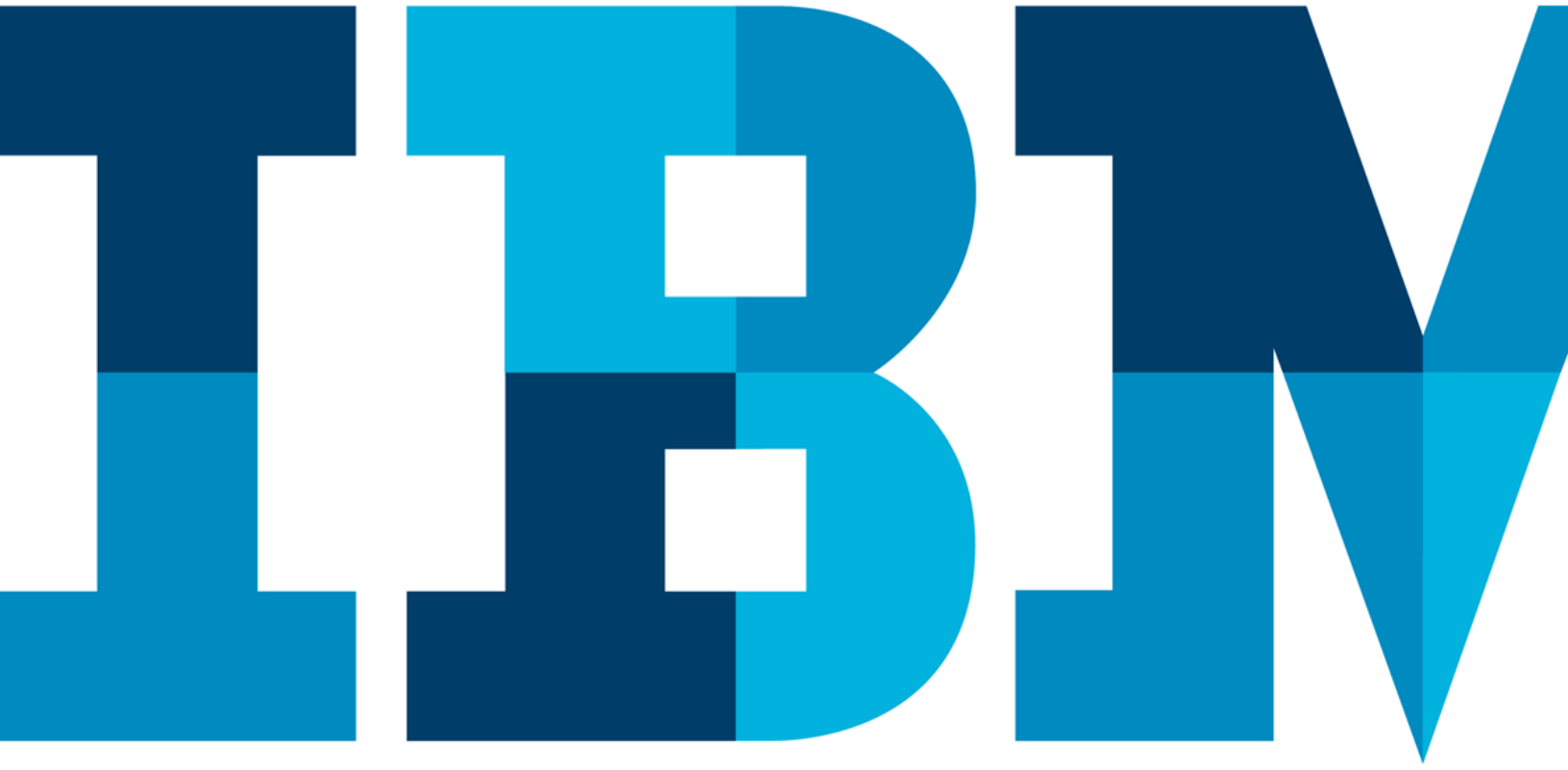
IBM Blockchain Platform Hands-On

Lab 3:

Connecting to an Existing Network



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1 Overview of the lab environment and scenario

This lab is a technical introduction to blockchain, specifically smart contract development using the latest developer enhancements in the Linux Foundation's Hyperledger Fabric v1.4 and shows you how IBM's Blockchain Platform's developer experience can accelerate your pace of development.

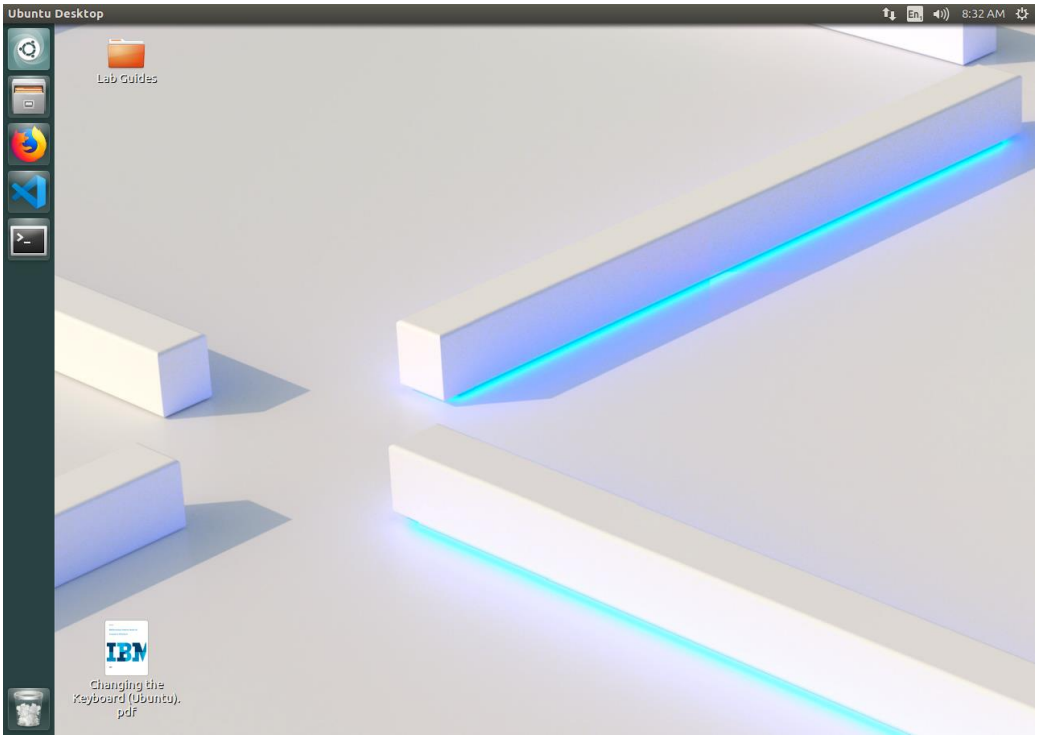
***Note**: The screenshots in this lab guide were taken using version **1.37.1** of **VS Code**, and version **1.0.9** of the **IBM Blockchain Platform** plugin. If you use different versions, you may see differences to those shown in this guide.*

Start here. Instructions are always shown on numbered lines like this one:

__ **1.** If it is not already running, start the virtual machine for the lab. The instructor will tell you how to do this if you are unsure.

__ **2.** Wait for the image to boot and for the associated services to start. This happens automatically but might take several minutes. The image is ready to use when the desktop is visible as per the screenshot below.

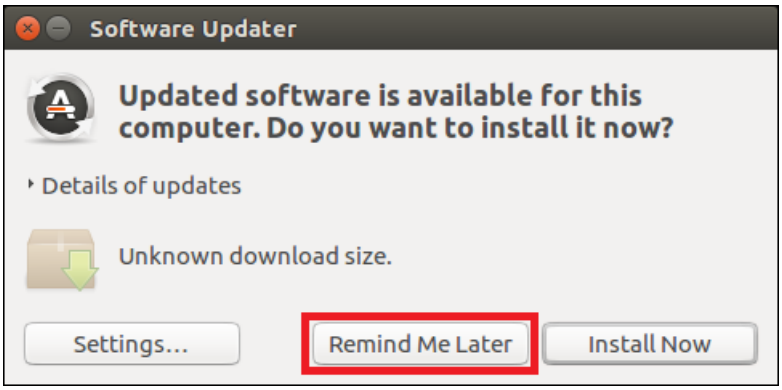
Note: If it asks you to login, the userid and password are both "**blockchain**".



1.1 Lab Scenario

In this lab, part three, we will take you through connecting to an existing network, one that is running outside of in Visual Studio Code (VS Code). The network we will be using is the '**basic-network**' used by the "**Commercial Paper**" Hyperledger Fabric tutorial, and we will stand this network up, run through a simple version of the tutorial and then extend the network with a new smart contract transaction.

***Note** that if you get an "Software Updater" pop-up at any point during the lab, please click "**Remind Me Later**":*



2 Connecting to an Existing Network

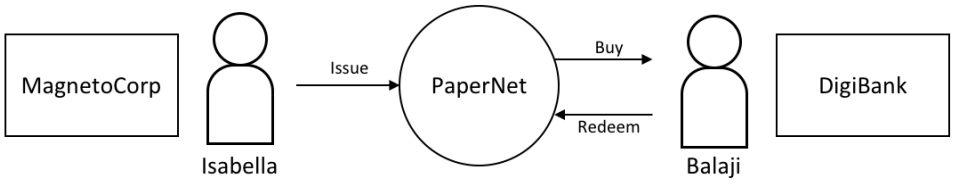
As mentioned above, in this lab will be using the Hyperledger Fabric "**Commercial Paper**" tutorial. The full version of this tutorial is available online and we will be using a simplified version of it designed to work well in a lab environment.

The scenario the tutorial follows is one of a commercial paper trading network called **PaperNet**. Commercial paper itself is a type of unsecured lending in the form of a "promissory note". The papers are normally issued by large corporations to raise funds to meet short-term financial obligations at a fixed rate of interest. Once issued at a fixed price, for a fixed term, another company or bank will purchase them at a discount to the face value and when the term is up, they will be redeemed for their face value.

As an example, if a paper was **issued** at a face value of 10 million USD for a 6-month term at 2% interest then it could be **bought** for 9.8 million USD (10M – 2%) by another company or bank who are happy to bear the risk that the issuer will not default. Once the term is up, then the paper could be **redeemed** or sold back to the issuer for their full face value of 10 million USD. Between buying and redemption, the paper can be bought or sold between different parties on a commercial paper market.

These three key steps of **issue**, **buy** and **redeem** are the main transactions in a simplified commercial paper marketplace, which we will mirror in our lab. We will see a commercial paper **issued** by a company called MagnetoCorp, and once issued on the PaperNet blockchain network another company called DigiBank will first **buy** the paper and then **redeem** it.

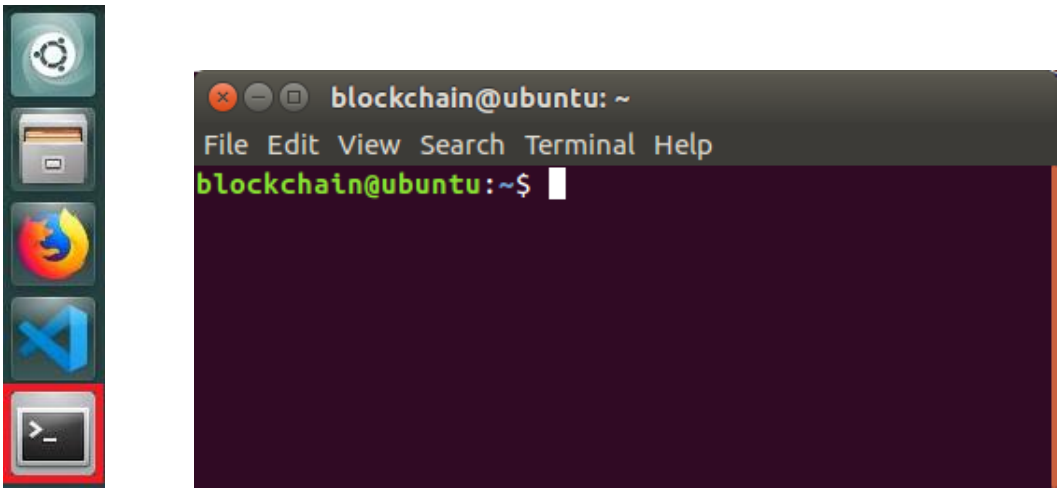
In diagram form it looks like this:



So, let's begin!

2.1 Setting up

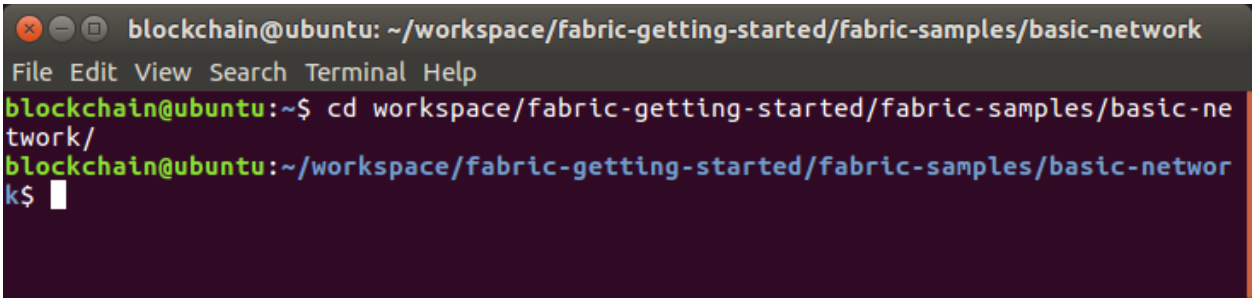
__ **3.** Use the launcher to open a terminal:



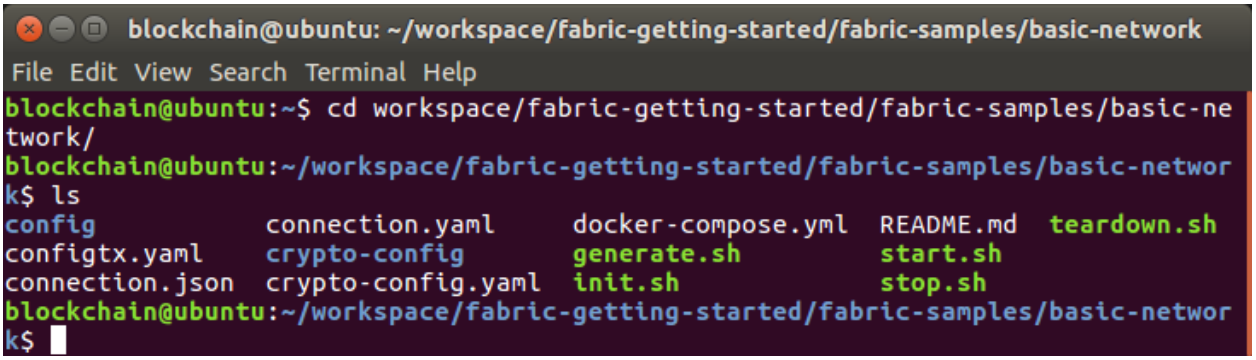
__ **4.** Enter the following **cd** command to change directory to the basic network folder that we will use for this lab:

```
cd workspace/fabric-getting-started/fabric-samples/basic-network
```

If you are not familiar with the command line, you can just copy and paste the above or you can type it yourself if you prefer. Remember you can press the **tab** key after typing the first few characters of the folder name to auto-complete the full name and save some typing. When you have run the command, your console should look like this:



__ **5.** Type the **ls** command and press **enter** to see the files that make up the basic-network.



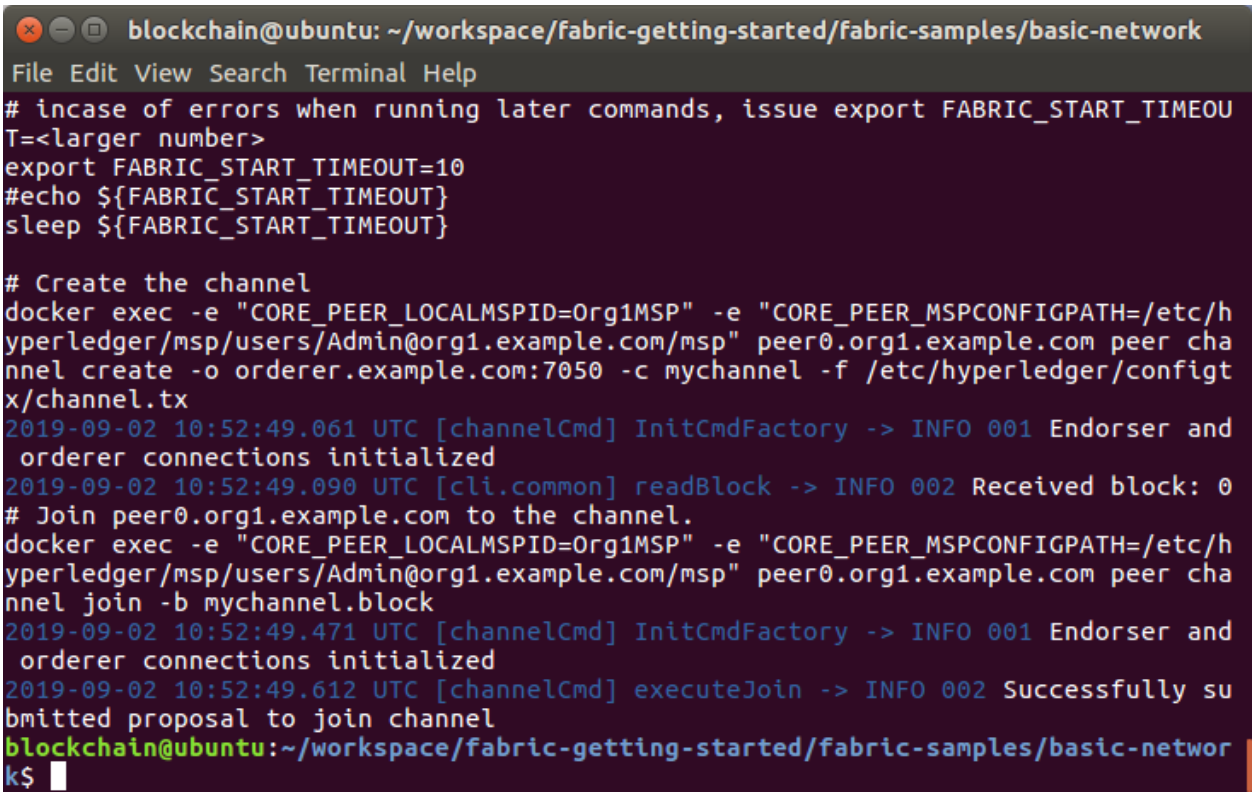
These files contain the configuration for the basic-network along with a script to set it up. Feel free to have a look at their contents if you are curious. The main files of interest are **start.sh** and **docker-compose.yml**; you can open the files to view them with a command like "**`code start.sh`**" but make sure you do not change the contents of any of the files.

