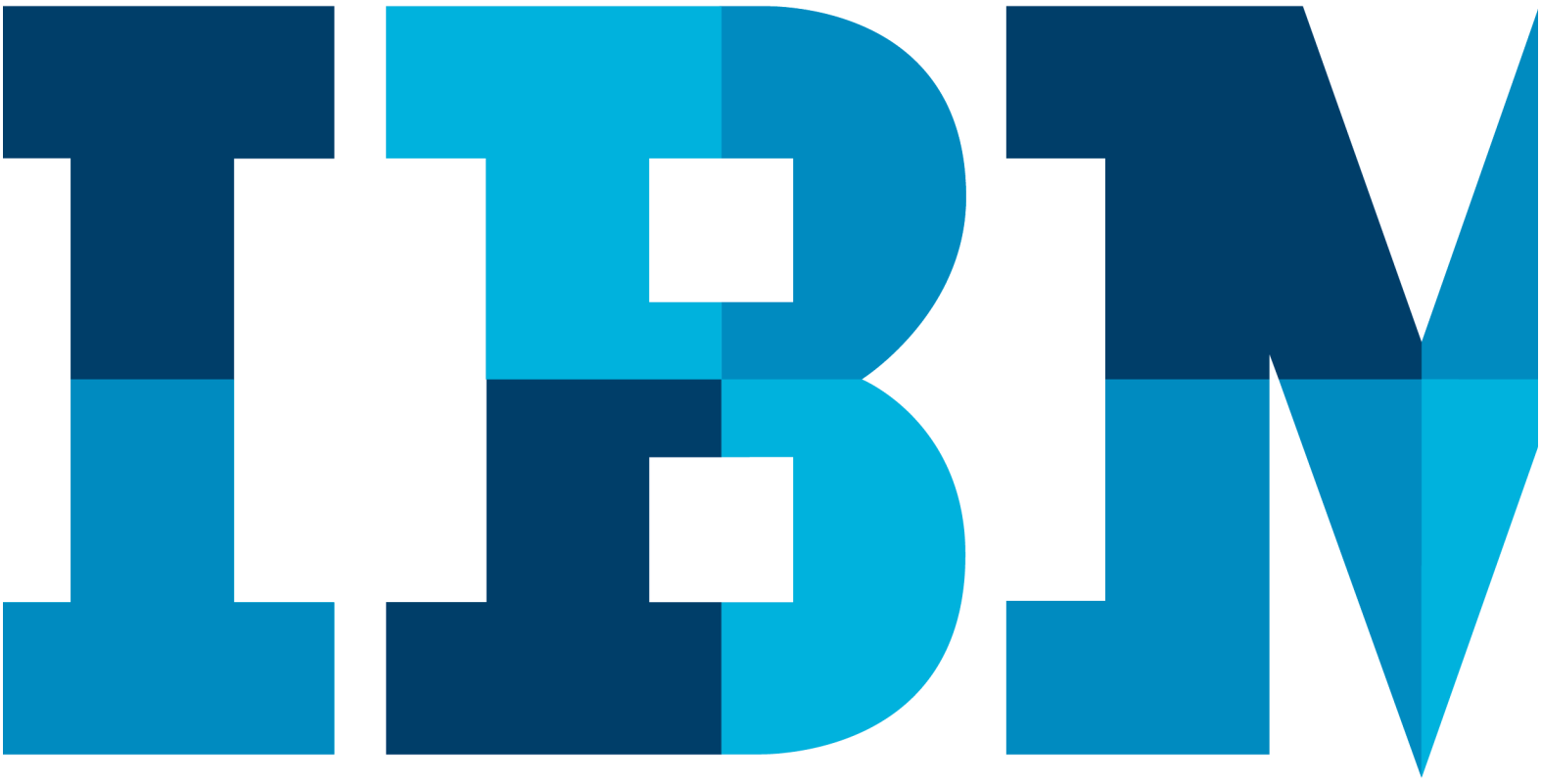
IBM Blockchain Hands-On
Fabric Node.js SDK (HFC)

Lab Two



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Contents

Overview

The aim of this lab is to get you writing some basic applications with the Fabric SDK. This will be done by replacing sections of the balance-transfer demo to illustrate the key features of HFC.

More information can be found here: https://fabric-sdk-node.github.io/tutorial-index_.html

Introduction

Pre-requisites:

- 4 cores
- 4GB RAM
- VMWare V10+
- The lab virtual machine

The virtual machine is based on Linux Ubuntu 16.04 and contains Hyperledger Fabric V1.0, Golang, Git, Visual Studio Code and Firefox.

A network needs to be visible to the virtual machine (even if the network is just to the host environment). If you do not see the up/down arrows in the status bar at the top of the screen, or if you receive errors about no network being available, please tell the lab leader. The virtual machine might need to be reconfigured in NAT mode.

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 the without a lab virtual machine if Hyperledger Fabric and the other pre-requisites have been installed.

It is recommended that students have previously completed the Blockchain Explained and Blockchain Explored labs.

Section 1. Setup & Overview of Structure

1.1. Setting up

a. Make a new folder

Navigate to `~/workspace/hfc-getting-started/examples/balance-transfer` and create a new folder called `workshop`.

b. Copy over dependencies

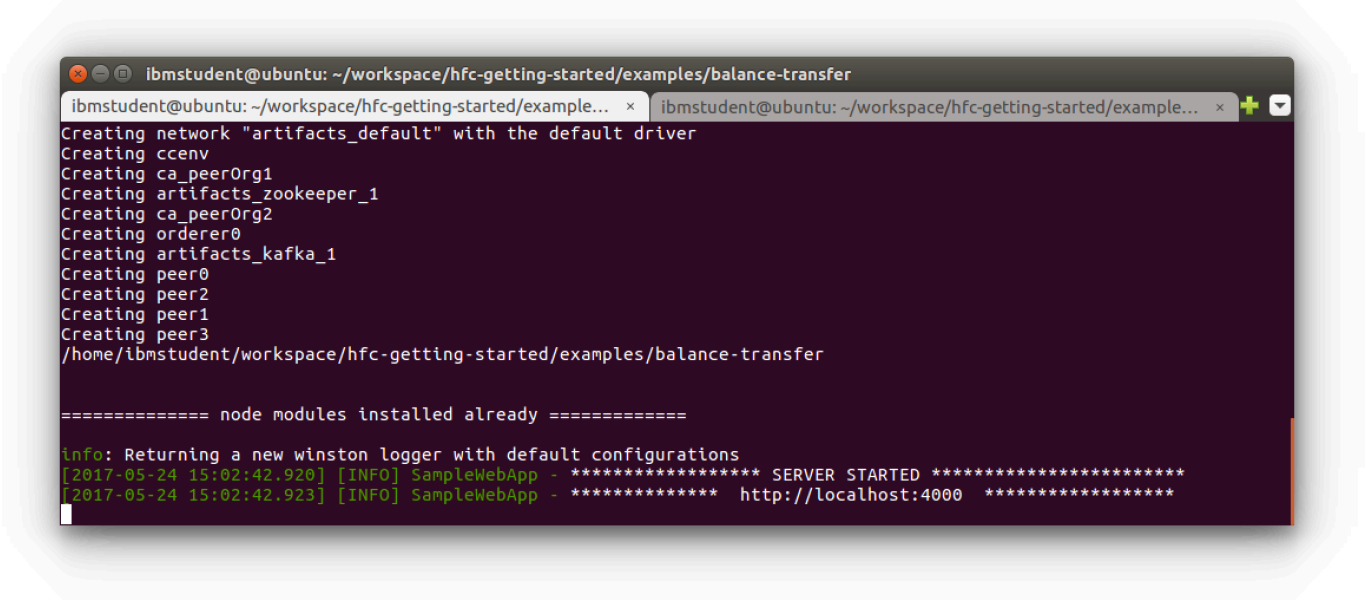
Copy `helper.js` and `network-config.json` from `balance-transfer/app` into this new directory.

