Ticket Sale Using Smart Contracts dApp on an Ethereum Blockchain

Use Case

The objective of this project is to demonstrate the ability to develop, test and deploy a Smart Contract decentralized application (dApp) on an Ethereum Blockchain for the following Use Case:

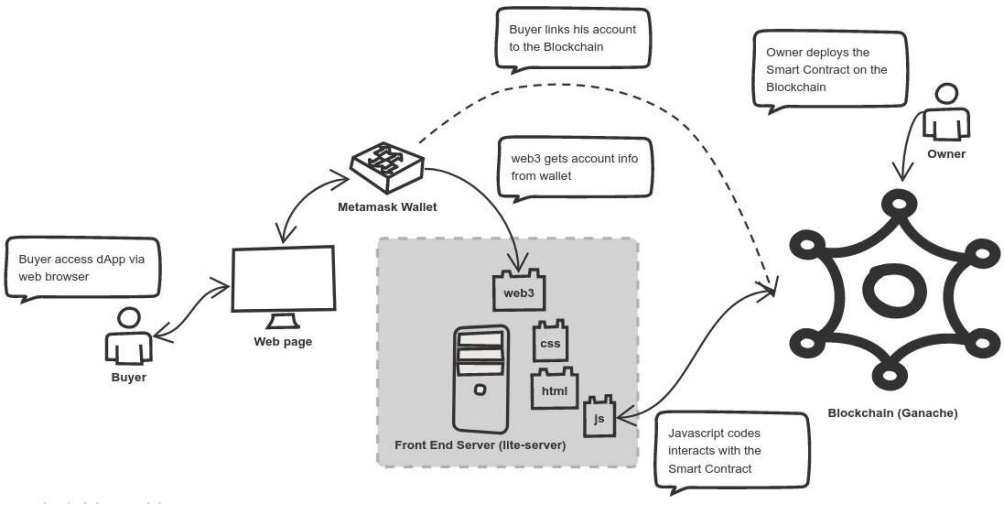
The Blockchain Owner, wishes to sell concert tickets securely to buyers using a Smart Contract running on an Ethereum Blockchain. Buyers can go to a web page to see how many tickets are available for purchase. Buyers can then purchase tickets using their own MetaMask wallets.

Scope of Project

The following are the deliverables:

- A Front End web page
    - Showing tickets available for purchase
    - Allowing buyers to select tickets to purchase
    - Updating tickets available for purchase after each transaction
- A Smart Contract using Solidity deployed on a Blockchain

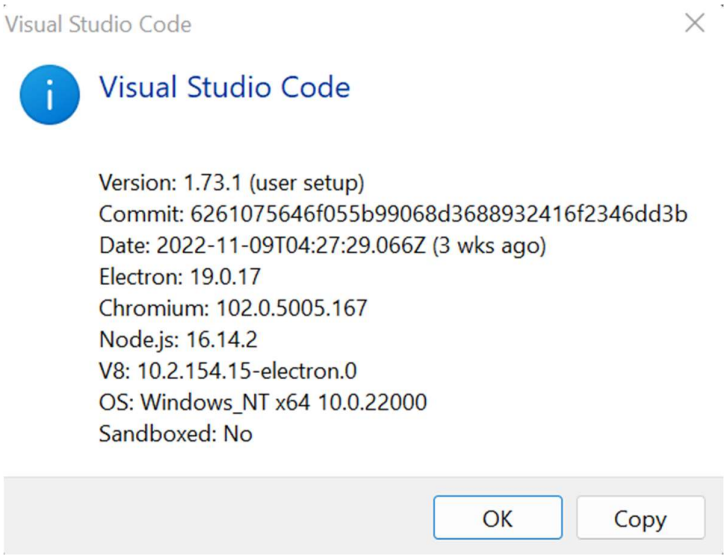
Project Architecture



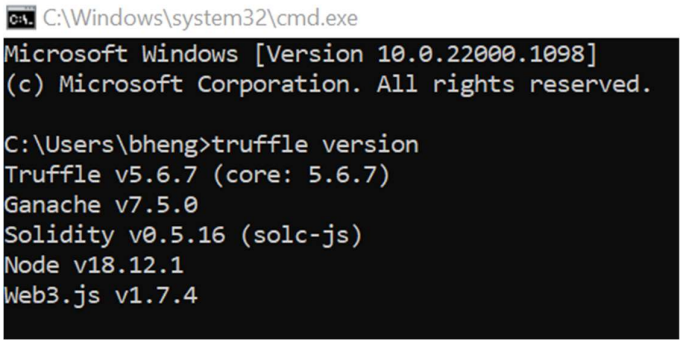
Environment Setup

The following tools are installed for development, testing and deployment:

- **Visual Studios Codes** for code development.



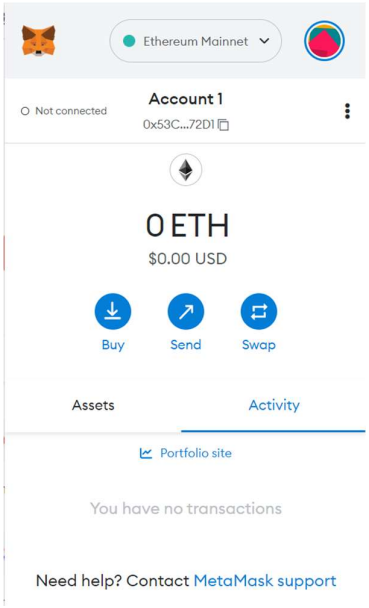
- **Truffle framework** to provide a framework for Smart Contract development, testing and deployment.
- **Ganache** to provide a personal local blockchain for Ethereum development to deploy the Smart Contract, develop applications, and run tests.
- **Solidity** for programming the Smart Contract.
- **Node.js** as a Javascript Runtime for executing Javascript codes.
- **Web3.js** libraries to interact with the Ethereum Blockchain using HTTP, IPC or WebSocket. It can retrieve user accounts, send transactions, interact with smart contracts, and more.
- **lite-server** is local web server bundled in the Truffle framework which will allow us to run the dApp on a browser.



- **Git** and **GitHub** for version control

```
C:\Users\bheng>git version
git version 2.38.1.windows.1
```

- **MetaMask** extension on Chrome browser to allow buyers to connect to the dApp.

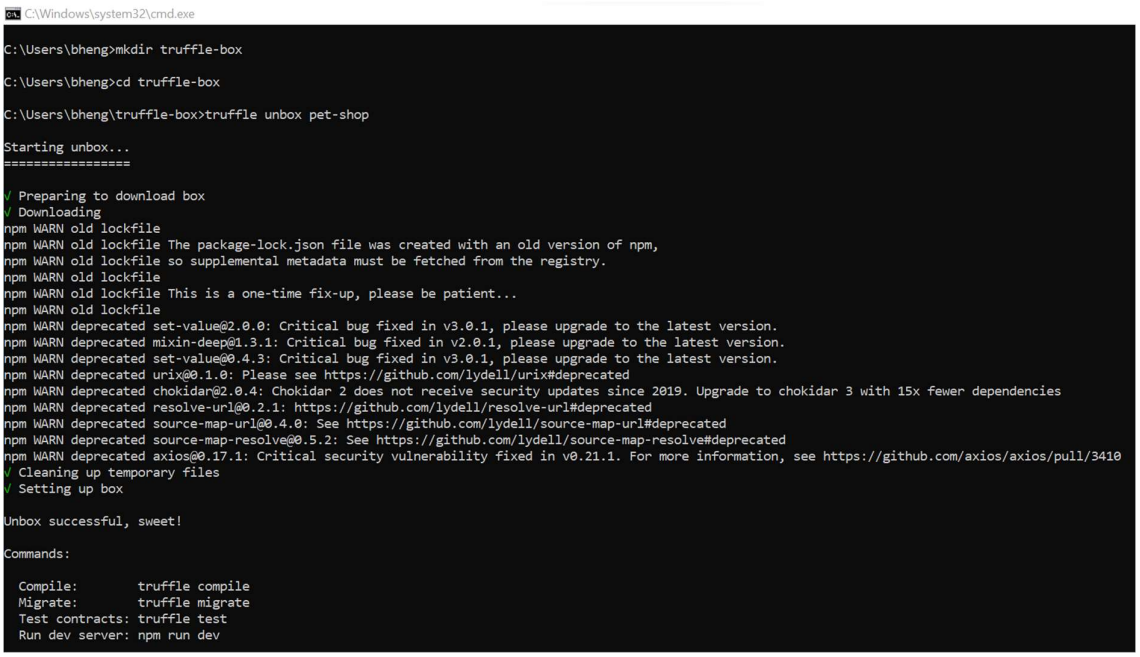


Directory Structure

We can start a project by either downloading a Truffle Box or starting a Truffle project from scratch.

To download a Truffle Box, issue the following commands in a terminal:

```
mkdir truffle-box
cd truffle-box
truffle unbox pet-shop
```



This will create the necessary directories and basic files. The key ones are described below:

- ***/build\contracts*** **directory**
  - **Initially, this directory is empty. But after compilation, two JSON files will be created. They are:**
    - ***Migrations.json*** **– This file contains information about the** ***Migrations.sol*** **contract in JSON format, including its Contract Application Binary Interface (ABI), which is the standard way to interact with contracts in the Ethereum ecosystem, both from outside the blockchain and for contract-to-contract interaction. Data is encoded according to its type, as described in this specification.**
    - ***Ticket.json*** **– As above, but for the** ***Ticket.sol*** **contract.**
- ***/contracts*** directory
  - ***Migrations.sol*** – This Smart Contract is provided as part of the Truffle framework to observe subsequent smart contract migrations and to ensure that we don't double-migrate unchanged contracts in the future. This file has not been modified for this project.
  - ***Ticket.sol*** – This is a new Smart Contract created to implement the required business logic for this project.
- ***/migrations*** directory

    - ***1_initial_migration.js*** – This JS file is provided as part of the Truffle framework to deploy the first contract (***Migrations.sol***). This file has not been modified for this project.
    - ***2_deploy_contracts.js*** – This is a new JS file created to deploy the second contract (***Ticket.sol***) contract.
- ***/src*** directory
    - ***index.html*** – This is a new html file to display the web page.
    - ***tickets.json*** – This is a new JSON file to contain the tickets' information.
- ***/src/images*** directory
    - Contains the JPEG files to be displayed on the web page.
- ***/src/js*** directory
    - ***bootstrap.min.js*** – Provided as part of the Truffle framework to integrate bootstrap libraries. This file has not been modified for this project.
    - ***truffle-contract.js*** – Provided as part of the Truffle framework to manage the Smart Contracts. This file has not been modified for this project.
    - ***web3.min.js*** – Provided as part of the Truffle framework to integrate web3 libraries. This file has not been modified for this project.
    - ***app.js*** – This is a new JS file created to implement the logic tying the Front End, web3 and Smart Contract together.
- ***/test*** directory
    - ***TestTicket.sol*** – This is a new file created to test the contract logic in ***Ticket.sol***
- ***Truffle-config.js***
    - Defines the Blockchain information.
- ***bs-config.json***
    - Tells the lite-server web server where to find the files.