__ **6.** To start the network running, run the following command in your terminal:

```
./start.sh
```

Note: make sure you enter the period (.) at the beginning of this command or the command will not be found.

This command is a script that starts the docker containers that make up the basic network and may take a minute or so to run. The command may output a warning which you can ignore. When it has finished, your terminal should look something like this:



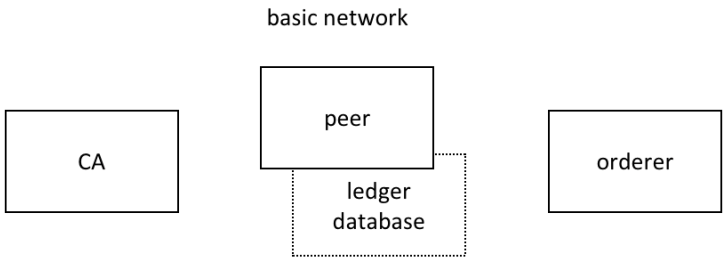
Next we will look at the containers that were started.

__ **7.** Run the command below in your terminal:

```
docker ps
```

```
blockchain@ubuntu: ~/workspace/fabric-getting-started/fabric-samples/basic-network
File Edit View Search Terminal Help
nnel join -b mychannel.block
2019-09-02 10:52:49.471 UTC [channelCmd] InitCmdFactory -> INFO 001 Endorser and
 orderer connections initialized
2019-09-02 10:52:49.612 UTC [channelCmd] executeJoin -> INFO 002 Successfully su
bmitted proposal to join channel
blockchain@ubuntu:~/workspace/fabric-getting-started/fabric-samples/basic-networ
k$ docker ps
CONTAINER ID        IMAGE                          COMMAND                  CREATE
D              STATUS              PORTS
    NAMES
f8b2cb0797db        hyperledger/fabric-peer        "peer node start"        About
a minute ago   Up About a minute   0.0.0.0:7051->7051/tcp, 0.0.0.0:7053->7053/tc
p   peer0.org1.example.com
6bc484a9dcba        hyperledger/fabric-couchdb     "tini -- /docker-ent…"   About
a minute ago   Up About a minute   4369/tcp, 9100/tcp, 0.0.0.0:5984->5984/tcp
    couchdb
cb5b23d21e33        hyperledger/fabric-ca          "sh -c 'fabric-ca-se…"   About
a minute ago   Up About a minute   0.0.0.0:7054->7054/tcp
    ca.example.com
b48c2aa391cc        hyperledger/fabric-orderer     "orderer"                About
a minute ago   Up About a minute   0.0.0.0:7050->7050/tcp
    orderer.example.com
blockchain@ubuntu:~/workspace/fabric-getting-started/fabric-samples/basic-networ
k$
```

This command lists the docker containers that are running. Although this output is a little hard to read, you can make your terminal window wider to see the output better if you wish. This command shows that we have started four containers, one for each of the Hyperledger **fabric-peer**, **fabric-ca**, **fabric-couchdb** and **fabric-orderer** components. Together these make up the simple **basic-network** that we will be using. A more realistic setup would have multiple copies of the components to better reflect the multiple parties in the network, but for a lab this simple network will suffice. In a diagram form, the network looks like this:



__ **8.** These containers are joined together into the same docker network called **net_basic**. A docker network lets containers communicate with each other. Take a look at the network by running this command to inspect it:

```
docker network inspect net_basic
```

You should see output similar to this:

Scroll back up and look at the output. You can see that each of the containers have their own IP address inside the same network so they can communicate with each other.

Next, we will begin working as if we were an administrator for MagnetoCorp who would want to see combined logs from all these components. Although proper dashboards could be created, we will use a simple log viewing tool in this lab.

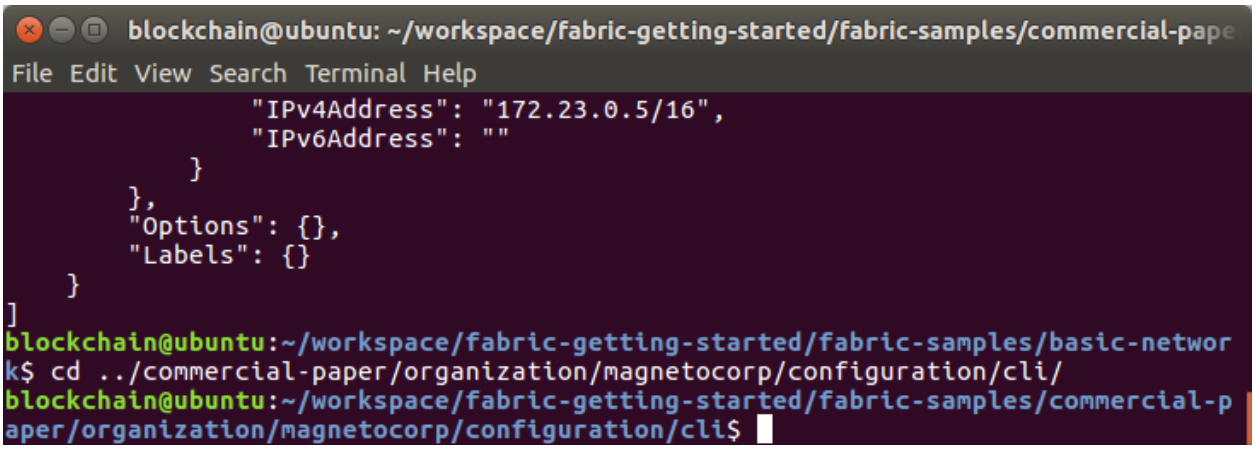
2.2 Working as MagnetoCorp.

__ **9.** From the terminal, change to the following folder:

```
cd ../commercial-paper/organization/magnetocorp/configuration/cli/
```

The full path should now be showing as:

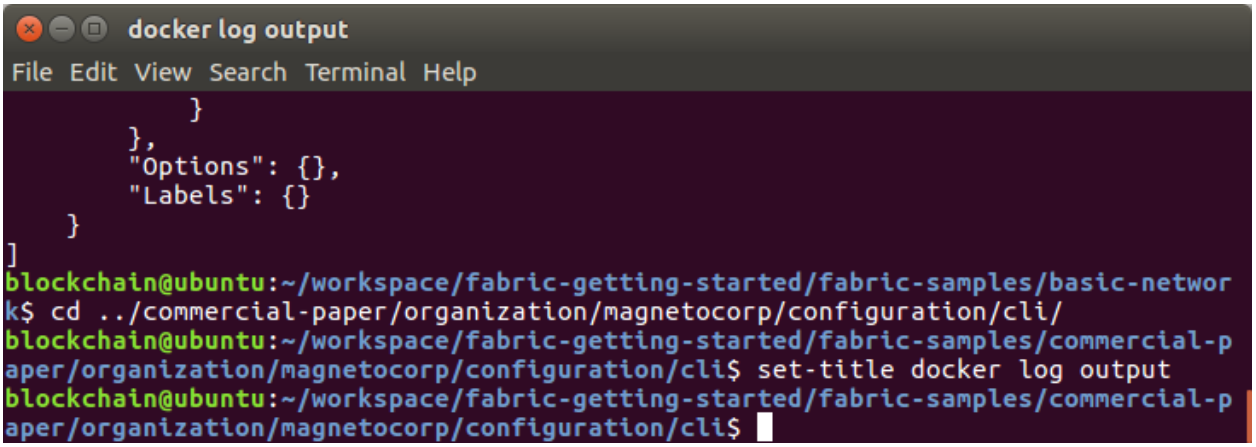
~/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/magnetocorp/configuration/cli



__ **10.** As this terminal is going to spend the rest of this lab showing the logs, let's give it a title so we can easily see what it is doing:

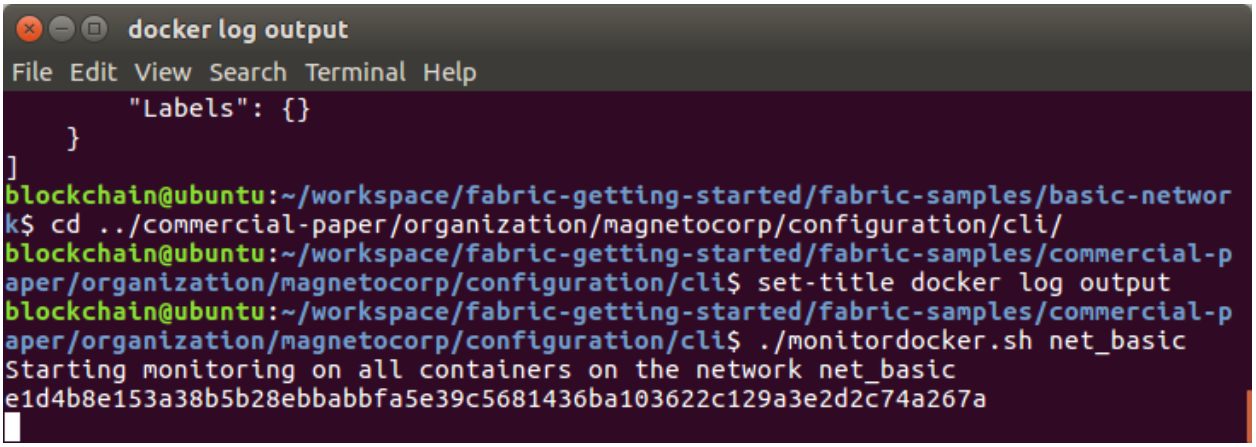
```
set-title docker log output
```

As you can see, this changes the title of the terminal window to make it easily identifiable:



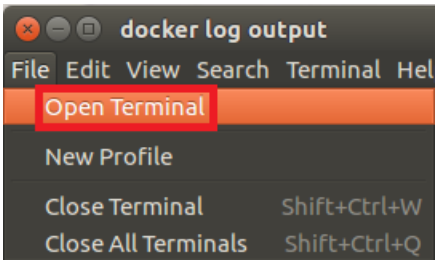
__ **11.** Now we will run the monitoring script to show the docker logs in this terminal:

```
./monitordocker.sh net_basic
```

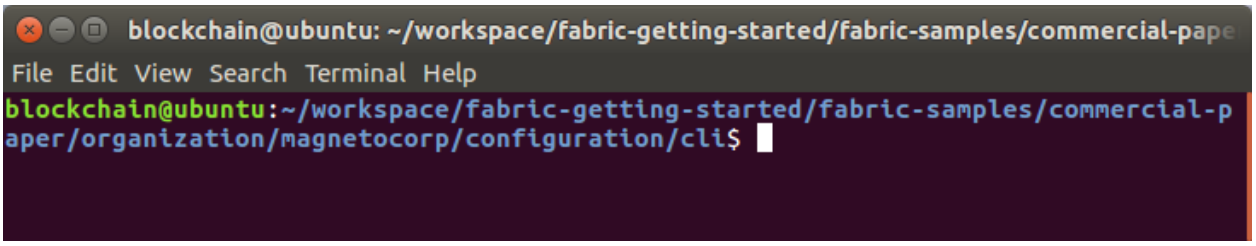


This terminal is now waiting to display any logging output from the **net_basic** docker network. Keep an eye on this terminal throughout the rest of this lab and you will see logging messages appear as we run the different commands.

__ **12.** Now we need a new terminal window as the current one is dedicated to logging output. Make sure the current terminal window is selected by clicking in it, and from the "**File**" menu at the top of the screen, choose "**Open Terminal**"



This should open a new terminal window, with the path set to the same location as the logging terminal where we can enter new commands:



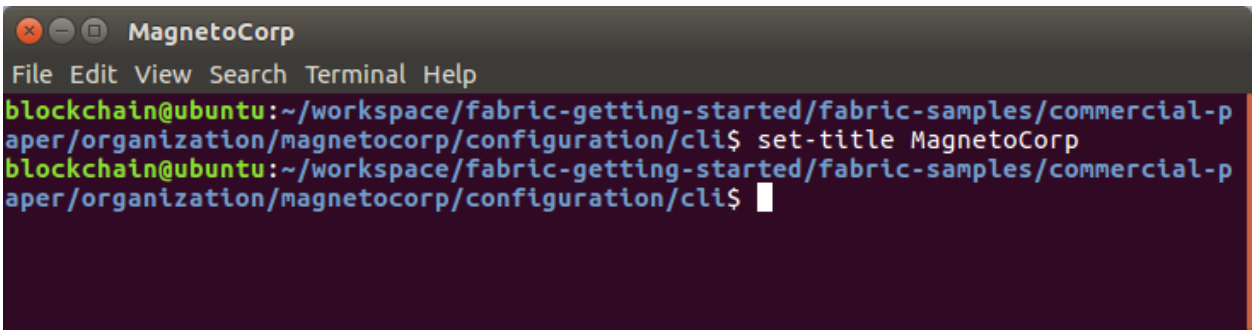
Next, we are going to act as a MagnetoCorp administrator again and interact with the network. To do this we need to issue commands to the peer to **install** and **instantiate** smart contracts (also known as chaincode). Unlike in the previous labs, we are going to do this manually without VS Code for now so we can see the different experience.

2.3 Running the Issue transaction as MagnetoCorp

__ **13.** First, let's give our terminal a name so we know who we are running as by issuing the command:

```
set-title MagnetoCorp
```

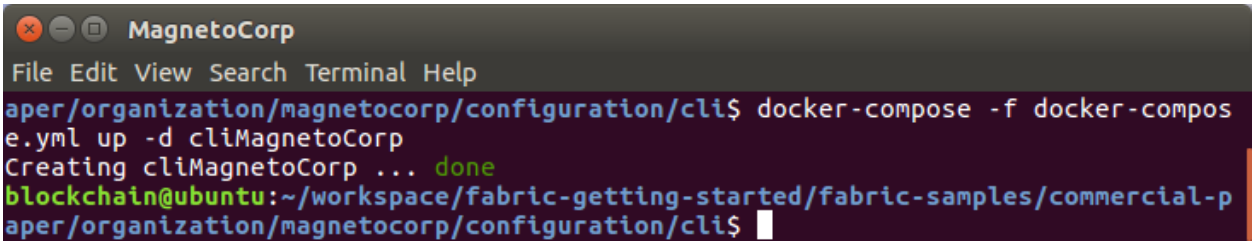
As before when we ran this for the logging window, you should see the terminal title change to **MagnetoCorp**:



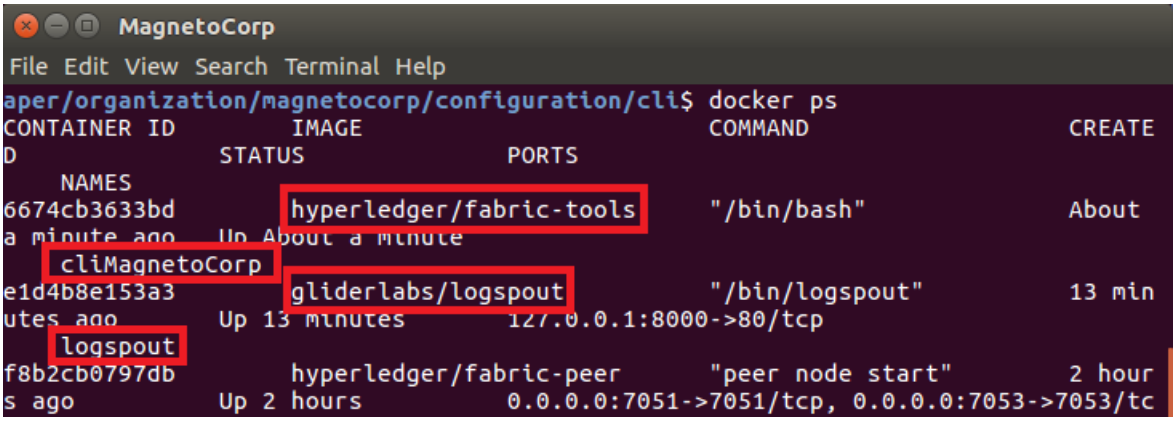
__ **14.** The Fabric commands we need to use are in the **fabric-tools** docker image, so let's start it running by issuing this docker-compose command to start the container:

```
docker-compose -f docker-compose.yml up -d cliMagnetoCorp
```

Docker compose is a tool that allows you to define and run multi-container applications. In this case it will start the **fabric-tools** container and join it to the existing **net_basic** network. You should see output telling you that the container has been created, with the **cliMagnetoCorp** name we gave it:



If we run the **docker ps** command again we should see that the new container is running. You can also see the container we created above for logging is running as well:



Both of these containers have also been added to the **net_basic** network as well and you can run the **docker network inspect net_basic** command again if you want to see this for yourself.

