Cluster Head Selection and Packet Delivery Estimation Based on K-Means and FCM

Anil Khandelwal, Yogendra Kumar Jain

Abstract: In this paper comparative study have been presented for the efficient cluster head selection based on k-means and fuzzy c-means (FCM) clustering algorithms. It is observed that the nodes assignment after the clustering is different through k-means and FCM. It is because of the variant initialization mechanism of the k-means and FCM. But the assignment of cluster does not affect the results. It is clearly depicted from the packet delivery time results by our approach. It shows that the k-means and FCM have the capability of CHs selection in the required time frame and it shows the effectiveness in different iterations also. When aggregate packet delivery has been considered the same situation has been observed which depicts the capability of our approach. K-means found to be faster in comparison to FCM.

Keywords: WSN, CHs, K-means, FCM, SAW and WPM.

I. INTRODUCTION

Wireless sensor networks (WSNs) provide a way of communication through data transmission and achieve a heterogeneous environment [1, 2]. The major drawbacks suggested in the previous works are the resource limitation and the communication failure [3−7]. The important factors for the analysis are network lifetime, energy efficiency and data synchronization [8, 9]. The use of k-means and FCM in explorative way is shown in [10−13]. In 2016, Yuvaraj and Narayana [14] suggested a hybrid cluster head selection method with the parameters Location centrality and Nodes' lingering energy on the fixed clusters. The recreation result represents that the proposed calculation is great at burden offsetting with low control overhead and stretching out system lifetime contrasted with regular steering calculation drain. In 2016, Devi and Rao [15] discussed ground breaking technology in case of WSN. They have suggested that almost all routing protocols main aim is to maximize the life time. They have suggested that the existing protocols are data centric, hierarchical, and location based and on demand routing protocols. They have also suggested the cluster-based

protocol like deterministic energy-efficient clustering (DEC), stable election protocol (SEP) and stable election protocol enhancement (SEP-E). In this paper they have compared the performances of SEP and DEC. Their result indicates that SEP-E have more energy available than DEC and SEP protocol. In 2017, Abushiba et al. [16] discussed large scale integration and energy-efficiency in WSN. They have suggested that the sensor-node energy has been consumed in case of energy-efficient solutions. They have suggested that the LEACH as the most common energy-efficiency sensor network. They have proposed a CH-LEACH. They have evaluated the performances based on energy consumption and network lifetime. They have found that the CH-LEACH provides 91% network lifetime which is better than LEACH. In 2017, Echoukairi et al. [17] discussed WSN in terms of centralized clustering approach. It is based on k-means method. They want to improve the LEACH-C protocol by applying k-means algorithm. It may be helpful in new cluster scheme and therefore lengthen the lifetime of the sensor network. They have implemented their approach in the NS2 simulator. The parameters for the performances they have considered are average end-to-end delay, packet delivery ratio, average energy consumption, average throughput and control routing overhead. Their approach result shows that it can effectively reduce the overhead. In 2019, Masoud et al. [18] discussed about the clustering impact on all the cases. They have proposed a hybrid clustering routing protocol (HCP). Their proposed protocol having cluster formation and data forwarding phases. In cluster formation and data forwarding phase, traffic has been decided to forward to the sink node according. It is based on the threshold value. If the nodes are less in the network, clustering will not be performed. Their result shows efficient reduction in network power consumption and increase impact has been achieved in case of network lifetime. In 2019, Liu et al. [19] discussed about the prolonging lifetime in WSNs. They have proposed an energy efficient cluster formation algorithm based on GA-optimized Fuzzy Logic (CGAFL). In this system fuzzy inference system (FIS) has been applied. For fuzzy inference rule optimization genetic algorithm (GA) has been used. Their results suggest that the CGAFL has the ability for the optimal fuzzy inference rules and also prolong the lifetime of WSNs. The results are based on the comparison from the LEACH, CFFL and FLCFP.

