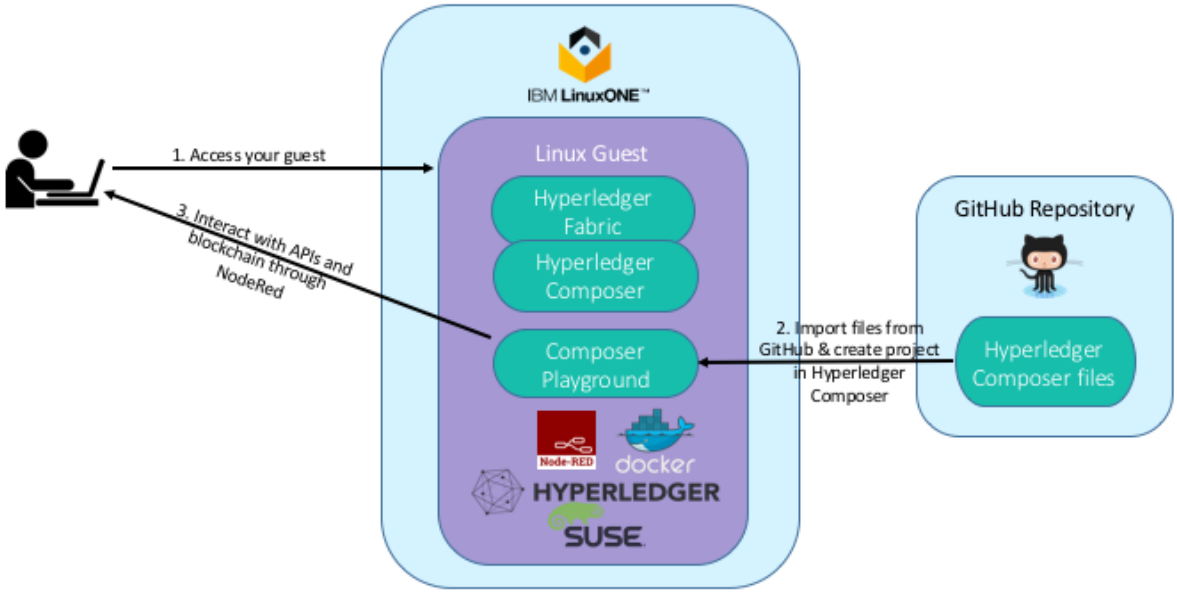
Hyperledger Fabric and Hyperledger Composer on LinuxONE

Note: To run this lab after TechU in Orlando, please use the link below.

https://github.com/IBM/hyperledger-fabric-on-linux-one

That guide will allow you to run the lab on a SLES guest on LinuxONE community cloud. The guide includes links to everything and information on how to get a LinuxONE Community Cloud guest.

Architecture



This lab will guide you through the following process.

1. Access your LinuxONE guest.
2. Setup and verify of your blockchain environment.
3. Create a blockchain project in Hyperledger Composer.
4. Interact with blockchain and third party APIs through Composer Rest Server and NodeRed.

Application Overview

This blockchain lab is intended to give you a basic understanding of how a developer would interact with Hyperledger Fabric using Hyperledger Composer. In this workshop you will use a browser based UI to modify chaincode, test your code and deploy your changes. You will also learn how tooling can take the code and generate API to allow for application integration through a RESTful interface.

This lab will be broken into three parts:

Part 1 — Setup your LinuxONE guest

1. Access your guest.
2. Run a setup script.
3. Verify the installation of Hyperledger Fabric and Hyperledger Composer

Part 2 — Creating a blockchain application and generating API

5. Importing the components of your blockchain application
6. Creating your blockchain application
7. Test application code
8. Deploy application to Hyperledger Fabric
9. Generating API from your blockchain application

Part 3 — Utilizing blockchain API through NodeRED

10. Importing your flow into NodeRED
11. Interacting with blockchain through a dashboard

Workshop Instructions

Scenario Overview

For this lab, we will simulate a thermostat and a temperature gauge to provide us temperature data. In a real world scenario, this could be a temperature sensor in your house or in an office building. The sensor could be connected to a real thermostat like Nest or other smart home devices via API. To keep family members, housemates, friends or children from excessively running air conditioning or heat, they must first find out if they have permission to adjust the thermostat by running a transaction defined in a smart contract running on Hyperledger Fabric. The contract will check the value recorded in the ledger for the temperature gauge to determine if their thermostat adjustment is environmentally friendly. Secondly, it will add integration to Weather.com to check current temperatures and adjust the thermostat to ideal settings based on the terms of the smart contract.

Part 1 - Setup your LinuxONE guest

In this section of the lab, you will use PuTTy to connect to your LinuxONE guest, setup your blockchain environment and verify everything is running. Your guest is a basic Ubuntu 16.04.3 server running on an IBM z13 server residning in the Washington Systems Center in Herndon, Virginia. You can verify your Ubuntu version the command, `uname -a` , once you're logged into your guest.

Access your LinuxONE guest

1. At your workstation, you should be given the IP address of a Linux guest you will be working with. Keep this information available throughout the lab.
2. This lab document assumes your lab instructors have already started your VPN for you. If you cannot get the next step to work, please ask a lab instructor for assistance.
3. **Open** PuTTy and **select** the preconfigured session showing the IP address of your guest to connect to your LinuxONE guest. Once you're connected you should see something like the image below.

```
Welcome to Ubuntu 16.04.4 LTS (GNU/Linux 4.4.0-116-generic s390x)

 * Documentation:  https://help.ubuntu.com
 * Management:     https://landscape.canonical.com
 * Support:        https://ubuntu.com/advantage
  Last login: Wed Mar  7 18:57:11 2018 from 192.168.215.44
```

Setup your blockchain environment

4. To save time in this lab, the pre-requisites for this lab are already installed. Use the following commands to verify installation.
   - Docker: `docker -v`
   - Docker Compose: `docker-compose -v`
   - Hyperledger Composer: `composer -v`
   - Hyperledger Fabric: `docker images`

```
bcuser@ubuntu16043:~$ docker -v
Docker version 17.06.2-ce, build cec0b72
bcuser@ubuntu16043:~$ docker-compose -v
docker-compose version 1.19.0, build 9e633ef
bcuser@ubuntu16043:~$ composer -v
v0.17.6
bcuser@ubuntu16043:~$ docker images
REPOSITORY                    TAG                 IMAGE ID            CREATED             SIZE
hyperledger/fabric-ca         s390x-1.1.0-alpha   f6930b769b2e        5 weeks ago         297MB
hyperledger/fabric-orderer    s390x-1.1.0-alpha   3ea7bb0520ae        5 weeks ago         227MB
hyperledger/fabric-peer       s390x-1.1.0-alpha   6180e7247c51        5 weeks ago         233MB
hyperledger/fabric-ccenv      s390x-1.1.0-alpha   6303ad1d7c33        5 weeks ago         1.32GB
hyperledger/fabric-couchdb    s390x-0.4.5         b4c1f99eddbc        6 weeks ago         1.7GB
bcuser@ubuntu16043:~$
```

5. To be ready to build your first blockchain application, you'll need to get everything running. This has been scripted for you. In your terminal, enter `ls` to see what is in your home directory. You should find a script called *SHARESacramentoBlockchainScript.sh*.

```
bcuser@ubuntu16043:~$ ls
CHANGELOG.md  README.md                          bin  fabric-tools  lib         share
LICENSE       SHARESacramentoBlockchainScript.sh  etc  include      playground
```

6. Take a look at the script to see the commands that will be run to start up your blockchain environment by issuing `cat SHARESacramentoBlockchainScript.sh`.

```
echo -e "*** Start the Hyperledger Fabric network ***"
echo -e ""
cd ~/fabric-tools
./startFabric.sh
./createPeerAdminCard.sh
nohup composer-playground >/home/bcuser/playground/playground.stdout 2>/home/bcuser/playground/playground.stderr & disown
#sudo bash -c "iptables-save > /etc/linuxone/iptables.save"

#Start NodeRed
echo -e "*** Starting NodeRed. ***"
echo -e ""
nohup node-red >/home/bcuser/playground/nodered.stdout 2>/home/bcuser/playground/nodered.stderr & disown
```

Start the Docker containers of Hyperledger Fabric

Create the Admin IDCard needed for Hyperledger Composer

Start up the Hyperledger Composer Playground

Start Node-RED

7. Enter `./SHARESacramentoBlockchainScript.sh` to run the script.

```
FABRIC_VERSION is set to 'hlfv11'
FABRIC_START_TIMEOUT is unset, assuming 15 (seconds)

Using composer-cli at v0.17.6

Successfully created business network card file to
        Output file: /tmp/PeerAdmin@hlfv1.card

Command succeeded


Successfully imported business network card
        Card file: /tmp/PeerAdmin@hlfv1.card
        Card name: PeerAdmin@hlfv1

Command succeeded

The following Business Network Cards are available:

Connection Profile: hlfv1
┌─────────────────┬────────────┬──────────────────┐
│ Card Name       │ UserId     │ Business Network │
├─────────────────┼────────────┼──────────────────┤
│ PeerAdmin@hlfv1 │ PeerAdmin  │                  │
└─────────────────┴────────────┴──────────────────┘


Issue composer card list --name <Card Name> to get details a specific card

Command succeeded

Hyperledger Composer PeerAdmin card has been imported, host of fabric specified as 'localhost'
*** Starting NodeRed. ***

bcuser@ubuntu16043:~$
```

Verify the installation of Hyperledger Fabric and Hyperledger Composer

8. To see if your blockchain network is up and running, use the command `docker ps -a`. You should see 4 containers with image names like the ones shown below.

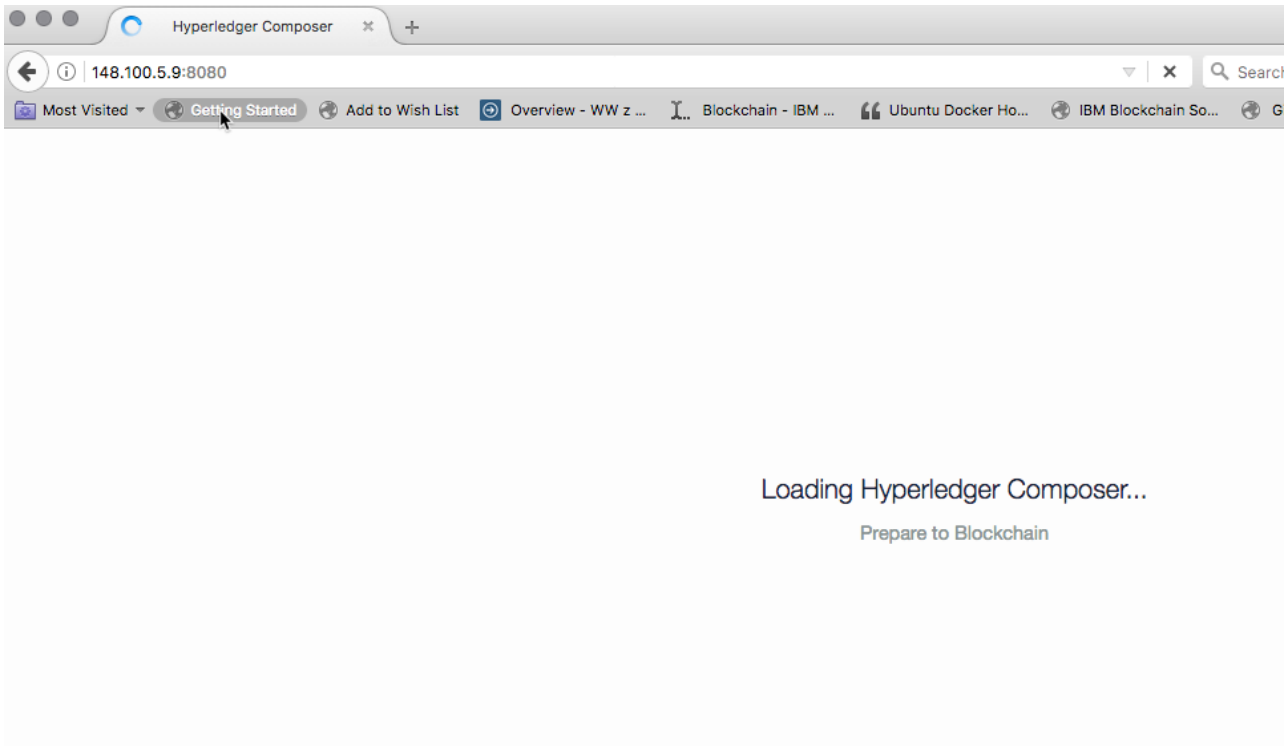
```
bcuser@ubuntu16043:~$ docker ps -a
CONTAINER ID        IMAGE                                      COMMAND                  CREATED             STATUS              PORTS                                            NAMES
aee06b16e8d3        hyperledger/fabric-peer:s390x-1.1.0-alpha  "peer node start"        45 minutes ago      Up 45 minutes       0.0.0.0:7051->7051/tcp, 0.0.0.0:7053->7053/tcp   peer0.org1.example.com
863b9f91dbbd        hyperledger/fabric-ca:s390x-1.1.0-alpha    "sh -c 'fabric-ca-..."   45 minutes ago      Up 45 minutes       0.0.0.0:7054->7054/tcp                           ca.org1.example.com
ca09dc049518        hyperledger/fabric-orderer:s390x-1.1.0-alpha  "orderer"                45 minutes ago      Up 45 minutes       0.0.0.0:7050->7050/tcp                           orderer.example.com
b3f81a569db2        hyperledger/fabric-couchdb:s390x-0.4.5     "tini -- /docker-e..."   45 minutes ago      Up 45 minutes       4369/tcp, 9100/tcp, 0.0.0.0:5984->5984/tcp       couchdb
bcuser@ubuntu16043:~$
```

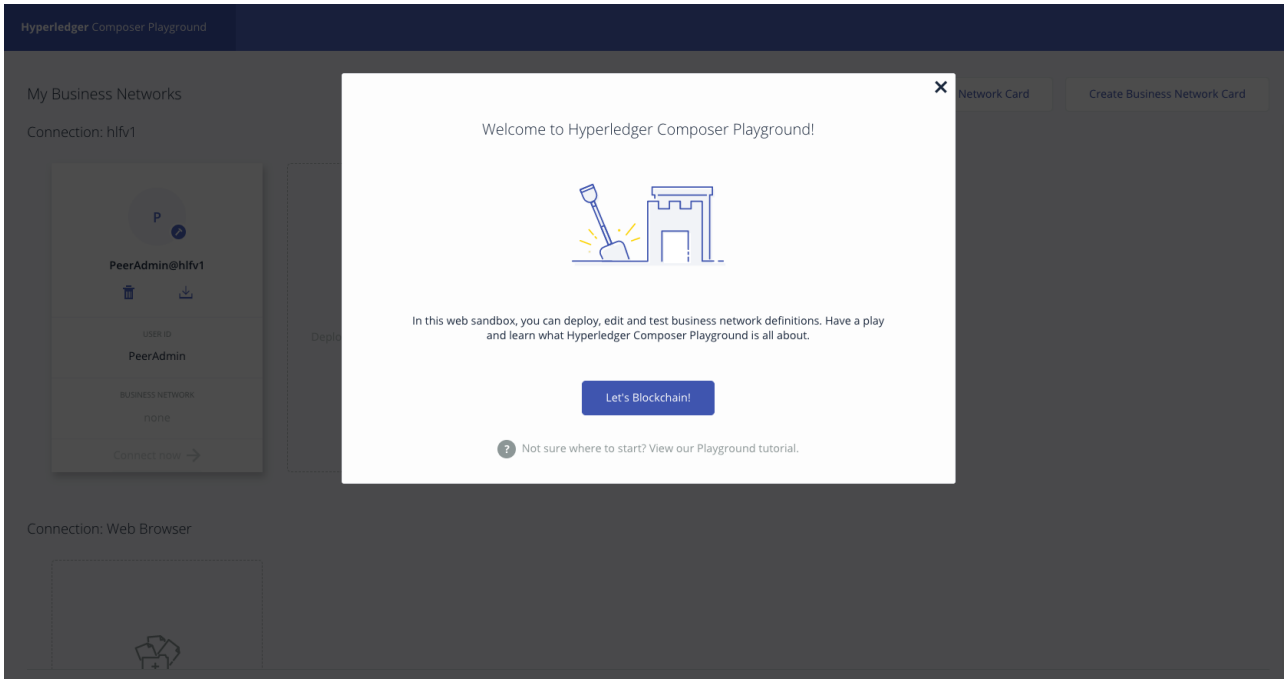
9. Verify Composer Playground is running by looking for its process using the command, `ps -ef|grep playground`.

```
bcuser@ubuntu16043:~$ ps -ef|grep playground
bcuser    5443     1  0 15:06 pts/0    00:00:00 node /home/bcuser/bin/composer-playground
bcuser    5549  4657  0 15:53 pts/0    00:00:00 grep --color=auto playground
bcuser@ubuntu16043:~$
```

10. Open a browser and enter `xxx.xxx.x.x:8080` into the address bar where the x's correspond to your Linux guest's IP address.

- **Note:** It is recommended to use Chrome as your browser for Hyperledger Composer Playground. It is also recommended that you open the Playground in a Incognito Window. This allows you to quickly clear cache and history if you start noticing odd behaviors.
- **Note:** If you use Firefox, you cannot use it in Private mode.
- You should see the following:





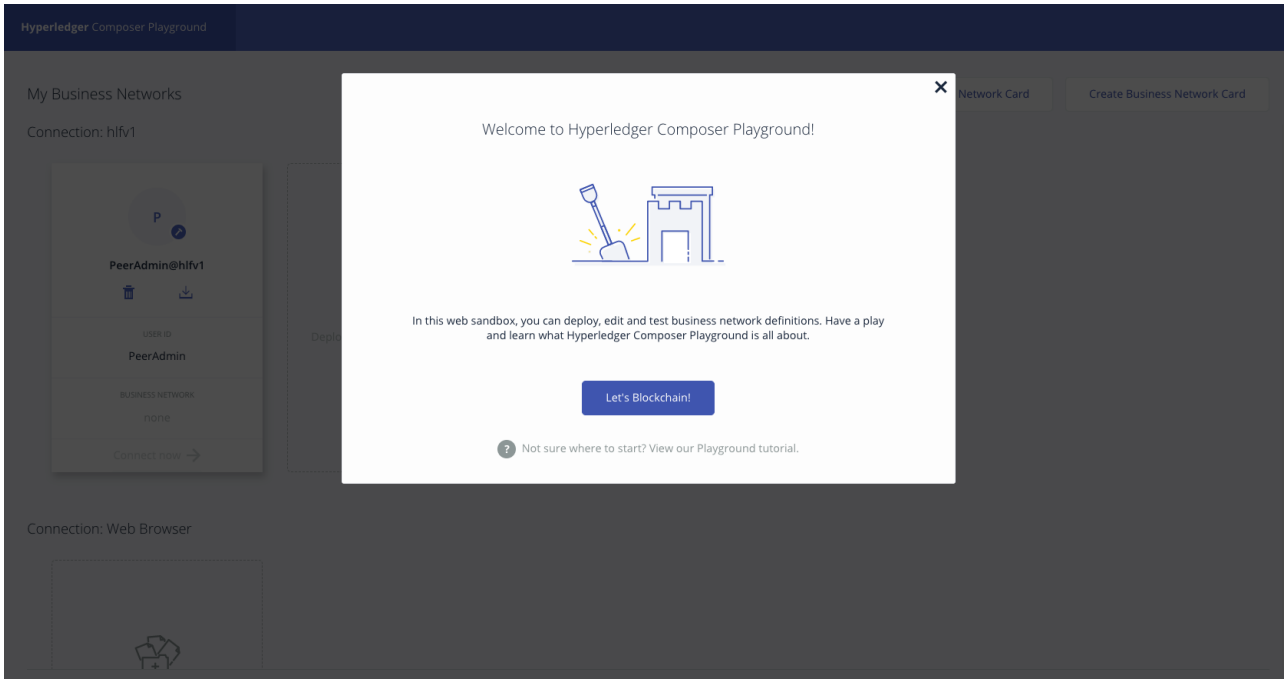
11. Congratulations! Part 1 is now complete! Lets get to work on the fun part. 😃

Part 2 — Creating a blockchain application and generating API

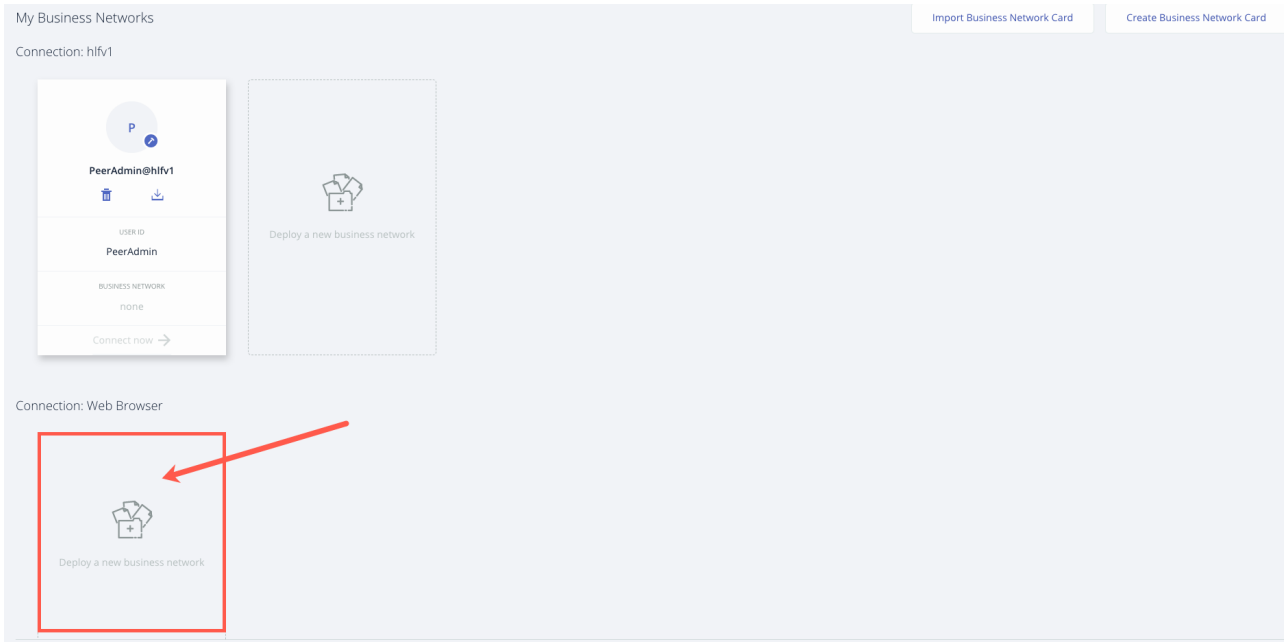
Importing the components of your blockchain application

1. On your workstation desktop, you will find a folder named `code`. This folder contains the artifacts you will need for the following steps.
2. Go back to your browser that has Composer Playground open. If you've closed it, you can open it in your browser by entering `xxx.xxx.x.x:8080` into the address bar where the x's correspond to your Linux guest's IP address.

- **Note:** You will need to view the browser in Full Screen (fully expanded) mode to be able to access everything and prevent issues with inability to scroll on certain screens.