Next we will begin to deploy the **PaperNet** smart contract.

__ **15.** Change directory to the **magnetocorp/contract** folder:

```
cd ../../contract/
```

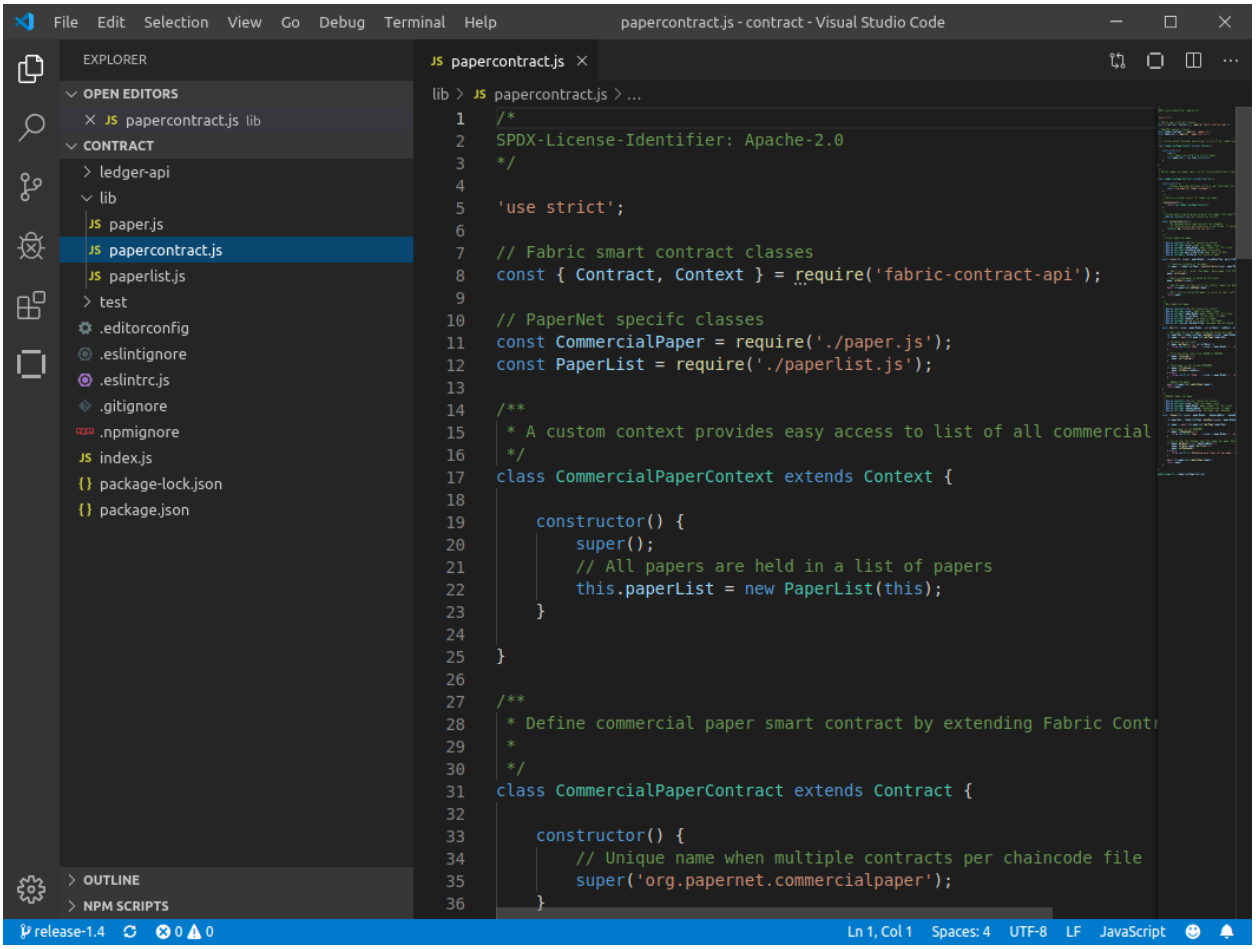
The full path should now be showing as: **~/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/magnetocorp/contract**

__ **16.** Let's take a brief look at the contract in VS Code. Open the contract folder in VS Code by running:

```
code .
```

Note: do not miss the period (**.**) after the word **code**.

__ **17.** When VS Code opens, expand the "**lib**" folder and double click on the **papercontract.js** file to open it in the edit pane:



__ **18.** The Commercial Paper contract is more sophisticated than the contracts we saw in labs one and two, but it mostly works the same way. The main **CommercialPaperContract** class starts on **line 31**, and if we use the "**>**" buttons highlighted below in the VS Code editor to fold the methods of this class we can see that the main transactions are **instantiate**, **issue**, **buy** and **redeem**.

Note: These "**>**" buttons only appear when you move your mouse over their location, as shown above.

__ **19.** Let's expand the **issue** transaction and take a look so we can see what it will do.

Line 68 creates a new **CommercialPaper** object from the parameters passed in using the static **createInstance** method on the **CommercialPaper** class. This class is defined in the separate "**paper.js**" file which is also if the **lib** folder alongside **papercontract.js** if you want to take a look at this method.

Line 71 then moves the newly created paper into the **ISSUED** state and on **line 74** it has its owner set from the parameters passed in.

Line 77 adds the paper to a "**paperList**" which is responsible for storing the state of the paper in the world state. This is defined in the **paperlist.js** file if you want to take a deeper look.

Line 80 then returns the paper to the client who called this transaction.

```
65    async issue(ctx, issuer, paperNumber, issueDateTime, maturityDateTime, faceValue) {
66
67        // create an instance of the paper
68        let paper = CommercialPaper.createInstance(issuer, paperNumber, issueDateTime, maturityDateTime, faceValue);
69
70        // Smart contract, rather than paper, moves paper into ISSUED state
71        paper.setIssued();
72
73        // Newly issued paper is owned by the issuer
74        paper.setOwner(issuer);
75
76        // Add the paper to the list of all similar commercial papers in the ledger world state
77        await ctx.paperList.addPaper(paper);
78
79        // Must return a serialized paper to caller of smart contract
80        return paper;
81    }
```

Feel free to have a look at the other files that make up the commercial paper smart contract. If you want to delve even deeper into the design of the **CommercialPaper** contract, there is much more information online if you have time to take a look.

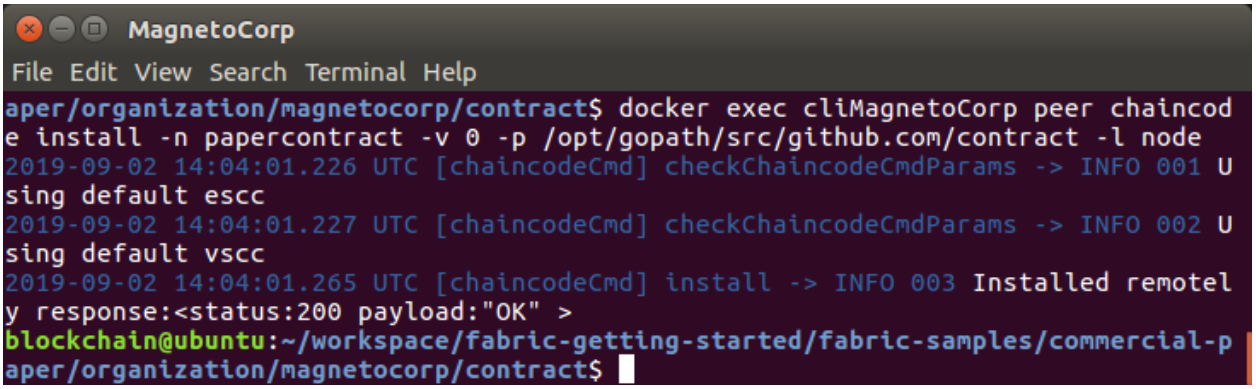
Now we are going to install the **papercontract** onto a peer in the network.

__ **20.** Switch back to the **MagnetoCorp** terminal window and issue the following command:

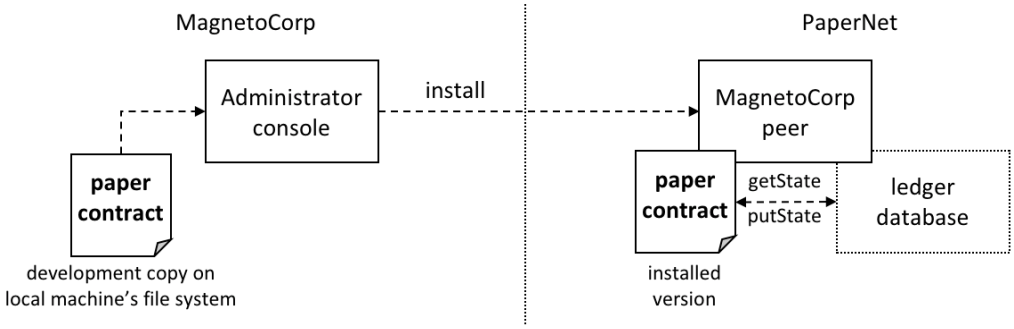
```
docker exec cliMagnetoCorp peer chaincode install -n
papercontract -v 0.0.3 -p /opt/gopath/src/github.com/contract -l
node
```

Note: The above command must be entered as a single line. If you copy and paste it from the pdf, be sure to enter it as a single line.

Note 2: In the above command, the flags are case-sensitive and the flag "`-l`" is a letter "**l**" for language and not a number one.



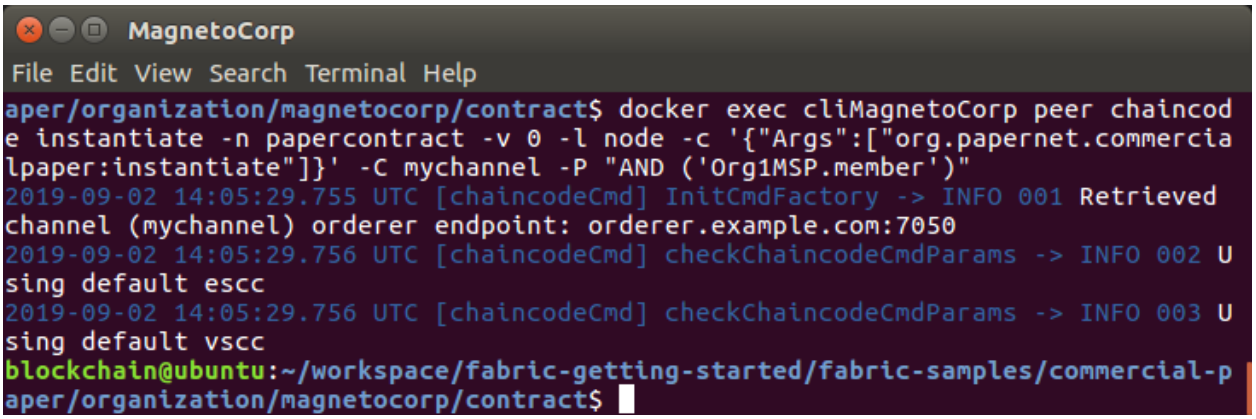
This command uses the **cliMagnetoCorp** container which was configured to send commands to **peer0.org1.example.com** in our basic network. Its main role is to copy the **papercontract** source code and send it to the remote peer, ready for it to be instantiated.



__ **21.** To instantiate the contract on **peer0**, issue the following command at the **MagnetoCorp** terminal:

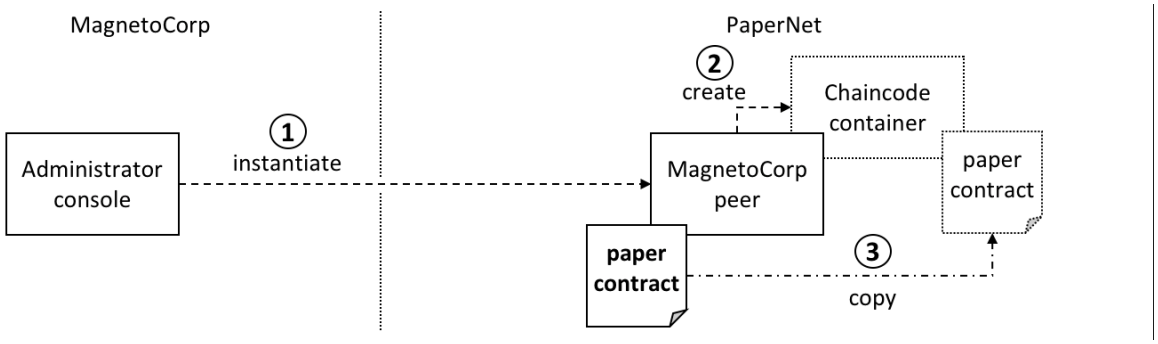
```
docker exec cliMagnetoCorp peer chaincode instantiate -n
papercontract -v 0.0.3 -l node -c
'{"Args":["org.papernet.commercialpaper:instantiate"]}' -C
mychannel -P "AND ('Org1MSP.member')"
```

Note: As before, the above command must be entered as a single line. If you copy and paste it from the pdf, be sure to enter it as a single line. Again, remember, the flags are case-sensitive and the flag "**-l**" is a letter "**l**" for language and not a number one.



This command also uses the **cliMagnetoCorp** container to cause the contract to become instantiated on the **mychannel** channel. In addition, it also invokes the **instantiate** transaction as part of the command which allows any required initialisation to take place. Finally, note the last option – the **-P** flag which specifies which organisations in the network need to endorse the transactions issued by this contract before they will be considered valid.

Note that this command may take a little time to run as it will cause the peer to create a new docker container to be created to run the contract in.



If you wish to see this new container, run the **docker ps** command again – it should have a name beginning with: **dev-peer0.org1.example.com-papercontract-0**.

Note 2: Log messages are written to the **`docker log output`** window as a result of the **instantiate** transaction if you want to take a quick look.

Now the contract is up and running, it is time to start running transactions, and to start things moving, **MagnetoCorp** is going to run an application to **issue** the first commercial paper on the **PaperNet** network. To do this we are going to act as **Isabella**, an employee of **MagnetoCorp.**

__ **22.** Change to the folder that contains the **issue** application.

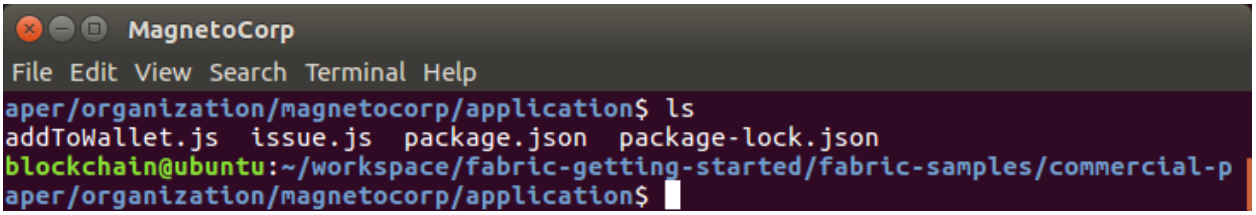
```
cd ../application/
```

The full path at this point should be: **~/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/magnetocorp/application**

__ **23.** Run the **ls** command to see the files in this folder:

```
ls
```

We see that there are several files:



Next let's take a look at the **issue** application.