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II. MATERIAL AND METHODS

In this dissertation an efficient k-means and fuzzy c-means (FCM) algorithms have been used for the cluster head (CH) selection in wireless sensor network (WSN). The ranking and the priority selection of the CHs have been determined based on the simple additive weighting (SAW) and weighted product method. In our work the weight assignments are based on the node operation. In the first phase the data pre-processing is applied based on the weight assigned.

It is the combination of the steps which is used in the all aspects of parameter selection according to the sink attributes. Then the pre-processed value is input for the clustering phase. The second phase is the clustering phase. In this phase k-means and FCM have been explored and analyzed based on the parameters. These approaches proved to be useful in

different scenario [10, 11]. K-means and FCM have been applied on the input data. The input data is processed through the preprocessing approach. The results of the clustering are based on the weight segments. For achieving maximum unbiases random approach has been used. In our approach automatic weight-based selection mechanism was applied. Higher strength group is selected first. The complete process was unbiased due to the randomness. Ranking algorithms have been applied after the clustering. SAW and WPM have been used for the final selection based on the complete results after the clustering approach.
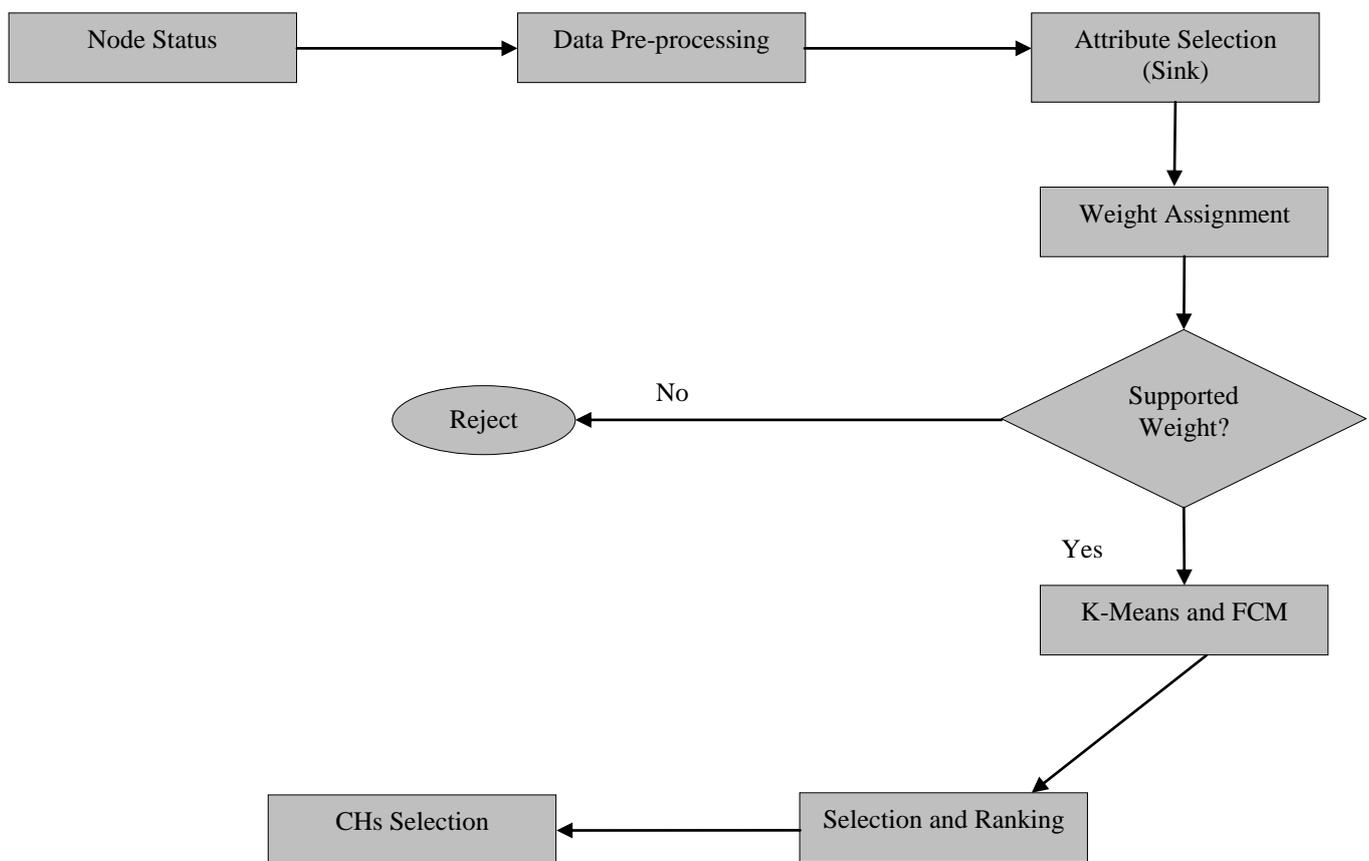
Figure 1 Overall System Structure

