**RESPONSE TO REVIEWERS’ COMMENTS RECEIVED FOR OUR SUBMISSION “***A Novel Blockchain Structure for Wireless Sensor Networks Based on IOTA Tangle*” (**Manuscript ID:** electronics-1829047)

The authors thank the anonymous reviewers for the in-depth scrutiny, and valuable feedback and suggestions, which have improved the quality of the paper. We would like to thank the editor for allowing us to resubmit the manuscript with minor revisions. In the following, we provide responses to the reviewers’ comments. The sentences highlighted in blue font are the new additions in the revised manuscript. These changes have been incorporated into our revised manuscript.

**REVIEWER 1**

**Reviewer 1, Comment 1:***This version of the paper has improved significantly. Now the problem tackled by the authors is clear; therefore, the contribution is also more explicit.*

*However, they need to improve some concepts, particularly in the introduction and background. The authors should better present IoTa (Tangle) and blockchain concepts. For instance, the following phrase :*

*"IOTA is a Blockchain technology designed for the Internet of Things (IoT) that is energy-efficient, scalable, lightweight, and can be transacted over the Blockchain network without any fees [5].*

*Is confusing, as it uses Blockchain and iota together. Similarly to this phrase :*

*"The IOTA technology uses Blockchain to …"*

*Currently, it is better to call Distributed Ledger Technology to all propositions similar to Blockchain, but without using blocks (as clearly stated by the authors). Blockchain should not be a concept used by "blockchains" and "tangle". The concepts shared by both approaches are transactions and distributed ledger.*

*I suggest reading IOTA white paper (The Tangle by Serguei Popov) to describe this concept in the introduction better. Making the difference between blockchain-based approaches and Tangle is critical to put the paper in context, as the paper tackles the IoTA approach.*

**Authors’ Response:**

Thank you for this excellent comment. In the revised manuscript, we have defined Distributed Ledger Technology (DLT) as the generic term encompassing technologies such as Blockchain, Hashchain, Hashgraph, IOTA Tangle and Sidechain. We have replaced “Blockchain” with the generic term “Distributed Ledger Technology (DLT)”.

1. The title has been appropriately changed to "A Novel Distributed Ledger Technology Structure for Wireless Sensor Networks Based on IOTA Tangle"
2. The blockchain mentioned in the abstract was changed to DLT, and the grammar error was corrected.

Abstract: Wireless Sensor Networks (WSNs) consist of many wireless sensor nodes for collecting and sensing information. Distributed Ledger Technologies (DLTs) such as Blockchain allow organizations to store and share data decentralized, immutable, and secure through a network of distributed peer-to-peer users or computers. The application of DLT to the Internet of Things (IoT) can improve the efficiency of information transmission and network security. IOTA Tangle is a DLT developed for IoT to process transactions. WSN is a core technology for IoT, and the two have a lot in common in terms of applications. Many solutions for IoT applications can be implemented with WSNs. However, the sensor nodes in WSNs have limited processing speed, storage capacity, communication bandwidth, and energy consumption capabilities. Therefore, a lightweight solution needs to be designed according to the characteristics of WSNs, rather than directly applying Tangle. The similarities between IoT and WSNs determine that the Tangle can be an essential reference for designing new solutions. In this paper, we propose a new DLT structure based on Tangle named Fishing Net Topology (FNT). The aim is to meet the lightweight requirements of sensor nodes in WSNs. We compared FNT with Tangle in terms of packet network structure and algorithm, and also experimentally analyzed the waste rate in the FNT network. It is concluded that FNT can be used at a reasonable Rate based on the requirement of the WSN applications, and it can significantly reduce the computation while enhancing the security of WSNs. Due to its structural stability and algorithmic simplicity, FNT outperforms Tangle in WSNs.

1. The second paragraph (Line 28~33) of the introduction was replaced with:

Distributed Ledger Technologies (DLTs) such as Blockchain offer a decentralized, immutable and secure network of distributed peer-to-peer users or machines to store and process transactions securely [2]. DLT involves many computer technologies such as distributed systems, cryptography, data structures or consensus algorithms [3]. Information in DLT is distributed in a network of nodes, and updates or modifications generated in the network are immediately reflected in the ledgers of all participants [4].