__ **24.** Run this command to open the **issue** application in the VS Code editor so we can see the code:

```
code issue.js
```

Take a look at the code for the issue application. The main points are:

Lines 18 - 21: Import various dependencies

Line 25: Load the identity from the wallet on the file system

Line 31: Create a new gateway

Line 41: Load the connection profile from file system

Line 53: Connect to the gateway

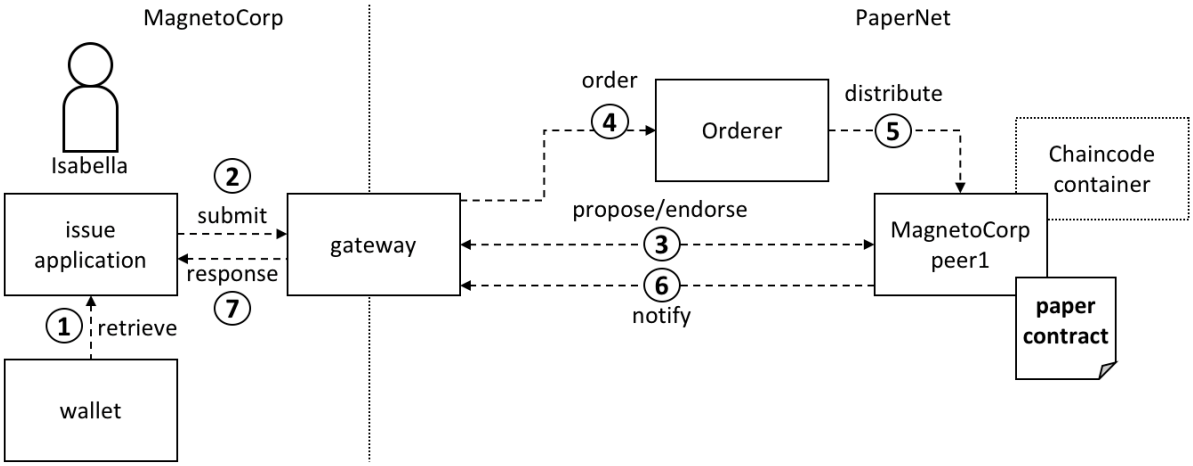
Line 58: Get the **mychannel** channel from the gateway network

Line 63: Get the **papercontract** contract from the gateway

Line 68: Use the contract to submit the **issue** transaction, passing in the details of the paper to be issued.

Line 71: Log the response

As we can see above on line 25, the **issue** application will need to load Isabella's identity before it can create the transaction, so we need to make sure her identity is in the wallet that the **issue** application will use as shown in this diagram:

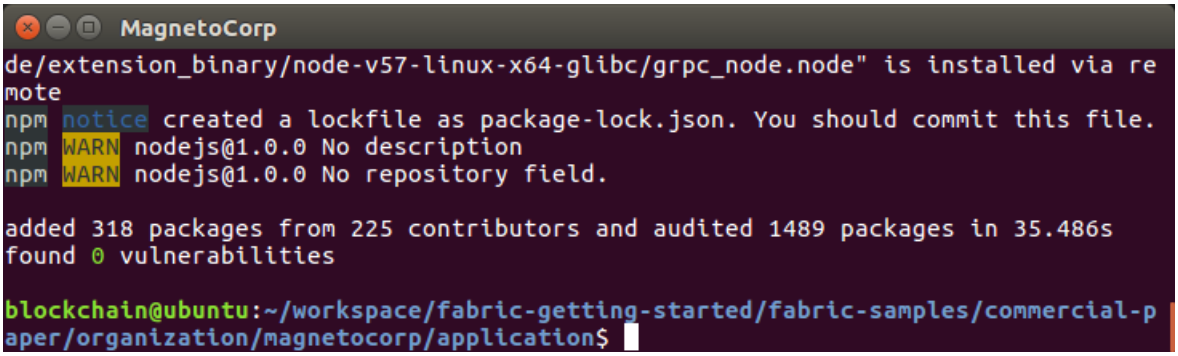


However, before we can run the application, we need to download the dependencies listed in the **package.json** file from **npm**

__ **25.** Switch back to the **MagnetoCorp** terminal and issue this command:

```
npm install
```

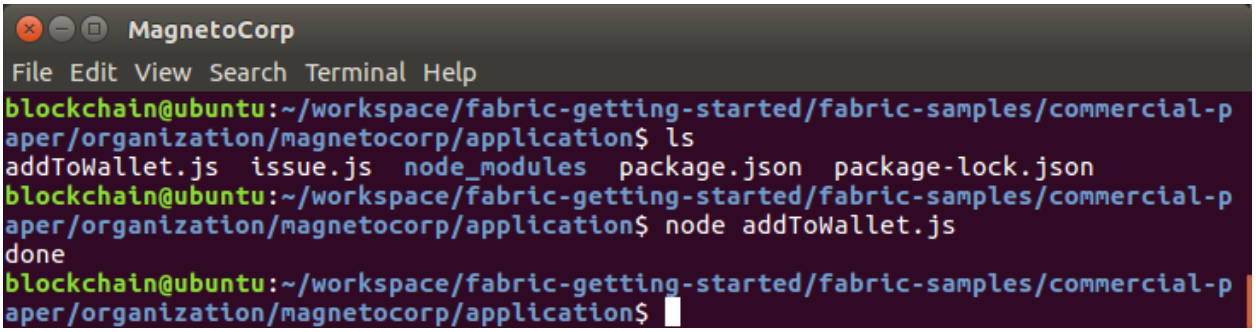
Note: This will take a while to download the dependencies and you may see a slightly different output to that shown below.



When the download has finished, if you run **ls** again, you will see a new **node_modules** folder has been created. It is the **node_modules** folder that contains the dependencies.

__ **26.** Now we are almost ready to issue a new commercial paper, we just need to load Isabella's digital certificate into the wallet before we can use it. To do this we run the following application:

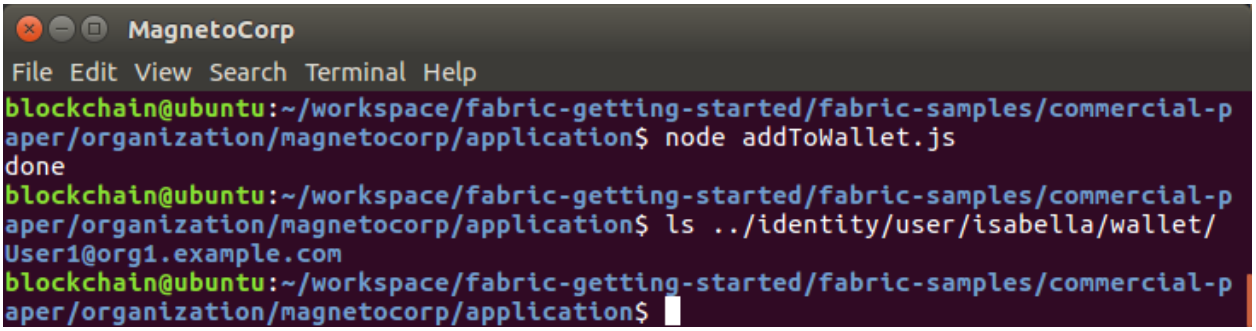
```
node addToWallet.js
```



addToWallet simply copies an identity from the **basic-network** to our wallet location for use by other applications.

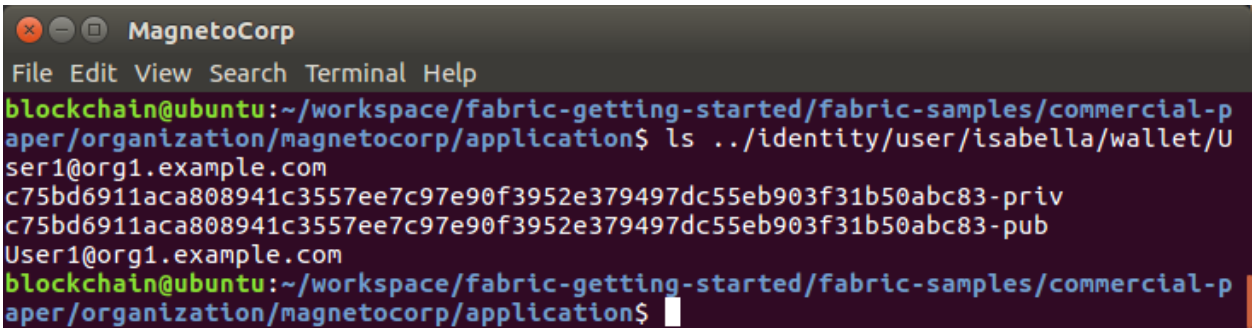
__ **27.** Run this command to see the contents of the newly created wallet:

```
ls ../identity/user/isabella/wallet/
```



Now you can see the **User1@org1.example.com** folder which is used by the issue application. If we run another command, we can see the three files that make up the identity itself:

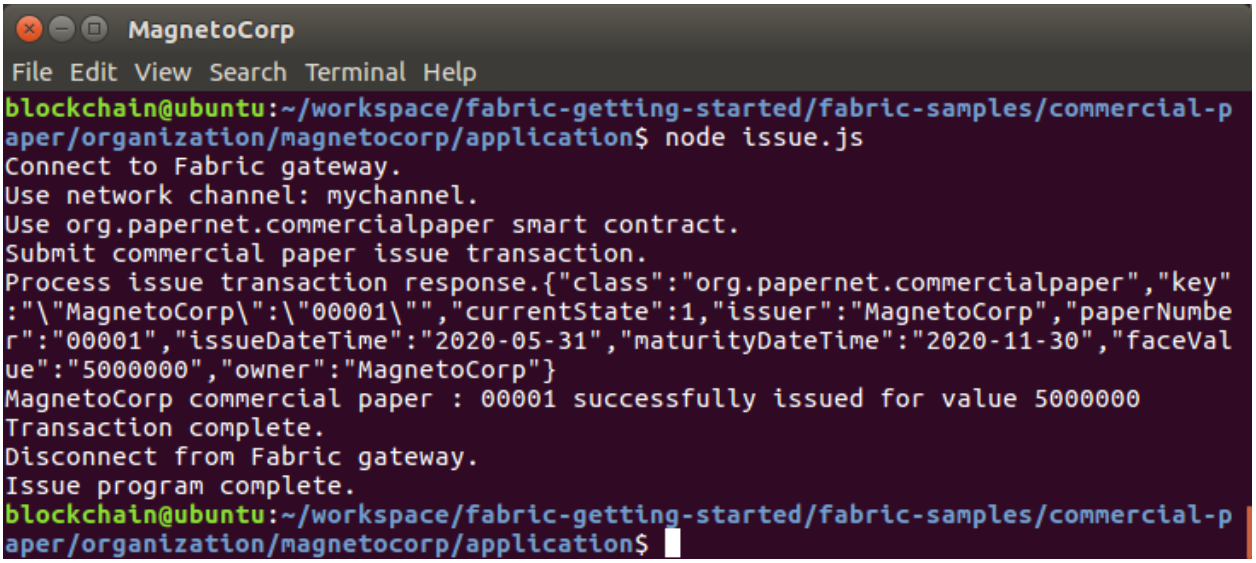
```
ls ../identity/user/isabella/wallet/User1@org1.example.com
```



These files consist of a private key for signing transactions, a public key linked to the private key and a file that contains both metadata and a certificate for our user.

__ **28.** Now we can finally issue the commercial paper by running:

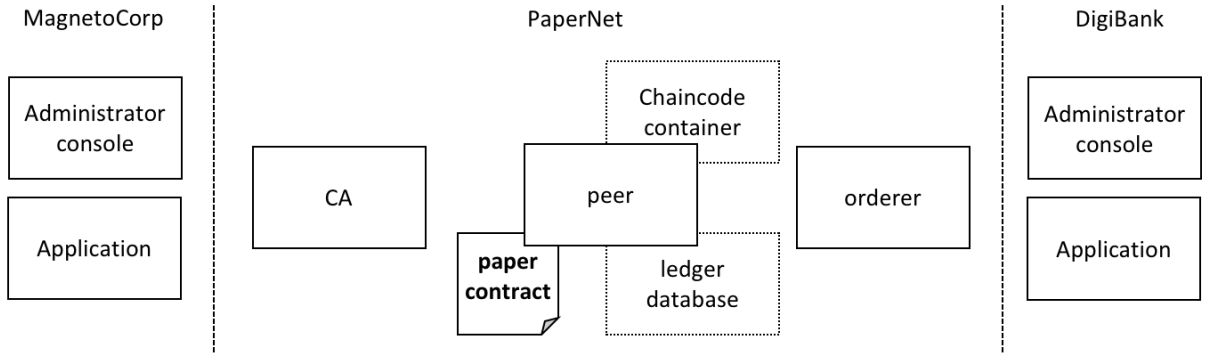
```
node issue.js
```



From the output you can see that we followed the steps outlined above to successfully issue commercial paper **00001** for **5,000,000** USD. We have submitted the transaction to the network and the contract has written these details to the world state and the ledger. The transaction was also endorsed and validated before it was committed.

2.4 Working as DigiCorp

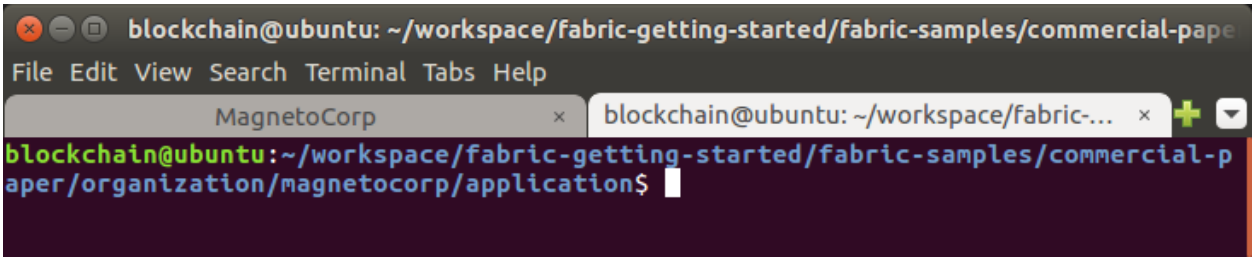
__ **29.** Now that we have issued paper **00001**, we want to take on the persona of an employee of **DigiBank** who is going to **buy** and **redeem** this paper. If we look at a diagram, we can see how they will interact with the same network:



__ **30.** Let's open up a new tabbed terminal window so we can act as **Balaji**, an employee of **DigiBank**. Make sure the **MagnetoCorp** terminal window has focus, then press:

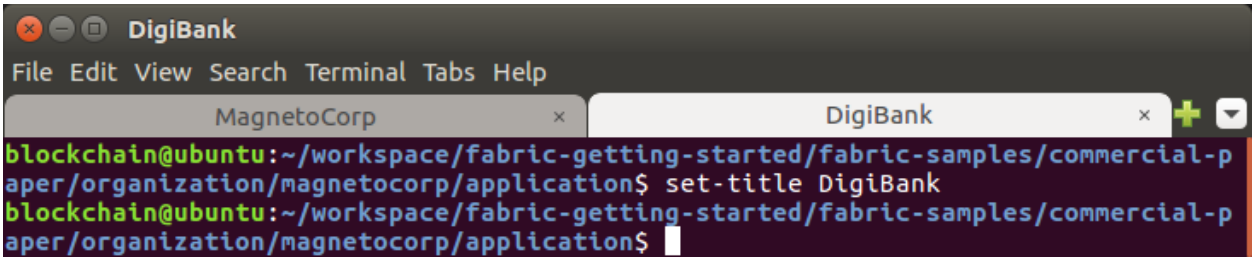
```
ctrl + shift + t
```

This will open up a new tab alongside the MagnetoCorp one:



__ **31.** For ease of use, let's give this new terminal tab a name:

```
set-title DigiBank
```



Now we can easily switch between the different users as required by clicking on the tab for the user we want.

