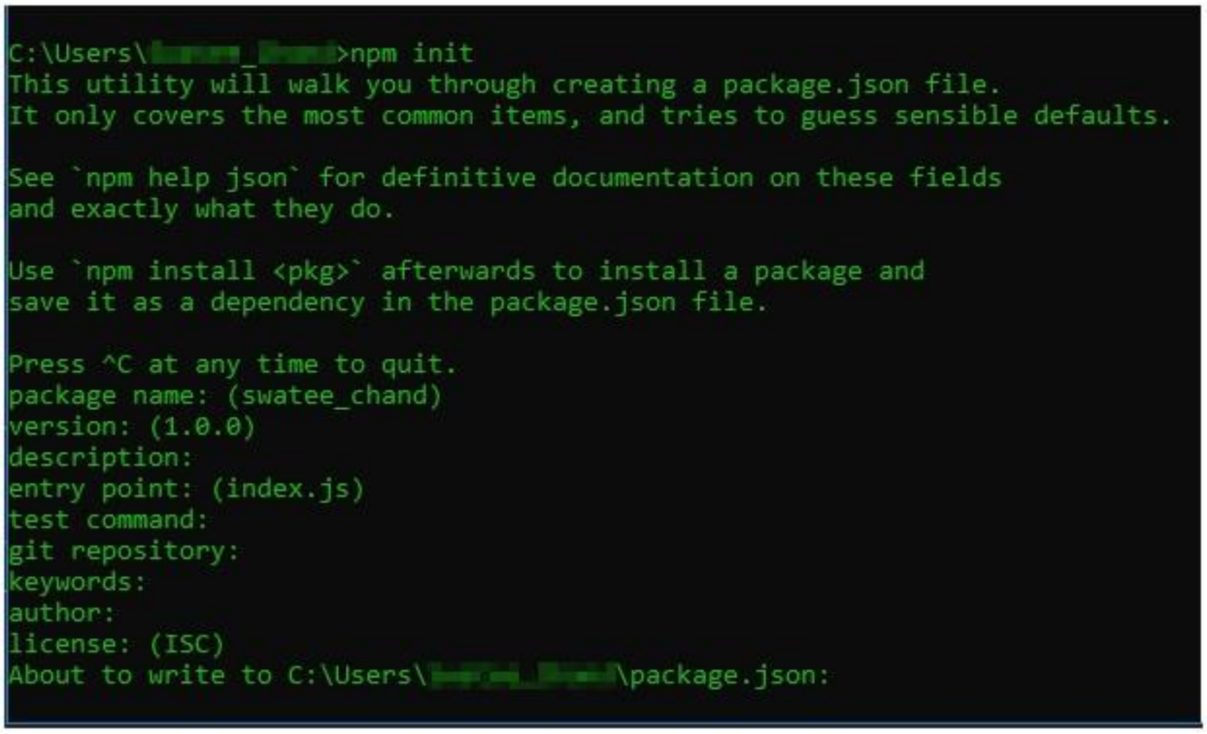
INPUT & OUTPUT:

1. npm init

When you hit enter, Node.js will ask you to enter some details to build the .json file such as:



```
C:\Users\[redacted]>npm init
This utility will walk you through creating a package.json file.
It only covers the most common items, and tries to guess sensible defaults.

See `npm help json` for definitive documentation on these fields
and exactly what they do.

Use `npm install <pkg>` afterwards to install a package and
save it as a dependency in the package.json file.

Press ^C at any time to quit.
package name: (swatee_chand)
version: (1.0.0)
description:
entry point: (index.js)
test command:
git repository:
keywords:
author:
license: (ISC)
About to write to C:\Users\[redacted]\package.json:
```

Next, we will be installing Express.js using the below command:

npm i express

npm i -g nodemon **package.json**

```
{
"name":
"samplerestapi",
"version": "1.0.0",
"description": "Edureka REST API with Node.js",
"main": "script.js",
"scripts": {
"test": "echo "Error: no test specified" && exit 1"
},
"author": "Edureka",
"license": "ISC",
"dependencies": {
"express": "^4.16.4",
"joi": "^13.1.0"
}
}
```

Create a Docker file

Docker file

```
FROM node:9-slim

# WORKDIR specifies the application directory

WORKDIR /app

# Copying package.json file to the app directory
COPY package.json /app

# Installing npm for DOCKER
RUN npm install


# Copying rest of the application to app directory
COPY . /app

# Starting the application using npm start
CMD ["npm","start"]
```

Build Docker Image

```
docker build -t <docker-image-name> <file path>
```

If we are getting an output something similar to the above screenshot, then it means that your application is working fine and the docker image has been successfully created. In the next section of this Node.js Docker article, I will show you how to execute this Docker Image.

Executing the Docker Image

Since you have successfully created your Docker image, now you can run one or more Docker containers on this image using the below-given command:

```
docker run it -d -p <HOST PORT>:<DOCKER PORT> <docker-image-name>
```

This command will start your docker container based on your Docker image and expose it on the specified port in your machine. In the above command ***-d flag*** indicates that you want to execute your Docker container in a detached mode. In other words, this will enable your Docker container to run in the background of the host machine. While the ***-p flag*** specifies which host port will be connected to the docker port.

To check whether your application has been successfully Dockerized or not, you can try launching it on the port you have specified for the host in the above command.

If We want to see the list of images currently running in your system, We can use the below command:

```
docker ps
```

Installing Fabric-samples Repository

To start out with fabric samples install the Fabric-samples bash script:

url -sSLO https://raw.githubusercontent.com/hyperledger/fabric/main/scripts/install-fabric.sh && chmod +x install-fabric.sh

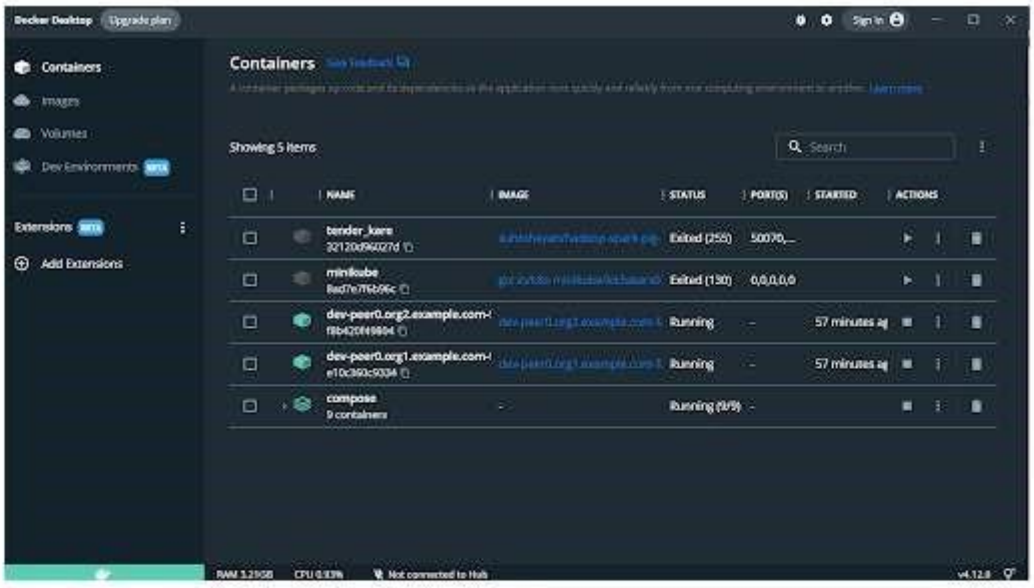
Then you can pull docker containers by running one of these commands:

./install-fabric.sh docker samples

./install-fabric.sh d s

To install binaries for Fabric samples you can use the command below:

./install-fabric.sh binary



Showing 5 items

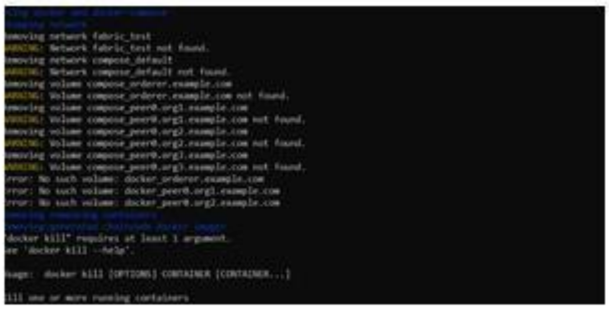
NAME	IMAGE	STATUS	PORT(S)	STARTED	ACTIONS
bender_kare 32120d96027d	[illegible]	Exited (255)	50070,...		
minikube 8ad7e7f6b96c	[illegible]	Exited (130)	0,0,0,0,0		
dev-peer0.org2.example.com- f8b420f49804	[illegible]	Running	-	57 minutes ag	
dev-peer0.org1.example.com- e10c360c9334	[illegible]	Running	-	57 minutes ag	
compose 9 containers	-	Running (9/9)	-		

Building First Network

Step 1: Navigate through the Fabric-samples folder and then through the Test network folder where you can find script files using these we can run our network. The test network is provided for learning about Fabric by running nodes on your local machine. Developers can use the network to test their smart contracts and applications. *cd fabric-samples/test-network*

Step 2: From inside this directory, you can directly run ./network.sh script file through which we run the Test Network. By default, we would be running ./network.sh down command to remove any previous network containers or artifacts that still exist. This is to ensure that there are no conflicts when we run a new network.

./network.sh down

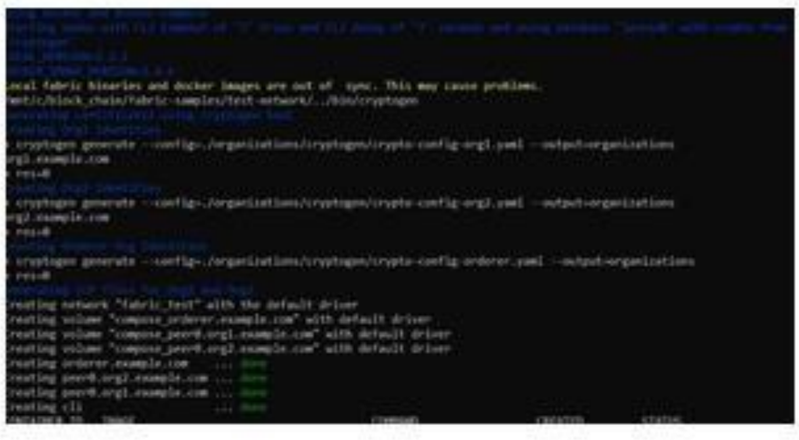


```
[illegible]
[illegible]
emoving network fabric_test
ARNING: Network fabric_test not found.
emoving network compose_default
ARNING: Network compose_default not found.
emoving volume compose_orderer.example.com
ARNING: Volume compose_orderer.example.com not found.
emoving volume compose_peer0.org1.example.com
ARNING: Volume compose_peer0.org1.example.com not found.
emoving volume compose_peer0.org2.example.com
ARNING: Volume compose_peer0.org2.example.com not found.
emoving volume compose_peer0.org3.example.com
ARNING: Volume compose_peer0.org3.example.com not found.
rror: No such volume: docker_orderer.example.com
rror: No such volume: docker_peer0.org1.example.com
rror: No such volume: docker_peer0.org2.example.com
[illegible]
[illegible]
"docker kill" requires at least 1 argument.
ee 'docker kill --help'.

sage:  docker kill [OPTIONS] CONTAINER [CONTAINER...]

ill one or more running containers
```

Step 3: Now you can bring up a network using the following command. This command creates a fabric network that consists of two peer nodes and one ordering node. No channel is created when you run ./network.sh up

./network.sh up

If the above command completes successfully, you will see the logs of the nodes being created below picture:



```
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
Local fabric binaries and docker images are out of  sync. This may cause problems.
mnt/c/block_chain/fabric-samples/test-network/../bin/cryptogen
[illegible]
[illegible]
 cryptogen generate --config=./organizations/cryptogen/crypto-config-org1.yaml --output=organizations
rg1.example.com
 res=0
[illegible]
 cryptogen generate --config=./organizations/cryptogen/crypto-config-org2.yaml --output=organizations
rg2.example.com
 res=0
[illegible]
 cryptogen generate --config=./organizations/cryptogen/crypto-config-orderer.yaml --output=organizations
 res=0
[illegible]
reating network "fabric_test" with the default driver
reating volume "compose_orderer.example.com" with default driver
reating volume "compose_peer0.org1.example.com" with default driver
reating volume "compose_peer0.org2.example.com" with default driver
reating orderer.example.com    ... done
reating peer0.org2.example.com ... done
reating peer0.org1.example.com ... done
reating cli                    ... done
ONTAINER ID   IMAGE                          COMMAND                 CREATED          STATUS
```

Etherum Network Installation

Step 1:

```
$ sudo apt install software-properties-common
```

After that we need to add the Ethereum repository as follows.

```
$ sudo add-apt-repository -y ppa:ethereum/ethereum
```

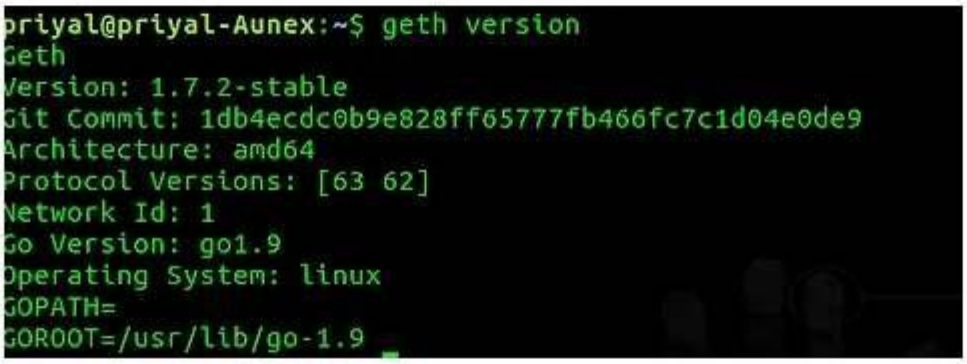
Then , update the repositories.

```
$ sudo apt update
```

Then install the Ethereum.

```
$ sudo apt install ethereum
```

We can check the installation by using the $ geth version command as follows.



