**Original Manuscript ID:** Access-2022-08771

**Original Article Title: Cell based Raft Algorithm for Optimized Consensus Process on Blockchain in Smart Data Market**

**To:** IEEE Access Editor

**Re:** Response to reviewers

Dear Editor,

Thank you for allowing a resubmission of our manuscript, with an opportunity to address the reviewers’ comments. We were able to develop a better paper. Each comment is so precious and helpful to our paper and thank you again.

We are uploading (a) our point-by-point response to the comments (below) (response to reviewers), (b) an updated manuscript with yellow highlighting indicating changes (*Supplementary Material for Review*), and (c) a clean updated manuscript without highlights (*Main Manuscript).*

Best regards,

Dana Yang et al.

**Reviewer#1, Concern # 1:**

**Author response:** This paper needs major improvements in the implementation section.

**Author action:** We updated the manuscript by clarifying the part of open source and the implementation of the proposed algorithm. The Raft algorithm is an already well-known algorithm, and we use the already implemented algorithm project by downloading Github (<https://raft.github.io>). Most of the downloaded projects were developed to achieve consensus in accordance with CBR, but improved AppendEntries RPC messages and RequestVote RPC messages, as well as the main parts where each node stores the logs in cell size in logging to State Machines (ref. IMPLEMENTATION AND EVALUATION p9).



**Reviewer#1, Concern # 2:**

**Author response:** The results are not presented impressively.

**Author action:** We updated the manuscript by describing the graphs of the simulation results of the improved CBR algorithm and the existing Raft algorithm in detail. We measure how much the number of messages burdening the blockchain network overhead has decreased according to the number of nodes, showing that on average it has decreased by 45.03%. As the number of nodes increases, TPS decreases for both algorithms. Especially, if the cell size is unconditionally increased to reduce the number of messages, the logs cannot be stored stably on the State Machine, resulting in lower TPS which affects the overall system. However, this paper proves the CBR algorithm that relieves the burden of the blockchain system and increases performance by increasing the TPS by 2.4% on average without intervals of rapid decrease (ref. PERFORMANCE EVALUATION p11).



**Reviewer#1, Concern # 3:**

**Author response:** The conclusion needs to be shortened by including your results and contributions only.

**Author action:** We updated the manuscript by summarizing the explanation of why the recent blockchain system is selected and the analysis of problems with the Raft algorithm as follows (ref. CONCLUSION p12).

“Based on various resources in the social sector, many companies are choosing blockchain systems for the purpose of introducing smart services to help human activities more broadly in fields such as health. Since the Raft algorithm adopted as the main consensus algorithm in these systems is a process in an environment composed of a small number of servers, it is difficult to apply it to smart services that require the participation of many nodes in various environments.”



**Reviewer#2, Concern # 1:**

**Author response:** 1-Figure 5 requires more explanation from the reader's point of view.

**Author action:** We updated the manuscript by describing the explanation of Figure 5 in detail. Figure 5 is a learning method that helps distributed devices collect data and learn from each device, but collects the learning results and updates the modeling of the device. Therefore, it is possible to generate more accurate learning results than to derive results by learning individually in an environment composed of distributed devices such as blockchain.



**Reviewer#2, Concern # 2:**

**Author response:** rigorous evaluation and validation of the work are lacking.

**Author action:** We updated the manuscript by adding the simulation and explaining the evaluation.

The red line in Figure 16 refers to the number of AppendEntries RPC messages when consensus is achieved with the optimized CBR algorithm through Federated Learning, and the black dotted line refers to a value obtained by fixing the cell size to 40 and measuring the number of messages regardless of the number of nodes. The reason why the cell size is fixed at 40 is that it is the cell size value that maintains the highest TPS in the correlation graph between the fail message and the TPS. For both Raft algorithms, as the number of nodes increases, the number of AppendEntries RPC messages increases. The Figure 16 can be seen that there is little difference in the number of messages between the proposed static CBR and the proposed optical CBR. Basically, when the number of nodes is the same, if the cell size is large, the number of messages exchanged will inevitably decrease. For example, when the number of nodes is 5, the optimized cell size is 80 larger than the CBR fixed at 40. However, the difference in the actual number of messages is not double. The reason is that as large as that size, an empty log occurs in storing the log, or the order of the log changes, so a large amount of fail messages are also generated(ref. PERFORMANCE EVALUATION p11).

The purple line and the green dotted line in Figure 17 are the TPS value measured by performing the proposed Raft algorithm. As the number of nodes increases, TPS decreases for both algorithms. In particular, if the blockchain system is out of the resource tolerance range, the TPS decreases rapidly, making the system impossible to process almost logs. In the case of fixing the cell size or obtaining an optimized cell value through federated learning, the TPS value is measured to be higher than the traditional Raft (ref. PERFORMANCE EVALUATION p12).



