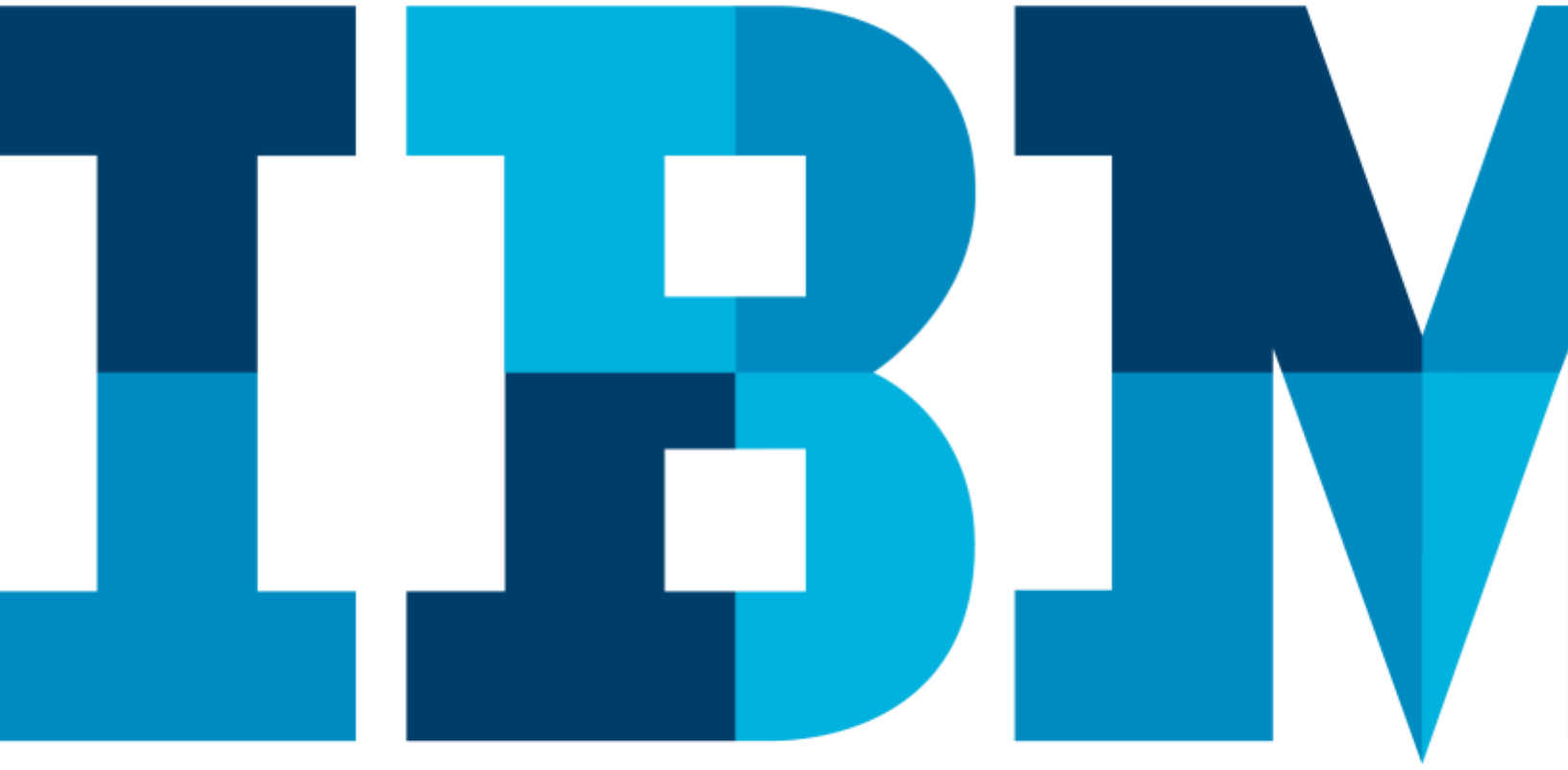
IBM Blockchain Hands-On
Blockchain Explained

Lab One – Vehicle Lifecycle Demo VM – Exercises



Contents

Overview

The purpose of this lab is to introduce you to the concepts of a blockchain by showing you how a blockchain transfers assets between participants in a business network. We will use car leasing as the scenario for the demo.

Introduction

The VM requires:

- 2 cores
- 4 GB RAM (8GB recommended)
- 40 GB Hard Drive

The virtual machine is based on Linux Ubuntu 14.04 and contains Composer Playground, Node-Red, Loopback, Yoman, Docker, Docker-Compose, Visual Studio Code with Hyperledger Composer extension.

There are no additional files or software that is proprietary to the lab in the virtual machine. This means that the lab may be run on a machine without a virtual machine if Hyperledger Fabric and the other pre-requisites have been installed.

Once the setup has been completed (done for you on the VM, follow appendix A. if this has not been completed) will open the following pages in your browser:

- Customers Car Order App: http://localhost:8100/
- Arium Manufacturer App: http://localhost:6002/
- VDA (Regulator) App: http://localhost:6001/
- Prince Insurer App: http://localhost:4200/overview
- Node Red Flows: http://localhost:1880/
- REST APIs: http://localhost:3000/explorer/
- Hyperledger Composer: http://localhost:8080/

Running the demo

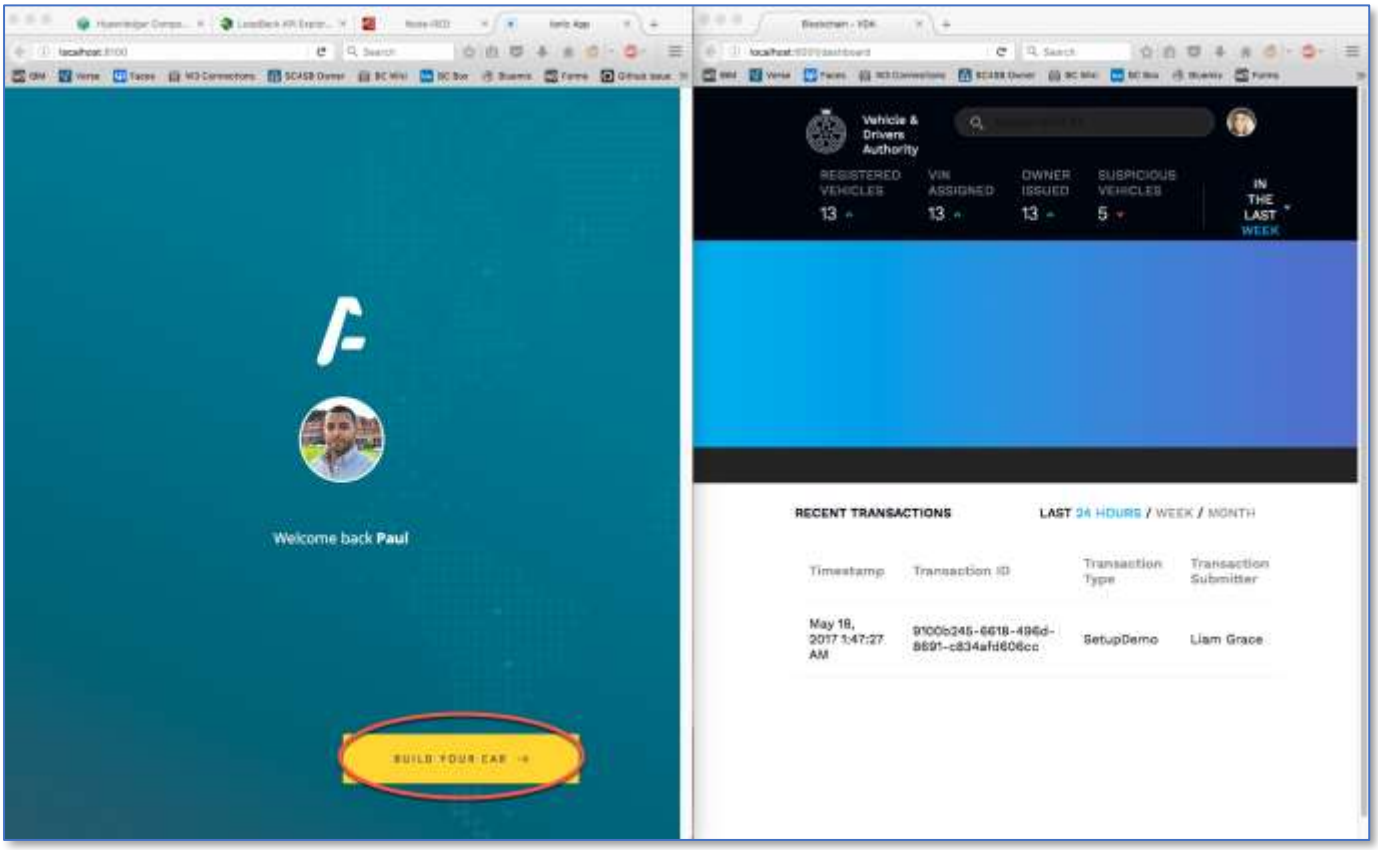
In this demo you will be playing the role of the 3 personas who use the vehicle lifecycle system.

- Paul the buyer/owner
- Mike an employee for the car manufacturer called Arium
- Debbie an administrator for the regulator called Vehicle & Drivers Authority (VDA)

These personas together work on ordering, building, transferring ownership of a vehicle whilst keeping all the other parties in the network updated and building the trust between them to allow them to work together efficiently.

1.1. Order the New Car

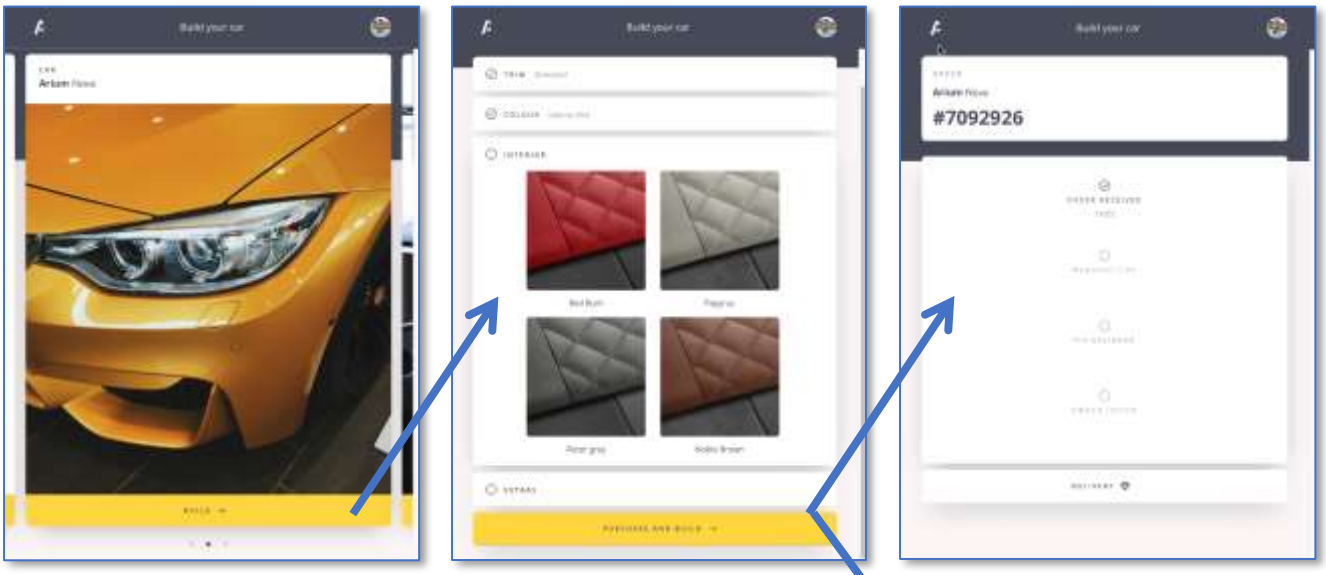
1. Open up the '**Ionic App**' tab (localhost:8100) and if possible the '**Vehicle & Drivers Authority**' tab (localhost:6001) next to it. If the tabs do not appear in the Chrome browser due to the instructor not prestarting the applications, then perform the following:
   __a. Open a terminal window
   __b. cd /VLD
   __c. ./restart.sh



This will log you into the ordering app as Paul and into the VDA dashboard as Debbie able to view the transactions in the network so far.

2. In the Arium 'Ionic App', click **'Build Your Car'**

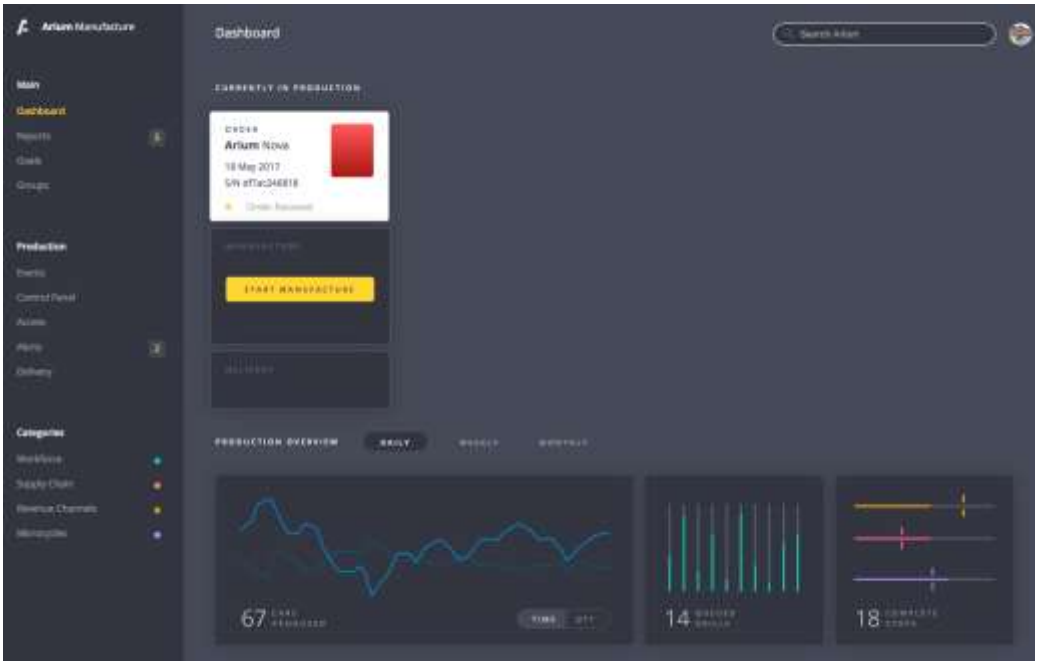
3. Swipe left and right to decide which car to build and then decide the options on your car



4. Once you place the order, you will immediately see the VDA view update with the latest block in blue and add the transaction to the list in white