III. RESULTS AND DISCUSSION

In this section comparative analysis based on k-means and FCM algorithm has been discussed. Firstly, the discussion based on the clustering has been performed. It is observed that the nodes assignment after the clustering is different through k-means and FCM. It is because of the variant initialization mechanism of the k-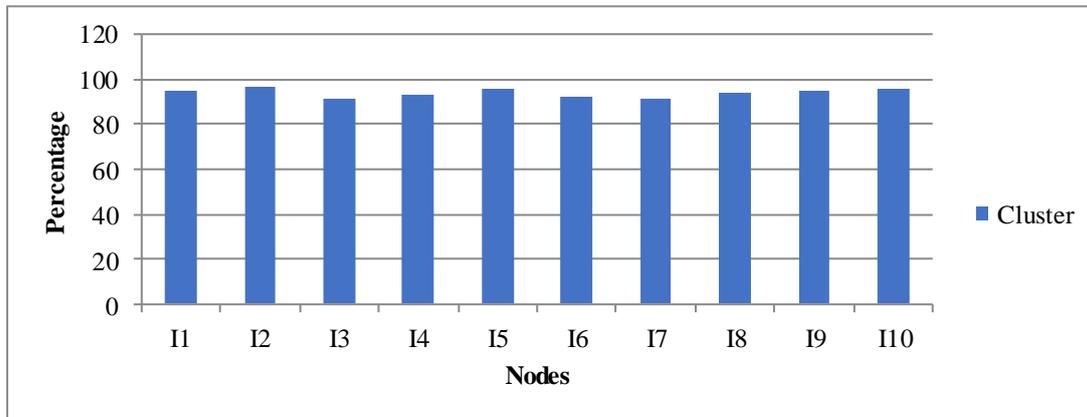means and FCM. Figure 2 shows th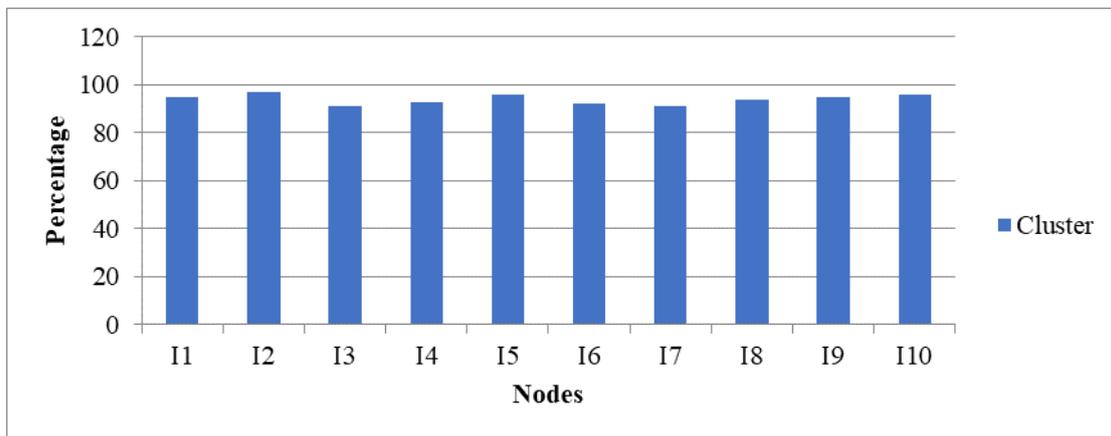e average cluster participation dissimilarity in random iterations with Cluster 1 [Considering K-means and FCM both]. Figure 3 shows the average cluster participation dissimilarity in random iterations with Cluster 2 [Considering K-means and FCM both]. But the assignment of cluster does