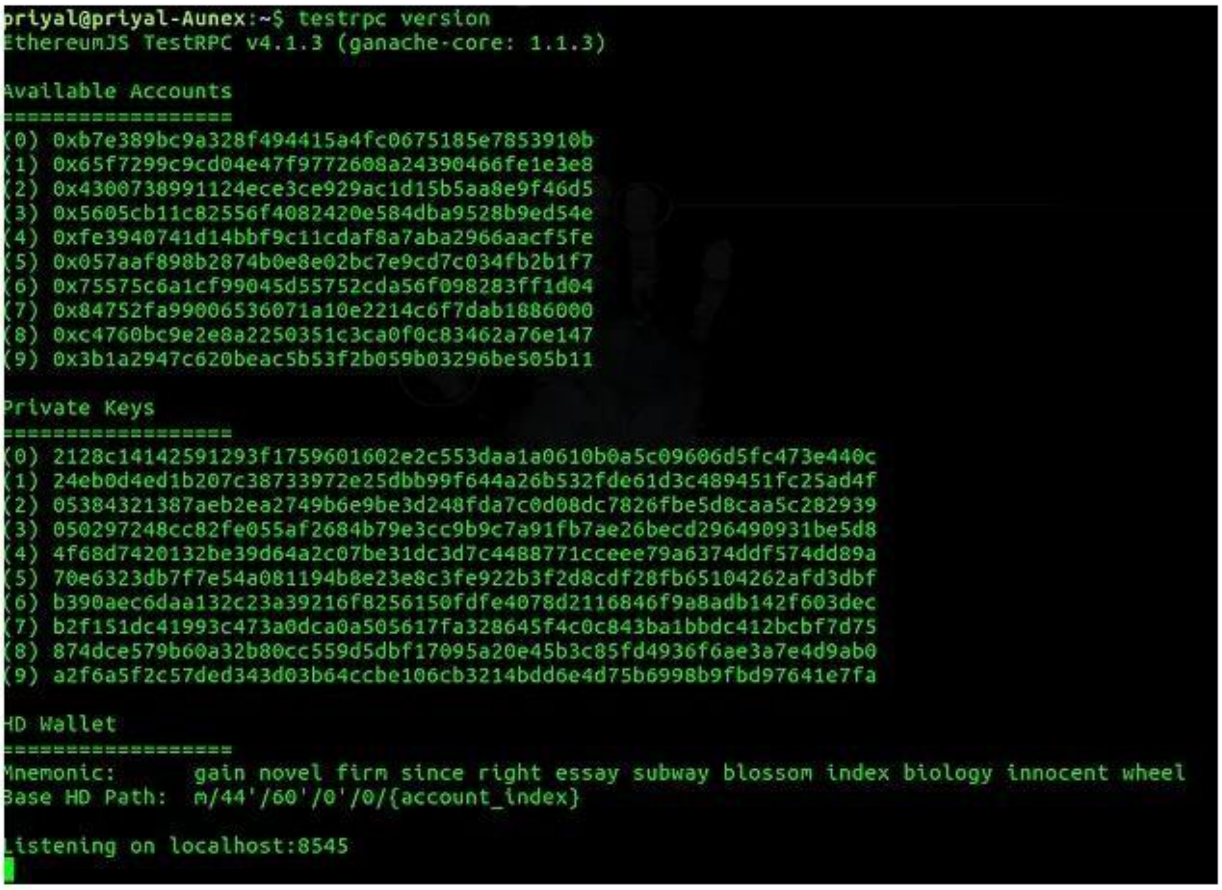
```
priyal@priyal-Aunex:~$ geth version
Geth
Version: 1.7.2-stable
Git Commit: 1db4ecdc0b9e828ff65777fb466fc7c1d04e0de9
Architecture: amd64
Protocol Versions: [63 62]
Network Id: 1
Go Version: go1.9
Operating System: linux
GOPATH=
GOROOT=/usr/lib/go-1.9
```

Image 2 : Check geth version

Installing Test RPC

Test RPC is an Ethereum node emulator implemented in NodeJS. The purpose of this Test RPC is to easily start the Ethereum node for test and development purposes. To install the Test RPC ;

```
sudo npm install -g ethereumjs-testrpc
```



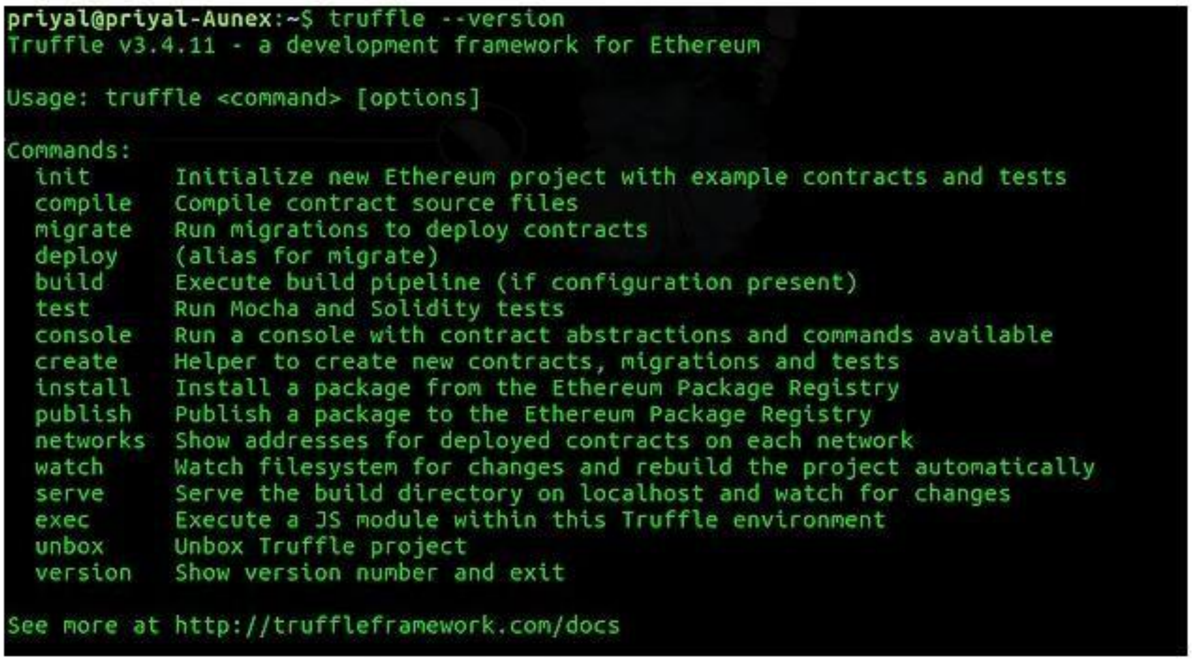
```
priyal@priyal-Aunex:~$ testrpc version
EthereumJS TestRPC v4.1.3 (ganache-core: 1.1.3)

Available Accounts
==================
(0) 0xb7e389bc9a328f494415a4fc0675185e7853910b
(1) 0x65f7299c9cd04e47f9772608a24390466fe1e3e8
(2) 0x4300738991124ece3ce929ac1d15b5aa8e9f46d5
(3) 0x5605cb11c82556f4082420e584dba9528b9ed54e
(4) 0xfe3940741d14bbf9c11cdaf8a7aba2966aacf5fe
(5) 0x057aaf898b2874b0e8e02bc7e9cd7c034fb2b1f7
(6) 0x75575c6a1cf99045d55752cda56f098283ff1d04
(7) 0x84752fa99006536071a10e2214c6f7dab1886000
(8) 0xc4760bc9e2e8a2250351c3ca0f0c83462a76e147
(9) 0x3b1a2947c620beac5b53f2b059b03296be505b11

Private Keys
==================
(0) 2128c14142591293f1759601602e2c553daa1a0610b0a5c09606d5fc473e440c
(1) 24eb0d4ed1b207c38733972e25dbb99f644a26b532fde61d3c489451fc25ad4f
(2) 05384321387aeb2ea2749b6e9be3d248fda7c0d08dc7826fbe5d8caa5c282939
(3) 050297248cc82fe055af2684b79e3cc9b9c7a91fb7ae26becd296490931be5d8
(4) 4f68d7420132be39d64a2c07be31dc3d7c4488771cceee79a6374ddf574dd89a
(5) 70e6323db7f7e54a081194b8e23e8c3fe922b3f2d8cdf28fb65104262afd3dbf
(6) b390aec6daa132c23a39216f8256150fdfe4078d2116846f9a8adb142f603dec
(7) b2f151dc41993c473a0dca0a505617fa328645f4c0c843ba1bbdc412bcbf7d75
(8) 874dce579b60a32b80cc559d5dbf17095a20e45b3c85fd4936f6ae3a7e4d9ab0
(9) a2f6a5f2c57ded343d03b64ccbe106cb3214bdd6e4d75b6998b9fbd97641e7fa

HD Wallet
==================
Mnemonic:      gain novel firm since right essay subway blossom index biology innocent wheel
Base HD Path:  m/44'/60'/0'/0/{account_index}

Listening on localhost:8545
```

Image 3 : List all localaccounts

Installing Truffle

```
$ sudo npm install -g truffle
```

check the installation as follows.



```
priyal@priyal-Aunex:~$ truffle --version
Truffle v3.4.11 - a development framework for Ethereum

Usage: truffle <command> [options]

Commands:
  init      Initialize new Ethereum project with example contracts and tests
  compile   Compile contract source files
  migrate   Run migrations to deploy contracts
  deploy    (alias for migrate)
  build     Execute build pipeline (if configuration present)
  test      Run Mocha and Solidity tests
  console   Run a console with contract abstractions and commands available
  create    Helper to create new contracts, migrations and tests
  install   Install a package from the Ethereum Package Registry
  publish   Publish a package to the Ethereum Package Registry
  networks  Show addresses for deployed contracts on each network
  watch     Watch filesystem for changes and rebuild the project automatically
  serve     Serve the build directory on localhost and watch for changes
  exec      Execute a JS module within this Truffle environment
  unbox     Unbox Truffle project
  version   Show version number and exit

See more at http://truffleframework.com/docs
```

Image 4 : check truffle version

Setting up a Private Ethereum network

First of all create a folder to host the database and private accounts that we are going to create. In my case it is ~/ETH/pvt.

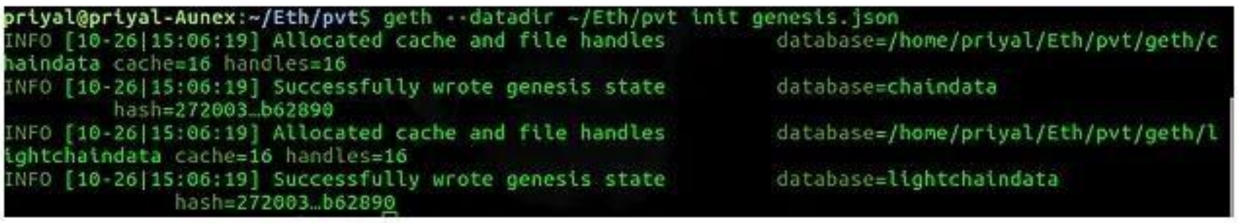
First of all we need to place the genesis block in our root (~/ETH/pvt). The file should be defined as genesis.json

```
{
    "nonce": "0x0000000000000042",
    "mixhash":
"0x0000000000000000000000000000000000000000000000000000000000000000",
    "difficulty": "0x400",
    "alloc": {},
    "coinbase": "0x0000000000000000000000000000000000000000",
    "timestamp": "0x0",
    "parentHash":
"0x0000000000000000000000000000000000000000000000000000000000000000",
    "extraData": "0x",
    "gasLimit": "0xffffffff",
    "config": {
       "chainId": 4224,
       "homesteadBlock": 0,
       "eip155Block": 0,
       "eip158Block": 0
    }
  }
```

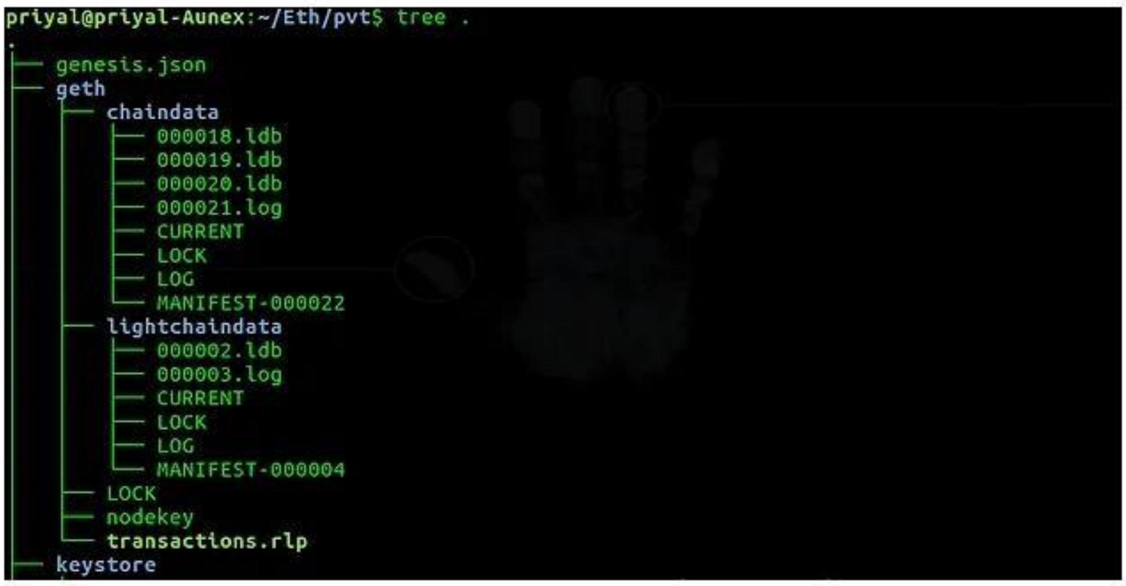
To initialize the chain instance , we need to use following geth command.

```
$ geth --datadir ~/Eth/pvt init genesis.json
```

datadir param specifies where we should save our network’s data. After initializing this, the root folder should contain something like following.



```
priyal@priyal-Aunex:~/Eth/pvt$ geth --datadir ~/Eth/pvt init genesis.json
INFO [10-26|15:06:19] Allocated cache and file handles         database=/home/priyal/Eth/pvt/geth/c
haindata cache=16 handles=16
INFO [10-26|15:06:19] Successfully wrote genesis state         database=chaindata
      hash=272003…b62890
INFO [10-26|15:06:19] Allocated cache and file handles         database=/home/priyal/Eth/pvt/geth/l
ightchaindata cache=16 handles=16
INFO [10-26|15:06:19] Successfully wrote genesis state         database=lightchaindata
             hash=272003…b62890
```



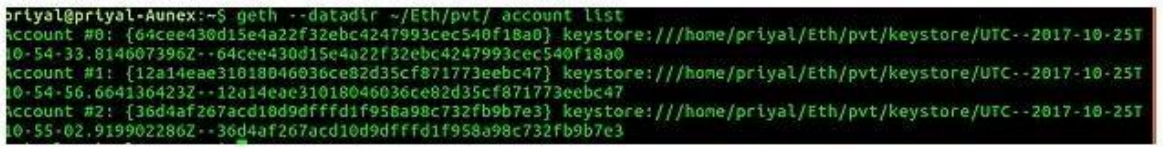
```
priyal@priyal-Aunex:~/Eth/pvt$ tree .
.
├── genesis.json
├── geth
│   ├── chaindata
│   │   ├── 000018.ldb
│   │   ├── 000019.ldb
│   │   ├── 000020.ldb
│   │   ├── 000021.log
│   │   ├── CURRENT
│   │   ├── LOCK
│   │   ├── LOG
│   │   └── MANIFEST-000022
│   ├── lightchaindata
│   │   ├── 000002.ldb
│   │   ├── 000003.log
│   │   ├── CURRENT
│   │   ├── LOCK
│   │   ├── LOG
│   │   └── MANIFEST-000004
│   ├── LOCK
│   ├── nodekey
│   └── transactions.rlp
├── keystore
```

Image 5 : Network folder structure

We can use the following geth command for this purpose.

```
$ geth --datadir ~/Eth/pvt/ account new
```

To list all created account lists you can use the account list command as



```
priyal@priyal-Aunex:~$ geth --datadir ~/Eth/pvt/ account list
Account #0: {64cee430d15e4a22f32ebc4247993cec540f18a0} keystore:///home/priyal/Eth/pvt/keystore/UTC--2017-10-25T
10-54-33.814607396Z--64cee430d15e4a22f32ebc4247993cec540f18a0
Account #1: {12a14eae31018046036ce82d35cf871773eebc47} keystore:///home/priyal/Eth/pvt/keystore/UTC--2017-10-25T
10-54-56.664136423Z--12a14eae31018046036ce82d35cf871773eebc47
Account #2: {36d4af267acd10d9dfffd1f958a98c732fb9b7e3} keystore:///home/priyal/Eth/pvt/keystore/UTC--2017-10-25T
10-55-02.919902286Z--36d4af267acd10d9dfffd1f958a98c732fb9b7e3
```

Image 6 : Account list

As the next step, we need to specify following startnode.sh file. This script will start the network with given params. **startnode.sh**

```
geth --networkid 4224 --mine --datadir "~/Eth/pvt" --nodiscover --rpc
--rpcport "8545"
--port "30303" --rpccorsdomain "*" --nat "any" --rpcapi
eth,web3,personal,net --unlock 0
--password ~/Eth/pvt/password.sec --ipcpath
"~/Library/Ethereum/geth.ipc"
```

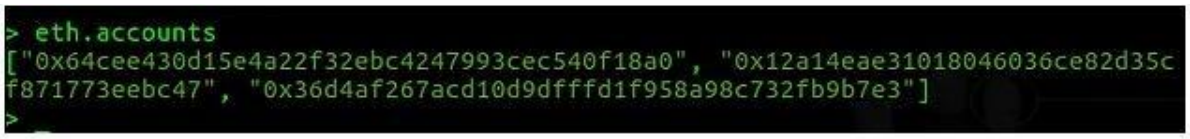
As the next step we need to log into the Geth console using the attach command as follows.

```
$ geth attach http://127.0.0.1:8545 --datadir /home/priyal/Eth/pvt
```

This will start the Geth console. To list all accounts we can use following command.

```
> eth.accounts
```

Account Creation output:



```
> eth.accounts
["0x64cee430d15e4a22f32ebc4247993cec540f18a0", "0x12a14eae31018046036ce82d35c
f871773eebc47", "0x36d4af267acd10d9dfffd1f958a98c732fb9b7e3"]
> _
```

Result:

INPUT:

1. Setup the Blockchain Network

Clone this repo using the following command.