c. Run the app

Navigate back into balance transfer and open up a terminal window with two tabs. Execute the following in one:

```
./runApp.sh
```

When you see the following output:



Run the following in the other tab:

```
./testAPIs.sh
```

This will execute balance transfer's code which will set up a network, create some channels, deploy some chaincode to it and then transact with this chaincode.

d. Structure of Balance Transfer

The code for each of the steps in balance transfer is contained within a suitably titled file (install-chaincode, invoke-transaction etc.) in `balance-transfer/app`.

Over the course of this lab we will be replacing these files with our own versions that perform the same tasks.

Section 2. Channels

3.1. Create Channel

a. Make a new file

Create a new file called `create-channel.js` in `balance-transfer/workshop` and insert the following:

```
var fs = require('fs');
var path = require('path');
var helper = require('./helper.js');
var logger = helper.getLogger('Create-Channel');

var createChannel = function(channelName, channelConfigPath, username, orgName) {
};

exports.createChannel = createChannel;
```

Each of the files in app defines a function like the one above that interacts with the chaincode in some way. We will be defining new versions of these functions.

b. Set up the network

Add the following in the body of the function:

```
logger.debug('\n\n====== Creating Channel \'' + channelName + '\' ======\n');

helper.setupOrderer();
var chain = helper.getChainForOrg(orgName);
```

The ‘helper’ module is used in balance-transfer for setting up details such as the addresses of orderers and peers. To save time we will also be making use of it. ‘setupOrderer’ scans the config file for the url of the ordering service and adds it to the client object for broadcasting to, please inspect the contents of helper.js and search for the function for the specific implementation details.

The getChainForOrg function returns the chain object for the current organisation. While channels are cross-organisation, orderers do belong to an organisation and as such we need to create the channel on an orderer that is owned by the organisation the nominated user belongs to.

c. Get the User context.

All transactions need to be signed by a user with appropriate privileges. As such the function requires a user be specified to do this signing.

The signing will be done by the Fabric Client automatically however to do this in the first place we need to check that a user context exists, again the helper function handily does this for us. Add the following below the code in **b**.

```
return helper.getRegisteredUsers(username, orgName).then((member) => {

});
```

`getRegisteredUsers` checks if there exists a User Context, if so it returns the User object representing said user. If there isn't it contacts the CA and downloads the certificate for the user, storing it in the KeyStore and setting the user as the current context. Again, please examine `helper.js` for further implementation details.

d. Send the create channel request

In the body of the `getRegisteredUsers` callback add the following:

```
var request = {
      envelope: fs.readFileSync(path.join(__dirname, channelConfigPath))
};

return chain.createChannel(request);
```

The `channelConfigPath` is passed in through the augments and is the path to `mychannel.tx`, the settings for the channel. This is packaged into a request object and passed into `createChannel` which creates a transaction, signs it with the User context and sends it to the network.

e. Respond to the outcome

Chain a `.then()` to the end of the `helper.getRegisteredUsers` promise like so:

```
return helper.getRegisteredUsers(username, orgName).then((member) => {

      var request = {
            envelope: fs.readFileSync(path.join(__dirname, channelConfigPath))
      };

      return chain.createChannel(request);

}).then((createChannelResults) => {

});
```

In the body of the new `.then()` add the following:

```
let response = {};

if (createChannelResults && createChannelResults.status === 'SUCCESS') {
    let msg = 'Channel \'' + channelName + '\' created Successfully';
    response.message = msg;
    response.success = true;
    logger.debug(msg);
} else {
```

```
    let msg = '\n!!!!!!!!! Failed to create the channel \'' + channelName +
'\' !!!!!!!!!\n\n';
    response.message = msg;
    response.success = false;
    logger.error(msg);
    throw new Error(msg);
}

return response;
```

This will output a Success or Failure message (both as a log and as a REST reply) in response to whether the channel creation has succeeded.

f. Creating a test script

To test individual scripts we are running we'll need a new test script. Create a new file in `balance-transfer` called `testWorkshop.sh`. Add the following to the new file:

```
#!/bin/bash

set -ev

jq --version > /dev/null 2>&1
if [ $? -ne 0 ]; then
     echo "Please Install 'jq' https://stedolan.github.io/jq/ to execute this
script"
     echo
     exit 1
fi
starttime=$(date +%s)


echo "POST request Enroll on Org1  ..."
echo
ORG1_TOKEN=$(curl -s -X POST \
  http://localhost:4000/users \
  -H "cache-control: no-cache" \
  -H "content-type: application/x-www-form-urlencoded" \
  -d 'username=Jim&orgName=org1')
echo $ORG1_TOKEN
ORG1_TOKEN=$(echo $ORG1_TOKEN | jq ".token" | sed "s/\"//g")
echo
echo "ORG1 token is $ORG1_TOKEN"
echo


echo "POST request Create channel  ..."
echo
curl -s -X POST \
  http://localhost:4000/channels \
  -H "authorization: Bearer $ORG1_TOKEN" \
  -H "cache-control: no-cache" \
```

```
  -H "content-type: application/json" \
  -H "x-access-token: $ORG1_TOKEN" \
  -d '{
     "channelName":"mychannel",
     "channelConfigPath":"../artifacts/channel/mychannel.tx"
}'
echo
echo
sleep 5
```

runApp.sh stands up a REST server with app.js routing requests to the files mentioned in 1.1(d). This script makes calls to the rest server, first ensuring that the credentials have been set up correctly and then calling the create channel endpoint.

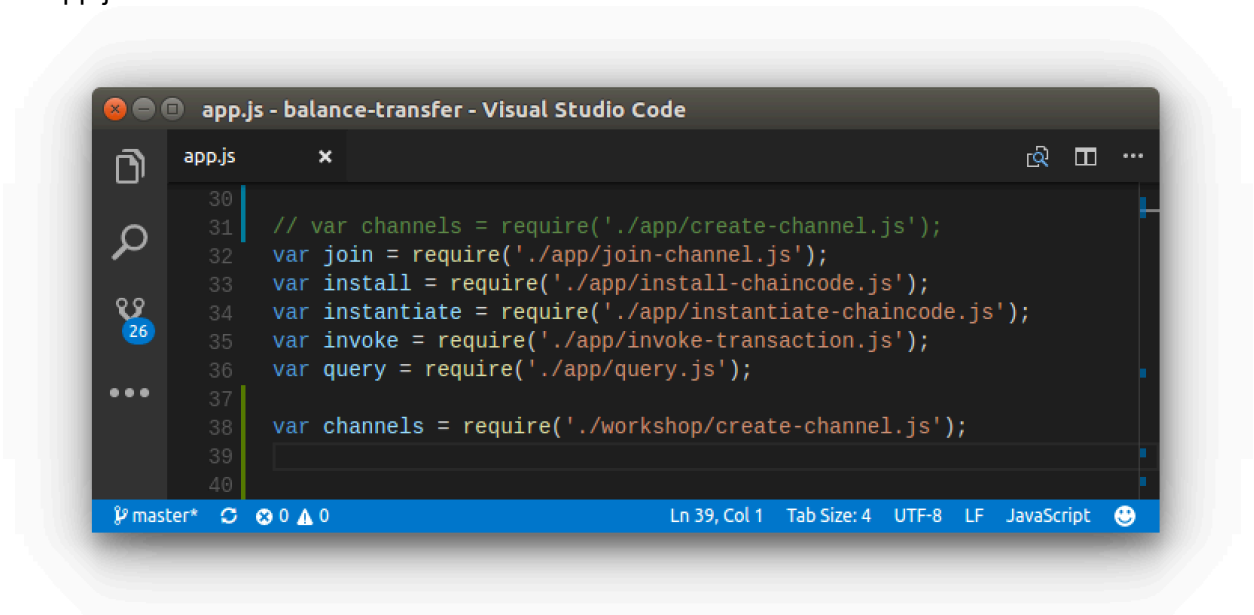
Issue the following to make testWorkshop.sh executable:

```
chmod +x testWorkshop.sh
```

Currently, this will be routed to the default file. We shall now change this.

g. Edit app.js

Open app.js in Visual Studio Code:



Comment out the line importing app/create-channel and add a new one below importing the file we have just created:

```
var channels = require('./workshop/create-channel.js');
```

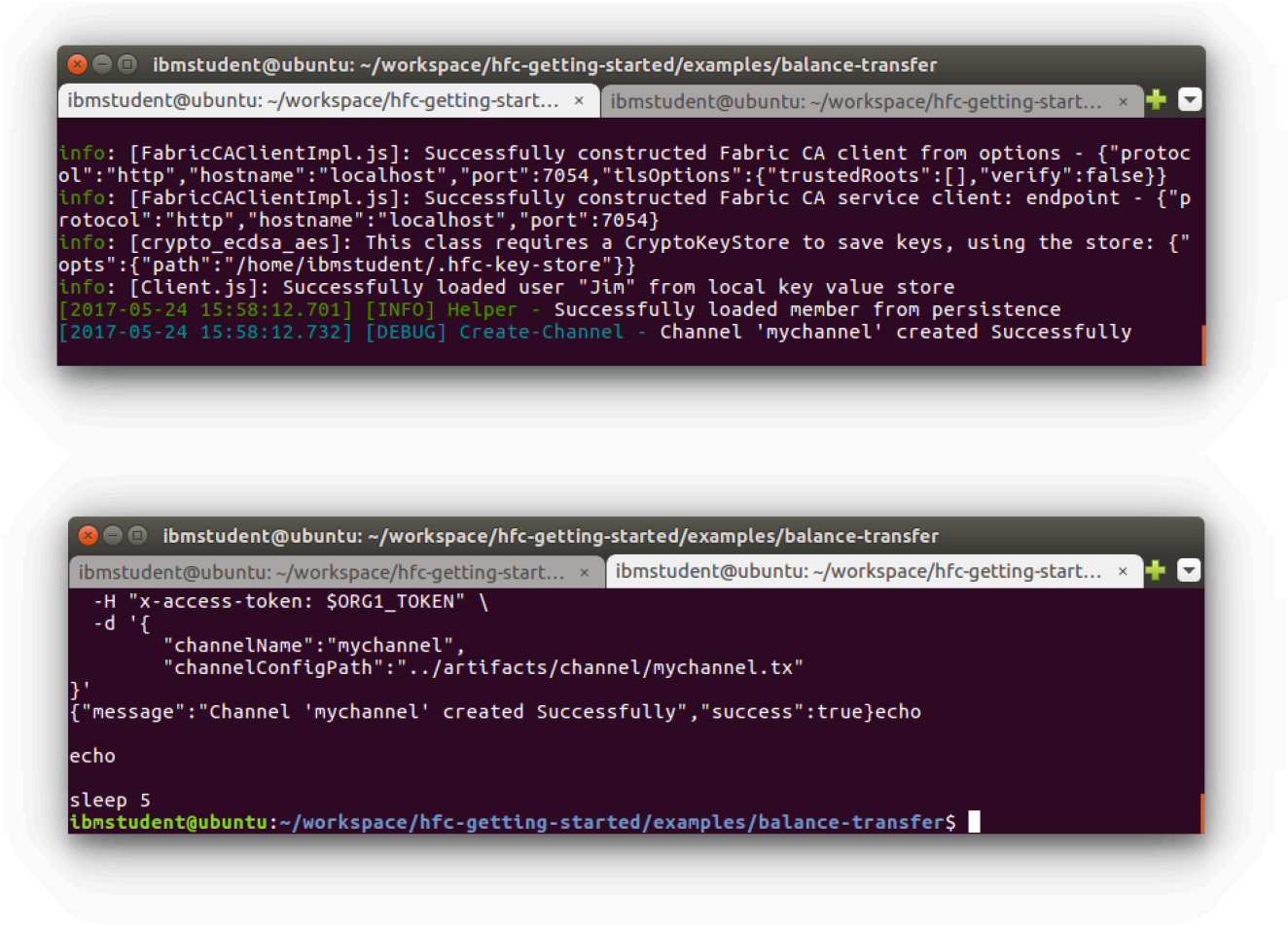
h. Run the test script

Restart the network by using `./runApp.sh`, wait until the same text shown in 1.1 appears.

