

CS 864: Blockchain and Cryptocurrencies

Project: Blockchain Implementation for DMV

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Introduction

Our goal was to design and implement a blockchain-based system for DMV website is at <https://www.dmv.virginia.gov/#/DMV2Go>. Since DMV provides multiple services to its customers including driver's information, vehicle registration and renewal and many more. We only focus on implementing few services which is following:

1. Online Services:

- Vehicle registration renewal
- Address change,
- DL renewal
- Report a vehicle sold/traded

2. Driver/ ID services:

- Practice exams
- Real ID
- Obtaining a vital record

3. Vehicle services:

- Selling/donating a vehicle
- Titling a vehicle in Virginia

Technical Framework and Environment

Node

Node.js employs an event-driven, non-blocking I/O model, making it lightweight and efficient, making it ideal for data-intensive real-time applications that run across distributed devices. Node.js is a cross-platform open-source runtime environment for developing server-side and networking applications. We used **v15.11.0** as the most recent version.

Npm

The package manager npm is for the JavaScript programming language. It is the JavaScript runtime environment Node.js's default package manager. It consists of a command line client, also known as npm, and the npm registry, an online database of public and paid-for private packages. The npm version used for this project is **7.6.3**.

Ganache CLI

Ganache-CLI is an Ethereum client, which can be connected to decentralized application for testing to a local blockchain. The blockchain emulator is quick and customizable. It allows you to call the blockchain without having to execute an actual Ethereum node. Ganache CLI is currently version **6.12.2**. To install the command in command prompt, type the following command.

Remix Browser

The smart contracts are written in the language of solidity programming. So, we used an IDE for programming and running the solidity, like Remix Browser. The compiler version of the solidity is version: **0.4.24+commit.e67f0147**.

Web3.js

Web3.js is a well-known library that enables programmers to interact with the Ethereum blockchain. It is a JavaScript language binding for Ethereum's JSON RPC interface, making it directly usable in web technology because JavaScript is natively supported in almost all web browsers. Web3.js is also popular on the server side in Node.js applications.

Sublime Text

Sublime Text is a Python application programming interface with cross platform source code editor (API). It supports many programming languages and banner languages, and users with plug-ins, generally community-built and maintained under free software licenses, can add functions. we used sublime text as a text editor to write the HTML/CSS, and JavaScript files.

Environment Setups

There are couple of steps we took to setup the environment:

Step 1:

First, we installed node.js (version v15.11.0) on our local machine and as well as Node Package manager npm (version 7.6.3.). Later, we installed Ganache client (version v6.12.2) using command line tool. Once we installed these packages, we started ganache by running the command **ganache-cli** on command prompt. This will initiate the ganache and will generate public and private keys and runs the blockchain.

Step 2:

We setup a project directory and initiated the node package manager in the project directory by running the “**npm init**” command.

Step 3:

Furthermore, we opened the Remix Browser (<https://remix.ethereum.org/>) to write the smart contract based on the requirement. We set the compiler version to 0.4.24 and then compiled each solidity file for each service that our DMV website provides. Later, we chose **Web3 Provider** on the browser and deployed the contract for each service. Note that, we provided the same localhost name where the Ethereum’s ganache-client is running so that it listens on the same endpoint to establish Web3 connection.

Step 4:

We wrote the html files for each service. Inside each HTML files we wrote the Web3 connection to connect to the blockchain. When we compiled each contract in the Remix browser in Step 3, we

copy the **ABI code** which returns a JSON and pasted inside each .html files under the Web3 connection to specify the same application binary interface.

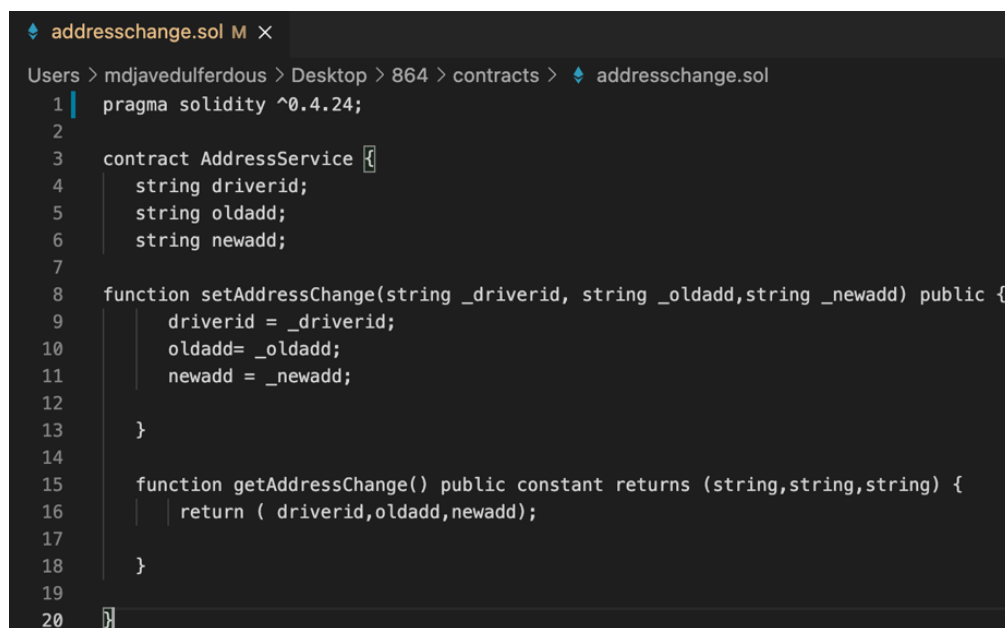
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947         },
948         {
949             "name": "_newadd",
950             "type": "string"
951         }
952     ],
953     "name": "updateAddress",
954     "outputs": [
955         {
956             "name": "",
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958         }
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960     "payable": false,
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963 },
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965     "constant": false,
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968             "name": "_driverid",
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970         },
971         {
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974         },
975         {
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978         }
979     ],
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982         {
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990 },
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1003             "name": "_newadd",
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1012         }
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1029         {
1030             "name": "_newadd",
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1032         }
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1055         },
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1059         }
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1065             "type": "string"
1066         }
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1070     "type": "function"
1071 },
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1073     "constant": false,
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1075         {
1076             "name": "_driverid",
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1079         {
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1081             "type": "string"
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1091             "name": "",
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1093         }
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1107             "name": "_oldadd",
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1110         {
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1113         }
1114     ],
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1119             "type": "string"
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1137         {
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1156         {
1157             "name": "_driverid",
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1159         },
1160         {
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1162             "type": "string"
1163         },
1164         {
1165             "name": "_newadd",
1166             "type": "string"
1167         }
1168     ],
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1171         {
1172             "name": "",
1173             "type": "string"
1174         }
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1179 },
1180 {
1181     "constant": false,
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1185             "type": "string"
1186         },
1187         {
1188             "name": "_oldadd",
1189             "type": "string"
1190         },
1191         {
1192             "name": "_newadd",
1193             "type": "string"
1194         }
1195     ],
1196     "name": "updateAddress",
1197     "outputs": [
1198         {
1199             "name": "",
1200             "type": "string"
1201         }
1202     ],
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1205     "type": "function"
1206 },
1207 {
1208     "constant": false,
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1212             "type": "string"
1213         },
1214         {
1215             "name": "_oldadd",
1216             "type": "string"
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1218         {
1219             "name": "_newadd",
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1221         }
1222     ],
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1224     "outputs": [
1225         {
1226             "name": "",
1227             "type": "string"
1228         }
1229     ],
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1232     "type": "function"
1233 },
1234 {
1235     "constant": false,
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1238             "name": "_driverid",
1239             "type": "string"
1240         },
1241         {
1242             "name": "_oldadd",
1243             "type": "string"
1244         },
1245         {
1246             "name": "_newadd",
1247             "type": "string"
1248         }
1249     ],
1250     "name": "updateAddress",
1251     "outputs": [
1252         {
1253             "name": "",
1254             "type": "string"
1255         }
1256     ],
1257     "payable": false,
1258     "stateMutability": "nonpayable",
1259     "type": "function"
1260 },
1261 {
1262     "constant": false,
1263     "inputs": [
1264         {
1265             "name": "_driverid",
1266             "type": "string"
1267         },
1268         {
1269             "name": "_oldadd",
1270             "type": "string"
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1275         }
1276     ],
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1278     "outputs": [
1279         {
1280             "name": "",
1281             "type": "string"
1282         }
1283     ],
1284     "payable": false,
1285     "stateMutability": "nonpayable",
1286     "type": "function"
1287 },
1288 {
1289     "constant": false,
1290     "inputs": [
1291         {
1292             "name": "_driverid",
1293             "type": "string"
1294         },
1295         {
1296             "name": "_oldadd",
1297             "type": "string"
1298         },
1299         {
1300             "name": "_newadd",
1301             "type": "string"
1302         }
1303     ],
1304     "name": "updateAddress",
1305     "outputs": [
1306         {
1307             "name": "",
1308             "type": "string"
1309         }
1310     ],
1311     "payable": false,
1312     "stateMutability": "nonpayable",
1313     "type": "function"
1314 },
1315 {
1316     "constant": false,
1317     "inputs": [
1318         {
1319             "name": "_driverid",
1320             "type": "string"
1321         },
1322         {
1323             "name": "_oldadd",
1324             "type": "string"
1325         },
1326         {
1327             "name": "_newadd",
1328             "type": "string"
1329         }
1330     ],
1331     "name": "updateAddress",
1332     "outputs": [
1333         {
1334             "name": "",
1335             "type": "string"
1336         }
1337     ],
1338     "payable": false,
1339     "stateMutability": "nonpayable",
1340     "type": "function"
1341 },
1342 {
1343     "constant": false,
1344     "inputs": [
1345         {
1346             "name": "_driverid",
1347             "type": "string"
1348         },
1349         {
1350             "name": "_oldadd",
1351             "type": "string"
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1353         {
1354             "name": "_newadd",
1355             "type": "string"
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1368 },
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1370     "constant": false,
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1372         {
1373             "name": "_driverid",
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1375         },
1376         {
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1378             "type": "string"
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1380         {
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1382             "type": "string"
1383         }
1384     ],
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1386     "outputs": [
1387         {
1388             "name": "",
1389             "type": "string"
1390         }
1391     ],
1392     "payable": false,
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1394     "type": "function"
1395 },
1396 {
1397     "constant": false,
1398     "inputs": [
1399         {
1400             "name": "_driverid",
1401             "type": "string"
1402         },
1403         {
1404             "name": "_oldadd",
1405             "type": "string"
1406         },
1407         {
1408             "name": "_newadd",
1409             "type": "string"
1410         }
1411     ],
1412     "name": "updateAddress",
1413     "outputs": [
1414         {
1415             "name": "",
1416
```

Web3 interface

The Web3 interface permits the network interaction. It includes the collection of libraries, including reading data from smart contracts, writing data to smart contracts and developing smart contracts. Web3 uses the JSON RPC to communicate to the blockchain network. This JSON RPC allows JavaScript to interact with the smart contract written in the language of solidity. We have copied the **ABI** from REMIX, pasted it in the JavaScript code written for a Web3 connection to work on this interaction.

Smart Contract

The smart contract is drawn up with the language of solidity programming. For each service, we used REMIX to write the contract. We used REMIX as an IDE, because it is user-friendly Browser-based, and allows for network interaction. REMIX assists us in building, deploying and executing a smart contract.

A screenshot of a code editor showing a Solidity smart contract named 'AddressService'. The code is written in a dark-themed editor with line numbers on the left. The contract defines three variables: 'driverid', 'oldadd', and 'newadd' of type 'string'. It includes two public functions: 'setAddressChange' which updates the variables, and 'getAddressChange' which returns their values. The path at the top of the editor indicates the file is located at 'Users > mdjavedulferdous > Desktop > 864 > contracts > addresschange.sol'.

```
addresschange.sol M x
Users > mdjavedulferdous > Desktop > 864 > contracts > addresschange.sol
1  pragma solidity ^0.4.24;
2
3  contract AddressService {
4      string driverid;
5      string oldadd;
6      string newadd;
7
8      function setAddressChange(string _driverid, string _oldadd,string _newadd) public {
9          driverid = _driverid;
10         oldadd= _oldadd;
11         newadd = _newadd;
12     }
13
14     function getAddressChange() public constant returns (string,string,string) {
15         return ( driverid,oldadd,newadd);
16     }
17 }
18
19
20 }
```

Blockchain Network

Generally, for the blockchain environment, we need Ethereum virtual machines. However, we used Ganache for our project. Ganache basically has ten default Ethereum addresses, private keys, gas price and the gas limit. The Ganache is a virtual blockchain. Gas is an Ether and can be used on the Ethereum Network for network use payment. Ganache is therefore an Ethereum client that we used to develop Ethereum.

```
(base) mdjavedulferdous@JF 864 % ganache-cli
Ganache CLI v6.12.2 (ganache-core: 2.13.2)

Available Accounts
=====
(0) 0x72cA6d3c32B414936eaE5E4A0159Cc874F05Cc1f (100 ETH)
(1) 0x3A9666e13b2672a3e94F5dbe36db11BcFec5F5bc (100 ETH)
(2) 0x45960d1a1953eC8fD27a796F3aC653abFBdeFbcf (100 ETH)
(3) 0xb2FcFecf8846F43226BDac8C656dD778b961C738 (100 ETH)
(4) 0xBc7AB10C38b166645df40f923A9C67794704061E (100 ETH)
(5) 0x9f296556fA5480BDE0DA6e7C9Cd8D3aa2dd7D12e (100 ETH)
(6) 0x7820b2eFd3f3C95610d7277eB94F5A78A4cF2C92 (100 ETH)
(7) 0x07c272F492Da081b0cAB31f459f96d54e7F4e7DE (100 ETH)
(8) 0x6a32DFc2263e4C035F233e68fF2Cbf8E7c993EE2 (100 ETH)
(9) 0xd7611E97F68103EB5cf168932044680D254C2C05 (100 ETH)

Private Keys
=====
(0) 0x205d03eadbf3fb457d8b2fbe269ae829708c768933c3cd336e59a0f6874e58ee
(1) 0x7175c0f94570283e9d16e6c6ae4366d981ef65f9ef1cf1042d7562d459ca9a6a
(2) 0xaa611605a10777ba2fad109dd3a491a0907dfb78b3d71631a901ee30270d035e
(3) 0x12914eaa4797b74fd79277b20b31b40fdb57b79f6284081b208197a15f06e915
(4) 0xd967c3471ae25623719d7bc1a3b81f8775b6b0e1651a814ca79f7410bb466285
(5) 0x3c315566b952926a2dee4cefacc46428b4c29c88afd987b3e3d448e299de68339
(6) 0x479e92f2e4892bebb58d3319b4ef11a1737de68a1ab27d87260e43c9870bfc11
(7) 0xd04778e3296ff80e52fd17c5fca94216858c9c164bba62546b7a0701203d7a9d
(8) 0xbfffe3151351a0d4d59d11c2f702ae5204cda1a8602bb6de7be18ec9d48e340da
(9) 0x27c6dbe0f5c4c69c4a4c22040d7405608b529026939750140dcccbb81f298306

HD Wallet
=====
Mnemonic:      document marriage person original attract imitate gap brother slot march zero run
Base HD Path:  m/44'/60'/0'/0/{account_index}

Gas Price
=====
20000000000

Gas Limit
=====
6721975

Call Gas Limit
=====
9007199254740991

Listening on 127.0.0.1:8545
```

Front End Implementation

Online Services: It has four part which are listed below:

1. Vehicle registration renewal: It has two function
 - I. setVehicleRegChange
 - II. getVehicleRegChange

Vehicle Registration

Driver ID
Vehicle Number
Address
Expiration Date
Renewal Until
Submit

2. Address change: It has two function
- I. setAddressChange
 - II. getAddressChange

Address Change

Driver ID
Previous Address
New Address
Submit

3. DL renewal: It has two function
- I. setDIRenewalChange
 - II. getDIRenewalChange

Driver License Renewal

Driver ID
Expiration Date
Renewal Until
Submit

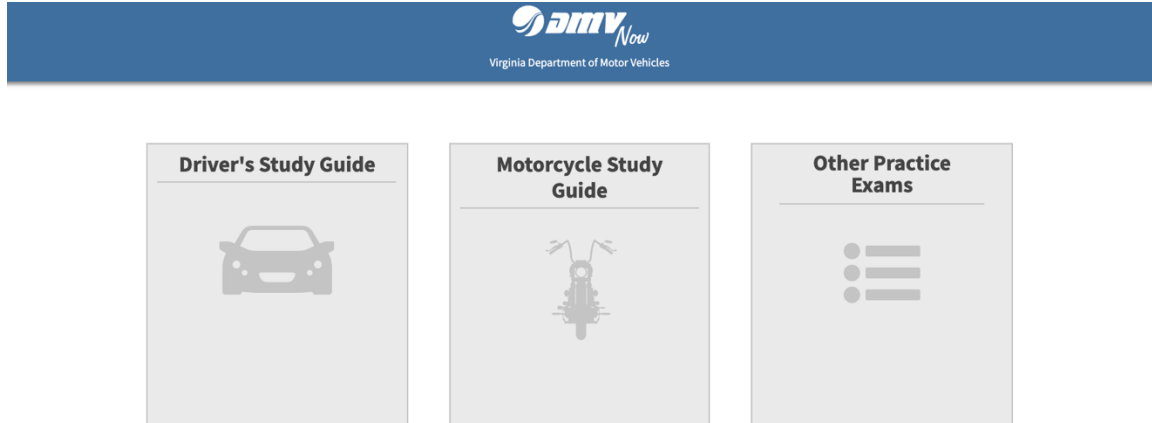
4. Report a vehicle sold/traded: It has two function
- I. setReportChange
 - II. getReportChange

Report a Vehicle Sold / Traded

Vehicle ID
Price
Mileage Reading
Transfer
Sold
Traded

Driver/ ID services

1. Practice exams:



2. Real ID: It has two function

- I. setRealIdChange
- II. getRealIdChange

Real ID

In order to obtain a real id, a user must have 2 forms of address proofs

Driver ID
Address Proof 1
Address Proof 2
Submit

3. Obtaining a vital record: It has two function

- I. setVitalRecordChange
- II. getVitalRecordChange

Vital Record

Deceased Name
Date of Death
Place of Death
Phone Number
Submit

Vehicle services

1. Selling/donating a vehicle: It has two function

- I. setvehicleChange

II. getvehicleChange



Selling or Donating a Vehicle

Vehicle ID
Vehicle Mileage
Vehicle Price
Vehicle Title
Submit

2. Titling a vehicle in Virginia: It has two function

- I. setVehicleTitle
- II. getVehicleTitle



Vehicle Headlining

Vehicle ID
Vehicle Mileage
Vehicle Price
Vehicle Title
Submit

Challenges

We faced couple of challenges while building the framework for DMV blockchain. We ran into compatibility issue for each technical framework that we used for our project and spent a lot of time to find the stable version. In terms of implementation, the project has a limitation such as it does not update the information of the services in the blockchain network rather it shows the message in the Alert box. Within the time frame given, it was very challenging for us to learn new frameworks, design and implement a Blockchain based DMV.

Conclusion

We learned a lot regarding blockchain and its technical framework. We utilized the basic knowledge that we gained throughout the coursework to design the system. For our current system we need to overcome the challenges such as updating the data in the blockchain network in the future.