$ git clone https://github.com/IBM/blockchain-application-using-fabric-java-sdk

To build the blockchain network, the first step is to generate artifacts for peers and channels using cryptogen and configtx. The utilities used and steps to generate artifacts are explained here. In this pattern all required artifacts for the peers and channel of the network are already generated and provided to use as-is. Artifacts can be located at:
network_resources/crypto-config network_resources/config

The automated scripts to build the network are provided under network directory. The network/dockercompose.yaml file defines the blockchain network topology.

cd network chmod

+x build.sh

./build.sh

To stop the running network, run the following script.

cd network chmod

+x stop.sh

./stop.sh

To delete the network completely, following script need to execute.

cd network chmod +x

teardown.sh

./teardown.sh

2. Build the client based on Fabric Java SDK

The previous step creates all required docker images with the appropriate configuration.

Java Client

The java client sources are present in the folder java of the repo.

Check your environment before executing the next step. Make sure, you are able to run mvn commands properly.

If mvn commands fails, please refer to Pre-requisites to install maven.

To work with the deployed network using Hyperledger Fabric SDK java 1.4.1, perform the following steps.

Open a command terminal and navigate to the java directory in the repo. Run the command mvn install.

cd ../java mvn

install

A jar file blockchain-java-sdk-0.0.1-SNAPSHOT-jar-with-dependencies.jar is built and can be found under the target folder. This jar can be renamed to blockchain-client.jar to keep the name short.

cd target

cp blockchain-java-sdk-0.0.1-SNAPSHOT-jar-with-dependencies.jar blockchain-client.jar

Copy this built jar into network_resources directory. This is required as the java code can access required artifacts during execution.

cp blockchain-client.jar ../../network_resources

3. Create and Initialize the channel

In this code pattern, we create one channel mychannel which is joined by all four peers. The java source code can be seen at src/main/java/org/example/network/CreateChannel.java. To create and initialize the channel, run the following command.

cd ../../network_resources java -cp blockchain-client.jar

org.example.network.CreateChannel

Output:

```
INFO: Deleting - users

Apr 20, 2018 5:11:45 PM org.example.network.CreateChannel main

INFO: Channel created mychannel

Apr 20, 2018 5:11:45 PM org.example.network.CreateChannel main

INFO: peer0.org1.example.com at grpc://localhost:7051

Apr 20, 2018 5:11:45 PM org.example.network.CreateChannel main

INFO: peer1.org1.example.com at grpc://localhost:7056

Apr 20, 2018 5:11:45 PM org.example.network.CreateChannel main

INFO: peer0.org2.example.com at grpc://localhost:8051

Apr 20, 2018 5:11:45 PM org.example.network.CreateChannel main

INFO: peer1.org2.example.com at grpc://localhost:8056
```

4. Deploy and Instantiate the chaincode

This code pattern uses a sample chaincode fabcar to demo the usage of Hyperledger Fabric SDK Java APIs. To deploy and instantiate the chaincode, execute the following command.

java -cp blockchain-client.jar org.example.network.DeployInstantiateChaincode

Output:

```
  INFO: Deploying chaincode fabcar using Fabric client Org1MSP admin

  Apr 23, 2018 10:25:22 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code deployment SUCCESS

  Apr 23, 2018 10:25:22 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code deployment SUCCESS

  Apr 23, 2018 10:25:22 AM org.example.client.FabricClient deployChainCode

  INFO: Deploying chaincode fabcar using Fabric client Org2MSP admin

  Apr 23, 2018 10:25:22 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code deployment SUCCESS

  Apr 23, 2018 10:25:22 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code deployment SUCCESS

  Apr 23, 2018 10:25:22 AM org.example.client.ChannelClient instantiateChainCode

  INFO: Instantiate proposal request fabcar on channel mychannel with Fabric client Org2MSP admin

  Apr 23, 2018 10:25:22 AM org.example.client.ChannelClient instantiateChainCode   INFO:

Instantiating Chaincode ID fabcar on channel mychannel

  Apr 23, 2018 10:25:25 AM org.example.client.ChannelClient instantiateChainCode

  INFO: Chaincode fabcar on channel mychannel instantiation
java.util.concurrent.CompletableFuture@723ca036[Not completed]

  Apr 23, 2018 10:25:25 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code instantiation SUCCESS

  Apr 23, 2018 10:25:25 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code instantiation SUCCESS

  Apr 23, 2018 10:25:25 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code instantiation SUCCESS
  Apr 23, 2018 10:25:25 AM org.example.network.DeployInstantiateChaincode main

  INFO: fabcar- Chain code instantiation SUCCESS
```

Note: The chaincode fabcar.go was taken from the fabric samples available at - https://github.com/hyperledger/fabric-samples/tree/release-1.4/chaincode/fabcar/go.

5. Register and enroll users

A new user can be registered and enrolled to an MSP. Execute the below command to register a new user and enroll to Org1MSP.

java -cp blockchain-client.jar org.example.user.RegisterEnrollUser

Output:

```
  INFO: Deleting - users    log4j:WARN No appenders could be found for logger

(org.hyperledger.fabric.sdk.helper.Config).    log4j:WARN Please initialize the log4j system

properly.    log4j:WARN See https://logging.apache.org/log4j/1.2/faq.html#noconfig for more info.

  Apr 23, 2018 10:26:35 AM org.example.client.CAClient enrollAdminUser

  INFO: CA -http://localhost:7054 Enrolled Admin.

  Apr 23, 2018 10:26:35 AM org.example.client.CAClient registerUser

  INFO: CA -http://localhost:7054 Registered User - user1524459395783

  Apr 23, 2018 10:26:36 AM org.example.client.CAClient enrollUser

  INFO: CA -http://localhost:7054 Enrolled User - user1524459395783
```

6. Perform Invoke and Query on network

Blockchain network has been setup completely and is ready to use. Now we can test the network by performing invoke and query on the network. The fabcar chaincode allows us to create a new asset which is a car. For test purpose, invoke operation is performed to create a new asset in the network and query operation is performed to list the asset of the network. Perform the following steps to check the same.

java -cp blockchain-client.jar org.example.chaincode.invocation.InvokeChaincode

Output:

```
 INFO: CA -http://localhost:7054 Enrolled Admin.

 Apr 20, 2018 5:13:04 PM org.example.client.ChannelClient sendTransactionProposal   INFO:

Sending transaction proposal on channel mychannel

 Apr 20, 2018 5:13:04 PM org.example.client.ChannelClient sendTransactionProposal

INFO: Transaction proposal on channel mychannel OK SUCCESS with transaction
```

```
id:a298b9e27bdb0b6ca18b19f9c78a5371fb4d9b8dd199927baf37379537ca0d0f     Apr
20,  2018  5:13:04  PM  org.example.client.ChannelClient  sendTransactionProposal
INFO:
 Apr 20, 2018 5:13:04 PM org.example.client.ChannelClient sendTransactionProposal
 INFO: java.util.concurrent.CompletableFuture@22f31dec[Not completed]
 Apr 20, 2018 5:13:04 PM org.example.chaincode.invocation.InvokeChaincode main
 INFO: Invoked createCar on fabcar. Status - SUCCESS java -cp blockchain-
client.jar org.example.chaincode.invocation.QueryChaincode
```

Output:

```
  Apr 20, 2018 5:13:28 PM org.example.client.CAClient enrollAdminUser
  INFO: CA -http://localhost:7054 Enrolled Admin.
  Apr   20,   2018   5:13:29   PM   org.example.chaincode.invocation.QueryChaincode   main
INFO: Querying for all cars ...
  Apr 20, 2018 5:13:29 PM org.example.client.ChannelClient queryByChainCode
  INFO: Querying queryAllCars on channel mychannel
  Apr 20, 2018 5:13:29 PM org.example.chaincode.invocation.QueryChaincode main
  INFO: [{"Key":"CAR1",
"Record":{"make":"Chevy","model":"Volt","colour":"Red","owner":"Nick"}}]
  Apr 20, 2018 5:13:39 PM org.example.chaincode.invocation.QueryChaincode main
  INFO: Querying for a car - CAR1
  Apr 20, 2018 5:13:39 PM org.example.client.ChannelClient queryByChainCode
  INFO: Querying queryCar on channel mychannel
  Apr 20, 2018 5:13:39 PM org.example.chaincode.invocation.QueryChaincode main
  INFO: {"make":"Chevy","model":"Volt","colour":"Red","owner":"Nick"}
```

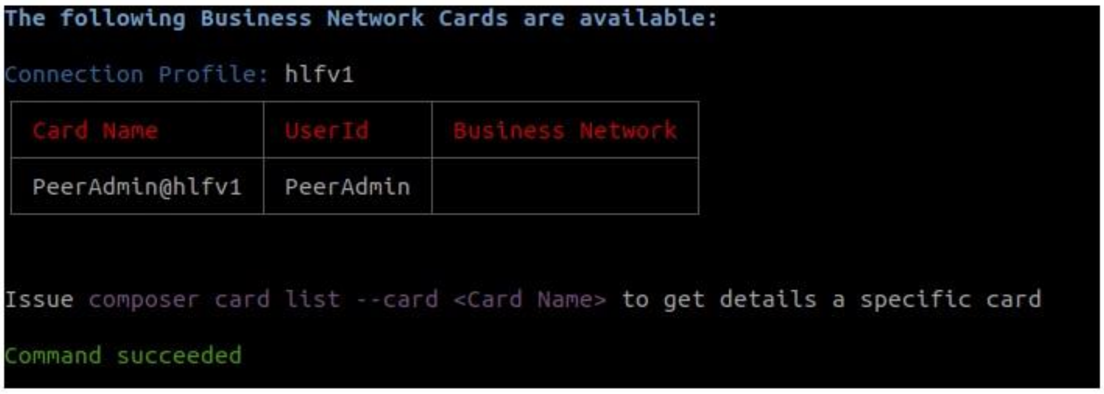
Program:

```
import java.io.IOException; import
java.nio.charset.StandardCharsets; import
java.nio.file.Path; import java.nio.file.Paths; import
java.util.concurrent.TimeoutException; import
org.hyperledger.fabric.gateway.Contract; import
org.hyperledger.fabric.gateway.ContractException; import
org.hyperledger.fabric.gateway.Gateway;
import org.hyperledger.fabric.gateway.Network;
import org.hyperledger.fabric.gateway.Wallet; import
org.hyperledger.fabric.gateway.Wallets;

class Sample {     public static void main(String[] args) throws
IOException {
    // Load an existing wallet holding identities used to access the network.
    Path walletDirectory = Paths.get("wallet");
    Wallet wallet = Wallets.newFileSystemWallet(walletDirectory);

    // Path to a common connection profile describing the network.
    Path networkConfigFile = Paths.get("connection.json");

    // Configure the gateway connection used to access the network.
    Gateway.Builder builder = Gateway.createBuilder()
        .identity(wallet, "user1")
        .networkConfig(networkConfigFile);

    // Create a gateway connection          try
(Gateway gateway = builder.connect()) {

      // Obtain a smart contract deployed on the network.
      Network network = gateway.getNetwork("mychannel");
```

```
            Contract contract = network.getContract("fabcar");


            // Submit transactions that store state to the ledger.

            byte[] createCarResult = contract.createTransaction("createCar")

                    .submit("CAR10",    "VW",    "Polo",    "Grey",    "Mary");System.out.println(new
String(createCarResult, StandardCharsets.UTF_8));


            // Evaluate transactions that query state from the ledger.

            byte[] queryAllCarsResult = contract.evaluateTransaction("queryAllCars");

            System.out.println(new String(queryAllCarsResult, StandardCharsets.UTF_8));


        } catch (ContractException | TimeoutException | InterruptedException e) {

e.printStackTrace();

        }

    }

}
```

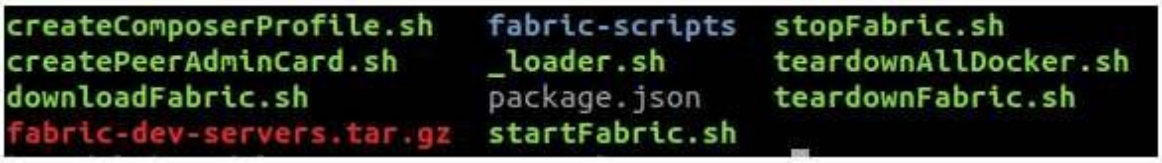
Result:

INPUT & OUTPUT:



```
The following Business Network Cards are available:

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

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

Command succeeded
```

Also, if you type ls you'll see this:

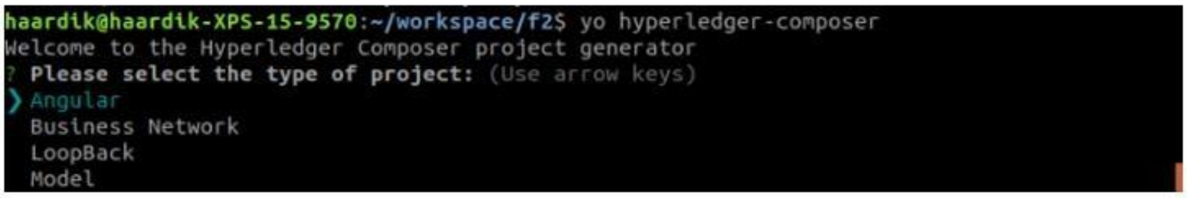


```
createComposerProfile.sh   fabric-scripts  stopFabric.sh
createPeerAdminCard.sh     _loader.sh      teardownAllDocker.sh
downloadFabric.sh          package.json    teardownFabric.sh
fabric-dev-servers.tar.gz  startFabric.sh
```

Basically what we did here was just download and start a local Fabric network. We can stop is using ./stopFabric.sh if we want to. At the end of our development session, we should run ./teardownFabric.sh

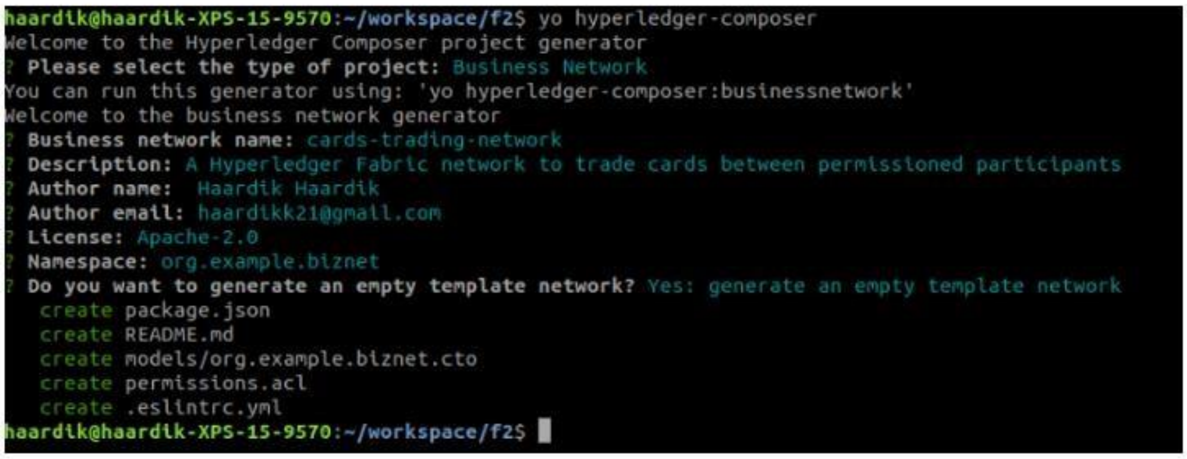
Creating and deploying our business network
1. Generating a business network

Open terminal in a directory of choice and type yo hyperledger-composer



```
haardik@haardik-XPS-15-9570:~/workspace/f2$ yo hyperledger-composer
Welcome to the Hyperledger Composer project generator
? Please select the type of project: (Use arrow keys)
❯ Angular
  Business Network
  LoopBack
  Model
```

you'll be greeted with something similar to the above. Select Business Network and name it cardstrading-network as shown below:



```
haardik@haardik-XPS-15-9570:~/workspace/f2$ yo hyperledger-composer
Welcome to the Hyperledger Composer project generator
? Please select the type of project: Business Network
You can run this generator using: 'yo hyperledger-composer:businessnetwork'
Welcome to the business network generator
? Business network name: cards-trading-network
? Description: A Hyperledger Fabric network to trade cards between permissioned participants
? Author name:  Haardik Haardik
? Author email: haardikk21@gmail.com
? License: Apache-2.0
? Namespace: org.example.biznet
? Do you want to generate an empty template network? Yes: generate an empty template network
   create package.json
   create README.md
   create models/org.example.biznet.cto
   create permissions.acl
   create .eslintrc.yml
haardik@haardik-XPS-15-9570:~/workspace/f2$ 
```

2. Modeling our business network

The first and most important step towards making a business network is identifying the resources present. We have four resource types in the modeling language:

Assets

Participants

Transactions

Events

For our cards-trading-network , we will define an asset typeTradingCard , a participant type Trader , a transaction TradeCard and an event TradeNotification.

