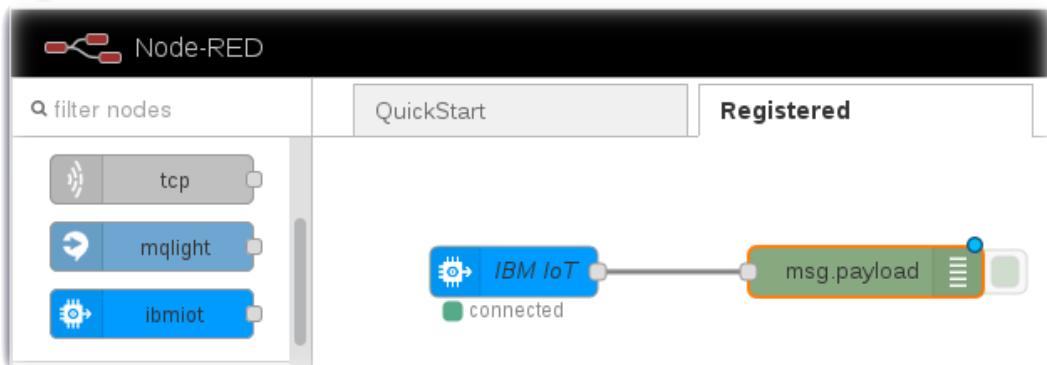
The screenshot shows the 'Device-Centric Analytics' dashboard. A red circle labeled '1' points to the title bar. Another red circle labeled '2' points to the 'Device Info' card on the right, which displays device details like name, type, and client ID. A third red circle labeled '3' points to the 'Device Properties' card below it, which shows a key-value pair: 'key' and 'LEFT'. The sidebar on the left includes icons for device management, rule creation, and alerting.

5. Return to your Bluemix Node-RED browser tab

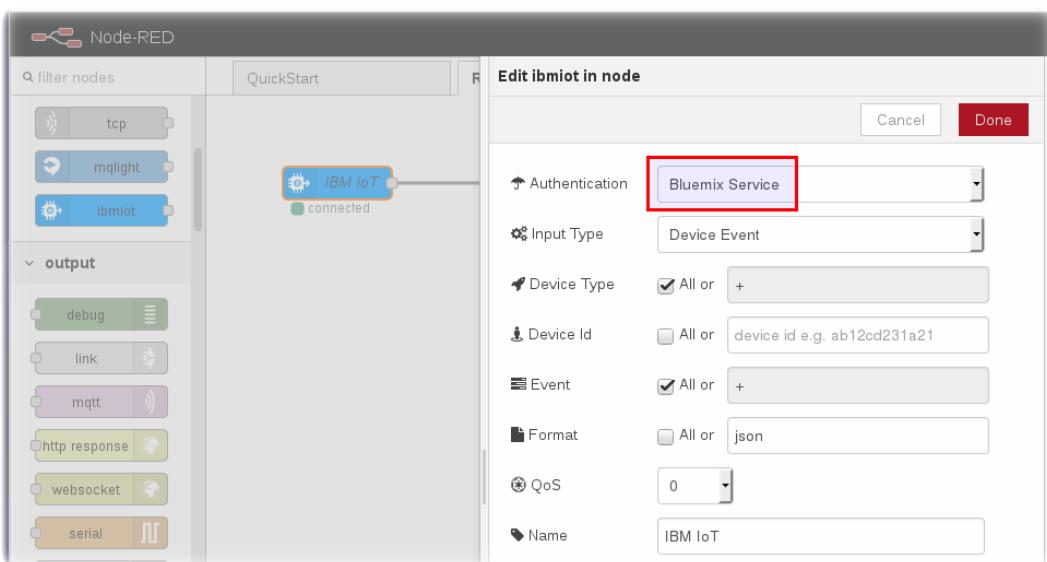
Node-RED Bluemix Watson IoT App Joystick Sensor data

In this section of Lesson 8 you will create a Node-RED flow on your Bluemix Watson IoT Application which receives joystick sensor data from the Raspberry Pi gateway and SenseHAT sensor device. Tweet and text the Up / Down / Left / Right alert.