not affect the results. It is clearly depicted from the packet delivery time. Figure 4 to Figure 11 clearly shows the fact that the result variations are nominal. It shows that the k-means and FCM have the capability of CHs selection in the required time frame and it shows the effectiveness in different iterations also. When aggregate packet delivery has been considered the same situation has been observed which depicts the capability of our approach. Figure 12 Packet delivery time through SAW Cluster 1 [FCM] Figure 13 shows the aggregate packet delivery time through SAW Cluster 1 [FCM]. Figure 14 shows the packet delivery time through SAW Cluster 2 [K-means].

Figure 15 shows the aggregate packet delivery time through SAW Cluster 2 [FCM]. Figure 16 shows the packet delivery time through WPM Cluster 1 [FCM]. Figure 17 shows the aggregate packet delivery time through WPM Cluster 1 [FCM]. Figure 18 shows the packet delivery time through WPM Cluster 2 [FCM]. Figure 19 shows the aggregate packet delivery time through WPM Cluster 2 [FCM].

The packet delivery time for the k-means is less in both cases as comparison to FCM algorithm due to the computational wideness of FCM algorithm.

Figure 2 Average cluster participation dissimilarity in random iterations with Cluster 1
[Considering K-means and FCM both]

Figure 3 Average cluster participation dissimilarity in random iterations with Cluster 2
[Considering K-means and FCM both]
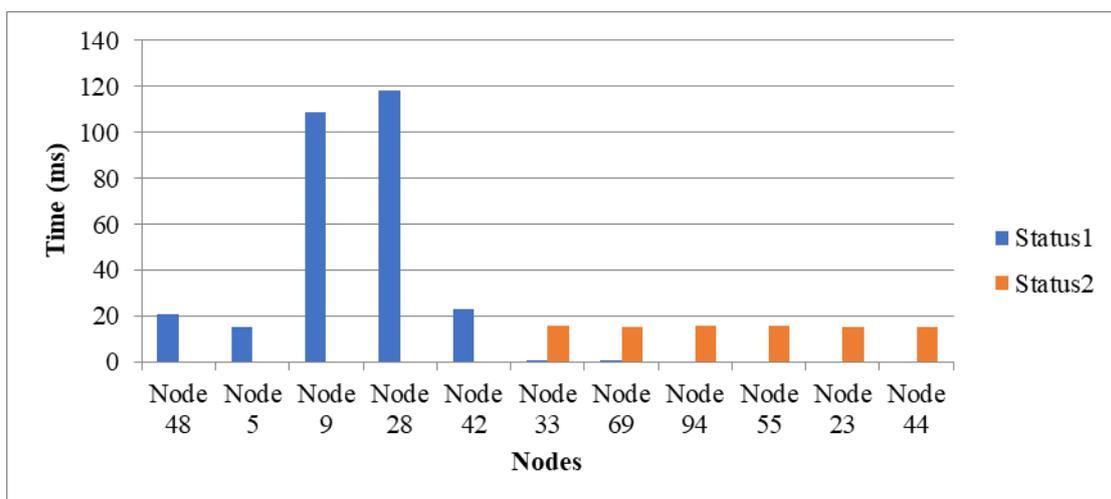
Figure 4 Packet delivery time through SAW Cluster 1 [K-means]

