TECHNOLOGY CAMP

DAY 4 : INTERNET-OF-THINGS

IoT Device Inputs & Outputs

Session 4

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Teacher Lesson Plan

IoT Device Inputs & Outputs

Session Name:

IoT Device Inputs & Outputs

Summary:

Internet-of-things devices receive inputs from a variety of sources and provide outputs to many different destinations. In this lesson, we will be building IoT devices that receive input from various sources, and provide outputs based on the inputs received.

Time Allotment:

65 minutes

Learning Objectives:

- *Build an IoT device to receive input from email and output a notification by lighting an LED*
- *Describe more common nodes and their uses*
- *Build an IoT device that accepts both manual and cloud inputs & outputs*

Supplies:

- *Scrap paper / notepad to take notes*
- *Laptop / computer with Internet access*
- *Raspberry Pi and connected breadboard with pre-built circuits*

Learning Activities:

- **(3 minutes) - Session overview**

  In the internet of things, devices both receive inputs from a variety of sources and provide outputs. In this lesson, we will be building IoT devices that receive input from various sources, and provide outputs based on the inputs received.

Students build an IoT Device to receive input from email and outputs a notification by lighting an LED, learn about common nodes and their uses, and build an IoT device that accepts both manual and cloud controls.

- **(4 minutes) – Node Review : Inject node, Debug node, GPIO output node**

  During the review, encourage students to discuss their experiences with the nodes. What worked well or presented them with challenges, and how they addressed those challenges.

  - *The inject node inserts (injects) a message, known as a payload into the flow. When first dropped on the workspace, the node defaults to timestamp, but edited to inject other payloads as selected from the drop down menu*
  - *The debug node displays either the message payload or the complete message object. The message can be output in to several different locations.*
  - *The rpi gpio output node (note the logo on the right) allows for message payloads (values) to control the state of GPIO pins to control IoT devices.*

- **(3 minutes) – Node Review : Function node, Switch Node**

  - *The function node allows for the addition of JavaScript code. Messages received by the function node can be processed by the JavaScript code and then return a message, message object(s), or nothing (ending the flow).*
  - *The switch node evaluates a received message based on a hierarchy of pre-defined rules. The switch can be set to stop at the first match or run through all the rules in the switch. Once the evaluation is complete, the switch routes message on based on the flow design.*

- **(3 minutes) – New Nodes : Email in node, Trigger node**

  - *The email in node polls an email account for an incoming message. If a message is received, msg.topic and msg.payload are populated. Depending on the requirements of the flow, msg.html, msg.from and msg.date are also*

available. Only 1 message is received per polling period, so multiple polling periods may be necessary to receive all incoming email.

- *The trigger node will send a message based when triggered by an input. This node can be triggered by receiving a msg.payload from another node.*

- **(2 minutes) - Video : Blink a led light on a Raspberry Pi using Node Red**

  https://www.youtube.com/watch?v=5Y5yHONKFt4

  Explain that this video shows the use of the twitter node. If learners have a twitter account, they can try this activity during the open lab time at the end of the lesson.

- **(3 minutes) - Lab: Raspberry Pi Set up**

  (Confirm that all students have both VNC and Node-RED running and open on their laptops before proceeding. Follow these instructions only if any students shut down their Raspberry Pi at the end of the last lesson)

  - *Please **do not** unplug or turn off the PI without shutting it down from the App Menu ( in the upper left corner). Doing so could corrupt the SD card.*

  - *Open your laptop and double click on the VNC Viewer icon.* 
  - *Login using the default credentials:*
  - *UserID: pi*
  - *Password: raspberry*

- *When the Raspberry Pi desktop appears, click on the VNC icon*  *in the upper right and note your IP address listed under Connectivity*

- *Open a new browser tab and enter **http://{Your IP Address Here}:1880** to start Node-RED*

- **(15 minutes) – Activity : LED Notification / Email Received**

In this lesson, we will build an IoT notification device that polls a designated email account and responds with a notification light (LED) when an email is received. This lesson demonstrates how IoT devices can both receive inputs independently and provide outputs for users.

