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Tie Zhang

School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China; The Center of National Railway Intelligent Transportation System Engineering and Technology, 102206, Beijing, China, tzhang2021@163.com

Ying Wang

School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China; The Center of National Railway Intelligent Transportation System Engineering and Technology, 102206, Beijing, China, ywang1@bjtu.edu.cn

Lei Huang

School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China; The Center of National Railway Intelligent Transportation System Engineering and Technology, 102206, Beijing, China

Tao Zhou

Loteem (Beijing) Rail Transit Technology Co.,Ltd., Beijing, 100070, China

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Extended Abstract

Enabling Trust in Cross-Organizational Data Sharing for EMU

Maintenance: a Double-Blockchain Solution

Tie Zhang^{1,3}, Ying Wang^{1,3*}, Lei Huang^{1,3}, Tao Zhou²

¹School of Economics and Management, Beijing Jiaotong University, Beijing, 100044, China

²Loteem (Beijing) Rail Transit Technology Co.,Ltd., Beijing, 100070, China

³The Center of National Railway Intelligent Transportation System Engineering and Technology, 102206, Beijing, China

Abstract: With the trend for smart maintenance for the Electric Multiple Unit (EMU), there is a critical need for cross-organizational data sharing. In maintenance field, blockchain technology has been introduced to enable trust among multiple stakeholders. However, the current blockchain solutions for data sharing are solely based on public chain or consortium chain, which may have the limitation of low transaction processing rate. Moreover, multiple levels of decentralization are required in cross-organizational data sharing for EMU maintenance. For the purpose of providing multiple types of ledger's governance and a performance improvement, this paper presents a method for developing EMU maintenance data sharing solution based on double blockchain. The method is validated using a case study at Shanghai EMU Depot. The proposed solution adopts Practical Byzantine Fault Tolerance (PBFT) as consensus mechanism. Interplanetary File System (IPFS) is introduced to reduce the payload of big data storage.

Keywords: blockchain, smart contract, IPFS, data sharing, EMU maintenance

1. INTRODUCTION

In the field of smart maintenance, there is a critical need for cross-organizational data sharing. Blockchain technology has been introduced to enable trust between multiple stakeholders. Nevertheless, the current blockchain solutions for data sharing in maintenance field are mainly based solely on public chain or consortium chain, which may have the limitation of low transaction processing rate ^[1, 2]. Besides, multiple types of ledger's governance are required in cross-organizational data sharing. Hence, the purpose of our research is to answer: *how to provide multiple levels of decentralization and a performance improvement for cross-organizational data sharing in maintenance field?* This paper proposes a method for developing EMU maintenance data sharing solution based on double blockchain. The double blockchain consists of a consortium chain and a private chain. Practical Byzantine Fault Tolerance (PBFT) is adopted as consensus mechanism. Interplanetary File System (IPFS) provides decentralized database functionality for the storage of encrypted data. Trusted maintenance data sharing service is provided through smart contracts.

2. RELATED WORK

In railway industry, for reasons such as the protection of data privacy and security, massive valuable data is distributed in different organizational departments and has not been fully shared among multiple stakeholders. In maintenance field, blockchain technology has been introduced to data sharing solutions to enable trust between multiple stakeholders ^[3]. However, the current solutions are mainly based solely on public chain or consortium chain, which have the limitation of significant computational overhead. What's more, such solutions may not provide different kinds of ledger's governance ^[1]. The data structure with double-blockchain has a higher level of data security ^[2]. Multiple levels of decentralization can be provided in this way, which are

* Corresponding author. Email: ywang1@bjtu.edu.cn (Ying Wang), tzhang2021@163.com (Tie Zhang)

required in EMU maintenance data sharing. To reduce the payload of big data storage, IPFS has been introduced to blockchain-based data sharing solutions [4]. All of these inspired us to combine the technology of double-blockchain structure and IPFS together to propose a data sharing solution for EMU maintenance.

3. THE METHOD

We propose a method for developing EMU maintenance data sharing solution based on double blockchain.

1) Investigation of the scenario of EMU maintenance: The maintenance scenario includes the steps of EMU maintenance, the stakeholders and their scope of work, as well as the data to be shared. The related data is held by cross-organizational stakeholders, including EMU Depot (EDP), Public Works Section (PWS), Original Equipment Manufacture (OEM), Maintenance Service Provider (MSP), among others. **2) Development of double blockchain:** The double blockchain adopted in our method consists of a private chain and a consortium chain. The private chain is composed of the nodes inside the railway corporation (e.g. EDP). The consortium chain is composed of the stakeholders in railway corporation and enterprises on the supply chain (e.g. OEM). **3) Details of the maintenance data sharing solution from three aspects:** data layer, consensus layer, application layer.

4. CASE STUDY

Under the background of EMU maintenance, a case study is conducted in Shanghai EMU Depot to verify the proposed method. According to our investigation, when Shanghai EMU Depot conducts maintaining work for EMU from other bureaus, the required data is held by multiple cross-organizational stakeholders: *Shanghai EMU Depot as Maintenance Planner (MPR), Home Depot of EMU (HDP), PWS, MSP and OEM*. MPR is responsible to proactively perceive requirements and determine the final maintenance plan using the shared data. In our scenario, the solution is detailed from three aspects: data layer, consensus layer and application layer. The nodes of MPR, HDP and PWS compose the private chain to enable trust among multiple stakeholders inside the railway corporation. The nodes of MPR, HDP, PWS, OEM and MSP compose the consortium chain. The data is stored through Merkle Tree. The blockchain utilizes PBFT. This solution provides stakeholders with trusted data sharing service, which can be achieved when some conditions are satisfied.

5. CONCLUSIONS

This paper proposes a method for developing double-blockchain data sharing solution to enable trust between multiple stakeholders in the scenario of EMU maintenance. The method is validated using a case study in Shanghai EMU Depot. In our solution, the private chain is composed of the nodes inside the railway corporation, and the consortium chain is responsible to enable trust between the railway corporation and enterprises on the supply chain. The proposed solution provides multiple types of ledger's governance and a performance improvement, which will be further extended in our future work.

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