Go ahead and open the generated files in a code editor of choice. Open up org.example.biznet.cto which is the modeling file. Delete all the code present in it as we're gonna rewrite it (except for the namespace declaration).

This contains the specification for our asset TradingCard . All assets and participants need to have a unique identifier for them which we specify in the code, and in our case, it's cardId

Also, our asset has a GameType cardType property which is based off the enumerator defined below. Enums are used to specify a type which can have up to N possible values, but nothing else. In our example, no TradingCard can have a cardType other than Baseball, Football, or Cricket.

Now, to specify our Trader participant resource type, add the following code in the modeling file

This is relatively simpler and quite easy to understand. We have a participant type Trader and they're uniquely identified by their traderIds.

Now, we need to add a reference to our TradingCards to have a reference pointing to their owner so we know who the card belongs to. To do this, add the following line inside your TradingCard asset:

--> Trader owner so that the

code looks like this:

This is the first time we've used --&gt; and you must be wondering what this is. This is a relationship pointer. o and --> are how we differentiate between a resource's own properties vs a relationship to another resource type. Since the owner is a Trader which is a participant in the network, we want a reference to that Trader directly, and that's exactly what --> does.

Finally, go ahead and add this code in the modeling file which specifies what parameters will be required to make a transaction and emitting an event.

3. **Adding logic for our transactions**

To add logic behind the TradeCard function, we need a Javascript logic file. Create a new directory named lib in your project's folder and create a new file named logic.js with the following code:

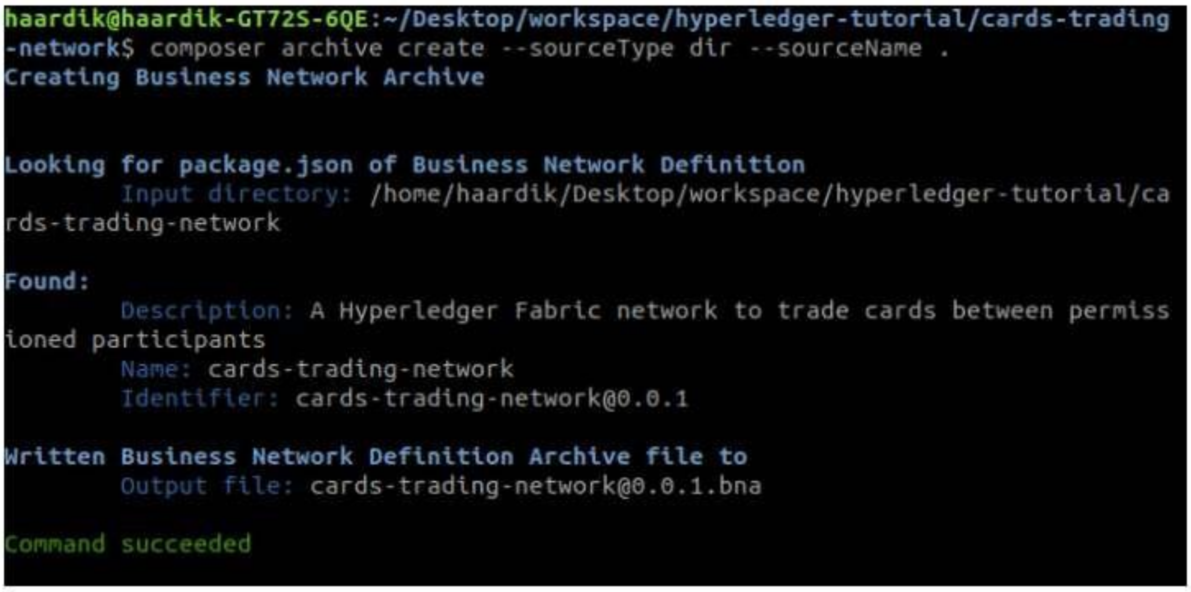
4. **Defining permissions and access rules**

Add a new rule in permissions.acl to give participants access to their resources. In production, you would want to be more strict with these access rules. You can read more about them here.

5. **Generating a Business Network Archive (BNA)**

Now that all the coding is done, it's time to make an archive file for our business network so we can deploy it on our local Fabric runtime. To do this, open Terminal in your project directory and type this: composer archive create --sourceType dir –sourceName

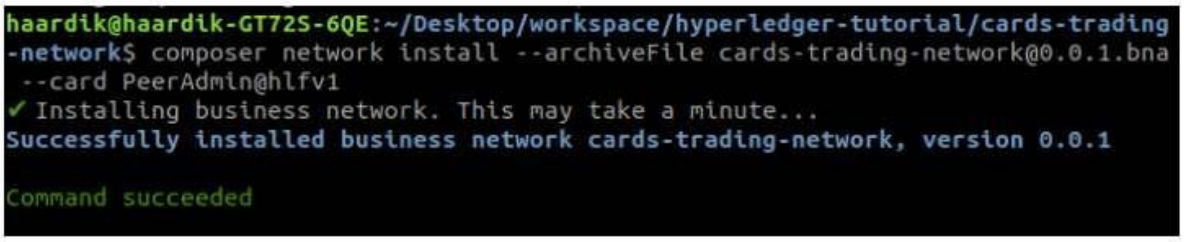
This command tells Hyperledger Composer we want to build a BNA from a directory which is our current root folder.



```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading
-network$ composer archive create --sourceType dir --sourceName .
Creating Business Network Archive


Looking for package.json of Business Network Definition
        Input directory: /home/haardik/Desktop/workspace/hyperledger-tutorial/ca
rds-trading-network

Found:
        Description: A Hyperledger Fabric network to trade cards between permiss
ioned participants
        Name: cards-trading-network
        Identifier: cards-trading-network@0.0.1

Written Business Network Definition Archive file to
        Output file: cards-trading-network@0.0.1.bna

Command succeeded
```

6. **Install and Deploy the BNA file**

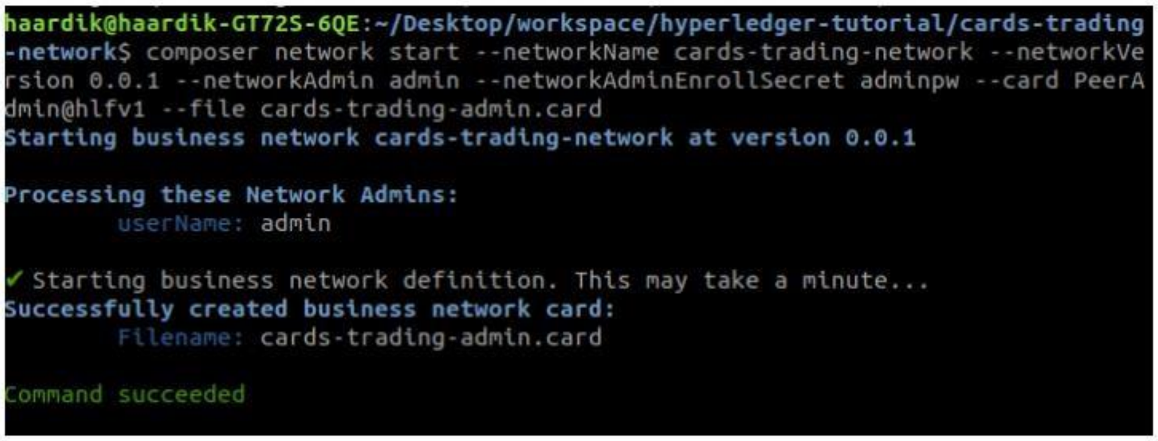
We can install and deploy the network to our local Fabric runtime using the PeerAdmin user. To install the business network, type composer network install --archiveFile cards-trading-network@0.0.1.bna --card PeerAdmin@hlfv1



```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading
-network$ composer network install --archiveFile cards-trading-network@0.0.1.bna
 --card PeerAdmin@hlfv1
✔ Installing business network. This may take a minute...
Successfully installed business network cards-trading-network, version 0.0.1

Command succeeded
```

To deploy the business network, type

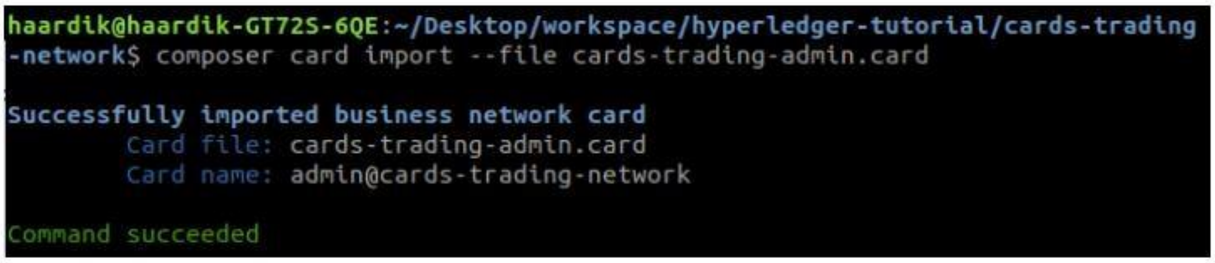
composer network start --networkName cards-trading-network --networkVersion 0.0.1 --networkAdmin admin --networkAdminEnrollSecret adminpw --card PeerAdmin@hlfv1 --file cards-trading-admin.card



```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading
-network$ composer network start --networkName cards-trading-network --networkVe
rsion 0.0.1 --networkAdmin admin --networkAdminEnrollSecret adminpw --card PeerA
dmin@hlfv1 --file cards-trading-admin.card
Starting business network cards-trading-network at version 0.0.1

Processing these Network Admins:
        userName: admin

✔ Starting business network definition. This may take a minute...
Successfully created business network card:
        Filename: cards-trading-admin.card

Command succeeded
```

The networkName and networkVersion must be the same as specified in your package.json otherwise it won't work.

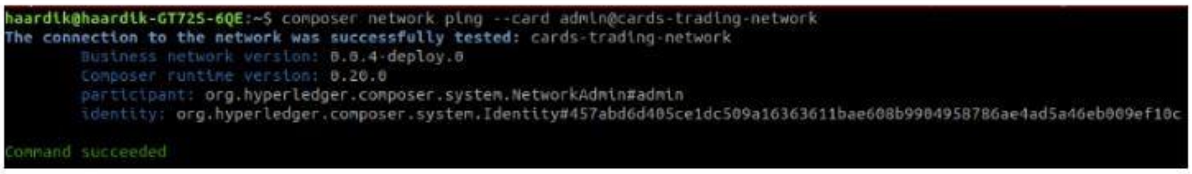
--file takes the name of the file to be created for THIS network's business card. This card then needs to be imported to be usable by typing composer card import --file cards-trading-admin.card



```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading
-network$ composer card import --file cards-trading-admin.card

Successfully imported business network card
        Card file: cards-trading-admin.card
        Card name: admin@cards-trading-network

Command succeeded
```

We can now confirm that our network is up and running by typing

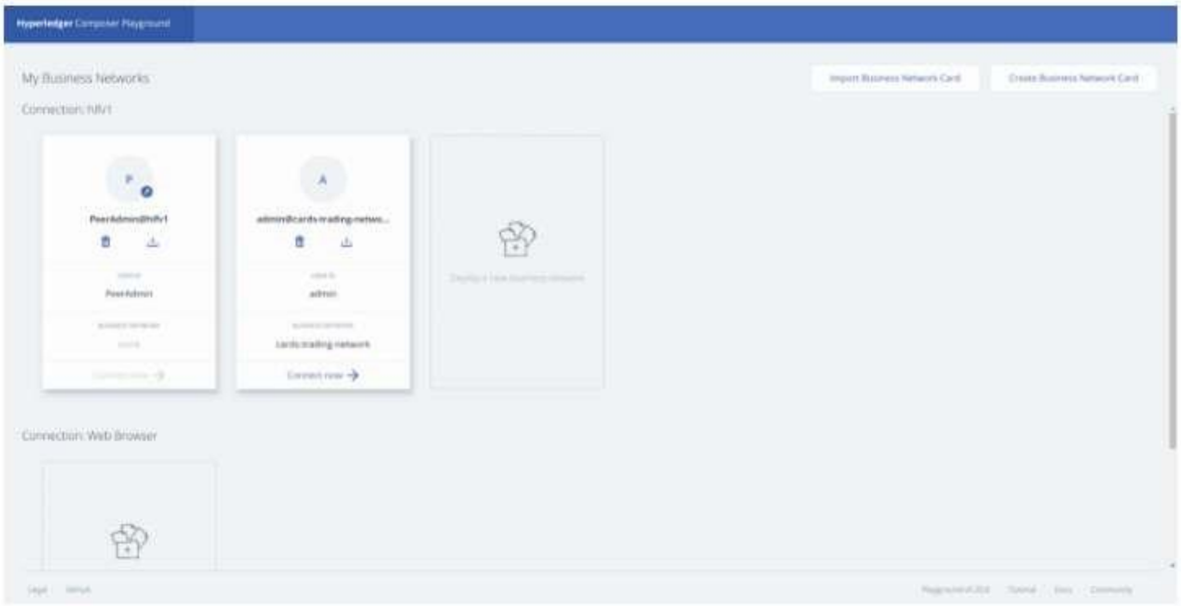
composer network ping --card admin@cards-trading-network --card
this time takes the admin card of the network we want to ping. If
everything went well, you should see something similar to this:



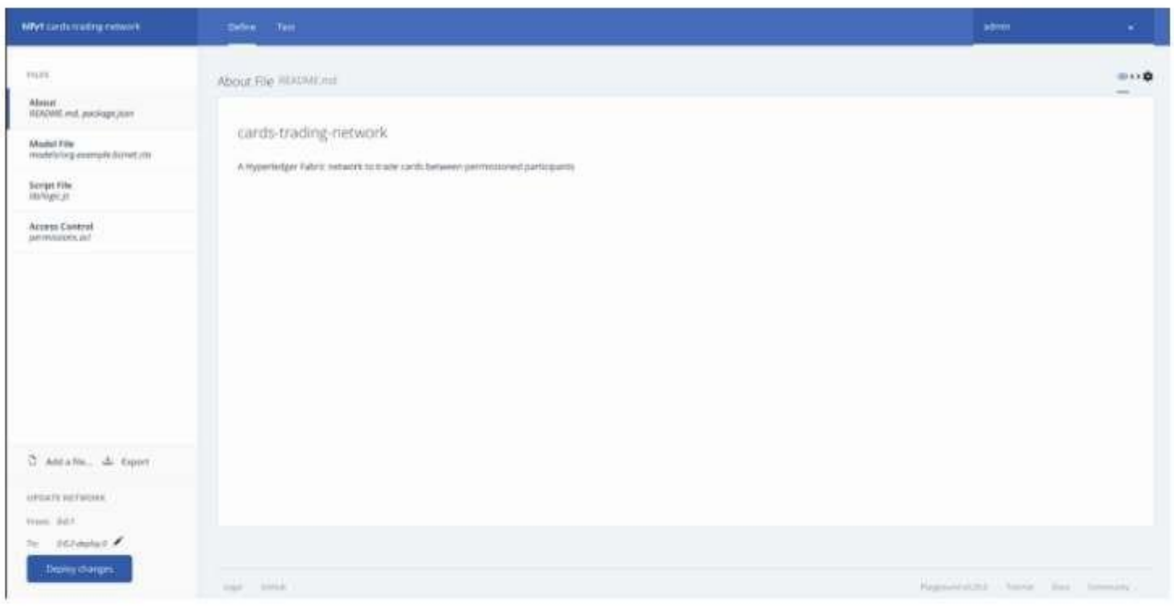
```
haardik@haardik-GT72S-6QE:~$ composer network ping --card admin@cards-trading-network
The connection to the network was successfully tested: cards-trading-network
        Business network version: 0.0.4-deploy.0
        Composer runtime version: 0.20.0
        participant: org.hyperledger.composer.system.NetworkAdmin#admin
        identity: org.hyperledger.composer.system.Identity#457abd6d405ce1dc509a16363611bae608b9984958786ae4ad5a46eb009ef10c

Command succeeded
```