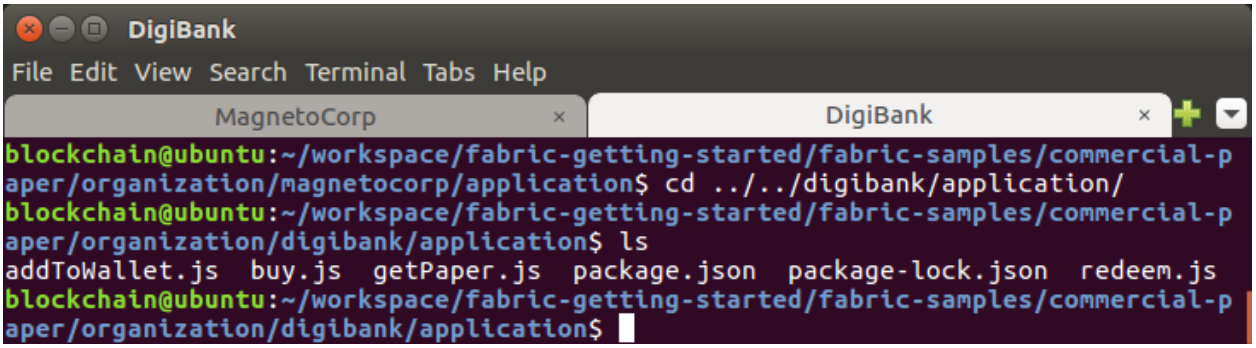
__ **32.** As DigiBank, let's change to **DigiBank**'s application folder:

```
cd ../../digibank/application/
```

The full path should be **~/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/application**

__ **33.** Let's have a look at what files we have in this folder by running:

```
ls
```

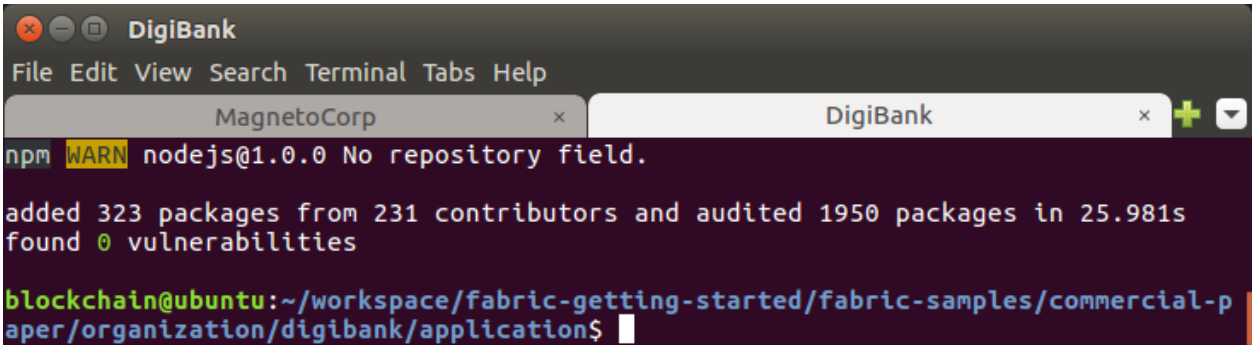


We can see this is similar to **MagnetoCorp's** application folder, but this time we have three different applications, **buy.js**, **redeem.js** and **getPaper.js** instead of **issue.js**.

Note: **getPaper.js** is added as part of this lab, and it is not part of the original **Commercial Paper** tutorial. The contents of this file are shown in the appendix to this lab guide.

__ **34.** As before, before we can run anything, we need to download the dependencies from **npm**:

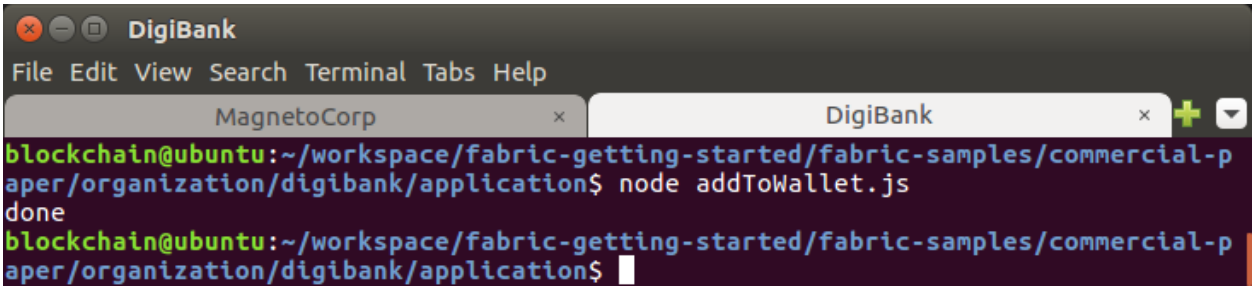
```
npm install
```



Note: remember this can take a while to complete.

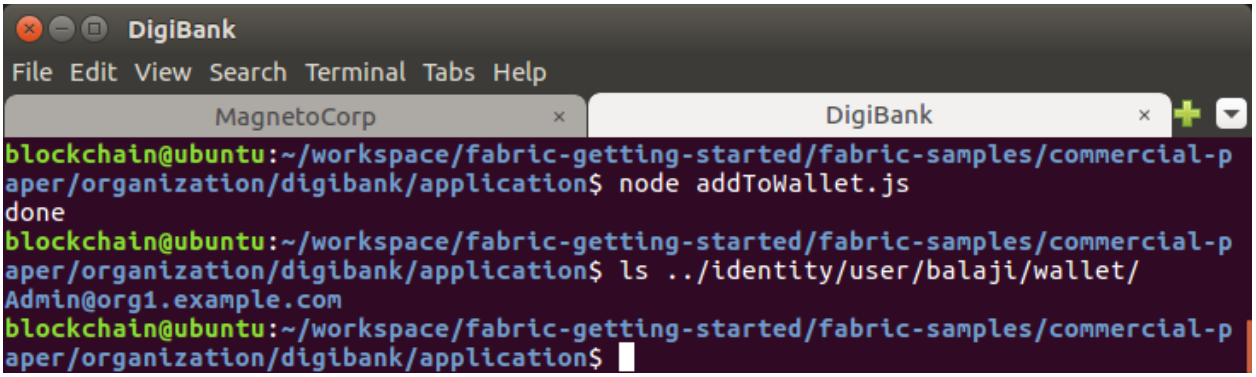
__ **35.** As we are going to be running as **Balaji**, we need to load the identity they are going to use into **DigiBank**'s wallet, just like we did for Isabella earlier:

```
node addToWallet.js
```



__ **36.** Let's take a quick look again at the identity the application copied:

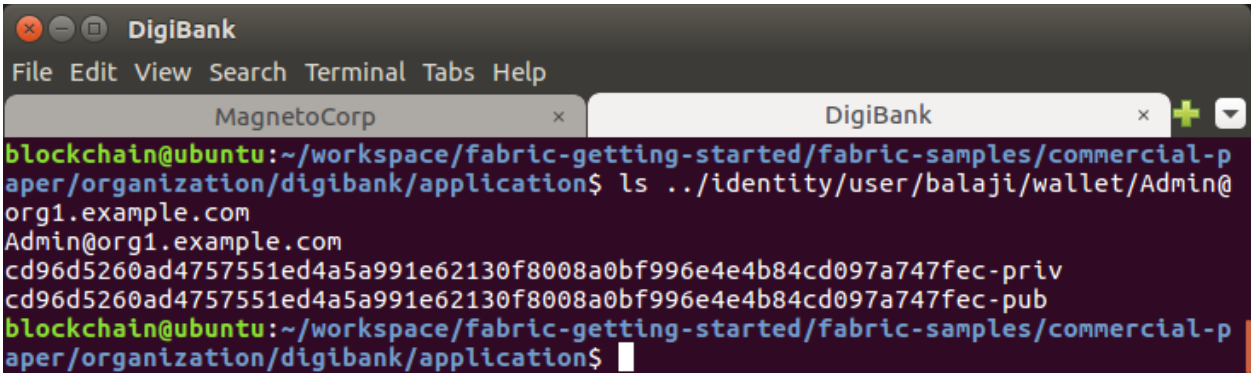
```
ls ../identity/user/balaji/wallet/
```



This time you can see the identity is **Admin@org1.example.com**, as Balaji is acting as an admin for DigiBank.

Just like last time, we can also run another command, we can see the three files that make up the identity itself:

```
ls ../identity/user/balaji/wallet/Admin@org1.example.com
```

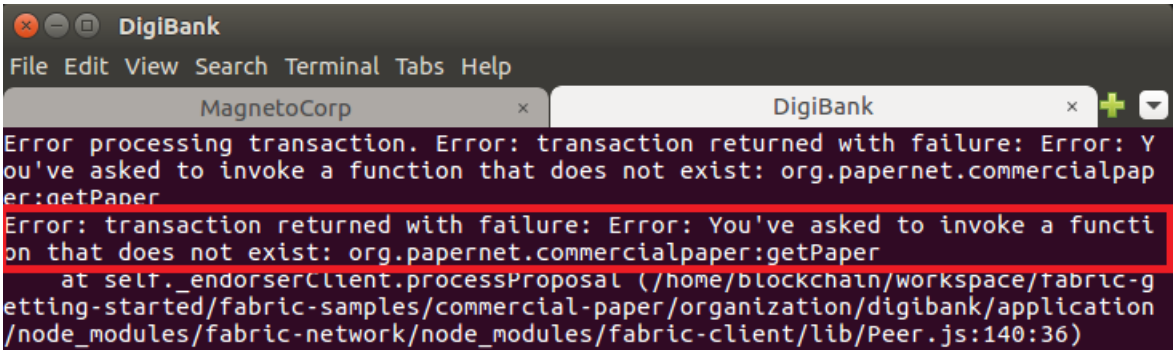


Again, these files consist of a private key for signing transactions, a public key linked to the private key and a file that contains both metadata and a certificate for our user.

Now **Balaji** from **DigiBank** would like to **buy** the commercial paper **00001**. However, he would like to take a look at this paper (00001) on the ledger before he submits the **buy** transaction.

__ **37.** As **Balaji** from the **DigiBank** terminal, run this command to take a look at the commercial paper:

node getPaper.js

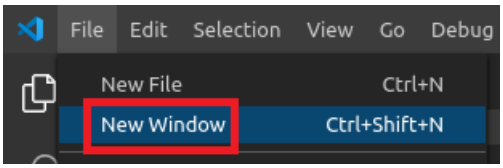


However, if we look at the output, we can see that running **getPaper.js** returns an error because the "**getPaper**" transaction does not exist in the commercial paper smart contract that is currently deployed into the **PaperNet** network.

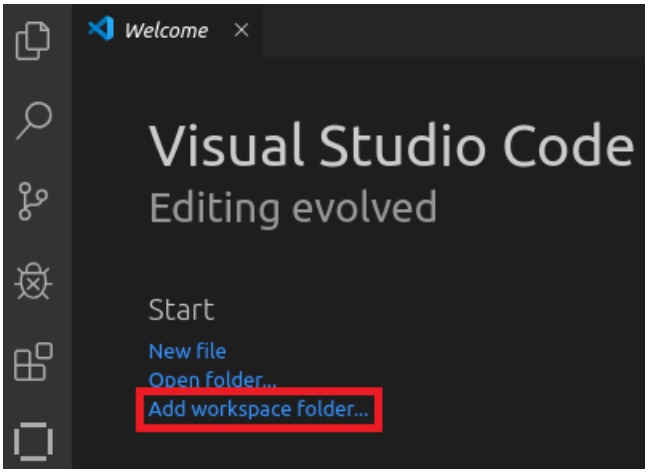
So now, we are going to help **Balaji** implement the new transaction in the commercial paper smart contract. Although Balaji could do this entirely from the command line, we are going to use VS Code to help us simplify the process.

__ **38.** Switch to the VS Code windows which should already be open, but we will open a new window so we can start from a clean editor:

Choose the **File / New Window** menu option

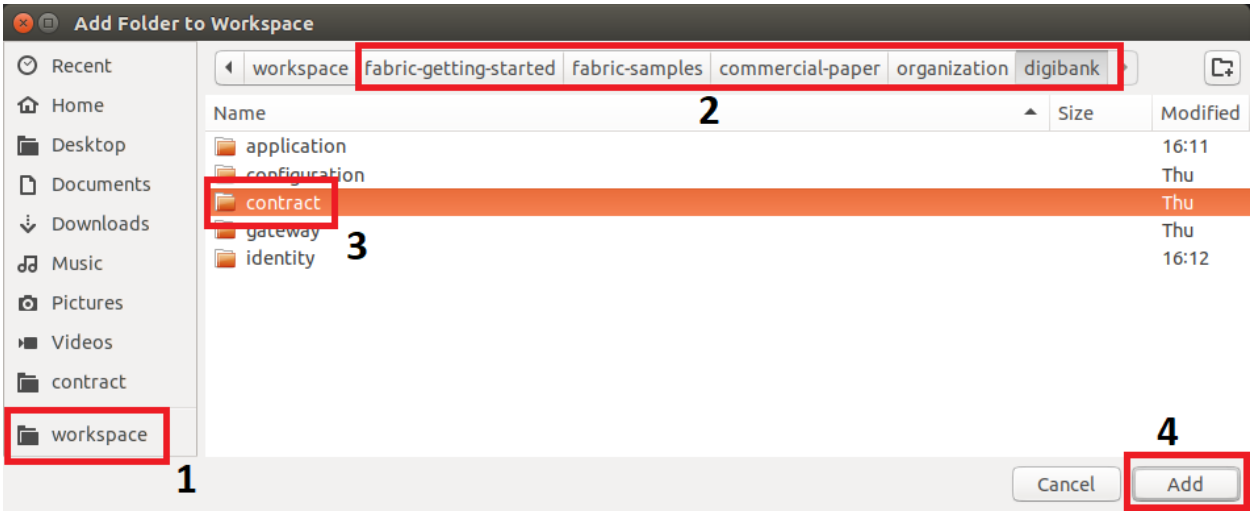


__ **39.** From the "**Welcome**" screen choose "**Add workspace folder...**":



__ **40.** Using the screen shot below as a guide, navigate to open a folder as follows:

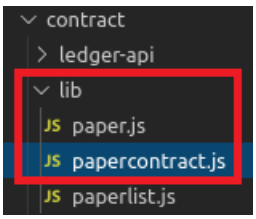
Step 1: Click in the **workspace** folder on the bottom left of the dialogue.
Step 2: Navigate to the folder: **`fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/`**
Step 3: Select the folder **`contract`**
Step 4: Click the **Add** button on the bottom right.



Note: the full path to the **contract** folder you are importing for reference is: **/home/blockchain/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/contract**

Note 2: Make sure you choose the **digibank** folder and **not** the **magnetocorp** one.

__ **41.** Once the folder is added to the workspace, expand the **lib** folder and double-click on the **papercontract.js** smart contract to open it in the main editing view:



__ **42.** We looked at the **issue** transaction in the **papercontract** earlier in this lab, but now we are going to create a new transaction called **getPaper**. It is going to be a simple transaction that just returns the paper that was requested as a parameter. We are going to insert it between the existing **instantiate** and **issue** transactions starting on **line 55**.

```
/**
 * Get commercial paper
 * @param {Context} ctx the transaction context
 * @param {String} issuer commercial paper issuer
 * @param {Integer} paperNumber paper number for this issuer
*/
async getPaper(ctx, issuer, paperNumber) {
  try {
    console.log('getPaper for: ' + issuer + ' ' + paperNumber);

    let paperKey = CommercialPaper.makeKey([issuer, paperNumber]);
    let paper = await ctx.paperList.getPaper(paperKey);
    return paper;

  } catch(e) {
    throw new Error('Paper: ' + paperNumber + ' absent for ' + issuer);
  }
}
```

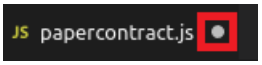
You can either copy the code above or type it in yourself, but make sure it is correct and in the right place as shown in the screenshot below:

```
49    async instantiate(ctx) {
50        // No implementation required with this example
51        // It could be where data migration is performed, if necessary
52        console.log('Instantiate the contract');
53    }
54
55    /**
56     * Get commercial paper
57     * @param {Context} ctx the transaction context
58     * @param {String} issuer commercial paper issuer
59     * @param {Integer} paperNumber paper number for this issuer
60    */
61    async getPaper(ctx, issuer, paperNumber) {
62        try {
63            console.log('getPaper for: ' + issuer + ' ' + paperNumber);
64
65            let paperKey = CommercialPaper.makeKey([issuer, paperNumber]);
66            let paper = await ctx.paperList.getPaper(paperKey);
67            return paper;
68
69        } catch (e) {
70            throw new Error('Paper: ' + paperNumber + ' absent for ' + issuer);
71        }
72    }
73
74    /**
75     * Issue commercial paper
76     *
```

Notice how the new **getPaper** code is placed after the **instantiate** transaction finishes, and before the **issue** transaction begins.

__ **43.** Make sure you save the changes, using the **File / Save** option or press **ctrl + s**

Note that when a file has changes pending it will have a filled in circle in its tab:

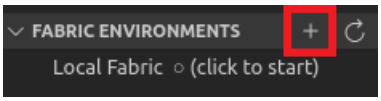


when it is saved this will change to an '**X**':

__ **44.** When the **papercontract.js** file is saved, click on the IBM Blockchain Platform icon in the sidebar to switch to the IBM Blockchain Platform view so we can use IBM Blockchain Platform to simplify the smart contract upgrade experience.

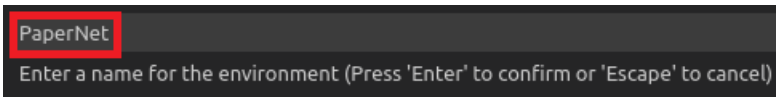
Now we need to connect VS Code to the running **PaperNet** network we set up earlier in this lab. To do this we need to configure a Fabric Environment in VS Code with the details of the nodes that make up the network.

__ **45.** Click on the **+** in the **Fabric Environments** panel on the left:

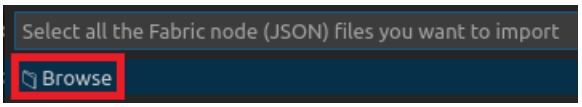


Note: the **+** only appears when you move your mouse over the **Fabric Environments** panel.