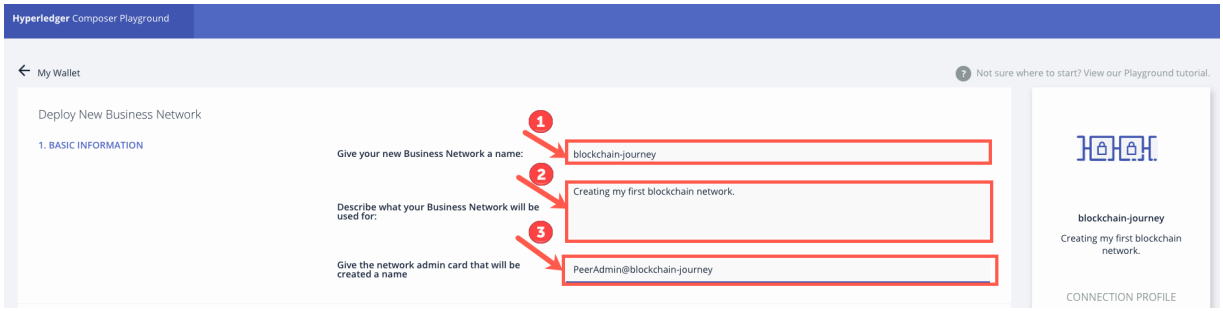


3. Select **Deploy a new business network** under *Connection: Web Browser*.

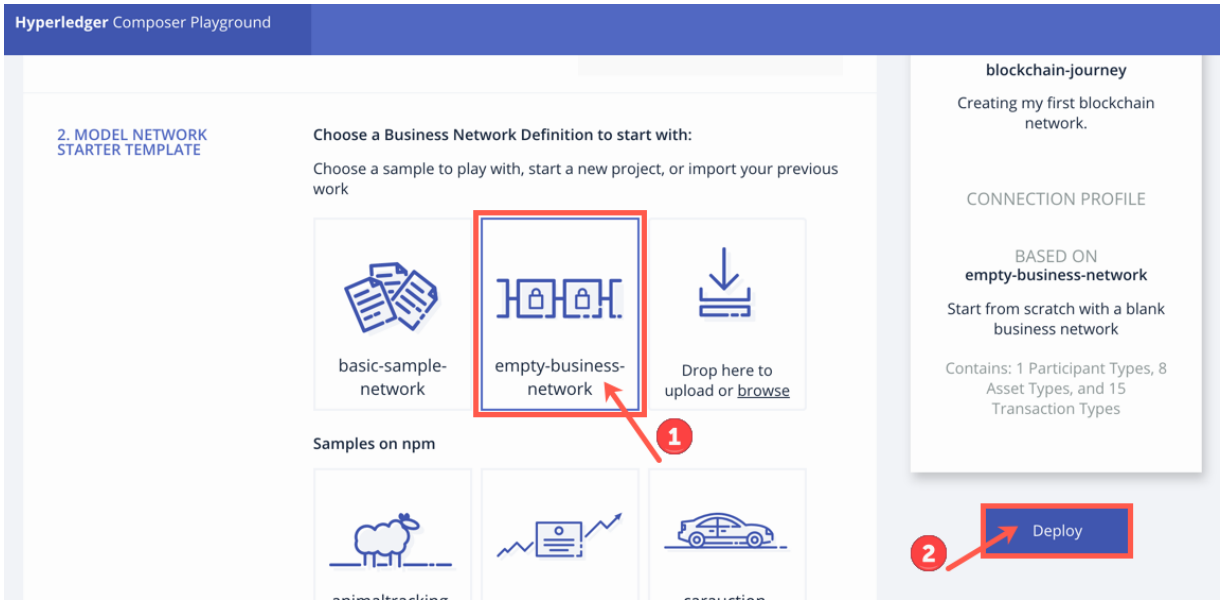


4. Complete the *BASIC INFORMATION*.

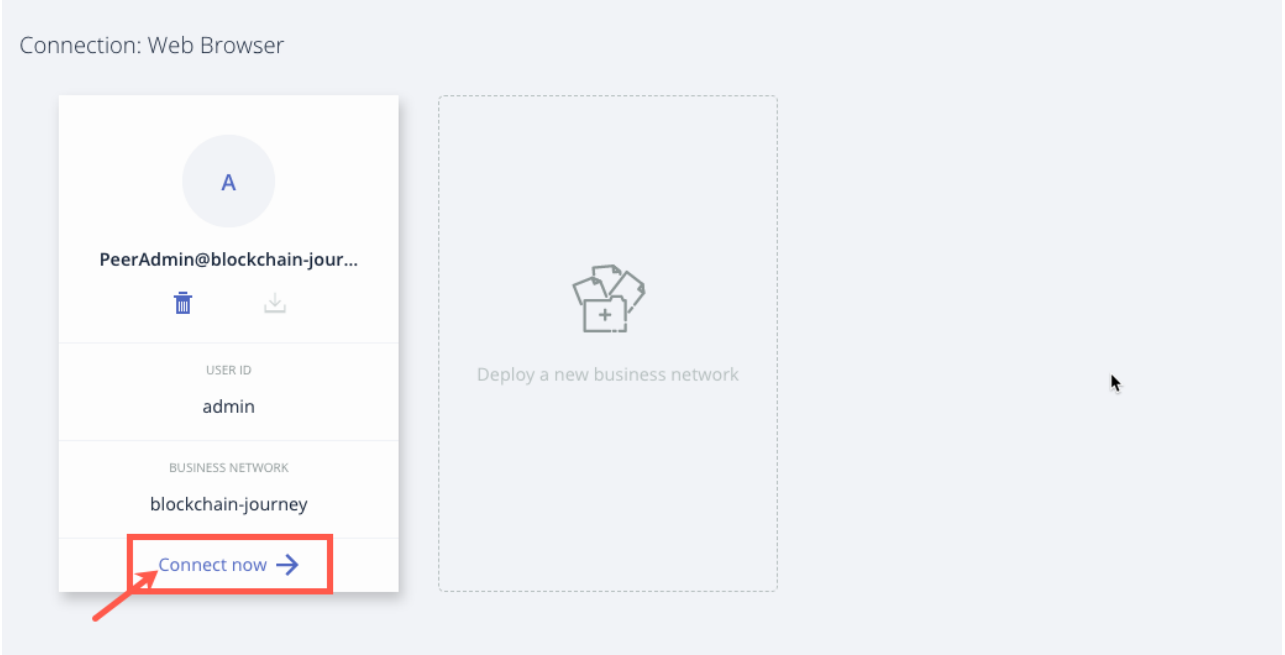
- Give your new Business Network a name: **blockchain-journery**
- Describe what your Business Network will be used for: **Creating my first blockchain network.**



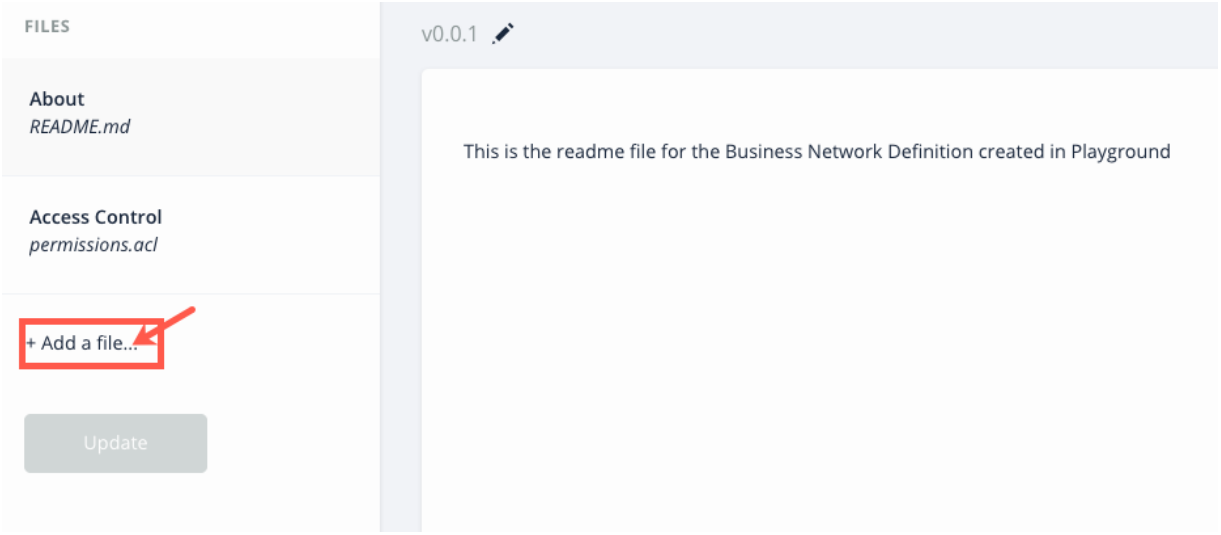
5. Scroll until you can see *Choose a Business Network Definition to start with:* and select **empty-business-network** and **Deploy**.



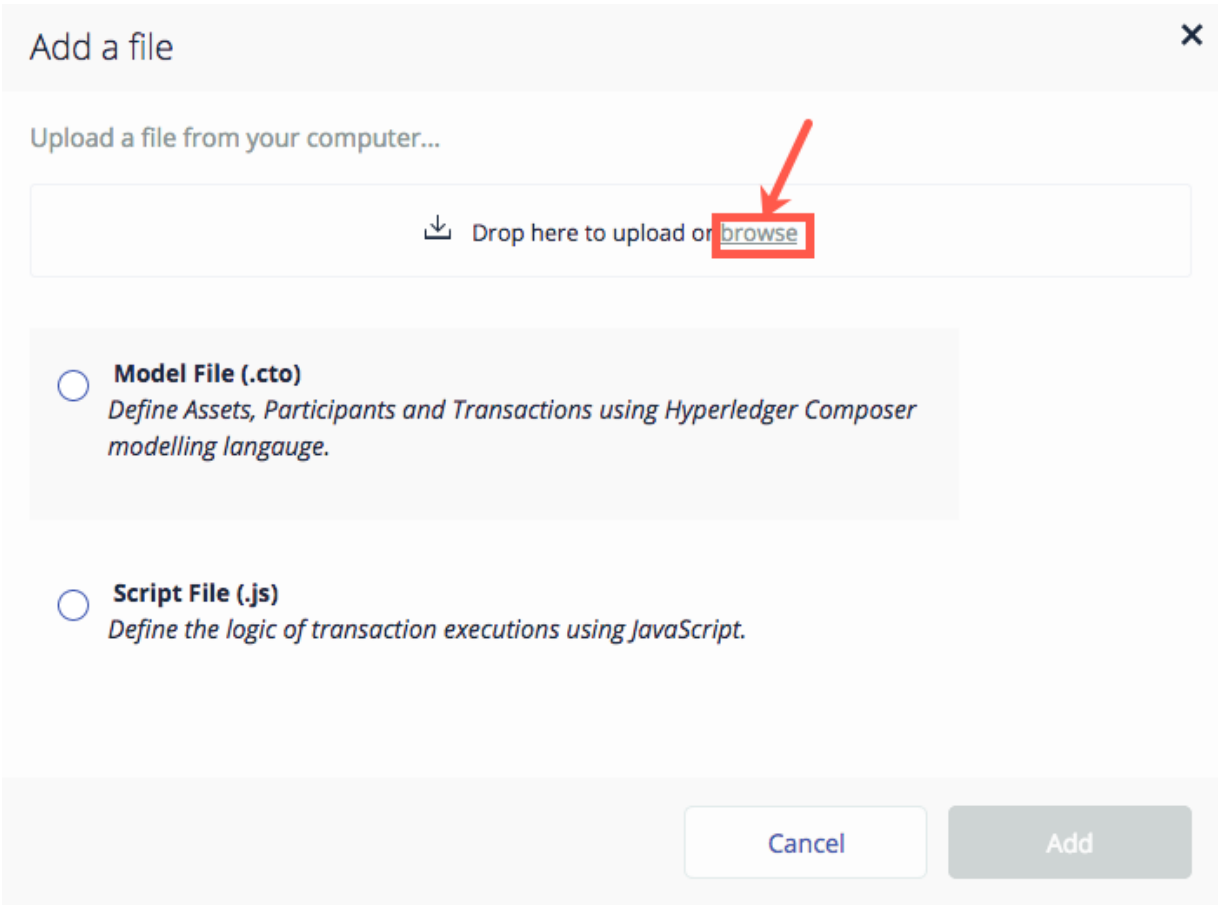
6. ○ From *My Wallet* select **Connect now** to go into your business network.



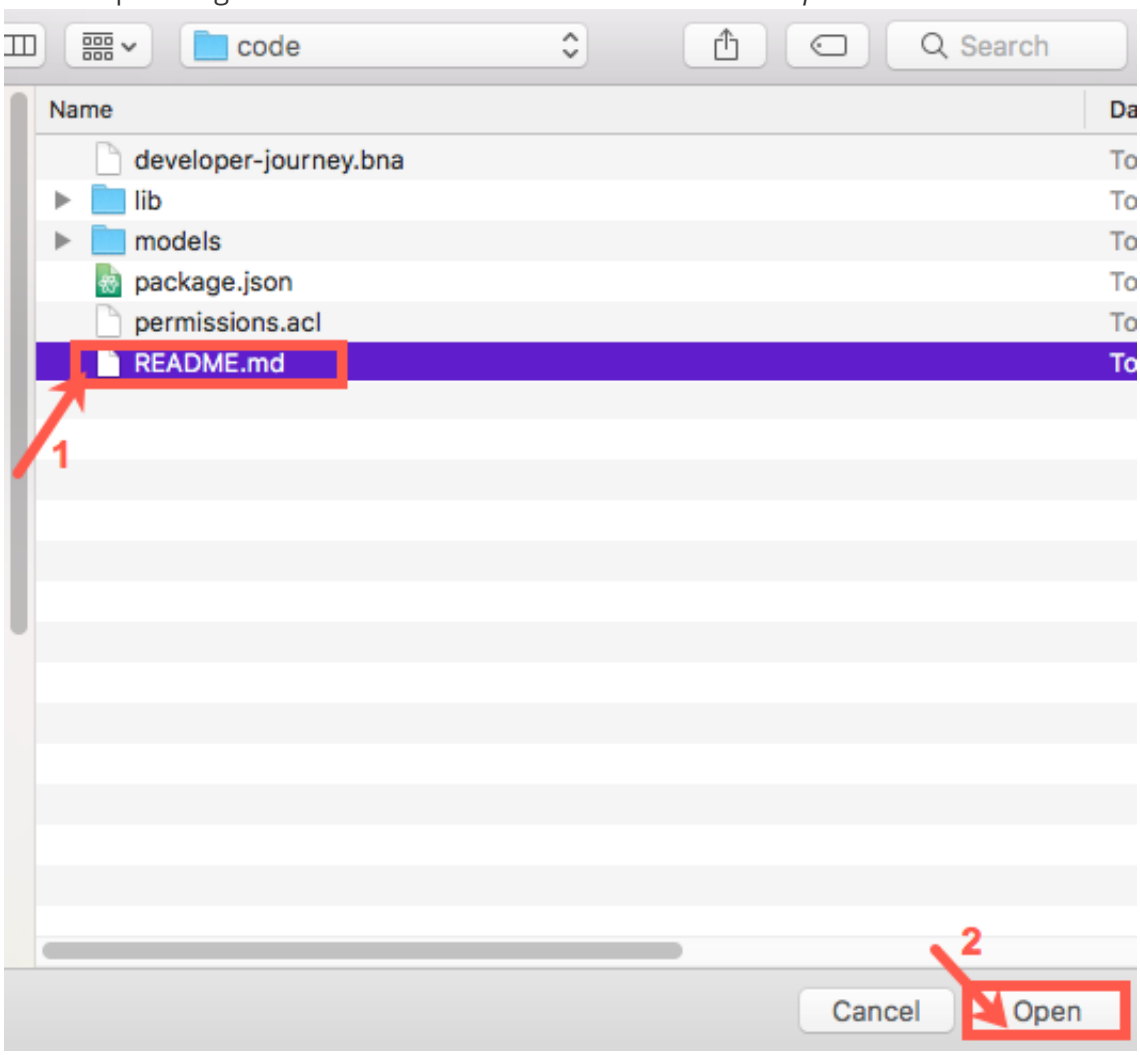
7. Select **Add a File**.



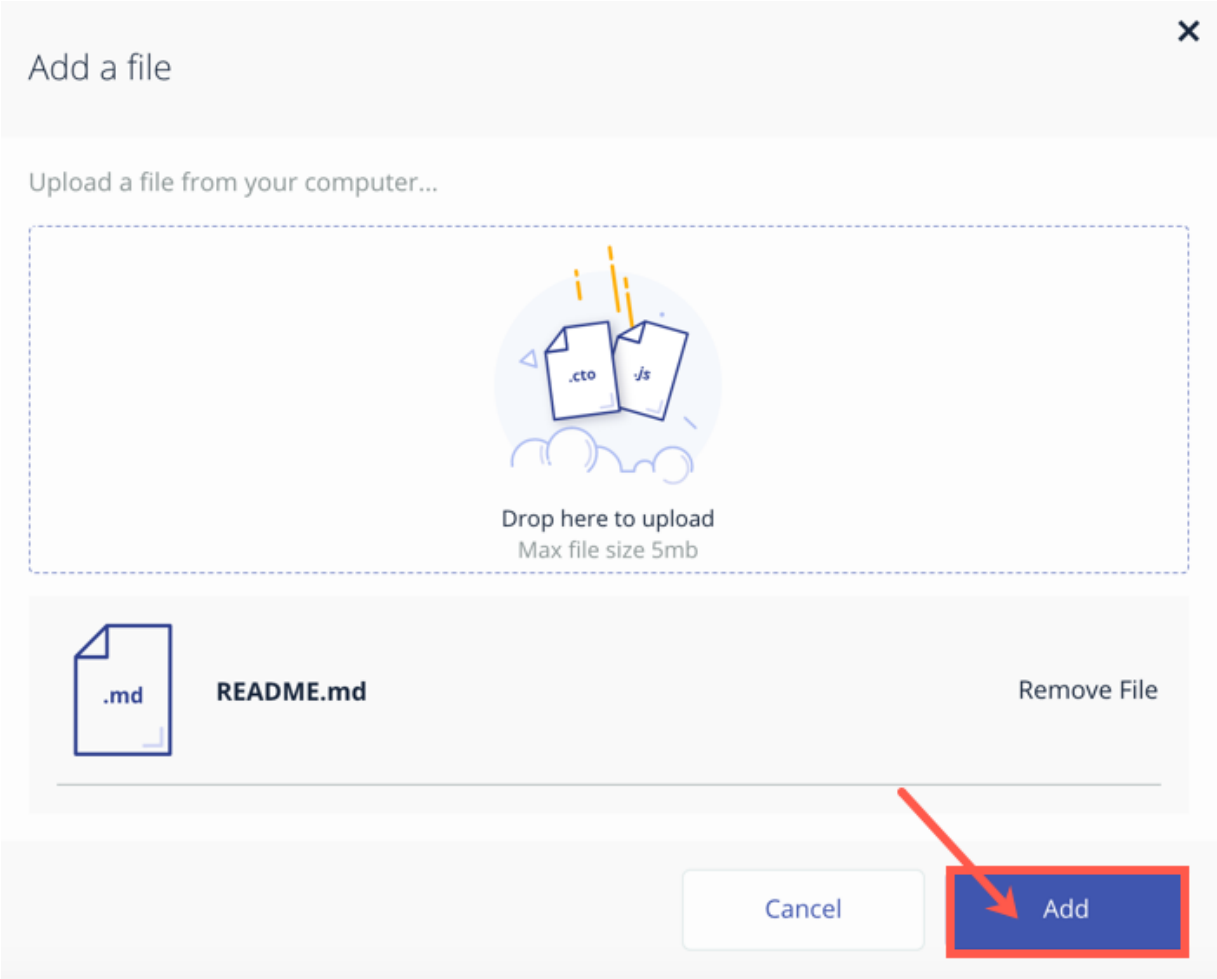
8. From the *Add a file* pop-up dialog, select **browse**.



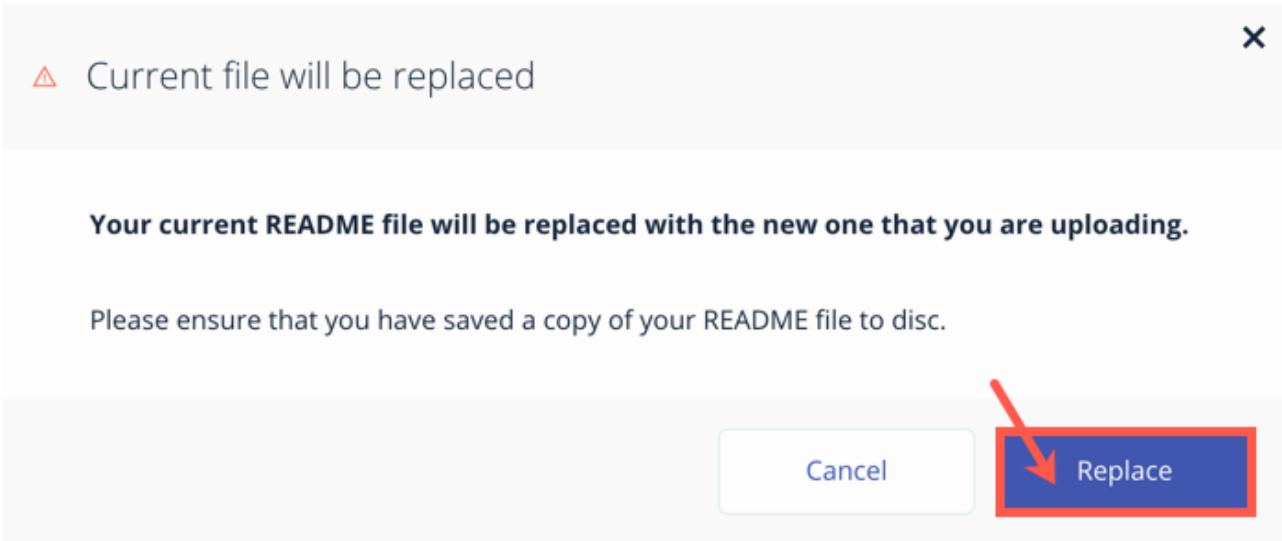
9. In the file explorer window, navigate to where you downloaded the files. Refer to step 5 if you need help finding this location. **Select** *README.md* and **Click** *Open*.



10. **Select** *Add*.



11. On the *Current file will be replaced* dialog, **select** *Replace*.



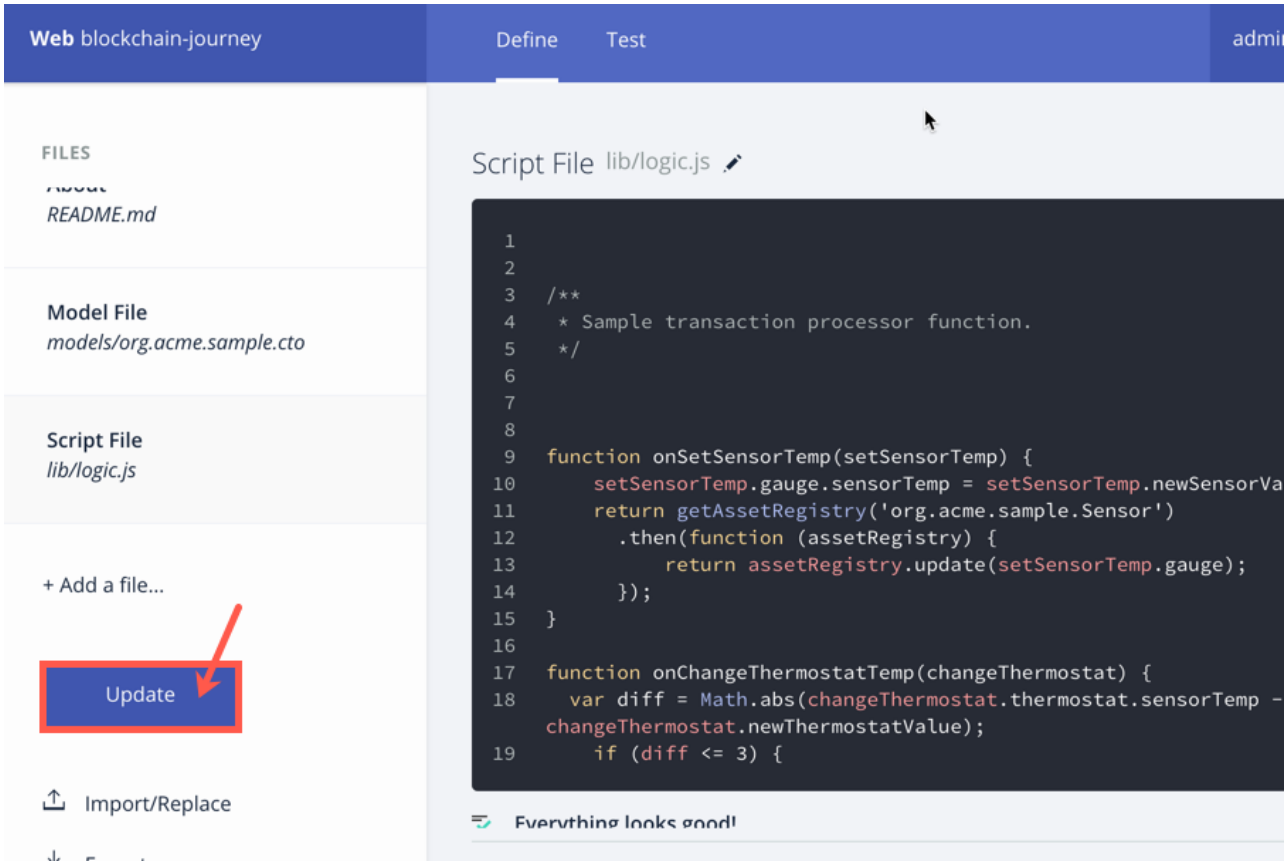
12. Let's keep adding the files to the Composer Playground. **Repeat steps 11-15 to add the following files**:

- *org.acme.sample.cto* — This is located in the models folder. In this exercise you'll use this file to create a model for your asset and transactions. You could also create participants in this file.