1. Create a new flow by pressing the + in the upper right corner of the Node-RED visual programming editor.
2. Name the flow “Registered” by double clicking on the tab. Name the first flow “Quickstart” by double clicking on that tab.
3. Drag a **IBM IoT input** node onto the canvas
4. Drag a **Debug** output node onto the canvas



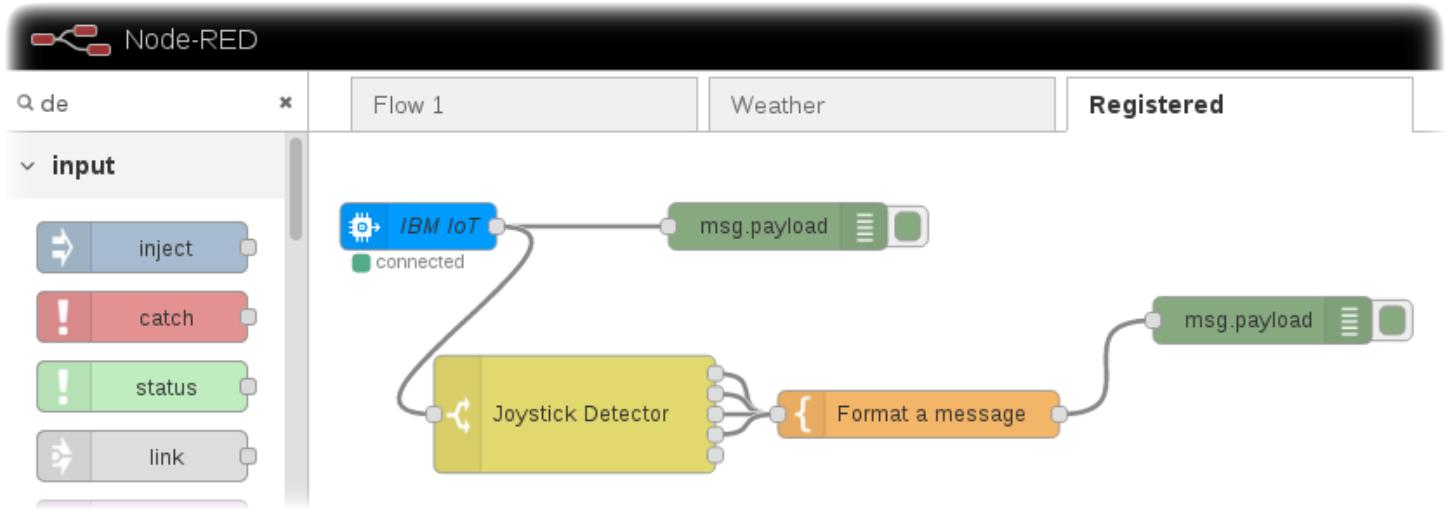
5. Wire the two nodes together
6. Double Click on the IBM IoT node. Once you select the Authentication as **Bluemix Service** it already knows your credentials.



7. Click on Deploy to save and deploy your changes.
8. You should see joystick data from the SenseHAT in the Debug tab.

9. Next we will create a Joystick Detector switch node that reports the joystick events.

10. Add these nodes as shown below.



These flows are available at <https://github.com/johnwalicki/Interconnect-IoT-Labs>

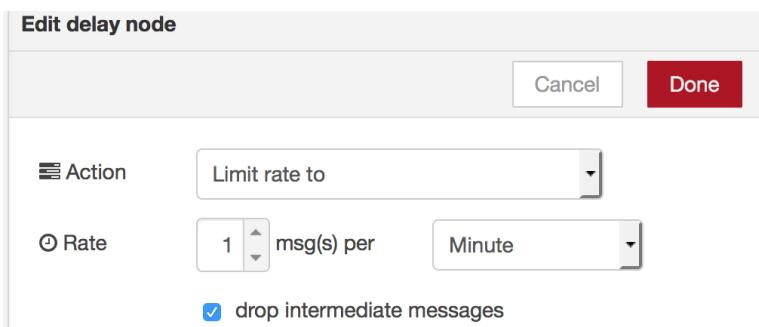
Lesson 9 - Connect to Twitter - Tweet Joystick events

In this section, we will connect a Twitter account and use the Twitter account to tweet when the joystick from the Raspberry Pi SenseHAT is pressed. This section is optional and may be skipped.