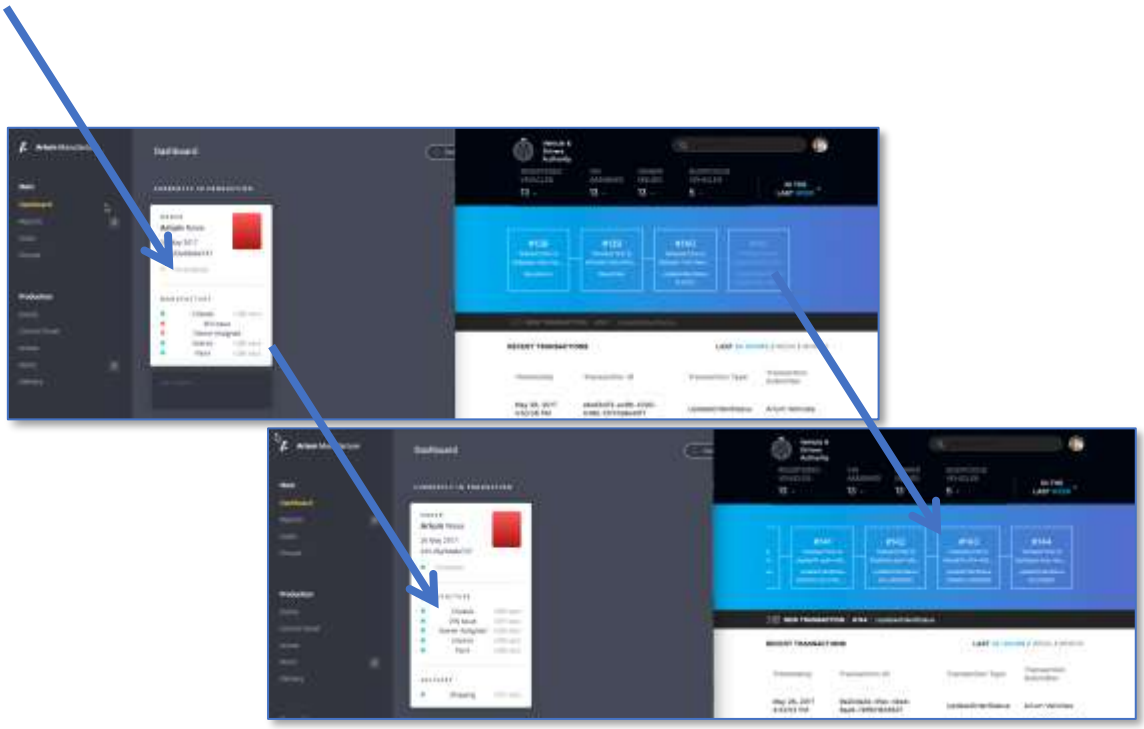
1.2. Manufacturing Process

5. After the car has been ordered, switch to the Manufacturer view (localhost:6002) and see your new car

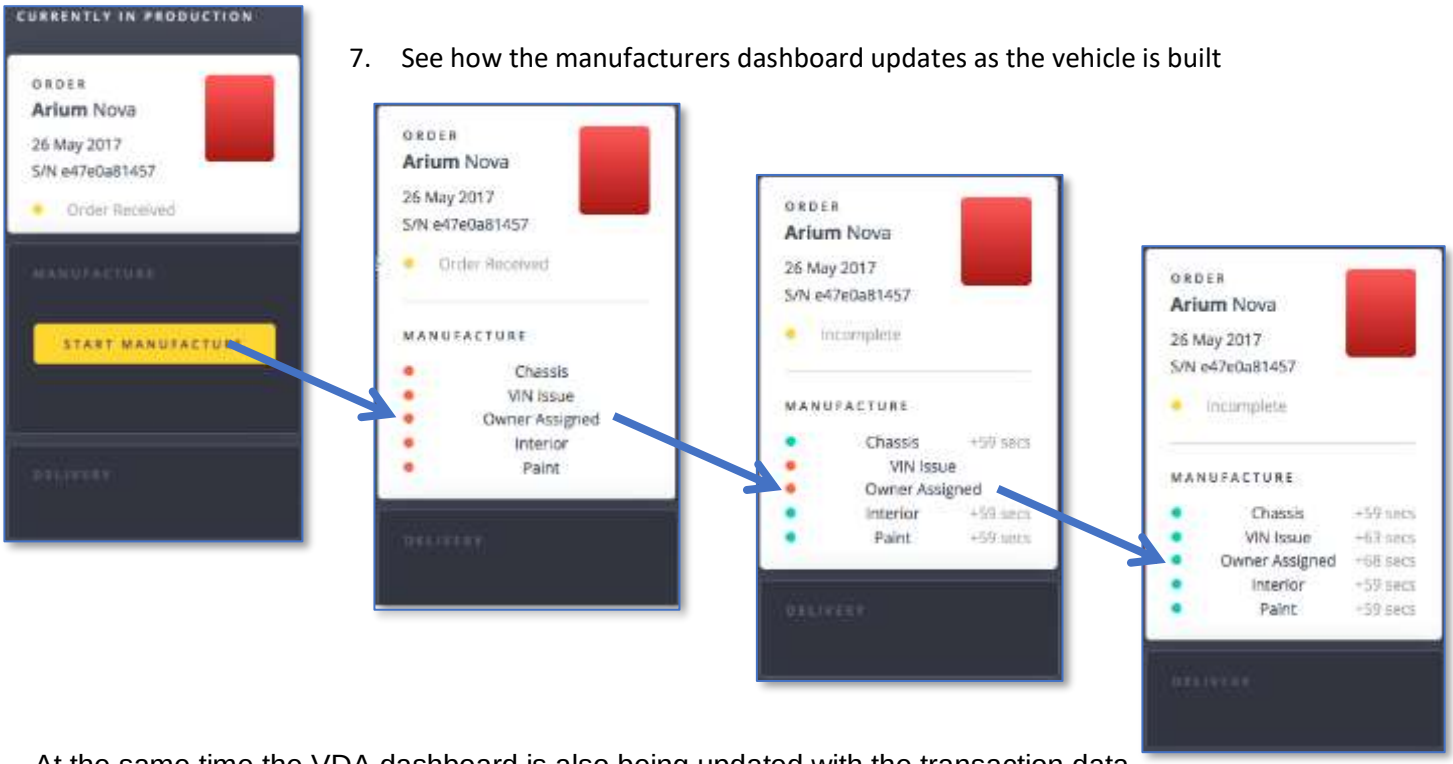


6. Click on **Start Manufacture**

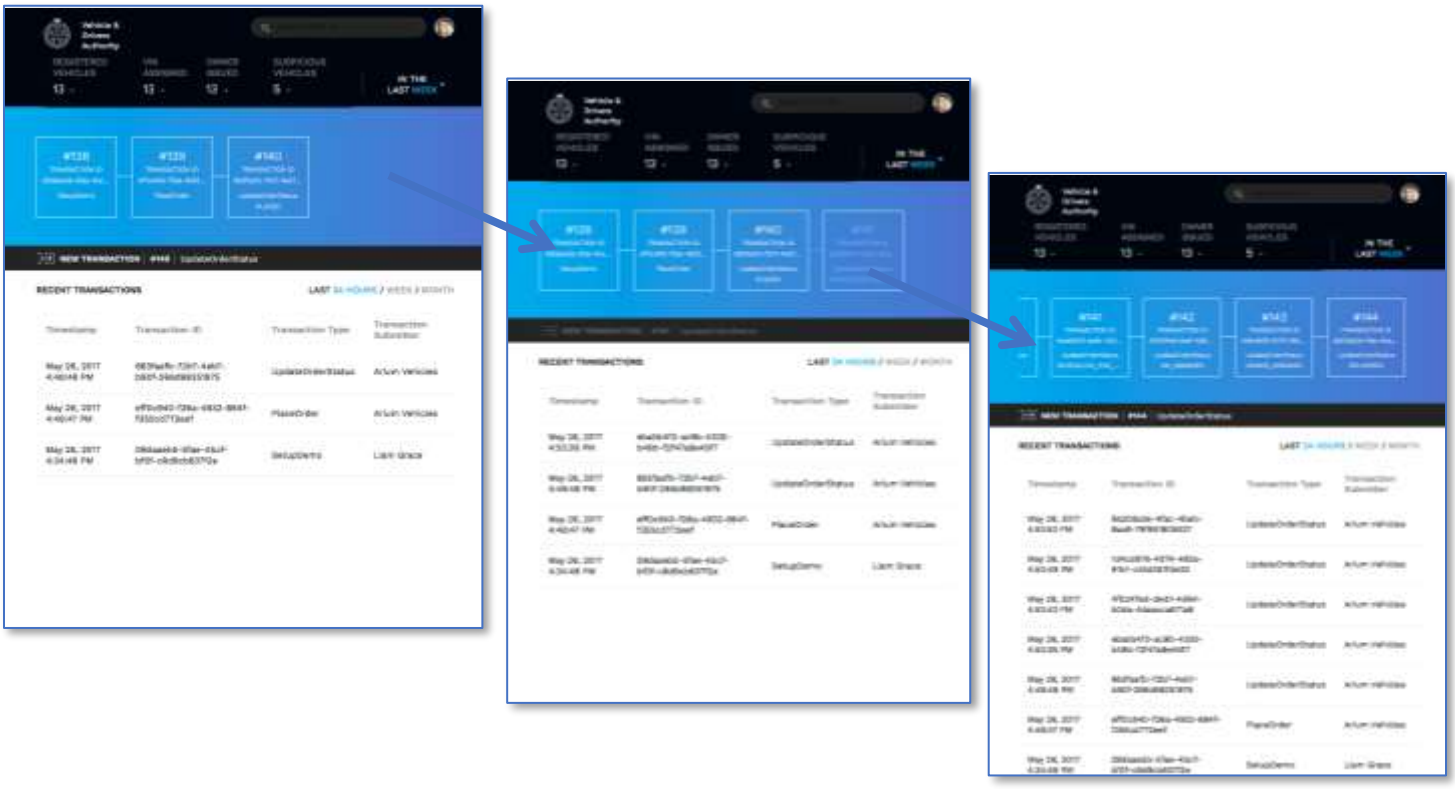
   This will initiate the production process which has been simulated, over the next several seconds, the vehicle will be ‘built’ updating the blockchain as reached certain points of production. These can be seen in both the Manufacturer dashboard and VDA dashboard



7. See how the manufacturers dashboard updates as the vehicle is built



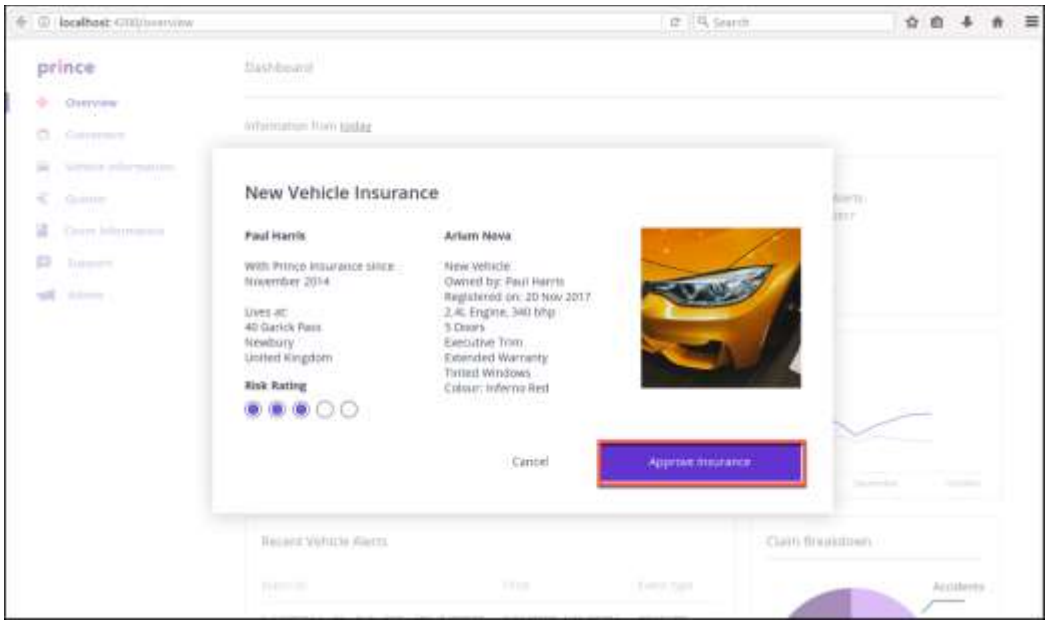
At the same time the VDA dashboard is also being updated with the transaction data information



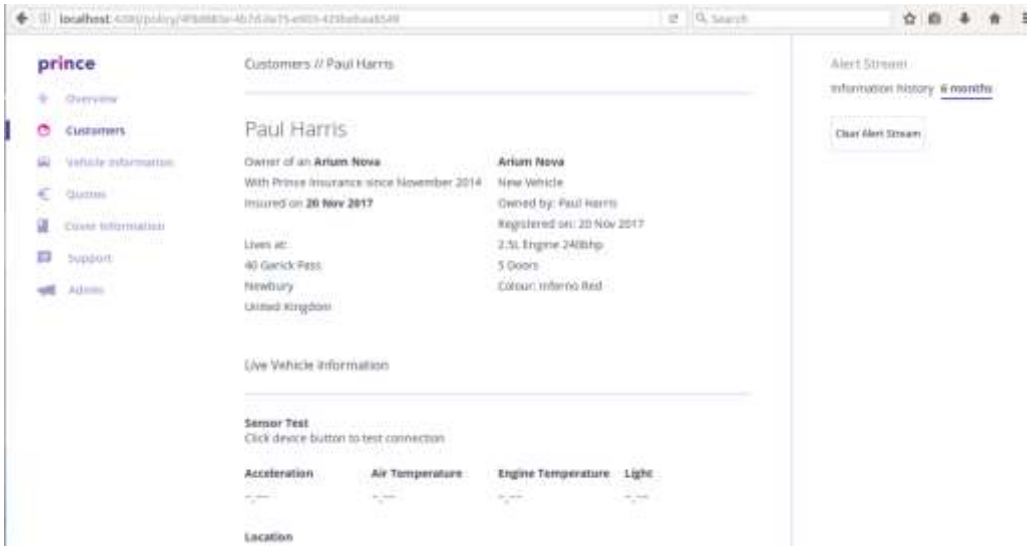
1.3. Insure the Car

8. After the car has been delivered, switch back to the Ionic App view where the owner ordered the car (localhost:8100), scroll down to the bottom, and click the **INSURE ME** button. Click to **Allow Location Access** if a popup appears.

9. Switch to the Insurer view (localhost:4200/overview) and click the **Approve Insurance** button.



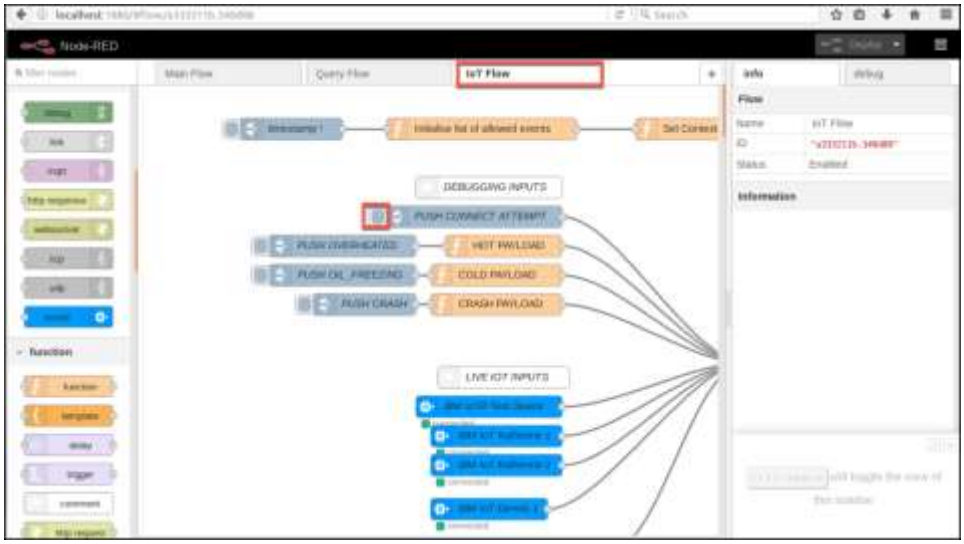
10. The owner is now insured by the insurance company.



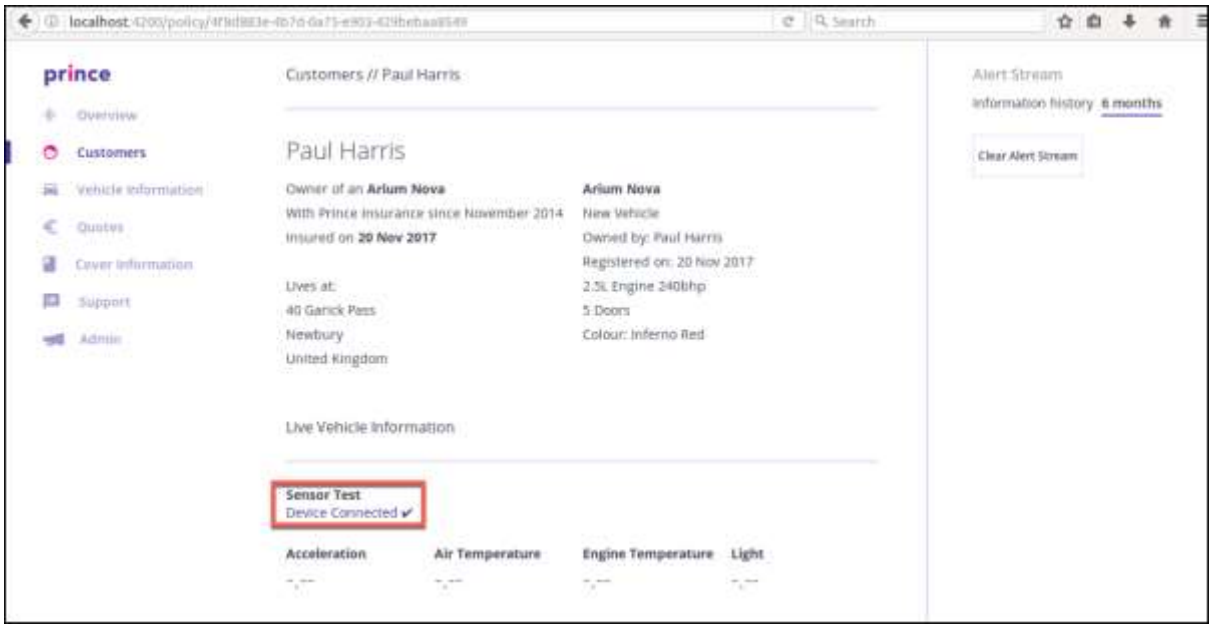
1.4. Internet of Things Integration

Once the car has been delivered and insured, we want to capture key vehicle events in the blockchain such as engine overheating, oil freezing, and accidents. The blockchain can easily integrate with the Watson IoT Platform using Node-Red Watson IBM IoT nodes to receive events from a device or send events from devices to the Watson IoT platform. We will use Node-Red Inject nodes to simulate receiving events from a device in the absence of having an actual physical sensor device.