This is similar to creating a Java class and defining what you would need in the class.

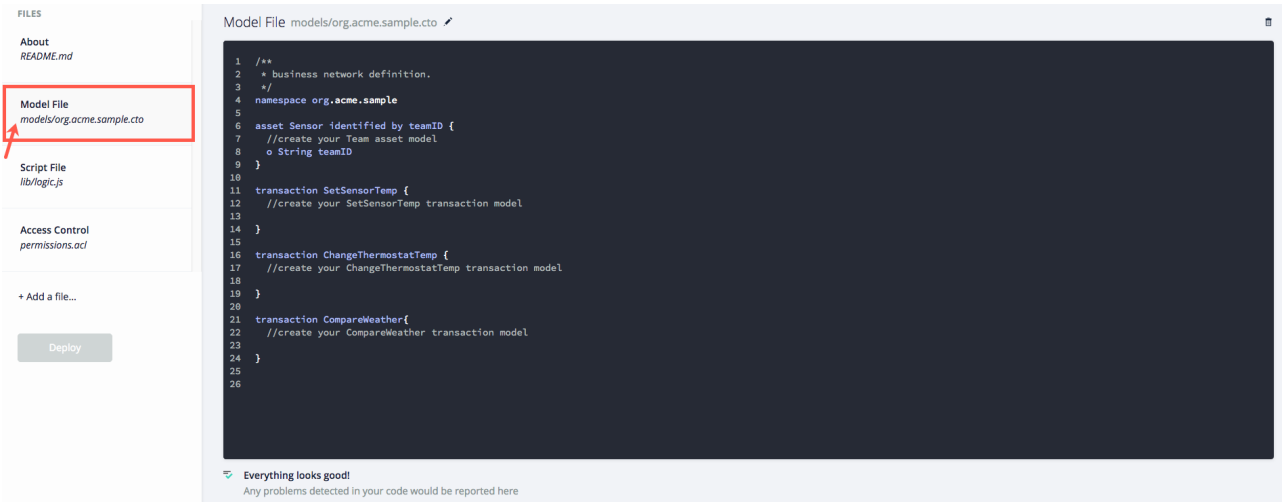
- *logic.js* — This is located in the lib folder. This is a JavaScript file that becomes the brains of your application. In this file is code, your smart contract, that defines how a transaction can happen. This is similar to Java methods.
- **Add last:** *permissions.acl* — This is where you would limit permissions for participants in a blockchain network.

13. Your files are all now loaded into Composer Playground. **Click** *Update* on the left side of the browser.



Creating your blockchain application

14. Click on **Model File**.

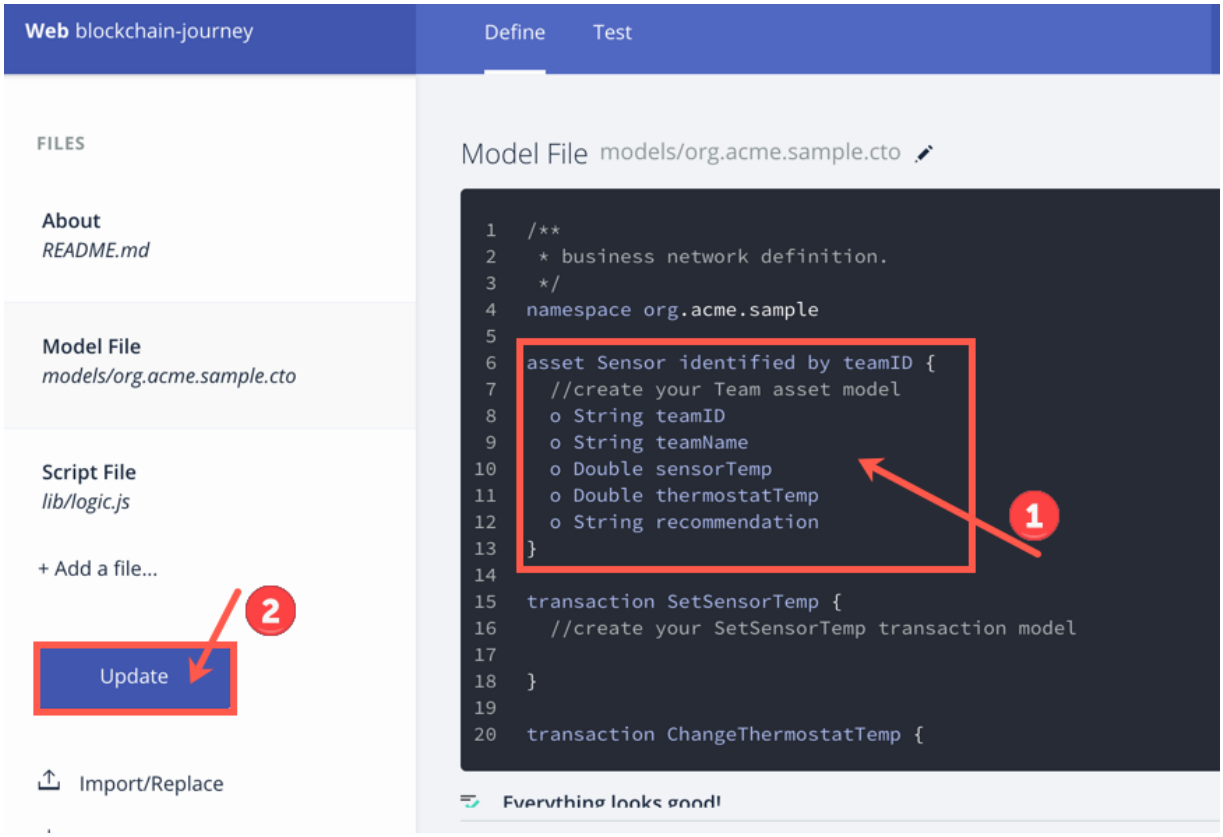


15. Click in the **editor** on the right to begin writing your models.

- NOTE: **DO NOT** modify the namespace during the lab.

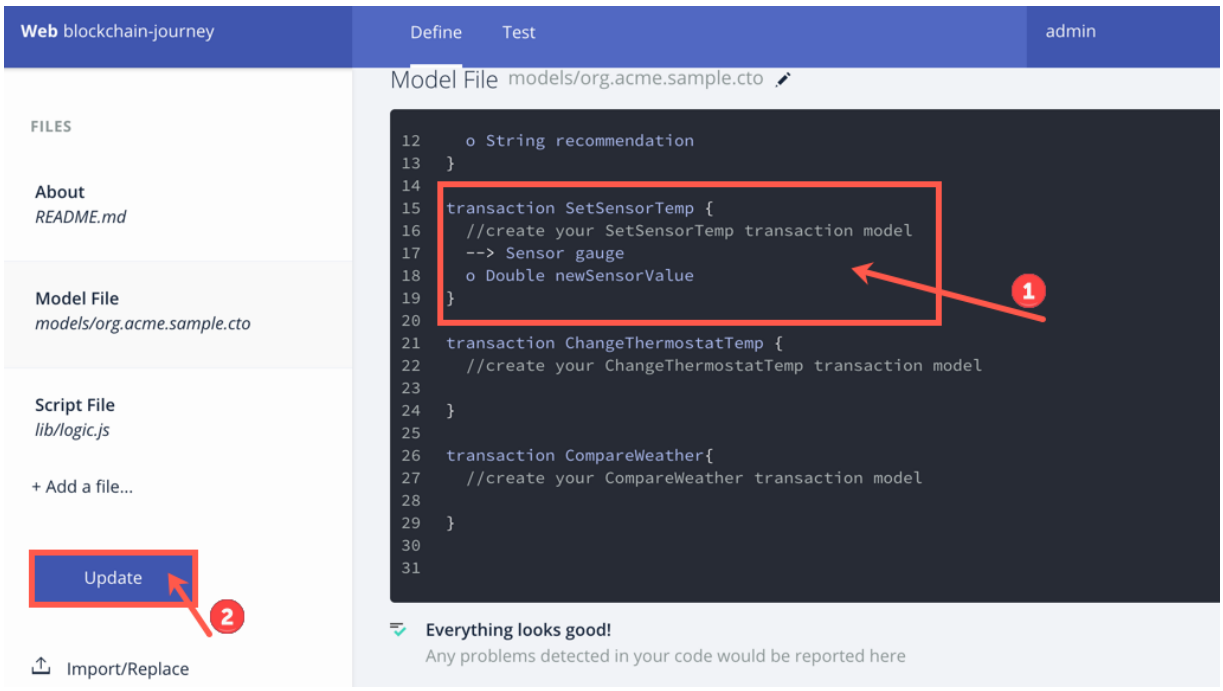
16. On a new line, give your asset `Sensor` the following attributes.

- Note: a small "o" is used as a bullet in the model.
- `o String teamID` — this will be the value that is assigned to your team. (already there!)
- `o String teamName` — this could be anything! Come up with something clever!
- `o Double sensorTemp` — temperature from the Raspberry Pi will be stored here.
- `o Double thermostatTemp` — you will create a temperature for the thermostat.
- `o String recommendation` — this will be populated based on the `CompareWeather` transaction.
- **Click** *Update* to save changes.



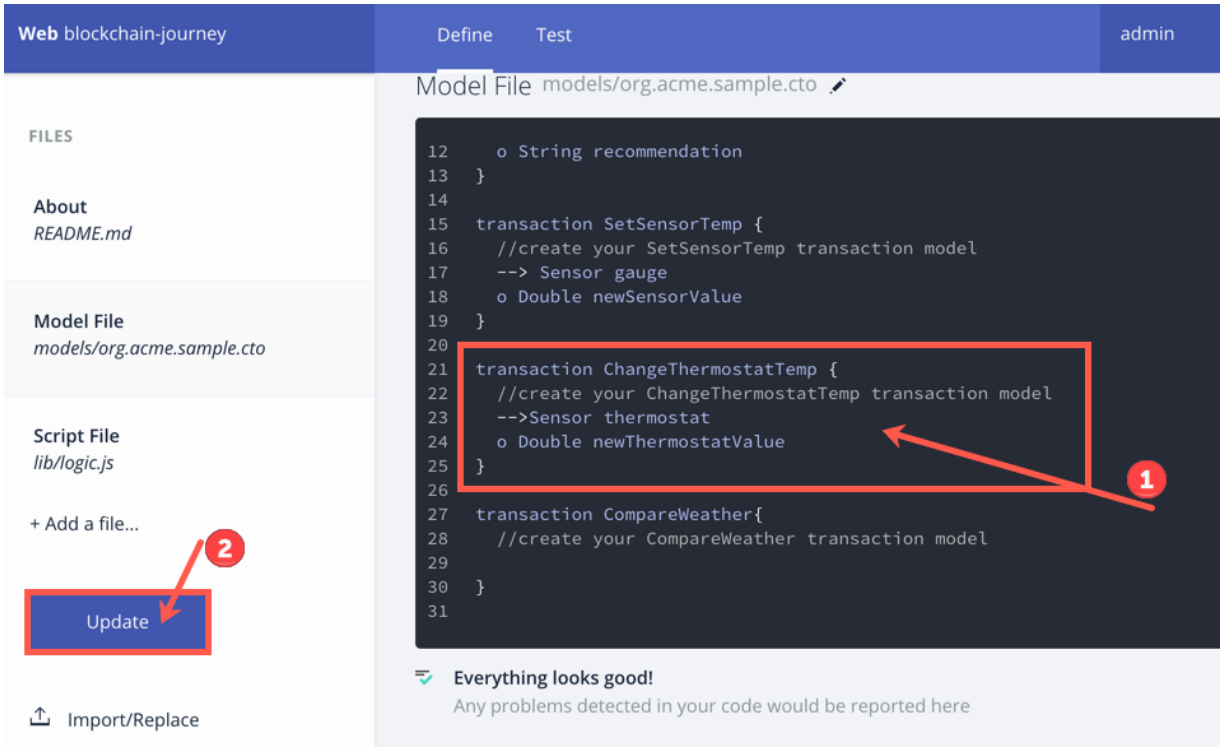
17. Now create your first transaction model for `SetSensorTemp`. Enter the following attributes:

- `--> Sensor gauge` — The transaction will need to put data into the `Sensor` asset. This passes a reference to the asset so we can work with the asset in the logic for the transaction.
- `o Double newSensorValue` — This is the variable that will be set by the temperature passed into the transaction from the NodeRed Sensor for picking up temperature.
- *Click** *Deploy* to save changes.



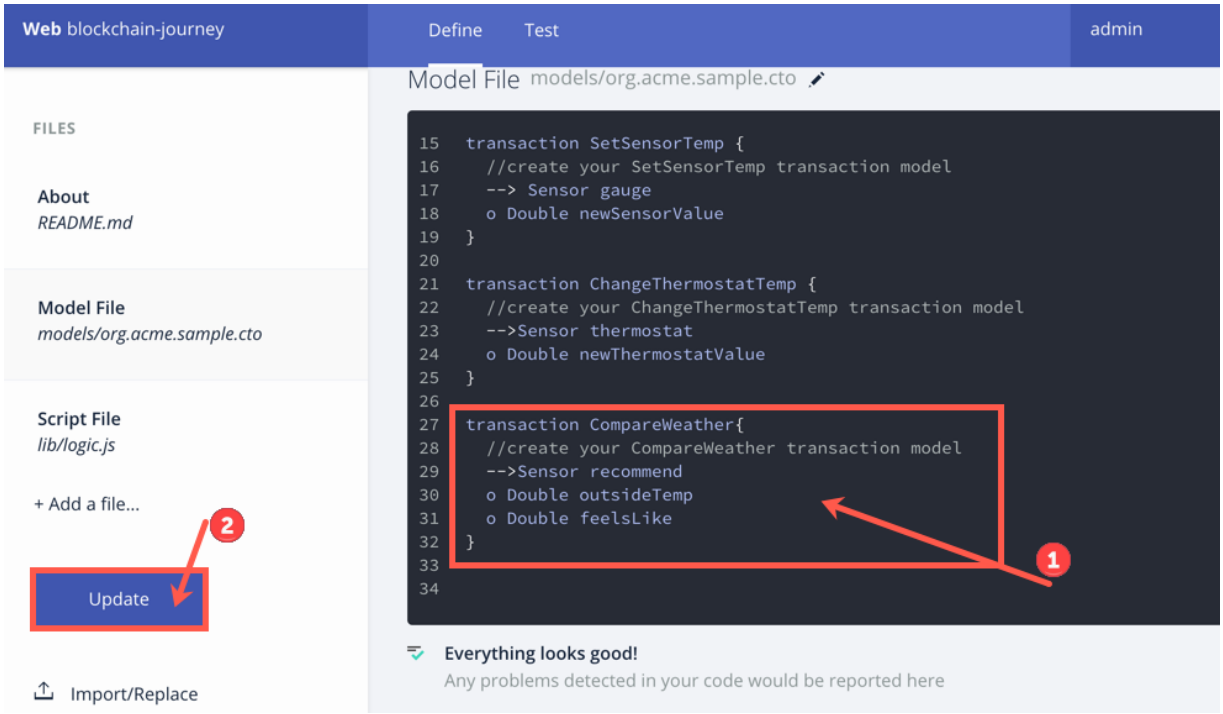
18. Build your `ChangeThermostatTemp` transaction model. Add the following:

- `--> Sensor thermostat` — The transaction will need to put data into the `Sensor` asset for the thermostat. This passes a reference to the asset so we can work with the asset in the logic for the transaction.
- `o Double newThermostatValue` — This allows for a new, proposed value to be sent into the transaction. In the logic tab, we will use this value to compare to what the gauge says and decide if the thermostat value should be adjusted.
- **Click** *Update* to save changes.

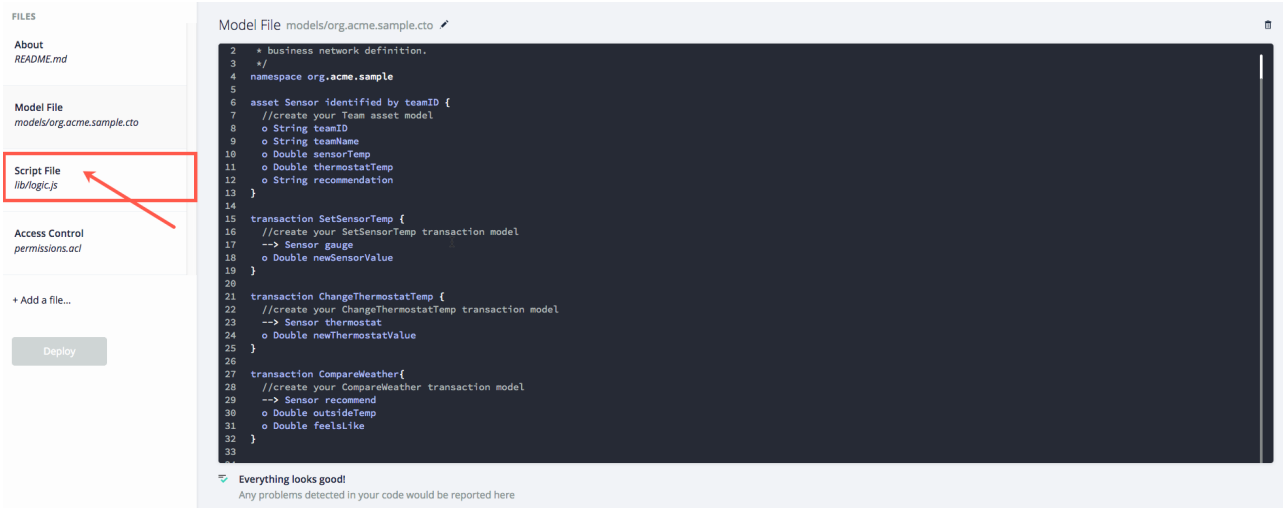


19. Enter the following values to build your `CompareWeather` transaction model:

- `--> Sensor recommend` — The transaction will need to put data into the `Sensor` asset. This passes a reference to the asset so we can work with the asset in the logic for the transaction.
- `o Double outsideTemp` — Looking at the [WeatherUnderground.com API] for Conditions, you can see all of the possible data that the call could return. Based on the data, it was decided to take the actual outside temperature and the feels like temperature to give a recommendation on thermostat settings. This variable stores the value passed into it via NodeRed from Weather.com for the outside temperature. The model on the API page shows up whether the data is returned in Celsius or Fahrenheit and its variable type. In this exercise we will use Celsius.
- `o Double feelsLike` — the variable to store the feels_like value from Weather.com.
- **Click** *Update* to save changes.



20. Click on the **Script File** tab.

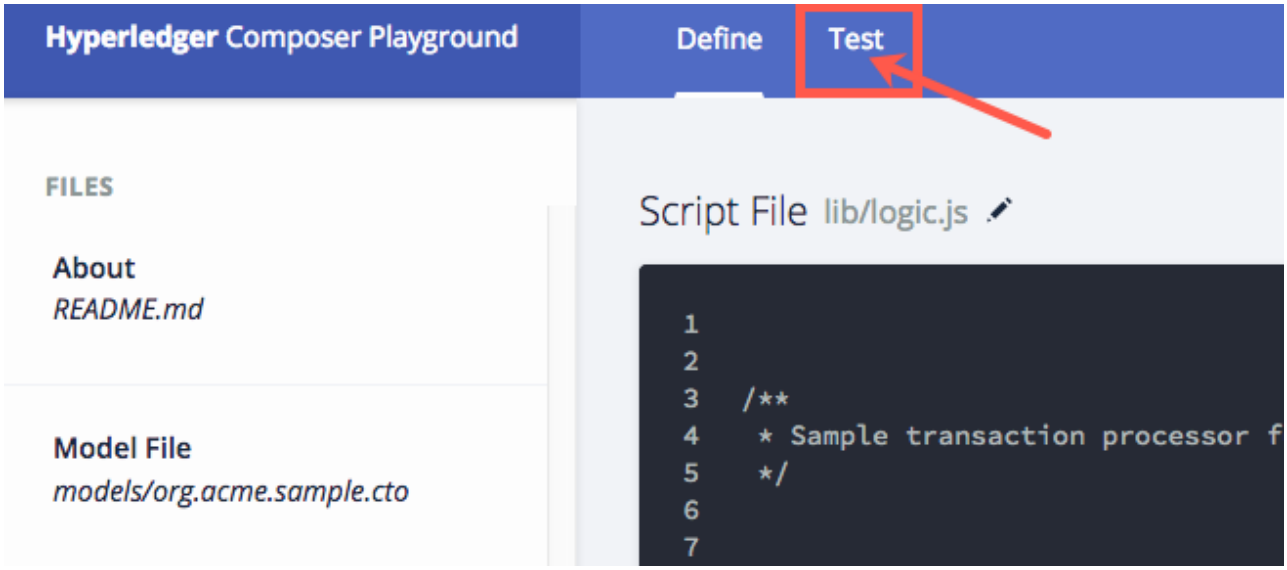


21. **Review the code in the editor.** Verify that your variable names match the variable names here. Capitalization does matter! If names don't match, you'll have errors.

- Any guesses what the code is doing for each transaction?

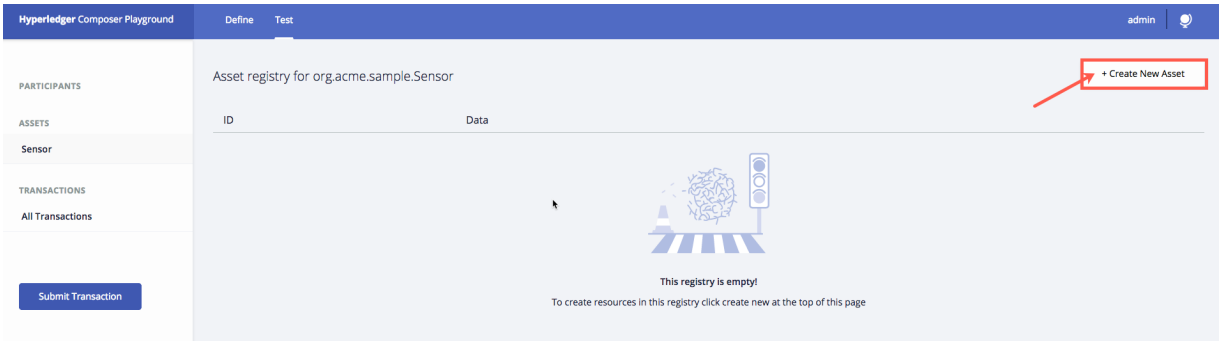
Test application code

22. Click on the **Test** tab at the top to try out your code.



23. Notice that in this particular case because we have no participants, the **Test** tab has opened to the **Asset** menu on the left. You must have an asset to be able to run any of the transactions.

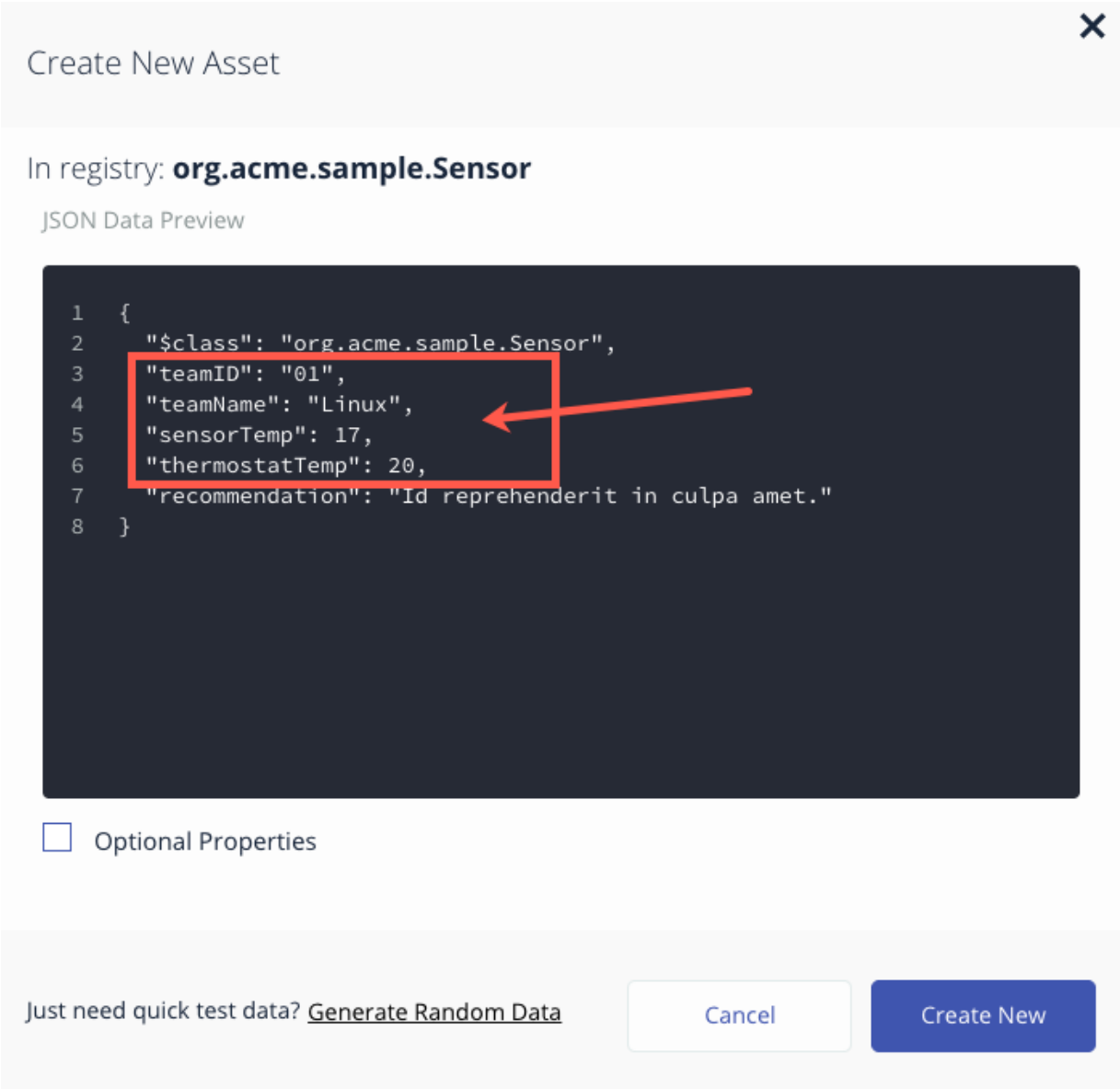
- Click **Create New Asset**.



