Investigating Blockchain as a Data Management Tool for IoT Devices in Smart City Initiatives

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ABSTRACT

This poster describes an ongoing research project that builds an IoT data management experimental environment based on Ethereum Blockchain and smart contracts. The goal of the project is to simulate the application of IoT devices in smart city initiatives, and explore how IoT data management could benefit from Blockchain technology. In this project, there are three basic questions we are attempting to answer. 1) How do you link various kinds of IoT devices to the Blockchain, as they have different computing capabilities? 2) How do you store data on Blockchain from different IoT devices, and retrieve data for further utilization? 3) To what extent, smart contracts can be designed to implement automated data access management?

CSS CONCEPTS

H.4.2 [**Information Systems Applications**]: Type of systems – *e-government applications*.

KEY WORDS

Internet of Things, Blockchain, Smart Contracts, IoT Data Management, Ethereum.

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1. INTRODUCTION

Internet of Things (IoT) data plays an important role in conceptualizing and building smart cities. Nowadays, IoT devices (camera, sensors etc.) can be found everywhere within cities; whether in fixed locations or carried by vehicles and citizens, making them mobile [1]. As a result of the increase in number and type of IoT sensors, the amount of IoT data keeps growing. Current IoT ecosystems rely on a centralized communication model, which is known as the server/client paradigm. On the one hand, in the server/client paradigm, the cloud center will face a big challenge for storing and processing the data produced by the continuous growth amount of IoT devices. On the other hand, edge computing [8] will enable automated communications among IoT devices. Therefore, IoT data management needs a more efficient way to both reduce the cloud center's pressure and enable faster and secure communications between autonomous devices. Blockchain is a decentralized, distributed ledger shared by all network participants. It has big potential for IoT data management and protection.

One IDC study highlights some of the impacts of Blockchain on data and data management [2]. Blockchain technology has already been tried for data sharing in clinical research [3] and intelligent vehicles [4], and has shown big potential for building trust, preserving privacy, and enhancing security. Also, it is believed to benefit supply chain management [5], in which it could establish a shared, secure record of information flows. This is like a 'shared version of events' across networks for supply chain transactions, processes and partners, and enables improved supply chain efficiencies, better multi-party collaboration, and streamlined processes resolution. Researchers depict an overview of Blockchain and smart contracts for IoT and point out issues that should be considered [6]. However, they do not address any issues related to the management of IoT data. In our project, we will build a simulation environment based on Ethereum to explore what Blockchain can do for IoT data management and identify issues that need to be tackled in practice.

2. MOTIVATION AND OUR APPROACH

One of the biggest issues with IoT data is security. According to a Gartner report, there will be more than 20 billion connected things by 2020 [7]. With so many IoT devices connected to the internet, IoT data management and security are a concern. The cloud servers will become overloaded and represent a single point of failure. If the central servers or databases becomes unavailable (e.g. go down), all connected devices will be affected. However, Blockchain enables distributed data storage and peer-to-peer messaging, and allows efficient autonomous communication between IoT devices. Failure of one node doesn't affect the functioning of other nodes. In addition， Blockchain provides a crypto based data storage and access control in its implementation, which will bring more security and trust in the overall network.

The project is designed to answer basic questions through building prototypes. We will set up a private Ethereum Blockchain that will be composed of a computer and several Raspberry PI devices working as Blockchain nodes. The objective is to build a simulation environment to learn about what Blockchain technology can do for IoT data and to develop our own smart contracts for testing various data management policies. Figure 1 describes the framework of our project.

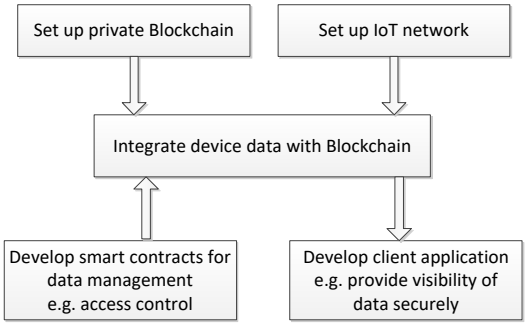

Figure 1. Framework of Our Project

3. EXPERIMENTAL ENVIRONMENTS

To demonstrate the efficiency and practicability of enhanced IoT data management based on Blockchain technology, we are going to implement a prototype system. To support development, a private Blockchain will be built on a laptop computer and a set of Raspberry Pi computers.

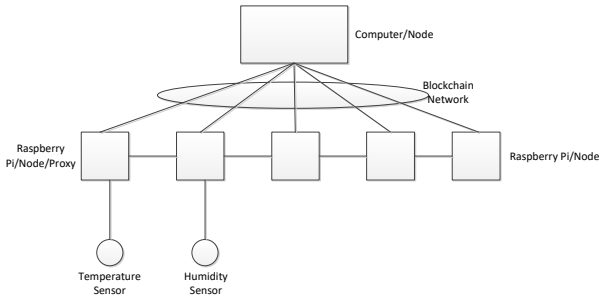

Figure 2. IoT Simulation Ecosystem

3.1 Build an IoT Simulation Ecosystem

One computer, several RPIs, and a few sensors (e.g. air temperature and humidity) are connected and working as an IoT ecosystem. See Figure 2 above.

3.2 Set Up a Blockchain Network

Ethereum is a decentralized platform that runs smart contracts as programmed without any possibility of third party interference. One computer and several RPIs are intended to act as nodes connected to a private Blockchain built based on Ethereum. For implementation, Ethereum client node needs to be installed on a computer and on several RPIs, respectively.

3.3 Design and Deploy Smart Contracts

Smart contracts make the automation of IoT data management possible. The contracts could add data and control access to the data on the Blockchain. In this project, we will design and implement a set of smart contracts for IoT data management, including storing, integrating and allowing exchange and utilization of IoT data. For example, the smart contract could be used to check if a user has permission to access specific IoT data.

4. CURRENT STATUS AND NEXT STEPS

The prototype provides a private Blockchain infrastructure of distributed IoT devices, which basically can replicate the device data and also validate the transactions among devices through smart contracts. However, in the implementation, more problems need to be resolved. For example, the prototype needs to translate IoT device data from device types into the format needed by the Blockchain. Moreover, IoT devices will produce data continuously, which could prove very expensive and processing intensive to store IoT data on Blockchain. The prototype needs to filter device events and send only the required data to the Blockchain. Also, smart contracts should be flexibly designed to try various data management policies.

5. ACKNOWLEDGMENTS

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REFERENCES

[1] A.M. Alteri, J.Ramon Gil-Garcia, N. Helbig, B. Burke. Citizens as Sensors: Examining Co-Production, Sensor Technologies, and Data Analytics in Government. TPMRAC. Minneapolis, MN, June 9-10, 2015

[2] Blockchain—A Data Management, Integration, and Integrity Disruptor? IDC report #US42074217.2017

[3] M.B and P.R, Blockchain Technology for Improving Clinical Research Quality,Trials(2017)18:335.

[4] M.cSingh and S. Kim. Blockchain Based Intelligent Vehicle Data sharing Framework. CoRR abs/1708.09721 (2017).

[5] The Benefits of Blockchain to Supply Chain Networks. IBM Watson Customer Engagement.2017.

[6] K. C and M. D, Blockchains and Smart Contracts for the Internet of Things, IEEE Access, vol.4, pp.2292-2303, 2016.

[7] Gartner Report：Leading the IoT. 2017.

[8] W. Shi etc. Edge Computing: Vision and Challenges, IEEE Internet of Things Journal, Vol.3, No.5, October 2016, pp.637-646.