Testing our Business Network

Now that our network is up and running on Fabric, we can start Composer Playground to interact with it. To do this, type composer-playground in Terminal and open up http://localhost:8080/ in your browser and you should see something similar to this:



Press Connect Now for admin@cards-trading-network and you’ll be greeted with this screen:

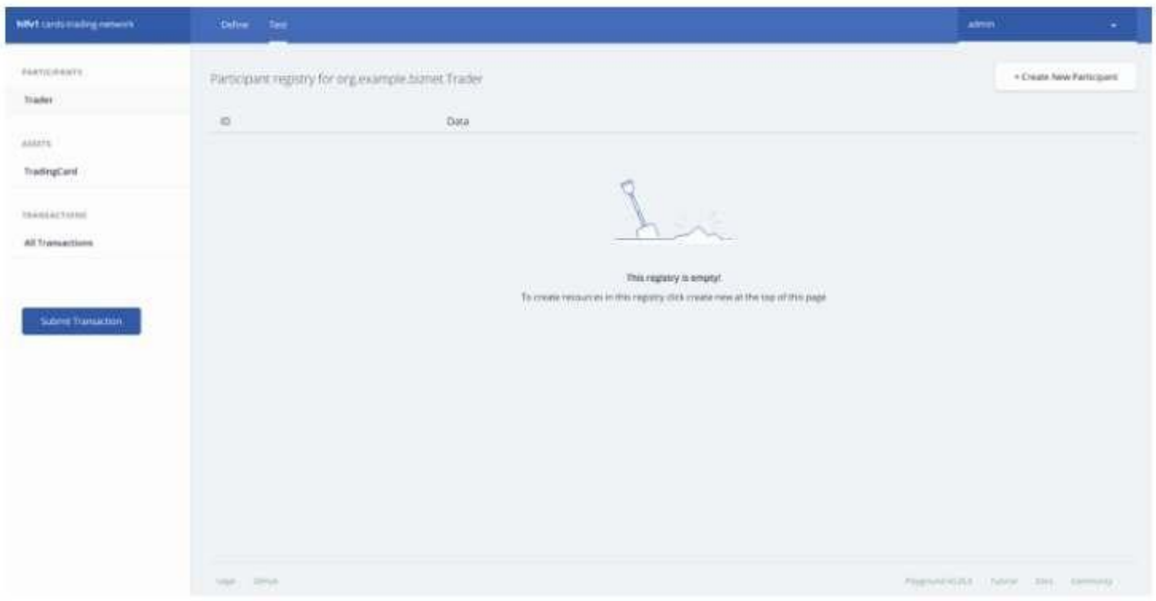


About File README.md

cards-trading-network

A Hyperledger Fabric network to trade cards between permissioned participants

The **Define** page is where we can make changes to our code, deploy those changes to upgrade our network, and export business network archives.
Head over to the **Test** page from the top menu, and you'll see this:

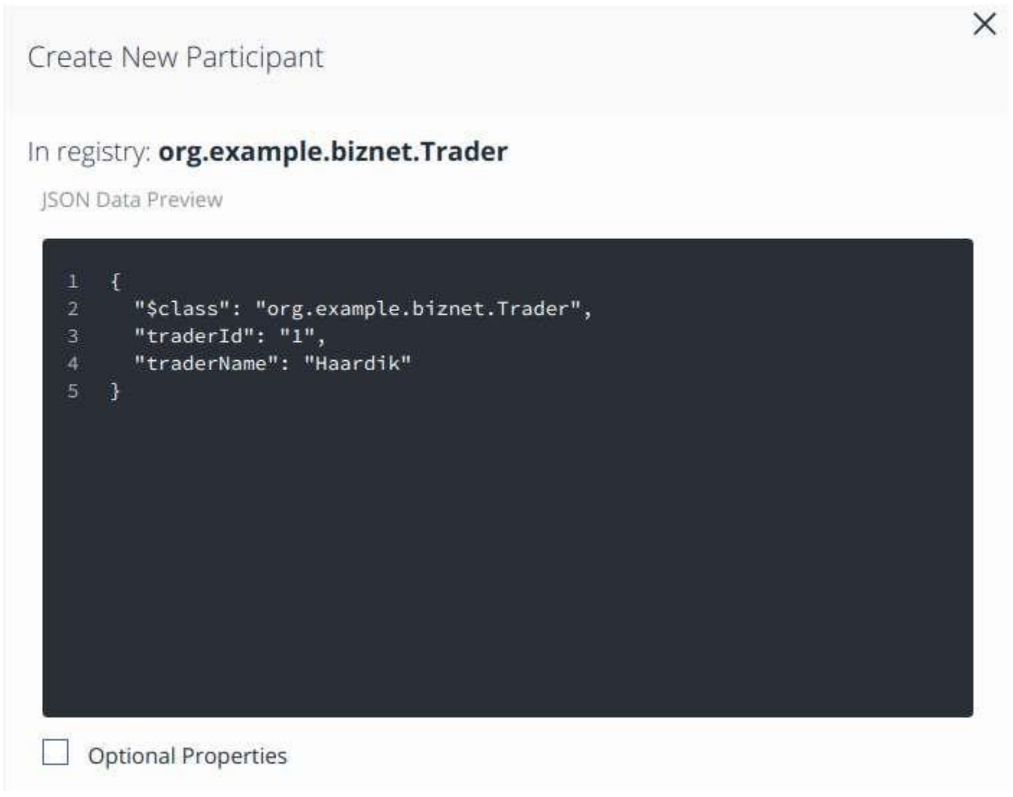


Participant registry for org.example.biznet.Trader

ID Data

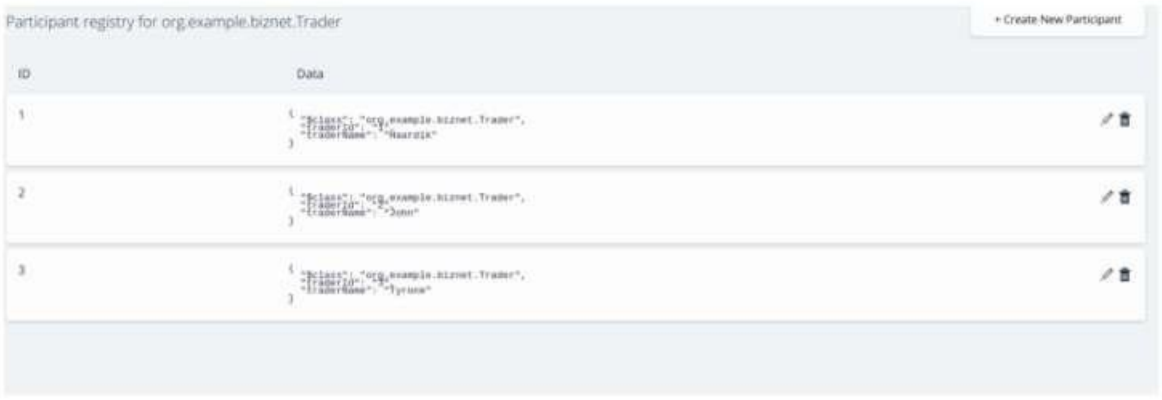
This registry is empty!
To create resources in this registry click create new at the top of this page

Select Trader from Participants, click on **Create New Participant** near the top right, and make a new Trader similar to this:



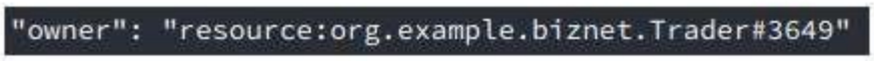
```
{
  "$class": "org.example.biznet.Trader",
  "traderId": "1",
  "traderName": "Haardik"
}
```

Go ahead and make a couple more Traders. Here are what my three traders look like with the names Haardik, John, and Tyrone.



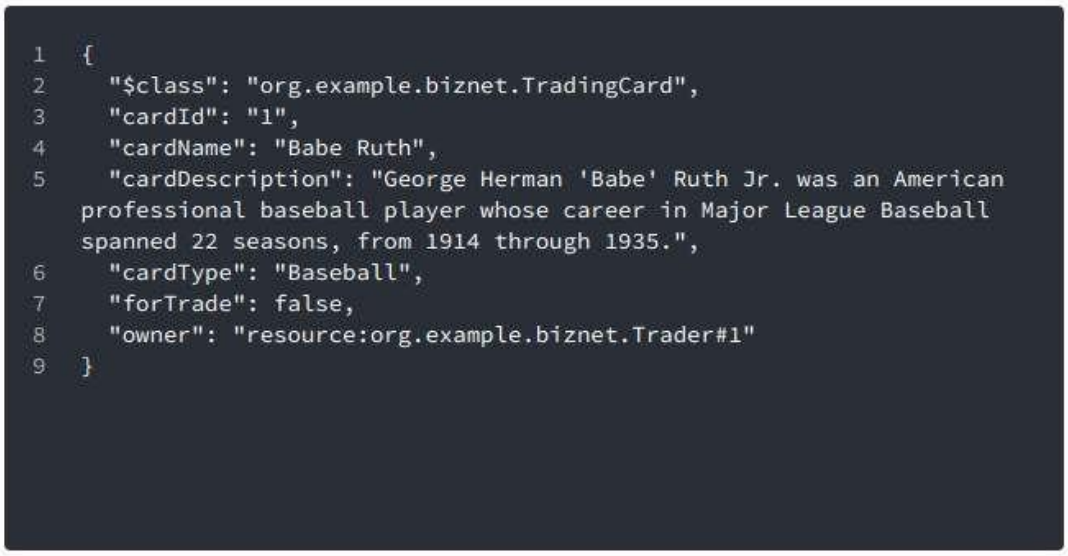
ID	Data
1	{ "$class": "org.example.biznet.Trader", "traderId": "1", "traderName": "Haardik" }
2	{ "$class": "org.example.biznet.Trader", "traderId": "2", "traderName": "John" }
3	{ "$class": "org.example.biznet.Trader", "traderId": "3", "traderName": "Tyrone" }

Click on TradingCard from the left menu and press **Create New Asset**. Notice how the owner field is particularly interesting here, looking something like this:



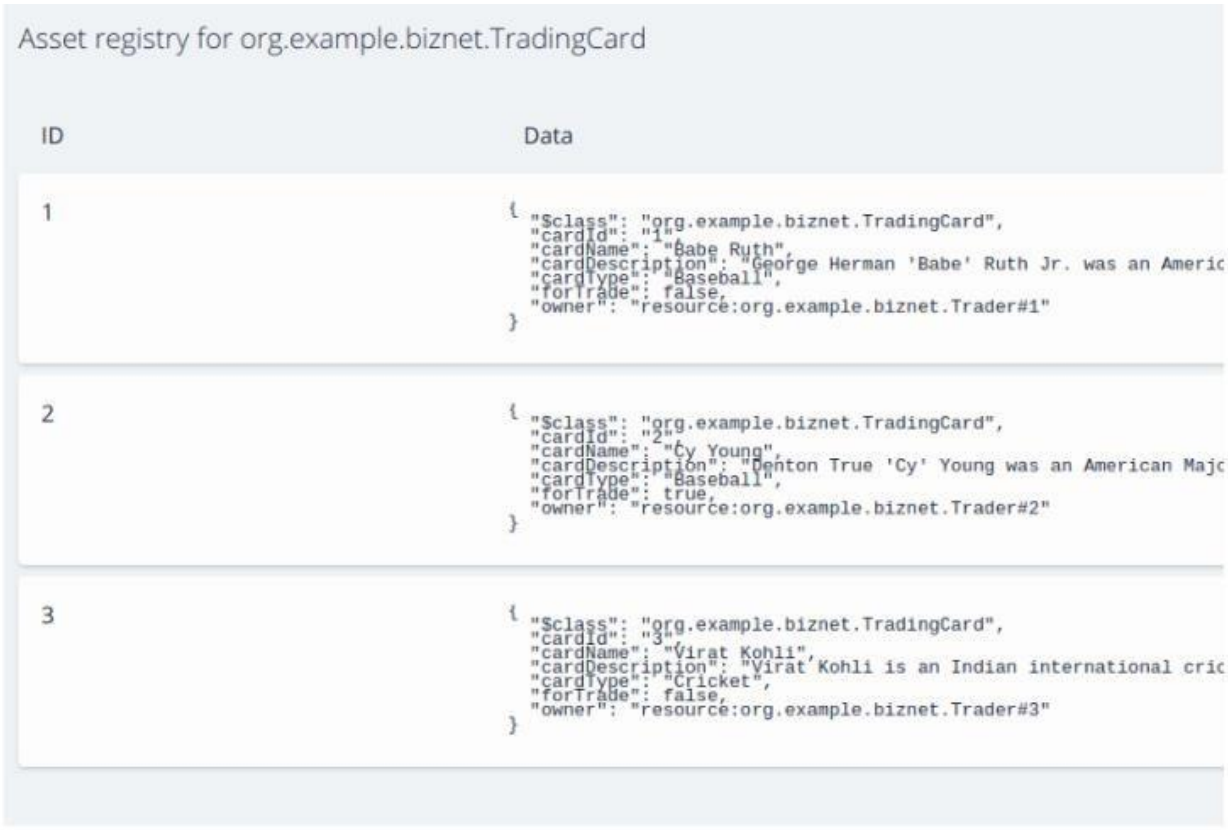
```
"owner": "resource:org.example.biznet.Trader#3649"
```

Go ahead and finish making a TradingCard something similar to this:



```
{
  "$class": "org.example.biznet.TradingCard",
  "cardId": "1",
  "cardName": "Babe Ruth",
  "cardDescription": "George Herman 'Babe' Ruth Jr. was an American
professional baseball player whose career in Major League Baseball
spanned 22 seasons, from 1914 through 1935.",
  "cardType": "Baseball",
  "forTrade": false,
  "owner": "resource:org.example.biznet.Trader#1"
}
```

Notice how the owner fields points to Trader#1 aka Haardik for me. Go ahead and make a couple more cards, and enable a couple to have forTrade set to true.