1. *Open the Node-RED tab in your browser and open a new workspace by clicking on the + tab button. Name the new tab "Email Alert"*

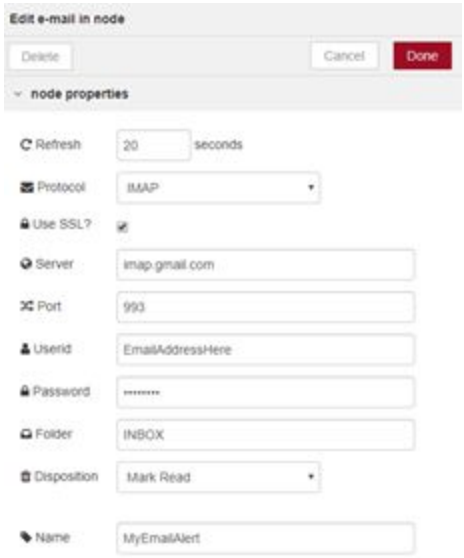
2. *Navigate to the tab from the prior lesson where you created the software buttons to control the LED. Select the rpi gpio node (in the example, Red LED) and Ctrl+C to copy. Then navigate back to your new tab (e.g. Email Alert) and Ctrl+V to paste. Select the location for the node and left click to set it on the workspace.*

3. *Select a debug node and drop it on the workspace near the rpi gpio node from step 2.*

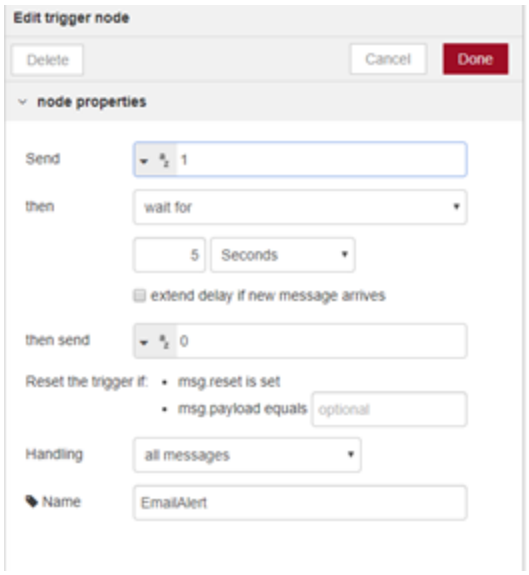
4. *Select an email node and place it near the left side of the workspace. This node will begin the input for our flow by polling and retrieving email.*

   Important: (As discussed in Session A, to access the Google SMTP server. Your Google account must be set to allow "Less secure App access". The setting is available from your Google Account Settings Security Tab.

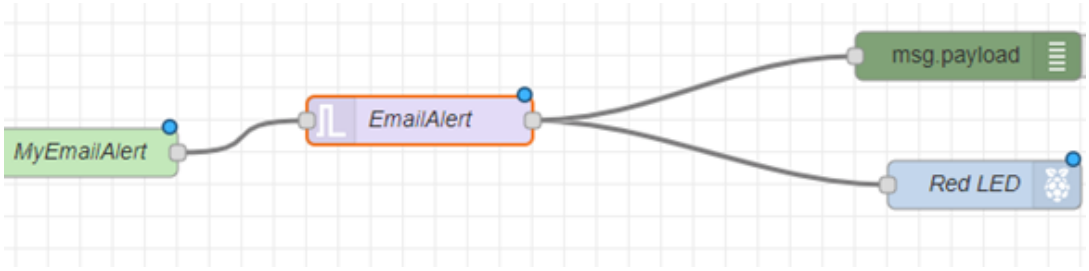
5. *Complete the email node properties as below and select Done.*



6. *Select a trigger node and place it between the email node and the rpi gpio node. Set the properties as below and select Done.*