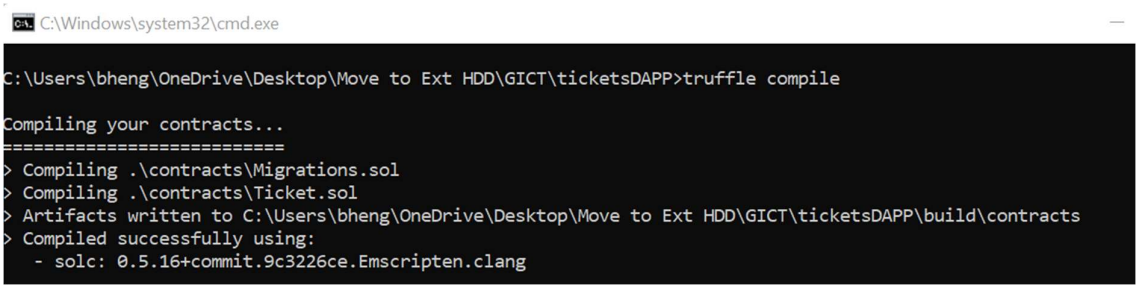
The source codes for the key files are attached in the Appendix.

Compiling the Smart Contracts

First, we need to compile the Solidity codes into bytecode for the Ethereum Virtual Machine (EVM) to execute.

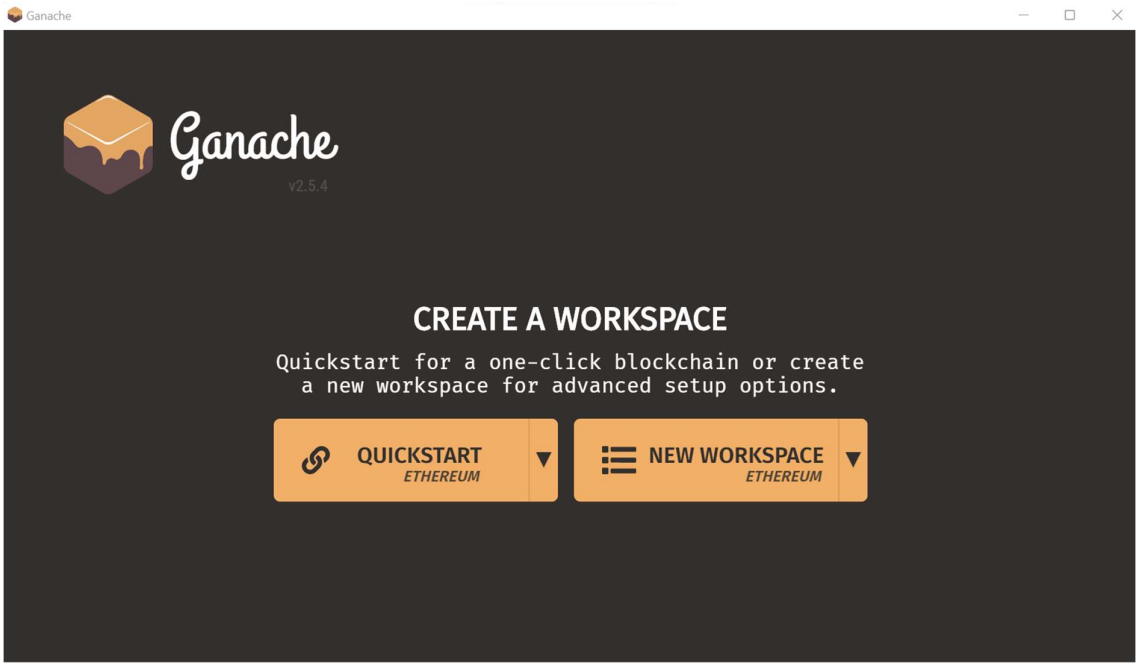
This is done by issuing the following command in the terminal: `truffle compile`

After compilation, the ***Migrations.json*** and ***Ticket.json*** files will be created in the ***/build\contracts*** directory. These files contain information about the ***Migrations.sol*** and ***Ticket.sol*** contracts in JSON format.



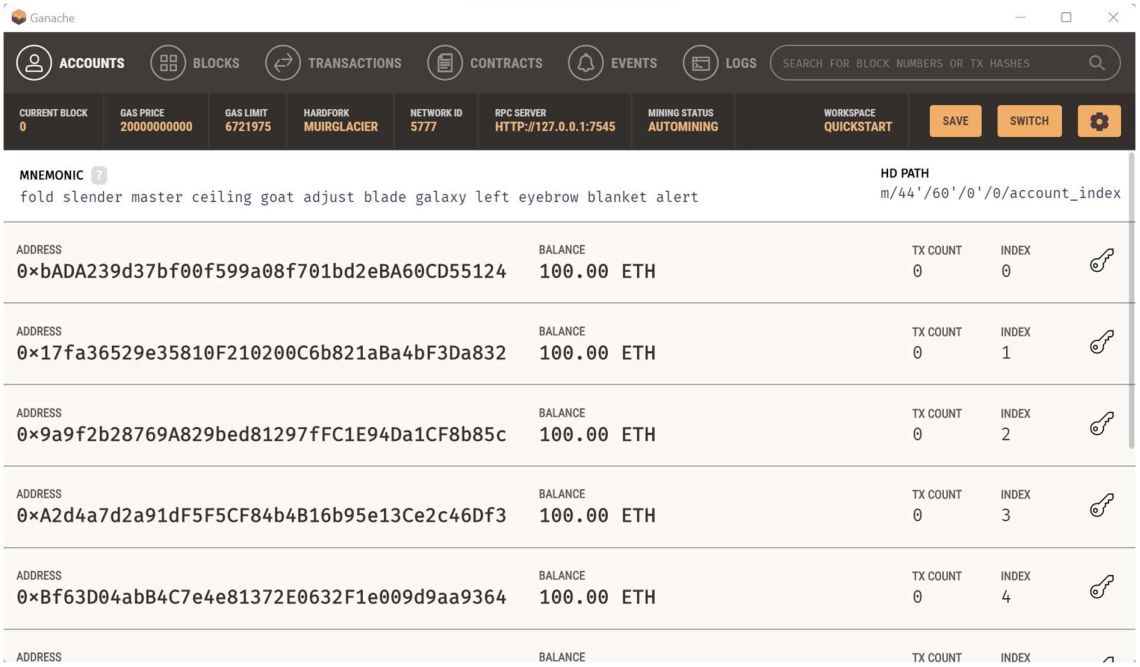
Setting up Ganache

Now we will use Ganache to setup a Ethereum Blockchain so that we can deploy and test the Smart Contract. Setting up the Blockchain is simply done by clicking on the Ganache icon to run the application.

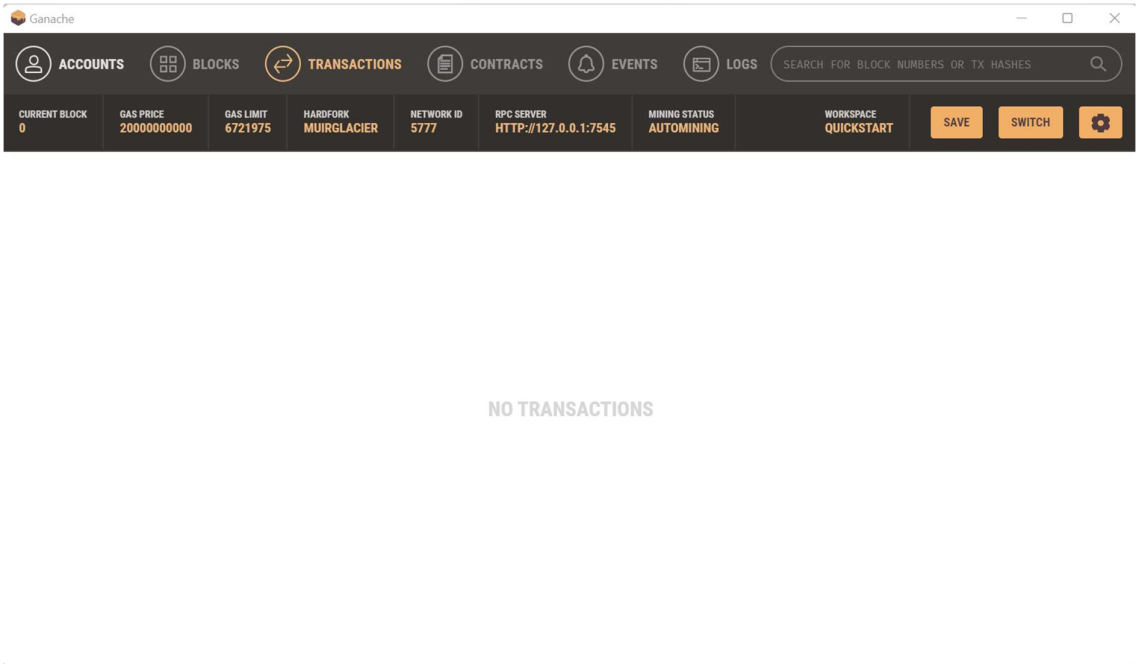


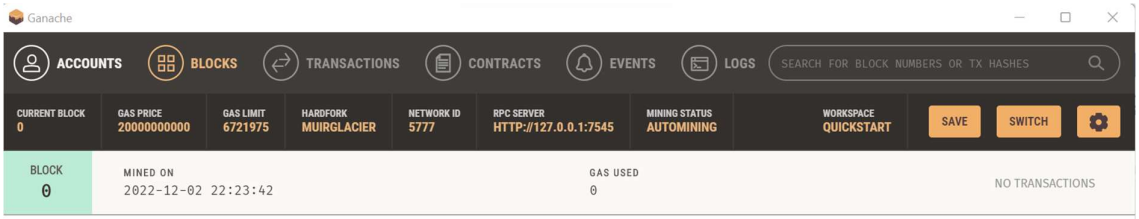
Selecting QuickStart will create a Blockchain with 10 accounts, each with an initial balance of 100 ETH, as shown below in the Accounts tab.

This Blockchain is running locally on port 7545 (see ***truffle-config.js***)



Since no Smart Contract has been deployed, there is currently no Transactions and no Blocks.