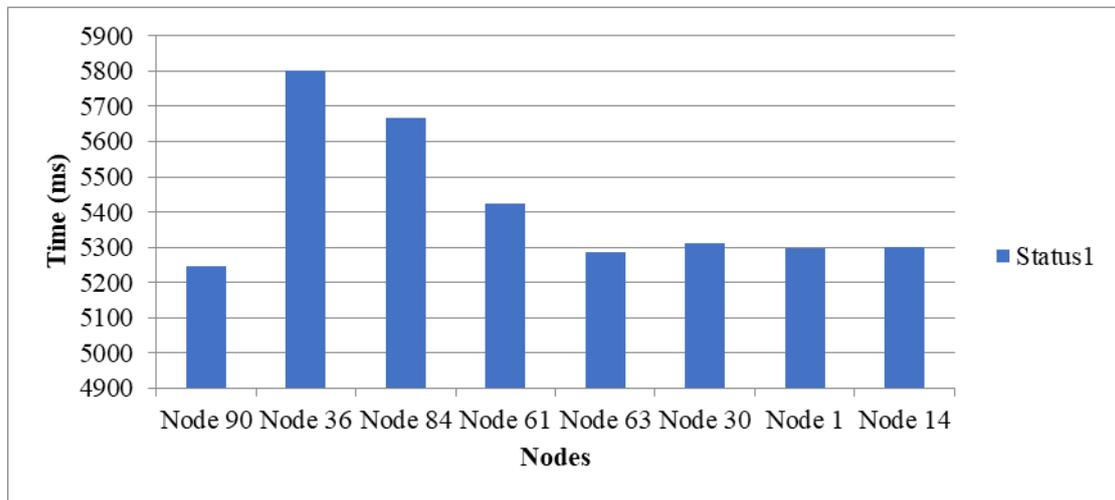# Cluster Head Selection and Packet Delivery Estimation Based on K-Means and FCM

Figure 5 Aggregate Packet delivery time through SAW Cluster 1 [K-means]
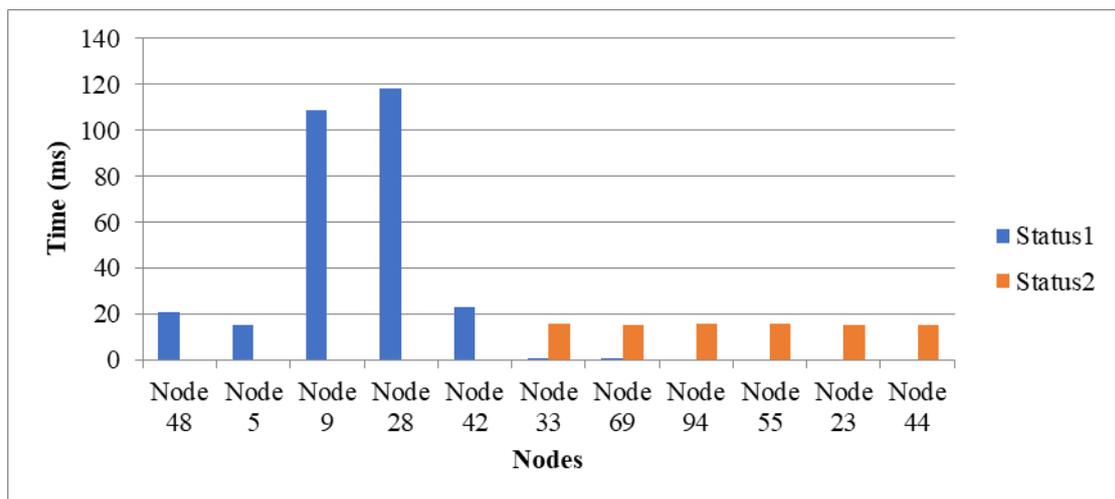