1. Sign up for a Twitter account at <http://twitter.com>

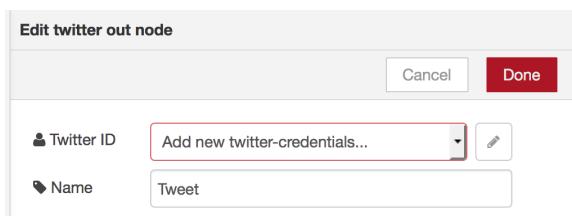
If you already have a Twitter account, proceed to step 2.

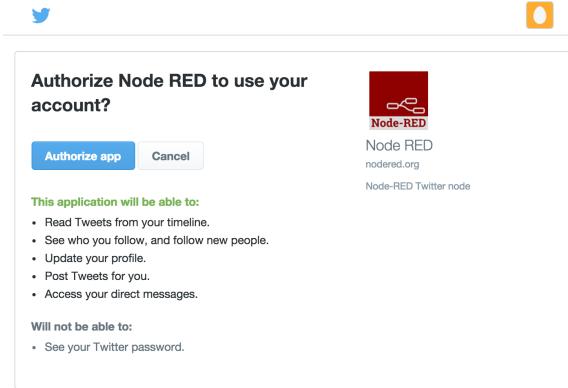
2. Add a  node as shown below.



The delay node limits how often the flow is run. Since the joystick can be set off often, without this node, a tweet would be sent every second. With this node limiting messages to once a minute, the Twitter node will send a tweet once a minute dropping any additional messages during the 60 second timeframe.

3. Add a  node. Click on the pencil button and authenticate with Twitter. The account you sign in with will be used to send tweets.

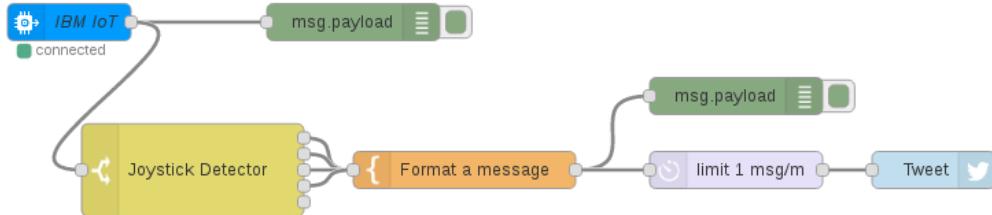




Return back to the node configuration. The settings for the Twitter node should have your username set. Click **Add**.



4. Connect the nodes as shown below.



5. Click on to save and deploy the changes.

6. Press your Raspberry Pi / SenseHat joystick. Be careful not to unplug it from the microUSB power.
7. The Alert template will compose a message, and pass it to the Twitter node. The Twitter node uses this message as the content for the tweet.
8. Visit the Twitter timeline for the user you authenticated with and verify the message has been tweeted.



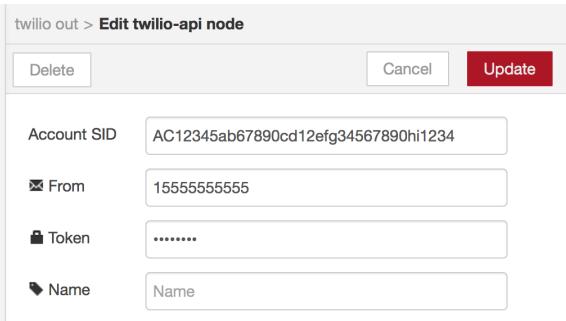
Lesson 10 - Use Twilio to Text Joystick events

In this section, we will connect a Twilio phone number to the application and send a text message notification when a Joystick event occurs. This section is optional and may be skipped.

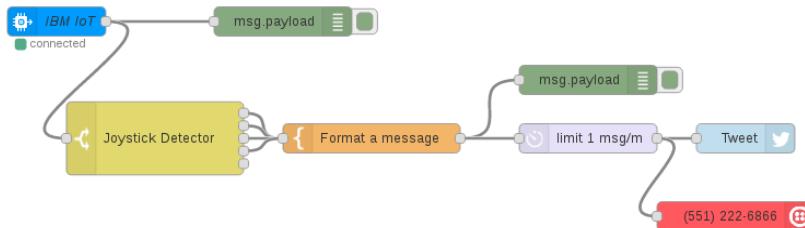
1. Sign up for a Twilio account at <http://twilio.com>. If you already have a Twilio account, sign in. Create a Twilio phone number that will be used in step #3.
2. In the Console Dashboard, click on the lock icon next to Auth Token. Copy the Account SID and Auth Token.

The screenshot shows the Twilio Console Beta dashboard. On the left, there's a sidebar with links for Home, Dashboard, Account, Billing, Logs, Usage, and What's New. The main area displays 'Account Summary' with fields for ACCOUNT SID (AC12345ab67890cd12efg34567890hi1234), AUTH TOKEN (a12b34c567d8ef981234567890123456), and BALANCE (+ \$6.632). A note says 'Auto Recharge is OFF'. Below this are sections for Recently Used Products (Programmable SMS, Phone Numbers, Programmable Voice, Add-ons) and All Twilio Products (Programmable Voice, Programmable Video).

3. Add a node. Click on the Pencil to provide your **Account SID** and **Auth Token** from step #2, and **From** phone number using the Twilio phone number from step #1. Fill in the **SMS to** textbox with a phone number that will be texted to.



4. Connect the nodes together as shown.



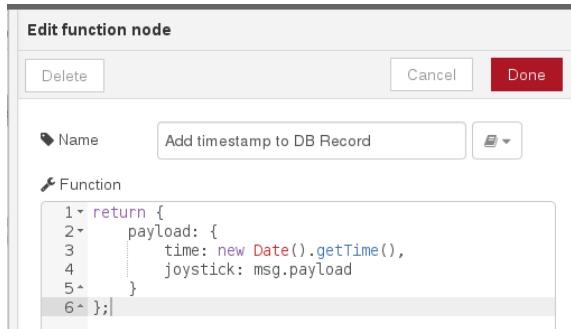
Get the code:
<https://github.com/johnwali/cki/Interconnect-IoT-Labs>

5. Click on to save and deploy the changes.
6. Press the Sensehat joystick on the Raspberry Pi. You should receive a text message shortly.

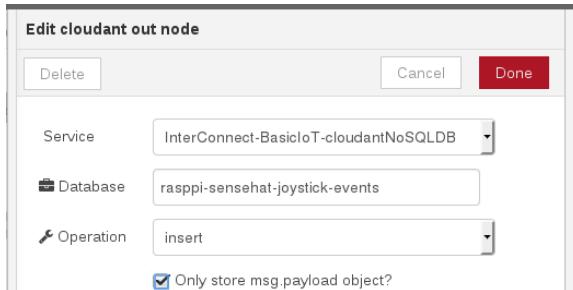
Lesson 11 - Store Joystick Events in a Cloudant NoSQL Database

This section will show how to add a Cloudant NoSQL database to the Node-RED application and store joystick reports (one per minute). This functionality can be useful to run historical analysis (outside the scope of this lab) or find patterns over time. This section is optional and can be skipped.

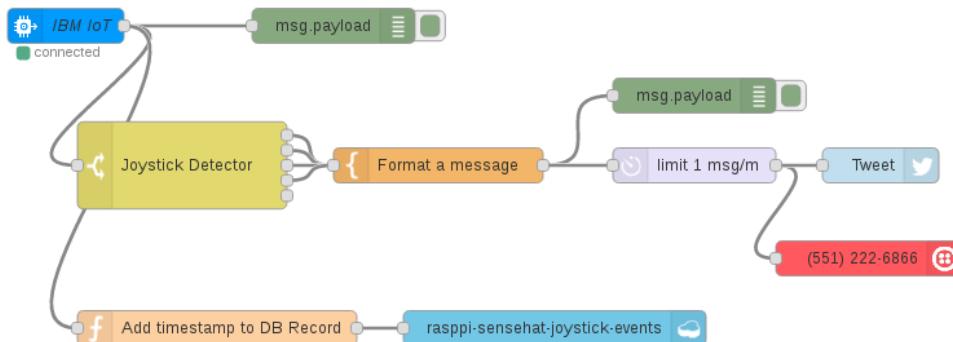
1. Add a  node as shown below.



2. Add a  node as shown below. Name your database using lowercase characters.



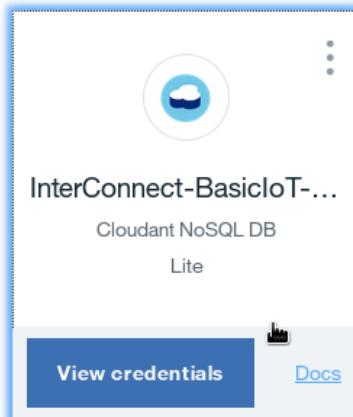
3. Connect the nodes together as shown below.



Get the Code:
<https://github.com/johnwalicki/Interconnect-IoT-Labs>

4. Click on  to save and deploy your changes.

5. Go back to the IBM Bluemix application dashboard and the **Connections** tab. Click on the **Cloudant NoSQL DB** service tile.



6. Click on the **Launch** button.

The screenshot shows the 'InterConnect-BasicIoT' service details page. The top navigation bar includes 'Docs', '209 Trial Days Remaining', 'John Walicki's Account | US South : walicki : dev', and 'Catalog', 'Support', 'Manage' buttons. Below the navigation is a breadcrumb 'InterConnect-BasicIoT' and the service name 'InterConnect-BasicIoT-cloudantNoSQLDB'. The main content area has tabs for 'Manage' (selected), 'Service credentials', 'Plan', and 'Connections'. Under 'Manage', there is a section for 'Cloudant NoSQL DB' with a 'LAUNCH' button.

7. This is the Cloudant NoSQL database dashboard. A list of databases is displayed. The database named **raspi-sensehat-joystick-events** contains documents representing each joystick event that has been received by the Node-RED application. Click on the database named **raspi-sensehat-joystick-events**

The screenshot shows the Cloudant NoSQL database dashboard. The left sidebar has links for 'Monitoring', 'Databases' (selected), 'Replication', 'Analytics', 'Active Tasks', 'Account', 'Support', and 'Documentation'. The 'Databases' section has a 'Create Database' button and a table with the following data:

Name	Size	# of Docs	Actions
_replicator	3.7 KB	1	
_users	66.6 KB	0	
nodered	107.6 KB	4	
raspi-sensehat-joystick-events	14.5 KB	11	

At the bottom, it says 'Showing 1-4 of 4 databases.' and has navigation arrows.

8. To see the expanded view of the documents, click on **Query**, check the box to include **Docs**.

9. Each box represents one document (in our case one joystick event) that contains the payload (time and joystick position) we stored earlier.

```

1+ {
2 "id": "797ce6d4a28f1a45c9c6dee4a15e5915",
3 "_rev": "1-1656eafcbc51b54afac8a1b89398a37",
4 "time": 1489848217644,
5 "joystick": {
6   "d": {
7     "key": "UP",
8     "state": 1
9   }
10 }
11 }

```

Additional Raspberry Pi / SenseHAT Resources

In this final section, we will challenge the workshop attendees to implement additional SenseHAT projects.

There are many Raspberry Pi Recipes available at:

<https://developer.ibm.com/recipes>

An excellent Marble Maze project is great fun:

Connecting a Sense HAT to Watson IoT using Node-RED

<https://developer.ibm.com/recipes/tutorials/connecting-a-sense-hat-to-watson-iot-using-node-red/>