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CPSS using Dynamic Spectrum Accessibility on the Blockchain over Non-Real-Time Data

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Abstract: Due to being dependent on wireless transmission through various devices for big data sharing in Cyber-Physical-Social Systems (CPSSs), radio spectrum resources are seriously in limited availability. Despite the fact that license-free access to the spectrum offers a great deal of promise to reduce the developing shortage of spectrum resources, competition for spectrum is more fierce due to the laxer access regulations. A dynamic cycle of "competition-verification-synchronization-competition" may be introduced by a blockchain technology to address this problem of competition. In this study, we offer a general architecture for managing license-free spectrum resources in CPSSs using blockchain and smart contracts. We precisely partition the spectrum of a local cell into numerous channels, each of which is equivalent to a blockchain. Next, we propose a blockchain-KM protocol that could expedite transaction processing while maintaining a generic blockchain's core features. Users of the Blockchain-KM protocol must mine or lease wireless spectrum, and the entire private chain is transformed into a multi-ring blockchain. In contrast to the conventional mining method, the prize in our mining process includes both a spectrum access licence and virtual currency. Once a miner has secured a permit for spectrum access, it will use the permit to send messages through wireless networks. If a miner decides not to send messages, it may sell its permit at auction. During the auction, we provide a virtual currency called Xcoin for trading spectrums or other items.

I. INTRODUCTION

An intelligent system that is cyber-physical-social system (CPSS) is multidimensional system. It is possible to use social qualities to take control of a conventional cyber-physical system after mining the social relations hidden in large data. CPSSs can realise real-time sensing , dynamic control, and information services, which can be anticipated to revolutionise our industrial paradigm , and enhance the quality of human life when integrated with the fast evolving computer, communication, and control technologies. However, the widespread use of devices in CPSSs has increased the problem of limited spectrum resources. To maximise the distribution of the available spectrum and enhance spectrum utilisation, a new spectrum scheduling approach must be created.Spectrum distribution in wireless communications nowadays is static. Government agencies (such as the Federal Communications Commission or China's State Radio Regulation) have a set allocation of spectrum that is only authorised to licenced users or licenced services. The licenced spectrum and license-free spectrum can be separated into two categories, according to the static allocation strategy. Although the static allocation technique enhances the licenced users' quality of service, the spectrum is not continuously being used by the licenced users, which results in a rather low spectrum utilisation .To optimally utilise the existing spectrum resources, researchers have created variable spectrum distribution methods, such as cognitive radio (CR) software. In CR networks, unlicensed users have opportunistic access to vacant spectrum.It is regarded as the best option to deal with static allocation's low spectrum utilisation.

However, simply increasing the licenced spectrum's utilisation is insufficient. Generally speaking, a wide range of wireless devices may be deployed using the license-free spectrum by service providers, businesses, and individual consumers. Co-channel interference is caused by the possibility of partial or complete spectrum overlap between distinct communication systems. With the widespread usage of wireless devices, device interference will become more serious, lowering system availability and user experience. Additionally, the license-free spectrum access device deployment style frequently uses a point-like and dispersed structure, making it difficult to grow networks.

A fair and effective spectrum competition access method must be established. Listen-before-talk (LBT) is the current access mechanism to address spectrum competition. Spectrum sensing is the foundation of LBT. If a node detects that the spectrum is empty, it may use it; if not, it will keep detecting until it does. Utilising LBT appears to address the issue of spectrum congestion. Nevertheless, during spectrum sensing, mistakes like exposing terminals and concealed terminals could happen.

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A persistent collision issue could also arise if several nodes in a system detect the same idle spectrum at the same time if there are too many nodes there may be prolonged collisions that cause the system crash. A cometitive access machanism, the aforementioned LBT based access approach. There will certaunly be collisions across the compition. This collision occurrence is basically a result of the lack of agreement. The main areas of research for blockchain technology that is focused on distributed systems are competition and consensus. As a result, using blockchain technology to tackle the accessibility issue with the dynamic spectrum makes sense. The blockchain is useful for the secure management of spectrum resources since it simultaneously logs spectrum users. We propose a spectrum-based blockchain-based semi-distributed edge computing architecture in this study.