Ganache
ACCOUNTS
BLOCKS
TRANSACTIONS
CONTRACTS
EVENTS
LOGS
SEARCH FOR BLOCK NUMBERS OR TX HASHES
CURRENT BLOCK
0
GAS PRICE
20000000000
GAS LIMIT
6721975
HARDFORK
MUIRGLACIER
NETWORK ID
5777
RPC SERVER
HTTP://127.0.0.1:7545
MINING STATUS
AUTOMINING
WORKSPACE
QUICKSTART
SAVE
SWITCH
BLOCK
0
MINED ON
2022-12-02 22:23:42
GAS USED
0
NO TRANSACTIONS

Deploying the first Smart Contract

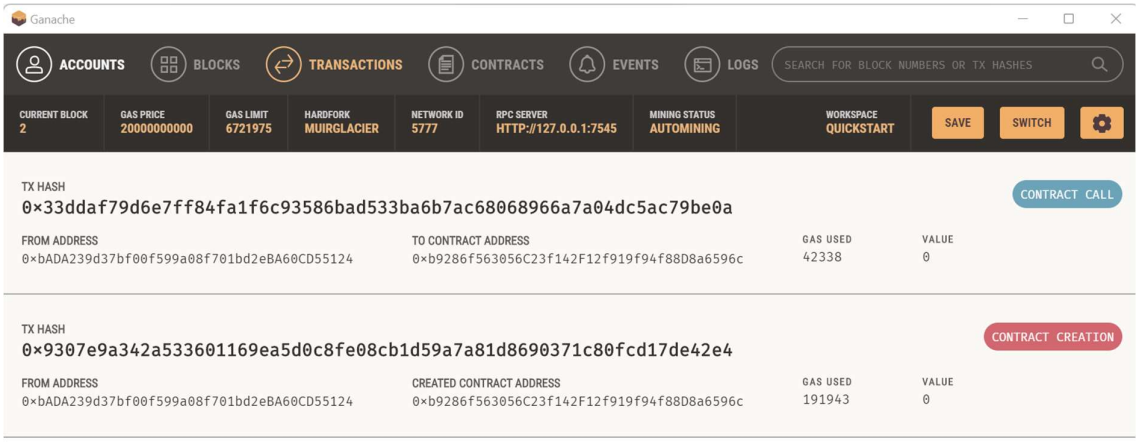
As mentioned earlier, Truffle framework has provided the ***Migrations.sol*** contract to observe subsequent smart contract migrations and to ensure that we don't double-migrate unchanged contracts in the future.

We will now migrate (ie deploy) this contract to the Blockchain (on port 7545) using the ***1_initial_migration.js*** by issuing the command **truffle migrate**

C:\Windows\system32\cmd.exe

```
C:\Users\bheng\OneDrive\Desktop\Move to Ext HDD\GICT\ticketsDAPP>truffle migrate

Compiling your contracts...
===========================
> Compiling .\contracts\Migrations.sol
> Compiling .\contracts\Tickets.sol
> Artifacts written to C:\Users\bheng\OneDrive\Desktop\Move to Ext HDD\GICT\ticketsDAPP\build\contracts
> Compiled successfully using:
   - solc: 0.5.16+commit.9c3226ce.Emscripten.clang


Starting migrations...
======================
> Network name:    'development'
> Network id:      5777
> Block gas limit: 6721975 (0x6691b7)


1_initial_migration.js
======================

   Deploying 'Migrations'
   ----------------------
   > transaction hash:    0x9307e9a342a533601169ea5d0c8fe08cb1d59a7a81d8690371c80fcd17de42e4
   > Blocks: 0            Seconds: 0
   > contract address:    0xb9286f563056C23f142F12f919f94f88D8a6596c
   > block number:        1
   > block timestamp:     1669993508
   > account:             0xbADA239d37bf00f599a08f701bd2eBA60CD55124
   > balance:             99.99616114
   > gas used:            191943 (0x2edc7)
   > gas price:           20 gwei
   > value sent:          0 ETH
   > total cost:          0.00383886 ETH

   > Saving migration to chain.
   > Saving artifacts
   -------------------------------------
   > Total cost:          0.00383886 ETH

Summary
=======
> Total deployments:   1
> Final cost:          0.00383886 ETH
```

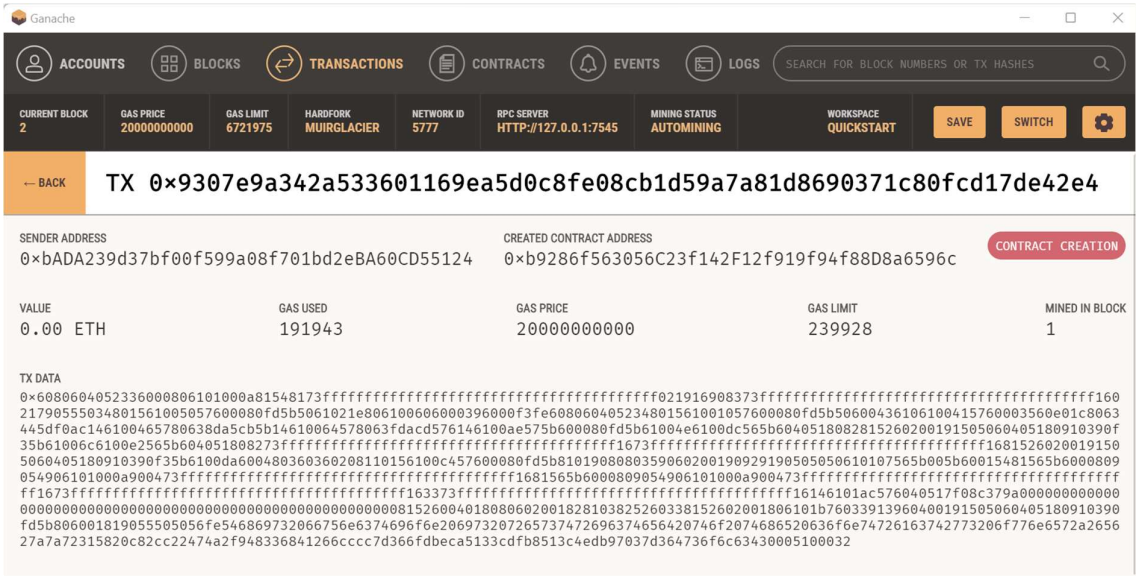
Because of this deployment, two transactions were made. This can be seen in Gananche:



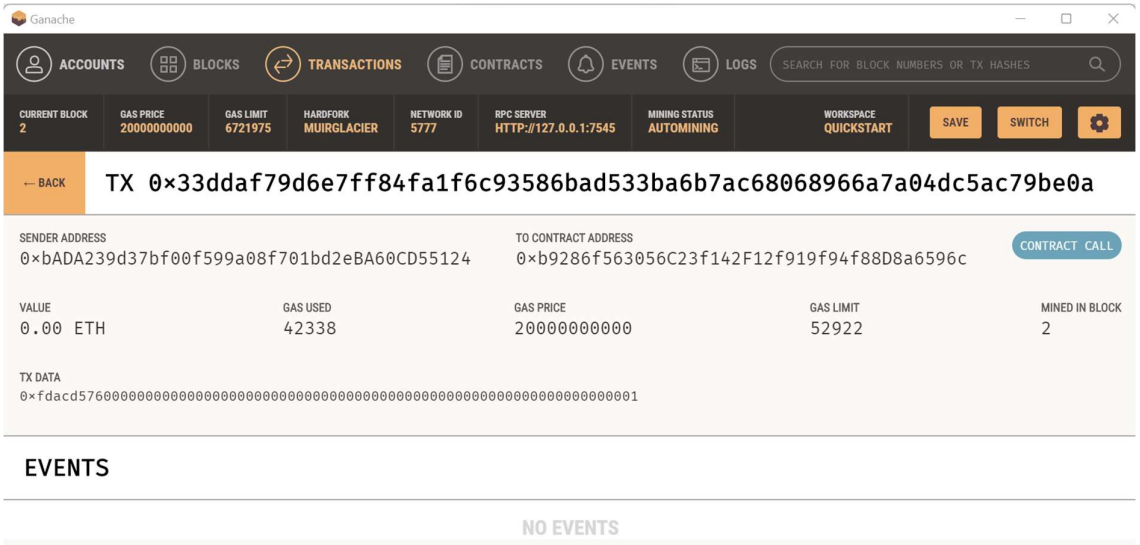
The first transaction (Contract Creation) creates the contract. The Contract Address is **b9286f563056C23f142F12f919f94f88D8a6596c**. The owner of the contract is **bADA239d37bf00f599a08f701bd2eBA60CD55124**, who is also the first account listed in Ganache.

The transaction details are shown below, including the gas fees incurred, the transaction data and transaction hash.

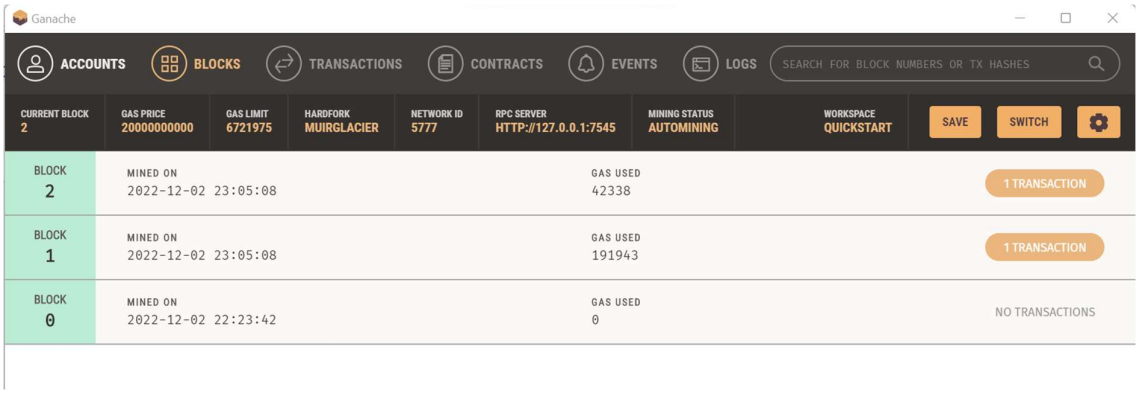
This transaction is mined in Block 1.



The second transaction (Contract Call) made to the same Contract Address by the same owner is mined in Block 2 and has the following details.



The 2 blocks are shown as follows:



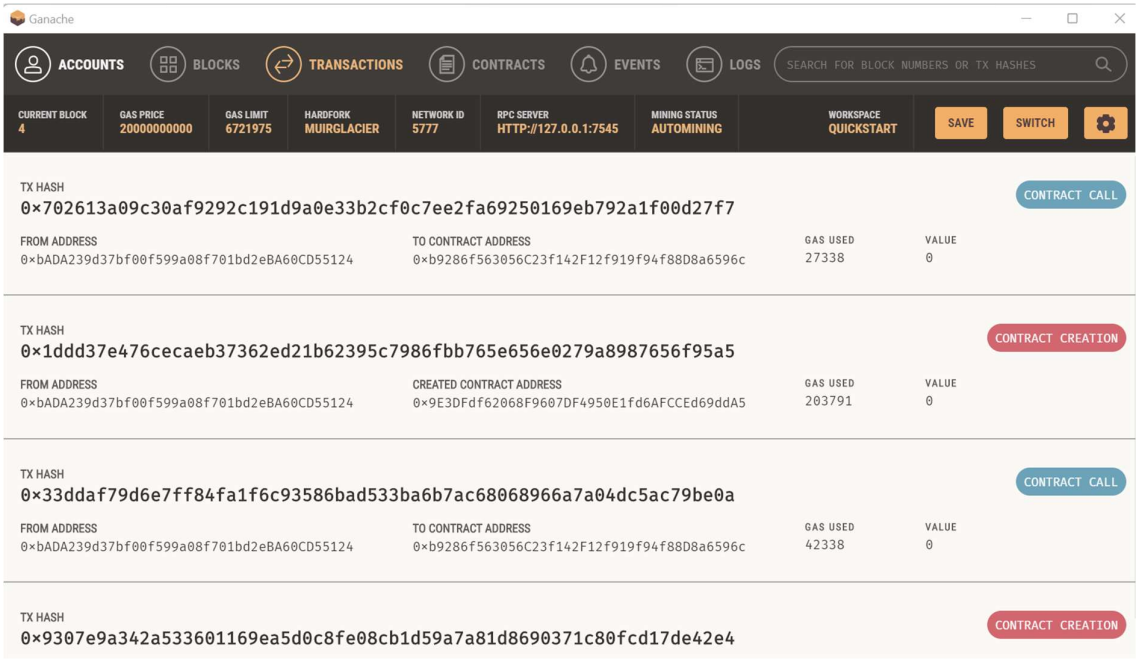
Deploying the second Smart Contract

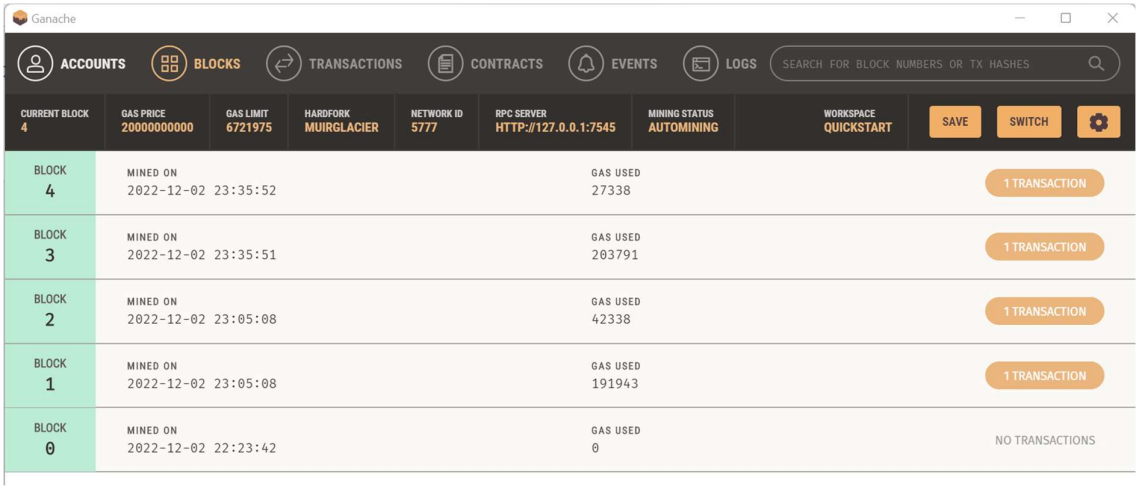
Now, we deploy the second contract `Ticket.sol` contract.

The same `truffle migrate` command is issued. This time, only the `2_deploy_contracts.js` script is executed.

```
2_deploy_contracts.js
=====================

   Replacing 'Ticket'
   ------------------
   > transaction hash:    0x463434341e0621544b0b59dcca275204a3658a04e733fb221e218b353bcfbaa3
   > Blocks: 0            Seconds: 0
   > contract address:    0x63908B122fC057661E886fFf88F00BBD070088E8
   > block number:        3
   > block timestamp:     1670148285
   > account:             0x0e9dED270fB69F35f363fC6AFf2AAaf2F3E00Eec
   > balance:             99.99123784
   > gas used:            203827 (0x31c33)
   > gas price:           20 gwei
   > value sent:          0 ETH
   > total cost:          0.00407654 ETH

   > Saving migration to chain.
   > Saving artifacts
   -------------------------------------
   > Total cost:          0.00407654 ETH

Summary
=======
> Total deployments:   2
> Final cost:          0.0079154 ETH
```

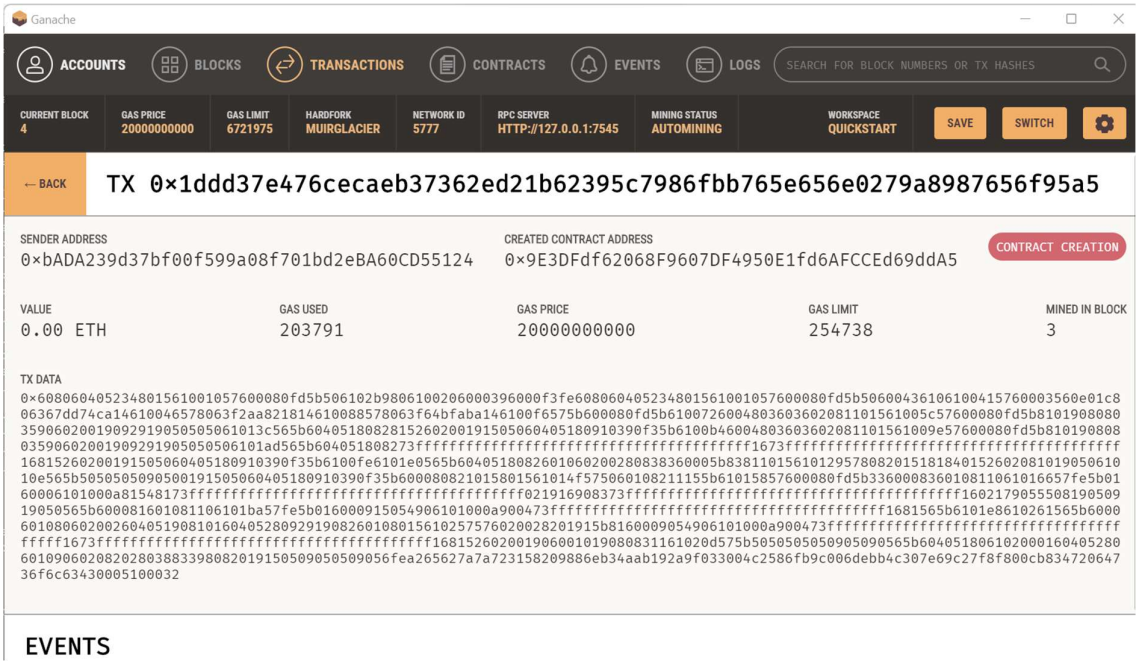
This time, two more transactions were mined in Block 3 and 4.



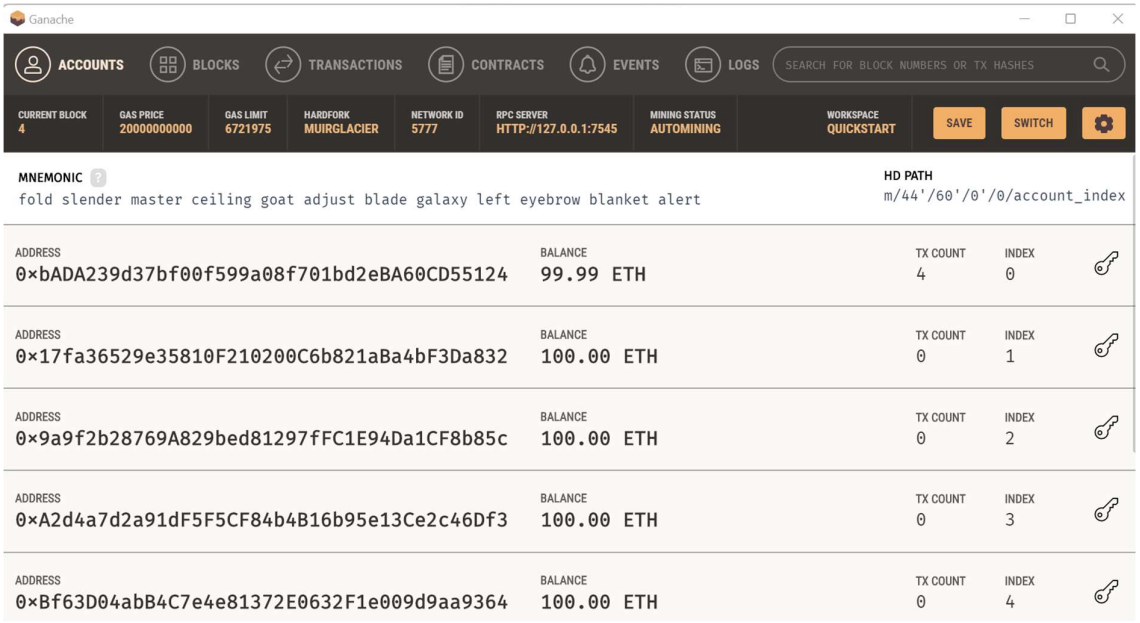


In particular, the transaction in Block 3 is to create the ***`Ticket.sol`*** contract.

The Contract Address is **`9E3DFdf62068F9607DF4950E1fd6AFCCEd69ddA5`**. The owner of the contract is **`bADA239d37bf00f599a08f701bd2eBA60CD55124`**, is the same as before.



The transactions have also incurred additional costs to the owner. His wallet now has a balance of 99.99 ETH.

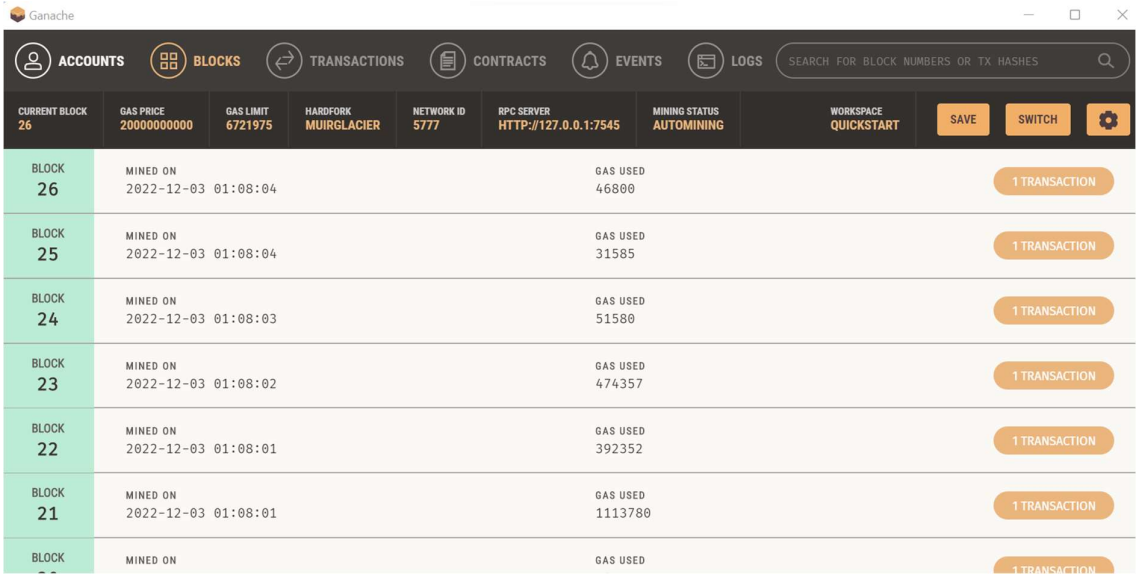

Ganache
ACCOUNTS
BLOCKS
TRANSACTIONS
CONTRACTS
EVENTS
LOGS
SEARCH FOR BLOCK NUMBERS OR TX HASHES
CURRENT BLOCK 4
GAS PRICE 20000000000
GAS LIMIT 6721975
HARDFORK MUIRGLACIER
NETWORK ID 5777
RPC SERVER HTTP://127.0.0.1:7545
MINING STATUS AUTOMINING
WORKSPACE QUICKSTART
SAVE
SWITCH
MNEMONIC
fold slender master ceiling goat adjust blade galaxy left eyebrow blanket alert
HD PATH
m/44'/60'/0'/0/account_index
ADDRESS 0×bADA239d37bf00f599a08f701bd2eBA60CD55124 BALANCE 99.99 ETH TX COUNT 4 INDEX 0
ADDRESS 0×17fa36529e35810F210200C6b821aBa4bF3Da832 BALANCE 100.00 ETH TX COUNT 0 INDEX 1
ADDRESS 0×9a9f2b28769A829bed81297fFC1E94Da1CF8b85c BALANCE 100.00 ETH TX COUNT 0 INDEX 2
ADDRESS 0×A2d4a7d2a91dF5F5CF84b4B16b95e13Ce2c46Df3 BALANCE 100.00 ETH TX COUNT 0 INDEX 3
ADDRESS 0×Bf63D04abB4C7e4e81372E0632F1e009d9aa9364 BALANCE 100.00 ETH TX COUNT 0 INDEX 4

