BLOCKCHAIN BASED DYNAMIC SPECTRUM ACCESS OF NON REAL TIME DATA IN CYBER PHYSICAL SOCIAL SYSTEMS

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ABSTRACT

Big data sharing in Cyber-Physical-Social Systems (CPSSs) relies on wireless transmission between numerous devices, causing a serious scarcity of radio spectrum resources. Although license-free spectrum access has great potential to alleviate the growing scarcity of spectrum resources, spectrum competition is more intense due to lower access requirements. A block chain technology may solve this competition problem by introducing a dynamic cycle of ``competition-verification-synchronization-competition''. In this paper, we propose a general framework for license-free spectrum resource management in CPSSs based on block chain technologies and smart contracts. The management framework is mainly used for edge computing of non-real-time data. In particular, we divide spectrum of a local cell into multiple channels and each channel corresponds to a blockchain. Then, we propose a blockchain-KM protocol that may improve transaction processing speed without losing typical attributes of a general blockchain. For the proposed Blockchain- KM protocol, the entire private chain becomes a multi-ring blockchain and users rely on mining or leasing to access wireless spectrum. Different from the traditional mining process, the reward in our mining process is not only virtual currency but also a spectrum access license. Once a miner obtain a spectrum access license, it will exploit the license to transmit its messages over wireless links. Also, the miner may sell its license by an auction when it does not want to transmit messages. In the auction, we introduce a virtual currency; called as X coin, for spectrums or other trading (e.g., paid edge computing services).

Keywords: ***Cyber-physical-social systems, edge computing, spectrum access, blockchain, smart contract.***

I. INTRODUCTION

A cyber-physical-social system (CPSS) is a multi-dimensional intelligent system. After mining social relationships behind big data, it can exploit social attributes to control a traditional cyber-physical system. Integrated with the rapidly developing computing-communication- control technologies, CPSSs can realize real-time sensing, dynamic control, and information services, which can be expected to revolutionize our industrial paradigm and improve the quality of human life. However, extensive deployment of devices in CPSSs has made scarce spectrum resources even more worse. It is necessary to develop a new spectrum scheduling strategy to optimize available spectrum allocation and improve spectrum utilization.

Nevertheless, there are various challenges and issues associated with big data techniques and applications, for example, data security and privacy, energy management, scalability of computing infrastructure, data management, data

interpretation, real-time data processing, big data intelligence. Among these challenges, security and privacy have been considered as important issues since big data often involves different types of sensitive personal information, e.g., age, addresses, personal preference, banking details, etc. There have been various solutions and techniques investigated to preserve data confidentiality and private information. An example is [6], where matching theory and a coalitional game were jointly utilized to optimize a resource allocation problem so as to secure mobile social networks with big data. The use of reinforcement learning was investigated in [7] to design a security aware algorithm for a smart grid system. Recently, blockchain as a ledger technology has emerged as attractive solutions for providing security and privacy in big data systems. For example, it was shown in [8] that blockchain can play a vital role in providing high-quality data and securing data sharing for industrial IoT applications. In [9], a blockchainbased mechanism was proposed for securing data collection in mobile ad hoc networks and incentivizing mobile nodes for efficient data collection. Furthermore, blockchain was also integrated with edge computing servers to enhance the data quality and process the compute-intensive tasks requested by IoT devices with security guarantees [10]. With its unique advantages, blockchain has the great potential to transform current big data systems by providing efficient security features and network management capabilities for enabling newly emerging big data services and applications. In this survey, we present a comprehensive review of blockchain for big data, ranging from approaches to opportunities and future directions.

Related Works

``A survey of dynamic spectrum access,''

Compounding the confusion is the use of the broad term cognitive radio as a synonym for dynamic spectrum access. As an initial attempt at unifying the terminology, the taxonomy of dynamic spectrum access is provided. In this article, an overview of challenges and recent developments in both technological and regulatory aspects of opportunistic spectrum access (OSA). The three basic components of OSA are discussed. Spectrum opportunity identification is crucial to OSA in order to achieve nonintrusive communication. The basic functions of the opportunity identification module are identified.

``Spectrum prediction in cognitive radio networks,''

Spectrum sensing is an important activity in the Cognitive Radio (CR) scenario. Presence of primary users (PU) over a specific band has to be monitored periodically in each time slots. Spectrum sensing and data communication have to be completed in each time slot. If we can reduce the time required for spectrum sensing, more data can be transmitted in the specified time slot. If the presence of a PU can be predicted by a CR, throughput of the system can be improved. In this paper we define a simple approach based on Bayesian theorem to predict spectrum occupancy status of PU, from its spectrum occupancy pattern. Its performance is compared with exponential weighted moving average (EWMA) based approach to predict the spectrum occupancy information. A modification to EWMA is also suggested named hybrid approach by including the Bayesian probability within the above approach. Their performance is compared in terms of predicted probability and spectrum decision. Spectrum decision at different parameters of beta distribution is compared. Impact of number of previous data considered for prediction is also

explored. Bit error rate of Bayesian approach is found less at certain data distributions. Computational requirement of Bayesian approach is also found relatively less.\

``Spectrum policy task force report,''

Classic spectrum management policies and regulations focused on unique frequency assignments for users to avoid intersystem interference. The growing demand for wireless communications along with the recognition that classic spectrum management leads to underutilized spectrum in time and space has resulted in interest in radio spectrum access techniques. Since spectrum use is highly regulated at the national and international levels, the status of regulatory policies is key to the implementation of new access technologies.

``Privacy-preserved data sharing towards multiple parties in industrial IoTs,''

The effective physical data sharing has been facilitating the functionality of Industrial IoTs, which is believed to be one primary basis for Industry 4.0. These physical data, while providing pivotal information for multiple components of a production system, also bring in severe privacy issues for both workers and manufacturers, thus aggravating the challenges for data sharing. Current designs tend to simplify the behaviors of participants for better theoretical analysis, and they cannot properly handle the challenges in IIoTs where the behaviors are more complicated and correlated. Therefore, this paper proposes a privacy-preserved data sharing framework for IIoTs, where multiple competing data consumers exist in different stages of the system. The framework allows data contributors to share their contents upon requests. The uploaded contents will be perturbed to preserve the sensitive status of contributors. The differential privacy is adopted in the perturbation to guarantee the privacy preservation. Then the data collector will process and relay contents with subsequent data consumers. This data collector will gain both its own data utility and extra profits in data relay. Two algorithms are proposed for data sharing in different scenarios, based on whether the service provider will further process the contents to retain its exclusive utility. This work also provides for both algorithms a comprehensive consideration on privacy, data utility, bandwidth efficiency, payment, and rationality for data sharing. Finally, the evaluation on real-world datasets demonstrates the effectiveness of proposed methods, together with clues for data sharing towards Industry 4.0.

II. EXISTING SYSTEM

It is necessary to establish a fair and efficient spectrum competition access mechanism. The existing access mechanism to solve spectrum competition is listen-before-talk (LBT). The core of LBT is spectrum sensing. A node can use the spectrum if it senses the spectrum is idle; otherwise it continues to sense until it finds an idle spectrum. It seems to solve the problem of spectrum contention by using LBT. Yet, there may exist errors in spectrum sensing, such as hidden terminals and exposed terminals. Moreover, when multiple nodes in a system simultaneously sense the same idle spectrum, there may be a persistent collision problem. The system may crash due to long-term collisions when the number of nodes is excessive.

DISADVANTAGES

- We make full use of the mining mechanism of the blockchain to solve the problem of spectrum contention.
- In a bit coin system, proof of work (PoW) is used to find a new block. In POW, users

need to solve a hash mathematical problem, called as mining, to generate blocks for many years.

III. PROPOSED SYSTEM

The above LBT based access mechanism is an opportunistic access mechanism that means competition. In the process of competition, collisions are inevitable. This collision phenomenon is actually because there is no consensus. Competition and consensus are precisely the key research content of blockchain technology that is oriented to distributed systems. Therefore, it is reasonable for us to use the blockchain technology to solve the issue of dynamic spectrum access. At the same time, users of the spectrum are recorded in the blockchain, which is also conducive to the secure management of spectrum resources. In this paper, we propose a blockchain based spectrum framework in a edge computing system that is a semi-distributed network.1 To the best of our knowledge, we are the first to use blockchain to achieve wireless spectrum access.

ADVANTAGES

- The collision probability increases as the number of nodes increases but does not exceed a certain upper limit, which shows that our blockchain based spectrum access mechanism has advantages when facing a large number of devices participating in spectrum access.
- Due to this structural feature, once the data of a specific block in the blockchain is changed, it will cause the entire chain to collapse.

IV Module Description

Cyber physical social system:

A cyber-physical-social system (CPSS) is a multi-dimensional intelligent system. After mining social relationships behind big data, it can exploit social attributes to control a traditional cyber-physical system. Integrated with the rapidly developing computing-communication- control technologies, CPSSs can realize real-time sensing , dynamic control , and information services, which can be expected to revolutionize our industrial paradigm and improve the quality of human life . However, extensive deployment of devices in CPSSs has made scarce spectrum resources even more worse. It is necessary to develop a new spectrum scheduling strategy to optimize available spectrum allocation and improve spectrum utilization.

Cognitive radio:

Spectrum allocation in current wireless communications is static. The spectrum is allocated fixedly by the government (e.g. Federal Communications Commission or State Radio Regulation of China) and authorized to licensed users or licensed services. According to the static allocation strategy, spectrum resources can be divided into two categories, licensed spectrum and license-free spectrum. Although the static allocation strategy improves quality of service of licensed users, the spectrum utilization is rather low due to the fact that licensed users do not continuously utilize their assigned spectrum. To make full use of spectrum resources, researchers present dynamic spectrum allocation strategies, such as the cognitive radio (CR) technology. In a CR network, an unlicensed user can access spectrum holes opportunistically. It is considered to be the best solution to cope with the low spectrum utilization of static allocation.

Spectrum utilization:

However, it is not enough to simply increase the spectrum utilization of licensed spectrum. In general, service providers, enterprises, and individual users may use the license-free spectrum to deploy numerous wireless devices. Spectrum of different communication systems may partially or completely overlap, resulting in co-channel interference. The interference among devices will be more serious along with the large-scale application of wireless devices, thereby reducing system availability and user experience. Also, the device deployment mode of license-free spectrum access is usually a point-like and scattered layout, causing hard to scale networks. Moreover, there is no a uniform and consistent standard for wireless access. To cope with the surge in wire- less services, the stability and sustainability of using license- free spectrum is a general trend. Thus, how to manage the license-free spectrum resources effectively is an urgent issue.

Wireless spectrum access:

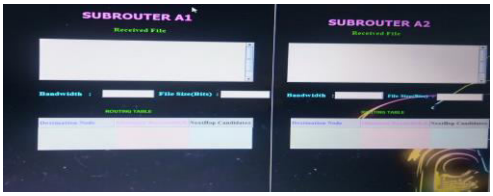
The above LBT based access mechanism is an opportunistic access mechanism that means competition. In the process of competition, collisions are inevitable. This collision phenomenon is actually because there is no consensus. Competition and consensus are precisely the key research content of blockchain technology that is oriented to distributed systems. Therefore, it is reasonable for us to use the blockchain technology to solve the issue of dynamic spectrum access. At the same time, users of the spectrum are recorded in the blockchain, which is also conducive to the secure management of spectrum resources. In this paper, we propose a blockchain based spectrum framework in a edge computing system that is a semi-distributed network.1 To the best of our knowledge, we are the first to use blockchain to achieve wireless spectrum access.

Result:

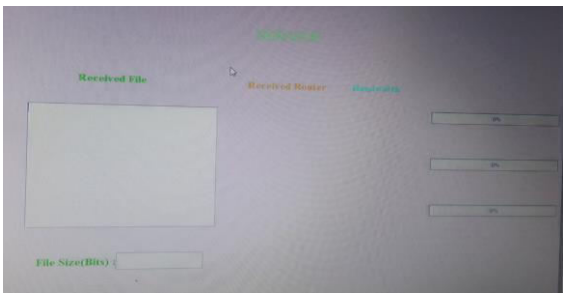
Home page

Claint file path

Router B ,Data trasver and Rout data



Subrouter A1 and A2 Data convert



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V. CONCLUSION

In this project, we pioneer a blockchain-based spectrum access mechanism for unlicensed spectrum in semi-decentralized wireless networks. The proposed spectrum access mechanism can be applied to the non-real time data transmission and processing for edge computing in CPSSs due to existing a certain access delay. We make full use of mining in block chains to solve spectrum contention. A Blockchain-KM protocol is proposed to achieve spectrum allocation and transaction recording in a network. In the proposed Blockchain-KM protocol, our blockchain is a private chain with a multi-ring structure, in which two types of blocks (key blocks and micro blocks) are adopted. A node needs to mine a key block by the proposed PoS-after-PoW mechanism to become a licensed user. For those nodes that do not become the licensed user, we propose a blockchain based spectrum leasing mechanism. The transactions in auctions are recorded in micro blocks that are generated by a lower-level PoW to reduce transaction delay. In addition, we analyze the collision of key blocks and present the performance analysis of the blockchain-based spectrum access mechanism.

Future work

In future work, we will study blockchain-based spectrum auction mechanisms, blockchain- based cooperative transmission and cloud-fog-edge computing schemes. In view of the drawback of PoW consuming resources, we will also study other lightweight consensus algorithms to apply to our framework.

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