1. New paragraph added in section 2.3, line 98~101. Title changed to “Distributed Ledger Technology and Blockchain”.

Distributed Ledger Technology (DLT) is the generic term for distributed digital systems to record transactions and use consensus algorithms to ensure data immutability [22]. DLT encompasses technologies such as Blockchain, IOTA Tangle, Hashchain, Sidechain, and Hashgraph [23].

1. Line 34: IOTA is a DLT designed for the Internet of Things (IoT) that is energy efficient, scalable, lightweight, and can be transacted over the blockchain network without any fees [5].
2. Line 39: The IOTA technology uses DLT to enable IoT to improve network security, which provides a new idea for solving similar problems in WSNs.
3. Line 44: We propose a new IOTA Tangle-based distributed ledger topology for WSN applications named Fishing Net Topology (FNT).
4. Line 117: IOTA Tangle is a DLT designed for IoT with high scalability, zero cost, quantum immunity, low energy consumption, and secure data transmission features [5].

**Reviewer 1, Comment 2:***Similarly, in the related works section (2.5), the authors should end the section with a summary of what is missing. After reading the section, the reader understands that there is ongoing research and even that it provides good results. I know these works focus on IoT, but a common reader might not find a difference between these results and the problem the authors are addressing (really constrained WSN). Make this difference clear at the end of this section, and connect to the following Summary section (2.6).*

**Authors’ Response:**

Thank you for the comment. We have added a paragraph, section 2.5, line 195~200, as follows:

Due to the lack of relevant literature and research, we introduced simulation studies of the IOTA Tangle, and current research cases on applying DLT to the IoT. The simulation studies on Tangle reflect some of the limitations of Tangle and its barriers to applications in WSN. IoT has many similarities with WSNs, and the studies mentioned above apply DLT to constrained IoT devices. While our research focuses on applying DLT to WSN devices; these research cases can be used as important references.

**Reviewer 1, Comment 3:***Finally, the authors should consider renaming the "Summary" section to "Problem definition."*

**Authors’ Response:**

Thank you for the comment. We have changed the title of section 2.6 to “Problem Definition” as requested. We have also resized figures 2,3,6,7 to fit the layout.

**Reference**

[2] Suciu, G.; N˘adrag, C.; Istrate, C.; Vulpe, A.; Ditu, M.C.; Subea, O. Comparative Analysis of Distributed Ledger Technologies. In Proceedings of the 2018 GlobalWireless Summit (GWS), 2018, pp. 370–373. https://doi.org/10.1109/GWS.2018.8686563.

[3] Antal, C.; Cioara, T.; Anghel, I.; Antal, M.; Salomie, I. Distributed ledger technology review and decentralized applications development guidelines. Future Internet 2021, 13, 62.

[4] Bouras, M.A.; Lu, Q.; Zhang, F.; Wan, Y.; Zhang, T.; Ning, H. Distributed ledger technology for eHealth identity privacy: state of the art and future perspective. Sensors 2020, 20, 483.

[5] Bhandary, M.; Parmar, M.; Ambawade, D. A Blockchain Solution based on Directed Acyclic Graph for IoT Data Security using IoTA Tangle. In Proceedings of the 2020 5th International Conference on Communication and Electronics Systems (ICCES), 2020, pp. 827–832. https://doi.org/10.1109/ICCES48766.2020.9137858.

[22] Farahani, B.; Firouzi, F.; Luecking, M. The convergence of IoT and distributed ledger technologies (DLT): Opportunities, challenges, and solutions. Journal of Network and Computer Applications 2021, 177, 102936.

[23] Akhtar, Z. From blockchain to hashgraph: distributed ledger technologies in the wild. In Proceedings of the 2019 International Conference on Electrical, Electronics and Computer Engineering (UPCON). IEEE, 2019, pp. 1–6.