Decentralized Transaction Network for Transparency Assurance in Smart Cities

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ABSTRACT

Smart cities have generated great interest in today's world, where technology is increasingly present in the life of the average citizen. However, in order for a city to be considered truly smart, it is necessary to involve the population and public management in the sharing and management of data generated by the city so that strategic decision-making is possible. In this sense, this work explores some solutions to the problems of transparency, security and performance in public services in smart cities. The hypothesis is that it is possible to combine Blockchain technology and Smart Contracts to solve these problems.

1 INTRODUCTION

The concept of smart city has aroused great interest nowadays, when technology is a constant in the daily routine of the citizens. A smart city uses diverse technologies as tools to improve the infrastructure and services, consequently bringing better quality of life to its citizens. In cities, public services are often managed by concession contracts, but they are difficult to audit. In smart cities, different types of sensors (sound, temperature, humidity, pressure, presence, energy, ultraviolet rays, magnetic field and various types of gases) measure levels and concentrations and exchange data themselves, generating a panorama of the current situation of the city in terms of traffic, pollution, energy consumption, etc. The data collected and grouped from these initiatives can then be used to chart improvement strategies and verify the quality of theses services [18].

This work proposes an architecture that provides a reliable decentralized network, searching transparency and reliability of public services in smart cities. The main goals of our work are:

- To investigate, propose, implement a decentralized transaction network for smart cities using blockchains;
- To investigate, propose, implement Smart Contracts to improve the quality of public services;
- To investigate, implement a middleware to homogenize the multiplicity of sensors interfaces;
- To propose, implement mechanisms of interaction user-blockchain-smart contracts via DApps;

2 BLOCKCHAIN AND SMART CONTRACTS IN SMART CITIES

This section presents the use of these concepts in smart cities and how they can be used to support this proposal.

2.1 Blockchain

In 2008, with the proposal to be a "Peer-to-Peer Electronic Cash System", Bitcoin appear [15], presenting for the first time the concept of a blockchain. In general, the platform defined by Bitcoin represents a peer-to-peer payments network.

In this network, all transactions are recorded in a data structure that forms a blockchain or a non-tampering and public block string. In this chain each block refers to the immediately preceding block. This blockchain works as a ledger containing the entire history of transactions performed. Transactions represent transfers of values between Bitcoin addresses. These addresses are essentially public keys that allow the use of encryption to verify the validity of transactions. Thus, these addresses can be viewed as pseudonyms, since no personal data is associated with a transaction, allowing the network to maintain the anonymity of its users.

Among the nodes that make up Bitcoin's peer-to-peer network, we have the miners nodes. These nodes are responsible for creating new transaction blocks and executing a proof of work. The proof of work is a mathematical calculation process (based on hashes) that requires great computational effort. The counterpart is that the miner receives incentives (Bitcoins) when mining a block. When it is able to generate a certain hash pattern, the miner transfers the newly generated block to the other nodes, which references the last block of the blockchain. If the blockchain continues to grow from this block, that is, a block that references the last block and thus successively creating the largest chain (consensus), this means that the block was accepted. With this the miner

receives the Bitcoins according to the transactions contained in the block generated by him [8].

2.2 Smart Contracts

In the year 2013 another application developed over Blockchain technology emerged. Ethereum [5] is a platform that allows any user to develop and execute Smart Contracts using a blockchain as a common database [13]. A Smart Contract is a program (code) that is stored in a blockchain and executed automatically in response to transactions triggered calls. Smart Contracts are executed by all nodes of the network and the results of the executions are also stored in the blockchain itself, representing changes in the state of the same. This code execution, based on an immutable and distributed data structure, gives the system the possibility of avoiding fraud or censorship, and does not present a single point of failure. A DApp is an open source application or service that allows interaction between users and Smart Contracts [10]. Examples of applications include the Everledger [7], Storj [17] and Golem [6]. Proposals to use Smart Contracts and blockchain to improve quality of services in smart cities are under development in several places in the world. Examples can be seen in [1].

2.3 Applications in Smart Cities

The use of the technology blockchain applied to smart cities can automate several services provided to the population, such as: proof of existence of documents [9], public safety [3], public transport, among others. Streamr [4], is an Ethereum-based network that aims to collect data on congestion, road quality and mechanical feedback on cars operating in a Smart City. If the data owner chooses, all of this can be sold to highway concessionaires, drivers, parts manufacturers, and Smart Cities operators who can use them to plan automotive road repairs, schedule vehicle maintenance, and redirect traffic in real time. In order to encourage citizen participation, DApps with attractive web interfaces can be generated to receive and send data to the blockchain through smart contracts. As an example, recently the Active Citizen [14] application by the Russian government for plebiscites on matters of public interest, migrated its database to a blockchain, becoming a DApp and thus ensuring greater transparency. Another example is CitySense [12] which uses blockchain and crowdsourcing [11].

3 PROPOSAL

The large mass of data produced by the sensors network in Smart Cities also requires the need for data analysis tools that produce inferences and can assist managers in decision making. As an example, in the case of urban logistics and traffic control, we can use Blockchain technology to receive and store data from city-wide devices, surveillance cameras and use this data to optimize traffic on public transport [2]. Likewise, it is possible to use blockchains to prove the existence of public debts, traffic tickets, etc. In addition, a DApp connected to a smart contract can show citizens the data stored in the blockchain. Moreover, within this research proposal, we aim to address the research challenges not only from a theoretical perspective, but also from a practical one, realizing and testing our solution in real smart city environment, namely using the Citylab testbed, which is part of the City of Things smart city, located in the city of Antwerp, Belgium [16].

Figure 1 represents the solution to be achievied with this research. In this, we can see how Smart Contracts can be a interface between sensors and the user. In (1) data from Sensors are being collected by Smart Contracts (2) and stored in a blockchain (3). Then users can audit this data via DApps (4) who uses the Smart Contract as a back-end, helping thus citizens engagement and transparency in the management of public services. Challenges in this approach are: the diversity of sensors interfaces, the amount of data generated in communication among devices versus the limited capacity of storage and time of validation of transactions in the blockchain.

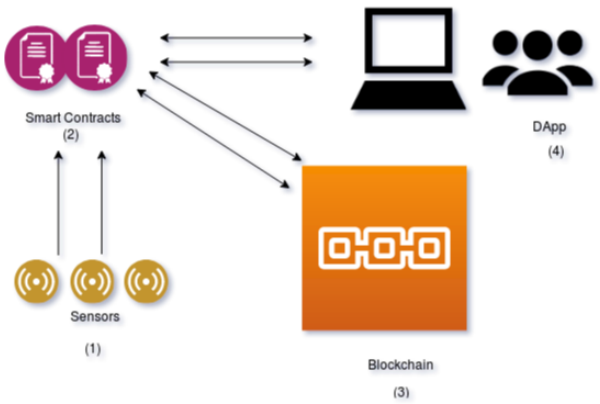

Figure 1: Architecture of a Decentralized Transaction Network for Transparency Assurance in Smart Cities

4 CONCLUSION

Currently the research contribution is in a preliminary phase, when a bibliographic review and experimentation are being done. As main results, it is hoped to contribute in the studies on smart cities, smart contracts and blockchain both with the proposal of specific solutions for each one of the mentioned problems, as the proposal and implementation of an architecture based on open standards that can be used in diverse scenarios, aiming to test them in real life conditions in the smart city of City of Things.

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