When this is the case, switch to the other tab and issue the following:

```
./testWorkshop.sh
```

You should get output similar to the following:



3.2. Join Channel

a. Make a new file

Create a new file in workshop called join-channel.js, insert the following code:

```
var util = require('util');
var helper = require('./helper.js');
var logger = helper.getLogger('Join-Channel');

var joinChannel = function(channelName, peers, username, org) {
});

exports.joinChannel = joinChannel;
```

b. Set up the network

Add the following code inside the `joinChannel` body:

```
helper.setupOrderer();
var chain = helper.getChainForOrg(org);
var targets = helper.getTargets(peers, org);
```

In addition to the same code as last time we also have `getTargets.` The join channel request will go out to multiple peers concurrently. Unlike where there is a single ordering service we need a list of the 'targets' to issue the transaction request. The `getTargets` function gathers this for us while it is registering the peers with the client. See helper.js for implementation details.

c. Get the User Context

Use the same code as last time for this, added below the network setup code:

```
return helper.getRegisteredUsers(username, org).then((user) => {
});
```

d. Send the join channel command

Add the following code to the body of the `getRegisteredUsers` callback to issue the `joinNetwork` request:

```
        nonce = helper.getNonce();
        tx_id = chain.buildTransactionID(nonce, user);

        var request = {
              targets: targets,
              txId: tx_id,
              nonce: nonce
        };

    return chain.joinChannel(request);
```

The new parts of this code are the `nonce` and the `tx_id`. Transaction IDs must be generated by you – fortunately HFC makes ready some tools to easily do this (namely an inbuilt function in chain).]

The `nonce` is a random integer of predetermined length that is combined with details about the `user` in `buildTransactionID` forms a pseudorandom transaction ID that can be used by the transaction.

e. Respond to the outcome

Attach a new then to the end of the `getRegisteredUsers` promise like in 2.1(e). Add the following code in the body of the new promise callback:

```
}).then((joinChannelResults) => {
```

```
// Check they were ok
let ok = joinChannelResults.length && true;
for(let i = 0; i < joinChannelResults.length; i++) {
    if(joinChannelResults[i].response.status !== 200) {
        ok = false;
    }
}

// Respond accordingly
let response = {};

if(ok) {
    let msg = util.format('Successfully joined peers in organization %s to the
channel \'%s\'', org, channelName);
    response.message = msg;
    response.success = true;
    logger.debug(msg);
} else {
    let msg = util.format('Failed to join peers in organization %s to the channel
\'%s\'', org, channelName);
    response.message = msg;
    response.success = false;
    logger.error(msg);
    throw new Error(msg);
}

return response;
```

This code iterates through the `joinChannelResults` looking for any bad replies. If it finds them it sets the `ok` flag to false which in turn triggers the output of error messages.

f. Add a new section to testWorkshop.sh

Add a new section to `testWorkshop.sh` after the existing code:

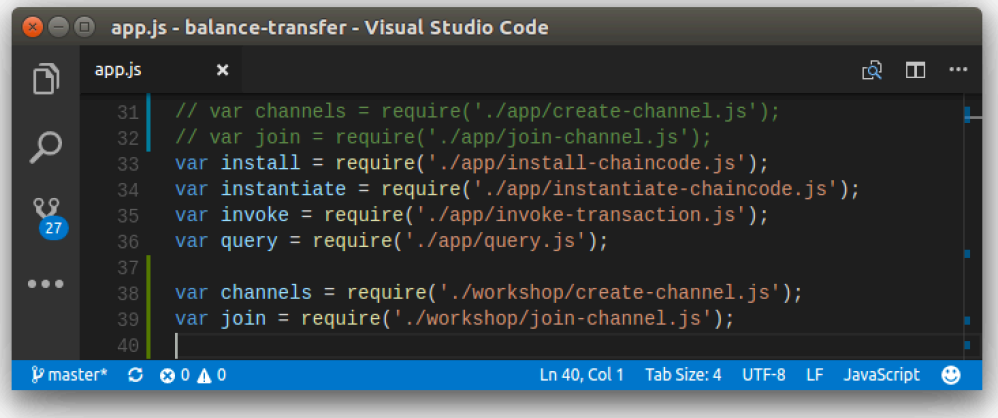
```
echo "POST request Join channel on Org1"
echo
curl -s -X POST \
  http://localhost:4000/channels/mychannel/peers \
  -H "authorization: Bearer $ORG1_TOKEN" \
  -H "cache-control: no-cache" \
  -H "content-type: application/json" \
  -H "x-access-token: $ORG1_TOKEN" \
  -d '{
      "peers": ["localhost:7051","localhost:7056"]
}'
echo
echo

sleep 5
```

g. Edit app.js

Comment out the import for the `join` library and add an entry for `join-channel.js`:

```
var join = require('./workshop/join-channel.js');
```

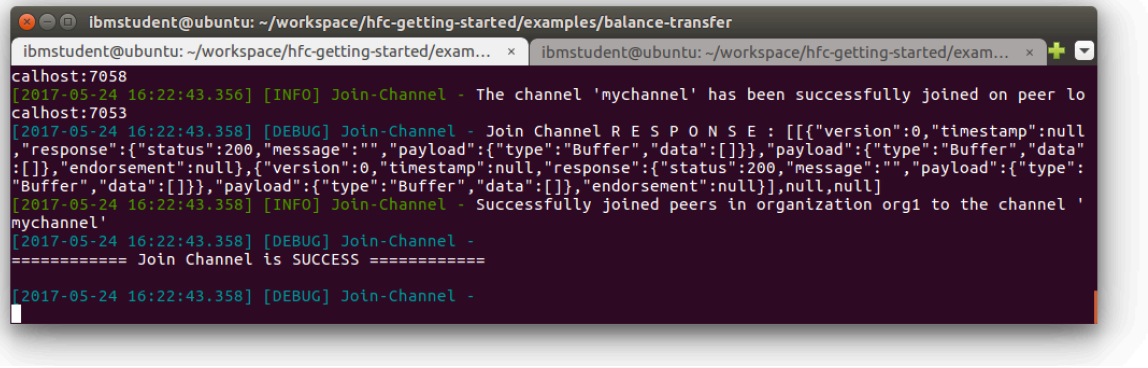


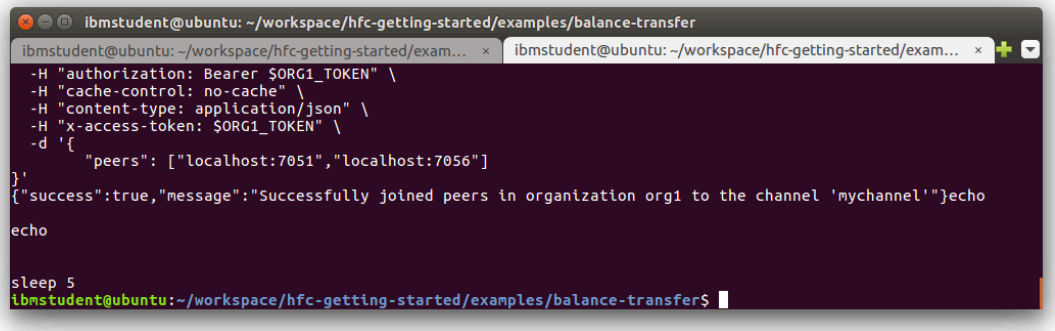
h. Run the Test script

Restart the network by using `./runApp.sh`, wait until the same text shown in 1.1 appears.

When this is the case, switch to the other tab and issue the following: `./testWorkshop.sh`

You should get output similar to the following:





Section 3. Chaincode

3.1. Installing Chaincode

a. Make a new file

Create a new file in `workshop` called `install-chaincode.js`, insert the following code into it:

```
const path = require('path');
const fs = require('fs');
const util = require('util');
const config = require('../config.json');
const helper = require('./helper.js');
const logger = helper.getLogger('install-chaincode');

var installChaincode = function(peers, chaincodeName, chaincodePath,
chaincodeVersion, username, org) {
});

exports.installChaincode = installChaincode;
```

b. Set up the network

Add the following code to the body:

```
helper.setupChaincodeDeploy();
let chain = helper.getChainForOrg(org);
helper.setupOrderer();
let targets = helper.getTargets(peers, org);
helper.setupPeers(chain, peers, targets);
```

This builds slightly on the `join-channel` setup code. The block begins with `setupChaincodeDeploy` which sets the GOPATH environment variable (for this process) to the location of the chaincode in, this being `hfc-getting-started/test/fixtures/src/github.com/example_cc`. The final line wires the peers together, registering the endpoint of each peer with the others.

c. Get the user context

Add the following under the setup code:

```
return helper.getRegisteredUsers(username, org).then((user) => {
});
```

d. Put together and send the install proposal

Add the following to the body of the `getRegisteredUsers` function:

```
let nonce = helper.getNonce();
let tx_id = chain.buildTransactionID(nonce, user);

let request = {
    targets: targets,
    chaincodePath: chaincodePath,
    chaincodeId: chaincodeName,
    chaincodeVersion: chaincodeVersion,
    txId: tx_id,
    nonce: nonce
};

// Send the install proposal (although it's really more of an order...)
logger.info('Sending Chaincode Install Proposal for ' + chaincodeName + '...');
return chain.sendInstallProposal(request);
```

As you can see, the same pattern has existed in the last 3 sections. A request object is built up containing a `nonce` and a `tx_id` accompanied by various data depending on what the function requires. If you inspect Lab 1 and look at the install/instantiate/channel functions you will notice that the request objects being built here map onto the arguments taken by those commands.

e. Respond to the outcome

Attach a new then to the end of the `getRegisteredUsers` promise like in 2.1(e). Add the following code in the body of the new promise callback:

```
}).then((results) => {

    // Decompose the responses
    let installChaincodeResults = results[0];

    // Check they were ok
    let ok = installChaincodeResults.length && true;
    for(let i = 0; i < installChaincodeResults.length; i++) {
        if(installChaincodeResults[i].response.status !== 200) {
            ok = false;
        }
    }

    // Respond accordingly
    let response = {};

    if(ok) {
        let msg = util.format('Successfully installed chaincode on peers in
organization %s', org);
        response.message = msg;
```

```
        response.success = true;
        logger.info(msg);
    } else {
        let msg = util.format('Failed to install chaincode on peers in
organization %s', org);
        response.message = msg;
        response.success = false;
        logger.info(msg);
        throw new Error(msg);
    }

    return response;
});
```

This code functions in an almost identical manner to that of the code which examines the join channel responses, save for the names of the variables it is inspecting and that the results obtained in a different manner. Responses to chaincode install requests contain a variety of data, one piece of which is the node responses.

f. Add a new section to testWorkshop.sh

Add a new section to `testWorkshop.sh` after the existing code:

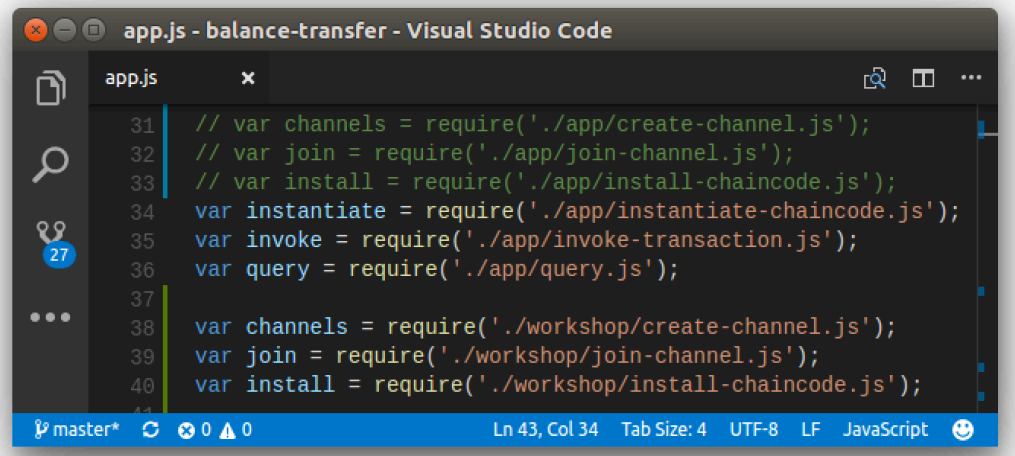
```
echo "POST Install chaincode on Org1"
echo
curl -s -X POST \
  http://localhost:4000/chaincodes \
  -H "authorization: Bearer $ORG1_TOKEN" \
  -H "cache-control: no-cache" \
  -H "content-type: application/json" \
  -H "x-access-token: $ORG1_TOKEN" \
  -d '{
      "peers": ["localhost:7051","localhost:7056"],
      "chaincodeName":"mycc",
      "chaincodePath":"github.com/example_cc",
      "chaincodeVersion":"v0"
}'
echo
echo

sleep 10
```

g. Edit app.js

Comment out the import for the `install` library and add an entry for `install-chaincode.js`:

```
var install = require('./workshop/install-chaincode.js');
```

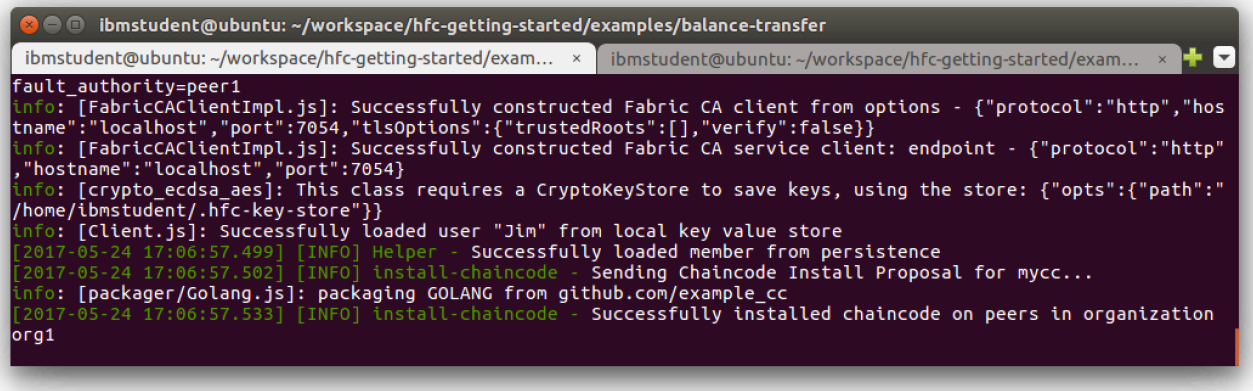


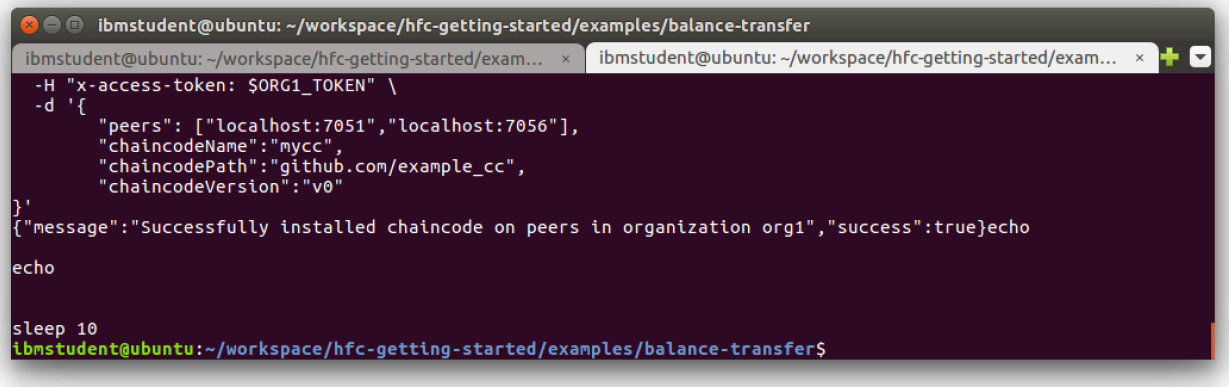
h. Run the Test script

Restart the network by using `./runApp.sh`, wait until the same text shown in 1.1 appears.

When this is the case, switch to the other tab and issue the following: `./testWorkshop.sh`

You should get output similar to the following:





3.1. Instantiating Chaincode

a. Make a new file

Create a new file in `workshop` called `instantiate-chaincode.js`, insert the following code into it:

```
var helper = require('./helper.js');
var logger = helper.getLogger('instantiate-chaincode');

var instantiateChaincode = function(peers, channelName, chaincodeName,
chaincodePath, chaincodeVersion, functionName, args, username, org) {
});

exports.instantiateChaincode = instantiateChaincode;
```

b. Set up the network

Add the following code to the body:

```
helper.setupChaincodeDeploy();
let chain = helper.getChainForOrg(org);
helper.setupOrderer();
let targets = helper.getTargets(peers, org);
helper.setupPeers(chain, peers, targets);
```

The code used for network setup when instantiating is identical to that used for installation.

c. Get the user context

Add the following under the setup code:

```
return helper.getRegisteredUsers(username, org).then((user) => {
});
```

d. Initialise the MSPs

Add the following code in the body of `getRegisteredUsers`:

```
member = user;

return chain.initialize();
```

The first line simply saves the user context object, we need to do this because of the second line – i.e. a new promise is started and as such we can't just use it locally.

The `chain.initialize()` function initialises the connections to the MSPs (CAs) that allow it to verify the signatures on any incoming transaction proposals related to this chaincode.

e. Send the instantiate proposal

Attach another `then()` on the end of the `getRegisteredUsers` promise chain:

```
}).then((success) => {
    nonce = helper.getNonce();
    tx_id = chain.buildTransactionID(nonce, member);

    var request = {
        targets: targets,
        chaincodePath: chaincodePath,
        chaincodeId: chaincodeName,
        chaincodeVersion: chaincodeVersion,
        fcn: functionName,
        args: args,
        chainId: channelName,
        txId: tx_id,
        nonce: nonce
    };

    return chain.sendInstantiateProposal(request);
});
```

The instantiate begins first with a proposal much like invoke transactions do, this contains the bulk of the information needed to instantiate the chaincode missing only the approval of the network to do so.

Remember that adding chaincode to a ledger is an equivalent action to adding data to a ledger, as such chaincode must adhere to the same submission protocol and as such can be rejected before it is formally made part of a channel.

f. Send the instantiate transaction

Attach another `then()` on the end of the `getRegisteredUsers` promise chain:

```
}).then((results) => {

    var proposalResponses = results[0];
    var proposal = results[1];
    var header = results[2];

    var request = {
        proposalResponses: proposalResponses,
        proposal: proposal,
        header: header
    };

    return chain.sendTransaction(request);

})
```

If the responses are acceptable (this is not checked here for code simplicity) then issue the instantiate transaction.

g. Respond to outcome

Add a final then() to the promise chain:

```
}).then((instantiateChaincodeResults) => {
    let response = {};

    if (instantiateChaincodeResults && instantiateChaincodeResults.status ===
'SUCCESS') {
        let msg = chaincodeName + ' instantiated successfully';
        response.message = msg;
        response.success = true;
        logger.debug(msg);
    } else {
        let msg = 'Failed to instantiate ' + chaincodeName;
        response.message = msg;
        response.success = false;
        logger.error(msg);
        throw new Error(msg);
    }

    return response;
});
```

Much the same as previous response callbacks this again inspects the response for markers that the operation was successful and if this is so, outputs appropriately.

h. Add a new section to testWorkshop.sh

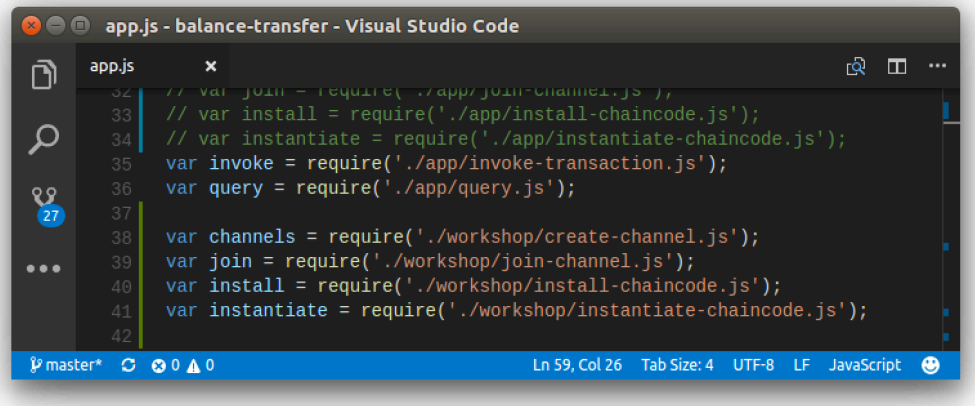
Add a new section to `testWorkshop.sh` after the existing code:

```
echo "POST instantiate chaincode on peer1 of Org1"
echo
curl -s -X POST \
  http://localhost:4000/channels/mychannel/chaincodes \
  -H "authorization: Bearer $ORG1_TOKEN" \
  -H "cache-control: no-cache" \
  -H "content-type: application/json" \
  -H "x-access-token: $ORG1_TOKEN" \
  -d '{
      "peers": ["localhost:7051"],
      "chaincodeName":"mycc",
      "chaincodePath":"github.com/example_cc",
      "chaincodeVersion":"v0",
      "functionName":"init",
      "args":["a","100","b","200"]
}'
echo
sleep 10
```

i. Edit app.js

Comment out the import for the `instantiate` library and add an entry for `instantiate-chaincode.js`:

```
var instantiate = require('./workshop/instantiate-chaincode.js');
```

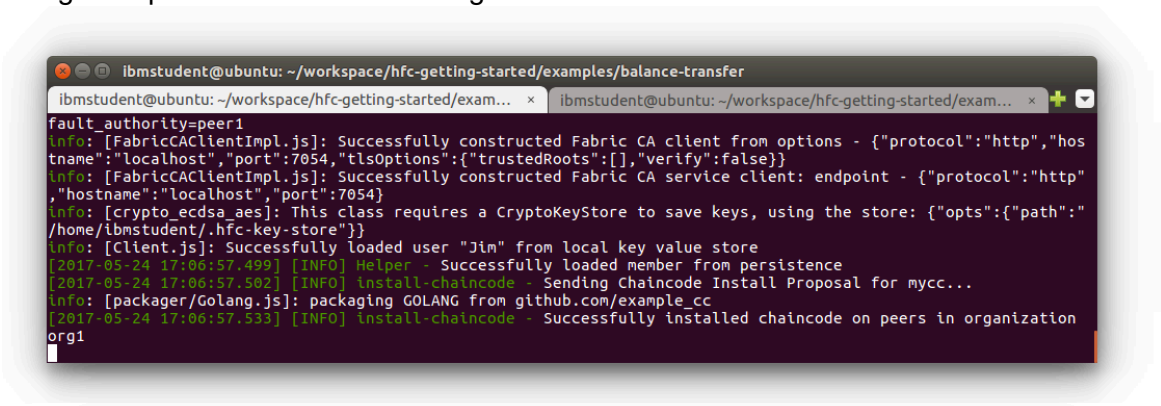


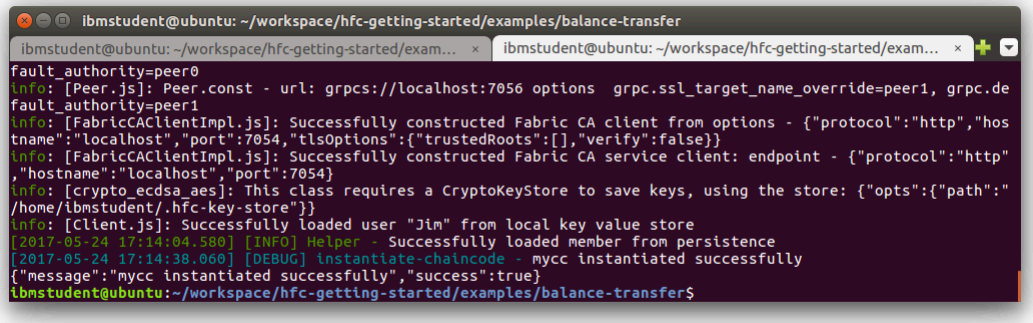
j. Run the Test script

Restart the network by using `./runApp.sh`, wait until the same text shown in 1.1 appears.

When this is the case, switch to the other tab and issue the following: `./testWorkshop.sh`

You should get output similar to the following:





Section 4. Transactions

4.1. Invocations

a. Make a new file

Create a new file in `workshop` called `invoke.js`, insert the following code into it:

```
var helper = require('./helper.js');
var hfc = require('fabric-client');
var logger = helper.getLogger('invoke-chaincode');

const invokeChaincode = function(peers, channelName, chaincodeName,
chaincodeVersion, args, username, org) {
});

exports.invokeChaincode = invokeChaincode;
```

b. Set up the network

Add the following code to the body:

```
    let chain = helper.getChainForOrg(org);
    helper.setupOrderer();
    let targets = helper.getTargets(peers, org);
    helper.setupPeers(chain, peers, targets);
```

c. Get the user context

Add the following under the setup code:

```
return helper.getRegisteredUsers(username, org).then((user) => {
});
```

d. Build the transaction proposal

Add the following under the user context code:

```
nonce = helper.getNonce();
tx_id = chain.buildTransactionID(nonce, user);

let request = {
    targets: targets,
    chaincodeId: chaincodeName,
    fcn: 'invoke',
    args: args,
```

```
    chainId: channelName,
    txId: tx_id,
    nonce: nonce
};

return chain.sendTransactionProposal(request);
```

As discussed in Blockchain Explored, the consensus system in Hyperledger involves a two-stage process whereby transaction proposals are first submitted to the network. On the basis of the response to them they may then be formally issued as transactions. In Fabric SDK you must write code to handle both stages – here you can implement systems to examine the responses yourself to see if they are valid (avoiding proceeding and this being discovered at a later stage).

e. Build the transaction proposal

Add a new then() to the promise chain:

```
}).then((results) => {

// We'll assume it went ok
let proposalResponses = results[0];
let proposal = results[1];
let header = results[2];

let request = {
    proposalResponses: proposalResponses,
    proposal: proposal,
    header: header
};

return chain.sendTransaction(request);
});
```

Assuming the proposal responses are acceptable, send off the transaction request. It should be noted that in instances like the above where no checks are made at this stage the code will still be rejected if it is found that it does not meet the endorsement policy during the checks performed right before committal.

f. Add a new section to testWorkshop.sh

Add a new section to `testWorkshop.sh` after the existing code:

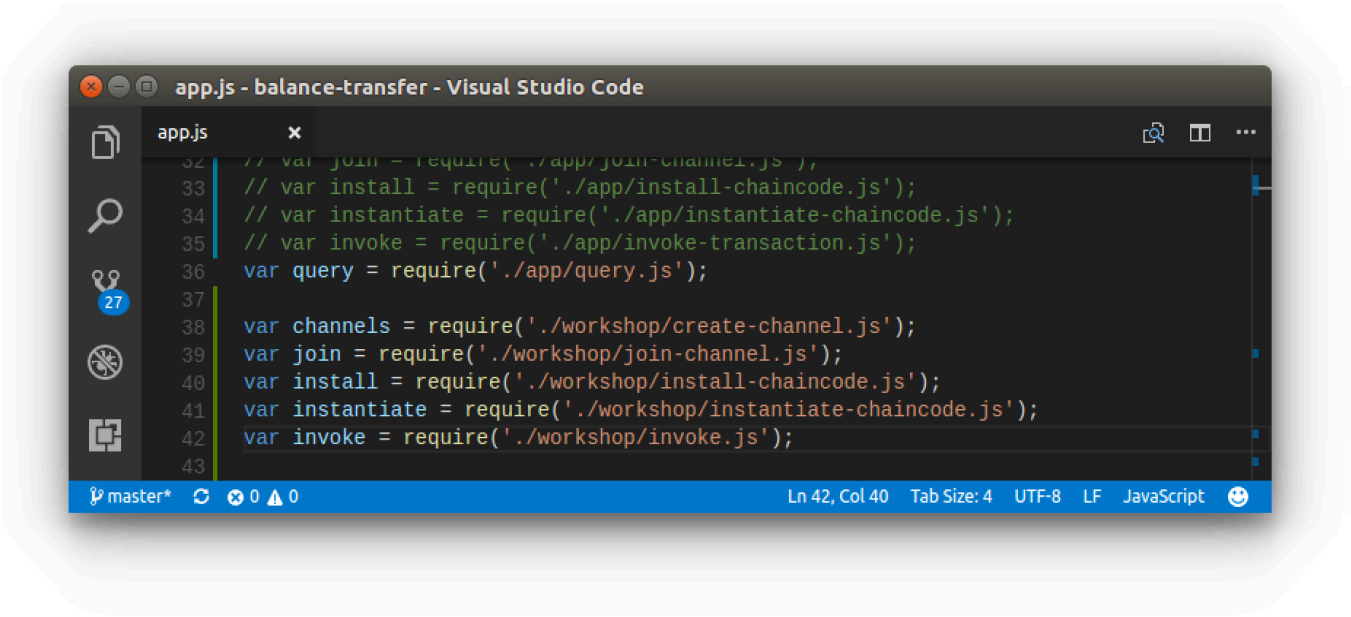
```
echo "POST invoke chaincode on peers of Org1"
echo
TRX_ID=$(curl -s -X POST \
  http://localhost:4000/channels/mychannel/chaincodes/mycc \
  -H "authorization: Bearer $ORG1_TOKEN" \
  -H "cache-control: no-cache" \
  -H "content-type: application/json" \
  -H "x-access-token: $ORG1_TOKEN" \
```

```
  -d '{
      "peers": ["localhost:7051", "localhost:7056"],
      "chaincodeVersion":"v0",
      "functionName":"invoke",
      "args":["move","a","b","10"]
}')
echo "Transacton ID is $TRX_ID"
echo
echo
sleep 10
```

g. Edit app.js

Comment out the import for the `invoke` library and add an entry for `invoke.js`:

```
var invoke = require('./workshop/invoke.js');
```

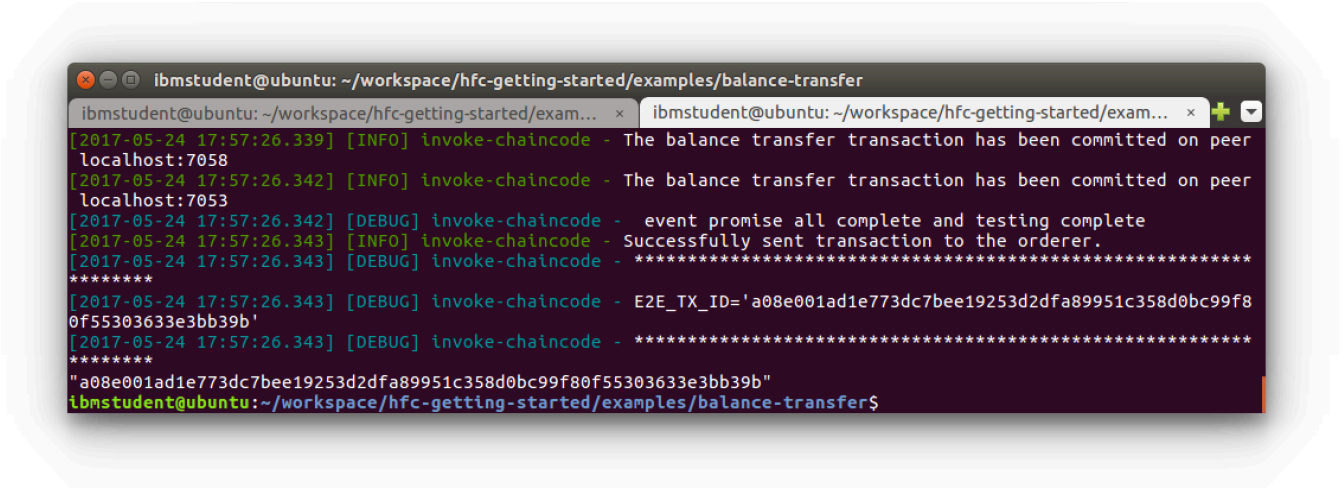


h. Run the Test script

Restart the network by using `./runApp.sh`, wait until the same text shown in 1.1 appears.

When this is the case, switch to the other tab and issue the following: `./testWorkshop.sh`

You should get output similar to the following:



There is no second screenshot as the invoke code does not output or return anything to the main window, it's output is contained to the hash string you see in the above:

4.2. Queries

a. Make a new file

Create a new file in `workshop` called `query.js`, insert the following code into it:

```
var helper = require('./helper.js');

var queryChaincode = function(peer, channelName, chaincodeName, chaincodeVersion,
args, username, org) {
});

exports.queryChaincode = queryChaincode;
```

b. Set up the network

Add the following code to the body:

```
var peers = [];
peers.push(helper.getPeerAddressByName(org, peer));
var chain = helper.getChainForOrg(org);
var targets = helper.getTargets(peers, org);
helper.setupPeers(chain, peers, targets);
```

c. Get the user context

Add the following under the setup code:

```
return helper.getRegisteredUsers(username, org).then((user) => {
});
```

d. Build the transaction proposal

Add the following under the user context code:

```
nonce = helper.getNonce();
tx_id = chain.buildTransactionID(nonce, user);

var request = {
    targets: targets,
    chaincodeId: chaincodeName,
    chaincodeVersion: chaincodeVersion,
    chainId: channelName,
    txId: tx_id,
    nonce: nonce,
    fcn: 'query',
    args: args
};

return chain.queryByChaincode(request);
```

e. Return the output

Add a final `then()` to the promise chain:

```
}).then((response_payloads) => {
      return 'User b now has ' + response_payloads[i].toString('utf8') + ' after the
move';
});
```

As you can see, query functions are incredibly simple compared to the bulk of other transactions as their purpose is simply to read data. Therefore there is little need for any kind of two-stage process or consensus about the activity.

Queries can also be directed at individual peers – as the activity is only reading it only needs to come from a single replica.

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