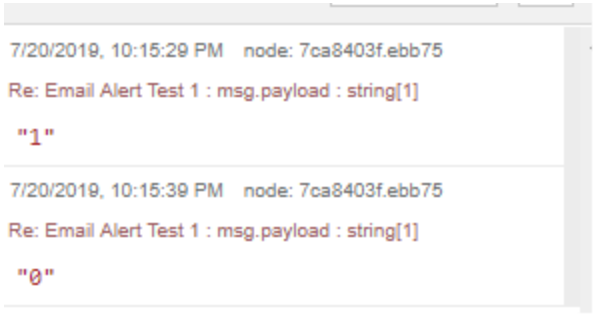


7. *Connect the email node to the trigger node, and the trigger node to both the debug node and the rpi gpio node, and deploy.*



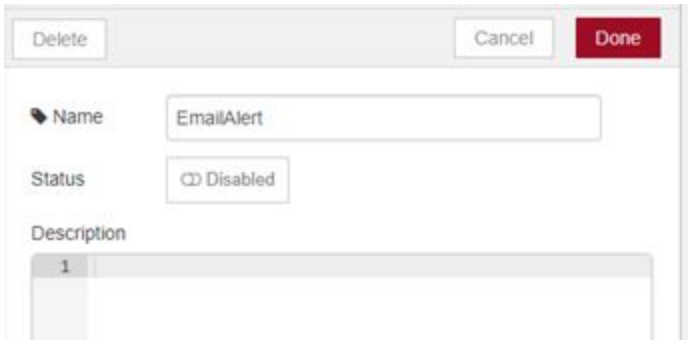
8. *Open another browser tab and login to your email account. You will be able to test the flow by sending emails to yourself. Send an email to yourself and watch the LED for the notification.*

9. *The LED will light when an email is received and the debug screen will display the payload sent to the rpi gpio when the LED is triggered and when it is reset*



10. *Send several emails in quick succession and note that only 1 email is returned per polling period. Send another email, and watch the flow run. Note that the email node displays connecting and fetching messages each time it polls the email account.*

11. *To stop the flow from continuing to run, double click on the tab (Email Alert), change the slider to disabled, select done, and then deploy.*

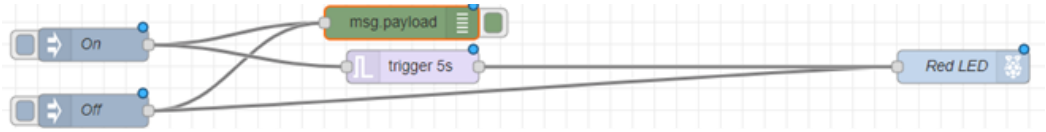


12. *You will notice that the tab now displays a stopped symbol and the name is greyed out.*

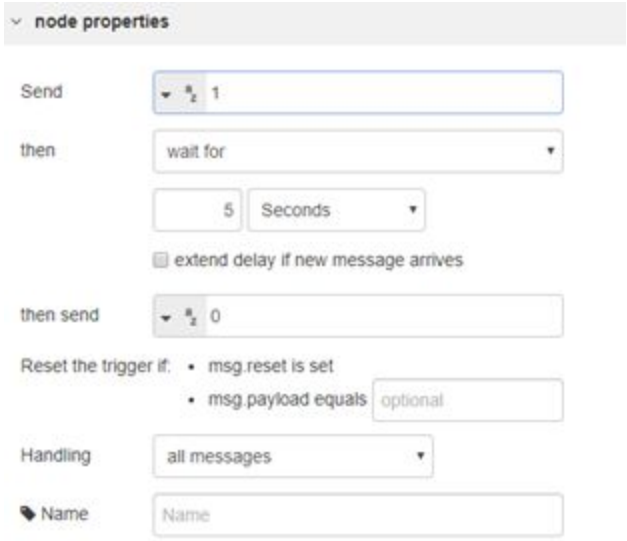
- **Optional Activity**

  If the previous activity allowed extra time to allow polling and to address any potential connection issues with student Gmail accounts. If, students complete the activity sooner than expected, you may demonstrate another use of the trigger node to create a timer.