__ **46.** In the "**Enter a name for the environment...**" pop up at the top of the screen, enter **PaperNet** and press **Enter**

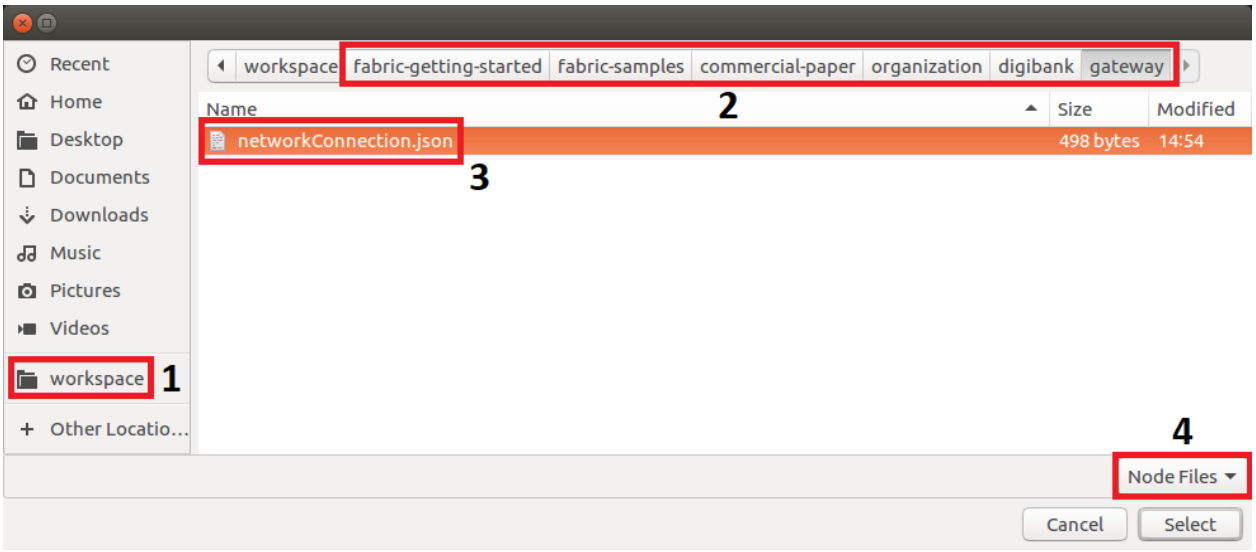


__ **47.** In the "**Select all the Fabric node (JSON) files you want to import**" pop up at the top of the screen, click **Browse**:



__ **48.** Using the screen shot below as a guide, navigate to open the nodes configuration file as follows:

Step 1: Click in the **workspace** folder on the bottom left of the dialogue.
Step 2: Navigate to the folder: **`fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/gateway/`**
Step 3: Select the file **`networkConnection.json`**
Step 4: Click the **Select** button on the bottom right.

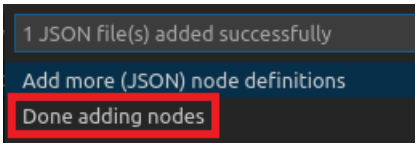


Note: the full path to the **`networkConnection.json`** file you are importing for reference is: **/home/blockchain/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/gateway/networkConnection.json**

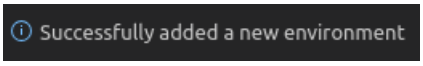
Make sure you choose the **digibank** folder and **not** the **magnetocorp** one. And make sure you choose the **networkConnection.json** file.

Note 2: **networkConnection .json** is added as part of this lab, and it is not part of the original **Commercial Paper** tutorial. The contents of this file are shown in the appendix to this lab guide.

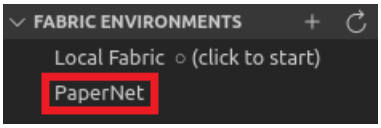
__ **49.** In the "**Add more (JSON) node definitions**" pop up at the top of the screen click "**Done adding nodes**"



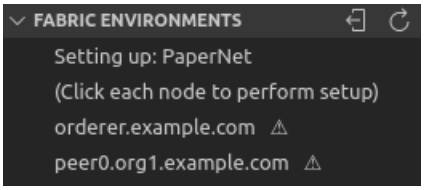
When it is complete you will see this **information message**



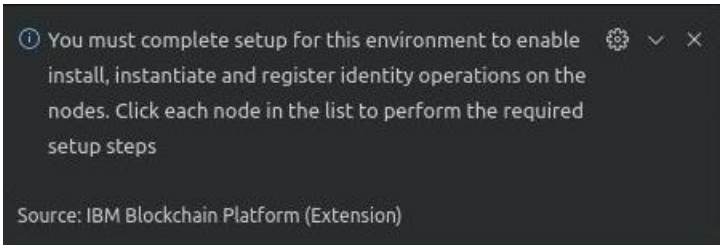
__ **50.** Click on the newly created **PaperNet** Fabric Environment:



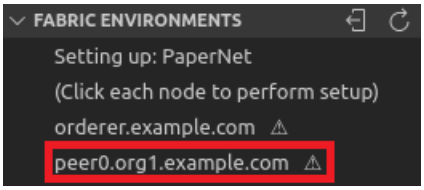
This will then change to show that PaperNet needs further setup for three nodes that were listed in the **networkConnection.json** file:



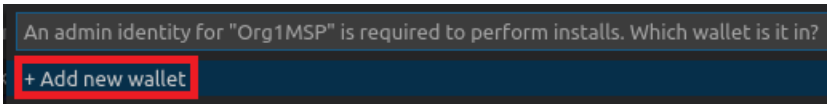
There is also an **information message** with more explanation:



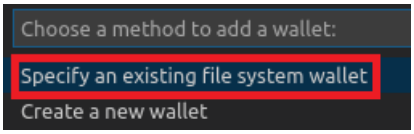
__ **51.** First, click on **peer0.org1.example.com**



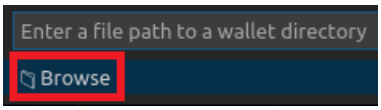
__ **52.** In the pop up at the top of the screen with the message "**An admin identity for "Org1MSP" is required to perform installs.**" click "**Add new wallet**":



__ **53.** As we already have a wallet that we created earlier in this lab, in the pop up choose "**Specify an existing file system wallet**":



__ **54.** In the "**Enter a file path to a wallet directory**" pop up choose "**Browse**":

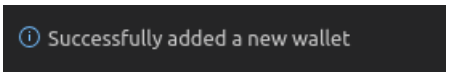


__ **55.** Using the screen shot below as a guide, navigate to open a wallet folder as follows:

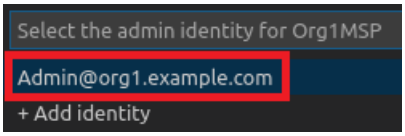
Step 1: Click in the **workspace** folder on the bottom left of the dialogue.
Step 2: Navigate to the folder: **`fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/identity/user/balaji/`**
Step 3: Select the folder **`wallet`**
Step 4: Click the **Select** button on the bottom right.

Note: the full path to the **`wallet`** folder you are importing for reference is: **/home/blockchain/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/identity/user/balaji/**

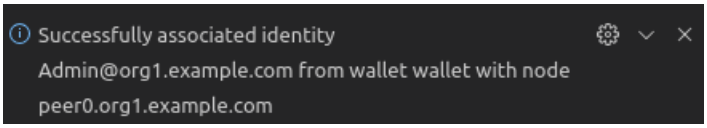
Make sure you choose the **digibank** folder and not the **magnetocorp** one. Also make sure you choose the **wallet** folder itself and **not** the **Admin@org1.example.com** folder inside it. You should then see an **information message** saying that the wallet was added successfully.



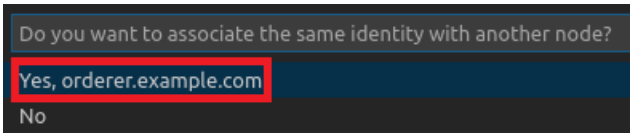
__ **56.** In the "**Select the admin identity for Org1MSP**" pop up at the top of the screen choose "**Admin@org1.example.com**":



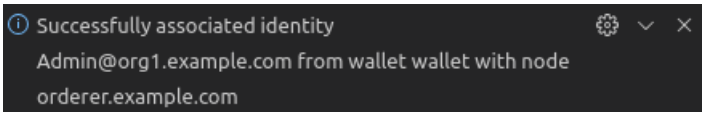
This will trigger an **information message** showing success:

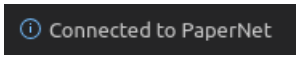


__ **57.** In the "**Do you want to associate the same identity with another node?**" pop up at the top of the screen choose "**Yes, orderer.example.com**":

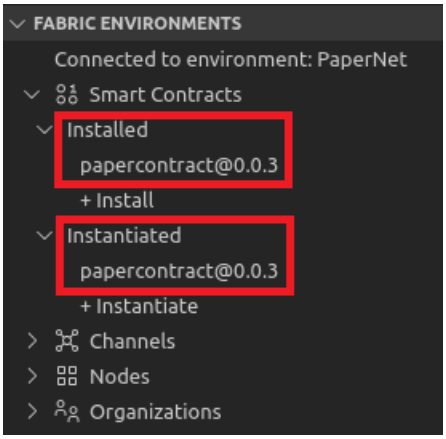


This will trigger two **information message**s showing we have successfully associated the identity and connected to the PaperNet network:





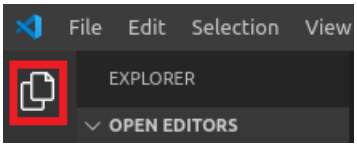
Finally, in the Fabric Environment view we can now see the **papercontract@0.0.3** smart contract that we installed and instantiated earlier in this lab:



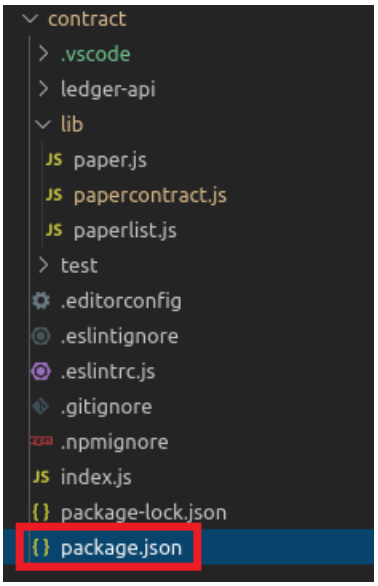
To change an instantiated contract, Hyperledger Fabric requires that we **upgrade** the existing contract to the new version. To do this we must first increment the **version** number of the contract and make sure the **name** of the package will match the contract we are upgrading.

__ **58.** Switch to the **Explorer** view in VS Code.

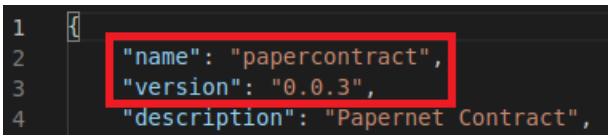
Note: If you are having problems and cannot see the **Explorer** view for any reason, click on its icon in the activity bar () or press "**ctrl** + **shift** + **e**" to show it.



__ **59.** Double click on the **package.json** file in the contract folder to open it for editing:



Lines two and three of the **package.json** file define the name and version of the contract package. Currently the name is **papercontract** and the version is **0.0.3**:



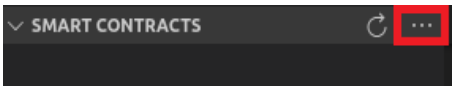
__ **60.** We can see that the name is correct and matches the contract we have deployed, but we need to increment the version to **0.0.4**:

```
{
    "name": "papercontract",
    "version": "0.0.4",
    "description": "Papernet Contract",
```

__ **61.** Make sure you save the changes, using the **File / Save** option or press **ctrl + s**

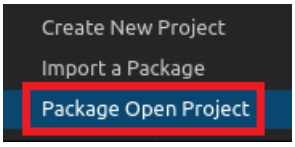
__ **62.** Switch back to the IBM Blockchain Platform view:

__ **63.** From the **Smart Contracts** pane, click the "More Actions" '**...**' button to package the contract:



Note: The '**...**' only appears when you move your mouse over the **Smart Contracts** bar.

__ **64.** From the pop up menu choose "**Package Open Project**":

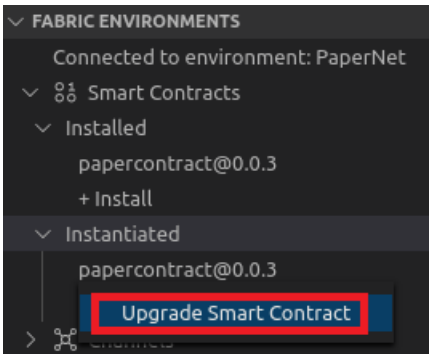


When the packaging is complete, you will see an **informational message**:

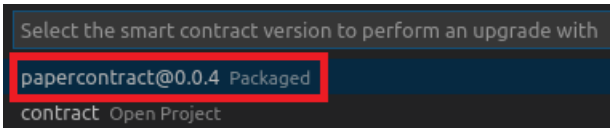
Also the package will appear in the **Smart Contracts** pane:

Note: Make sure that your package has got the correct name and version. If it does not, make sure you enter the correct details in the **package.json** file as instructed above and repackage it.

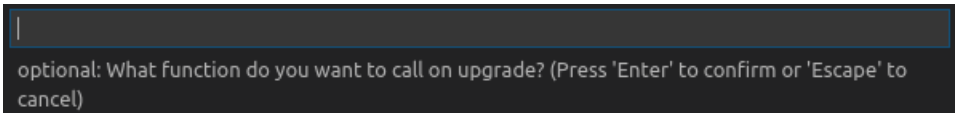
__ **65.** To upgrade the contract to the new version that contains our **getPaper** transaction, right click on the **instantiated papercontract@0.0.3** contract and choose the **Upgrade Smart Contract** menu option:



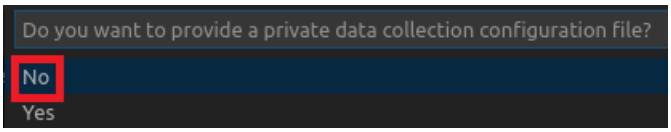
__ **66.** From the "**Select the smart contract version to perform an upgrade with**" pop up at the top of the screen, choose the **papercontract@0.0.4 Packaged** option:



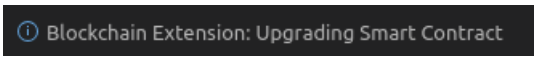
__ **67.** As the instantiate method in our smart contract does not perform and necessary task, we do not need to call it, so from the "**optional: What function do you want to call...**" pop up menu, just press enter:



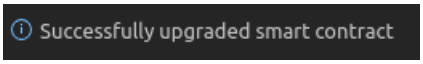
__ **68.** As we are not using private data collections, from the "**Do you want to provide a private data collection configuration file** pop up menu, just press enter:



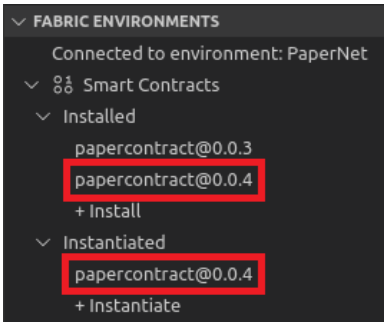
Upgrading a smart contract can take several minutes as a new docker container is built to contain the new contract. Whilst it is happening you should see this **information message**



When it is complete you will see this **information message**

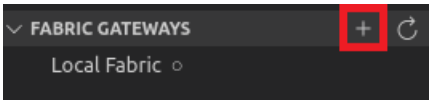


Once complete, the "**Fabric Environments**" view will change to show the new contract **papercontract@0.0.4** has been **installed** and **instantiated** as part of the upgrade process:



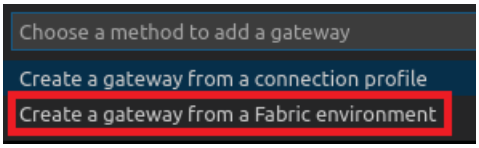
Now we have upgraded the contract, we need create a new gateway to interact with it as gateways are the way you connect to a Fabric network.

__ **69.** Click on the **+** in the **Fabric Gateways** panel on the left to add a new gateway:



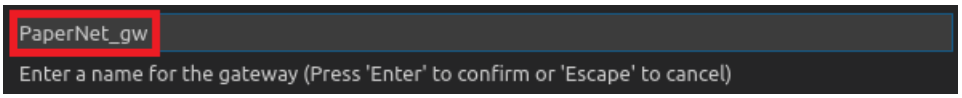
Note: the **+** only appears when you move your mouse over the **Fabric Gateways** panel.

__ **70.** In the "**Choose a method to add a gateway**" pop up at the top of the screen, choose "**Create a gateway from a Fabric environment**":

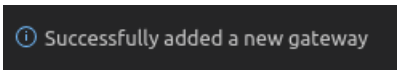


Note: We could have created a gateway from a connection profile instead, by using the profile that comes with the commercial paper sample in the "**`~/workspace/fabric-getting-started/fabric-samples/commercial-paper/organization/digibank/gateway/networkConnection.yaml`**" folder, but as we already have an environment we can simplify the process by using it.