Asset registry for org.example.biznet.TradingCard

ID | Data

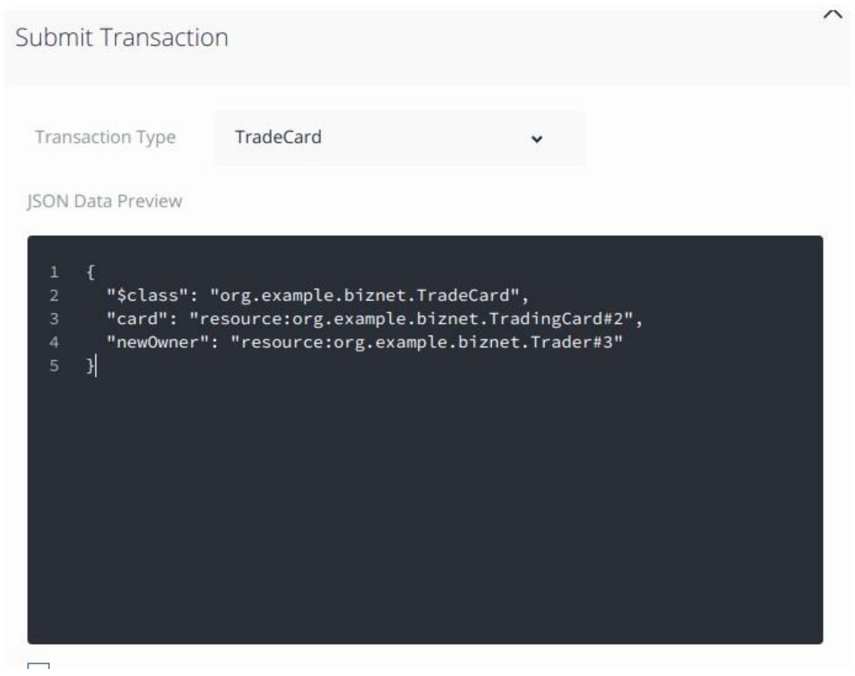
1
```
{
  "$class": "org.example.biznet.TradingCard",
  "cardId": "1",
  "cardName": "Babe Ruth",
  "cardDescription": "George Herman 'Babe' Ruth Jr. was an Americ
  "cardType": "Baseball",
  "forTrade": false,
  "owner": "resource:org.example.biznet.Trader#1"
}
```

2
```
{
  "$class": "org.example.biznet.TradingCard",
  "cardId": "2",
  "cardName": "Cy Young",
  "cardDescription": "Denton True 'Cy' Young was an American Majo
  "cardType": "Baseball",
  "forTrade": true,
  "owner": "resource:org.example.biznet.Trader#2"
}
```

3
```
{
  "$class": "org.example.biznet.TradingCard",
  "cardId": "3",
  "cardName": "Virat Kohli",
  "cardDescription": "Virat Kohli is an Indian international cric
  "cardType": "Cricket",
  "forTrade": false,
  "owner": "resource:org.example.biznet.Trader#3"
}
```

Notice how my Card#2 has forTrade == true?
Now for the fun stuff, let's try trading cards :D

Click on **Submit Transaction** in the left and make card point to TradingCard#2 and newOwner point to Trader#3 like this:


Submit Transaction

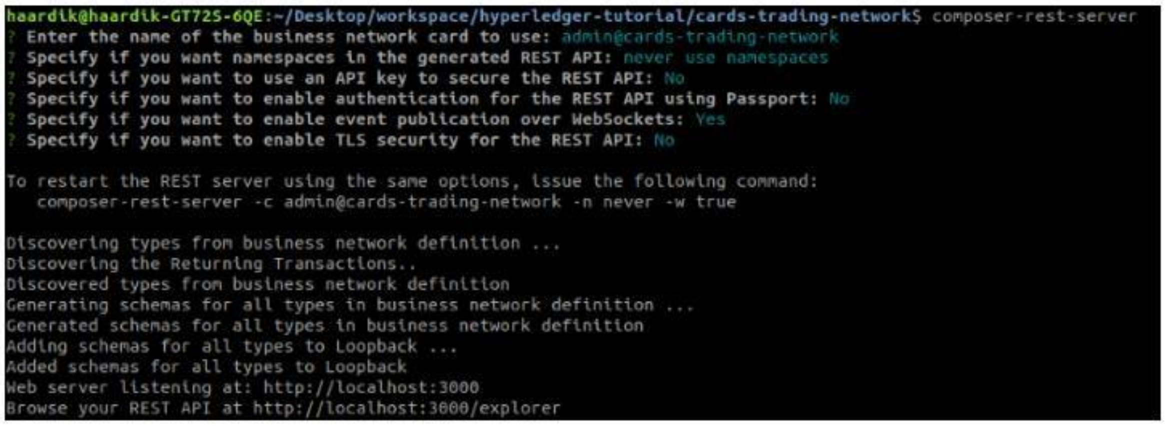
Transaction Type TradeCard

JSON Data Preview

```
{
  "$class": "org.example.biznet.TradeCard",
  "card": "resource:org.example.biznet.TradingCard#2",
  "newOwner": "resource:org.example.biznet.Trader#3"
}
```

Generating a REST API Server

Doing transactions with Playground is nice, but not optimal. We have to make client-side software for users to provide them a seamless experience, they don't even have to necessarily know about the underlying blockchain technology. To do so, we need a better way of interacting with our business network. Thankfully, we have the composer-rest-server module to help us with just that.
Type composer-rest-server in your terminal, specify admin@cards-trading-network , select **never use namespaces**, and continue with the default options for the rest as follows:

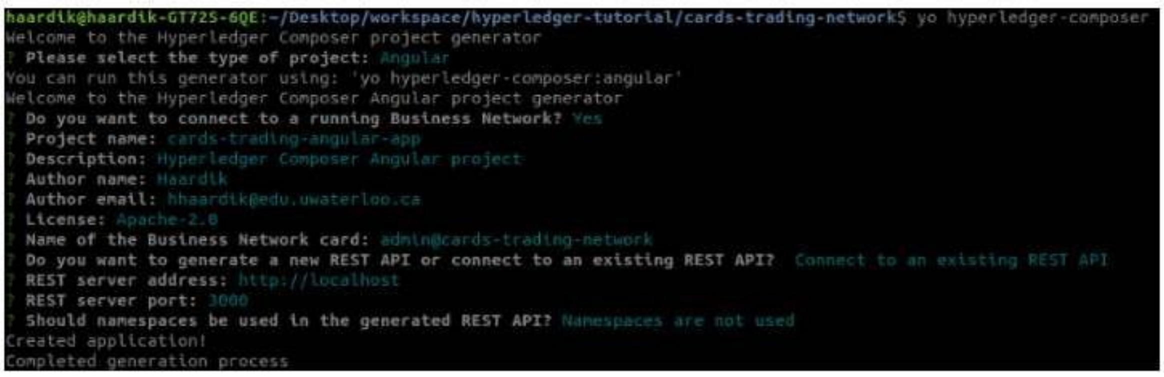


```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading-network$ composer-rest-server
? Enter the name of the business network card to use: admin@cards-trading-network
? Specify if you want namespaces in the generated REST API: never use namespaces
? Specify if you want to use an API key to secure the REST API: No
? Specify if you want to enable authentication for the REST API using Passport: No
? Specify if you want to enable event publication over WebSockets: Yes
? Specify if you want to enable TLS security for the REST API: No

To restart the REST server using the same options, issue the following command:
   composer-rest-server -c admin@cards-trading-network -n never -w true

Discovering types from business network definition ...
Discovering the Returning Transactions..
Discovered types from business network definition
Generating schemas for all types in business network definition ...
Generated schemas for all types in business network definition
Adding schemas for all types to Loopback ...
Added schemas for all types to Loopback
Web server listening at: http://localhost:3000
Browse your REST API at http://localhost:3000/explorer
```

Open http://localhost:3000/explorer/ and you'll be greeted with a documented version of an automatically generated REST API :D

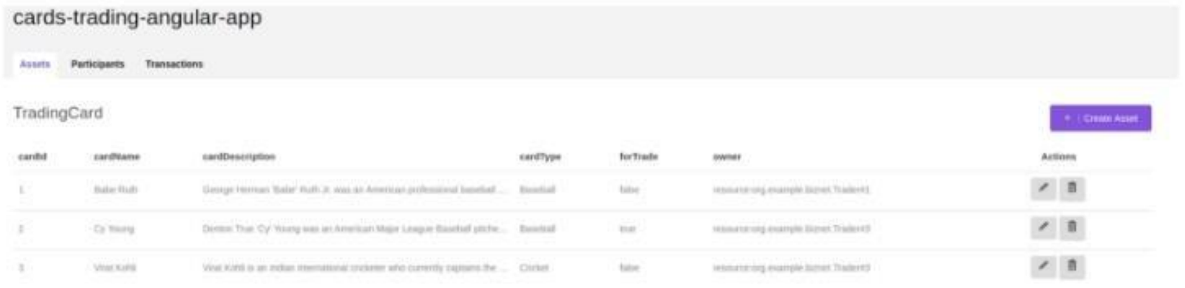
Generating an Angular application which uses the REST API

To create the Angular web application, type yo hyperledger-composer in your Terminal, select Angular, choose to connect to an existing business network with the card admin@cards-trading-network, and connect to an existing REST API as well.



```
haardik@haardik-GT72S-6QE:~/Desktop/workspace/hyperledger-tutorial/cards-trading-network$ yo hyperledger-composer
Welcome to the Hyperledger Composer project generator
? Please select the type of project: Angular
You can run this generator using: 'yo hyperledger-composer:angular'
Welcome to the Hyperledger Composer Angular project generator
? Do you want to connect to a running Business Network? Yes
? Project name: cards-trading-angular-app
? Description: Hyperledger Composer Angular project
? Author name: Haardik
? Author email: hhaardik@edu.uwaterloo.ca
? License: Apache-2.0
? Name of the Business Network card: admin@cards-trading-network
? Do you want to generate a new REST API or connect to an existing REST API?  Connect to an existing REST API
? REST server address: http://localhost
? REST server port: 3000
? Should namespaces be used in the generated REST API? Namespaces are not used
Created application!
Completed generation process
```

This will go on to run npm install , give it a minute, and once it's all done you'll be able to load up http://localhost:4200/ and be greeted with a page similar to this:
Edit: Newer versions of the software may require you to run npm install yourself and then run npm start



cardId	cardName	cardDescription	cardType	forTrade	owner	Actions
1	Babe Ruth	George Herman 'Babe' Ruth Jr. was an American professional baseball ...	Baseball	false	resource:org.example.biznet.Trader#1	
2	Cy Young	Denton True 'Cy' Young was an American Major League Baseball pitche...	Baseball	true	resource:org.example.biznet.Trader#3	
3	Virat Kohli	Virat Kohli is an Indian international cricketer who currently captains the ...	Cricket	false	resource:org.example.biznet.Trader#3	

You can now play with your network from this application directly, which communicates with the network through the REST server running on port 3000.

Congratulations! You just set up your first blockchain business network using Hyperledger Fabric and Hyperledger Composer :D

You can add more features to the cards trading network, setting prices on the cards and giving a balance to all Trader. You can also have more transactions which allow the Traders to toggle the value of forTrade . You can integrate this with non blockchain applications and allow users to buy new cards which get added to their account, which they can then further trade on the network.

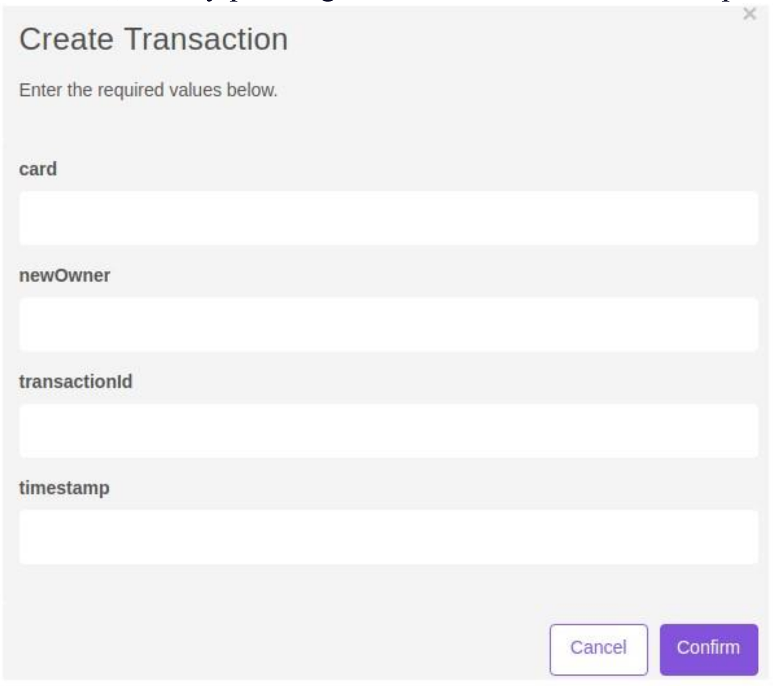
The possibilities are endless, what will you make of them? Let me know in the comments :D

1. Get a modal to open when you press the button

The first change we need to make is have the button open the modal window. The code already contains the required modal window, the button is just missing the (click) and data-target attributes.
To resolve this, open up /cards-trading-angular-app/src/app/**TradeCard/TradeCard.component.html** The file name can vary based on your transaction name. If you have multiple transactions in your business network, you'll have to do this change across all the transaction resource type HTML files.
Scroll down till the very end and you shall see a <button> tag. Go ahead and add these two attributes to that tag:
(click)="resetForm();" data-target="#addTransactionModal" so
the line looks like this:

```
<button type="button" class="btn btn-primary invokeTransactionBtn" data-toggle="modal"
(click)="resetForm();" data-target="#addTransactionModal">Invoke<;/button>
```

The (click) attribute calls resetForm(); which sets all the input fields to empty, and data-target specifies the modal window to be opened upon click.
Save the file, open your browser, and try pressing the invoke button. It should open this modal:



Create Transaction

Enter the required values below.

card

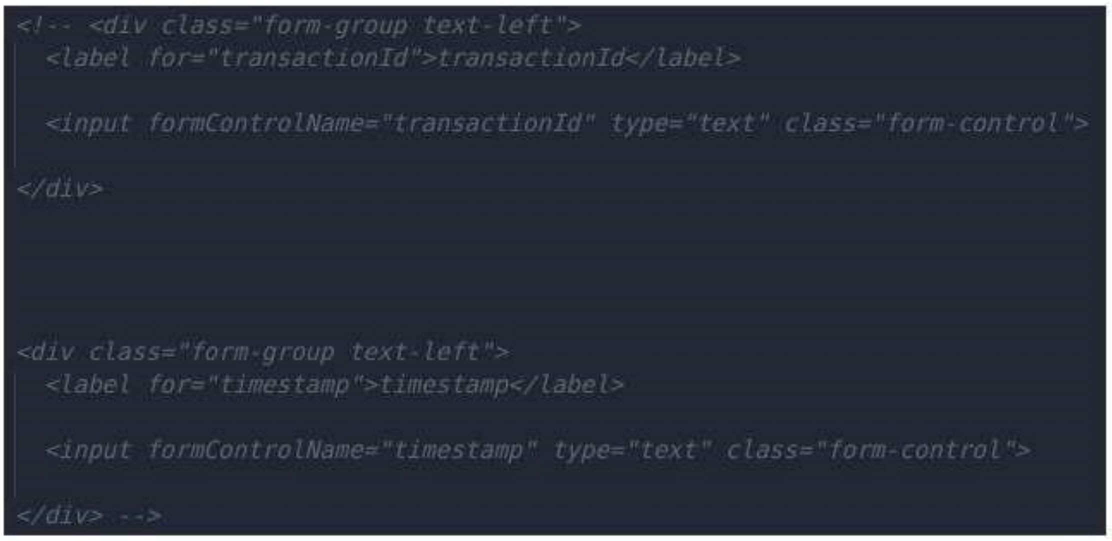
newOwner

transactionId

timestamp

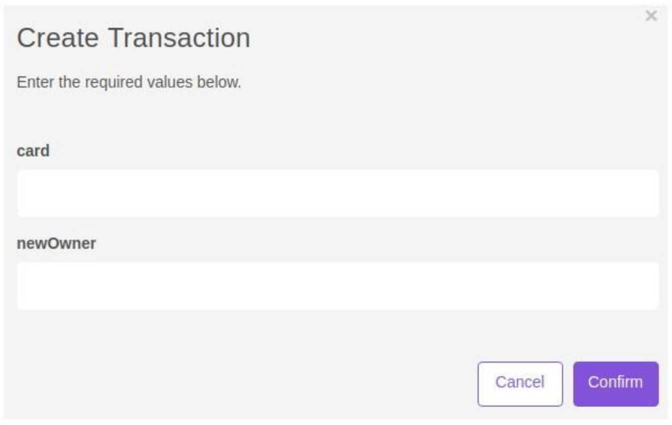
2. Removing unnecessary fields

Just getting the modal to open isn't enough. We can see it requests transactionId and timestamp from us even though we didn't add those fields in our modeling file. Our network stores these values which are intrinsic to all transactions. So, it should be able to figure out these values on it's own. And as it turns out, it actually does. These are spare fields and we can just comment them out, the REST API will handle the rest for us.
In the same file, scroll up to find the input fields and comment out the divs responsible for those input fields inside addTransactionModal



```
<!-- <div class="form-group text-left">
  <label for="transactionId">transactionId</label>

  <input formControlName="transactionId" type="text" class="form-control">

</div>




<div class="form-group text-left">
  <label for="timestamp">timestamp</label>

  <input formControlName="timestamp" type="text" class="form-control">

</div> -->
```

Save your file, open your browser, and press Invoke. You should see this:



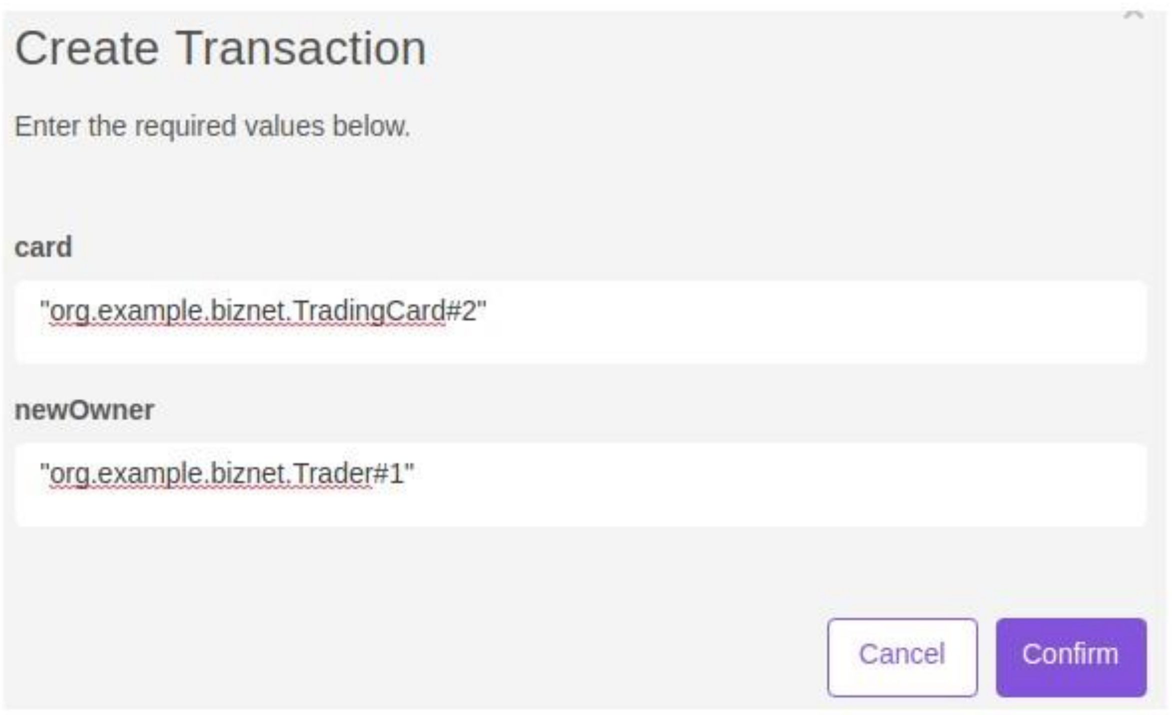
Create Transaction

Enter the required values below.

card

newOwner

You can now create transactions here by passing data in these fields. Since card and newOwner are relationships to other resources, we can do a transaction like this:


Create Transaction

Enter the required values below.