**Reviewer#2, Concern # 3:**

**Author response:** The authors should compare their solution with the existing solutions.

**Author action:** We updated the manuscript by adding the simulation and explaining the evaluation. The Raft algorithms that collect and process existing schedule logs often perform better than Raft algorithms when comparing TPS or the number of messages. However, CBR proves a significant reduction in the number of messages and that TPS also ensures a more stable system than the traditional Raft. In addition, blockchain systems consisting of lightweight devices that cannot perform both federated learning and consensus algorithms show performance comparable to optimal CBR even when they are forced to perform consensus with a static cell size (ref. PERFORMANCE EVALUATION p12).



**Reviewer#2, Concern # 4:**

**Author response:** Assumptions of the study need to be specified more clearly.

**Author action:** We updated the manuscript by specifying the blcochain system. Unlike Raft in existing distributed systems which store the changed values in the log, Raft algorithms in blockchain systems proceed with the consensus process by storing one log on a transaction line or block. In fact, we implement CBR and measure performance by constructing a virtual node provided through an open-source, as there is no environment in which more than five devices can be obtained (ref. IMPLEMENTATION AND EVALUATION p9).



**Reviewer#2, Concern # 5:**

**Author response:** Scope and limitations of the study need to be included in a separate section.

**Author action:** We updated the manuscript by dividing the Implementation part and the evaluation part. The specifications of the open-source and simulated devices required for the study are included in the implementation part and the limitations of the simulation are explained also in the implementation part. As mentioned above, we implement CBR and measure performance by constructing a virtual node provided through an open-source, as there is no environment in which more than five devices can be obtained (ref. IMPLEMENTATION AND EVALUATION p9).



**Reviewer#2, Concern # 6:**

**Author response:** The reference list needs to be updated with more recent works.

**Author action:** We updated the the reference list. The references was revised mainly on papers published after 2018.



**Reviewer#3, Concern # 1:**

**Author response:** Section II has redundant information. Please revise.

**Author action:** We updated the manuscript by reducing the redundant information as follows.

"The term "smart data" describes the development from initially unstructured mass data to data that can be converted to intelligent processing and knowledge.”



**Reviewer#3, Concern # 2:**

**Author response:** How is federated learning used with the proposed scheme? Please make it more clear.

**Author action:** We updated the manuscript by clearing the proposed CBR. The final goal of the CBR algorithm is to calculate the optimal cell size for the entire blockchain system with the consensus capability of the distributed servers. Where the consensus is achieved by arbitrarily determining a cell size, the number of messages could be lowered to solve the network overhead problem, but it is observed that the specification of the system is low in terms of performance, such as TPS, because the Raft algorithm arbitrarily determining a cell size was not considered at all. Specifically, consensus nodes in the blockchain generate the local weight, and a third-party agency, such as a trust organization, generates the global weight and distributes the global weight to the nodes. The learning data is configured based on TPS information measured by variously changing cell sizes at each node. Finally, it is to obtain the optimal cell size that can lead to the highest TPS according to the number of nodes in the blockchain (ref. FEDERATED LEARNING p5).



**Reviewer#3, Concern # 3:**

**Author response:** Please discuss in more detail Figs. 14 and 15.

**Author action:** We updated the manuscript by describing Figs. 14 and 15 in detail. Each node constituting the blockchain calculates local weight with learning data including TPS and receives global weight from trust organization to update the modeling. Figure 14 shows that the more the local model of the node is updated through federated learning, the more accurately the optimized cell can be obtained. In the early epoch of 10 or less, the accuracy dropped to around 0.5, but after that, the exact cell size can be obtained by converging to 1. Furthermore, as the learning of each node increases, the training loss rate value also gradually decreases and converges to zero, proving that optimized cells can be accurately obtained (ref. FEDERATED LEARNING p5).



**Reviewer#3, Concern # 4:**

**Author response:** Please improve the visibility of Fig. 6.

**Author action:** We updated the manuscript by increasing the resolution and enlarging the Figure 6(p7).



**Reviewer#3, Concern # 5:**

**Author response:** A comparison of the proposed scheme with other baselines is required.

**Author action:** We updated the manuscript by adding the static cell size-simulation and explaining the evaluation. The Raft algorithms that collect and process existing schedule logs often perform better than Raft algorithms when comparing TPS or the number of messages. However, CBR proves a significant reduction in the number of messages and that TPS also ensures a more stable system than the traditional Raft. In addition, blockchain systems consisting of lightweight devices that cannot perform both federated learning and consensus algorithms show performance comparable to optimal CBR even when they are forced to perform consensus with a static cell size (ref. PERFORMANCE EVALUATION p12).



**Reviewer#3, Concern # 6:**

**Author response:** There are many grammatical mistakes in the paper. Please proofread.

**Author action:** We updated the manuscript by Using the English grammar check program.



***Note:*** *References suggested by reviewers should only be added if it is relevant to the article and makes it more complete. Excessive cases of recommending non-relevant articles should be reported to ieeeaccesseic@ieee.org*