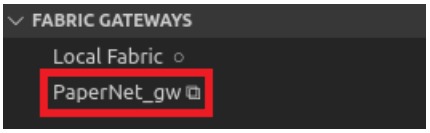
__ **71.** In the "**Enter a name for the gateway...**" pop up at the top of the screen, enter "**PaperNet_gw**":



When it has finished an information message will appear:



__ **72.** Click on the new **PaperNet_gw** gateway to connect to the **PaperNet** network:

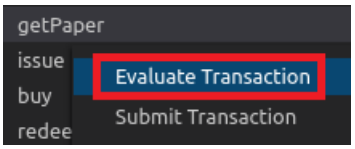


__ **73.** Expand the Channels section and the “myChannel” channel to see the upgraded contract **papercontract@0.0.4**. Expand the contract and you will see the new **getPaper** transaction is now available:

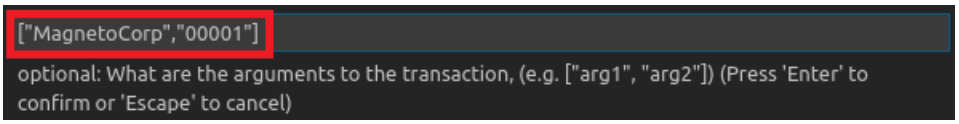
Note: If you don’t see the **getPaper** transaction, make sure you edited the **Digibank** copy of **package.json** and **papercontract.js**.

Let’s run the **getPaper** transaction from within VS Code

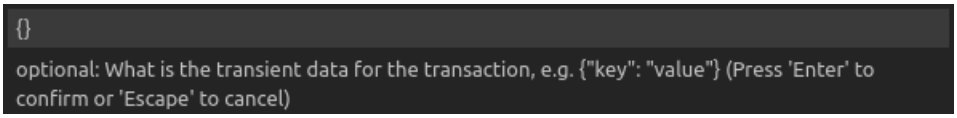
__ **74.** Right click on the **getPaper** transaction and choose **Evaluate Transaction**:



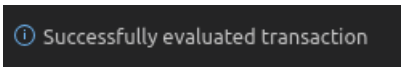
__ **75.** In the pop up at the top of the screen enter **`"MagnetoCorp,"00001"`** inside the array square brackets [ ]. Make sure you include the **`""`** marks around each parameter.



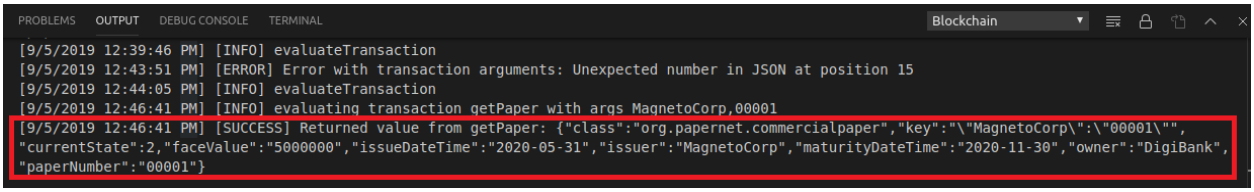
__ **76.** In the next optional pop up, just press enter as we have no transient data:



If you have entered everything correctly you will see a success **information message**:



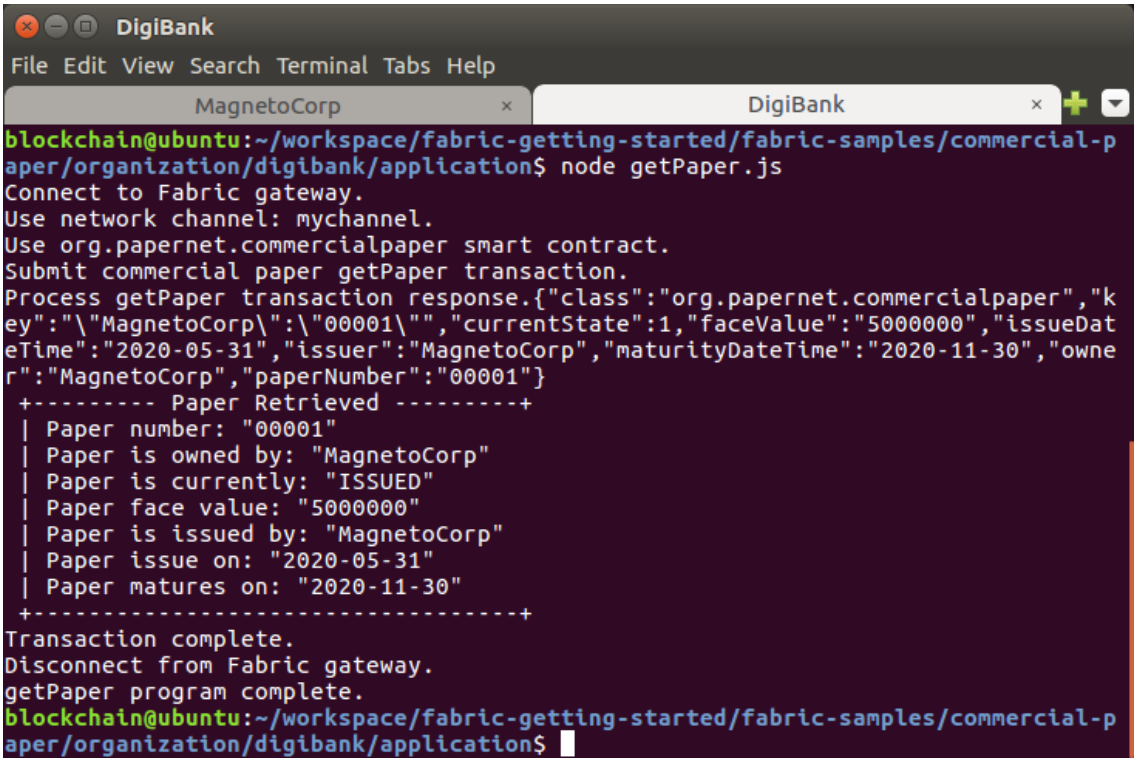
In addition in the output window you will see the paper **00001** data that has been returned:



However, this data is not very well formatted, so now we will use the DigiBank getPaper.js command line application which better formats the response.

__ **77.** Now switch back to **DigiBank**'s terminal window and run the **getPaper** command again as you did earlier in this lab:

```
node getPaper.js
```



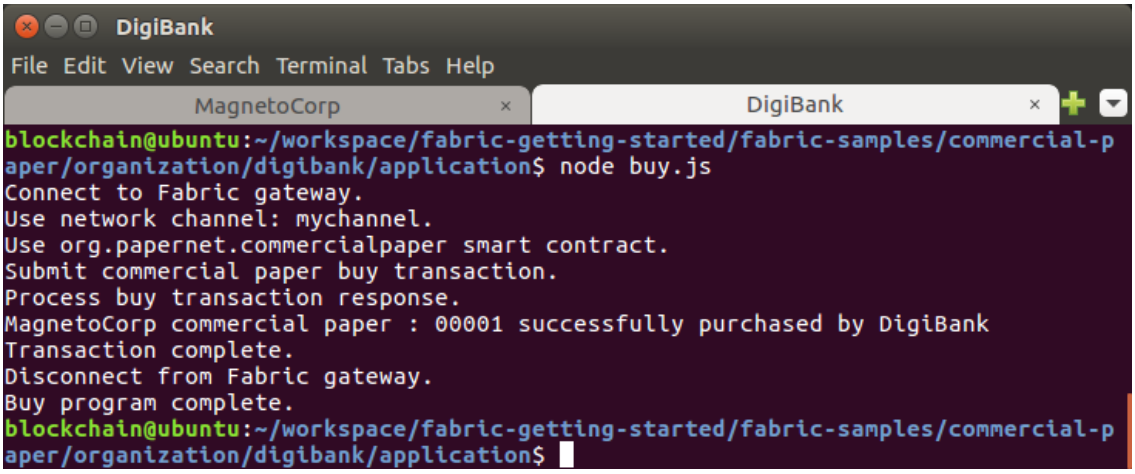
This time we can see that the transaction was run successfully and we can see that the paper **00001** was successfully retrieved and that its state is currently **ISSUED**.

Now **Balaji** is ready to buy the paper.

2.5 Running the Buy and Redeem transactions as DigiBank

__ **78.** In the same **DigiBank** terminal, run the **buy** application:

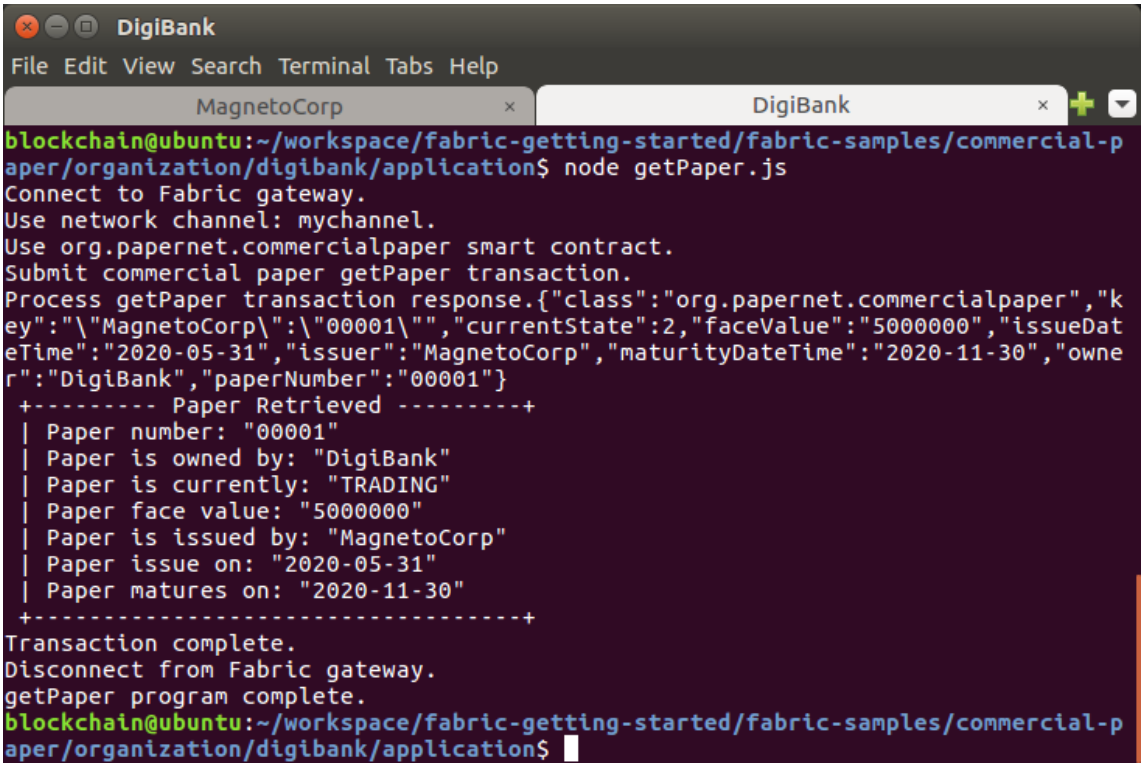
```
node buy.js
```



As you can see the transaction went through successfully, and paper **0001** is now owned by DigiBank.

__ **79.** In the same terminal, let's run **getPaper** again to see the current state of the paper and observe the changes made:

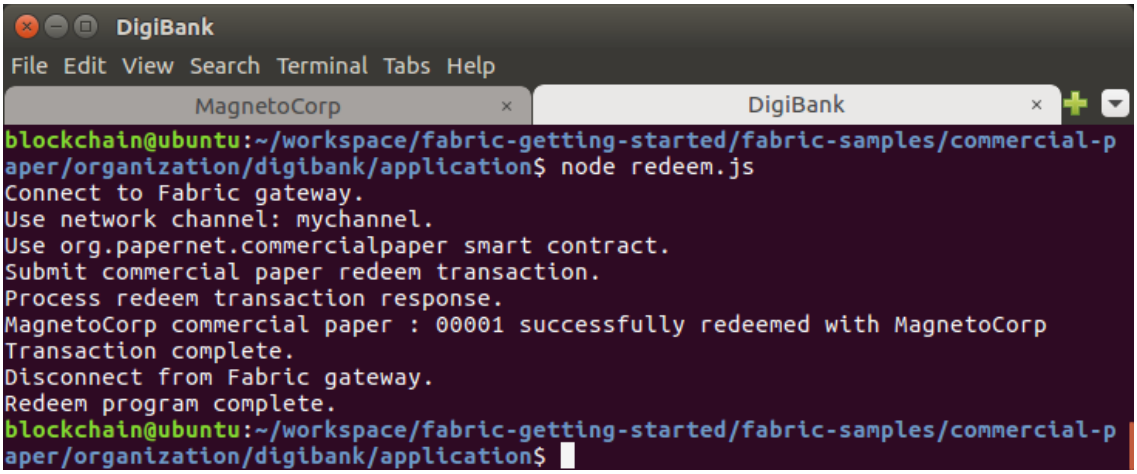
```
node getPaper.js
```



Now we can see that the paper indeed owned by **DigiBank** and that the state of the paper is currently **TRADING**. It is still clear that the paper was issued by **MagnetoCorp** though.

__ **80.** Next, let's assume that the maturity date has been reached and **DigiBank** wants to redeem the paper. Also in the DigiBank terminal, let's run the redeem application as Balaji:

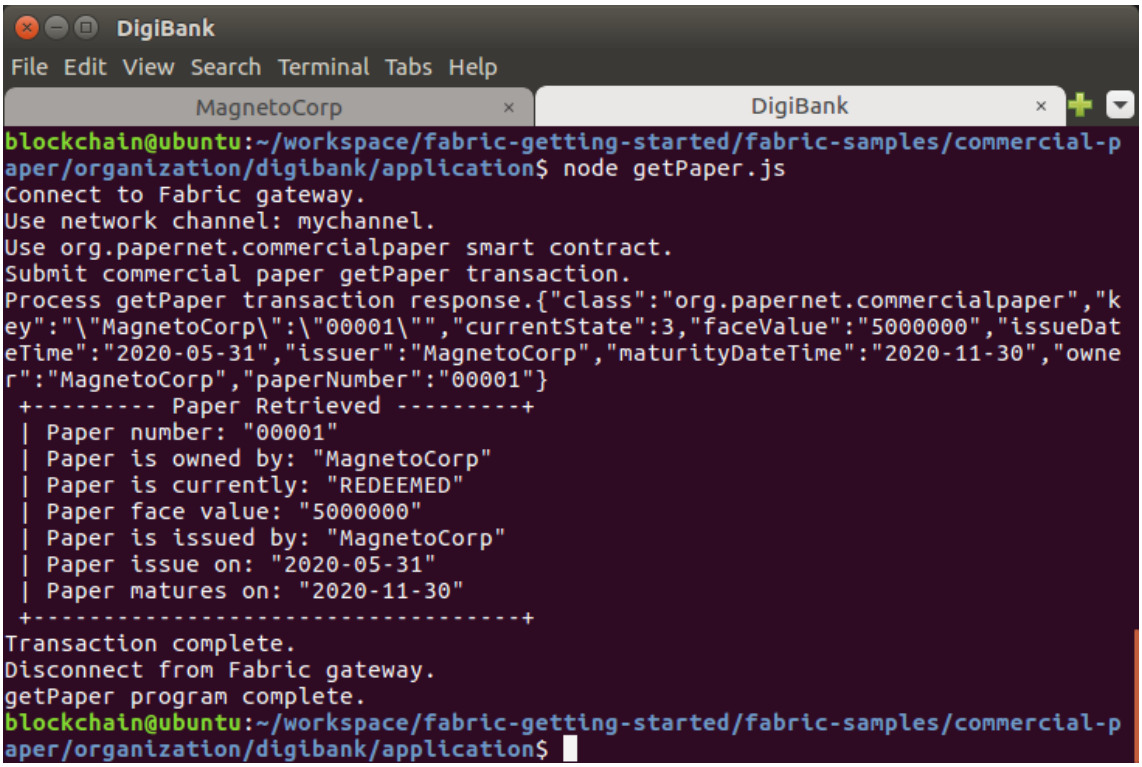
```
node redeem.js
```



Again the transaction has run smoothly, and the paper was redeemed with MagnetoCorp.

__ **81.** Let's run **getPaper** one more time to see the final state of the paper and observe the changes made:

```
node getPaper.js
```



As you can see, the paper is now in **REDEEMED** state, and is now owned by **MagnetoCorp** again.

Now we have most things working, let's issue a new commercial paper, but this time we will go through the steps a little faster.