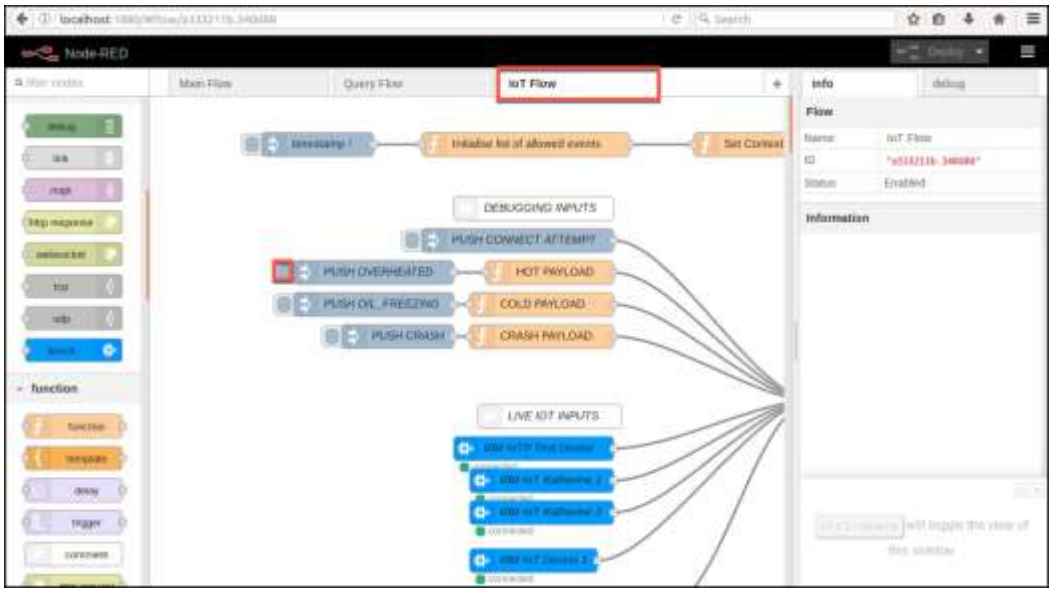
11. Switch to the Node-Red view tab (localhost:1880), select the **IoT Flow** tab, and click the button next to the **PUSH CONNECT ATTEMPT** node.



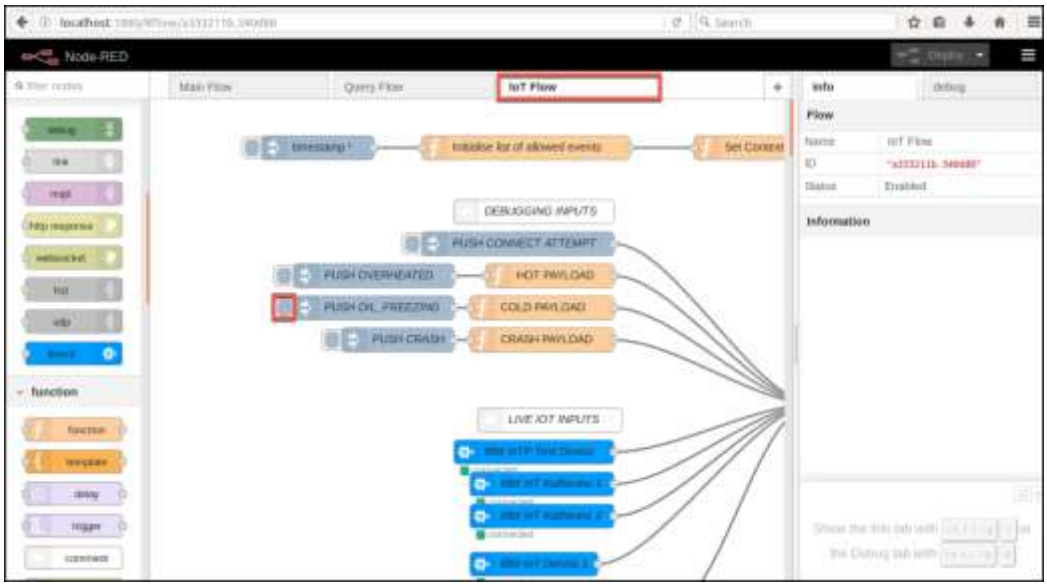
12. Switch to the Insurer view tab (localhost:4200), and notice under **Sensor Test** below that the vehicle sensor is now connected.



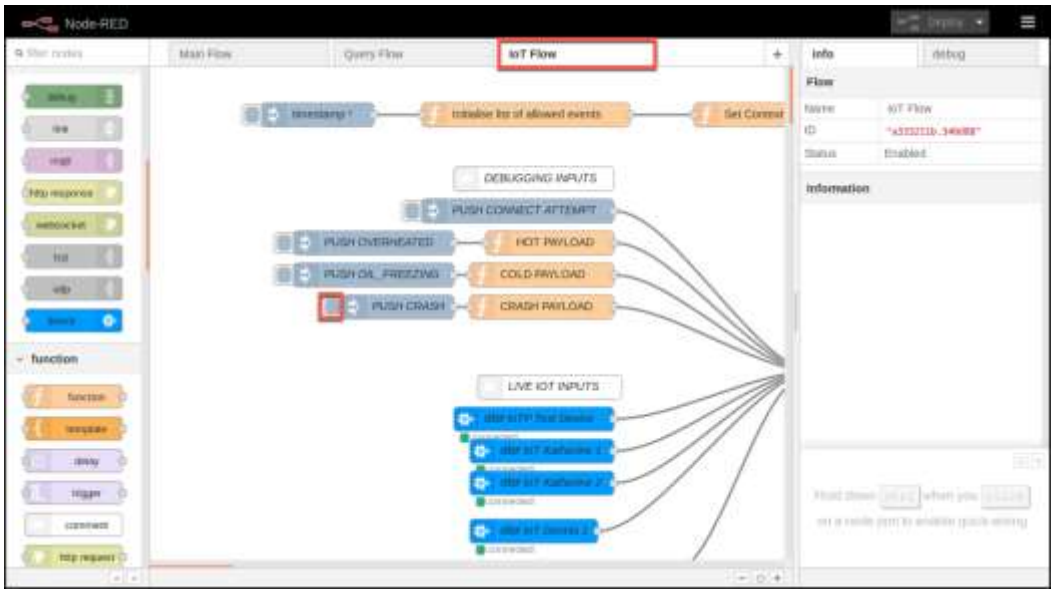
13. Switch back to the Node-Red view tab (localhost:4200), and click the button next to the **PUSH OVERHEATED** node. You should see a **successfully injected** message. We are simulating receiving an engine overheated event from a sensor.



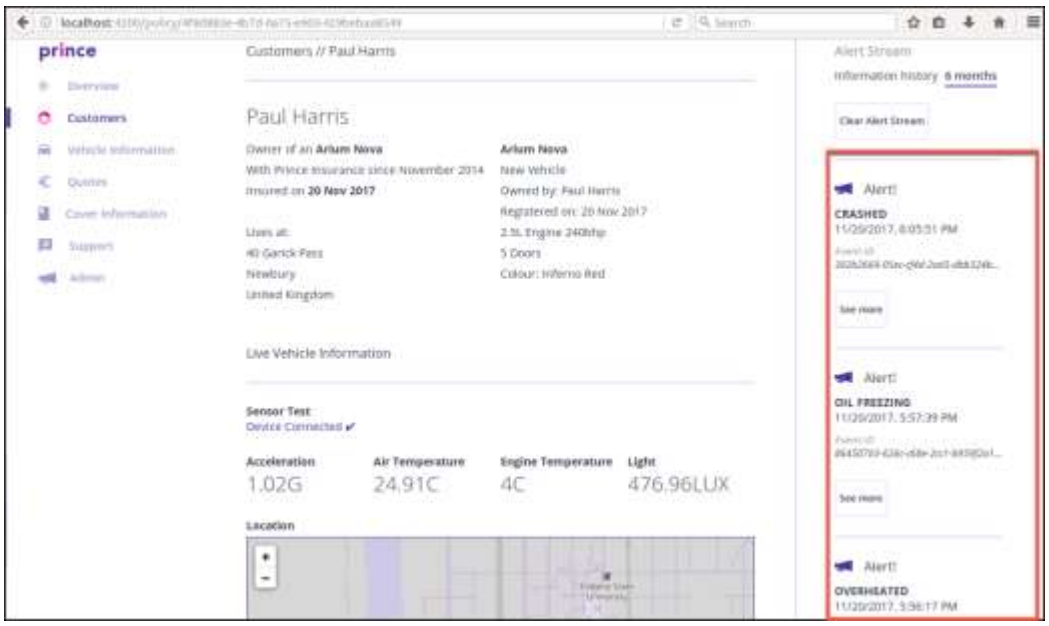
14. Click the button next to the **PUSH OIL_FREEZING** node. We are simulating receiving an engine oil freezing event from a sensor.



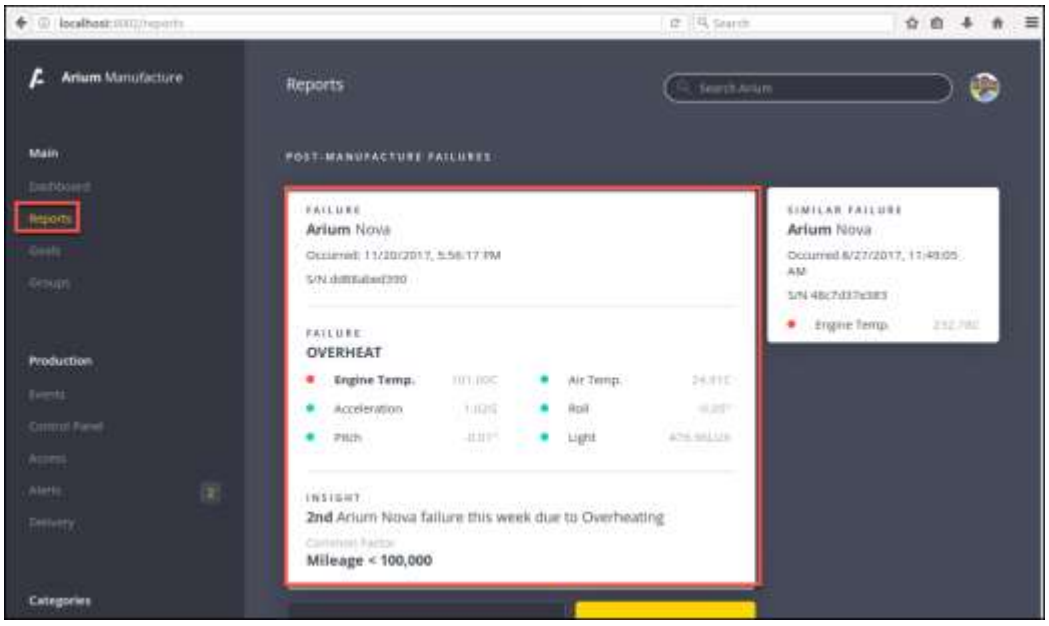
15. Click the button next to the **PUSH CRASH** node. We are simulating receiving a vehicle crashed event from a sensor.



16. Switch back to the Insurer view tab (localhost:4200). Note, that all three events (engine overheaded, oil freezing, and crashed) show in this view. These events were captured in the blockchain and the insurer role has permission see all three events.



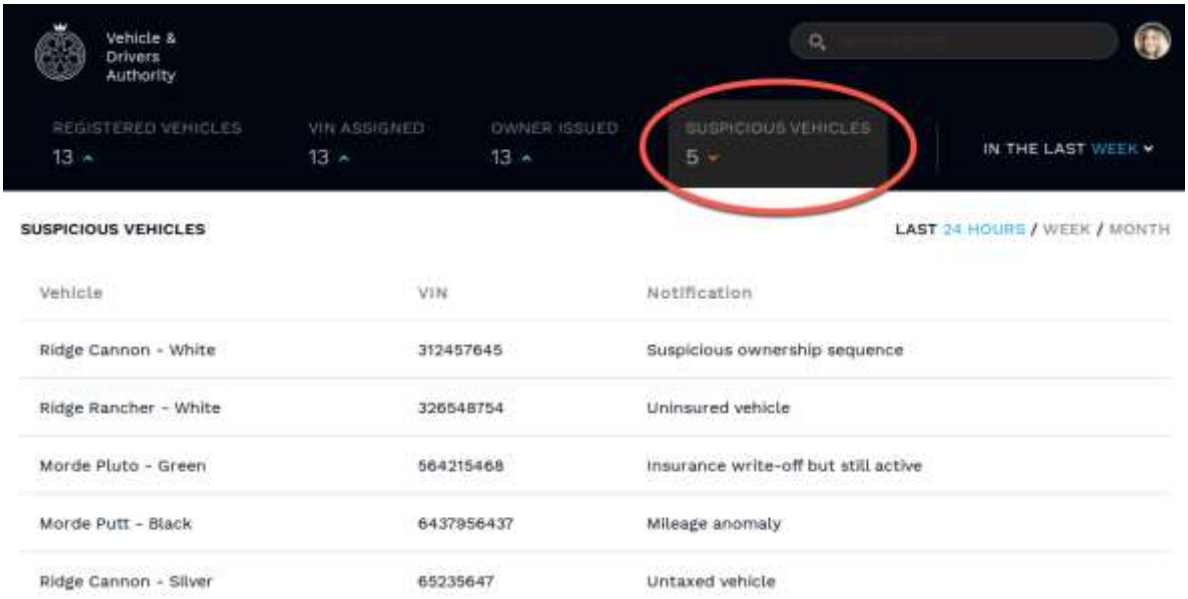
17. Switch back to the Manufactuer view tab (localhost:6002) and click the **Reports** link. The engine overheated events show in this view. These events were captured in the blockchain and the manufacturer role has permission see this type of event. The manufacturer wishes to detect trends in engine overheated failures in order to determine if a factory defect is causing this condition.



1.5. Regulator Analytics

The VDA (regulator) in this scenario has run additional analytics on the transactions on the blockchain to look for suspicious behaviour that the smart contract was not designed to prevent. This gives the ability to have the power of data analytics on top of the benefits of a blockchain such as a verifiably clean source of information to analyse among the most relevant for analytics.

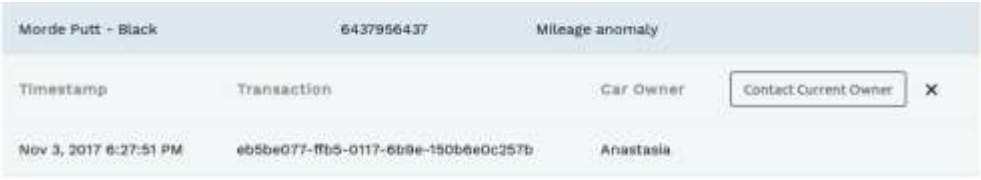
18. In the Vehicle & Driver Authority app (http://localhost:6001) click the **SUSPICIOUS VEHICLES** tab near the top.



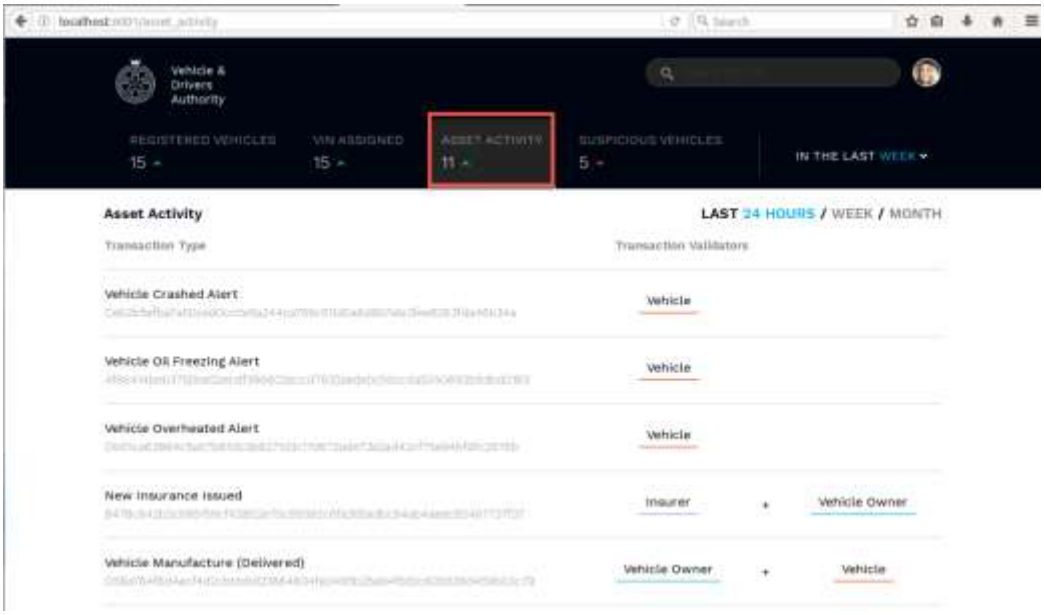
Here we can see the analytics has found a number of vehicles with associated suspicious transactions that may warrant further investigation.

19. Click on the 'mileage anomaly' in the list of vehicles

This shows a list of transactions that are associated with this anomaly and In this instance, the mileage of the vehicle may not match with insurance records or possibly decreased from previous records.



20. In the Vehicle & Driver Authority app (http://localhost:6001) click the **ASSET ACTIVITY** tab near the top.



Here we can see a record of all transactions for the vehicles including all the Internet of Things events.

21. Cleanup the hyperledger fabric environment for the next lab. Perform the following at the command prompt in the VLD directory:
    __a. ***./stopAll.sh***

Congratulations on completing the Vehicle Lifecycle Demo lab!

Appendix A. Starting the sample Application

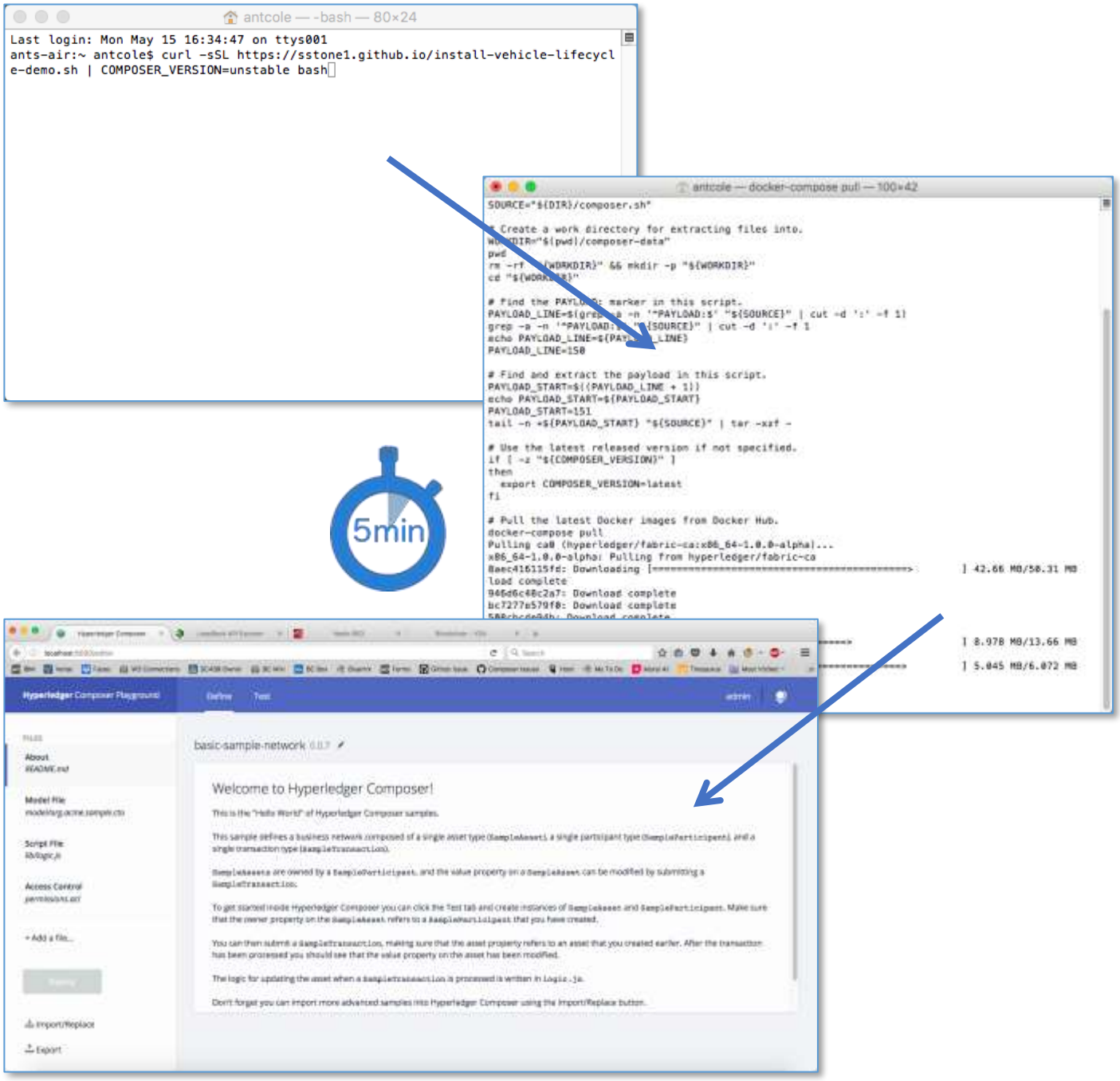
On the VM, the samples have been pre-downloaded from Github and already started. If for any reason they have broken or need restarting, them follow these steps:

1. Open a terminal and input:

cd Documents/composer-sample-applications-master/packages/vehicle-lifecycle

./build.sh

cat installers/hlfv1/install.sh | bash

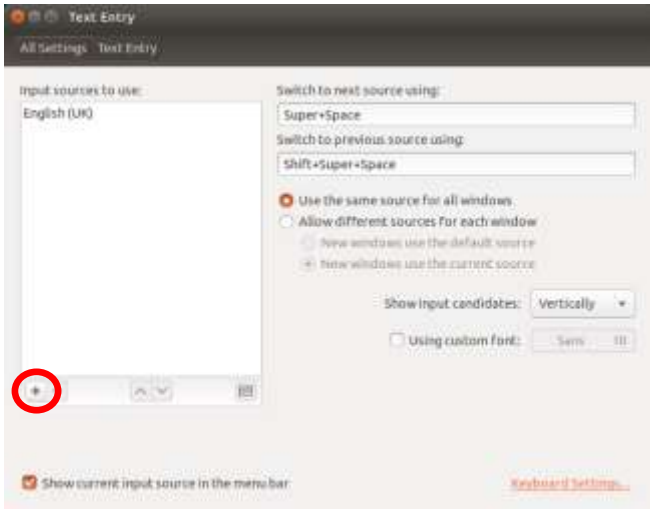


Appendix B. Keyboard Language Change

To change the keyboard language to enable you to use foreign laptops follow these steps:

Click on the  icon in the top right & select **Text Entry Settings...**

Select the  symbol



Type your **Language** (E.G. English) and then **country** (E.G. US)
Select the appropriate keyboard and click '**Add**'

Close the Settings box

Select the '**EN**' in the top right of the screen and select your new keyboard

Your keyboard is now ready to use

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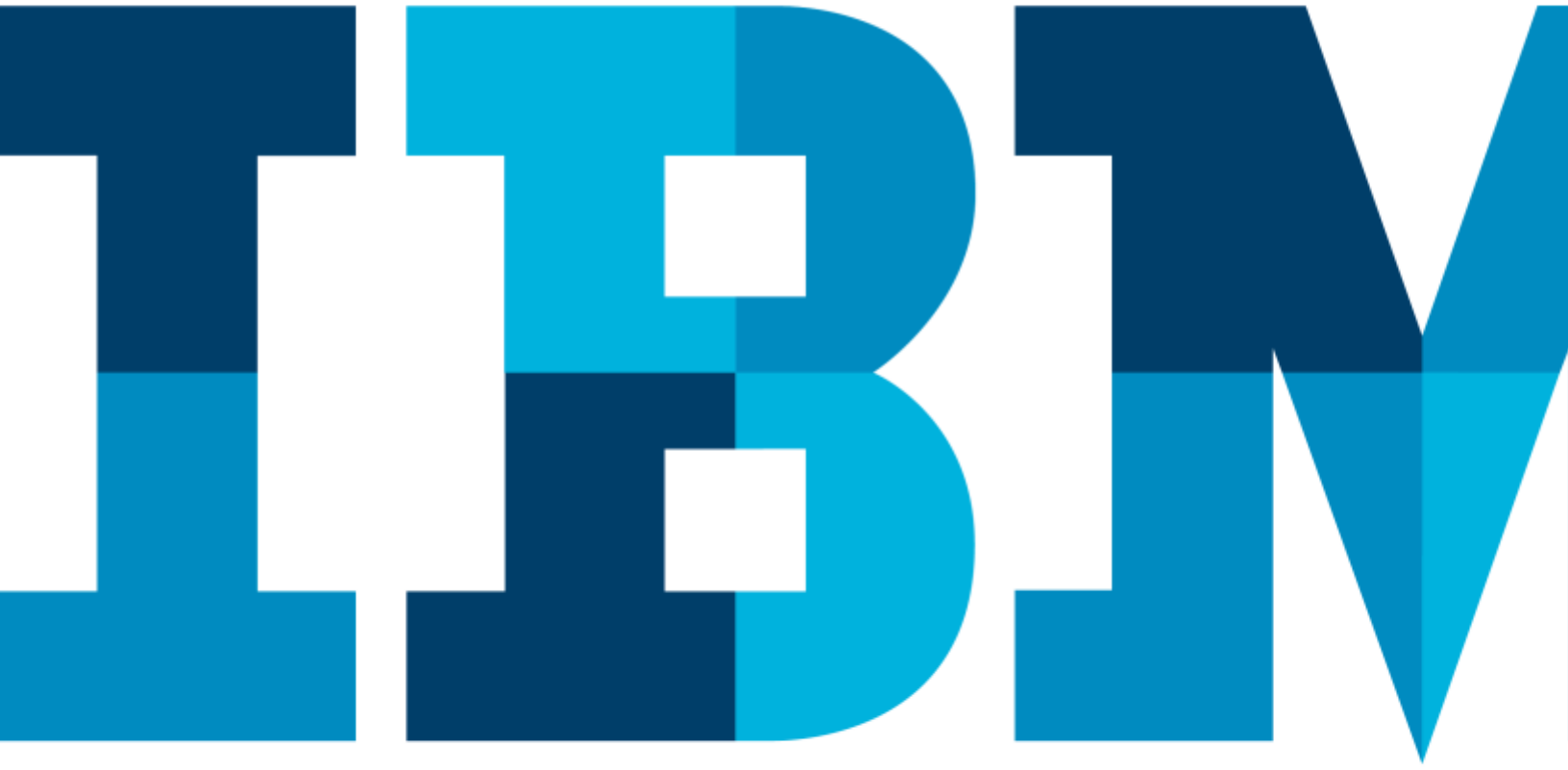
IBM Blockchain Hands-On
Hyperledger Composer Playground

Lab Two – Exercises



Contents

Introduction to this section of the lab

Skill requirements:

- There are no skill prerequisites to completing the first section called ‘Car Auction Sample’. It is desirable but not essential to have some background knowledge of JavaScript for the later section called ‘Explore the Editor Views’.

Technical pre-requisites:

- Internet Connection
- Web browser

This section of the lab takes place entirely in the web browser using Hyperledger *Composer Playground*.

Playground simulates the entire blockchain network within the browser by providing a sandpit environment to define, test and explore business networks defined using Composer. It is possible to connect to a live blockchain Hyperledger Fabric instance, or install the Composer Playground on a local machine for more developer friendly tools.

Hyperledger Composer Playground is one method to use Hyperledger Composer, other methods are also available at https://hyperledger.github.io/composer/installing/installing-index.html.

Section 1. Using Hyperledger Composer

Hyperledger Composer (https://hyperledger.github.io/composer) is an open-source set of tools designed to make building blockchain applications easier.

It allows users to model the business networks, assets and transactions that are required for blockchain applications, and to implement those transactions using simple JavaScript functions. The blockchain applications run on instances of Linux Foundation Hyperledger Fabric (www.hyperledger.org).

The purpose of this lab is to introduce you to the concepts of a blockchain by showing you how a blockchain transfers assets between participants in a business network. We will use the implementation of a simple blind car auction as the scenario for the demo.

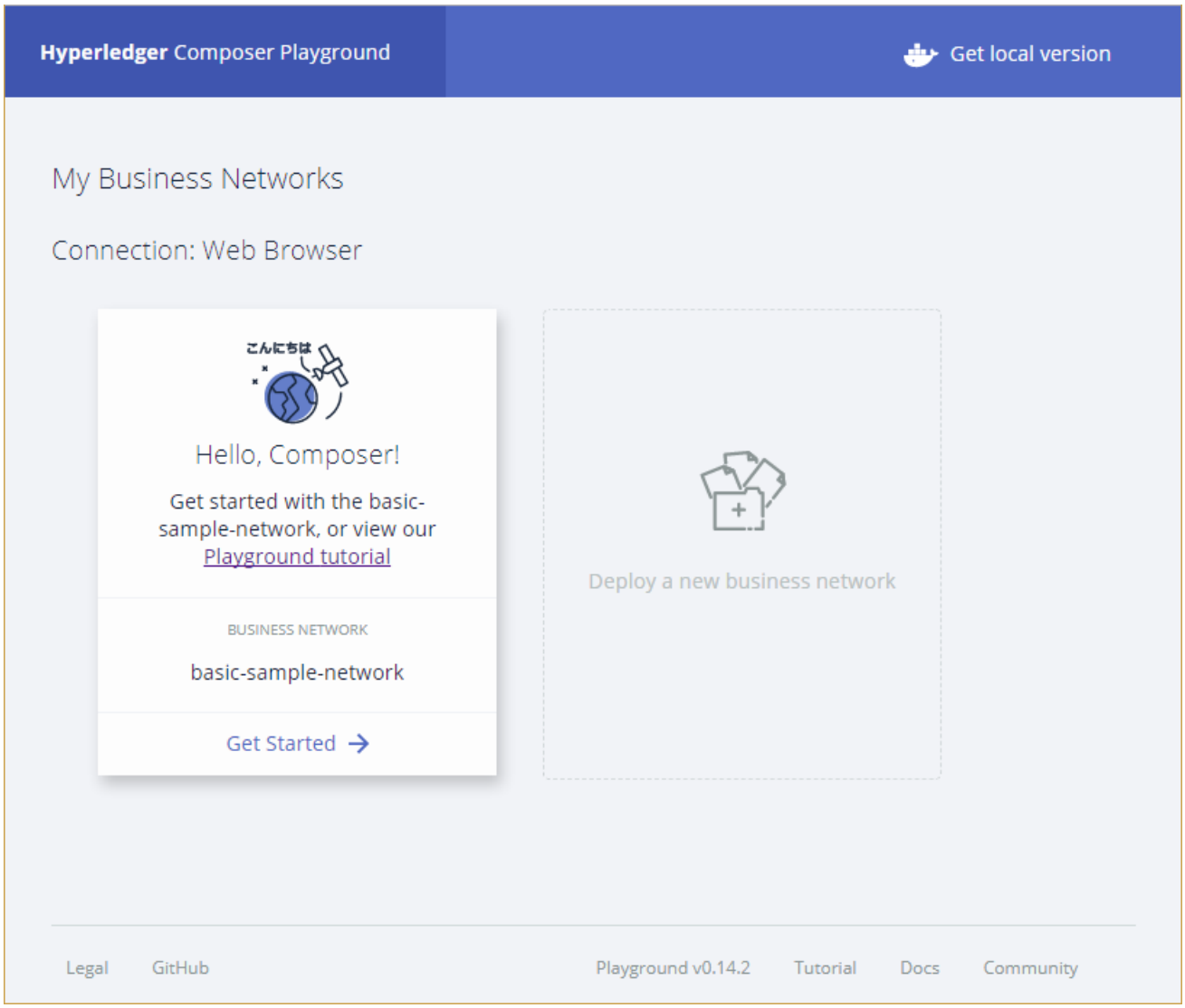
The car auction business network has a set of known participants (buyers and sellers), assets (cars and car listings) and transactions (placing bids and closing auctions). We will model these using Hyperledger Composer and test the business logic that makes the auction work.

Crucially, a blockchain could be used to bring together the buyers and sellers of these assets without needing any trusted third party. However, an auctioneer could be used to provide visibility and governance of the network if required.

Car Auction Sample

1.1.1. Open the Playground

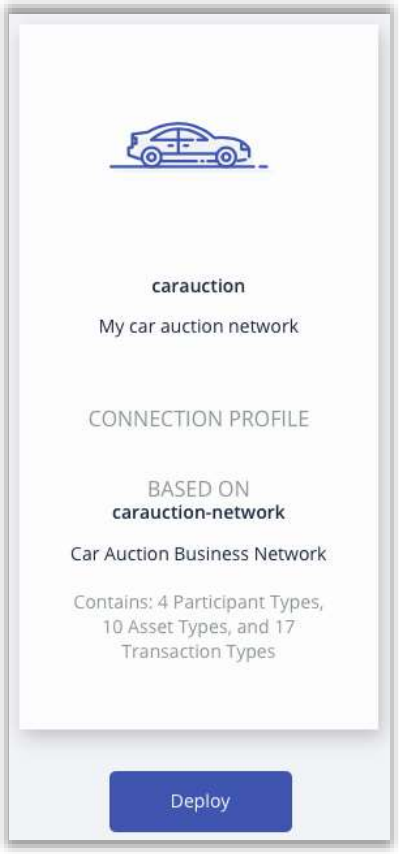
1. Open a web browser and go to http://composer-playground.mybluemix.net. Dismiss the welcome screen to show the playground wallet screen which is used to connect and deploy new business networks:



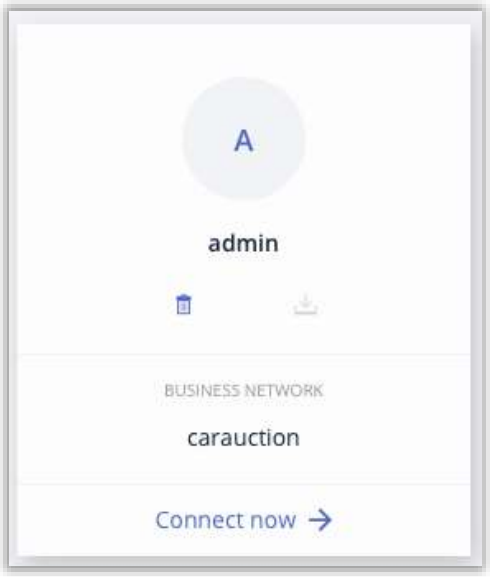
2. Click the “Deploy a business network” box. Then scroll down and select the carauction-network:

3. Next give the business network a name and description:

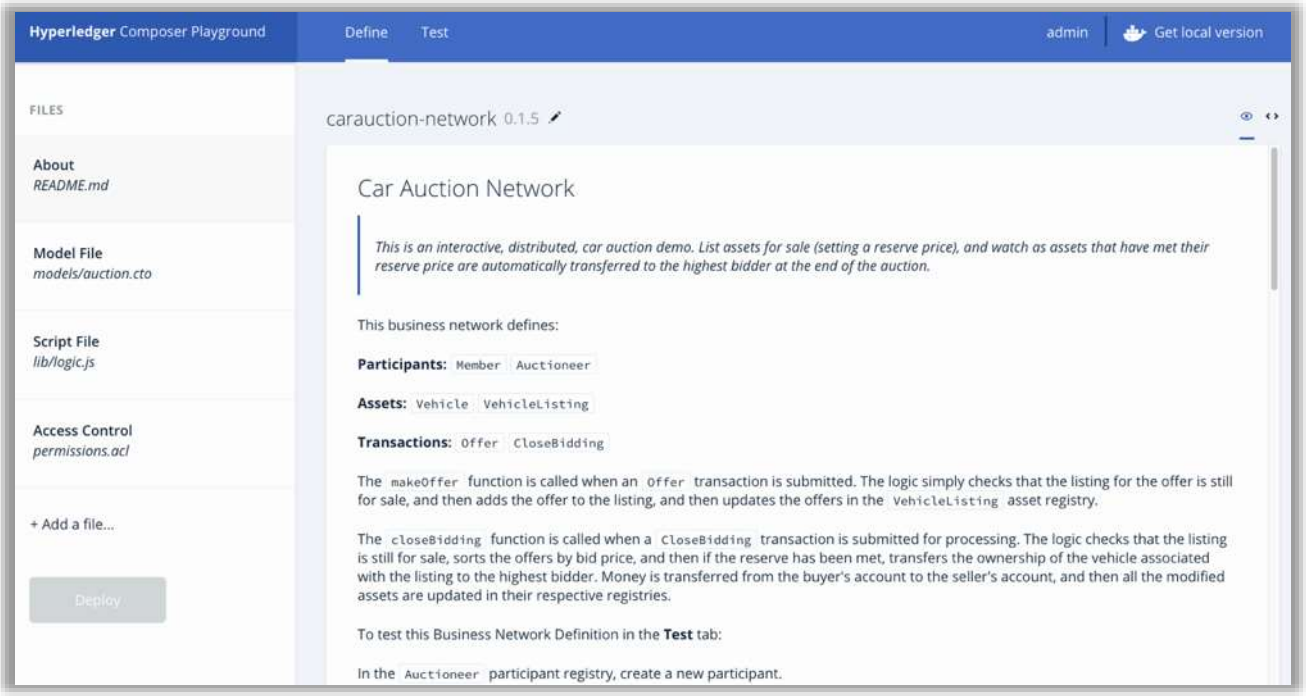
4. Click the Deploy button to deploy the new car auction business network:



5. Click “Connect now” in the new identity card for the carauction network:



6. Take a few minutes to read through the description of the car auction sample, to help understand the participants, assets and transactions associated with this particular network.



1.1.2. Add Three Participants

In the next section we will now work with the deployed car auction blockchain network.

We will first instantiate three *Member* participants of the car auction business network:

- Alice Smith (alice@email.com), who will make a bid on a car,
- Bob Jones (bob@email.com), who will also make a bid on a car, and
- Charlie Brown (charlie@email.com), who currently owns a car.

We will not instantiate an Auctioneer in this demo; this could be used in order to provide oversight of the network, although is not necessary.

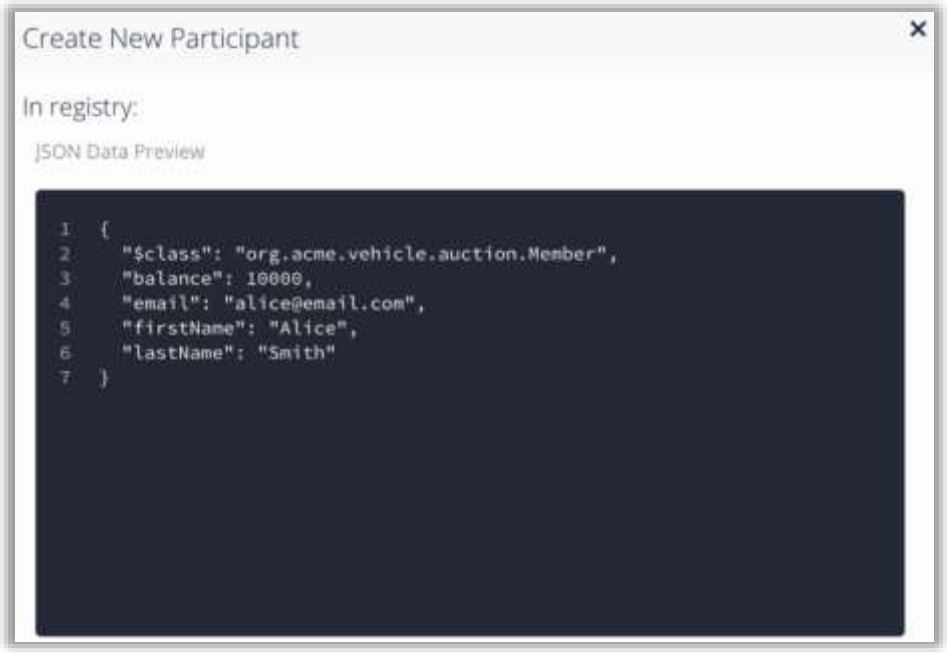
7. Click the **Test** tab and then click on the *Member* participant registry:

The registry is empty as no members have currently been defined.

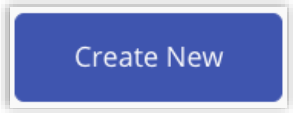
8. Click on **Member** to view there are no current members in the environement

9. Click **Create New Participant** to add a new Member.

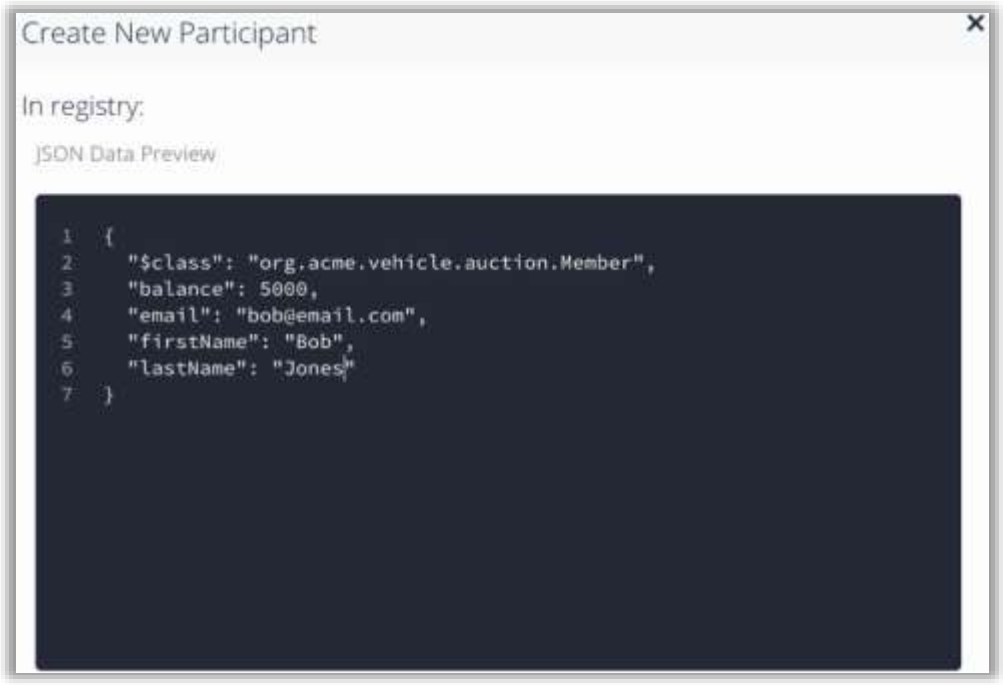
10. Type the correct values into the JSON data structure to add Alice to the business network. Let's give her a starting balance of 10000.



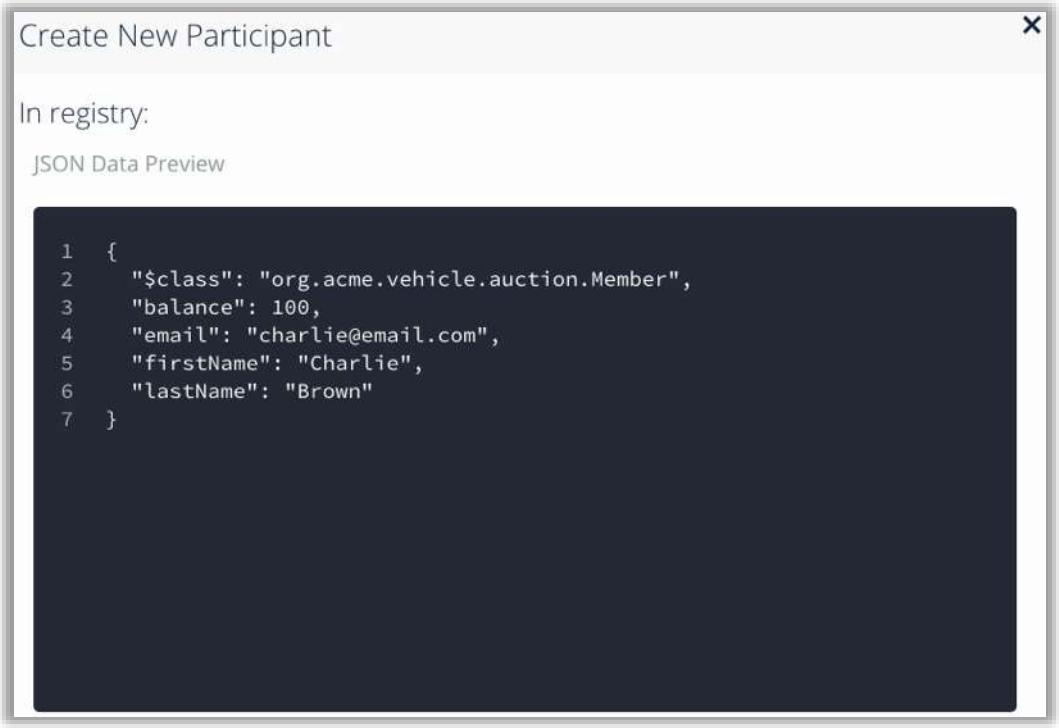
11. Click **Create New** to add Alice to the registry.



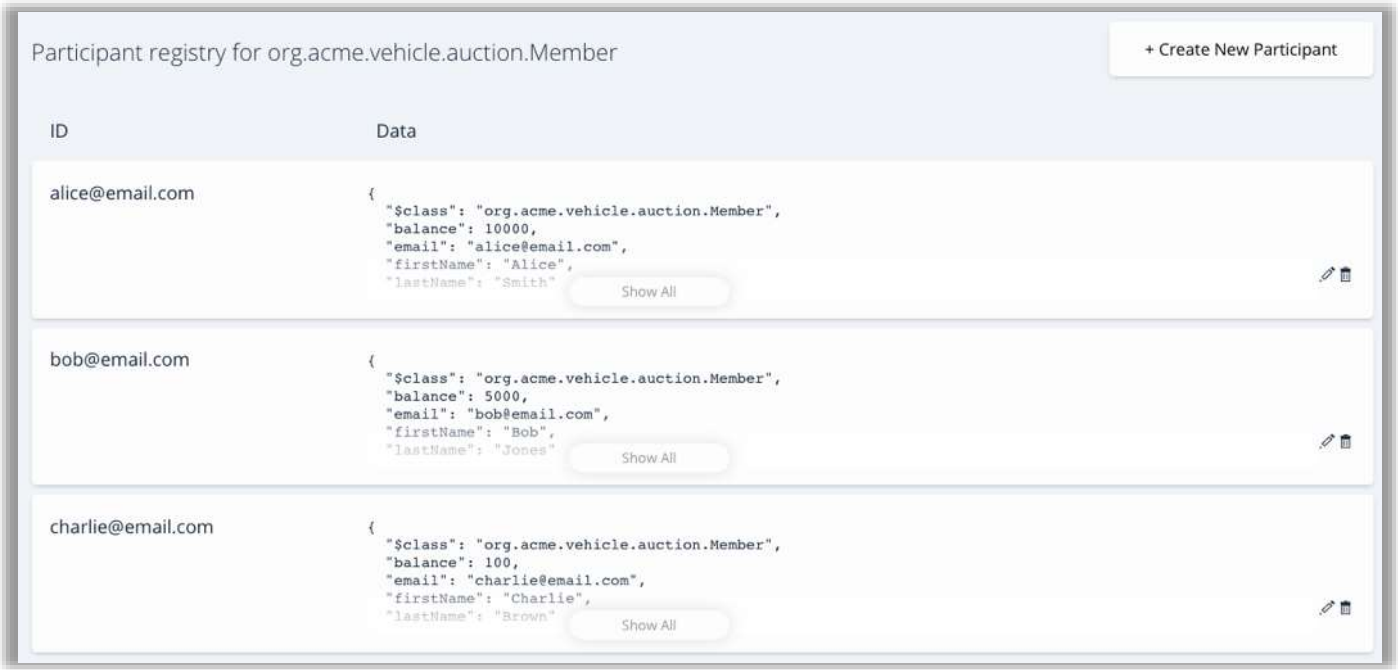
12. Do the same for Bob. Let's give him a starting balance of 5000.



13. Finally do the same for Charlie. He hasn't got so much money (he's selling his car, after all) so let's give him a starting balance of 100.



14. Verify that all participants in the business network have been correctly defined. Use the appropriate Edit button ( ) to make any changes.



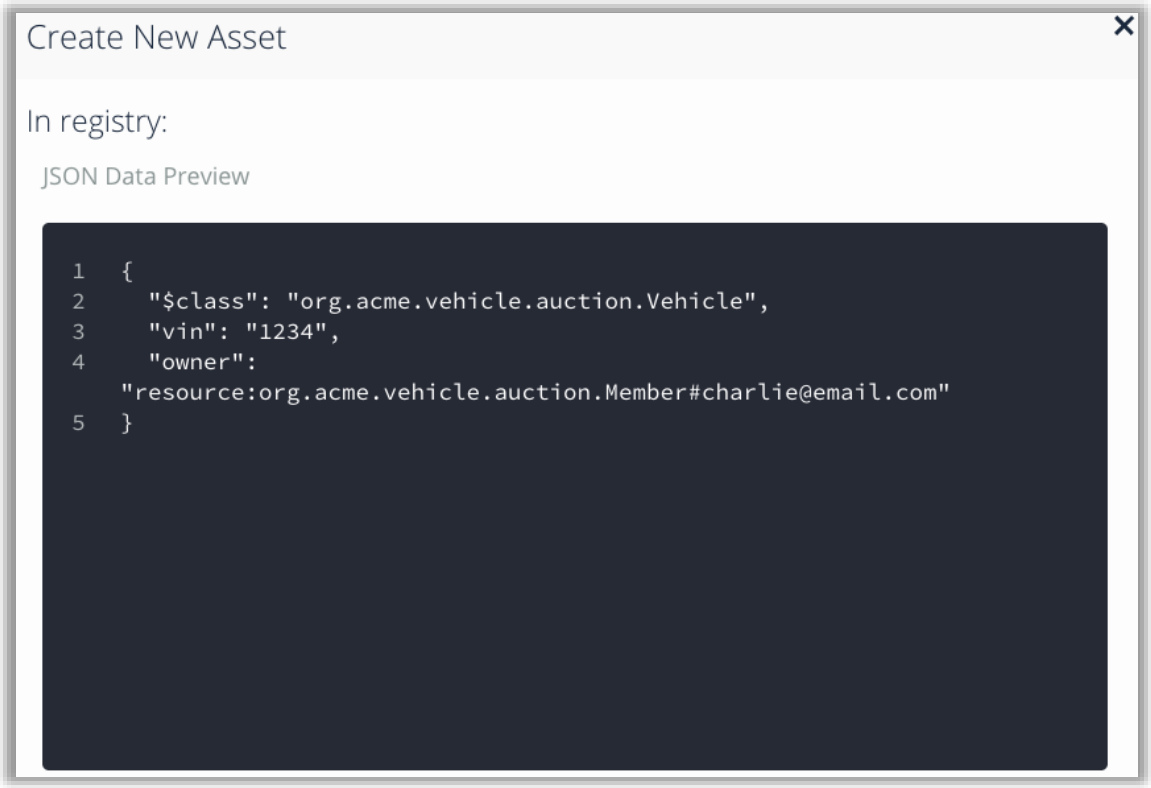
1.1.3. Add an Asset

We will now add Charlie's car to the Vehicle Asset registry.

15. Click the ***Vehicle*** asset registry.

16. This registry contains no assets currently. Click the **Create New Asset** button to add a new asset.

17. Instantiate the car by adding a vehicle identification number (VIN) of 1234 and assign it to Charlie by filling in the JSON object as follows. (We use his email address to identify him; this was specified as the key field in the User definition using the 'identified by' statement.)



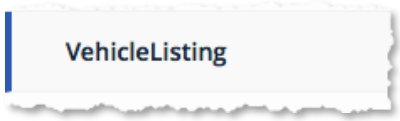
18. Click **Create New** to add the new vehicle to the registry.

19. View your newly added asset in the registry.

1.1.4. Add a Vehicle Listing

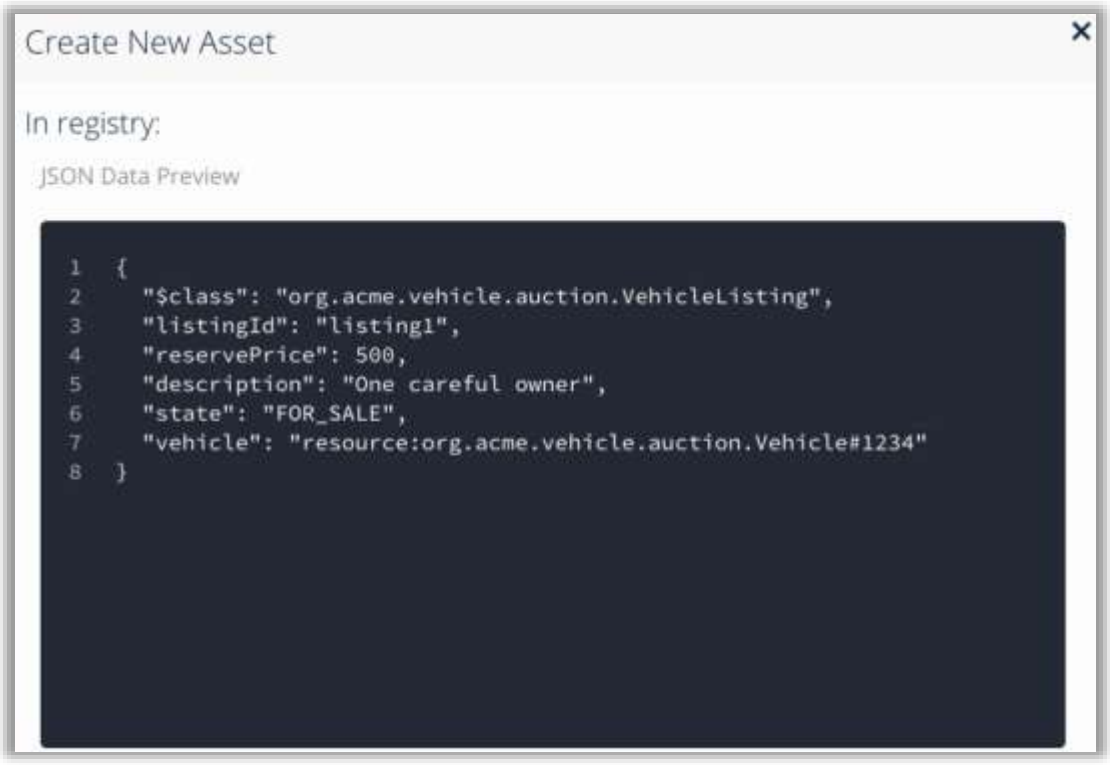
In this section we will put the car up for sale by creating a *VehicleListing* instance.

20. Click the ***VehicleListing*** asset registry. Once more, the VehicleListing registry should be empty.

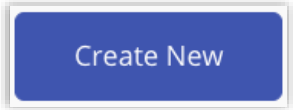


21. Click the **Create New Asset** button to add the asset.

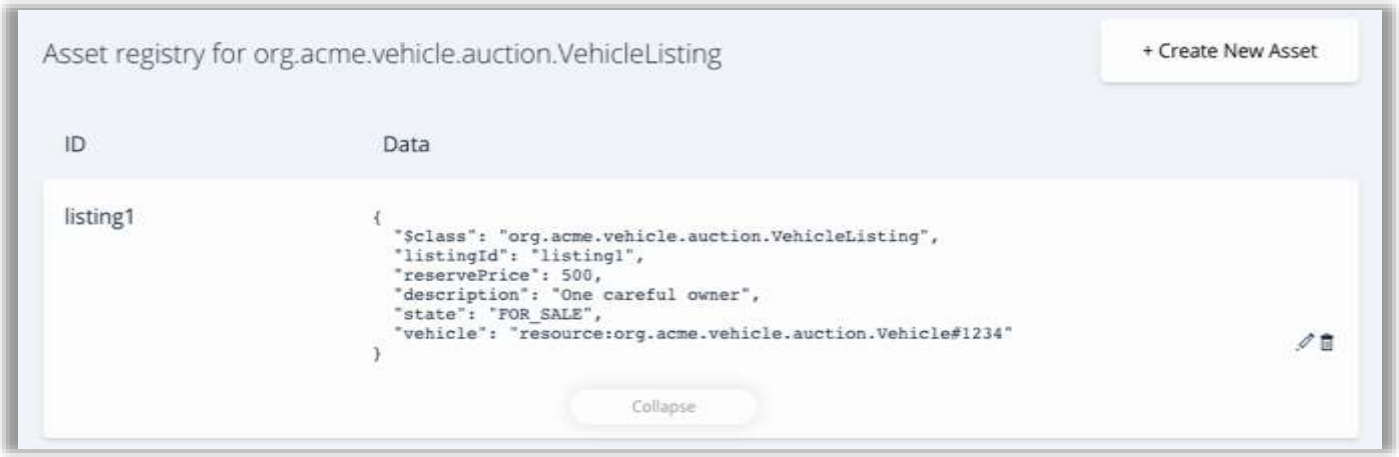
22. Update the fields and remove the random offers to show the below. Syntactic validation of the object occurs at this point, so correct any errors if necessary.



23. Click **Create New** to add the new vehicle listing to the registry.



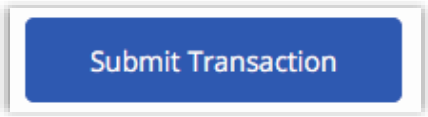
24. View the listing in the registry.



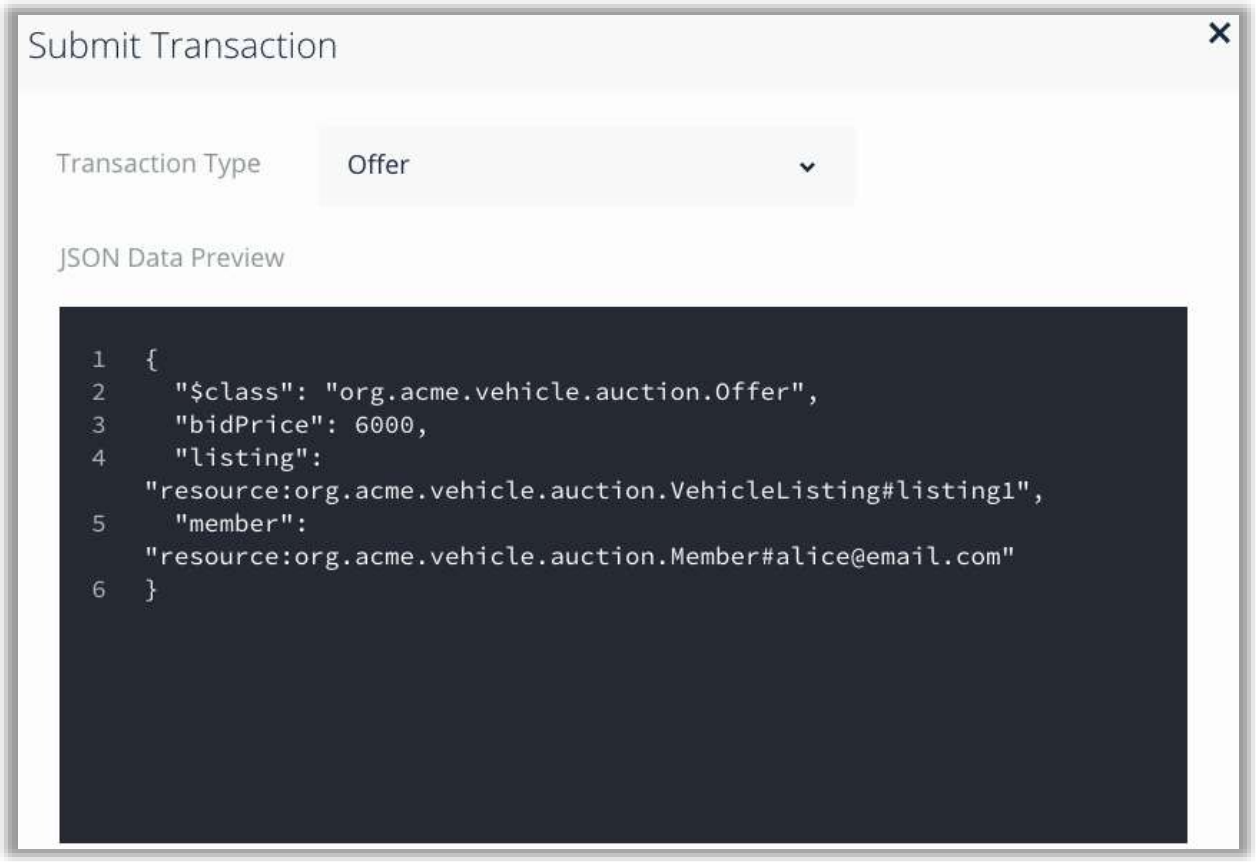
1.1.5. Submit offers on the vehicle

We will now let Alice and Bob bid on the vehicle.

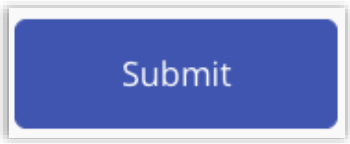
25. Click on the Submit Transaction button



26. Let Alice put in a bid of 6000.



27. Click **Submit** to submit the offer transaction.

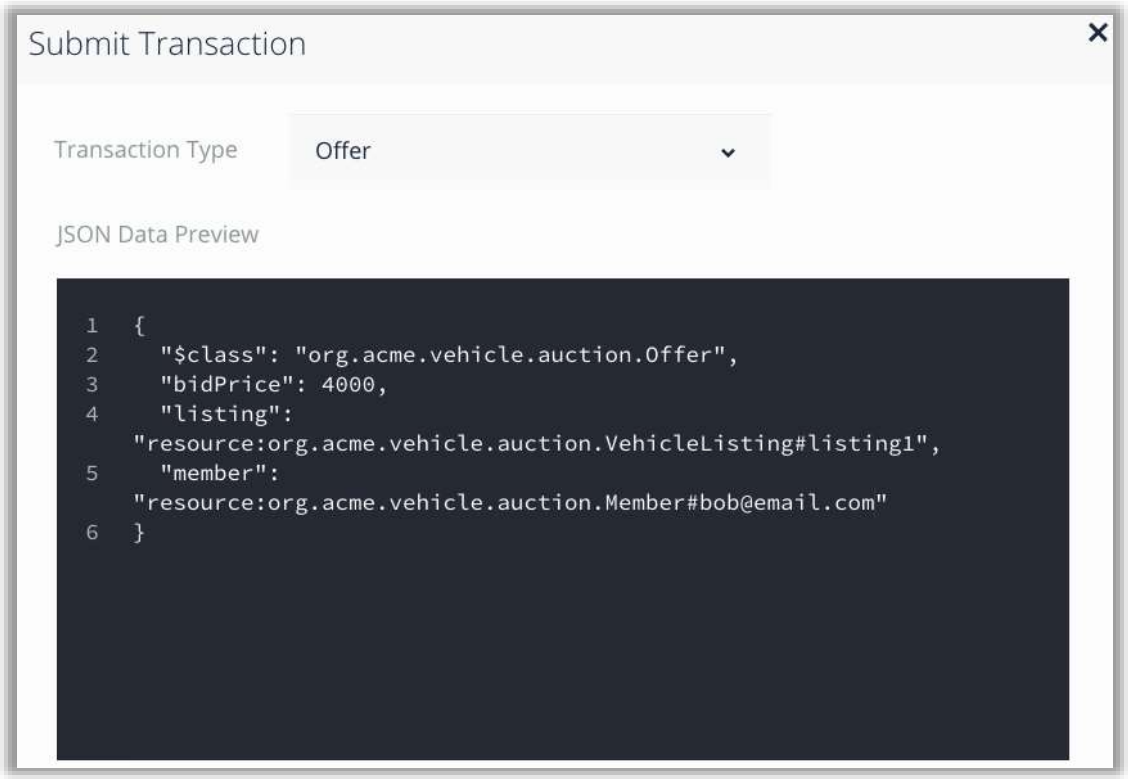


28. See the transaction successful appear in the Historian registry. Swich to view all transactions by clicking ‘All Transactions’:

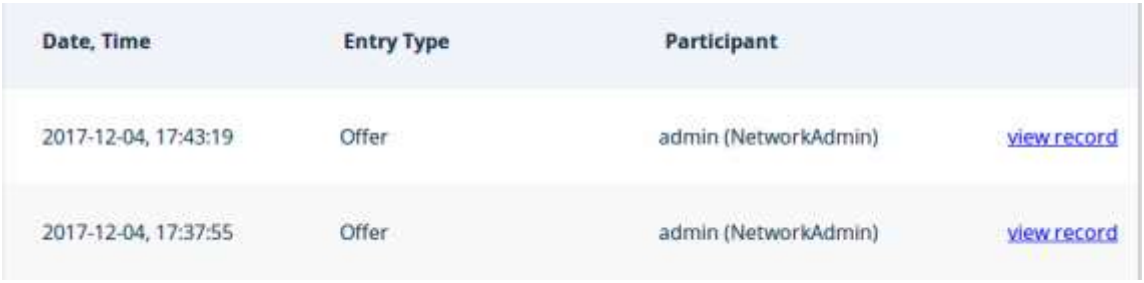
29. You will also notice additional transactions for creating participants and assets. Click “view record” for more information.

Date, Time	Entry Type	Participant	
2017-12-04, 17:37:55	Offer	admin (NetworkAdmin)	view record

30. Let Bob put in a bid of 4000.



31. Verify the transactions in the registry.



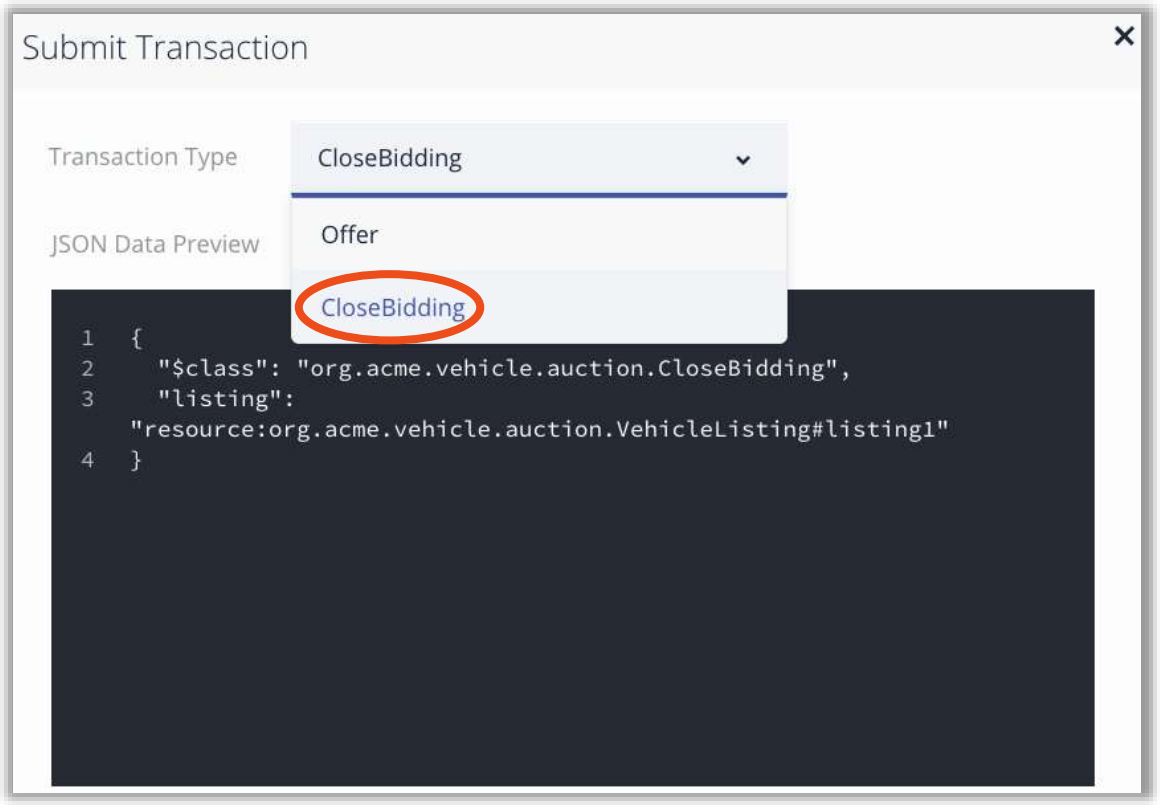
Date, Time	Entry Type	Participant	
2017-12-04, 17:43:19	Offer	admin (NetworkAdmin)	view record
2017-12-04, 17:37:55	Offer	admin (NetworkAdmin)	view record

Note that the transactions cannot be edited or individually deleted once submitted; this is one of the defining characteristics of a blockchain.

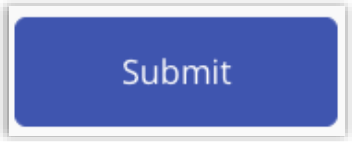
1.1.6. Closing the bidding

To close the bidding on the listing we need to submit a *CloseBidding* transaction.

32. Submit a new transaction, this time selecting **CloseBidding** from the drop-down 'Transaction Type' field.



33. Click **Submit** to submit the CloseBidding transaction.



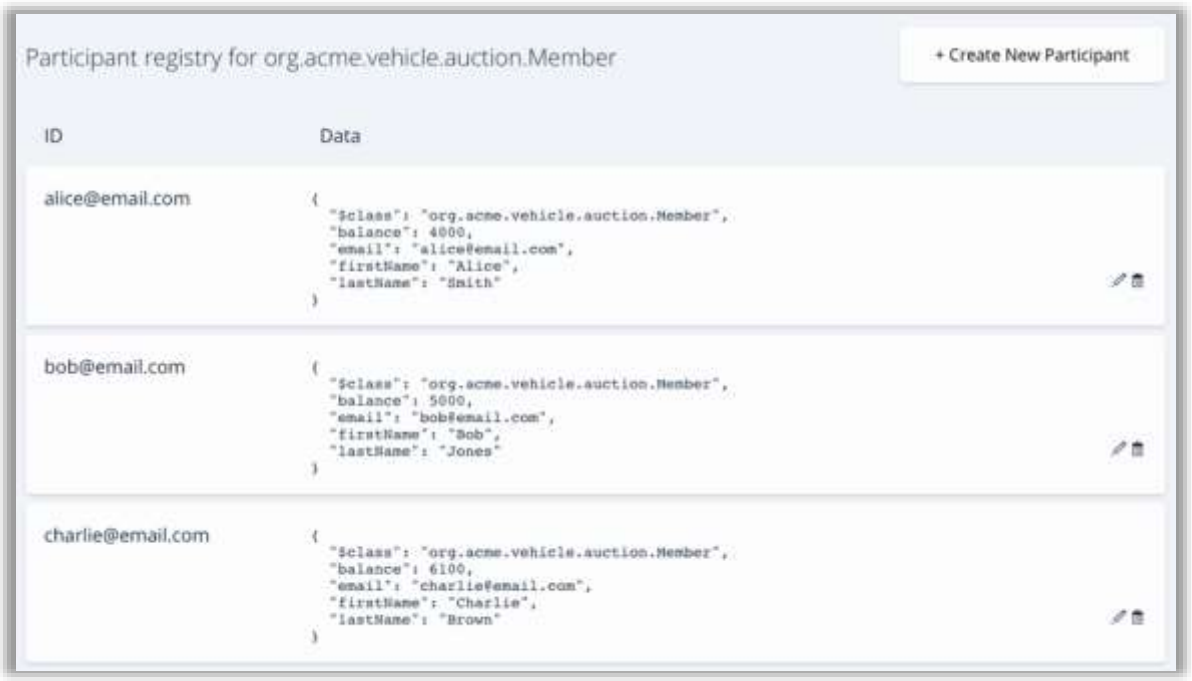
34. Verify that the transaction has been added to the blockchain transaction registry. Click on 'view record' to see the content of the transaction.

Based on the bids we submitted, Alice should now be the owner as she put in the highest bid. We should also be able to verify that the owner of the car has changed and appropriate balances increased or decreased accordingly.

35. Go to the ***Vehicle*** asset registry to see the vehicle owner has been updated to Alice.

36. You will see the following vehicle owned by Alice in the vehicle registry.

37. Go to the ***Member*** asset registry to see that Charlie's balance has increased by the winning bid amount, and that Alice's balance has decreased by the same.

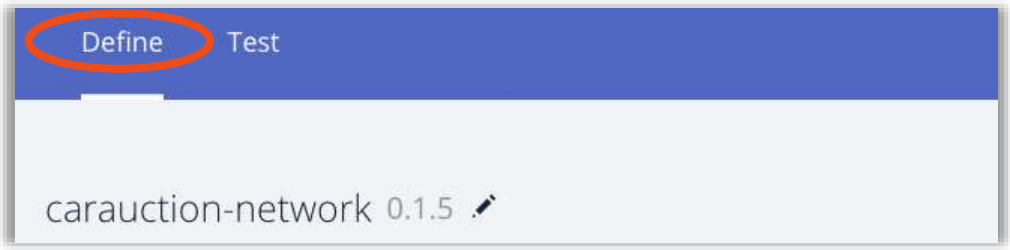


Congratulations! You have completed the first part of this lab.

Explore the Editor Views

1.1.7. Model File

38. Click on the define tab to go back to the main playground window.



39. Click the Model File (models/auction.cto) to open it.

This .cto file models the assets, participants and transactions for this blockchain application.

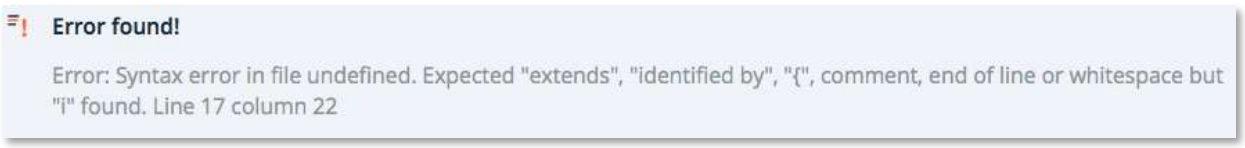
40. Look at the Vehicle asset:

```
asset Vehicle identified by vin {
  o String vin
  --> Member owner
}
```

This uses the Hyperledger Composer Modeling Language which will be looked at more later. An *asset* is anything of worth that will be transferred around the blockchain. Here we can see the asset class is called '*Vehicle*' and will have an associated *vin* and a reference (indicated by "-->") to a '*Member*' participant that we will call '*owner*'.

41. Type and add some characters in an appropriate point to show the live validation of the model.

```
asset VehicleListing identified by listingId {
  o String listingId
  o Double reservePrice
  o String description
  o ListingState state
  o Offer[] offers optional
  --> Vehicle vehicle
}
```



42. Scroll down and look at the abstract '*User*' participant.

The participant will be the people or companies within the business network. Each *User* participant will be defined as having a *email*, *firstName* and *lastName*. As the class is **abstract** instances of it cannot be created; instances are instead implemented by the *Member* and *Auctioneer* classes.

```
abstract participant User identified by email {
  o String email
  o String firstName
  o String lastName
}

participant Member extends User {
  o Double balance
}

participant Auctioneer extends User {
}
```

Here the user can become a *Member* requiring a *balance*, or an *Auctioneer* that does not.

43. Look at the *Offer* and *CloseBidding* transaction definitions:

```
transaction Offer {
  o Double bidPrice
  --> VehicleListing listing
  --> Member member
}

transaction CloseBidding {
  --> VehicleListing listing
}
```

The *transaction* definitions give a description of the transactions that can be performed on the blockchain. They are implemented in a Transaction Processor file using the Javascript language.

1.1.8. Transaction Processors

44. Click on the lib/logic.js file:

45. Scroll to **the bottom of the file** to review the logic used to make an offer on a car being auctioned:

```
/**
 * Make an Offer for a VehicleListing
 * @param {org.acme.vehicle.auction.Offer} offer - the offer
 * @transaction
 */
function makeOffer(offer) {
    var listing = offer.listing;
    if (listing.state !== 'FOR_SALE') {
        throw new Error('Listing is not FOR SALE');
    }
    if (listing.offers == null) {
        listing.offers = [];
    }
    listing.offers.push(offer);
    return getAssetRegistry('org.acme.vehicle.auction.VehicleListing')
        .then(function(vehicleListingRegistry) {
            // save the vehicle listing
            return vehicleListingRegistry.update(listing);
        });
}
```

This implements the *makeOffer* function, which is executed when the *Offer* transaction is invoked on the blockchain. (It is the **@param** comment above the function that links the full transaction name as defined by the model to the Javascript method that implements it.)

Other Interesting areas of the function implementation include:

a) The logic that the vehicle must be for sale to submit an offer on it
b) The retrieval and update of the asset registry a few lines later
c) Saving the updated asset back to the registry

1.1.9. Access Control List

The final file that defines the blockchain application is the Access Control List, which describes the rules which govern which participants in the business network can work with which parts of the blockchain.

46. Click the permissions.acl file:

47. Look at the ACL rules defined:

```
/**
 * Access Control List for the auction network.
 */
rule Auctioneer {
    description: "Allow the auctioneer full access"
    participant: "org.acme.vehicle.auction.Auctioneer"
    operation: ALL
    resource: "org.acme.vehicle.auction.*"
    action: ALLOW
}

rule Member {
    description: "Allow the member read access"
    participant: "org.acme.vehicle.auction.Member"
    operation: READ
    resource: "org.acme.vehicle.auction.*"
    action: ALLOW
}

rule VehicleOwner {
    description: "Allow the owner of a vehicle total access"
    participant(m): "org.acme.vehicle.auction.Member"
```

The rule allows or denies users to access aspects of the blockchain.

Updating the Model (Advanced and Optional)

48. Try updating the model (*auction.cto*) for the *Vehicle* asset definition to include manufacturer make and model fields. Add in new *String* fields and click 'Deploy' to make the changes live.

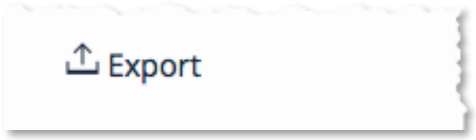
    Note that when you update the model, the syntax of any existing assets in the registry must be compatible with the new model. Use either the **optional** or **default="…"** qualifiers next to the new fields. If you make incompatible changes, you must first reset the demo.

    Once you've deployed the changes, try adding new *Vehicle* assets to the registry to test the changes.

    For more information on the Hyperledger Composer modelling language please refer to: https://hyperledger.github.io/composer/reference/cto_language.html

Export the Business Network Archive

49. Exporting to a Business Network Archive will save the Read Me, Model File(s), Script File(s) and Access Control rules that can be easily imported to a local developer enviroment, handed to a network operator to deploy to a live network or saved asa backup. More details on local installation at https://hyperledger.github.io/composer/installing/installing-index.html.



Congratulations! You have completed this lab.

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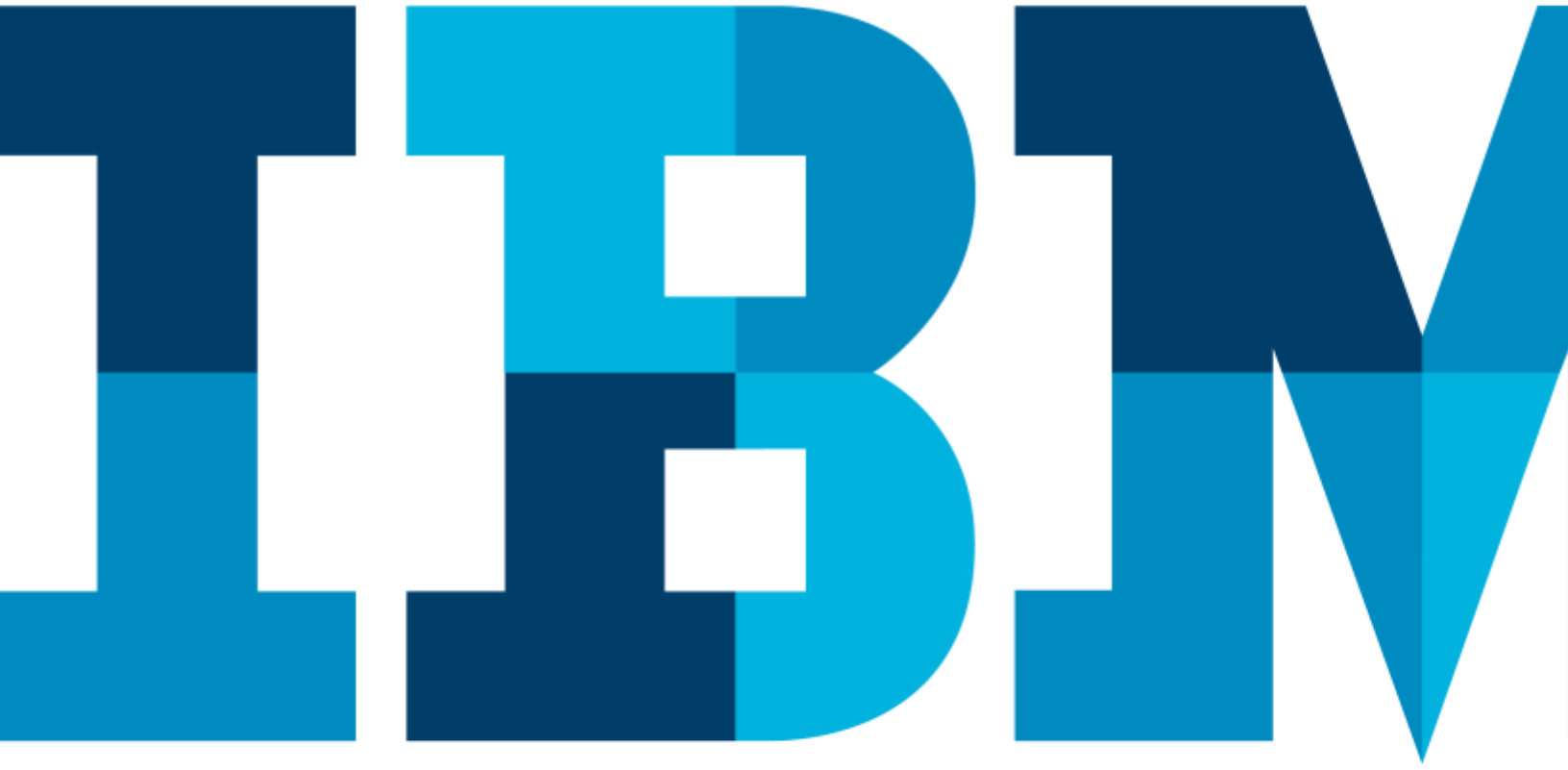
IBM Blockchain Hands-On Hyperledger Composer - Developer Lab

Lab Three VM Exercises Guide



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Overview

The purpose of this lab is to introduce you to the Hyperledger Composer development environment. It is intended to be run on any machine that can meet the Hyperledger Composer specification.

```
Operating Systems: Ubuntu Linux 14.04 / 16.04 LTS (both 64-bit), or Mac OS 10.12
Docker Engine: Version 17.03 or higher
Docker-Compose: Version 1.8 or higher
Node: 6.x (note version 7 is not supported)
npm: 3.10.x
git: 2.9.x
A code editor of your choice, we recommend VSCode.
```

Where to start?

Section 1 will lead you through the installation instructions for Hyperledger Composer and Hyperledger Fabric.
Section 2 will lead you through the creation, deployment and testing of a sample business network application. It will also show you how to generate a REST interface.

If you are running on a machine that has not been configured for Hyperledger Composer (for example, your personal laptop), then install the pre-requisites above and then start with Section 1.

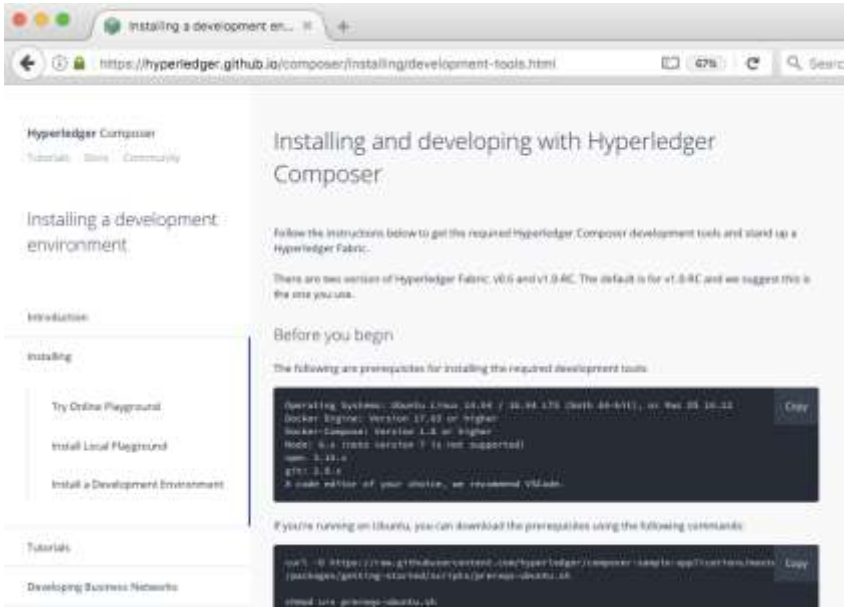
If you are running on a machine that is provided for you as part of a classroom environment, your instructor will tell you where to begin this lab.

Section 1: Installing Hyperledger Composer Development Tools

The master copy of the instructions for this section are online. It is recommended that you use the online version where possible, as this may contain updates to the instructions.

1. **Optionally just read thru the material on the Web page below for your own reference. These steps have already been performed for you on the VMWare image.** Bring up a web browser and navigate to the following page:

   https://hyperledger.github.io/composer/installing/development-tools.html



2. Read thru the material in the link above ***but do not perform any of the steps***.

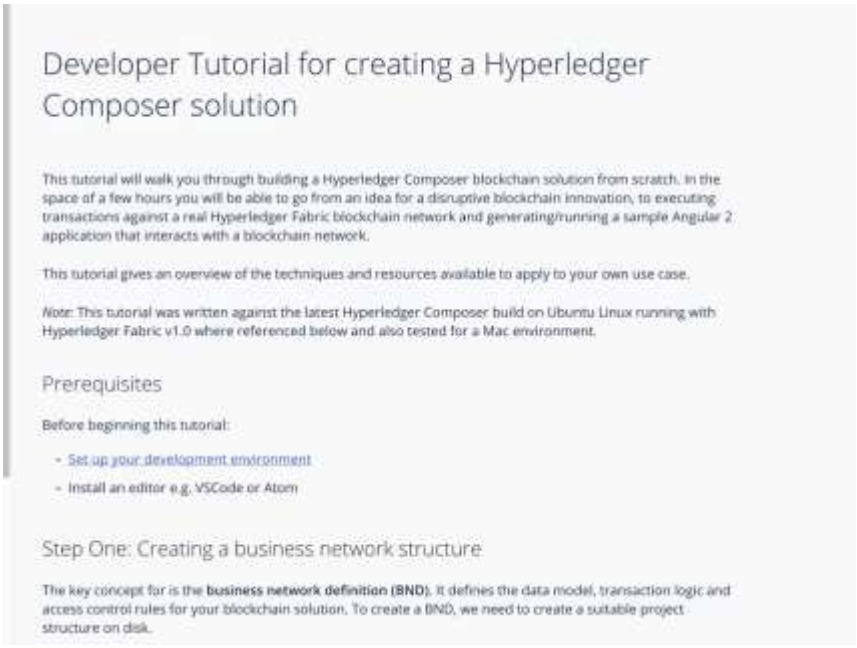
3. Once you have been able to successfully start the fabric and create a composer profile, you will have completed this section. Run the following shell commands and scripts to ensure the containers are started and the environment is ready for you:
   - **cd ~/fabric-tools**
   - **./teardownFabric.sh**
   - **./startFabric.sh**
   - **./createPeerAdminCard.sh**

Section 2: Developer Tutorial

The master copy of the instructions for this section are also online. It is recommended that you use the online version where possible, as this may contain updates to the instructions. The online site also allows you to more easily copy and paste snippets of text, which is necessary for some of the steps.

4. Bring up a web browser and navigate to the following page:

https://hyperledger.github.io/composer/tutorials/developer-tutorial.html



Follow the instructions contained within this page starting at the **Create a business network structure** section. Ensure your terminal window is open to the **/home/blockchain** directory as all git clone commands will clone projects from Github in that directory. There is no need to install Hyperledger Composer or the VSCode Editor since the VMWare image has this installed for you.

Once you have been able to successfully to generate a REST server, you will have completed this section. Be sure to complete step 5 below to cleanup the environment before moving on to the next lab.

5. Cleanup the Hyperledger Fabric environment for the next lab. Perform the following steps:

    - **cd ~/fabric-tools**
    - **./stopFabric.sh**
    - **./teardownFabric.sh**

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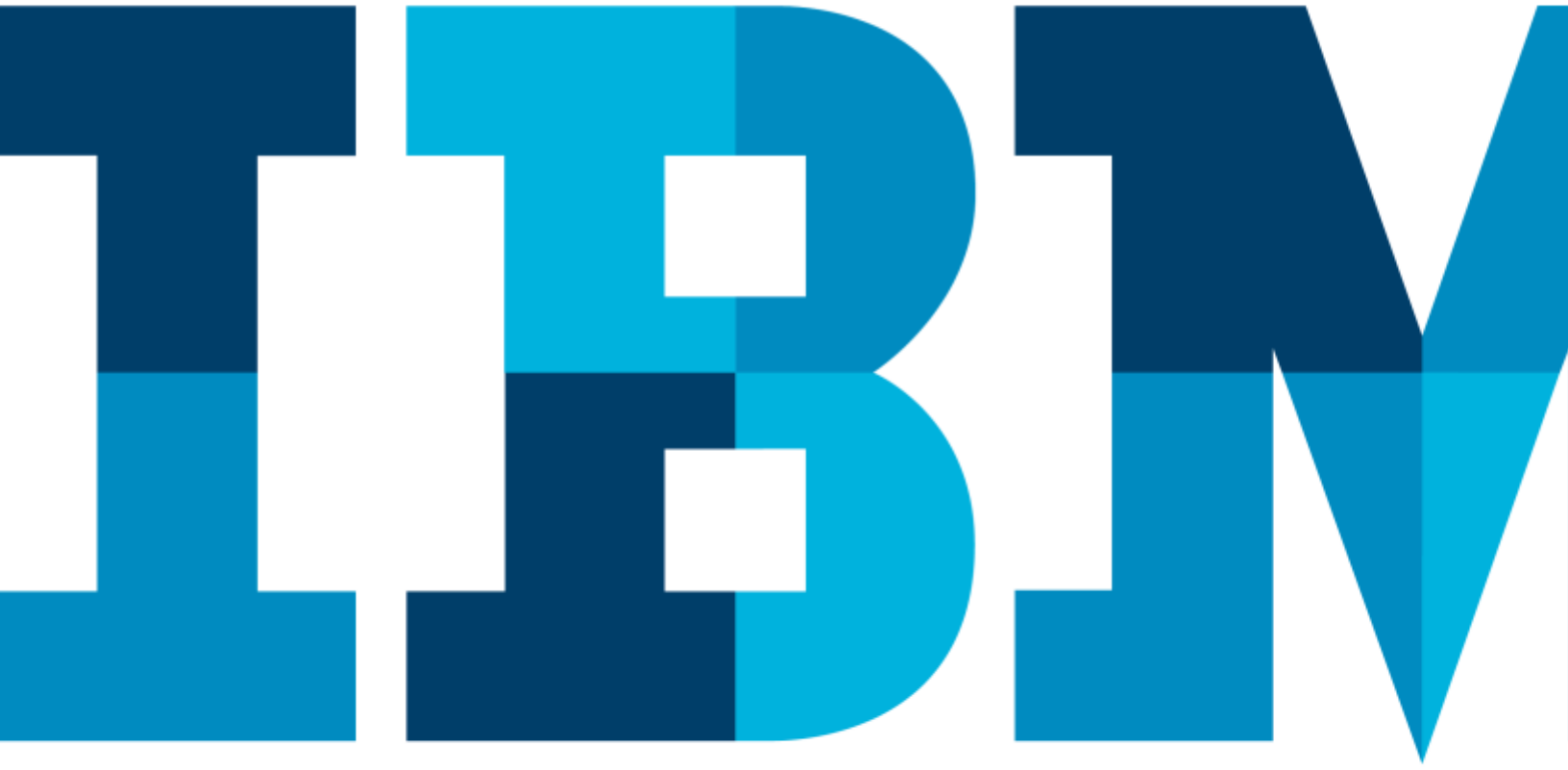
IBM Blockchain Hands-On

Hyperledger Fabric Lab – Writing Your First Application

Lab 4 – VM Exercises



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Overview

The purpose of this lab is to enable you to write your first blockchain application by introducing you to the Hyperledger Fabric SDK.

Introduction

The lab can be run on any supported level of Mac OSX, Linux and Windows machines. A browser and internet connectivity is required to complete the lab.

Please note that as several hundred MBs in the form of docker images will be downloaded, suitable internet bandwidth and disk space is required.

The following prerequisite software are also required:

- Git commandLine
- cURL (or Windows equivalent)
- Docker
- Docker Compose
- Node.js

It is important to ensure the correct versions of Docker, Docker Compose and Node.js are installed. Incorrect versions will lead to random errors. Please follow directions on this page for installing the correct versions: http://hyperledger-fabric.readthedocs.io/en/latest/prereqs.html

Writing your first Hyperledger Fabric application

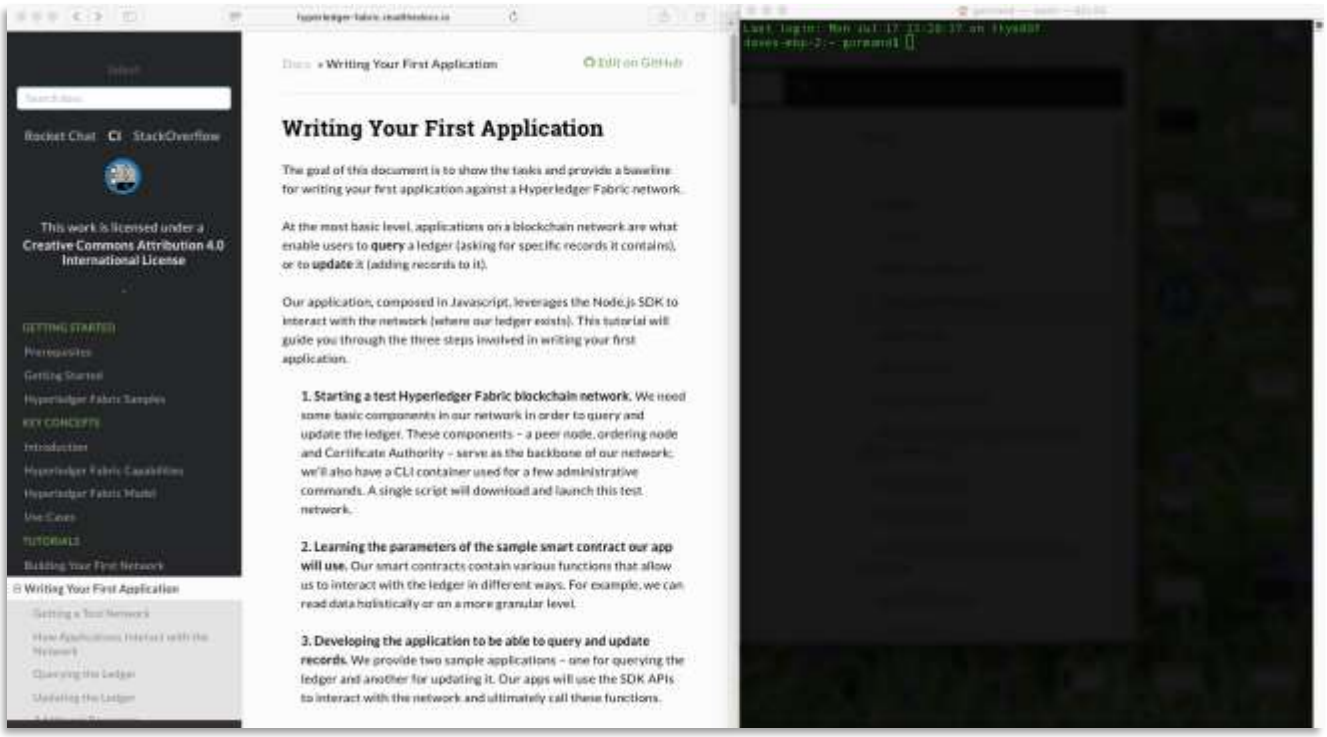
The master copy of the instructions for this lab are online. It is recommended that you use the online version where possible, as this may contain updates to the instructions. The online site also allows you to more easily copy and paste snippets of text, which is necessary for some of the steps.

1. Bring up a web browser and navigate to the following page:

   http://hyperledger-fabric.readthedocs.io/en/latest/write_first_app.html

   You will also need to open a terminal window.

   It is recommended that you open the browser side-by-side with the terminal screen, as you will be working from the browser page and following the instructions in the terminal window.



2. Follow all the instructions contained within the tutorial starting at the Visit the Hyperledger Fabric Samples page. Do not visit the prerequisites page as the prereqs have been installed for you. Ensure your terminal window is initially open to the **/home/blockchain** directory. Once you have successfully run the query.js and invoke.js applications to transfer ownership of a car, you will have completed the lab.

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