  1. *Open the Node-RED tab in your browser and open a new workspace by clicking on the + tab button. Name the new tab "Timer"*
  2. *Navigate to the tab from the prior lesson where you created the software buttons to control the LED. Select all of the nodes by holding down Shift and clicking on each node, then enter Ctrl+C to copy.*
  3. *Navigate back to the "Timer" tab, then enter Ctrl+V to paste.*
  4. *Select a trigger node and drop it on the line between the (On) inject node and the (Red LED) rpi gpio node. The trigger node will automatically be wired between the two nodes.*



  5. *Since this is a demonstration, we will set a short 5-second timer. Note that by adjusting the values under then wait for, you can modify the timer to run for milliseconds, seconds, minutes, or hours. Set the values as below, select done, and deploy.*



6. *Press the On button and the LED will light for 5 seconds and go out. Reversing the Send and then send values of the trigger will create a timer that waits for 5 seconds from the button push to light.*

7. *Note that you will need to use the Off button, as the LED will remain on once triggered.*

- **(15 minutes) – Activity : Cloud and Manual Control LED**

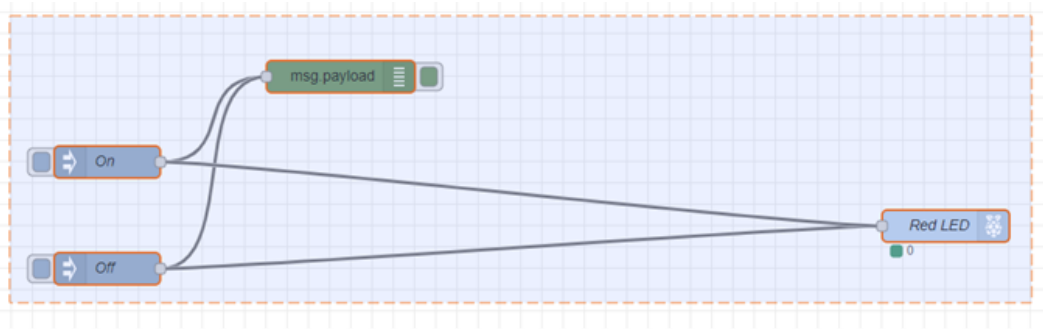
  So far we have built our flows from scratch, but in this activity, we will be importing a flow built by a developer named IgnacioRubio. The flow is written in JSON (JavaScript Object Notation). The original can be found at:

  https://flows.nodered.org/flow/3dbd62dfa8f6db78a598d0c7263f0f97

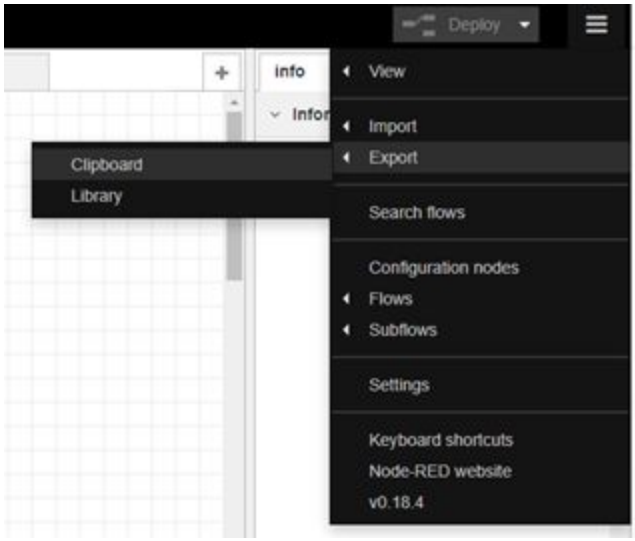
  1. *Open a new workspace by clicking on the + tab button. Name the new tab "Dual Control".*

  2. *Navigate to the tab from the prior lesson where you created the software buttons to control the LED.*