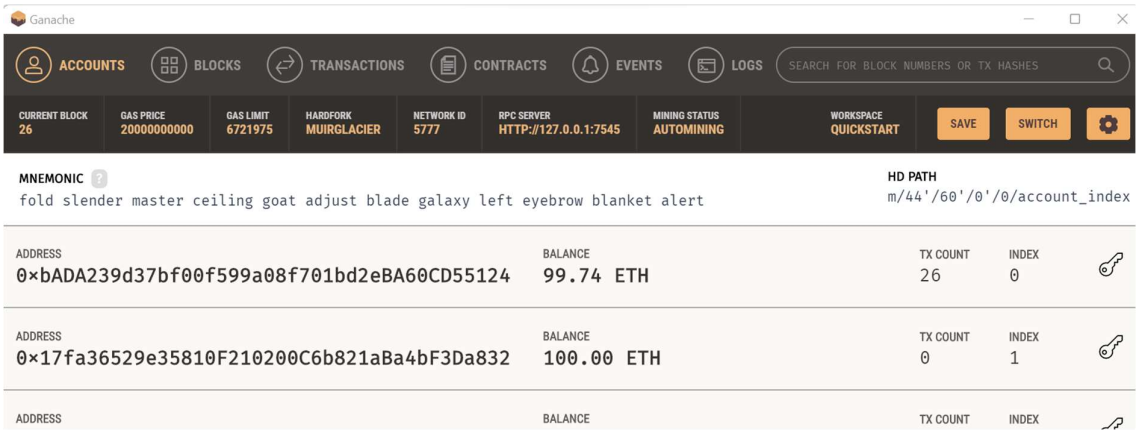
Testing the Smart Contract

Now, we use the `truffle test` command to execute the ***`TestTicket.sol`*** script in order test the logic in ***`Ticket.sol`*** contract.

```
C:\Users\bheng\OneDrive\Desktop\Move to Ext HDD\GICT\ticketsDAPP>truffle test
Using network 'development'.


Compiling your contracts...
===========================
> Compiling .\contracts\Migrations.sol
> Compiling .\contracts\Ticket.sol
> Compiling .\test\TestTicket.sol
> Compiling truffle\Assert.sol
> Compiling truffle\AssertAddress.sol
> Compiling truffle\AssertAddressArray.sol
> Compiling truffle\AssertBalance.sol
> Compiling truffle\AssertBool.sol
> Compiling truffle\AssertBytes32.sol
> Compiling truffle\AssertBytes32Array.sol
> Compiling truffle\AssertGeneral.sol
> Compiling truffle\AssertInt.sol
> Compiling truffle\AssertIntArray.sol
> Compiling truffle\AssertString.sol
> Compiling truffle\AssertUint.sol
> Compiling truffle\AssertUintArray.sol
> Compiling truffle\DeployedAddresses.sol
> Artifacts written to C:\Users\bheng\AppData\Local\Temp\test--2760-dJI89fJrJjvc
> Compiled successfully using:
   - solc: 0.5.16+commit.9c3226ce.Emscripten.clang


  TestTicket
    √ testBuyTicket (682ms)
    √ testGetBuyerAddressByTicketID (586ms)
    √ testGetBuyerAddressByTicketIDInArray (554ms)


  3 passing (17s)
```

Running the test has also created a number of transactions, which also resulted in some ETH being used up (99.74 ETH now).

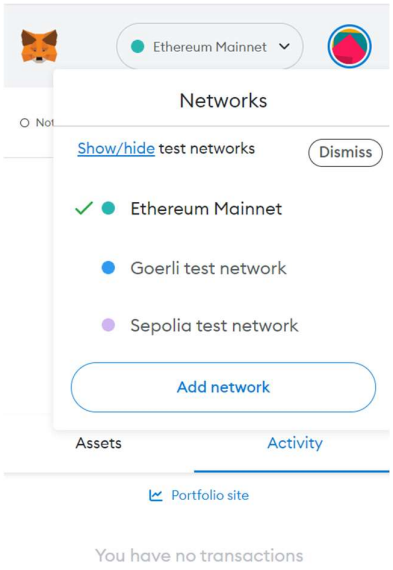

Ganache
ACCOUNTS
BLOCKS
TRANSACTIONS
CONTRACTS
EVENTS
LOGS
SEARCH FOR BLOCK NUMBERS OR TX HASHES
CURRENT BLOCK 26
GAS PRICE 20000000000
GAS LIMIT 6721975
HARDFORK MUIRGLACIER
NETWORK ID 5777
RPC SERVER HTTP://127.0.0.1:7545
MINING STATUS AUTOMINING
WORKSPACE QUICKSTART
SAVE
SWITCH
BLOCK 26 MINED ON 2022-12-03 01:08:04 GAS USED 46800 1 TRANSACTION
BLOCK 25 MINED ON 2022-12-03 01:08:04 GAS USED 31585 1 TRANSACTION
BLOCK 24 MINED ON 2022-12-03 01:08:03 GAS USED 51580 1 TRANSACTION
BLOCK 23 MINED ON 2022-12-03 01:08:02 GAS USED 474357 1 TRANSACTION
BLOCK 22 MINED ON 2022-12-03 01:08:01 GAS USED 392352 1 TRANSACTION
BLOCK 21 MINED ON 2022-12-03 01:08:01 GAS USED 1113780 1 TRANSACTION
BLOCK MINED ON GAS USED

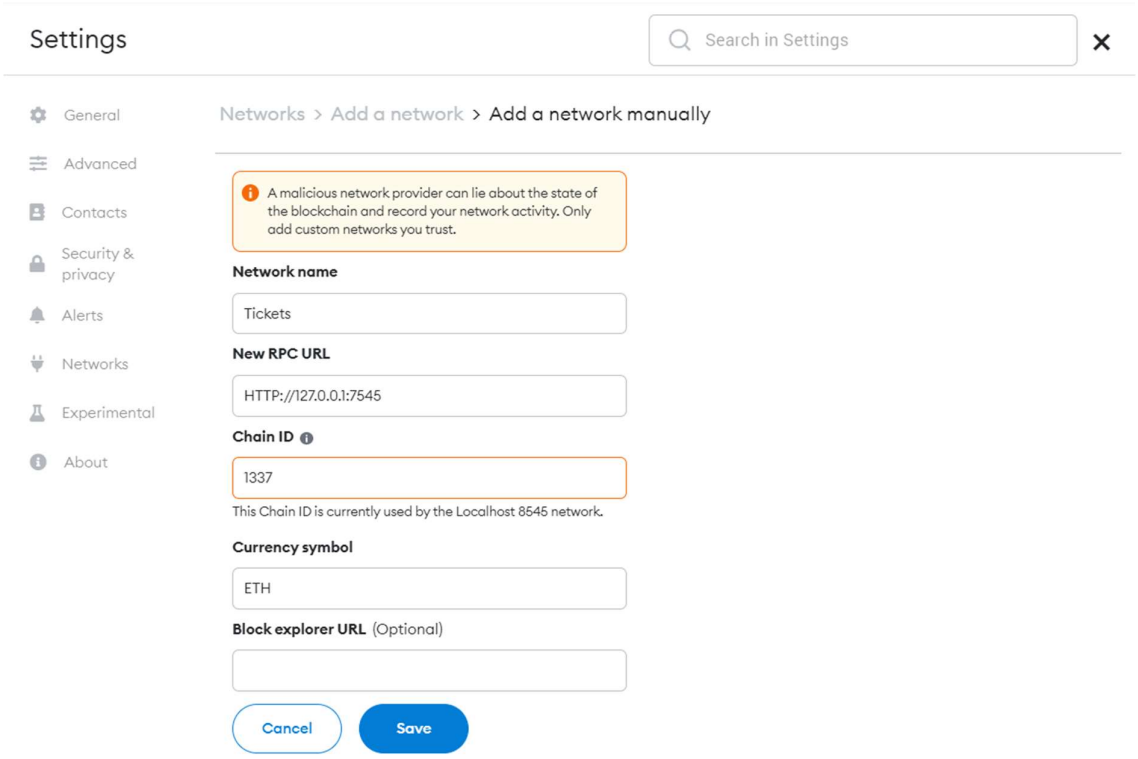

Ganache
ACCOUNTS
BLOCKS
TRANSACTIONS
CONTRACTS
EVENTS
LOGS
SEARCH FOR BLOCK NUMBERS OR TX HASHES
CURRENT BLOCK 26
GAS PRICE 20000000000
GAS LIMIT 6721975
HARDFORK MUIRGLACIER
NETWORK ID 5777
RPC SERVER HTTP://127.0.0.1:7545
MINING STATUS AUTOMINING
WORKSPACE QUICKSTART
SAVE
SWITCH
MNEMONIC
fold slender master ceiling goat adjust blade galaxy left eyebrow blanket alert
HD PATH
m/44'/60'/0'/0/account_index
ADDRESS 0×bADA239d37bf00f599a08f701bd2eBA60CD55124 BALANCE 99.74 ETH TX COUNT 26 INDEX 0
ADDRESS 0×17fa36529e35810F210200C6b821aBa4bF3Da832 BALANCE 100.00 ETH TX COUNT 0 INDEX 1
ADDRESS BALANCE TX COUNT INDEX

Setting up the Metamask wallet for the Buyer

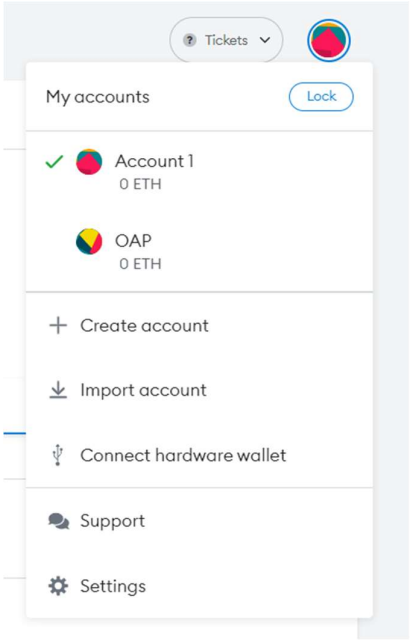
Prior to using the dApp, the buyer needs to set up his MetaMask wallet first.