II. RELATED WORK

There is currently no spectrum available without a licence standard. LBT, which includes IEEE 802.11 medium access control protocols used in WiFi systems, is the most used unlicensed spectrum access technique in wireless communications. As an opportunistic access mechanism, WiFi uses the carrier sense multiple access and collision avoidance principle, which is founded on contention. Before they can access a channel in CSMA/CS, nodes must monitor. A user may receive access to a channel only after it has been examined and found to be empty. Because of its simple architecture. However, its low spectrum utilization and collision susceptibility may degrade system performance.The previously proposed LBT technique is analogous to distributed spectrum accessibility.

To avoid channel congestion and monitoring errors, centralised spectrum access solutions are offered to address the collision problem. Using this strategy, a control centre will be in charge of managing network access and spectrum allotment. Because of the presence of the control centre, market-driven spectrum access mechanisms, particularly auction-based and pricing-based procedures, have been thoroughly examined.

More equitable pricing competition and a lessened reliance on global information distinguish these approaches. Pricing-based spectrum access mechanisms, as opposed to auction-based spectrum access mechanisms, place a greater emphasis on how to price spectrum and demand more data from bidding customers.

A centralised spectrum access mechanism could outperform LBT options. Distributed wireless networks are, on the other hand, incompatible with the central mechanism. Now a days, license-free spectrum works better for centralized networks. Market-based spectrum access methods are clearly no longer sustainable because license-free spectrum is now available to everyone for free, thereby prohibiting the government from selling unlicensed spectrum to the general public.

We employ blockchain technology in this study to increase the bar for spectrum distribution in distributed wireless networks. It should be noted that blockchains have been employed for spectrum access in a number of recent studies. Blockchains are only used by them as a trading platform, though.

To confirm the safety of spectrum transactions in cognitive radio networks between primary and secondary users, the authors used a blockchain as a decentralised database. Unlike them, we fully leverage the mining mechanism of the blockchain to overcome the problem of spectrum contention. A node is given the power to temporarily manage the spectrum, including the ability to occupy, use, or auction it, when a key block is successfully located.

III. BLOCKCHAIN

The only thing that has recently attracted substantial attention to a blockchain is the rise of bitcoin. Due to the enormous success of bitcoin, a variety of industries, including smart contracts, management of human resources, collaboration, reputation systems, safety measures, privacy preservation, supply chain, verification of information, and IoT, have quickly adopted blockchain technology. . Essentially, it is a decentralised database created for use in unreliable environments to record transactions and data. As long as it is acknowledged by the general public, a new block in a blockchain that contains a number of operations are connected to its predecessor block by the prior block's hash value. Due to this structural aspect, if the information in a particular blockchain block is modified, the chain as a whole will disintegrate.

The methods used by various blockchain systems to create new blocks vary. A new block is discovered using proof of work (PoW) in the bitcoin system. In PoW, users must resolve a problem of hash value calculation, known as mining, in order to produce blocks over an extended period of time. But because the hash problem is so difficult to solve, mining it demands a lot of computational power. Here We leverage the blockchain technologies outlined above to address the spectrum access challenges. Based on blockchain technology, we present a foundation for a dynamic cognitive radio system. We upgraded the existing consensus procedures so that they could be used with our spectrum access method. We generate three different sorts of blocks and connect them into a multi-ring structure using three different consensus mechanisms: PoS-after-PoW, lower-level PoW, and non-PoW.

IV. OVERVIEW

Assuredly, the wireless network in Fig. 1 possesses an edge device, a fog access server, and a server for the cloud data centre. Data alone is stored, sent, and synchronised by the cloud data centre server and fog access servers. They don't block communication between edge devices when using edge computing. Edge devices can communicate with one another directly over unlicensed frequency bands or, if they are not immediately reachable, they can transmit messages to a fog access server. Because they offer cooperative services rather than dictating node behaviour, the servers, which are viewed as semi-centralized nodes, show The semi-decentralized nature of the system. Each node in the system has the potential to consume enough spectrum resources to result in harmful co-frequency interference.

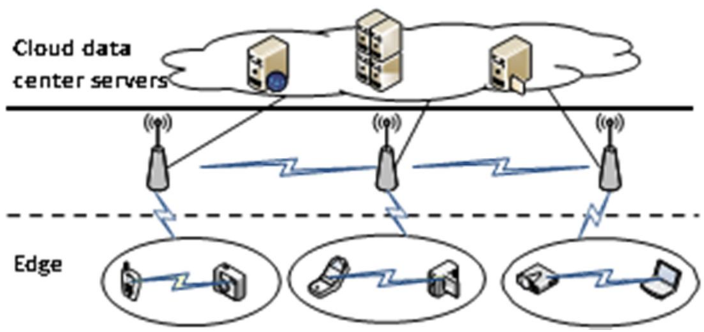


Figure 1. A semi-decentralized wireless system

Orthogonal sub channels were formed from the spectrum resources into on the blockchain and select two of them to operate as same channels. This same information such are broadcast over the first similar channel, C1. Only synchronization occurs on the second common channel, C2. Over C2, nodes can transmit and receive synchronization requests and data. We assume that each channel is consistent and evenly distributed across the time slots T1, T2,..., Tn,... The length of the T slot is determined by the system.

There are two types of spectrum access methods in blockchain-based spectrum access mechanisms: mining and auction. Each sub-channel is a block chain comprised of key blocks and micro blocks. A network node may choose to mine any blockchain. Once a critical block has been successfully mined, the node can take over as the PU of the blockchain-related channel. Secondary users are additional nodes that do not develop into PUs. The subchannel's frequency spectrum may be accessed and used by PU. The spectrum can be leased to secondary users through auctions if the PU decides it will not be using the acquired airwaves. Transaction data is recorded using micro blocks, including spectrum and cooperative communication service, computing resource transactions and so on.

Our method employs a blockchain with many chains, each of which represents a different channel. For application in such a blockchain system, we recommend the Blockchain-KM key-micro blockchain protocol.The two types of blocks in Blockchain-KM are key blocks, which are used to replace spectrum owners, and micro blocks, which are used to record transactions. Each block contains the previous block's hash value. Operations are completed more quickly and effectively when using this blockchain layout. The Blockchain-KM proposal transforms the blockchain of each channel into a chain with several rings..

A. *Spectrum Access Design Using Blockchain*

In this part, we propose a wireless network that is relatively decentralised and uses a blockchain-based spectrum access mechanism. From the available spectrum resources, we generate m orthogonal subchannels and select two of them as the common channels. C1, the initial common channel, sends information that all users share, such as blockchain updates, transactional data, auction data, and bidding data. Everything that occurs on the second common channel, C2, is synchronisation. Nodes can send synchronisation requests and receive synchronisation information via C2. Assuming that all channels are reliable and evenly distributed across the time slots T1, T2,..., Tn,..., the system requirements will determine the size of Tslot for each slot. A flowchart of our blockchain-based spectrum access system shows two different spectrum access methods: mining and auction. A block chain made up of key blocks and micro blocks represents each sub-channel. Any blockchain may be selected by network nodes for mining purposes. The node might take over as the PU of the blockchain-related channel if it is successful in mining a crucial block. Nodes with secondary users status do not reach PU status. The subchannel's frequency spectrum is available to and usable by PU. The PU may put the acquired spectrum up for auction to other users if it decides not to use it. Transactional data, such as spectrum, mutually beneficial communication services, and computational resource operations, are stored in microblocks.

B. Access Process For Mining

A key block is used to select a new PU. The channel identifier, the time stamp, the value of the founded nonce, and the hash of the first microblock created by the prior PU are all provided.

By computing the hash value of the most recent data, a new block is created in order to create a key block.A node does not automatically become a new PU when it creates a new key block due to the forking problem, which allows many nodes to generate key blocks at once. To solve this problem, we suggest a PoS-based strategy. PoS might offer interest depending on the amount and lifetime of the virtual money. The digital currency that one node holds is going to generate Coin-age under the PoS the system. In to our assessment, once the coin has been used to execute the transaction, its Coin-age will be reset to zero. This shows that coins' initial Coin-age, regardless of how they were obtained, is 0. Additionally, once a node locates a block that has been noticed by the public, the Coin-age of all the coins it contains is changed to 0. If the annual interest rate is 0.05, then each time a node uses 365 Coin-age, it will earn 0.05 coins in interest.

The PoS approach allows us to compare the Coin-age of two miners that discover a block at the same time and award the mining operation to the older user. A transaction is only valid when the user has logged it in micro blocks. The user will be unable to use the virtual money that was included in the transaction until it has been validated. As a result, consumers expect their transaction to be confirmed and stored in a micro block as fast as practical. A PU can impose transaction fees to encourage the recording of transactions.

Therefore, a lower-level PoW with a lower difficulty value than the PoW for creating a key block should be used to generate micro blocks. Nodes will link the new key block to the first micro block created by the previous PU after receiving the message enthroning the new PU. When more than two blocks are generated simultaneously, a fork could happen. The multi-ring blockchain can fork into two different types of forks. In this situation, the PoS technique should be used to prevent forks. All nodes that discover key blocks simultaneously cannot create a new PU if PoS cannot resolve this issue. Then they will receive reimbursement in the form of a specified amount of virtual currency. If all nodes wait one more time slot after getting the micro block, the fork problem for the conflict between a micro block and a key block can be avoided. And if a new key is created, the nodes may link the microblock to the blockchain.

C. Access Mechanism Based On The Market

After the PU is recognised, the system might evolve into a dynamic cognitive radio network (CRN). The blockchain-based spectrum management solution supports all current ways for proving CRN performance. Market-based spectrum access techniques, including price-based and auction-based mechanisms, can be used more successfully under our methodology.. We take advantage of a trading system based on smart contracts to explain why. Faster transaction speeds can be achieved by using blockchain technology and smart contracts for spectrum transactions. The blockchain's micro blocks contain a record of every transaction, which is updated by miners. Then, all transactions are verified using the blockchain to enhance and secure spectrum leasing.

D. The Strategy For Cooperative Communication

Network performance can be increased through cooperative communication. To increase system performance, a user might choose other users to act as cooperative relays. The user is required to pay other users in exchange for their support. Blockchains are another option for completing the transactions, which might speed them up. As a result, adopting cooperative communication can further enhance system performance. Due to the abundance of references already available, we also neglect the specifics of cooperative communication systems .

E. Analysis of Applicability

In fact, the blockchain technology requires a lot of resources and overhead. These restrictions also affect our blockchain-based spectrum access system. In order to limit energy usage, we only enable PUs to generate microblocks when designing microblocks, which reduces the difficulty of PoW. All data is stored in cloud data centres or fog access servers and can be retrieved as needed, while edge devices retain recent blockchain data to save storage resources. Furthermore, this three-tier storage strategy promotes decentralisation and avoids single points of failure. Despite the fact that we worked hard to develop our solution to overcome these resource-intensive constraints, the participating devices must still have extra resources to enable the blockchain system to function. The lengthy spectrum acquisition process also restricts real-time data transfer via our spectrum access method.

V. CONCLUSION AND FUTURE WORK

In this study, we provide a blockchain-based partially decentralised wireless network with an unlicensed spectrum access mechanism. Because of the access delay, the proposed spectrum access technique can be employed for non-real time data transmission and processing for edge computing in CPSSs. We use blockchain mining to completely resolve spectrum disagreements. To manage spectrum allocation and transaction monitoring in a network, a Blockchain-KM protocol is recommended. In addition to other types of blocks, our blockchain employs key blocks and micro blocks. It is a multi-ring private chain that use the Blockchain-KM protocol, which is still in development. Before a node can be considered an authorised user under the proposed PoS-after-PoW scheme, it must mine a key block. We propose a blockchain-based spectrum leasing model for nodes that do not become authorised users. To minimise transaction time, auction transactions are saved in micro blocks, which are constructed using a lower-level PoW. We also examine key block collisions and give a performance analysis of the blockchain-based spectrum access system. Future research will focus on cloud-fog-edge computing techniques, cooperative transmission, and procedures for spectrum auctions based on blockchain technology. Because PoW uses resources, we'll also research additional lightweight consensus techniques to use with our framework.

REFERENCES

[1] X. Zheng, Z. Cai, J. Yu, C. Wang, and Y. Li, “Follow but no track: Privacy preserved profile publishing in cyber-physical social systems,” IEEE Internet of Things Journal, vol. 4, no. 6, pp. 1868–1878, Dec 2017.

[2] J. Mao, W. Tian, Y. Yang, and J. Liu, “An efficient social attribute inference scheme based on social links and attribute relevance,” IEEE Access, vol. 7, pp. 153 074–153 085, 2019.

[3] X. Wang, L. T. Yang, X. Xie, J. Jin, and M. J. Deen, “A cloud-edge comput- ing framework for cyber-physical-social services,” IEEE Communications Magazine, vol. 55, no. 11, pp. 80–85, Nov 2017.

[4] Z. Cai, X. Zheng, and J. Yu, “A differential-private framework for urban traffic flows estimation via taxi companies,” IEEE Transactions on Indus- trial Informatics, vol. 15, no. 12, pp. 6492–6499, Dec 2019.

[5] Z. Cai and Z. He, “Trading private range counting over big iot data,” in 2019 IEEE 39th International Conference on Distributed Computing Systems (ICDCS), July 2019, pp. 144–153.

[6] X. Zheng and Z. Cai, “Privacy-preserved data sharing towards multiple parties in industrial IoTs,” IEEE Journal on Selected Areas in Communi- cations, pp. 1–1, 2019.

[7] X. Wang, L. T. Yang, L. Kuang, X. Liu, Q. Zhang, and M. J. Deen, “A tensor-based big-data-driven routing recommendation approach for het- erogeneous networks,” IEEE Network, vol. 33, no. 1, pp. 64–69, January 2019.

[8] P. Kolodzy and P. Kolodzy, “Spectrum policy task force report,” Federal Communications Commission Tech.rep.rep.et Docket, vol. 40, no. 4, pp. 147–158, 2002.

[9] X. Xing, T. Jing, W. Cheng, Y. Huo, and X. Cheng, “Spectrum prediction in cognitive radio networks,” IEEE Wireless Communications, vol. 20, no. 2, pp. 90–96, April 2013.

[10] Q. Zhao and B. M. Sadler, “A survey of dynamic spectrum access,” IEEE Signal Processing Magazine, vol. 24, no. 3, pp. 79–89, 2007.

[11] V. S. Bhargavi and S. V. Raju, "Enhancing security in MANETS through trust-aware routing," 2016 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), Chennai, India, 2016, pp. 1940-1943, doi: 10.1109/WiSPNET.2016.7566481.

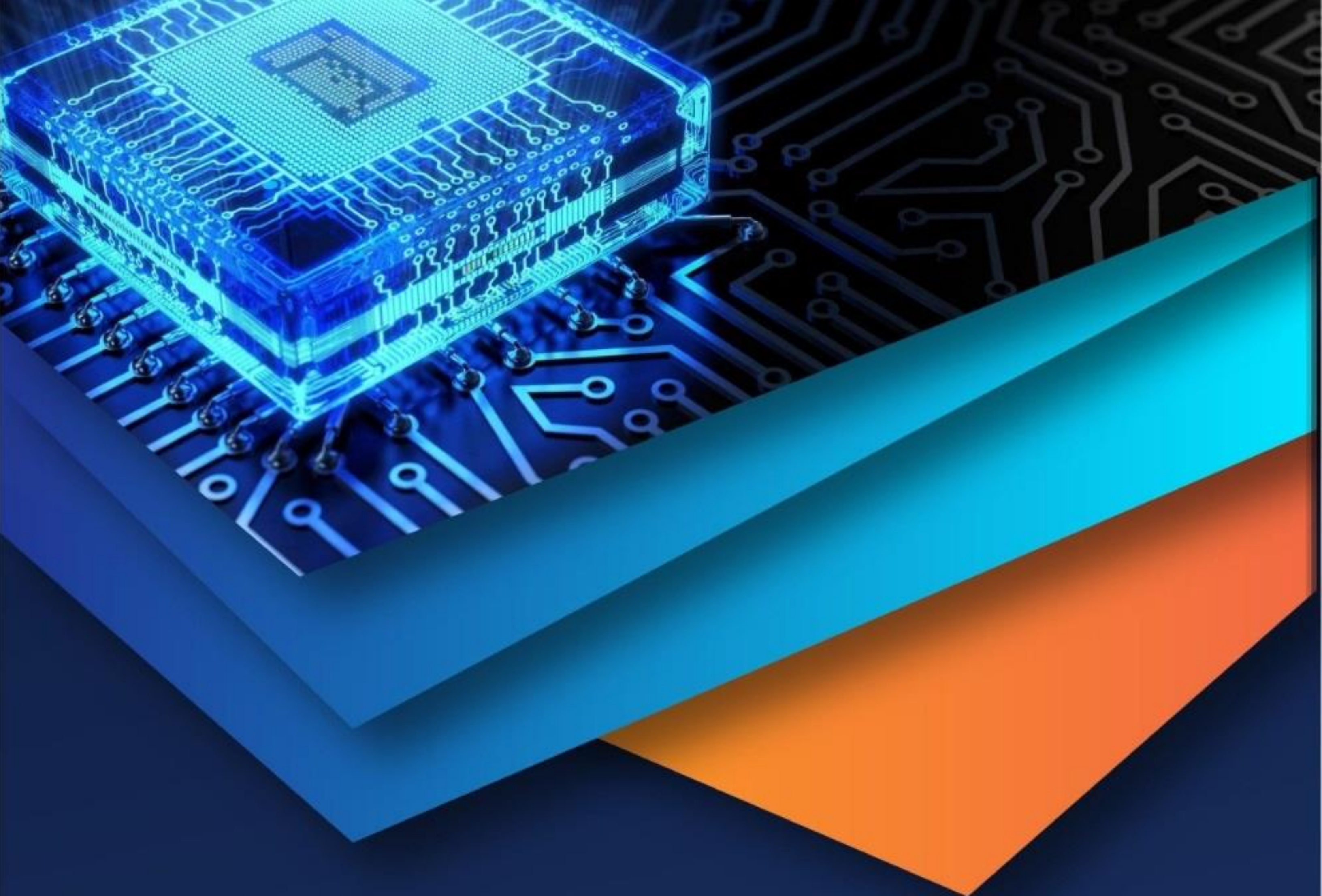
[12] Velagaleti, Sesha Bhargavi, Dr M. Seetha, and Dr S. Viswanadha Raju. "A Simulation And Analysis Of Secured S-DSR Protocol In Mobile Ad Hoc Networks." International Journal of Computer & Organization Trends 3.9 (2013): 425-430.

[13] R. H. Tehrani, S. Vahid, D. Triantafyllopoulou, H. Lee, and K. Moessner, “Licensed spectrum sharing schemes for mobile operators: A survey and outlook,” IEEE Communications Surveys & Tutorials, vol. 18, no. 4, pp. 2591–2623, 2017.

[14] A. Sultana, X. Fernando, and L. Zhao, “An overview of medium access control strategies for opportunistic spectrum access in cognitive radio networks,” Peer-to-Peer Networking and Applications, vol. 10, no. 5, pp. 1113–1141, 2017.

[15] C. Raman, R. D. Yates, and N. B. Mandayam, “Scheduling variable rate links via a spectrum server,” in First IEEE International Symposium on New Frontiers in Dynamic Spectrum Access Networks, 2005. DySPAN 2005., Nov 2005, pp. 110–118.

[16] X. Wang, L. T. Yang, Y. Wang, X. Liu, Q. Zhang, and M. J. Deen, “A distributed tensor-train decomposition method for cyber-physical-social services,” ACM Trans. Cyber-Phys. Syst., vol. 3, no. 4, pp. 35:1–35:15, Oct. 2019.



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