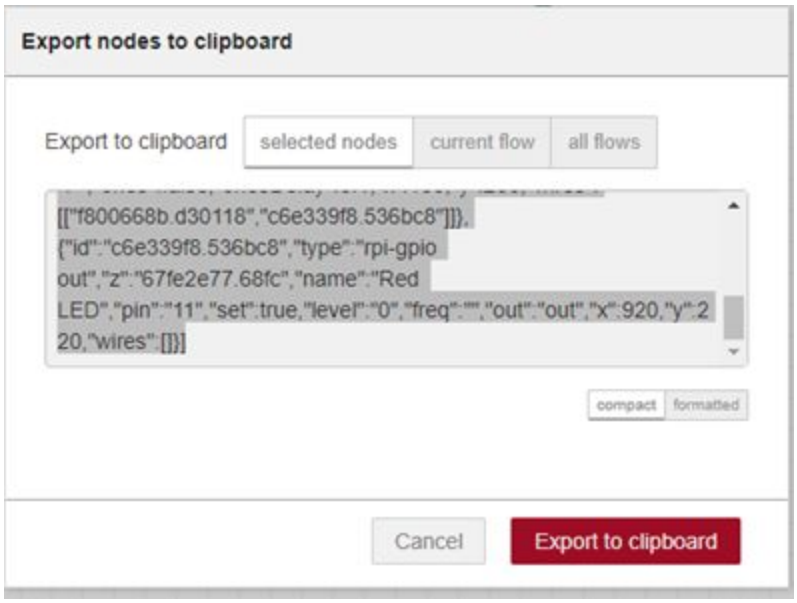
3. *With the cursor in a "+" shape over an open area of the workspace, select an area that contains all of the nodes.*



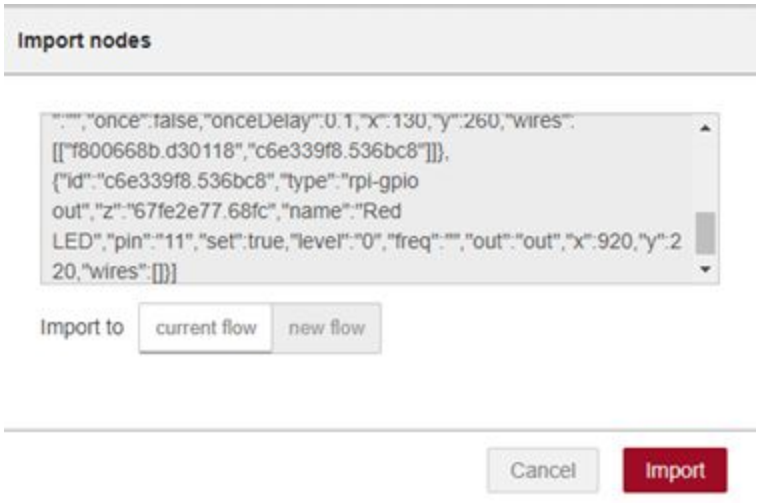
4. *Select the hamburger menu in the upper right>Export>Clipboard*



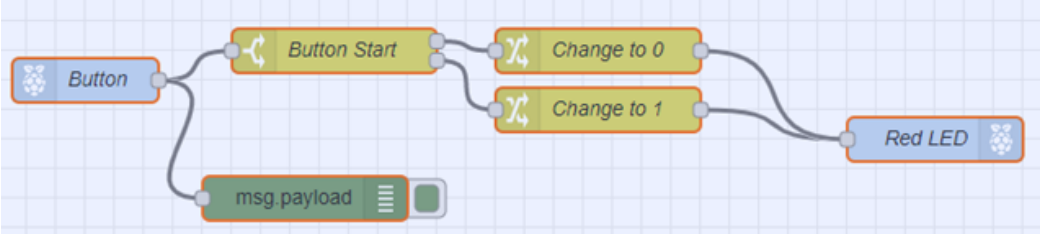
5. *Select the Export to clipboard button*



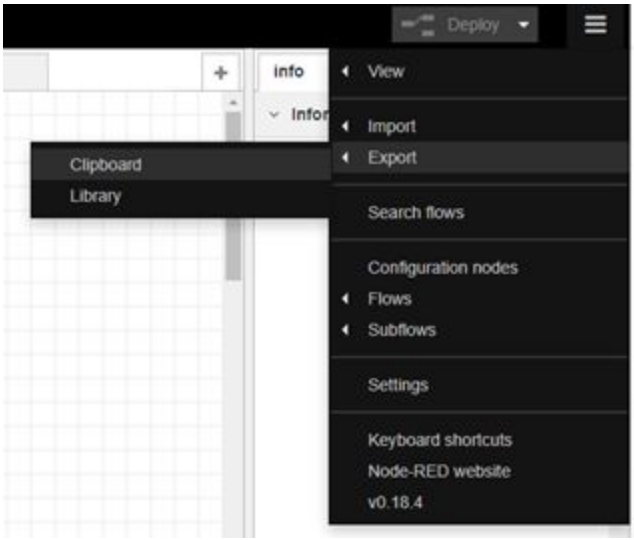
6. *Navigate to the Dual Controls tab and select Import>Clipboard*
7. *Ctrl+V in the Paste nodes here space. Confirm that current flow is selected and select Import*



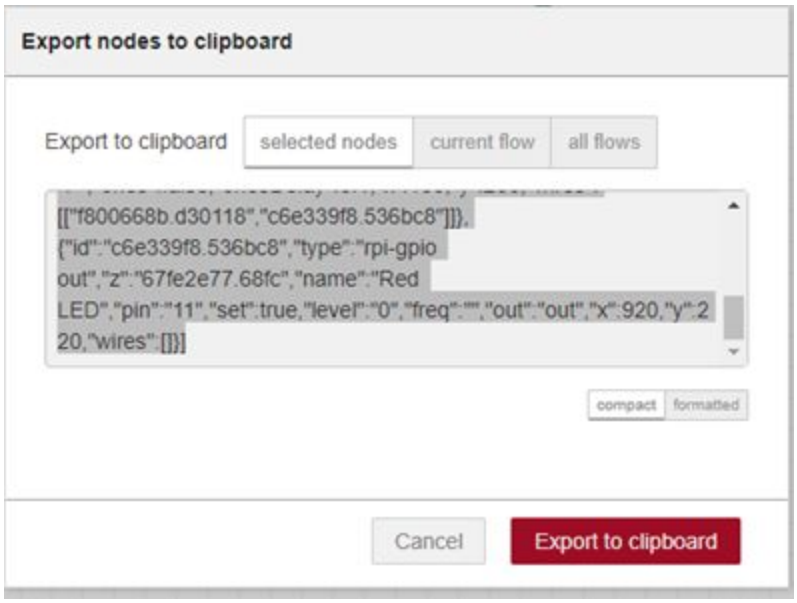
8. *Select a location near the top of the workspace and click to set the flow in place.*
9. *Navigate to the tab from the prior lesson where you created a flow to control the LED using a manual button.*
10. *With the cursor in a "+" shape over an open area of the workspace, select an area that contains all of the nodes.*



11. *Select the hamburger menu in the upper right>Export>Clipboard*

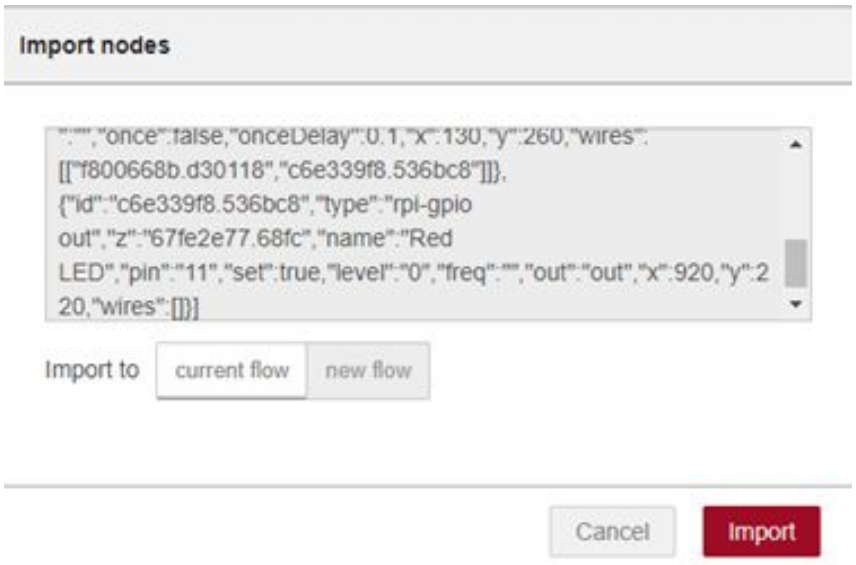


12. *Select the Export to clipboard button*

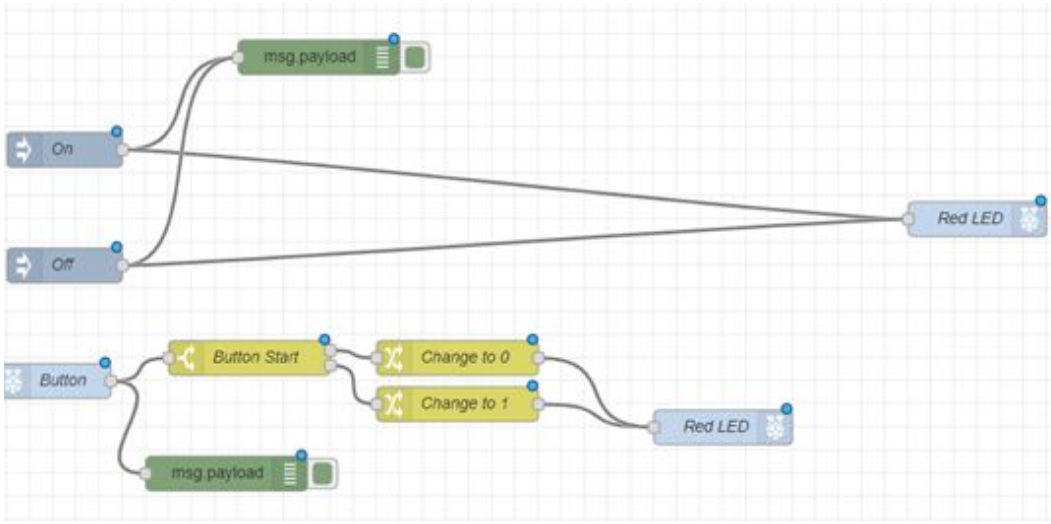


13. *Navigate to the Dual Controls tab and select Import>Clipboard*

14. *Ctrl+V in the Paste nodes here space. Confirm that current flow is selected and select Import*

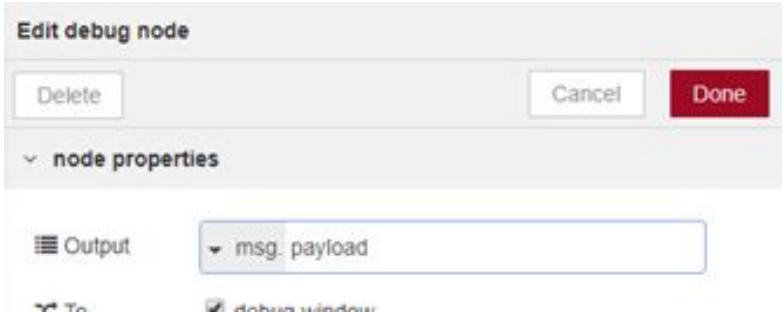


15. *Select a location below the prior flow and click to set the flow in place.*

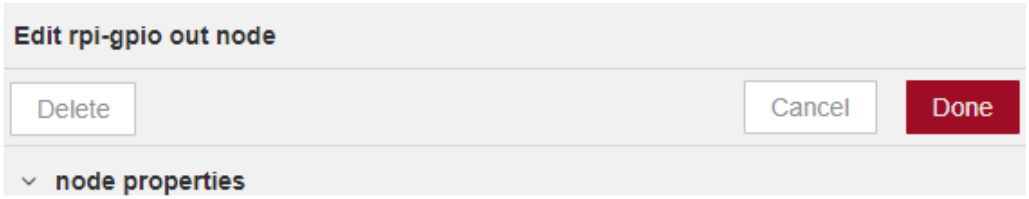


16. *We now have all the nodes we need, but we need to do some revising and rewiring.*

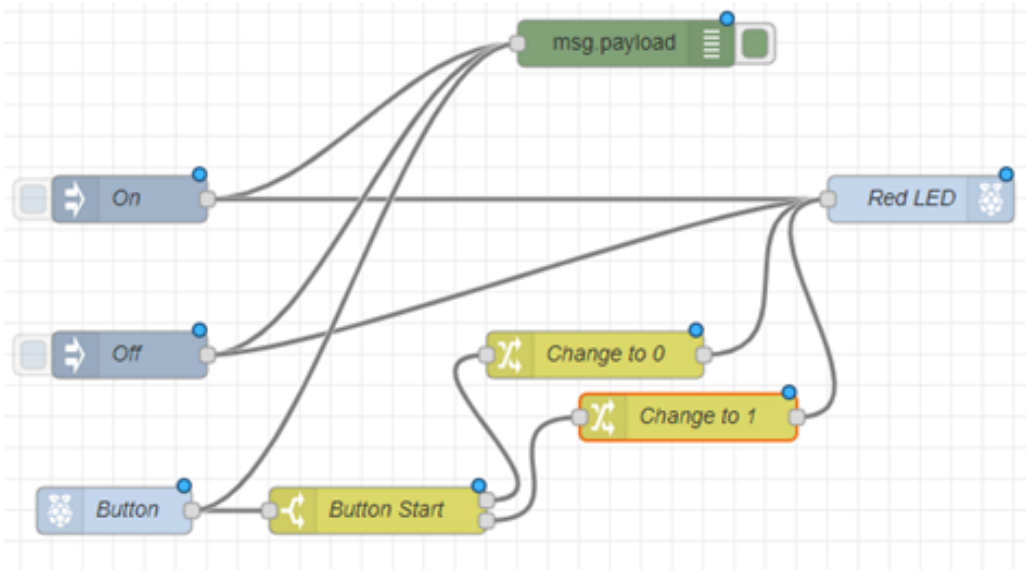
17. *First, we have 2 debug nodes and we only need 1, so double click on the lower one and select delete*



18. *We also have 2 rpi gpio output nodes (Red LED), but we only need 1. Again, double click on the lower one and select delete.*



19. *We are now ready to finish up the wiring.*
    - *First, connect the rpi gpio input node (Button) to the debug node*
    - *Then connect the change nodes Change to 0 and Change to 1 to the rpi gpio output nodes (Red LED)*
20. *You can now click and drag the nodes around until the flow is neat and the connections are clear. Once you are satisfied with the layout, select deploy.*



21. You are now ready to test.

- *First, test that the software buttons are working correctly by turning the LED on and off.*
- *Next, with the LED off, press the manual button to confirm that it works.*
- *Lastly, press the manual button to turn the LED off*

This activity functions similarly to a smart plug which can be turned on and off either from a cloud app (commonly a cellphone app) or with a manual button on the plug.

Question: The manual button was configured to turn on when pushed, so why does the manual button turn off the LED if it was turned on by the software button.

Hint: Check the debug output

Answer: The button works as expected, on first press the button changes the payload to a 1, but since the LED is already lit, you don't notice. Then when the button is released, the payload changes to a 0 and the LED turns off.

- **(15 minutes) Try It!**
    - *Modify the flows you built.*
    - *Build your own flows.*
    - *Experiment with using different options and not the results.*
- **(2 minutes) Closing / Wrap-up**
    - *Build an IoT Device to receive input from email and outputs a notification by lighting an LED*
    - *Describe more common nodes and their uses*
    - *Build an IoT device that accepts both manual and cloud controls*
- **(1 minutes) - What's next?**

    Inform students that they are finished with Internet-of-Things day of the camp. Students can head back to the cafeteria to be picked up by their parents, and remind them to be back tomorrow for another fun day of learning. Day 5 is all about Hands-on with Hardware, prizes, giveaways, raffles, certificates, and a whole lot more fun.