First, we need to add the Ganache Blockchain network.

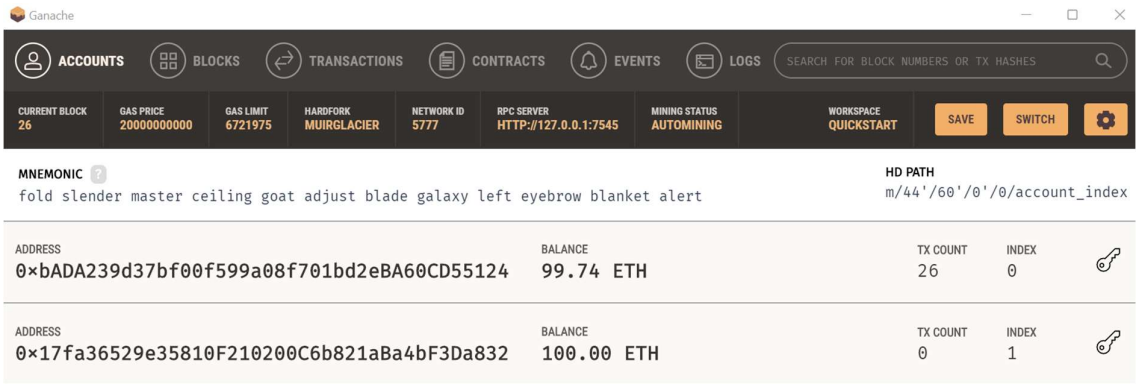




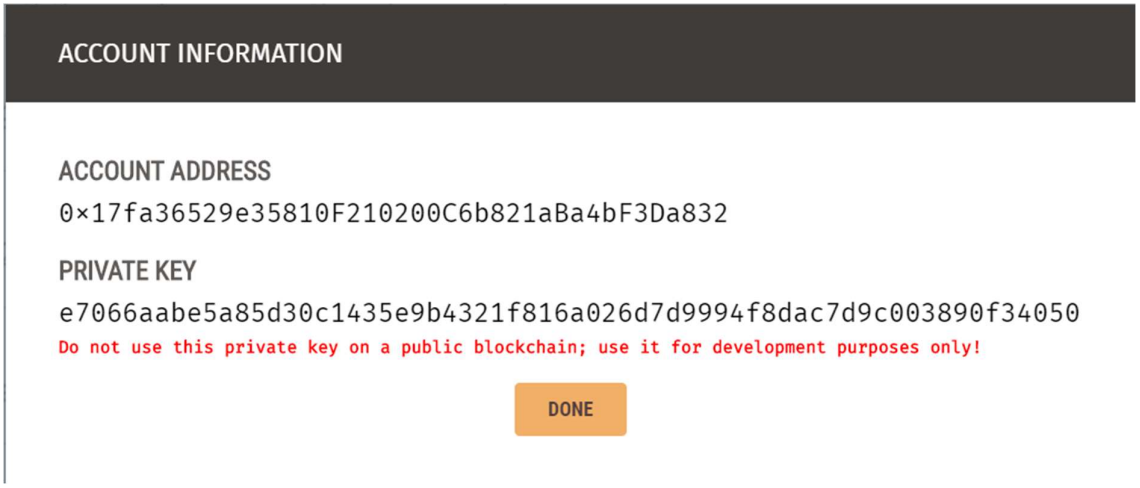
Now, we import an account into Metamask.



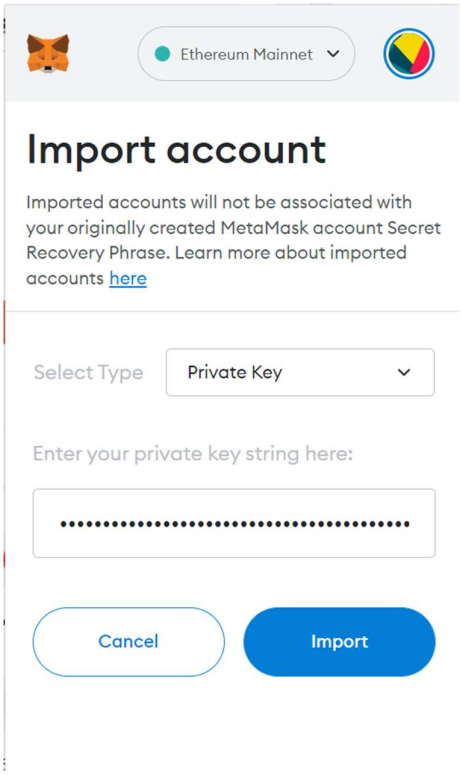
For this example, let’s use the second account in Ganache.



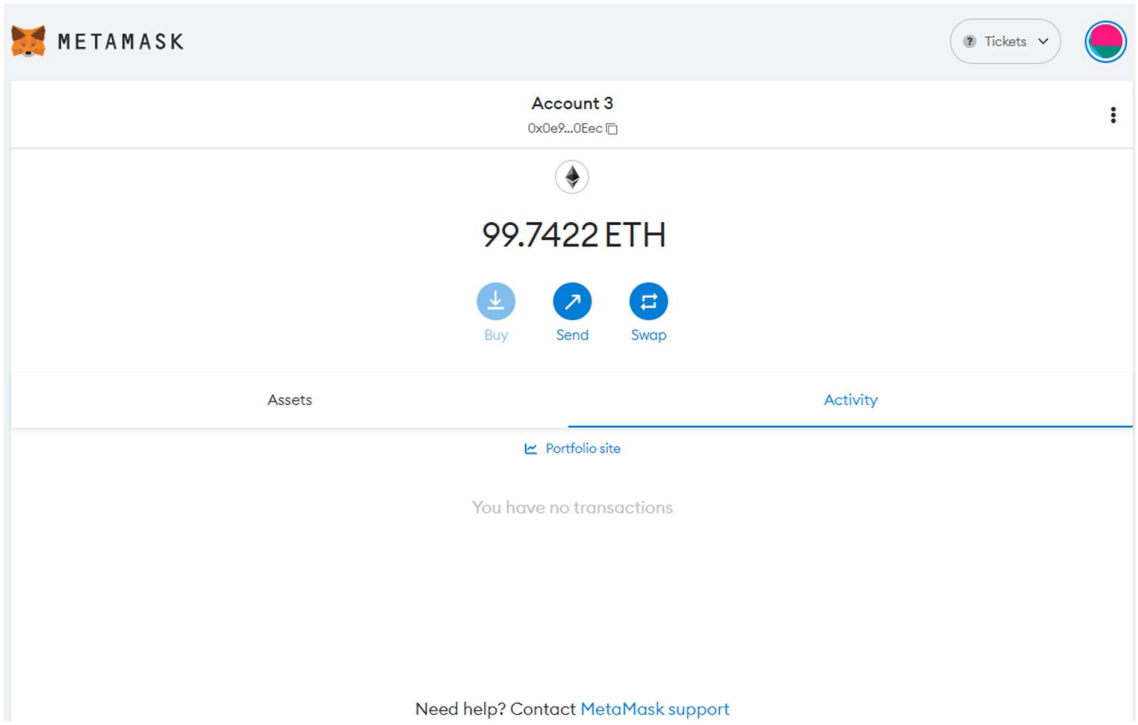
Copy the private key for the account.



Paste it into Metamask.



A new account will be created and connected to the “Tickets” network.


METAMASK
Tickets
Account 3
0x0e9...0Eec
99.7422 ETH
Buy
Send
Swap
Assets
Activity
Portfolio site
You have no transactions
Need help? Contact MetaMask support

Using the dApp

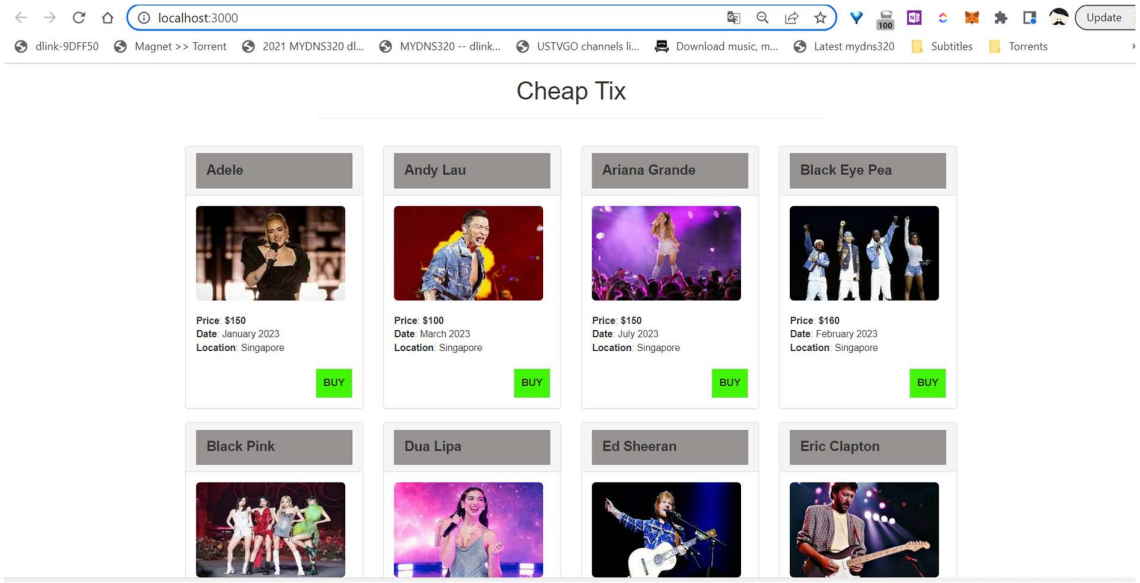
First, we start the local web server by issuing this command **`npm run dev`**

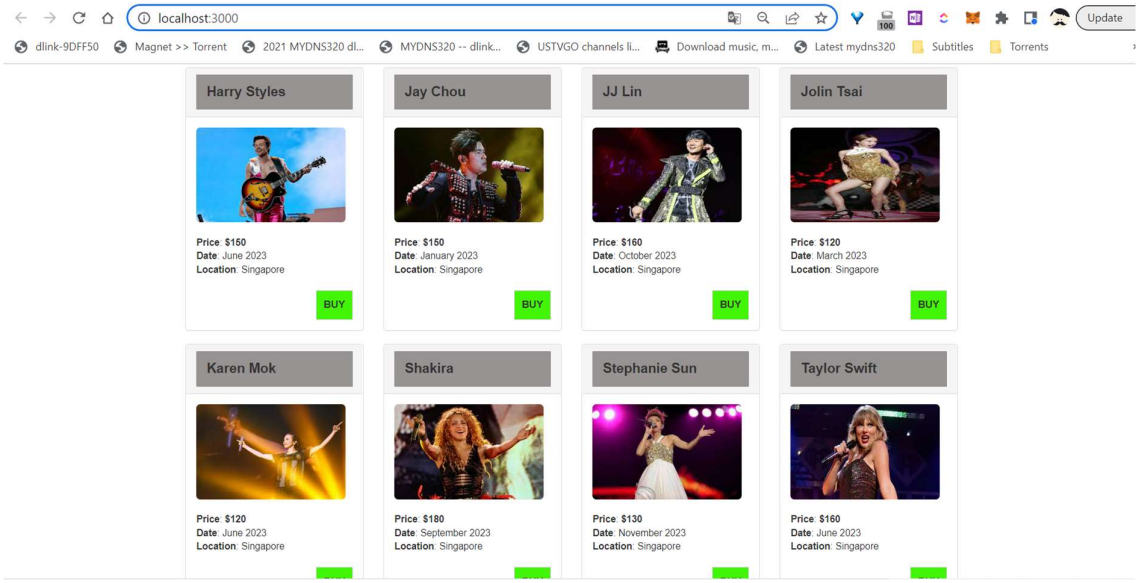
lite-server

```
C:\Users\bheng\OneDrive\Desktop\Move to Ext HDD\GICT\ticketsDAPP>npm run dev

> ticketsDAPP@1.0.0 dev
> lite-server

** browser-sync config **
{
  injectChanges: false,
  files: [ './**/*.{html,htm,css,js}' ],
  watchOptions: { ignored: 'node_modules' },
  server: {
    baseDir: [ './src', './build/contracts' ],
    middleware: [ [Function (anonymous)], [Function (anonymous)] ]
  }
}
[Browsersync] Access URLs:
 ------------------------------------
       Local: http://localhost:3000
    External: http://192.168.18.30:3000
 ------------------------------------
          UI: http://localhost:3001
 UI External: http://localhost:3001
 ------------------------------------
[Browsersync] Serving files from: ./src
[Browsersync] Serving files from: ./build/contracts
[Browsersync] Watching files...
22.12.03 20:28:50 200 GET /index.html
22.12.03 20:28:50 200 GET /css/bootstrap.min.css
22.12.03 20:28:50 200 GET /js/bootstrap.min.js
22.12.03 20:28:50 200 GET /js/web3.min.js
22.12.03 20:28:50 200 GET /js/app.js
22.12.03 20:28:50 200 GET /js/truffle-contract.js
22.12.03 20:28:51 200 GET /Tickets.json
22.12.03 20:28:51 404 GET /images/adele.jpeg
22.12.03 20:28:51 404 GET /images/andylau.jpeg
```

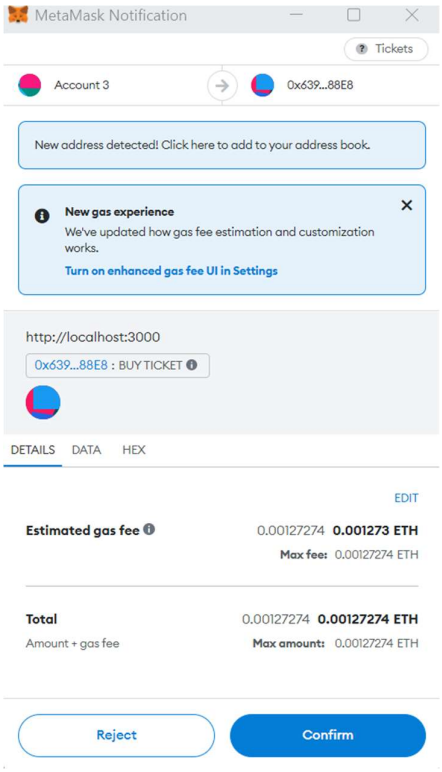
```
22.12.03 20:28:51 404 GET /images/arianagrande.jpeg
22.12.03 20:28:51 404 GET /images/blackeyepea.jpeg
22.12.03 20:28:51 404 GET /images/dualipa.jpeg
22.12.03 20:28:51 404 GET /images/blackpink.jpeg
22.12.03 20:28:51 404 GET /images/edsheeran.jpeg
22.12.03 20:28:51 404 GET /images/ericclapton.jpeg
22.12.03 20:28:51 404 GET /images/harrystyles.jpeg
22.12.03 20:28:51 404 GET /images/jaychou.jpeg
22.12.03 20:28:51 404 GET /images/jj.jpeg
22.12.03 20:28:51 404 GET /images/jolintsai.jpeg
22.12.03 20:28:51 404 GET /images/karenmok.jpeg
22.12.03 20:28:51 404 GET /images/shakira.jpeg
22.12.03 20:28:51 404 GET /images/stephaniesun.jpeg
22.12.03 20:28:51 404 GET /images/taylorswift.jpeg
22.12.03 20:28:52 304 GET /Tickets.json
```

On the browser, the following web page will appear.



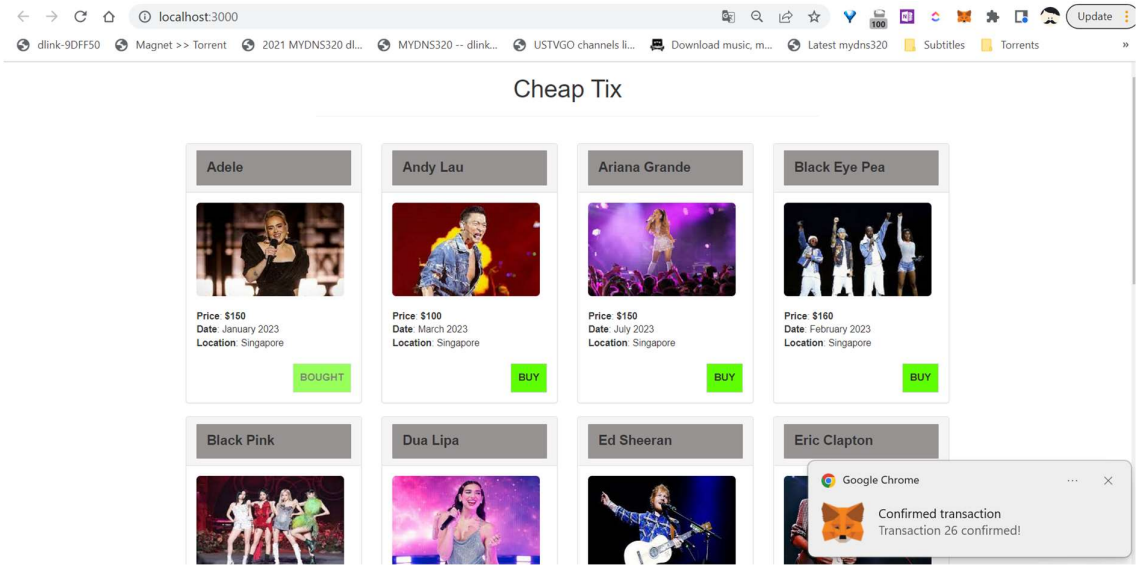


Buyer can now purchase any of the tickets by clicking on any of the BUY buttons. The Metamask for the account we just imported will pop up.



Click on “Confirm” to confirm the purchase.

The ticket will be shown as “BOUGHT” and a small pop up will appear confirming the transaction.


localhost:3000
Update
dlink-9DFF50
Magnet >> Torrent
2021 MYDNS320 dl...
MYDNS320 -- dlink...
USTVGO channels li...
Download music, m...
Latest mydns320
Subtitles
Torrents
Cheap Tix
Adele
Price: $150
Date: January 2023
Location: Singapore
BOUGHT
Andy Lau
Price: $100
Date: March 2023
Location: Singapore
BUY
Ariana Grande
Price: $150
Date: July 2023
Location: Singapore
BUY
Black Eye Pea
Price: $160
Date: February 2023
Location: Singapore
BUY
Black Pink
Dua Lipa
Ed Sheeran
Eric Clapton
Google Chrome
Confirmed transaction
Transaction 26 confirmed!

Tickets.sol

```
pragma solidity ^0.5.0;
contract Ticket {
    // Array containing each ticket's buyer's Ethereum Address.
    // Index to array is 0 to 15 (16 tickets)
    address[16] public buyers;
    // Buy ticket
    function buyTicket(uint _ticketID) public returns (uint) {
        // Make sure that the _ticketID is between 0 and 15
        require(_ticketID >= 0 && _ticketID <= 16);
        // Write the buyer's Address into the array
        buyers[_ticketID] = msg.sender;
        // Return the _ticketID for confirmation
        return _ticketID;
    }
    // Get all the buyers
    function getBuyers() public view returns (address[16] memory) {
        // Return the array of buyers
        return buyers;
    }
}
```

2_deploy_contracts.js

```
// This is the script to deploy the Ticket.sol contract.

// Get the contract information from Ticket.json
var Ticket = artifacts.require("Ticket");

// Deploy the contract.
module.exports = function(deployer) {
  deployer.deploy(Ticket);
};
```

style.css

```
.panel-title {
    background-color: rgb(151, 147, 147);
    padding: 15px;
    border-radius: 1px;
    font-size: 20px;
    font-weight: bold;
  }

.btn-buy{
    background-color: rgb(96, 255, 4);
    padding: 10px;
    border-radius: 1px;
    font-size: 15px;
    font-weight: bold;
    float: right;
  }

.price{
   font-weight: bold;
  }
```