2.6 Issuing another paper as MagnetoCorp

__ **82.** Switch to the **MagnetoCorp** terminal tab and open the issue application in VS Code so we can edit it for a new paper:

```
code issue.js
```

Edit the **submitTransaction** call on **line 68** so we can see some differences from the previous one. Use **00002** for the paper number to match the rest of this lab. A valid set of options would be:

```
'issue','MagnetoCorp','00002','2020-07-31','2020-12-31','6000000'
```

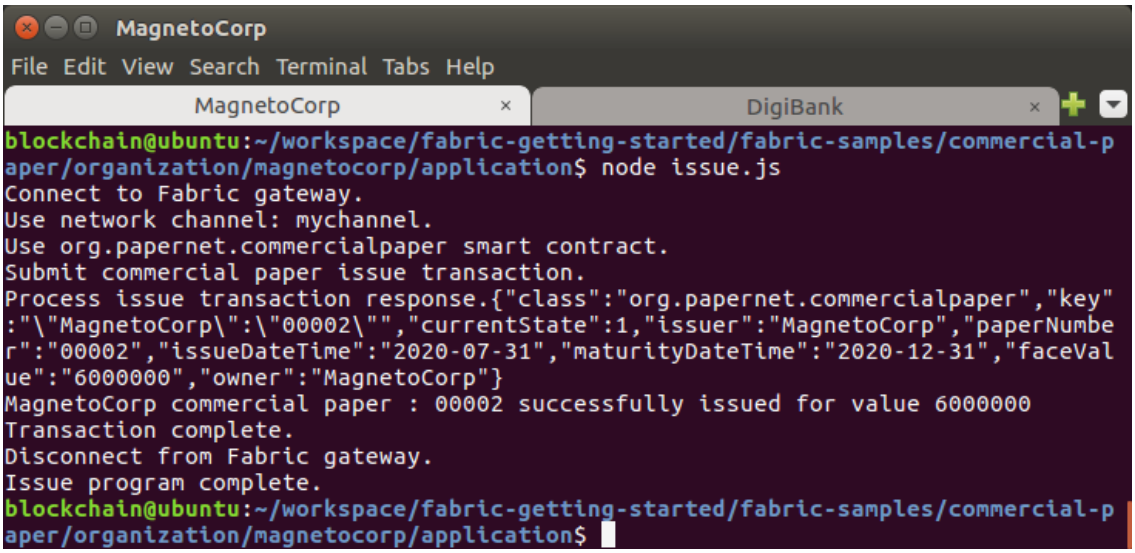
These will issue paper **00002** at a face value of **6,000,000** USD.

__ **83.** Make sure you save the changes, using the **File / Save** option or press **ctrl + s**

__ **84.** Back in the **MagnetoCorp** terminal, run the **issue** command again:

```
node issue.js
```

If you edited the file correctly, the transaction will go through and you can see the new paper was issued matching the new details:



2.7 Buying another paper as DigiBank

__ **85.** Switch back to **DigiBank's** terminal tab and open the **getPaper** application in VS Code so we can edit it to retrieve the new paper:

```
code getPaper.js
```

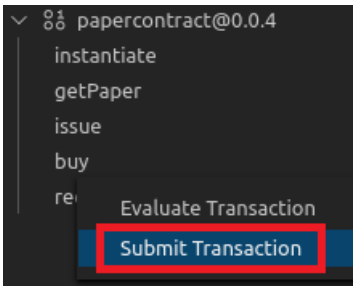
Edit the **evaluateTransaction** call on **line 67** so that it retrieves paper **00002**.

__ **86.** Make sure you save the changes to **getPaper.js**, using the **File / Save** option or press **ctrl + s**

__ **87.** Run the **getPaper** application so you can confirm that paper **00002** is correct before we buy it:

```
node getPaper.js
```

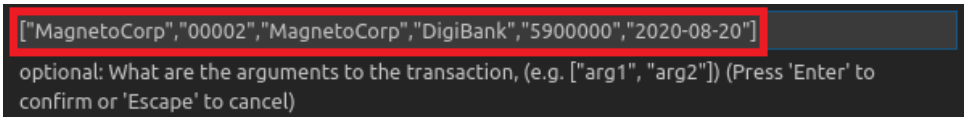
__ **88.** This time we will issue the **buy** transaction from VS Code for a change. Right click on the **buy** transaction for the contract in the gateway and choose **Submit Transaction**:



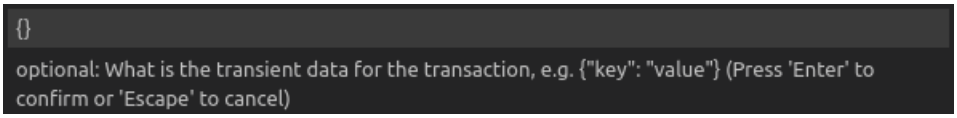
__ **89.** In the pop up at the top of the screen enter the arguments:

```
"MagnetoCorp","00002","MagnetoCorp","DigiBank","5900000","2020-08-20"
```

and press "Enter". Make sure you enter the quotes around the strings, but do not add any extra spaces as otherwise they will be taken as part of the string itself which will result in an error.



__ **90.** In the next optional pop up, just press enter as we have no transient data:



When the transaction has finished , if you have entered everything correctly you will see a **success** message in the OUTPUT window, along with the **information message**:

Note: If instead you get an error, you may have entered the string incorrectly. Please check for an error and try this step again.

__ **91.** Once the transaction has been successfully submitted, back in the **DigiBank** terminal window, enter **node getPaper.js** again the see the resulting changes to the paper. You should see that it is now owned by **DigiBank** as expected and the status is **TRADING** rather than **ISSUED**.

__ **92.** Lastly, repeat the above four steps, but this time call the **redeem** transaction, passing the parameters instead:

```
"MagnetoCorp","00002","DigiBank","2022-12-31"
```

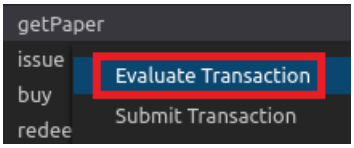
Once the **redeem** transaction has been submitted, check that the paper has been updated correctly again by running **node getpaper.js** again.

2.8 Looking at Errors

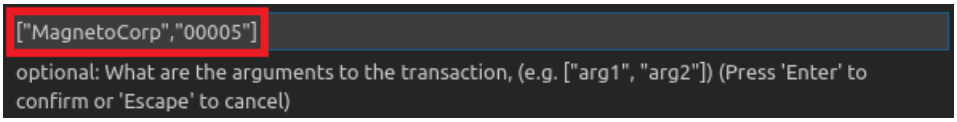
__ **93.** As a final part of this lab, we will look at how errors are reported back in VS Code. Open the code for the **getPaper** transaction in the **papercontract.js** file. We can see that if there is an error, such as a paper not being found, it throws an **Error** exception back to the caller:

```
async getPaper(ctx, issuer, paperNumber) {
    try {
        console.log('getPaper for: ' + issuer + ' ' + paperNumber);

        let paperKey = CommercialPaper.makeKey([issuer, paperNumber]);
        let paper = await ctx.paperList.getPaper(paperKey);
        return paper;

    } catch (e) {
        throw new Error('Paper: ' + paperNumber + ' absent for ' + issuer);
    }
}
```

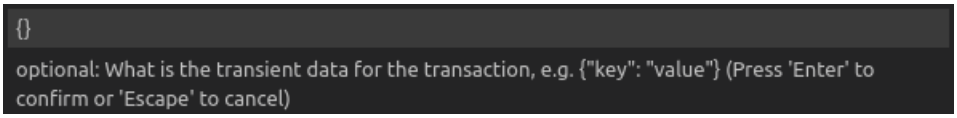
__ **94.** Let's give this a try. Right click on the **getPaper** transaction and choose **Evaluate Transaction**:



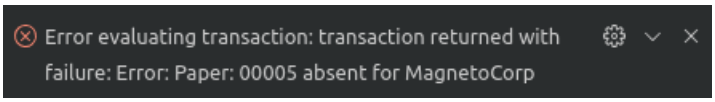
__ **95.** In the pop up at the top of the screen enter **`"MagnetoCorp","00005"`** inside the array square brackets [ ], which is a paper number that we have not created in this lab and so should not exist. Make sure you include the **`""`** marks around each parameter.



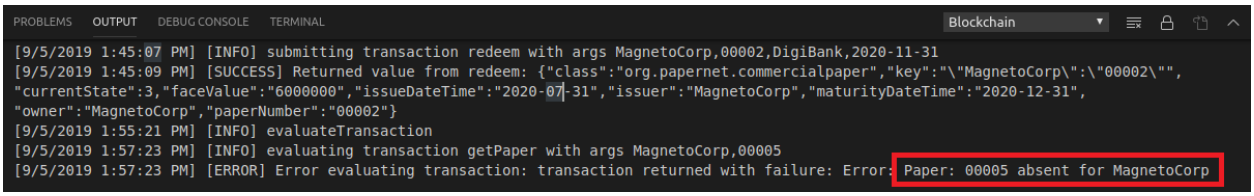
__ **96.** In the next optional pop up, just press enter as we have no transient data:



If you have entered everything correctly, this time you will see the expected failure **information message** reporting the error:



This shows that the contents of the exception thrown in the **getPaper** transaction has been reported to the user in the **information message**. You can also see this message in the blockchain **Output Window** as well:



The error message is also reported in a more raw form from the getPaper.js application in the DigiBank terminal window. To see this, we need to edit the getPaper.js file again.

__ **97.** From the DigiBank terminal window, enter:

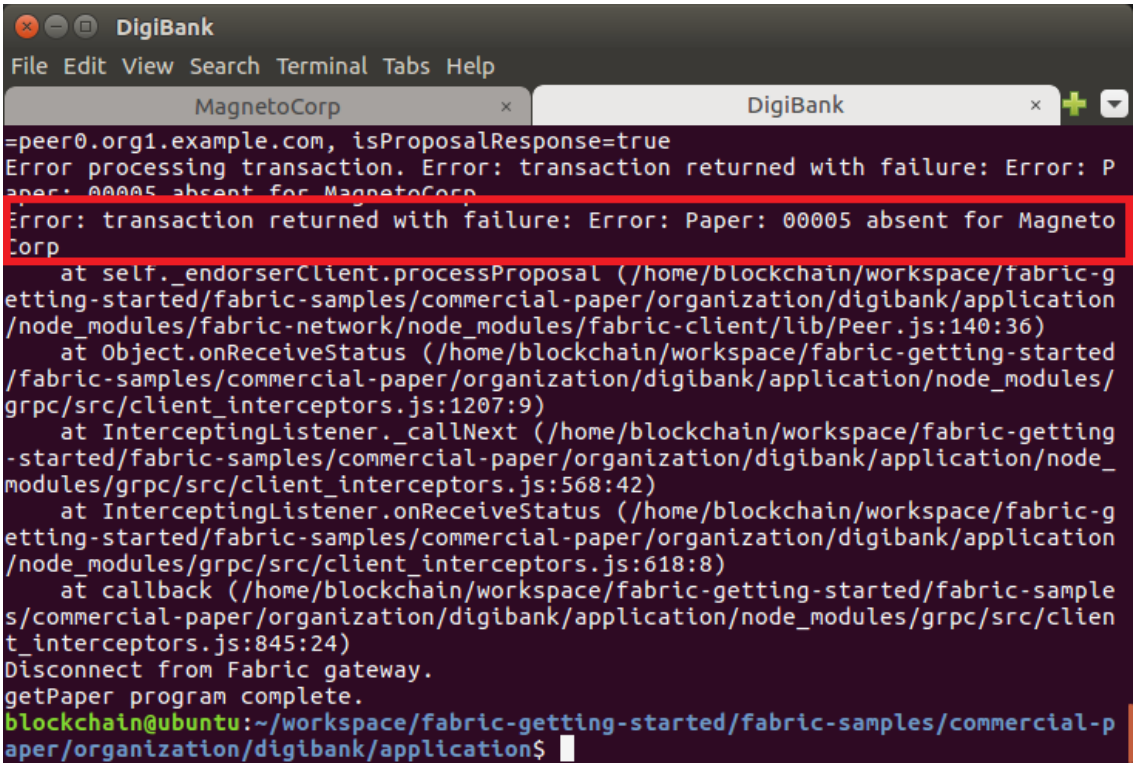
```
code getPaper.js
```

Edit the **evaluateTransaction** call on **line 67** so that it retrieves paper **00005**.

__ **98.** Make sure you save the changes to **getPaper.js**, using the **File / Save** option or press **ctrl + s**

__ **99.** Run the **getPaper** application one more time so you can see the error generated:

```
node getPaper.js
```



Although we can see the error, we also see the more detailed stack trace leading up to the error in the client.

__ **100.** We have now completed part three of this lab **– Connecting to an Existing Network** and we hope you enjoyed it. If you have any time remaining, please feel free to experiment further on your own, maybe changing one of the command line applications or even changing and upgrading the contract itself again.

3 We Value Your Feedback!

- Please ask your instructor for an evaluation form. Your feedback is very important to us as we use it to continually improve the lab material.

- If no forms are available, or you want to give us extra information after the lab has finished, please send your comments and feedback to "**blockchain@uk.ibm.com**"

4 Running the lab on your own machine:

The following Appendixes list the files and changes needed to run this lab outside of the VM provided so you can try the exercises in your own environment.

Appendix 1 The networkConnection.json file:

This file should be placed into the following folder:
"**fabric-samples/commercial-paper/organization/digibank/gateway**".

```
[
  {
    "name": "peer0.org1.example.com",
    "api_url": "grpc://localhost:7051",
    "type": "fabric-peer",
    "msp_id": "Org1MSP"
  },
  {
    "name": "orderer.example.com",
    "api_url": "grpc://localhost:7050",
    "type": "fabric-orderer",
    "msp_id": "OrdererMSP"
  }
]
```

Appendix 2 The getPaper.js file:

This file should be placed into the following folder:
"**fabric-samples/commercial-paper/organization/digibank/application**".

```
/*
SPDX-License-Identifier: Apache-2.0
*/

/*
 * This application has 6 basic steps:
 * 1. Select an identity from a wallet
```

```
 * 2. Connect to network gateway
 * 3. Access PaperNet network
 * 4. Construct request to query a commercial paper
 * 5. Submit transaction
 * 6. Process response
 */

'use strict';

// Bring key classes into scope, most importantly Fabric SDK network class
const fs = require('fs');
const yaml = require('js-yaml');
const { FileSystemWallet, Gateway } = require('fabric-network');
const CommercialPaper = require('../contract/lib/paper.js');

// A wallet stores a collection of identities for use
const wallet = new FileSystemWallet('../identity/user/balaji/wallet');

// Main program function
async function main() {

  // A gateway defines the peers used to access Fabric networks
  const gateway = new Gateway();

  // Main try/catch block
  try {

    // Specify userName for network access
    // const userName = 'isabella.issuer@magnetocorp.com';
    const userName = 'Admin@org1.example.com';

    // Load connection profile; will be used to locate a gateway
    let connectionProfile =
yaml.safeLoad(fs.readFileSync('../gateway/networkConnection.yaml', 'utf8'));

    // Set connection options; identity and wallet
    let connectionOptions = {
      identity: userName,
      wallet: wallet,
      discovery: { enabled:false, asLocalhost: true }
    };

    // Connect to gateway using application specified parameters
```

```
    console.log('Connect to Fabric gateway.');

    await gateway.connect(connectionProfile, connectionOptions);

    // Access PaperNet network
    console.log('Use network channel: mychannel.');

    const network = await gateway.getNetwork('mychannel');

    // Get addressability to commercial paper contract
    console.log('Use org.papernet.commercialpaper smart contract.');

    const contract = await network.getContract('papercontract',
'org.papernet.commercialpaper');

    // get commercial paper
    console.log('Submit commercial paper getPaper transaction.');

    const getPaperResponse = await contract.evaluateTransaction('getPaper',
'MagnetoCorp', '00001');

    // process response
    console.log('Process getPaper transaction response.');

    let paper = CommercialPaper.fromBuffer(getPaperResponse);
    let paperState = "Unknown";
    if(paper.isIssued()) {
      paperState = "ISSUED";
    } else if(paper.isTrading()){
      paperState = "TRADING";
    } else if(paper.isRedeemed()){
      paperState = "REDEEMED";
    }

    console.log(` +--------- Paper Retrieved ---------+ `);
    console.log(` | Paper number: "${paper.paperNumber}"`);
    console.log(` | Paper is owned by: "${paper.owner}"`);
    console.log(` | Paper is currently: "${paperState}"`);
    console.log(` | Paper face value: "${paper.faceValue}"`);
    console.log(` | Paper is issued by: "${paper.issuer}"`);
    console.log(` | Paper issue on: "${paper.issueDateTime}"`);
    console.log(` | Paper matures on: "${paper.maturityDateTime}"`);
    console.log(` +----------------------------------+ `);
```

```
    console.log('Transaction complete.');
    //console.log('Transaction complete.' + JSON.stringify(paper));

  } catch (error) {

    console.log(`Error processing transaction. ${error}`);
    console.log(error.stack);

  } finally {

    // Disconnect from the gateway
    console.log('Disconnect from Fabric gateway.')
    gateway.disconnect();

  }
}
main().then(() => {

  console.log('getPaper program complete.');

}).catch((e) => {

  console.log('getPaper program exception.');
  console.log(e);
  console.log(e.stack);
  process.exit(-1);

});
```

Appendix 3 The fabric-samples\basic-network\docker-compose.yml file

This file has been edited in this lab to enable discovery which is required for VS Code to connect to a remote environment. The following line should be added to the environment section for the peer0.org1.example.com:

```
CORE_PEER_GOSSIP_EXTERNALENDPOINT=peer0.org1.example.com:7051
```