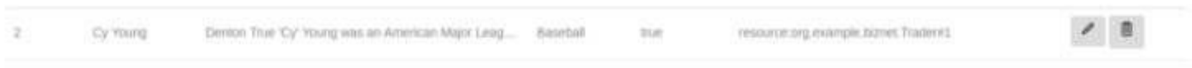
card

"org.example.biznet.TradingCard#2"

newOwner

"org.example.biznet.Trader#1"

Press **Confirm**, go back to the **Assets** page, and you will see that TradingCard#2 now belongs to Trader#1:



2	Cy Young	Denton True 'Cy' Young was an American Major Leag...	Baseball	true	resource:org.example.biznet.Trader#1

Result:

INPUT & OUTPUT:

1. Sample application: which makes calls to the blockchain network, invoking transactions implemented in the chaincode (smart contract). The application is located in the following fabricsamples directory:

```
asset-transfer-basic/application-javascript
```

2. Smart contract itself, implementing the transactions that involve interactions with the ledger. The smart contract (chaincode) is located in the following fabric-samples directory

```
asset-transfer-basic/chaincode-(javascript, java, go, typescript)
```

3. Explore a sample smart contract. We'll inspect the sample assetTransfer (javascript) smart contract to learn about the transactions within it, and how they are used by an application to query and update the ledger.

3. Interact with the smart contract with a sample application. Our application will use the asset Transfer smart contract to create, query, and update assets on the ledger. We'll get into the code of the app and the transactions they create, including initializing the ledger with assets, querying an asset, querying a range of assets, creating a new asset, and transferring an asset to a new owner.

Install the Hyperledger Fabric SDK for Node.js.

If you are on Windows, you can install the windows-build-tools with npm which installs all required compilers and tooling by running the following command

```
npm install --global windows-build-tools
```

Set up the blockchain network

Navigate to the `test-network` subdirectory within your local clone of the `fabric-samples` repository.

```
cd fabric-samples/test-network
```

If you already have a test network running, bring it down to ensure the environment is clean.

```
./network.sh down
```

Launch the Fabric test network using the `network.sh` shell script.

```
./network.sh up createChannel -c mychannel -ca
```

Next, let’s deploy the chaincode by calling the ./network.sh script with the chaincode name and language options.

```
./network.sh deployCC -ccn basic -ccp ../asset-transfer-basic/chaincode-javascript/ -ccl javascript
```

If the chaincode is successfully deployed, the end of the output in your terminal should look similar to below:

```
ommitted chaincode definition for chaincode 'basic' on channel 'mychannel':
ersion: 1.0, Sequence: 1, Endorsement Plugin: escc, Validation Plugin: vscc, Approvals: [Org1MSP:
==================== Query chaincode definition successful on peer0.org2 on channel 'mychannel' ==

==================== Chaincode initialization is not required =====================
```

Sample application

Next, let’s prepare the sample Asset Transfer Javascript application that will be used to interact with the deployed chaincode.

JavaScript Application

Open a new terminal, and navigate to the application-javascript folder.

```
cd asset-transfer-basic/application-javascript
```

This directory contains sample programs that were developed using the Fabric SDK for Node.js. Run the following command to install the application dependencies. It may take up to a minute to complete:

```
npm install
```

This process is installing the key application dependencies defined in the application’s package.json. The most important of which is the fabric-network Node.js module; it enables an application to use identities, wallets, and gateways to connect to channels, submit transactions, and wait for notifications. This tutorial also uses the fabric-ca-client module to enroll users with their respective certificate authorities, generating a valid identity which is then used by the fabric-network module to interact with the blockchain network.

Once npm install completes, everything is in place to run the application. Let’s take a look at the sample

JavaScript application files we will be using in this tutorial. Run the following command to list the files in this directory:

```
ls
```

```
app.js                 node_modules              package.json        package-lock.json
```

Let’s run the application and then step through each of the interactions with the smart contract functions. From the `asset-transfer-basic/application-javascript` directory, run the following command:

```
node app.js
```

In the sample application code below, you will see that after getting reference to the common connection profile path, making sure the connection profile exists, and specifying where to create

the wallet, `enrollAdmin()` is executed and the admin credentials are generated from the Certificate Authority.

```
async function main() {
  try {
    // build an in memory object with the network configuration (also known as a connection profile)
const ccp = buildCCP();

    // build an instance of the fabric ca services client based on
    // the information in the network configuration
    const caClient = buildCAClient(FabricCAServices, ccp);

    // setup the wallet to hold the credentials of the application user     const
wallet = await buildWallet(Wallets, walletPath);

    // in a real application this would be done on an administrative flow, and only once     await
enrollAdmin(caClient, wallet);
```

This command stores the CA administrator’s credentials in the `wallet` directory. You can find administrator’s certificate and private key in the `wallet/admin.id` file

```
Wallet path: /Users/<your_username>/fabric-samples/asset-transfer-basic/application-javascript/wall
Successfully enrolled admin user and imported it into the wallet
```

Because the admin registration step is bootstrapped when the Certificate Authority is started, we only need to enroll the admin.

Second, the application registers and enrolls an application user

Now that we have the administrator’s credentials in a wallet, the application uses the admin user to register and enroll an app user which will be used to interact with the blockchain network. The section of the application code is shown below.

```
// in a real application this would be done only when a new user was required to be added
// and would be part of an administrative flow
await registerAndEnrollUser(caClient, wallet, mspOrg1, org1UserId, 'org1.department1');
```

Scrolling further down in your terminal output, you should see confirmation of the app user registration similar to this:

```
Successfully registered and enrolled user appUser and imported it into the wallet
```

You will notice that in the following lines of application code, the application is getting reference to the Contract using the contract name and channel name via Gateway:

// Create a new gateway instance **for** interacting with the fabric network.
// In a real application this would be **done** as the backend server session is setup **for** // a user that has been verified. const gateway = new Gateway();

try {
  // setup the gateway instance
  // The user will now be able to create connections to the fabric network and be able to // submit transactions and query. All transactions submitted by this gateway will be // signed by this user using the credentials stored **in** the wallet. await gateway.connect(ccp, {
wallet, identity: userId,
    discovery: {enabled: true, asLocalhost: true} // using asLocalhost as this gateway is using a fabric network deployed locally
  });

  // Build a network instance based on the channel where the smart contract is deployed const network = await gateway.getNetwork(channelName);

  // Get the contract from the network.
  const contract = network.getContract(chaincodeName);

When a chaincode package includes multiple smart contracts, on the getContract() API you can specify both the name of the chaincode package and a specific smart contract to target. For example:

```
const contract = await network.getContract('chaincodeName', 'smartContractName');
```

Fourth, the application initializes the ledger with some sample data

The submitTransaction() function is used to invoke the chaincode InitLedger function to populate the ledger with some sample data.

Sample application `'InitLedger'` call

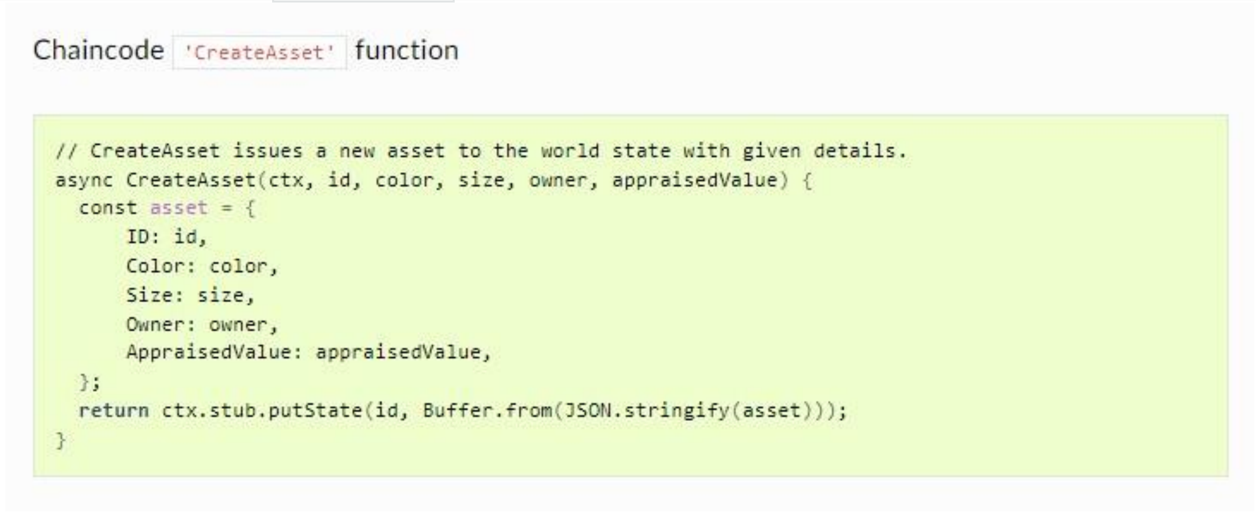
```
// Initialize a set of asset data on the channel using the chaincode 'InitLedger' function.
// This type of transaction would only be run once by an application the first time it was started after it
// deployed the first time. Any updates to the chaincode deployed later would likely not need to run // an
"init" type function.
console.log('\n--> Submit Transaction: InitLedger, function creates the initial set of assets on the ledger');
await contract.submitTransaction('InitLedger');
console.log('*** Result: committed');
```

Chaincode `'InitLedger'` function

```
async InitLedger(ctx) {
    const assets = [
        {
            ID: 'asset1',
            Color: 'blue',
            Size: 5,
            Owner: 'Tomoko',
            AppraisedValue: 300,
        },
        {
            ID: 'asset2',
            Color: 'red',
            Size: 5,
            Owner: 'Brad',
            AppraisedValue: 400,
        },
        {
            ID: 'asset3',
            Color: 'green',
            Size: 10,
            Owner: 'Jin Soo',
            AppraisedValue: 500,
        },
        {
            ID: 'asset4',
            Color: 'yellow',
            Size: 10,
            Owner: 'Max',
            AppraisedValue: 600,
        },
        {
            ID: 'asset5',
            Color: 'black',
            Size: 15,
            Owner: 'Adriana',
            AppraisedValue: 700,
Result: [
     "Key": "asset1",
  "Record": {
       "ID": "asset1",
       "Color": "blue",
       "Size": 5,
       "Owner": "Tomoko",
       "AppraisedValue": 300,
       "docType": "asset"
     }
   },
   {
     "Key": "asset2",
  "Record": {
       "ID": "asset2",
       "Color": "red",
       "Size": 5,
       "Owner": "Brad",
       "AppraisedValue": 400,
       "docType": "asset"
     }
   },
   {
     "Key": "asset3",
  "Record": {
       "ID": "asset3",
       "Color": "green",
       "Size": 10,
       "Owner": "Jin Soo",
       "AppraisedValue": 500,
       "docType": "asset"
     }
   },
   {
     "Key": "asset4",
  "Record": {
       "ID": "asset4",
       "Color": "yellow",
       "Size": 10,
       "Owner": "Max",
       "AppraisedValue": 600,
       "docType": "asset"
     }
   },
   {
     "Key": "asset5",
  "Record": {
       "ID": "asset5",
       "Color": "black",
      "Size": 15,
      "Owner": "Adriana",
      "AppraisedValue": 700,
      "docType": "asset"
    }
  },
  {
    "Key": "asset6",
    "Record": {
      "ID": "asset6",
      "Color": "white",
      "Size": 15,
      "Owner": "Michel",
      "AppraisedValue": 800,
      "docType": "asset"
    }
  }
]
```

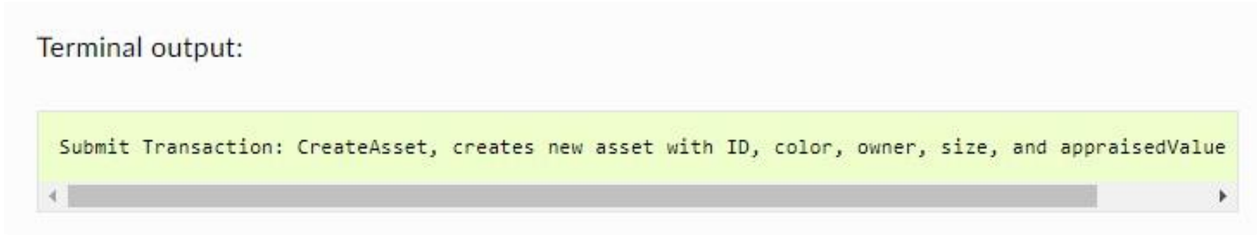
Next, the sample application submits a transaction to create ‘asset13’.