app.js

```
// This JS file ties in the Front End, web3 and Smart Contract together.

App = {

  // Initialize some variables first
  web3Provider: null,
  contracts: {},

  // init function to get tickets information from the JSON file and write to the HTML (ID =
ticketTemplate)
  init: async function() {
    // Get from JSON file
    $.getJSON('../tickets.json', function(data) {
      var ticketsRow = $('#ticketsRow');
      var ticketTemplate = $('#ticketTemplate');
```

```
      for (i = 0; i < data.length; i ++) {
        ticketTemplate.find('.panel-title').text(data[i].name);
        ticketTemplate.find('img').attr('src', data[i].picture);
        ticketTemplate.find('.price').text(data[i].price);
        ticketTemplate.find('.date').text(data[i].date);
        ticketTemplate.find('.location').text(data[i].location);
        ticketTemplate.find('.btn-buy').attr('data-id', data[i].id);

        ticketsRow.append(ticketTemplate.html());
      }
    });

    // Once done, call initWeb3()
    return await App.initWeb3();
  },

  // initweb3 function to initialize the web3 module accordingly.
  initWeb3: async function() {
    // If it is a modern dApp browser
    // or more recent versions of MetaMask where an Ethereum provider is injected into the
window object.
    if (window.ethereum) {
      App.web3Provider = window.ethereum;
      try {
        // Request access to the account
        await window.ethereum.enable();
      } catch (error) {
        // User denied account access...
        console.error("User denied account access")
      }
    }
    // Else if it is a legacy dApp browsers
    // ie an older dapp browser (like Mist or an older version of MetaMask)
    else if (window.web3) {
      App.web3Provider = window.web3.currentProvider;
    }
    // Else if no injected web3 instance is detected, fall back to Ganache
    // This fallback is fine for development environments, but insecure and not suitable for
production.
    else {
      App.web3Provider = new Web3.providers.HttpProvider('http://localhost:7545');
    }

    // Create instance of web3 object here
    web3 = new Web3(App.web3Provider);

    // Now call initContract() to instantiate the contract
    return App.initContract();
  },

  // initContract function to instantiate our smart contract so web3 knows where to find it
and how it works.
  initContract: function() {

    // Get the contract JSON file data
    $.getJSON('Ticket.json', function(data) {
      // We first retrieve the artifact file for our smart contract.
      // Artifacts are information about our contract such as its deployed address and
      // Application Binary Interface (ABI).
      // The ABI is a JavaScript object defining how to interact with the contract including
      // its variables, functions and their parameters.
      var TicketArtifact = data;
      // Once we have the artifacts in our callback, we pass them to TruffleContract().
      // This creates an instance of the contract we can interact with.
      App.contracts.Ticket = TruffleContract(TicketArtifact);

      // Set the provider for our contract
      App.contracts.Ticket.setProvider(App.web3Provider);

      // Use our contract to retrieve and mark the relevant tickets as bought
      return App.markBought();
    });

    return App.bindEvents();
  },

  bindEvents: function() {
```

```
    $(document).on('click', '.btn-buy', App.handleBuy);
  },

  // markBought function to mark tickets that were already bought previously.
  // We've encapsulated this in a separate function since we'll need to update the UI
  // any time we make a change to the smart contract's data.
  markBought: function() {

    // We first declare the variable ticketInstance outside of the smart contract calls so we
can
    // access the instance after initially retrieving it.
    var ticketInstance;

    // We access the deployed Tickets contract, then call getBuyers() on that instance.
    // Using call() allows us to read data from the blockchain without having to send a full
    // transaction, meaning we won't have to spend any ether.
    App.contracts.Ticket.deployed().then(function(instance) {
      ticketInstance = instance;

      return ticketInstance.getBuyers.call();

    }).then(function(buyers) {

      // After calling getBuyers(), we then loop through all of them, checking to see if an
address is
      // stored for each ticket.
      // Since the array contains address types, Ethereum initializes the array with 16 empty
addresses.
      // This is why we check for an empty address string rather than null or other false
value.
      // If the ticket is NOT 0x0000000..... it means it has been bought.
      for (i = 0; i < buyers.length; i++) {
        if (buyers[i] !== '0x0000000000000000000000000000000000000000') {
          // We disable its BUY button and change the button text to "BOUGHT", so the user
gets some feedback.
          $('.panel-
ticket').eq(i).find('button').text('BOUGHT').attr({'disabled':true,'background-
color':'#808080'});
        }
      }

    }).catch(function(err) {
      console.log(err.message);
    });

  },

  // handleBuy function handles the ticket purchase operation
  handleBuy: function(event) {

    event.preventDefault();

    var ticketID = parseInt($(event.target).data('id'));

    var ticketInstance;

    // We use web3 to get the user's accounts. In the callback after an error check,
    // we then select the first account.
    web3.eth.getAccounts(function(error, accounts) {
      if (error) {
        console.log(error);
      }
      var account = accounts[0];

      // We get the deployed contract as we did above and store the instance in
ticketInstance.
      App.contracts.Ticket.deployed().then(function(instance) {
        ticketInstance = instance;

        // This time we will send a transaction instead of a call.
        // Transactions require a "from" address and have an associated cost.
        // This cost, paid in ether, is called gas.
        // The gas cost is the fee for performing computation and or storing data in a smart
contract.
        // We send the transaction by executing the buyTicket() function with both the ticket
ID and
        // an object containing the account address, which we stored earlier in account.
```

```
        return ticketInstance.buyTicket(ticketID, {from: account});
      }).then(function(result) {
        // The result of sending a transaction is the transaction object.
        // If there are no errors, we proceed to call our markBought() function to sync the UI
with
        // our newly stored data.
        return App.markBought();
      }).catch(function(err) {
        console.log(err.message);
      });
    });

  }

};

$(function() {
  $(window).load(function() {
    App.init();
  });
});
```

index.html

```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <meta name="viewport" content="width=device-width, initial-scale=1">
    <!-- The above 3 meta tags *must* come first in the head; any other head content must come
*after* these tags -->
    <title>Cheap Tix</title>

    <!-- Bootstrap -->
    <link href="css/bootstrap.min.css" rel="stylesheet">

    <!-- HTML5 shim and Respond.js for IE8 support of HTML5 elements and media queries -->
    <!-- WARNING: Respond.js doesn't work if you view the page via file:// -->
    <!--[if lt IE 9]>
      <script src="https://oss.maxcdn.com/html5shiv/3.7.3/html5shiv.min.js"></script>
      <script src="https://oss.maxcdn.com/respond/1.4.2/respond.min.js"></script>
    <![endif]-->
  </head>
  <body>
    <div class="container">
      <div class="row">
        <div class="col-xs-12 col-sm-8 col-sm-push-2">
          <h1 class="text-center">Cheap Tix</h1>
          <hr/>
          <br/>
        </div>
      </div>

      <div id="ticketsRow" class="row">
        <!-- TICKETS LOAD HERE -->
      </div>
    </div>

    <div id="ticketTemplate" style="display: none;">
      <div class="col-sm-6 col-md-4 col-lg-3">
        <div class="panel panel-default panel-ticket">
          <div class="panel-heading">
            <h3 class="panel-title">Name</h3>
          </div>
          <div class="panel-body">
            <img alt="140x140" data-src="holder.js/140x140" class="img-rounded img-center"
width="220" height="140"  src="https://animalso.com/wp-content/uploads/2017/01/Golden-
Retriever_6.jpg" data-holder-rendered="true">
            <br/><br/>
            <strong>Price</strong>: <span class="price">$$$</span><br/>
            <strong>Date</strong>: <span class="date">January 2023</span><br/>
            <strong>Location</strong>: <span class="location">Singapore</span><br/><br/>
            <button class="btn btn-default btn-buy" type="button" data-id="0">BUY</button>
          </div>
```

```
        </div>
      </div>
    </div>

    <!-- jQuery (necessary for Bootstrap's JavaScript plugins) -->
    <script src="https://ajax.googleapis.com/ajax/libs/jquery/1.12.4/jquery.min.js"></script>
    <!-- Include all compiled plugins (below), or include individual files as needed -->
    <script src="js/bootstrap.min.js"></script>
    <script src="js/web3.min.js"></script>
    <script src="js/truffle-contract.js"></script>
    <link rel="stylesheet" href="css/style.css" />
    <script src="js/app.js"></script>
  </body>
</html>
```

tickets.json

```
[
  {
    "id": 0,
    "name": "Adele",
    "picture": "images/adele.jpeg",
    "price": "$150",
    "date": "January 2023",
    "location": "Singapore"
  },
  {
    "id": 1,
    "name": "Andy Lau",
    "picture": "images/andylau.jpeg",
    "price": "$100",
    "date": "March  2023",
    "location": "Singapore"
  },
  {
    "id": 2,
    "name": "Ariana Grande",
    "picture": "images/arianagrande.jpeg",
    "price": "$150",
    "date": "July 2023",
    "location": "Singapore"
  },
  {
    "id": 3,
    "name": "Black Eye Pea",
    "picture": "images/blackeyepea.jpeg",
    "price": "$160",
    "date": "February 2023",
    "location": "Singapore"
  },
  {
    "id": 4,
    "name": "Black Pink",
    "picture": "images/blackpink.jpeg",
    "price": "$120",
    "date": "March 2023",
    "location": "Singapore"
  },
  {
    "id": 5,
    "name": "Dua Lipa",
    "picture": "images/dualipa.jpeg",
    "price": "$160",
    "date": "August 2023",
    "location": "Singapore"
  },
  {
    "id": 6,
    "name": "Ed Sheeran",
    "picture": "images/edsheeran.jpeg",
    "price": "$180",
    "date": "April 2023",
    "location": "Singapore"
  },
  {
```

```
    "id": 7,
    "name": "Eric Clapton",
    "picture": "images/ericclapton.jpeg",
    "price": "$140",
    "date": "May 2023",
    "location": "Singapore"
  },
  {
    "id": 8,
    "name": "Harry Styles",
    "picture": "images/harrystyles.jpeg",
    "price": "$150",
    "date": "June 2023",
    "location": "Singapore"
  },
  {
    "id": 9,
    "name": "Jay Chou",
    "picture": "images/jaychou.jpeg",
    "price": "$150",
    "date": "January 2023",
    "location": "Singapore"
  },
  {
    "id": 10,
    "name": "JJ Lin",
    "picture": "images/jj.jpeg",
    "price": "$160",
    "date": "October 2023",
    "location": "Singapore"
  },
  {
    "id": 11,
    "name": "Jolin Tsai",
    "picture": "images/jolintsai.jpeg",
    "price": "$120",
    "date": "March 2023",
    "location": "Singapore"
  },
  {
    "id": 12,
    "name": "Karen Mok",
    "picture": "images/karenmok.jpeg",
    "price": "$120",
    "date": "June 2023",
    "location": "Singapore"
  },
  {
    "id": 13,
    "name": "Shakira",
    "picture": "images/shakira.jpeg",
    "price": "$180",
    "date": "September 2023",
    "location": "Singapore"
  },
  {
    "id": 14,
    "name": "Stephanie Sun",
    "picture": "images/stephaniesun.jpeg",
    "price": "$130",
    "date": "November 2023",
    "location": "Singapore"
  },
  {
    "id": 15,
    "name": "Taylor Swift",
    "picture": "images/taylorswift.jpeg",
    "price": "$160",
    "date": "June 2023",
    "location": "Singapore"
  }
]
```


TestTicket.sol

```
// This Solidity script is used to test the Tickets.sol contract.

pragma solidity ^0.5.0;

// The Assert helper allows us to use various Asserts (eg Equality, inequality etc) to
// conduct our tests.
import "truffle/Assert.sol";

// When running tests, Truffle will deploy a fresh instance of the contract being tested
// to the blockchain. This smart contract gets the address of the deployed contract.
import "truffle/DeployedAddresses.sol";

import "../contracts/Ticket.sol";

contract TestTicket {

    // Get the address of the contract to be tested
    Ticket ticket = Ticket(DeployedAddresses.Ticket());

    // We will use this as the ticket ID to test the contract
    uint expectedTicketID = 5;

    // We will use this as the buyer of the ticket (ID = 5)
    address expectedBuyer = address(this);

    // Function to test the buyTicket() function in Tickets.sol
    function testBuyTicket() public {

        // Call the buyTicket() function with the ticket ID of 5
        uint returnedId = ticket.buyTicket(expectedTicketID);

        // Assert the returned value to be equal to 5.
        // If test fail, the print the message.
        Assert.equal(returnedId, expectedTicketID,
            "Purchased Ticket ID should match what is returned.");

    }

    // Function to test the retrieval of a buyer information
    function testGetBuyerAddressByTicketID() public {

        // We get the Address of the buyer by supplying the ticket ID = 5
        // NOTE -- The "buyers" array is declared as a "public" array in Tickets.sol.
        // So, it is possible to just call ticket.buyers to access the array directly.
        address buyer = ticket.buyers(expectedTicketID);

        // Assert the returned value to be equal to buyer.
        // If test fail, the print the message.
        Assert.equal(buyer, expectedBuyer,
            "Buyer of the ticket does not match");
    }


    // Function to test the getBuyers() function in Tickets.sol
    function testGetBuyerAddressByTicketIDInArray() public {

        // Store buyers in memory rather than contract's storage
        address[16] memory buyers = ticket.getBuyers();

        // Assert the returned array to be equal to buyer.
        // If test fail, the print the message.
        Assert.equal(buyers[expectedTicketID], expectedBuyer,
            "Buyer of the ticket does not match");
    }

}
```