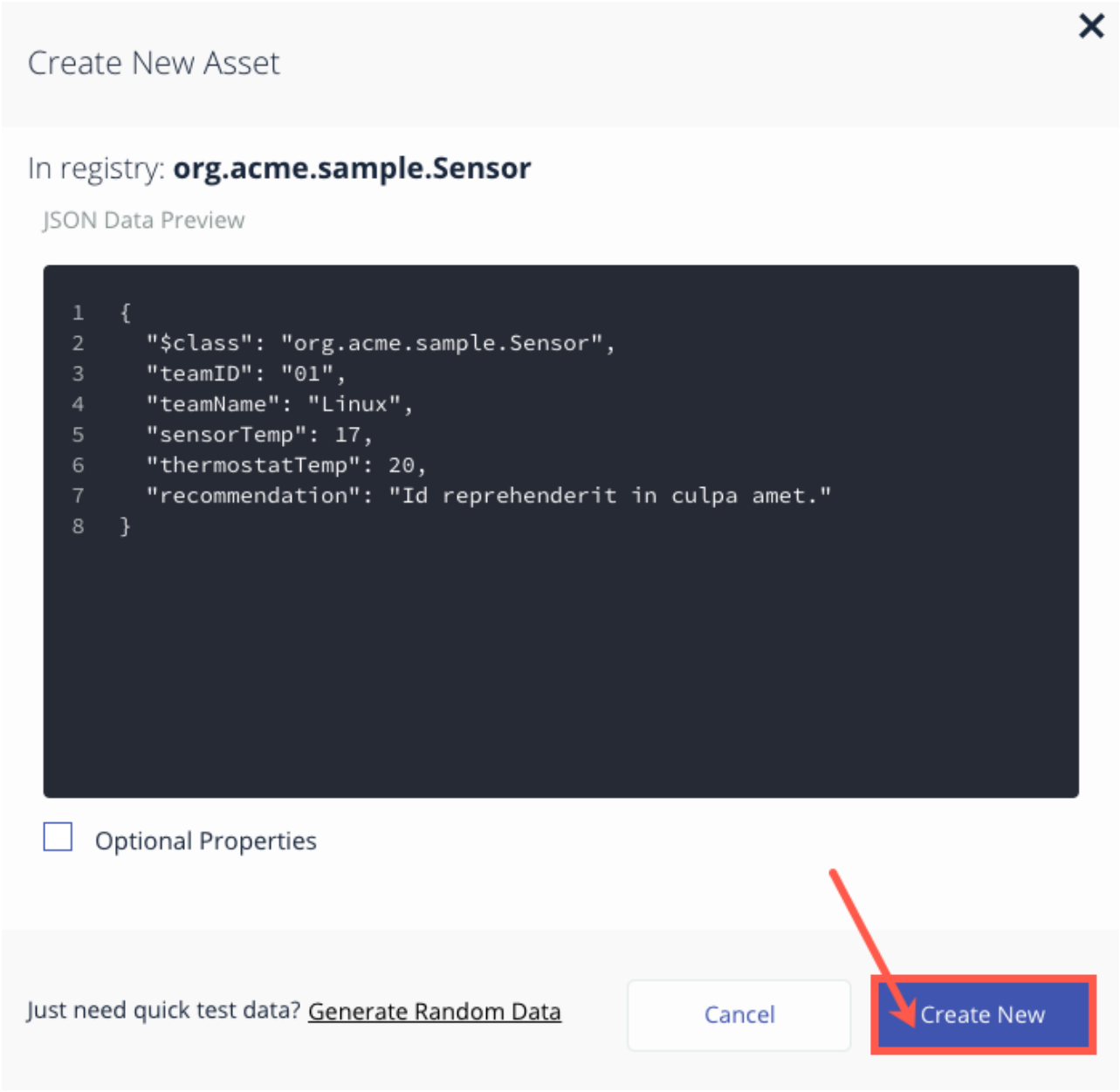
24. Create an example asset to test your code by filling in the following information:

- `"teamID": "teamID:**xxx**"` where ** **xxx** ** is any team number you'd like.

- `"teamName":""` — this could be any name you'd like. Be clever! :bowtie:
- `"sensorTemp": **0**` — Set ** **0** ** to any value. When you work with NodeRed, temperatures will be in Celsius.
- `"thermostatTemp": **0**` — Set ** **0** ** to any value. This is initializing your thermostat so pick a value you want to work with.
- `"recommendation": ""` — Leave this as is.
- *Make a note somewhere** of the values you used for `sensorTemp` and `thermostatTemp`.



25. Click **Create New**.

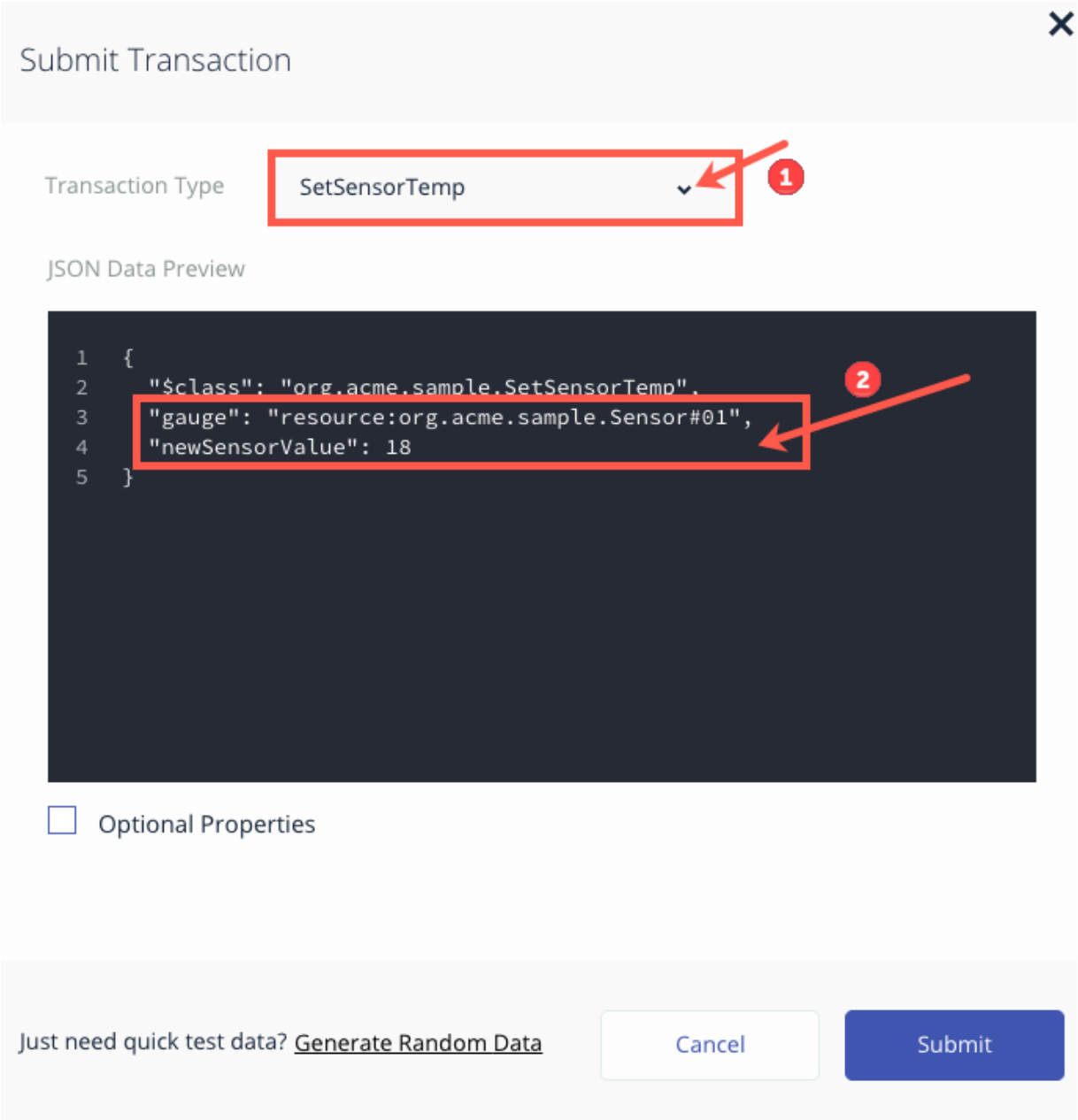


26. Once your **Team** asset is created it should show in the registry as shown below.

27. You're ready to run your first transaction. **Click** on *Submit Transaction*.

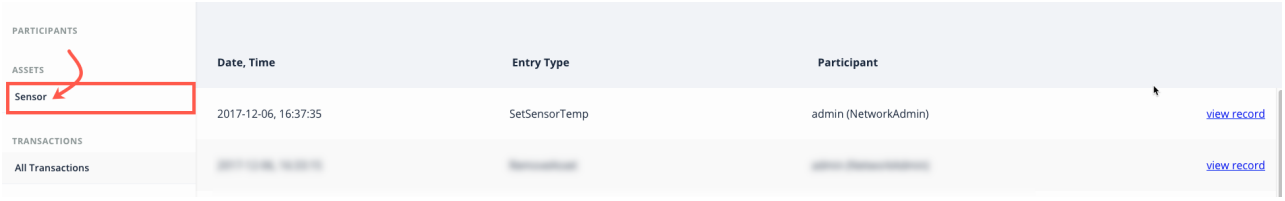
28. The **Submit Transaction** dialog will open a new window.

- Make sure that the **Transaction Type** is set to `SetSensorTemp`.
- Modify the JSON data `"gauge": "resource:org.acme.sample.Sensor#xxxx"` — enter your team's identifier in place of the value where **xxxx** is in the sample JSON data.
- Modify the JSON data `"newSensorValue": 0` — enter a value your sensor could have.
- Click **Submit**.

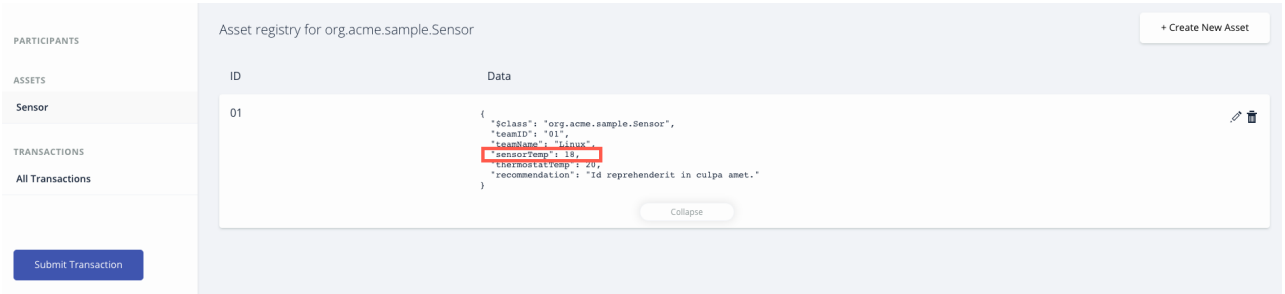


29. If you submitted the transaction with your correct team ID, then you should have a transaction showing under *All Transactions*. **Click view record** to see the data you entered in the prior step. Congratulations! You've now completed a transaction. 👍

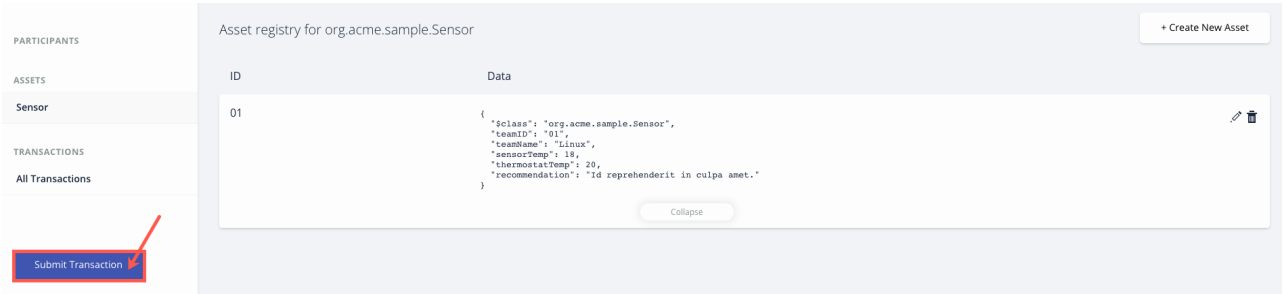
30. Verify that `SetSensorTemp` updated the `sensorTemp` value in your asset. Click **Sensor**.



31. Check the `sensorTemp` value. Does it have the new value from the `SetSensorTemp` transaction?

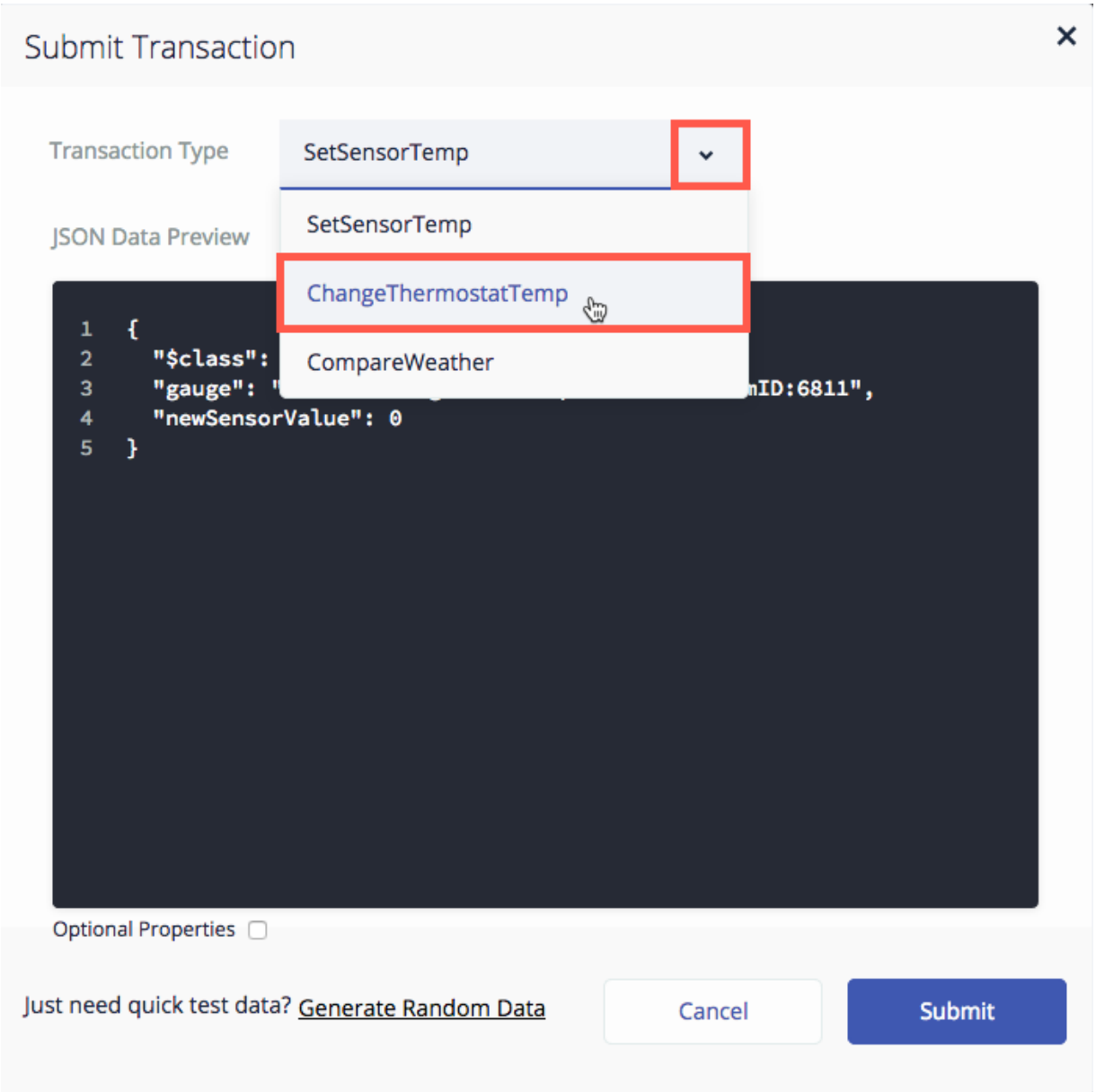


32. Let's do another transaction. Select **Submit Transaction**.

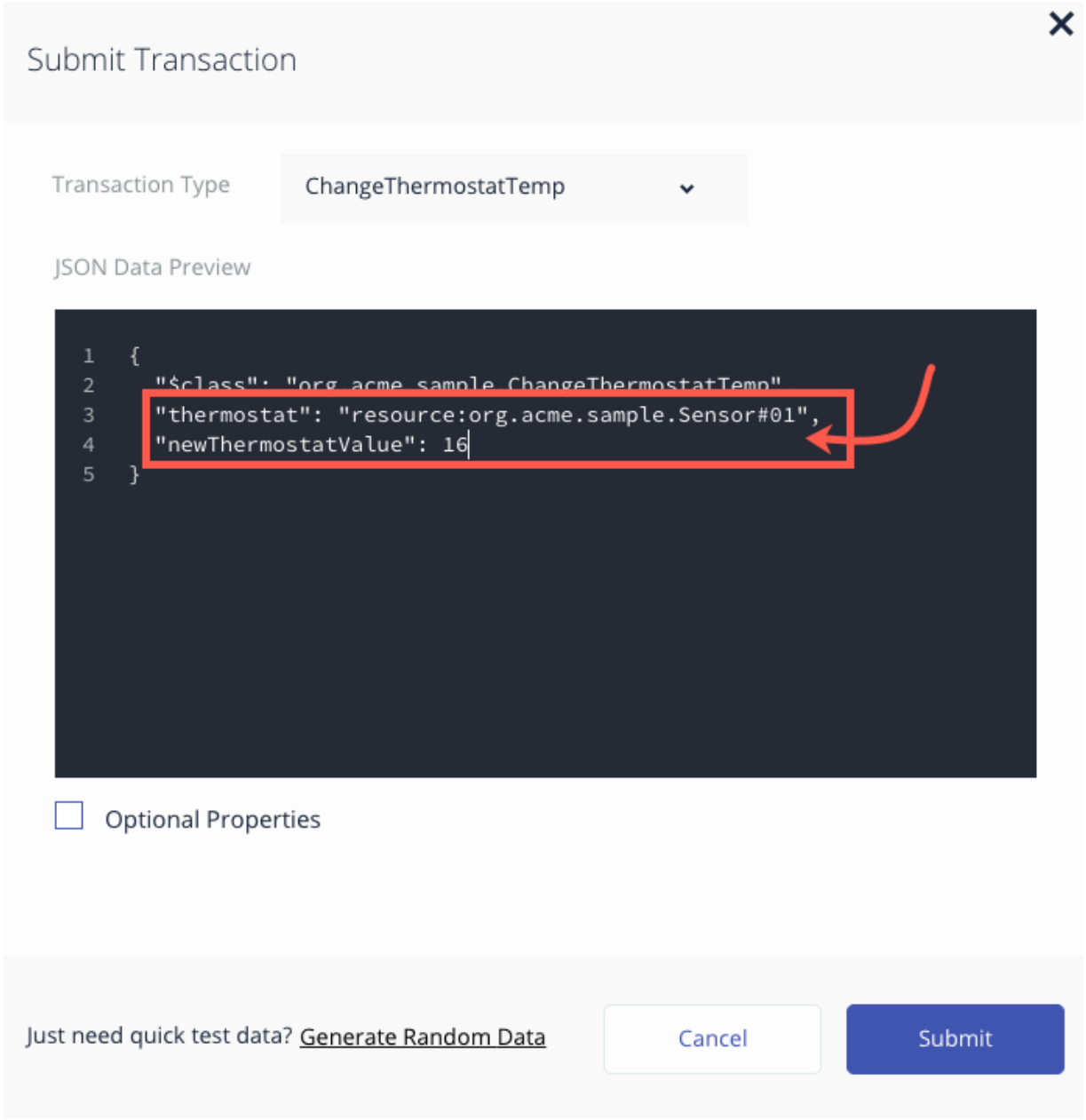


33. This time let's run, `ChangeThermostatTemp`.

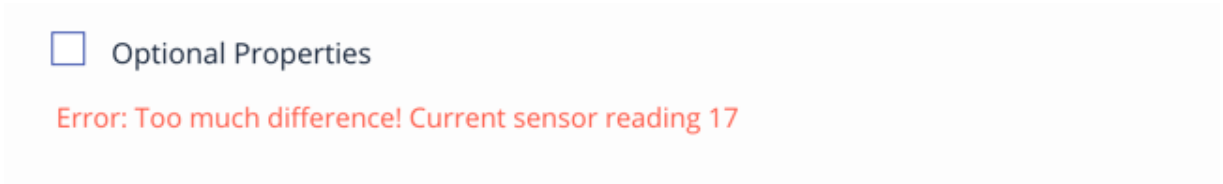
- In the **Transaction Type** drop down, select `ChangeThermostatTemp`.



- Edit the sample JSON for the transaction `"thermostat": "resource:org.acme.sample.Sensor#xxxx"` — change **xxxx** to your team ID value.
- Edit the sample JSON for the transaction `"newThermostatValue": 0` — Replace **0** with a value to which you would like to see if you can adjust the thermostat.
- Click **Submit**.



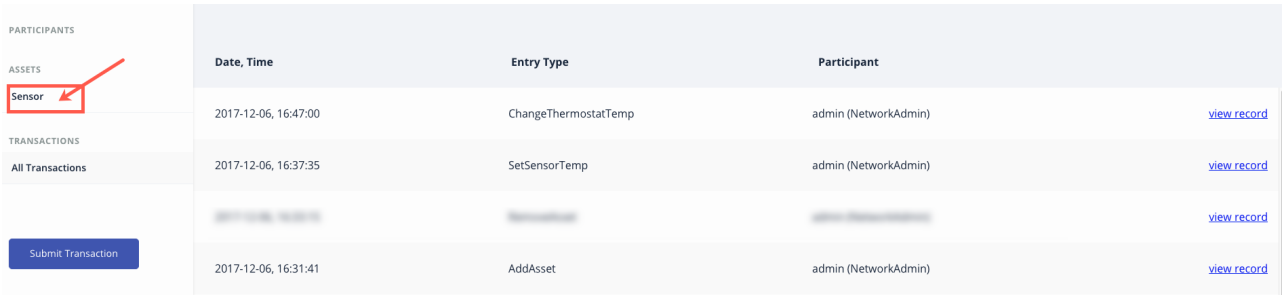
- If you select a temperature for the thermostat that is not within 3 degrees of the `sensorTemp` value, then you will get an error message like the one below. If you get this message, enter another value and click submit.



- If you do have permission to adjust the thermostat, you will be returned back to the transaction registry where you can see the data you just submitted.

- If for some reason you forget to modify your teamID value or update it to the wrong value, you will see an error like the one shown below. Check your value for teamID and try again.

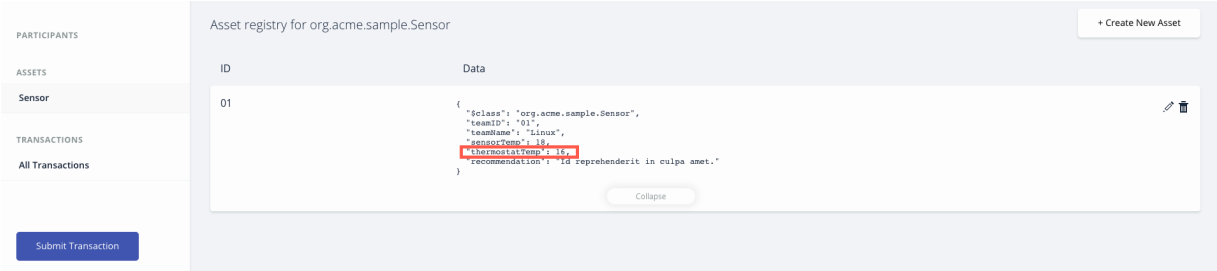
34. Verify that the last transaction updated your asset. Click **Sensor**.



35. Verify that the `thermostatTemp` attribute for your Team has been updated to the value you

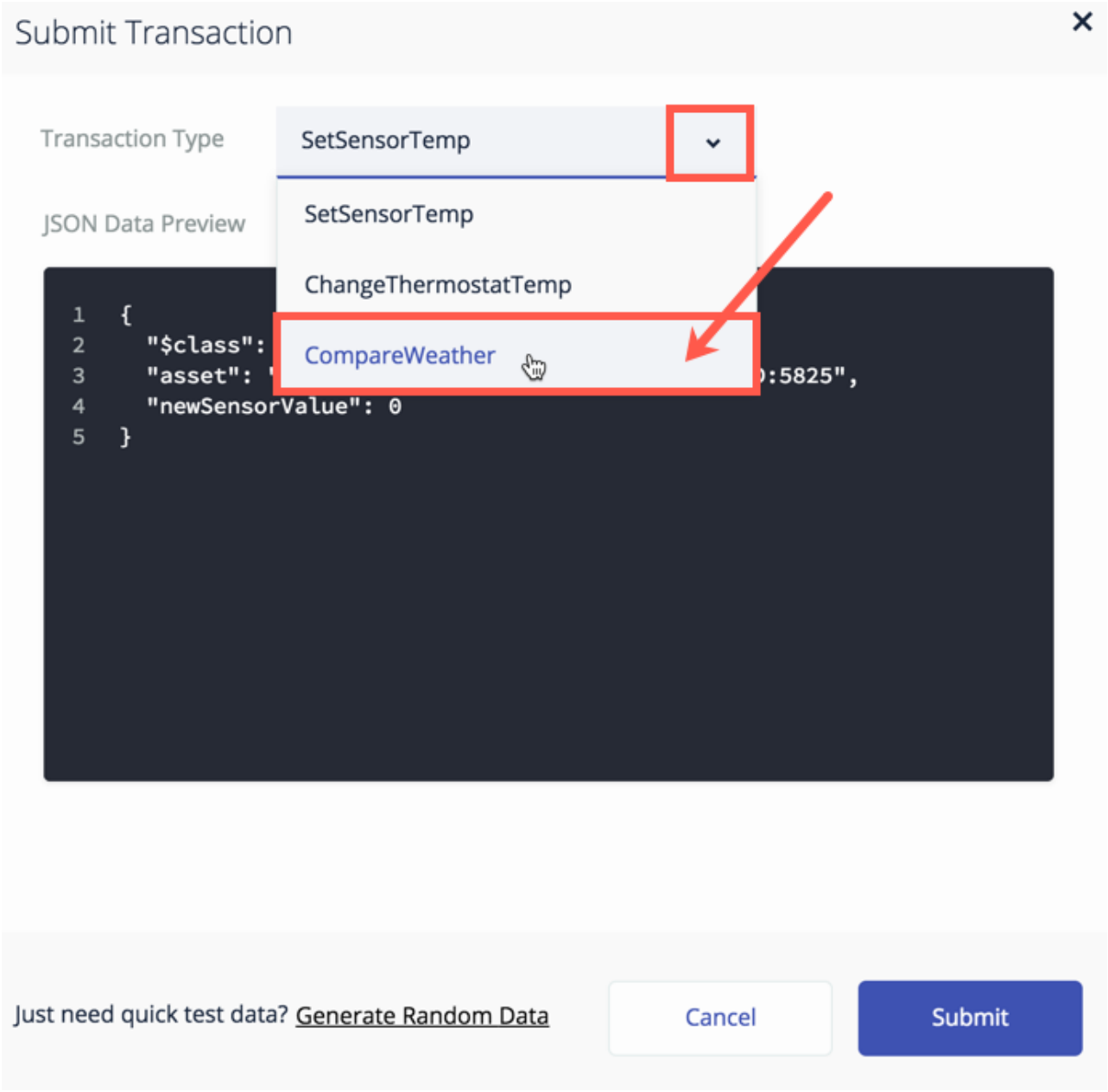
gave successsfully in the `ChangeThermostatTemp` transaction.

- **Note**: In step 40, you can verify that the thermostat was originally set to 20 and is now set to 16.



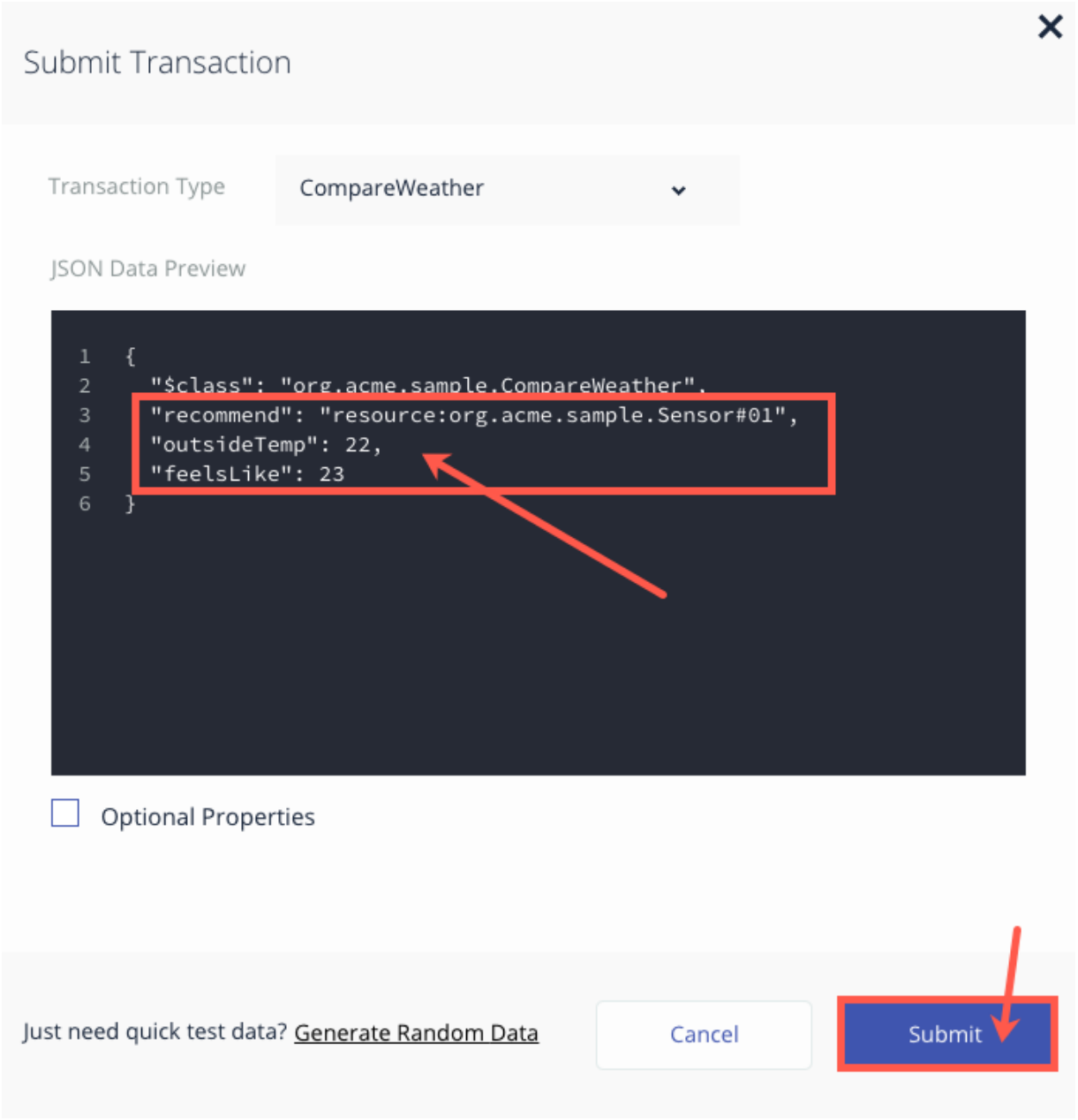
36. Time to work with the `CompareWeather` transaction. Click **Submit Transaction**.

37. Select **CompareWeather** from the *Transaction Type* drop down.

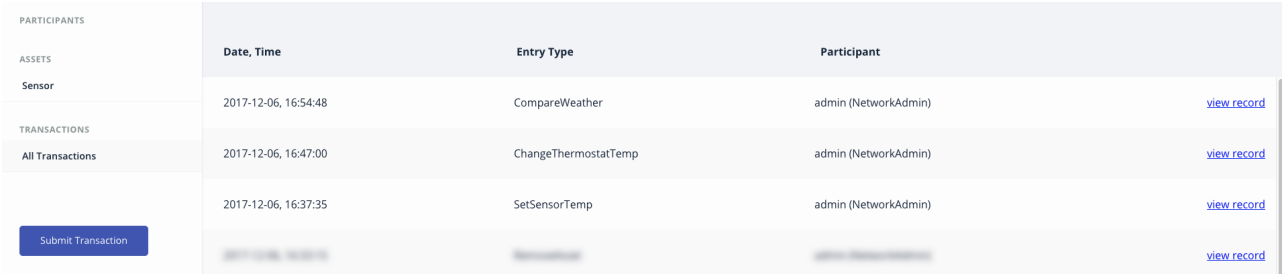


38. Complete the **CompareWeather** transaction.

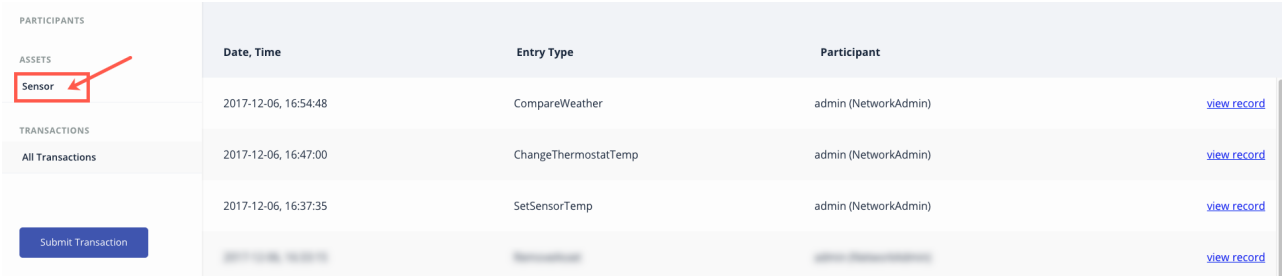
- Modify the JSON, `"recommend": "resource:org.acme.sample.Sensor#xxxx"` — Replace **xxxx** with your team ID.
- Modify the JSON for `"outsideTemp": 0` — Enter a value for an outside temperature.
- Edit the JSON for `"feelsLike": 0` — Enter a value for what temperature it could feel like outside.
- Click **Submit**.



39. Verify that your transaction is showing in the Transaction Registry.



40. Click on **Sensor**.



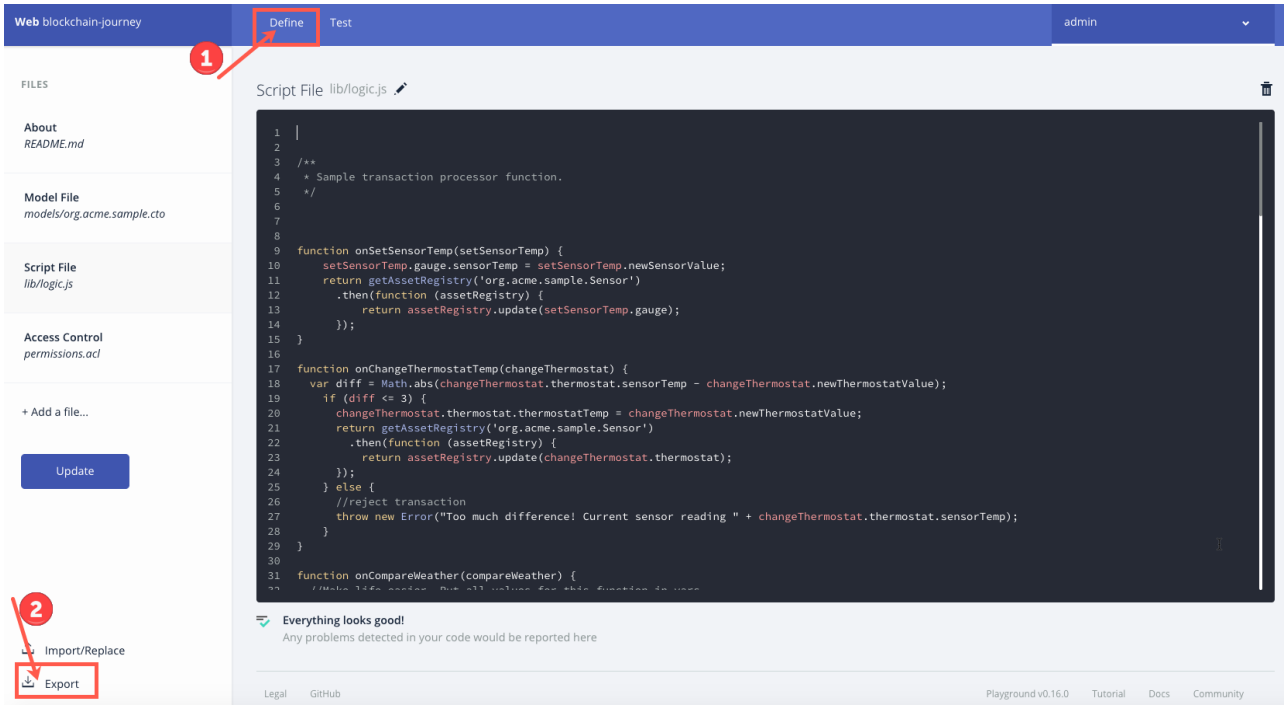
41. Verify there is now a message in the `recommendation` variable in your Team asset and that the `thermostatValue` has been updated to the recommended value.

42. Continue testing your code for all scenarios to understand what your contract(s) can do. The hints to the remaining scenarios are as follows: (Yes, you'll have to look at the Script File under the Define Tab to figure out the criteria.)

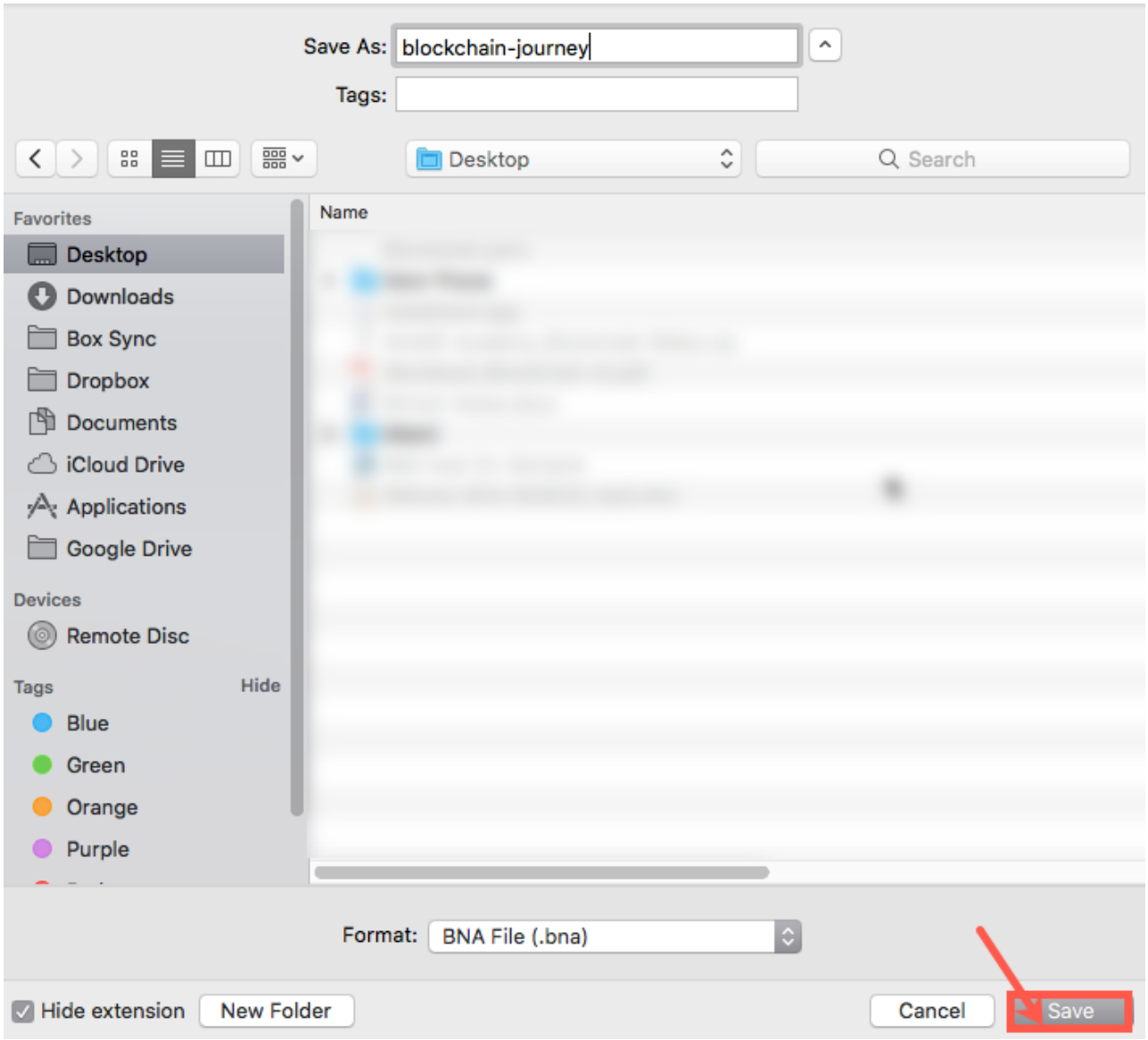
- ChangeThemostatTemp:
  - [ ] A successful transaction where the `thermostatValue` is updated in the Sensor asset.
  - [ ] An error message in the *Submit Transaction* window advising you do not have permission to adjust the thermostat.
- CompareWeather:
  - [ ] A transaction based on `outsideTemp` values where it is really hot.
  - [ ] A transaction based on `outsideTemp` values where it is quite nice.
  - [ ] A transaction based on `outsideTemp` values where it is cold.
  - [ ] A transaction based on `feelsLike` values where it hot.
  - [ ] A transaction based on `feelsLike` values where it is quite nice.
  - [ ] A transaction based on `feelsLike` values where it is cold.
- **Note:** You should verify that your asset values have been updated appropriately after each transaction like you did in prior steps.

Deploy application to Hyperledger Fabric

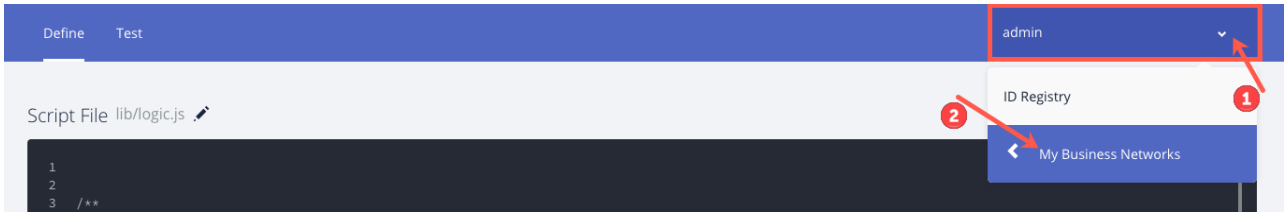
43. Back in your browser where Hyperledger Composer Playground is running, **click** the *Define* tab and then **click** *Export* to save your code to your desktop. This is a safety measure. Export saves all of the indivudual files we imported at the beginning of Part 2 into a compressed file called a business network archive (.bna).



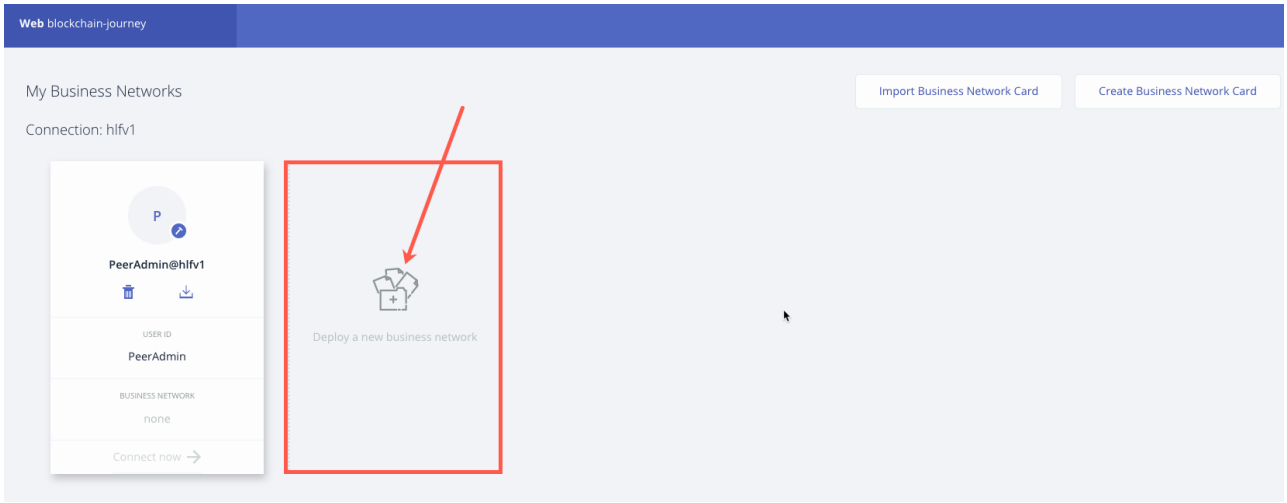
44. In the pop-up dialog, **choose** your directory location and **click** *Save*.



45. In the upper right corner of your browser, **select** *admin* and **click** *My Business Networks*.

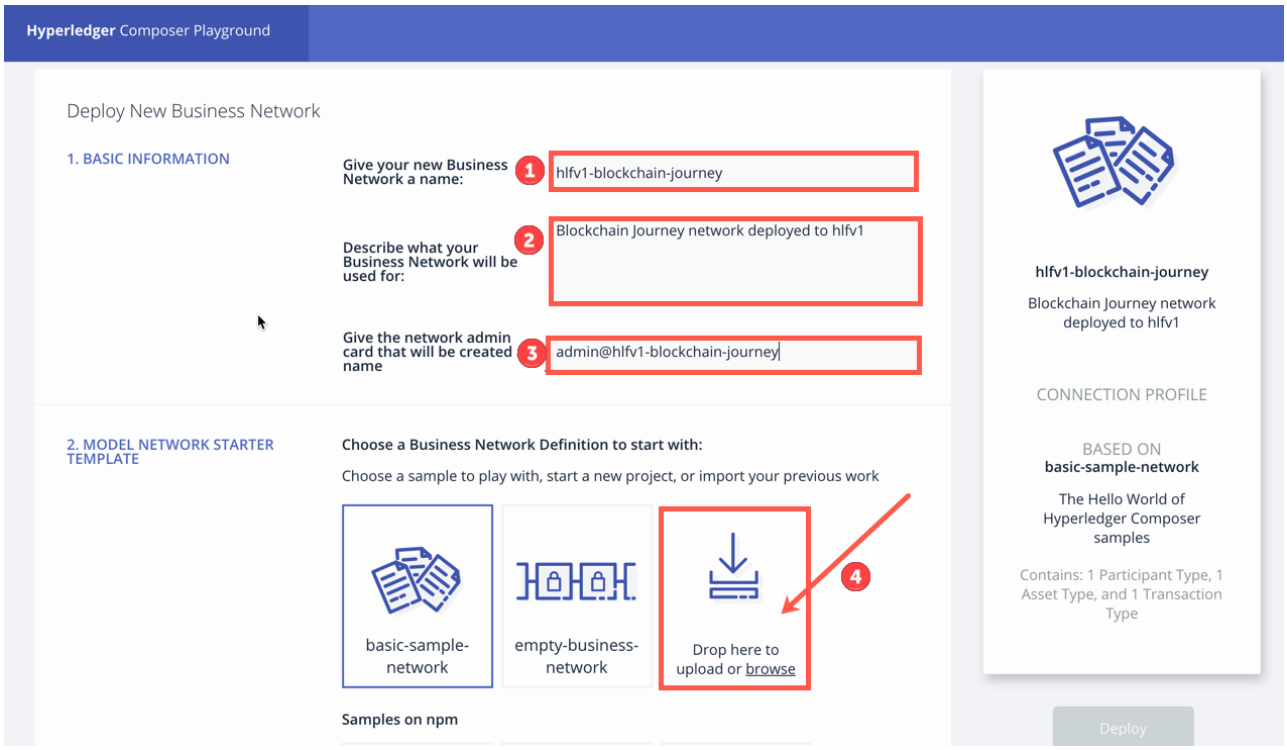


46. In the middle of the page, **click** *Deploy a new business network* under the *Connection: hlfv1* business network.

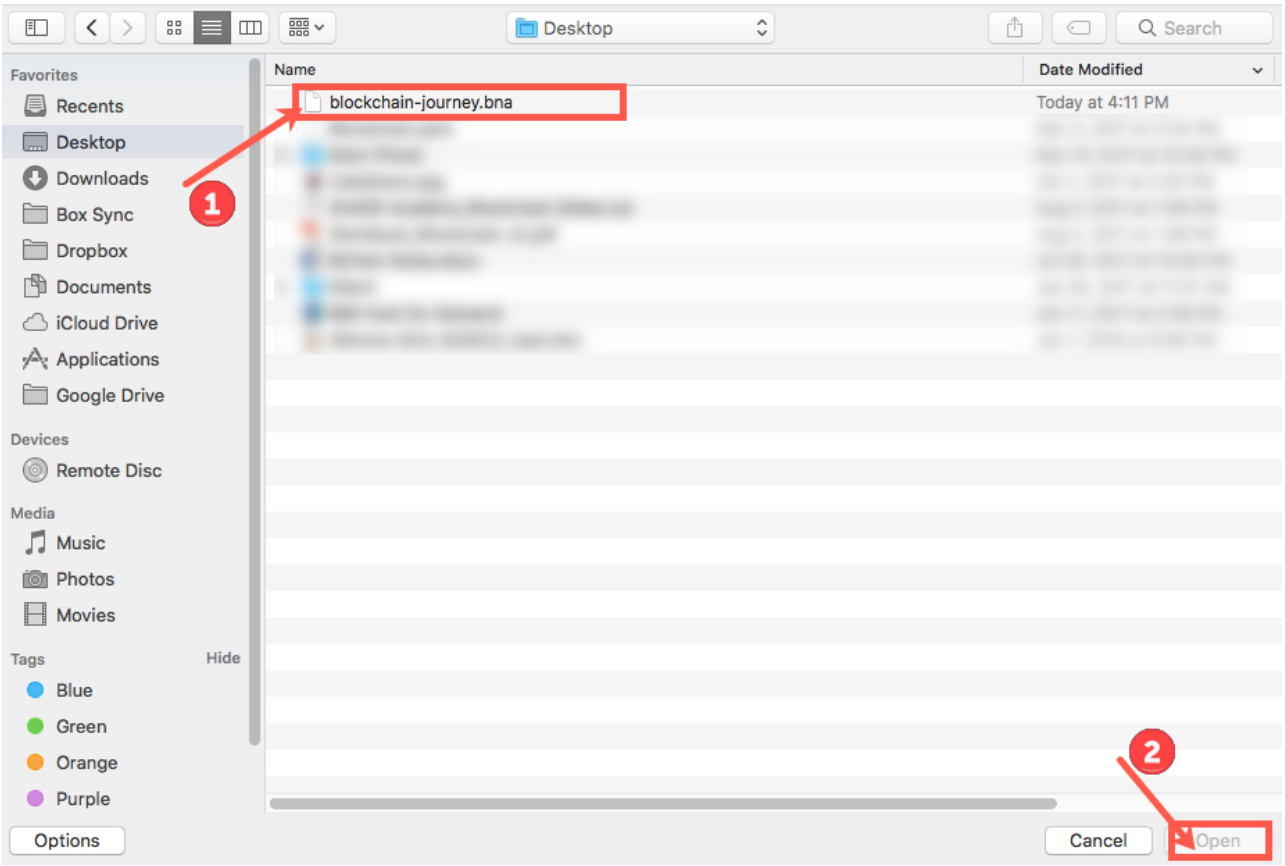


47. Complete the fields under *Basic Information* and then **click** *Drop here to upload or browse*.

- Business Network: `hlfv1-blockchain-journey`
- Description: "Blockchain Journey network deployed to hlfv1"
- Network Admin Card: `admin@hlfv1-blockchain-journey`

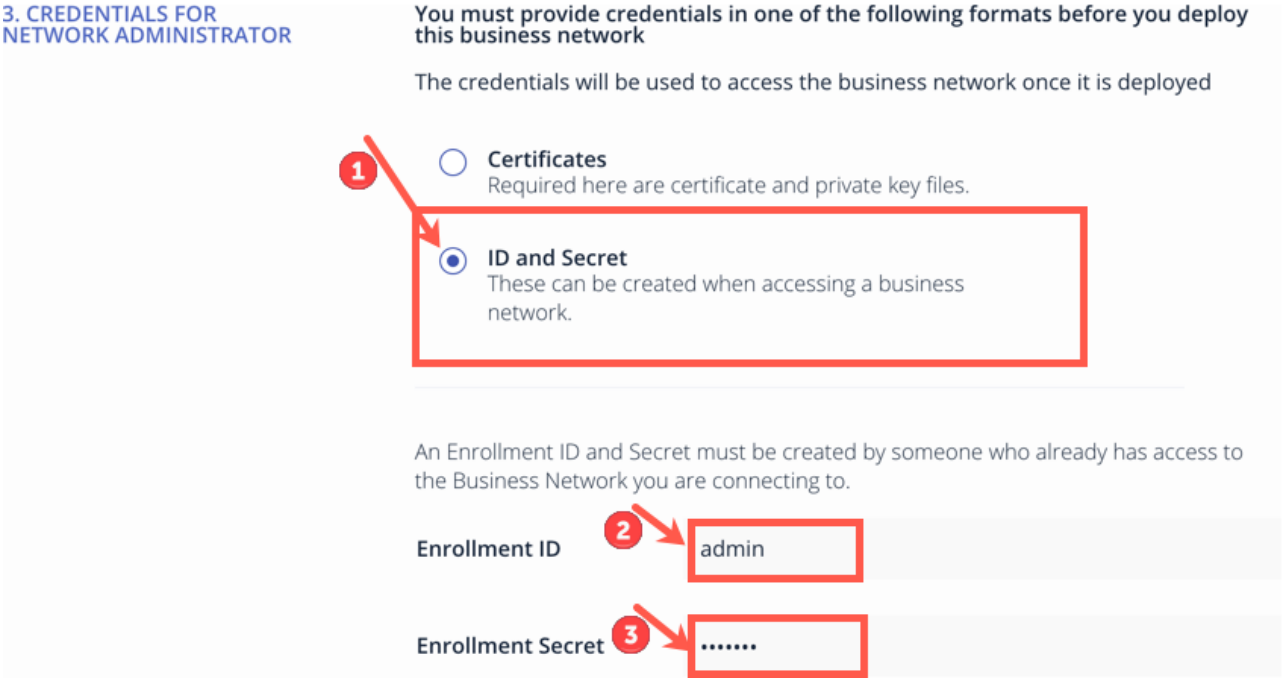


48. Navigate to where you saved your blockchain-journey.bna in step 49. **Select** blockchain-journey.bna from its directory and **click** *Open*.

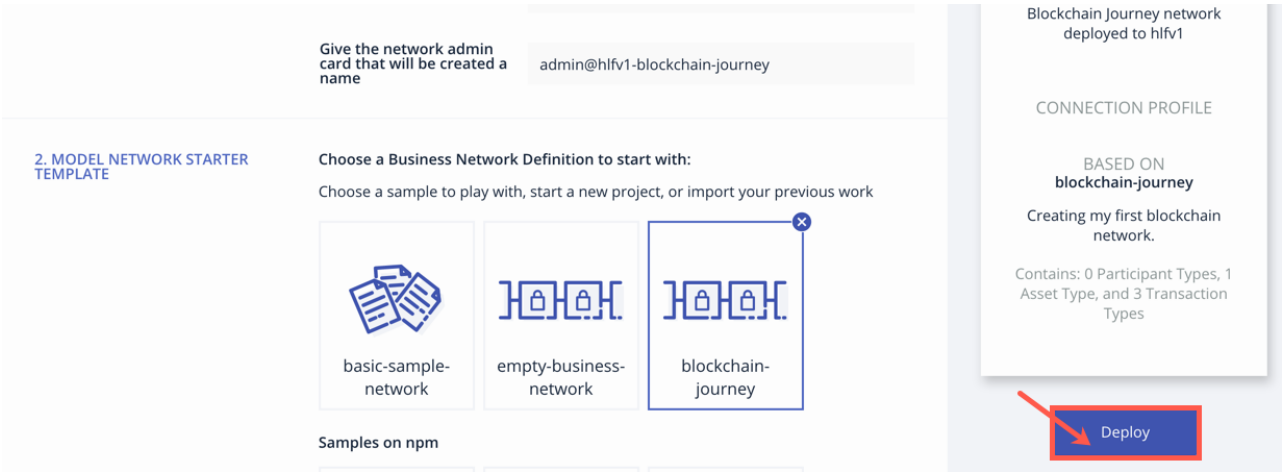


49. Scroll to the bottom of the page and complete the following:

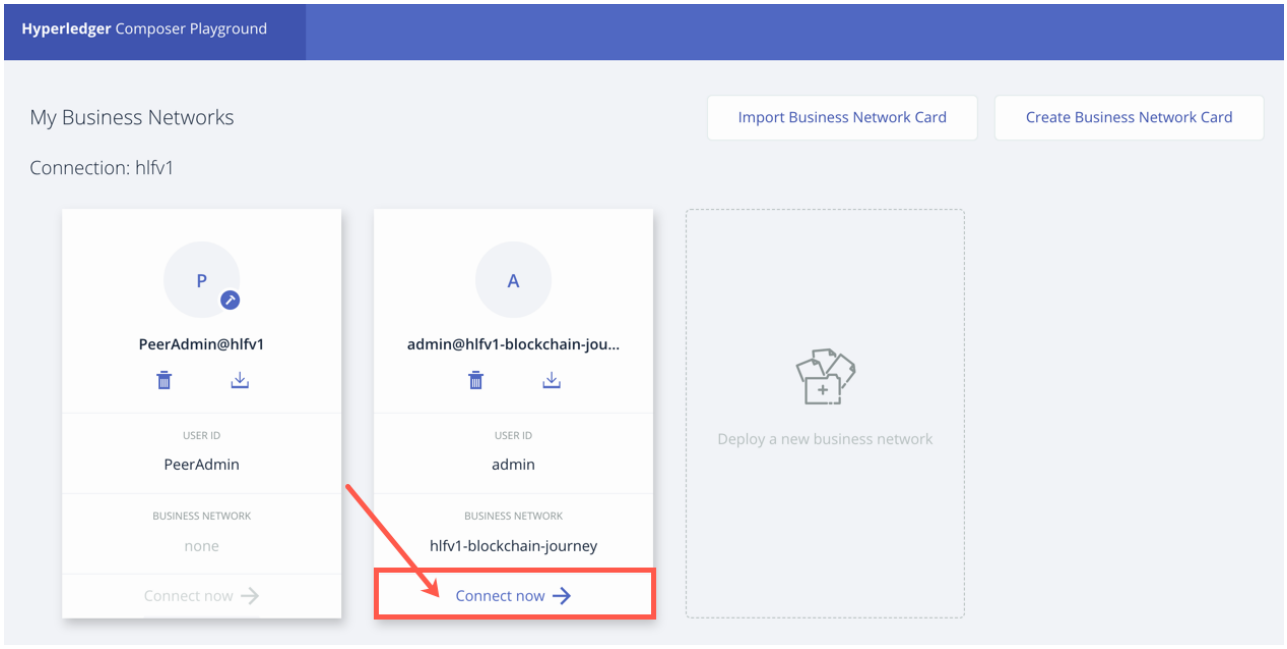
- **Select** *ID and Secret*.
- **Create** an *Enrollment ID* of `admin`.
- **Create** an *Enrollment Secret* of `adminpw`.
- Note: If you create a different *Enrollment Id* and *Enrollment Secret* then you will need to create and import a network card for that ID. See [Hyperledger Composer documentation for more information.]



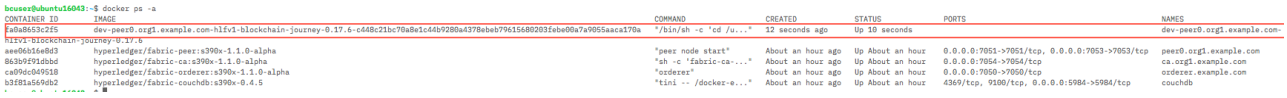
50. Scroll up to the top and **click** *Deploy* on the right side.



51. Under *Connection: hlfv1*, find your newly deployed network *hlfv1-blockchain-journey*. **Click** *Connect now*.



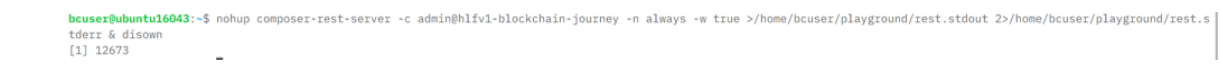
52. Back in your terminal, enter `docker ps -a` . You can see there is now a new container running where Composer Playground has deployed code to the Hyperledger Fabric.



53. Congratulations! You've deployed your first blockchain application to Hyperledger Fabric.

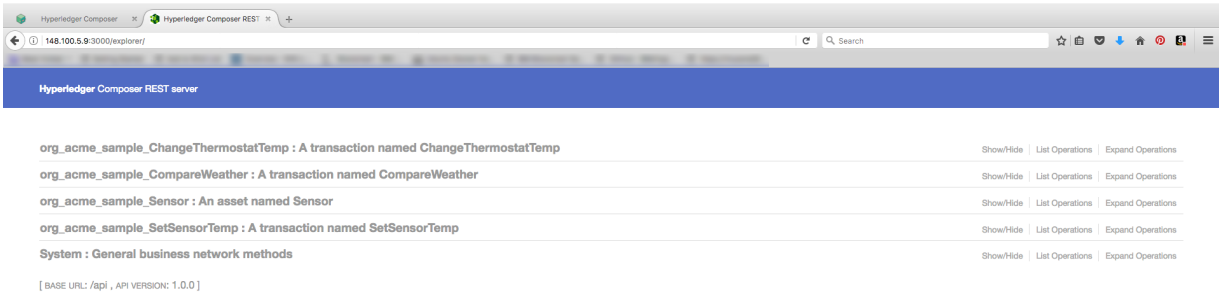
Generating API

54. In your terminal, issue the following command to start the API rest server:
    - `nohup composer-rest-server -c admin@hlfv1-blockchain-journey -n always -w true >/home/bcuser/playground/rest.stdout 2>/home/bcuser/playground/rest.stderr & disown`

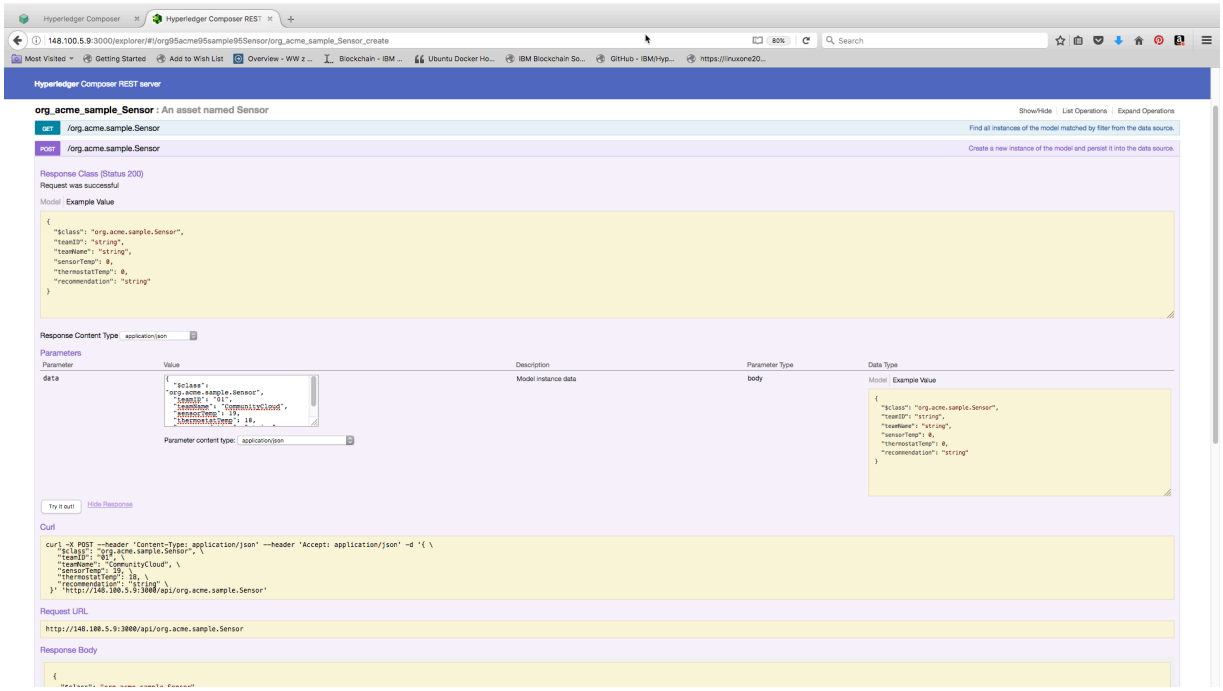


55. Verify the rest server process is running. `ps -ef|grep rest`

56. To see your API, go back to your browser and open a new tab or window. In the address bar, enter `http://xxx.xxx.x.x:3000/explorer` where the x's are the IP address for your Linux guest. You should see a page like the one shown.



57. Expand the different methods to see the various calls and parameters you can make through REST API. You can also test the API in this browser to learn how to form the API and see the responses.

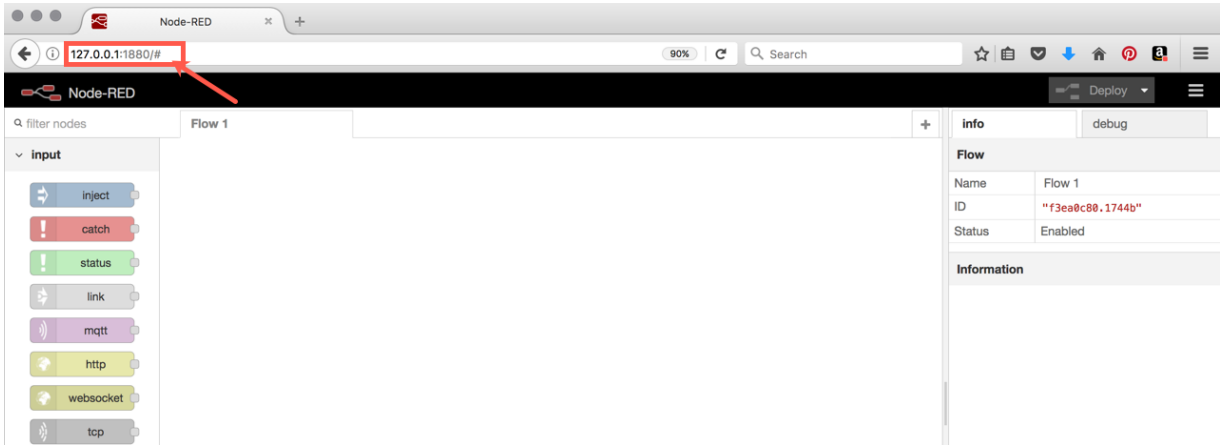


58. Congratulations! You now have a working blockchain application and have created APIs to call your blockchain application.

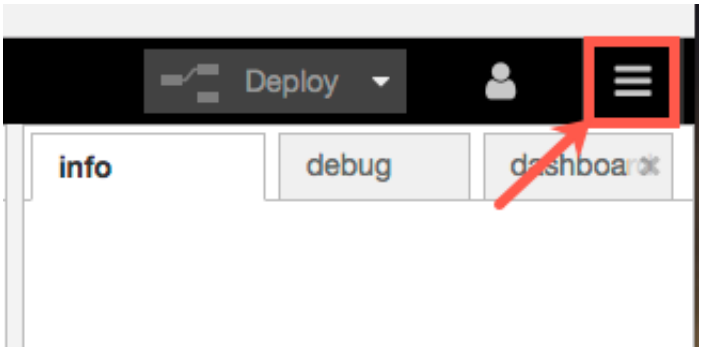
Part 3 — Utilizing blockchain API through NodeRED

Importing your flow into NodeRED

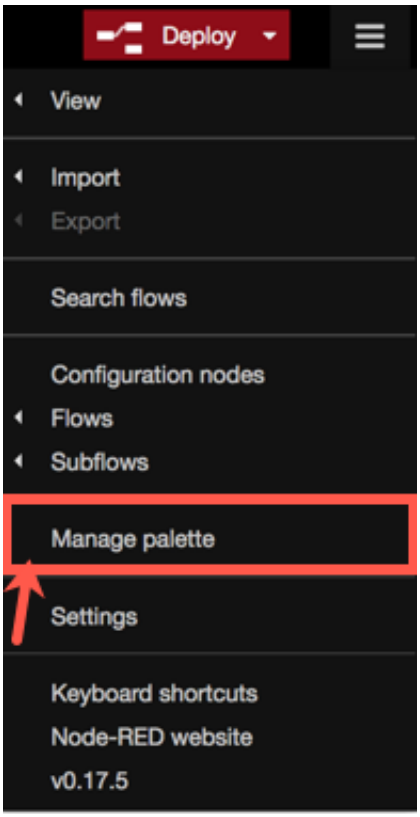
1. Open NodeRED in your browser in a new tab or window. Enter `http://xxx.xxx.x.x:1880` in the address bar where the x's correspond to your Linux guest IP address.
    - Note: You may need to use a browser other than Chrome for Node-RED. There have been intermittant issues with Node-RED loading properly in Chrome.



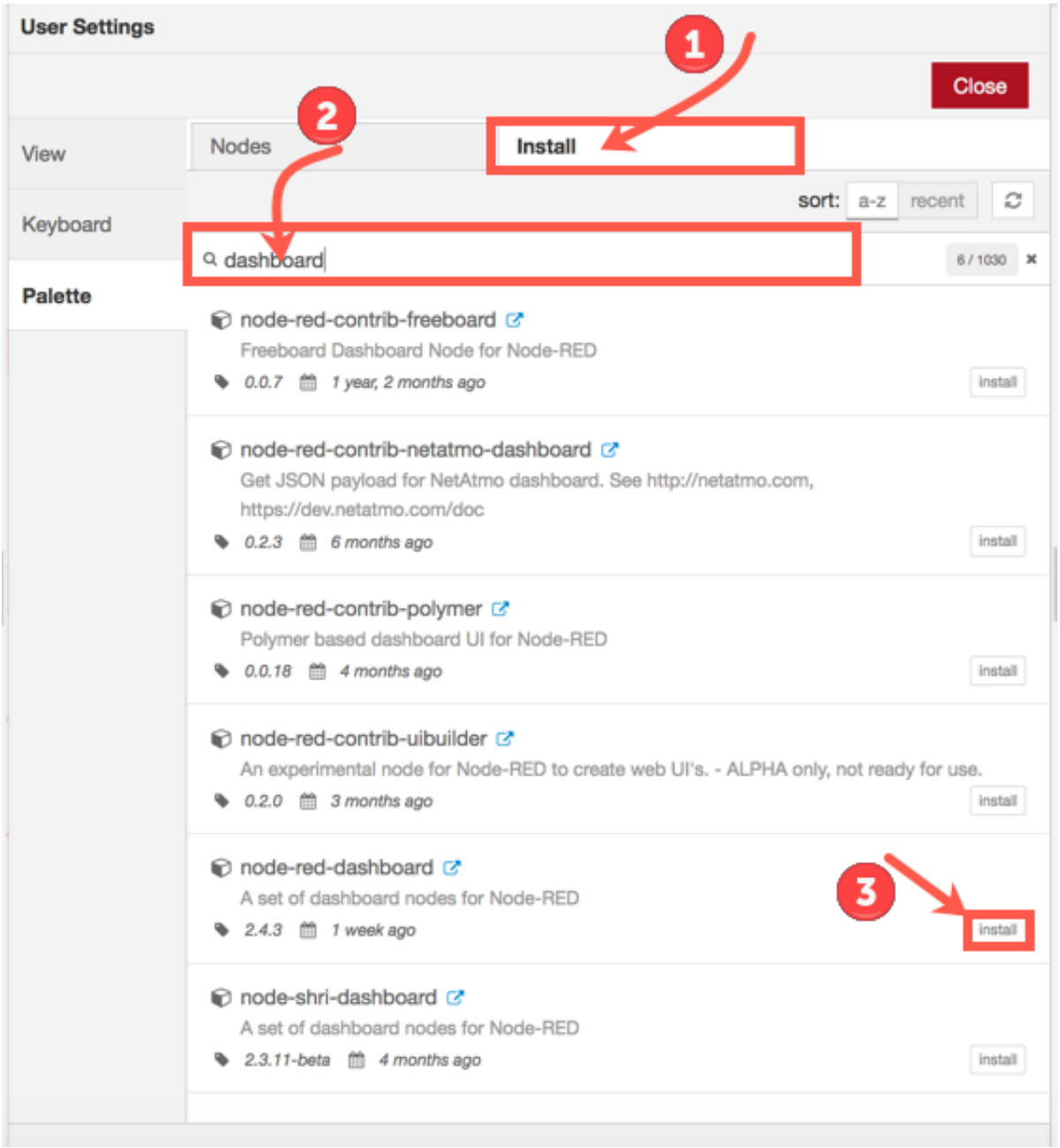
2. You'll need to add a few more nodes to your NodeRED palette to have complete working flows. To do this, **select** the *menu* button in the upper right corner.



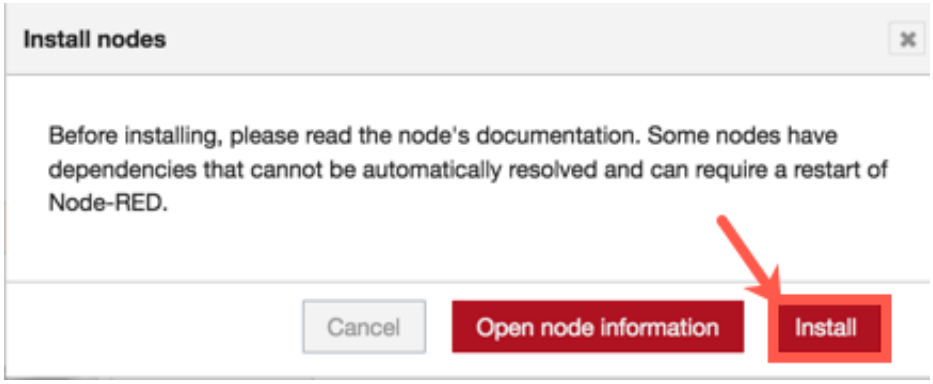
3. **Select** *Manage Palette* from the drop down menu.



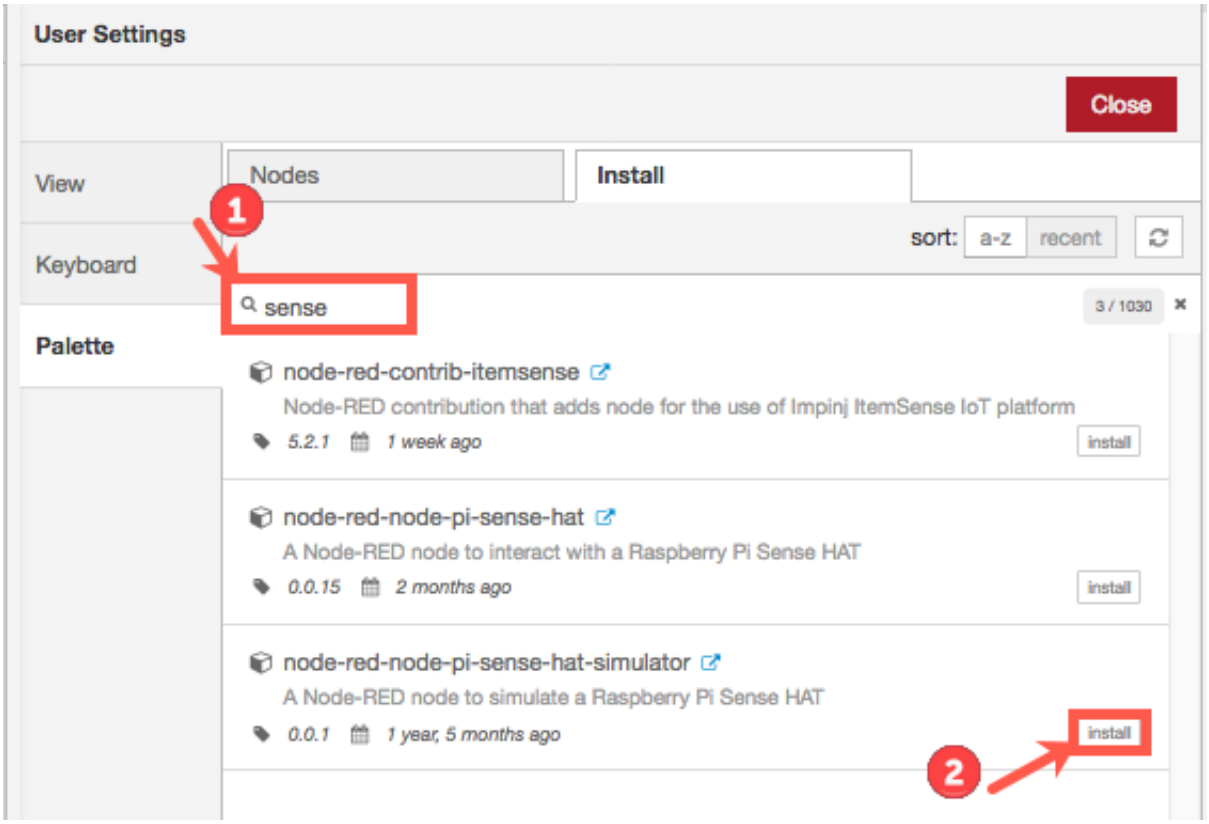
4. In the *User Settings* window, **click** *Install*, **type** `dashboard` in the search bar and select **install** next to *node-red-dashboard*.



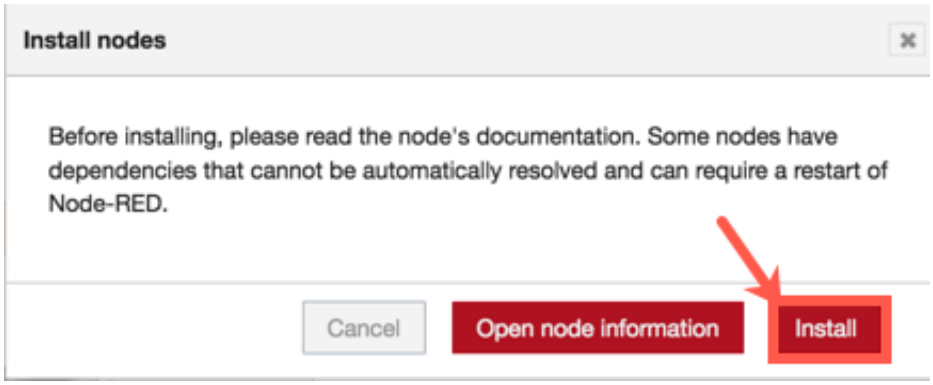
5. In the *Install nodes* pop-up, **click** *Install*.



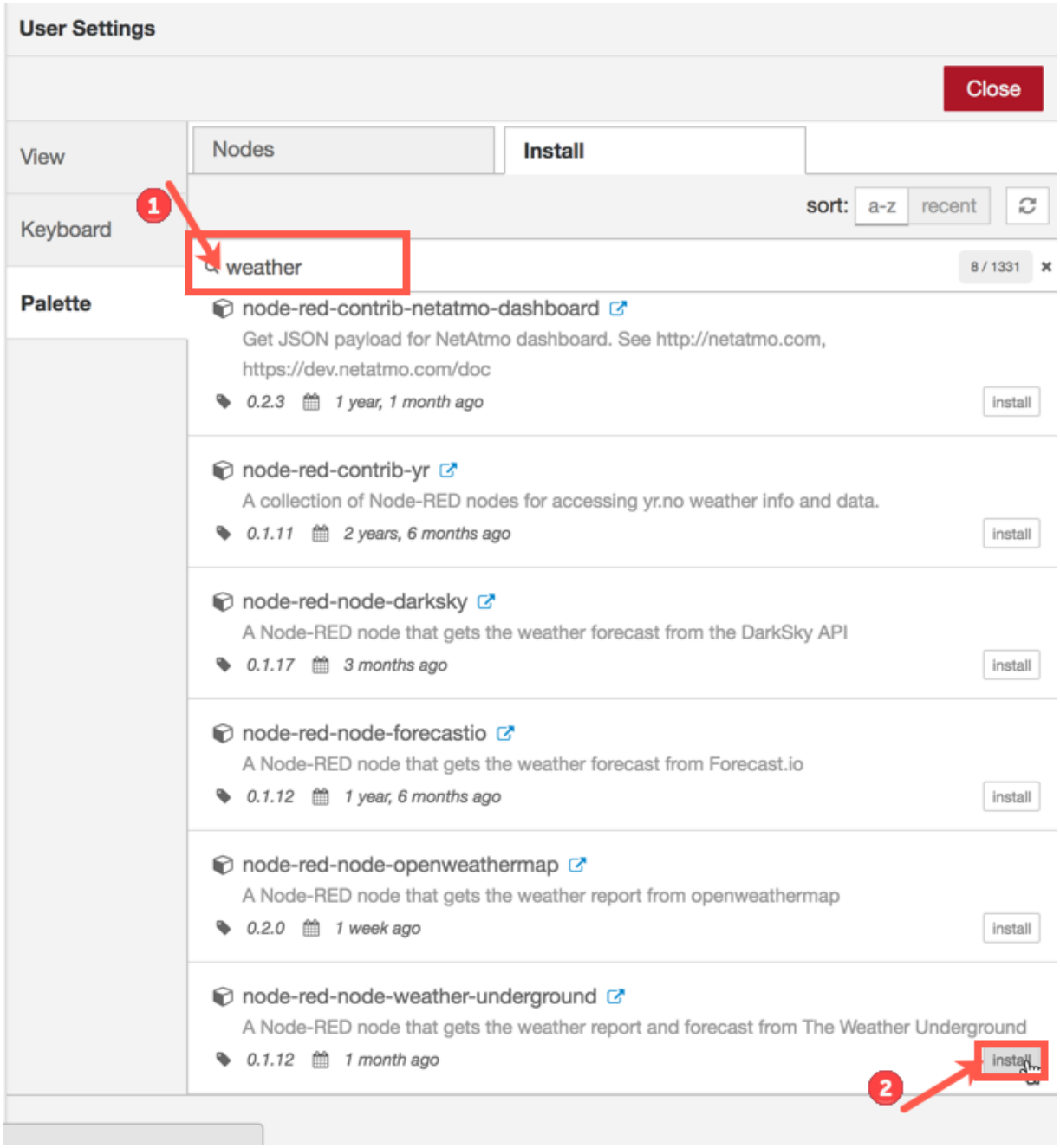
6. Now it's time to install a RaspberryPi Sense Hat simulator. In the *User Settings* window under *Install*, **type** `sense` in the search bar and select **install** next to *node-red-pi-sense-hat-simulator*.



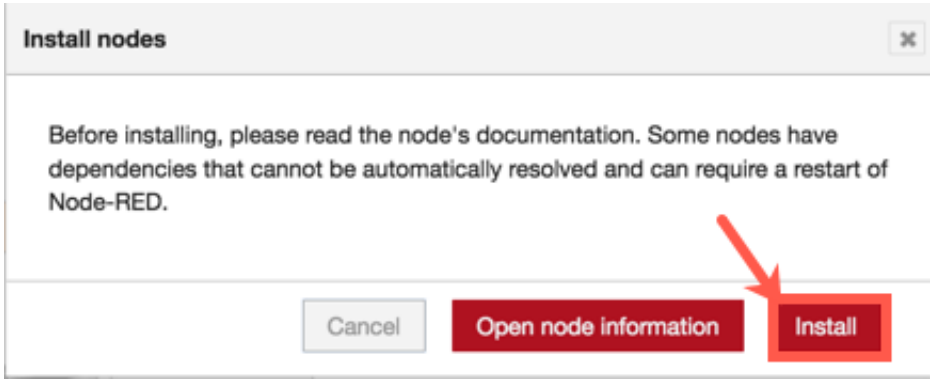
7. In the *Install nodes* pop-up, **click** *Install*.



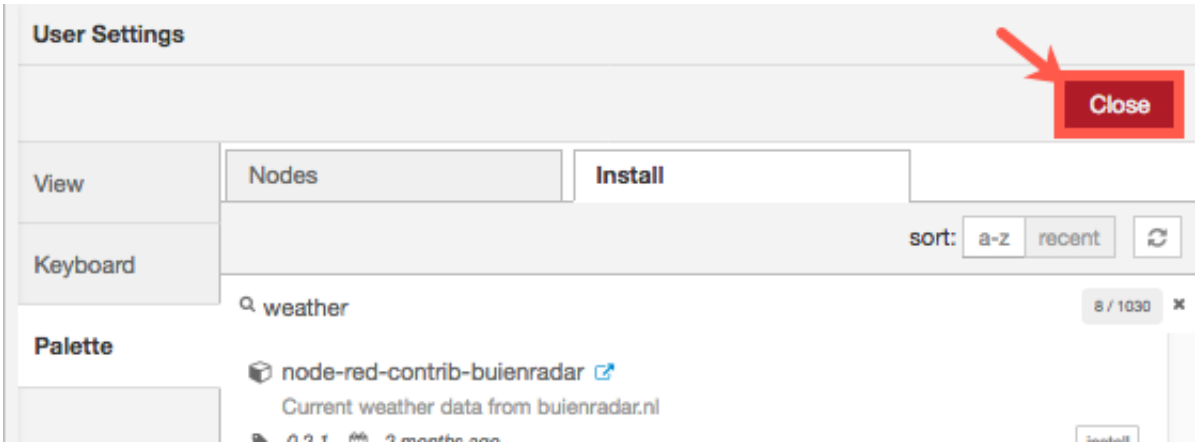
8. One more node to add, **type** *weather* in the search dialog and **select** *install* next to *node-red-node-weather-underground*.



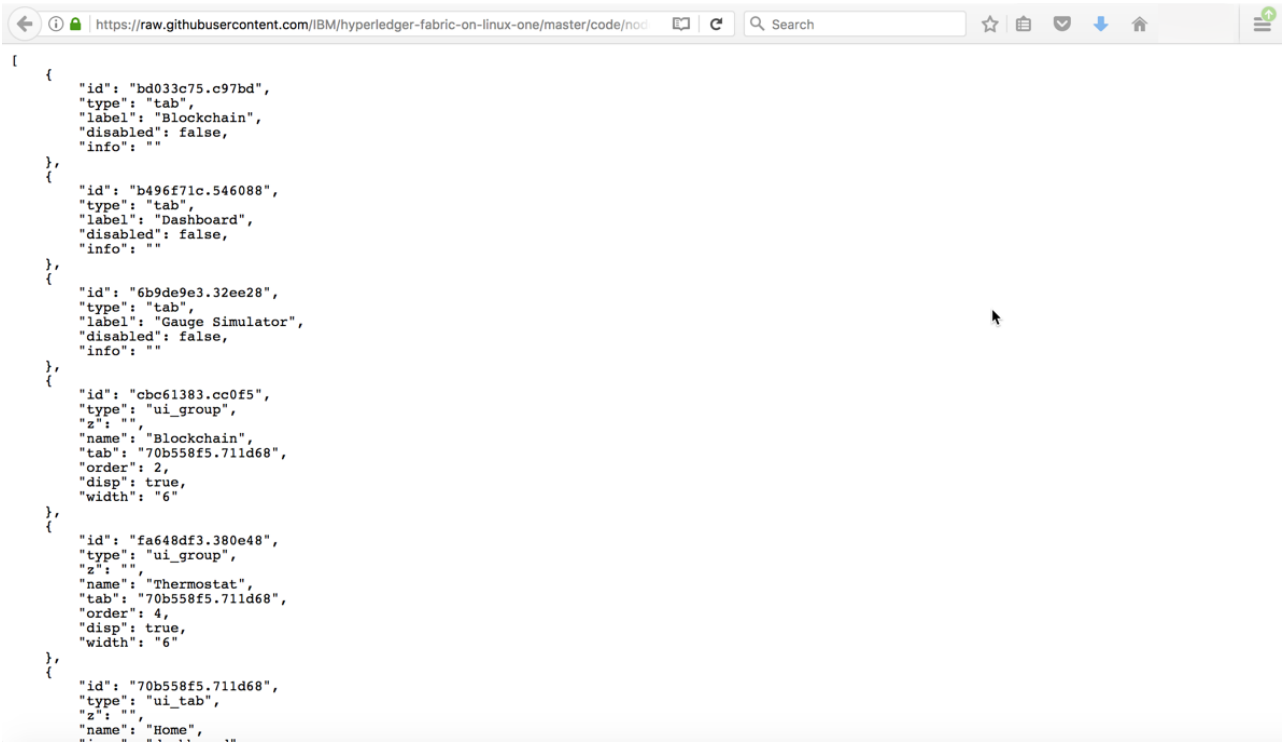
9. In the *Install nodes* pop-up, **click** *Install*.



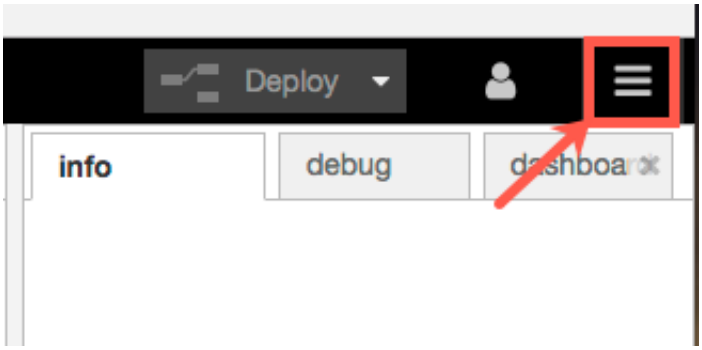
10. **Click** *Close* to leave the User Settings dialog.



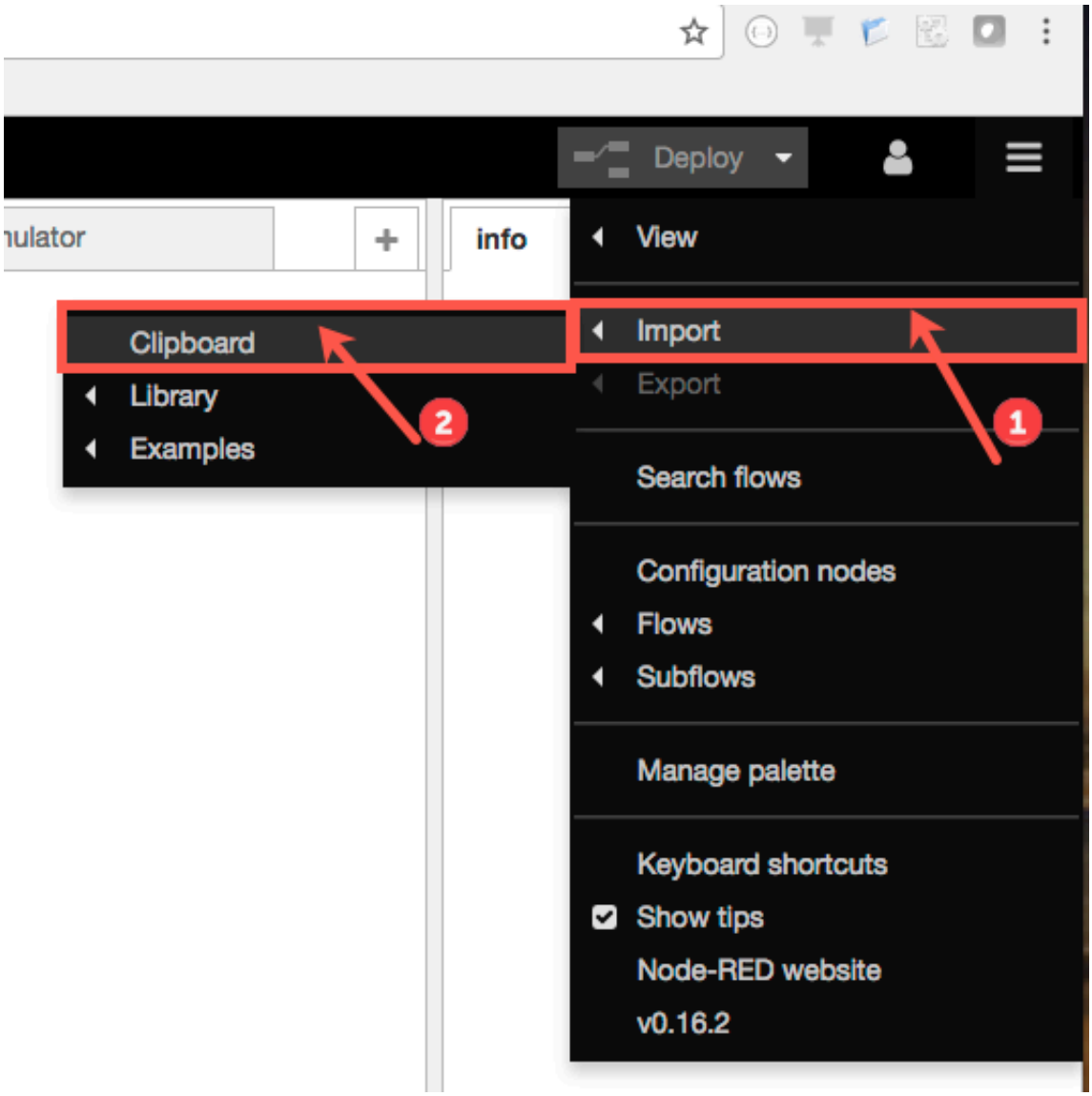
9. **Copy** all of the JSON from the [GitHub repository] to import into the flow.
    - **Note:** The easiest way to do this is clicking the hyperlink above. You can also find it in the GitHub repository in the code folder as `node-red.json`. To view it in GitHub, **click** on *node-red.json*, **select** *raw* and then copy it.



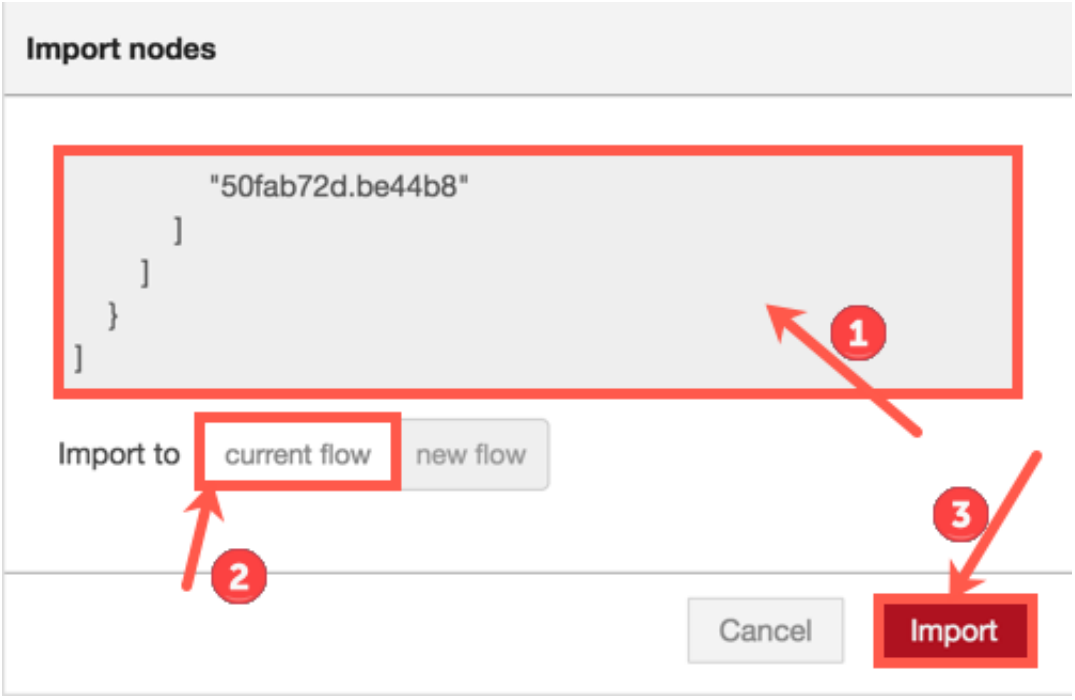
10. Paste it into NodeRed, by **clicking** on the *menu icon* in the upper right corner.