Sample application 'CreateAsset' call



Chaincode 'CreateAsset' function

```
// CreateAsset issues a new asset to the world state with given details.
async CreateAsset(ctx, id, color, size, owner, appraisedValue) {
  const asset = {
      ID: id,
      Color: color,
      Size: size,
      Owner: owner,
      AppraisedValue: appraisedValue,
  };
  return ctx.stub.putState(id, Buffer.from(JSON.stringify(asset)));
}
```



Terminal output:

```
Submit Transaction: CreateAsset, creates new asset with ID, color, owner, size, and appraisedValue
```

Sample application 'ReadAsset' call

Chaincode 'ReadAsset' function

```
// ReadAsset returns the asset stored in the world state with given id.
async ReadAsset(ctx, id) {
  const assetJSON = await ctx.stub.getState(id); // get the asset from chaincode state
  if (!assetJSON || assetJSON.length === 0) {
      throw new Error(`The asset ${id} does not exist`);
  }
  return assetJSON.toString();
}
```

Terminal output:

```
Evaluate Transaction: ReadAsset, function returns an asset with a given assetID
Result: {
  "ID": "asset13",
  "Color": "yellow",
  "Size": "5",
  "Owner": "Tom",
  "AppraisedValue": "1300"
}
```

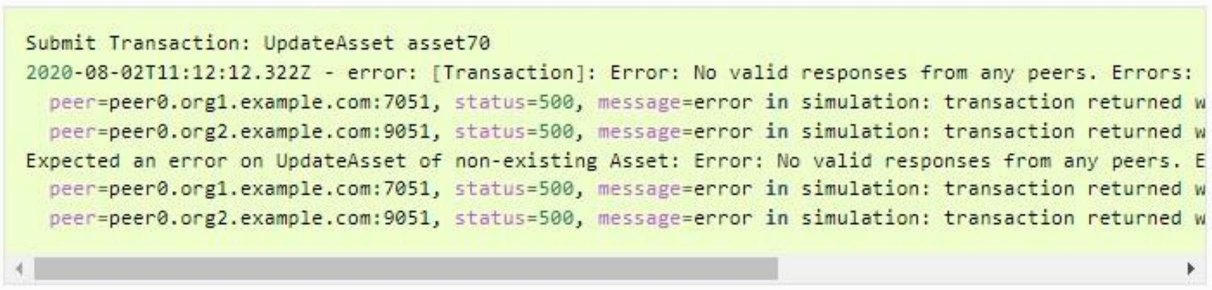
Sample application 'UpdateAsset' call

```
try {
  // How about we try a transactions where the executing chaincode throws an error
  // Notice how the submitTransaction will throw an error containing the error thrown by the chainc
  console.log('\n--> Submit Transaction: UpdateAsset asset70, asset70 does not exist and should ret
  await contract.submitTransaction('UpdateAsset', 'asset70', 'blue', '5', 'Tomoko', '300');
  console.log('******** FAILED to return an error');
} catch (error) {
  console.log(`*** Successfully caught the error: \n    ${error}`);
}
```

Chaincode 'UpdateAsset' functio n

```
// UpdateAsset updates an existing asset in the world state with provided parameters.
async UpdateAsset(ctx, id, color, size, owner, appraisedValue) {
    const exists = await this.AssetExists(ctx, id);
    if (!exists) {
        throw new Error(`The asset ${id} does not exist`);
    }

      // overwriting original asset with new asset
      const updatedAsset = {
          ID: id,
          Color: color,
          Size: size,
          Owner: owner,
          AppraisedValue: appraisedValue,
      };
      return ctx.stub.putState(id, Buffer.from(JSON.stringify(updatedAsset)));
  }
```

Terminal output:



```
Submit Transaction: UpdateAsset asset70
2020-08-02T11:12:12.322Z - error: [Transaction]: Error: No valid responses from any peers. Errors:
  peer=peer0.org1.example.com:7051, status=500, message=error in simulation: transaction returned w
  peer=peer0.org2.example.com:9051, status=500, message=error in simulation: transaction returned w
Expected an error on UpdateAsset of non-existing Asset: Error: No valid responses from any peers. E
  peer=peer0.org1.example.com:7051, status=500, message=error in simulation: transaction returned w
  peer=peer0.org2.example.com:9051, status=500, message=error in simulation: transaction returned w
```

When you are finished using the asset-transfer sample, you can bring down the test network using `network.sh` script.

```
./network.sh down
```

Result:

INPUT & OUTPUT:

1. Set up Hyperledger Fabric network:

You need to set up a Hyperledger Fabric network with a few nodes. Refer to the official documentation for detailed instructions.

2. Define smart contracts:

Define smart contracts to handle fitness club rewards. Here's a simple example in Go:

```
package main import
(
   "encoding/json"
   "fmt"
   "github.com/hyperledger/fabric-contract-api-go/contractapi"
)
type          RewardsContract          struct          {
contractapi.Contract
} type Reward struct
{
   MemberID string `json:"memberID"`
   Points   int    `json:"points"`
}
func (rc *RewardsContract) IssueReward(ctx contractapi.TransactionContextInterface, memberID string,
points int) error {
   reward := Reward{
      MemberID: memberID,
      Points:   points,
   }
   rewardJSON, err := json.Marshal(reward)
   if   err   !=   nil   {
return err
   }
   return ctx.GetStub().PutState(memberID, rewardJSON)
}
func (rc *RewardsContract) GetReward(ctx contractapi.TransactionContextInterface, memberID string)
(*Reward,    error)    {                    rewardJSON,    err    :=
ctx.GetStub().GetState(memberID)
   if    err    !=    nil    {
return nil, err
   }
   if rewardJSON == nil {          return nil, fmt.Errorf("reward for member
%s not found", memberID)
   }
   var    reward    Reward                         err    =
json.Unmarshal(rewardJSON, &reward)
   if    err    !=    nil    {
return nil, err
   }


   return &reward, nil
}
```

3. Develop a web application frontend:

You can use any frontend framework like React, Vue.js, etc. Here's a simple React component to interact with the smart contract: RewardsComponent.js

```
import React, { useState } from 'react';
import { useContract } from './useContract'; // Assume this hook connects to the contract const
RewardsComponent = () => {
   const    [memberID,    setMemberID]    =    useState('');
const [points, setPoints] = useState('');
   const { issueReward, getReward } = useContract();
const handleIssueReward = async () => {          await
issueReward(memberID, points);
   };
   const    handleGetReward    =    async    ()    =>    {
const    reward    =    await    getReward(memberID);
console.log(reward);
```

```
   };
return (
      <div>
         <input type="text" placeholder="Member ID" value={memberID} onChange={(e) =>
setMemberID(e.target.value)} />
         <input type="number" placeholder="Points" value={points} onChange={(e) =>
setPoints(e.target.value)} />
         <button onClick={handleIssueReward}>Issue Reward</button>
         <button onClick={handleGetReward}>Get Reward</button>
      </div>
   );
};
export default RewardsComponent;
```

4. Connect the frontend to the Hyperledger Fabric network:

Use a library like fabric-network to interact with the Hyperledger Fabric network. Implement functions like issueReward and getReward to interact with the smart contract.

Now, integrate this frontend component into your web application. Here's a screenshot of what the UI might look like:

In this example, users can input a member ID and points to issue rewards, and they can retrieve rewards by providing the member ID.

Remember, this is a basic example. In a real-world application, you would need to consider security, scalability, and other factors. Additionally, you'll need to handle user authentication, authorization, and other functionalities as per your requirements.

Result:

INPUT & OUTPUT:

Program:

```
package main
import (
   "encoding/json"

   "fmt"

   "github.com/hyperledger/fabric-contract-api-go/contractapi"

)

type          CarAuctionContract          struct          {

contractapi.Contract

}


 type Auction struct {

   ID         string `json:"id"`

   Car        string `json:"car"`

   HighestBid  int    `json:"highestBid"`

   HighestBidder string `json:"highestBidder"`

}

func (c *CarAuctionContract) CreateAuction(ctx contractapi.TransactionContextInterface, auctionID
string, car string) error {     auction := Auction{

      ID:    auctionID,

      Car:   car,

   }

   auctionJSON, err := json.Marshal(auction)

   if   err   !=   nil   {

return err

   }

   return ctx.GetStub().PutState(auctionID, auctionJSON)

}

func (c *CarAuctionContract) PlaceBid(ctx contractapi.TransactionContextInterface, auctionID string,
bidder string, bidAmount int) error {     auctionJSON, err := ctx.GetStub().GetState(auctionID)
```

```
   if   err   !=   nil   {
return err
   }
   if auctionJSON == nil {         return fmt.Errorf("auction %s
does not exist", auctionID)
   }


   var    auction    Auction                    err    =
json.Unmarshal(auctionJSON, &auction)
   if   err   !=   nil   {
return err
   }
   if        bidAmount        >        auction.HighestBid        {
auction.HighestBid                    =                    bidAmount
auction.HighestBidder = bidder        updatedAuctionJSON,
_    :=    json.Marshal(auction)                              return
ctx.GetStub().PutState(auctionID, updatedAuctionJSON)
   }
   return fmt.Errorf("bid amount should be higher than the current highest bid")
}
func (c *CarAuctionContract) GetAuction(ctx contractapi.TransactionContextInterface, auctionID string)
(*Auction,    error)    {                auctionJSON,    err    :=
ctx.GetStub().GetState(auctionID)
   if   err   !=   nil   {
return nil, err
   }
   if auctionJSON == nil {         return nil, fmt.Errorf("auction %s
does not exist", auctionID)
   }
   var    auction    Auction                    err    =
json.Unmarshal(auctionJSON, &auction)
```

```
   if  err  !=  nil  {
return nil, err
   }
   return &auction, nil
}
```

3. Develop a Node.js application:

Use the Hyperledger Fabric Node SDK to interact with the chaincode. This application will have functions to create auctions, place bids, and retrieve auction results.

```
// app.js const { Gateway, Wallets } = require('fabric-
network'); const path = require('path'); const fs = require('fs');
const ccpPath = path.resolve(__dirname, '..', 'connection.json');
const ccpJSON = fs.readFileSync(ccpPath, 'utf8');
const ccp = JSON.parse(ccpJSON); async
function main() {
   try {           const walletPath = path.join(process.cwd(), 'wallet');
const   wallet   =   await   Wallets.newFileSystemWallet(walletPath);
const gateway = new Gateway();        await gateway.connect(ccp, {
         wallet,           identity: 'user1',
discovery: { enabled: true, asLocalhost: true }
      });
      const   network   =   await   gateway.getNetwork('mychannel');
const contract = network.getContract('carAuction');
      //   Invoke   chaincode   functions   here
await gateway.disconnect();
   }  catch  (error)  {           console.error(`Failed  to  submit
transaction: ${error}`);        process.exit(1);
   }
} main();
```

4. Implement basic functionalities:

Implement functions in `app.js` to interact with the chaincode.

```
async function createAuction(auctionID, car) {     await
contract.submitTransaction('CreateAuction', auctionID, car);
console.log(`Auction ${auctionID} created for car ${car}`);
} async function placeBid(auctionID, bidder, bidAmount)
{     await contract.submitTransaction('PlaceBid',
auctionID, bidder, bidAmount);     console.log(`Bid
placed for auction ${auctionID} by ${bidder} with
amount ${bidAmount}`);
} async function getAuction(auctionID) {     const auctionJSON = await
contract.evaluateTransaction('GetAuction', auctionID);     const auction =
JSON.parse(auctionJSON.toString());     console.log(`Auction ${auctionID}:
${JSON.stringify(auction, null, 2)}`); }
```

Output:

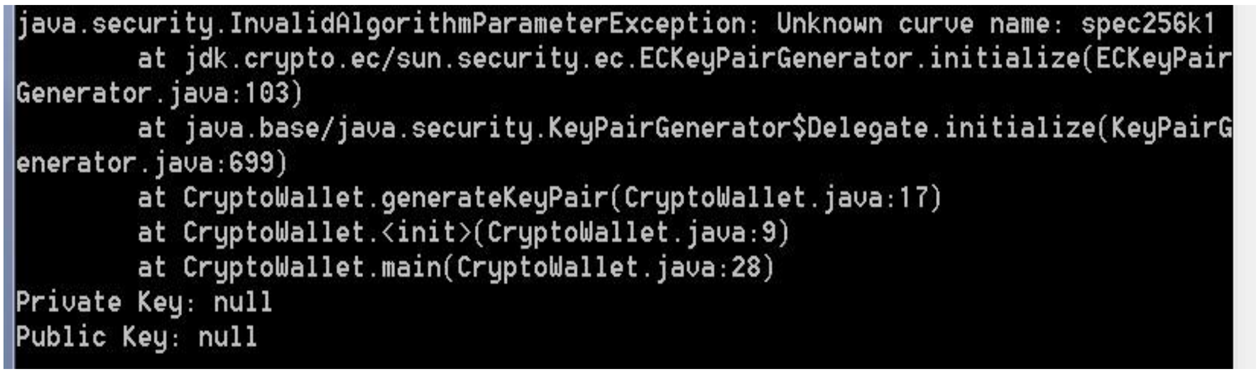
```
Auction CAR123 created for car BMW
Bid placed for auction CAR123 by bidder1 with amount 5000
Auction CAR123: {
  "id": "CAR123",
  "car": "BMW",
  "highestBid": 5000,
  "highestBidder": "bidder1"
}
```

Result:

INPUT :

```
import java.security.*;
import
java.security.spec.ECGenParameterSpec; public
class CryptoWallet { private PrivateKey
privateKey; private PublicKey publicKey;
public CryptoWallet() { generateKeyPair();
}
public void generateKeyPair() { try
{
KeyPairGenerator keyGen = KeyPairGenerator.getInstance("EC");
publicKey = keyPair.getPublic(); } catch (Exception e) {
e.printStackTrace(); }}
public static void main(String[] args) {
CryptoWallet wallet = new CryptoWallet();
System.out.println("Private Key: " + wallet.privateKey);
System.out.println("Public Key: " + wallet.publicKey);
}}
```

EXPECTED OUTPUT:



```
java.security.InvalidAlgorithmParameterException: Unknown curve name: spec256k1
        at jdk.crypto.ec/sun.security.ec.ECKeyPairGenerator.initialize(ECKeyPair
Generator.java:103)
        at java.base/java.security.KeyPairGenerator$Delegate.initialize(KeyPairG
enerator.java:699)
        at CryptoWallet.generateKeyPair(CryptoWallet.java:17)
        at CryptoWallet.<init>(CryptoWallet.java:9)
        at CryptoWallet.main(CryptoWallet.java:28)
Private Key: null
Public Key: null
```

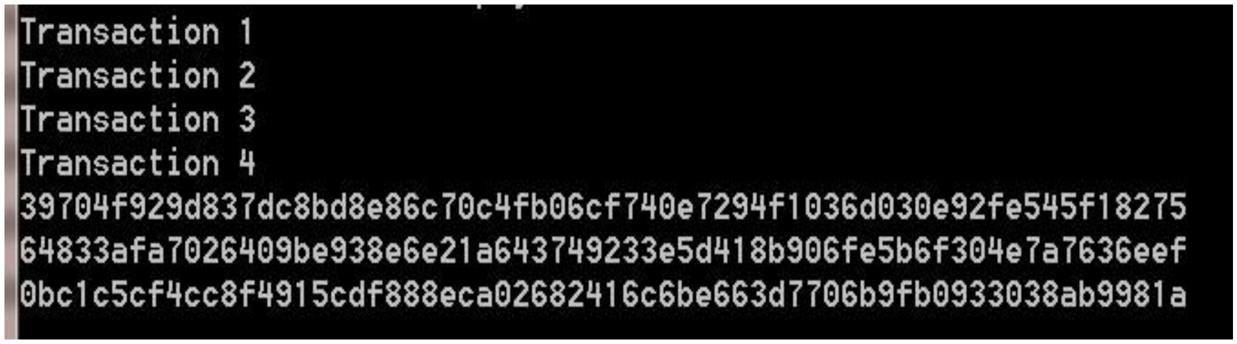
RESULT:

INPUT:

```
Import java.nio.charset.StandardCharsets; Import
java.security.MessageDigest; import
java.security.NoSuchAlgorithmException;  import
java.util.ArrayList; import java.util.List;  public
class MerkleTree {
privateList<String>transactions; private
List<String> merkleTree; public
MerkleTree(List<String> transactions)
{
 this.transactions = transactions;
this.merkleTree = buildMerkleTree(transactions);
}
private String calculateHash(String data)
 {
 try
{
MessageDigest digest = MessageDigest.getInstance("SHA-256"); byte[]
hashBytes = digest.digest(data.getBytes(StandardCharsets.UTF_8));
StringBuilder hexString = new StringBuilder();
for (byte hashByte : hashBytes) {
String hex = Integer.toHexString(0xff &hashByte); if (hex.length() == 1)
{


                    hexString.append('0');
}
hexString.append(hex);
}
return hexString.toString();
} catch
(NoSuchAlgorithmException e) {
e.printStackTrace();
} return null; }
private List<String> buildMerkleTree(List<String> transactions)
 {
List<String> merkleTree = new ArrayList<>(transactions); int
levelOffset = 0;
for (int levelSize = transactions.size(); levelSize> 1;
levelSize = (levelSize + 1) / 2)
{  for (int left = 0; left <levelSize; left +=
2)
{
int right = Math.min(left + 1, levelSize - 1);
String leftHash = merkleTree.get(levelOffset +left);
String rightHash = merkleTree.get(levelOffset +right);
String parentHash = calculateHash(leftHash + rightHash); merkleTree.add(parentHash);
}
levelOffset += levelSize;
} return
merkleTree;
} public
List<String>getMerkleTree()
 {  return
merkleTree;
}
public static void main(String[] args)
```

```
{
List<String> transactions = new
ArrayList<>();
transactions.add("Transaction 1");
transactions.add("Transaction 2");
transactions.add("Transaction 3");
transactions.add("Transaction 4");
MerkleTree merkleTree = new MerkleTree(transactions); List<String> tree =
merkleTree.getMerkleTree(); for (String hash : tree)
{
System.out.println(hash;
}
}
}
```

EXPECTED OUTPUT:



```
Transaction 1
Transaction 2
Transaction 3
Transaction 4
39704f929d837dc8bd8e86c70c4fb06cf740e7294f1036d030e92fe545f18275
64833afa7026409be938e6e21a643749233e5d418b906fe5b6f304e7a7636eef
0bc1c5cf4cc8f4915cdf888eca02682416c6be663d7706b9fb0933038ab9981a
```

RESULT: