Underground Injection Control Review Process Based On Blockchain Technology

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Introduction

Blockchain is a method of implementing secure, distributed record of information. A simple description of a blockchain's structure is a linked list of blocks, distributed among peers, with each peer maintaining their own copy. Injection wells are devices used in the oil industry to pump various fluids into drill sites to stimulate oil production. In order to create these wells, their construction must first be approved by various agencies which must evaluate various environmental and location data to determine the viability for the well.

Problem

The approval and exchanging of data between each agency leads to inconsistency of data, miscommunication, as well as delays in the creation of a well. Each agency will also have different data management systems which will make the structure of the data set harder to review and analyze.

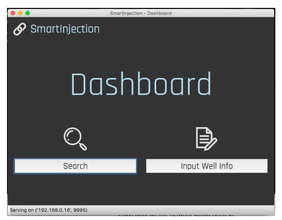
Proposed Solution

In order to improve the accessibility and security of injection well data, we propose moving the process of maintaining and accessing that information to a blockchain network. Each agency involved in Underground Injection Control Review process would serve as peer within the network, capable of adding a new record to the chain and taking part in the validation process of other submitted records. The ledger in the blockchain is distributed which would allow for each agency to have their own copy of the well data available to access at any time. Since the blockchain is immutable, it would prevent any agencies from tampering with recorded data.

User Interface

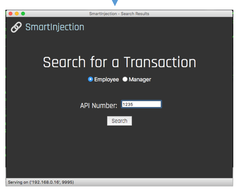
For the user interface, we used PyQt5 which is Python bindings that would make the interface look good on any operating system.

Connection Screen



Dashboard

Search



Search through Blockchain

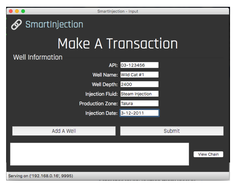
Employee Role

API
Well Name
Injection Date

Manager Role

API
Well Name
Well Depth
Injection Fluid
Production Zone
Injection Date

Make a Transaction



Input Well Information Data

API
Well Name
Well Depth
Injection Fluid
Production Zone
Injection Date

Sent to Blockchain

Peer-to-Peer Network

The peer-to-peer network would allow the blockchain to be distributed between each organization instantly once the block was created. We established simple messaging where we package the data that can be transported through the network then unpacked when it reaches its destination. We used Python's byte literals and struct library that packages fixed-sized integers into a byte literal format.
With simple messaging implemented, we moved to packaging and passing full block objects through the network using JSON. A handler would be implemented for each client that can pass messages back and forth between computers. Two peers would exchange blocks and get the height of their peer. If the peer responded with a greater height the lesser height peer would request for blocks until it reached its peer's height. In our project we used the Asychio library to get the program to run asynchronously to keep the program running without halting to listen for messages.

Data Structures

Each peer on the network would need to decode the messages being sent through the blockchain so there needed to be a concrete structure to the data being passed back and forth. We designed the structure following oil well data found at the California Department of Conservation website. Each oil well in the block will be identified through a unique API number as well as the Public Land Survey System (PLSS) which would give the well's district, county, township, and location.
The blockchain will start with a genesis block that is a template data structure for all other blocks in the chain. We used JSON objects for simplicity and the ability to convert it into a byte literal format. We decided to go for a one-to-one, one transaction for one block, for the blockchain architecture.

Results

We are able to get 3 computers to communicate with one another, sending blocks and addresses between one another, be able to search through blocks, and create a user interface to interact with the blockchain.

We will expand on this project and work with the California Geological Energy Management Division (CalGEM). We'll be using enterprise-level tools to build a more efficient blockchain. Our future goal is to build a fully realized application that can be used for a faster and more secure Underground Injection Control Process Review.