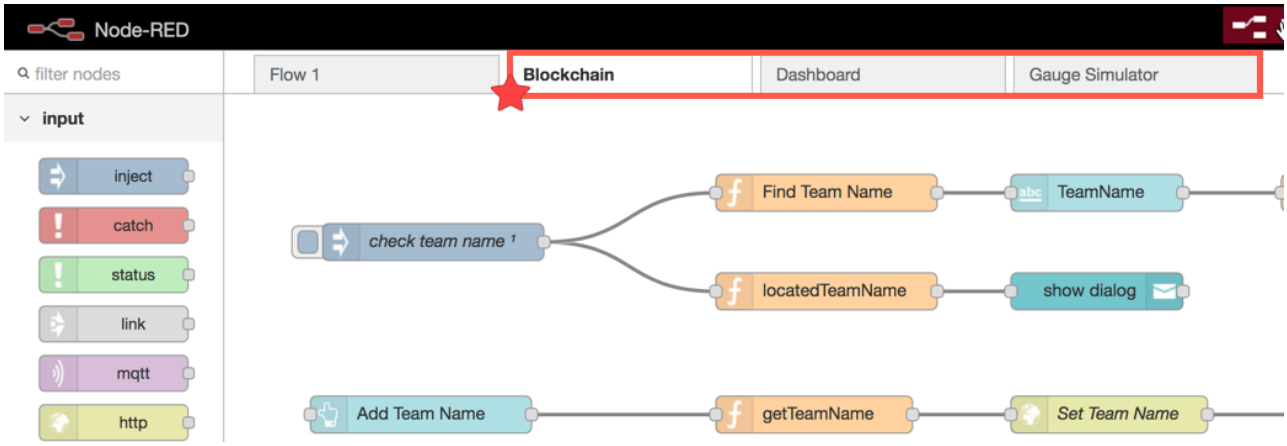
11. **Select** *Import -> Clipboard*.



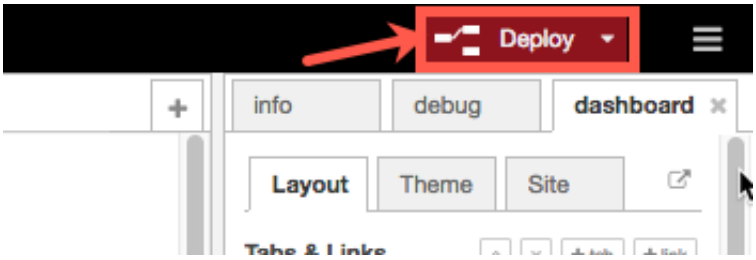
12. **Paste** the code in the editor. Make sure to **select** "current flow" button. **Select** *Import*.



13. You should now have three flows in NodeRED — Blockchain, Dashboard and Gauge.

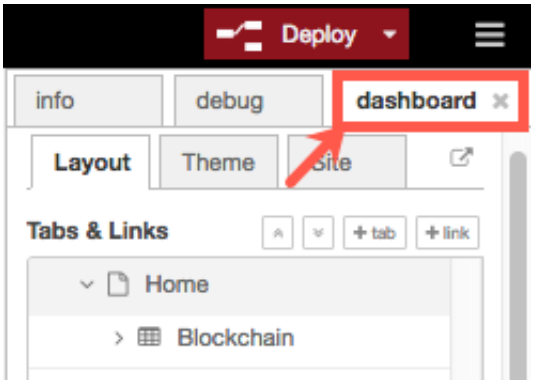


14. On the right side of the Node-RED browser, **click** *Deploy* to save the work you've imported.

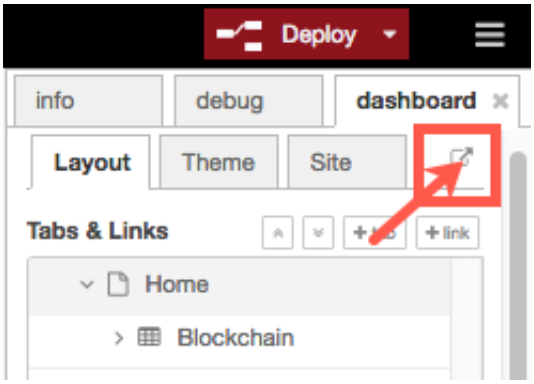


Interacting with blockchain through a dashboard

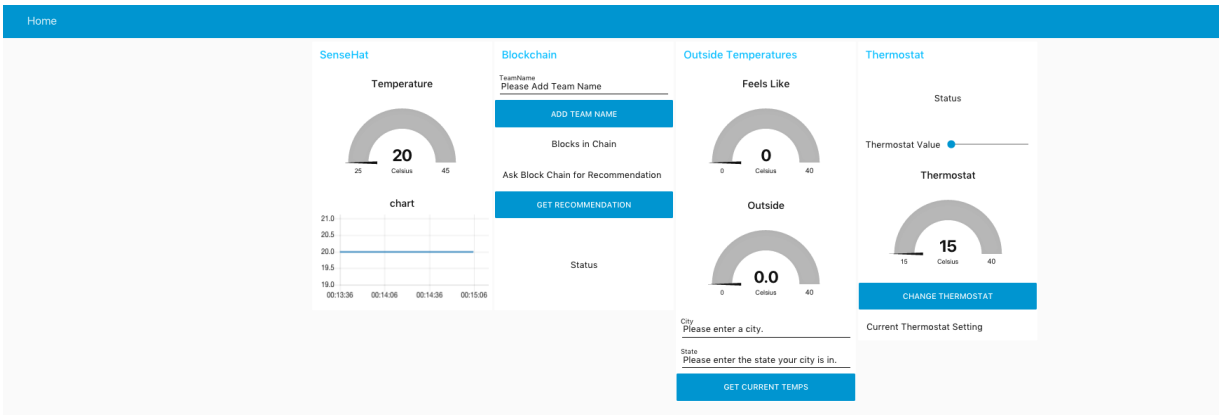
15. **Click** the *dashboard* tab in the upper right corner under *Deploy*.



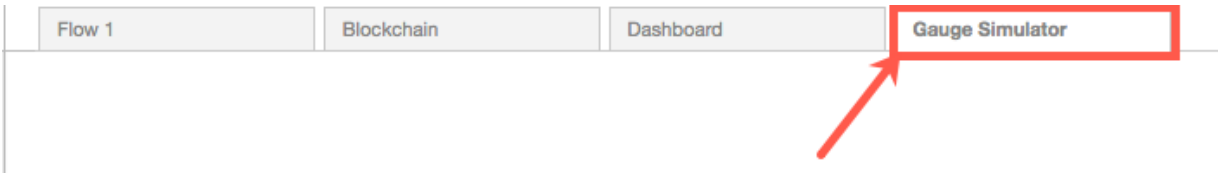
16. **Click** the *pop out* button to open the dashboard in a browser.



17. A new tab should open. Your dashboard should look like the following image.

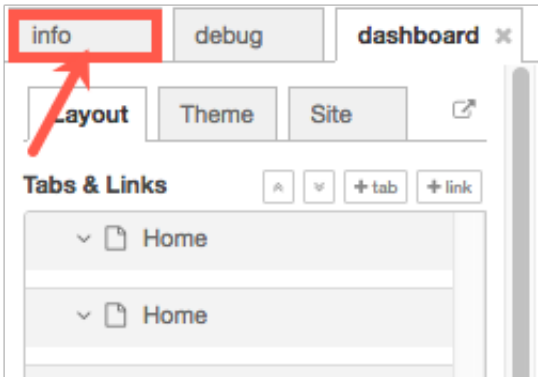


18. To interact with your simulated RaspberryPi, go back to your Node-RED tab and **select** the *Gauge Simulator* tab.

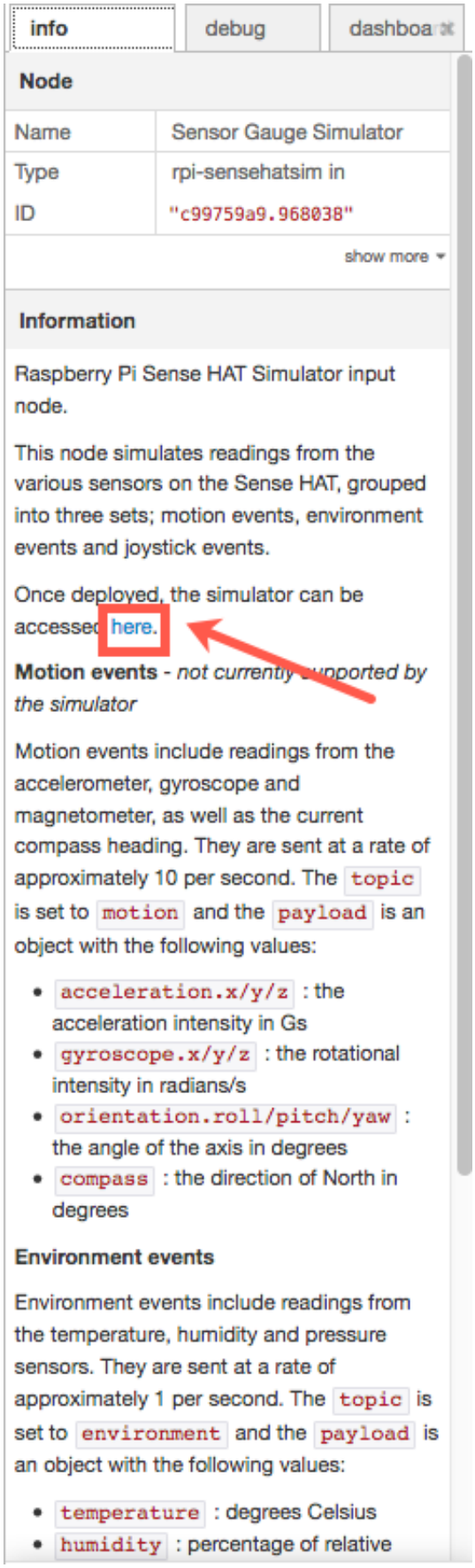


19. **Click** on the *Sensor Gauge Simulator* node.

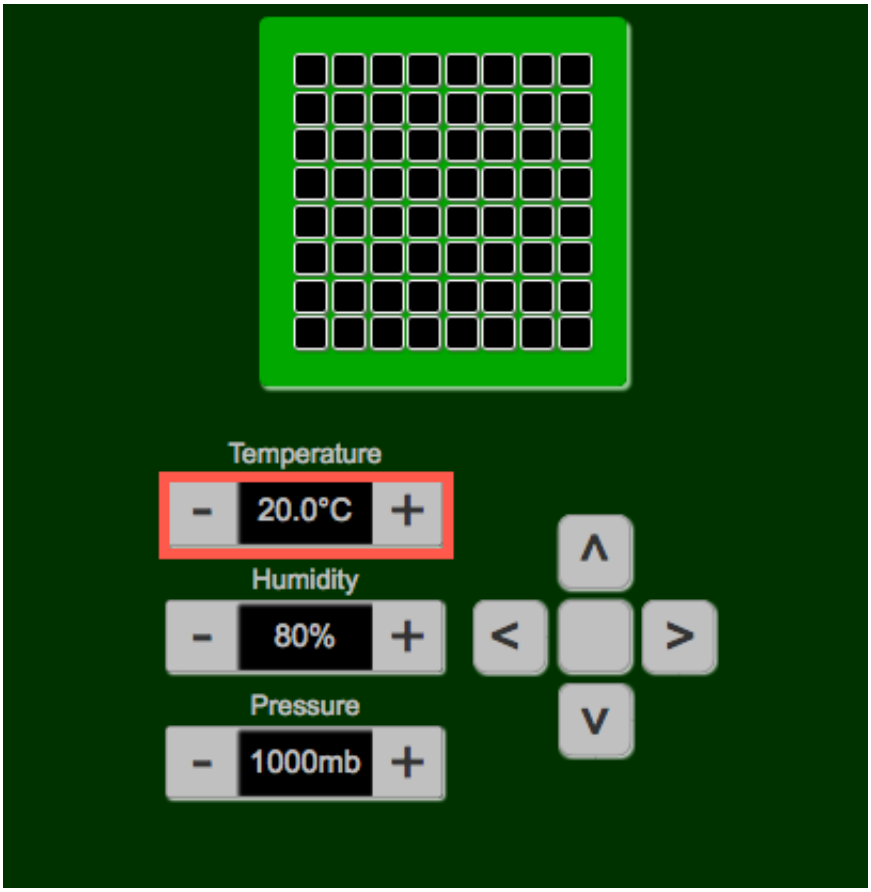
20. On the right side of the browser, **click** on the *Info* tab.



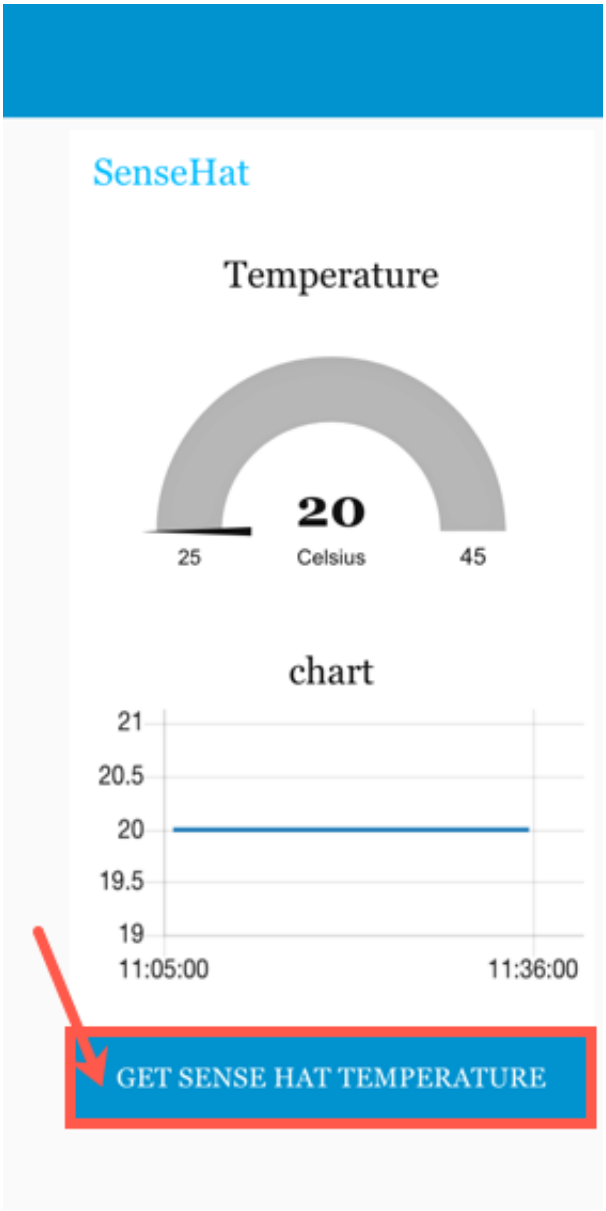
21. In the third paragraph under Information there is a hyperlink for the word *here*. That hyperlink opens the simulator in a new tab. **Click** *here*.



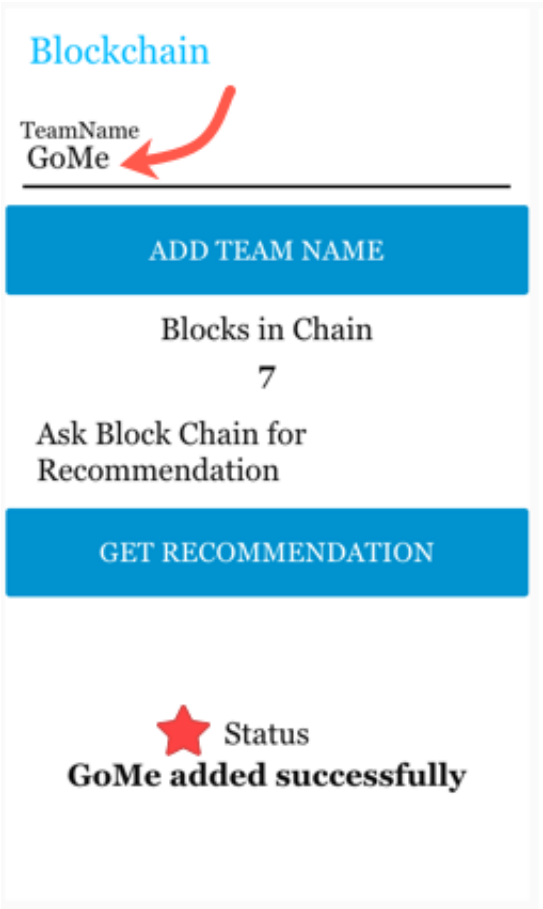
22. **Adjust** the temperature of the sensor in the simulator from 20 C.



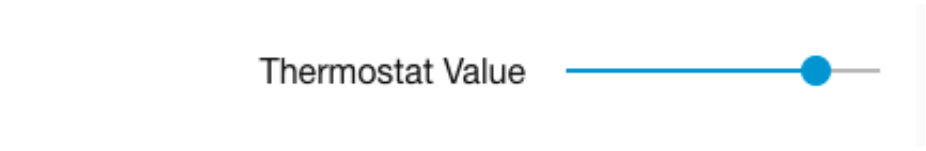
23. Switch to the tab for your dashboard, **click** *Get Sense Hat Temperature* to see the change to the sensor temperature and graph.



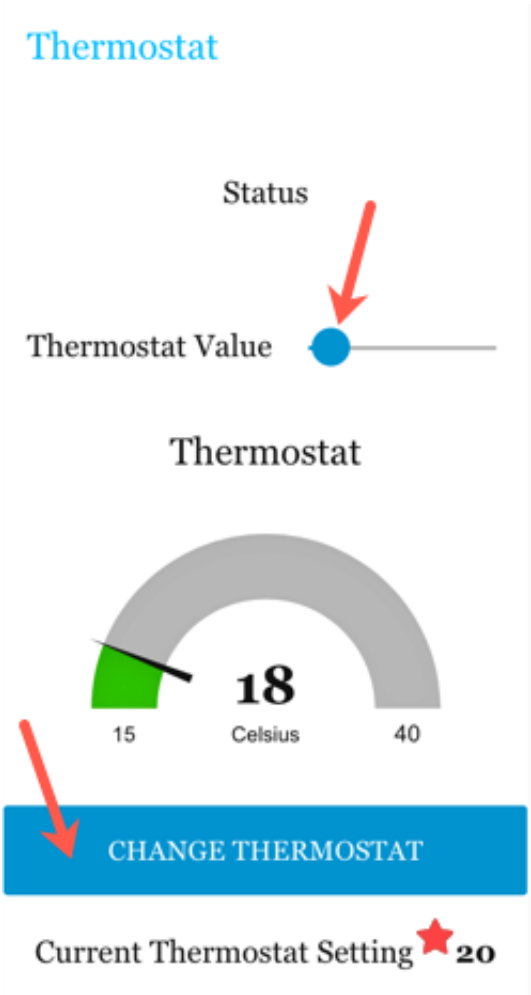
24. Continue to play with your dashboard to interact with blockchain via API. You can try the following:
    - Type in a team name & click *Add Team Name*. You should see a successful message afterward.



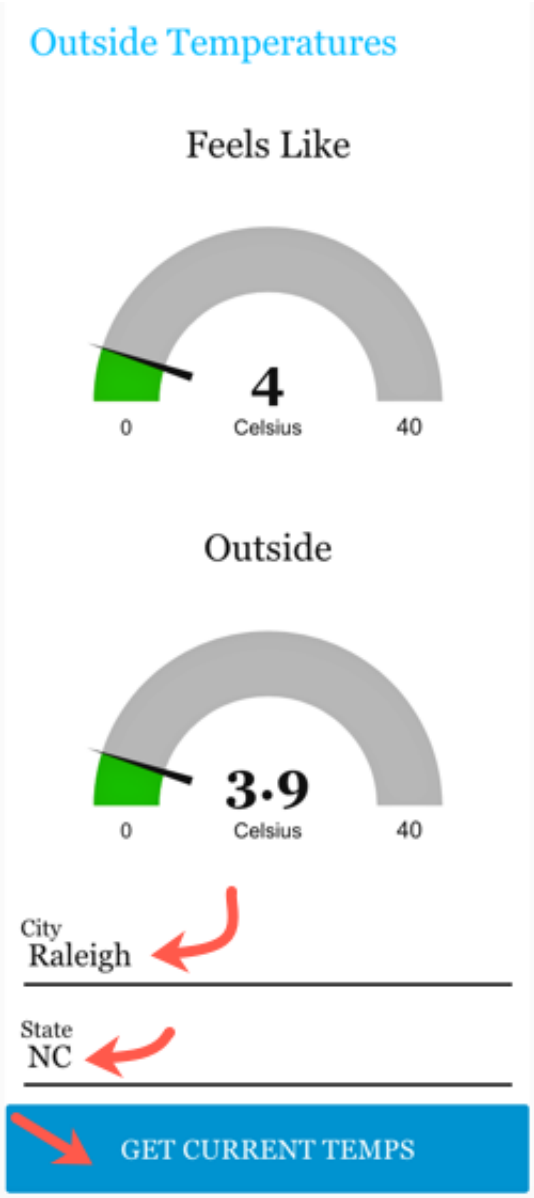
- Change the thermostat by moving the slider next to *Thermostat Value*. Click *Change Thermostat* to send the value to blockchain.'



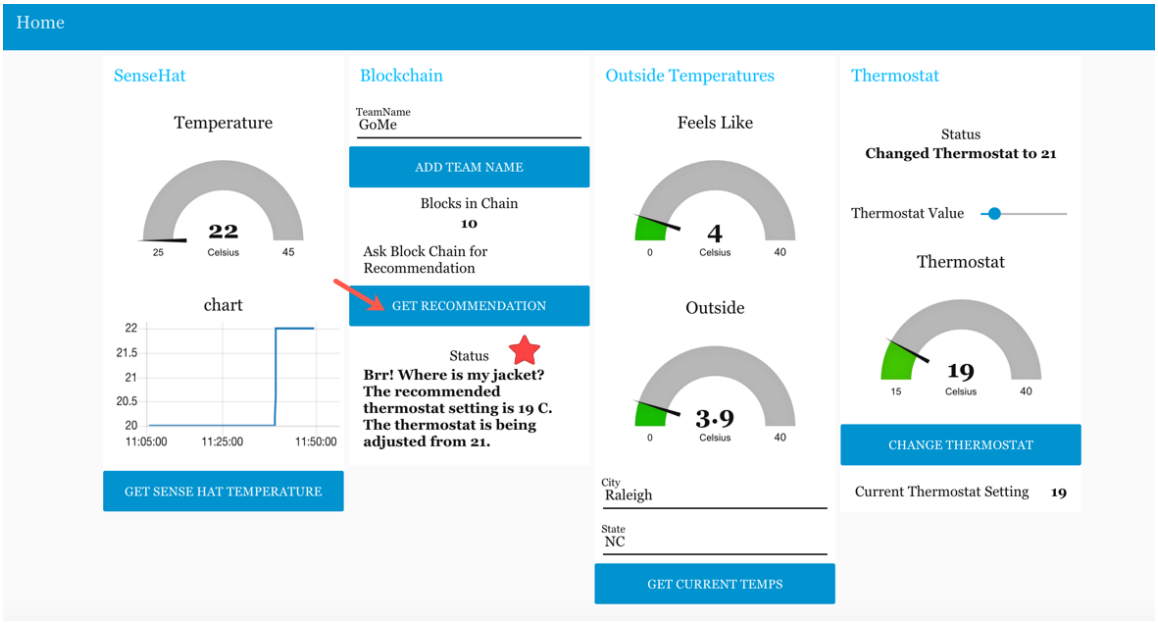
'



- Type in a City and State to find outside temperatures. Click *Get Current Temps* to get the values.



- After you have outside temperatures, you can click *Get Recommendation* to find the ideal temperatures for the thermostat. Notice that this will adjust your thermostat in the dashboard.
-



25. Congratulations! You've completed this lab!