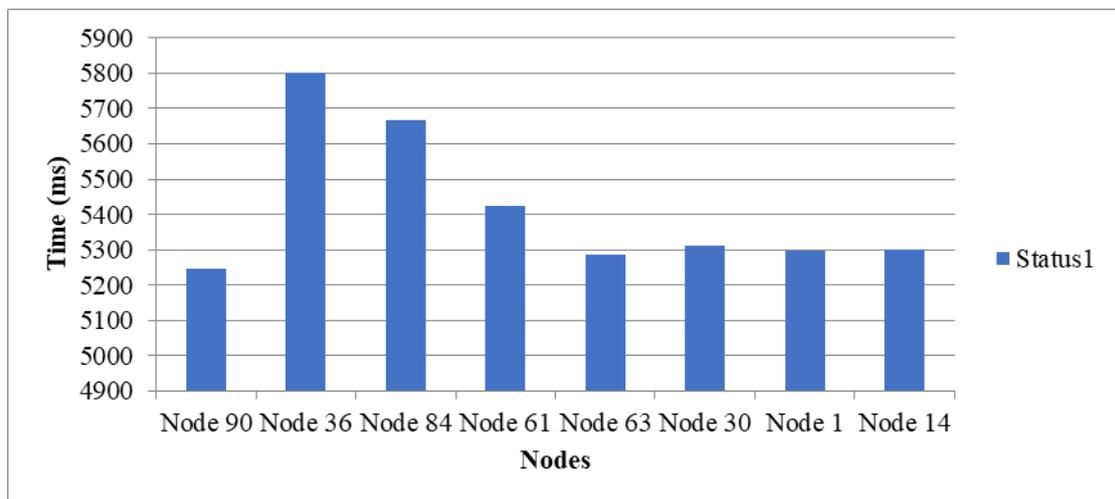**Figure 6 Packet delivery time through SAW Cluster 2 [K-means]**

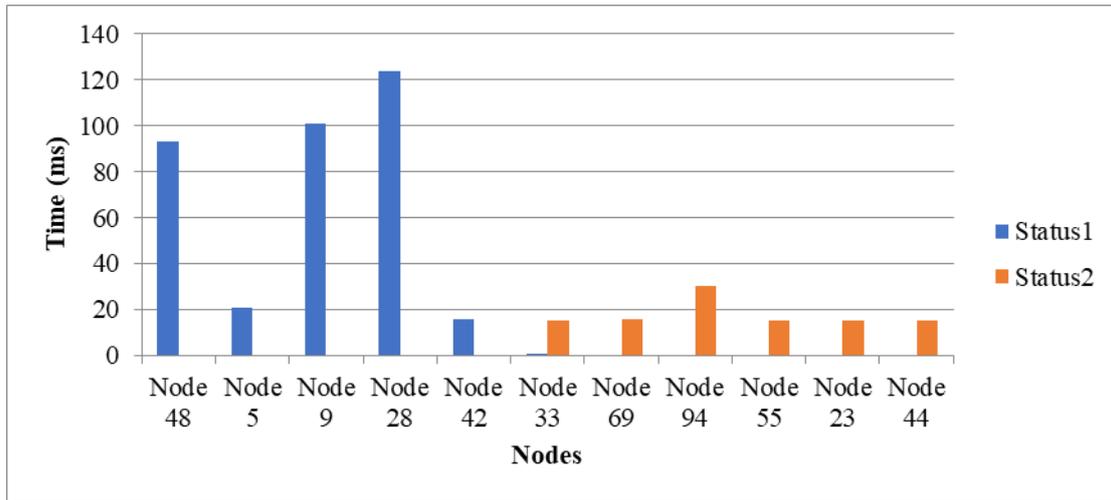**Figure 7 Aggregate Packet delivery time through SAW Cluster 2 [K-means]**

Figure 8 Packet delivery time through WPM Cluster 1 [K-means]
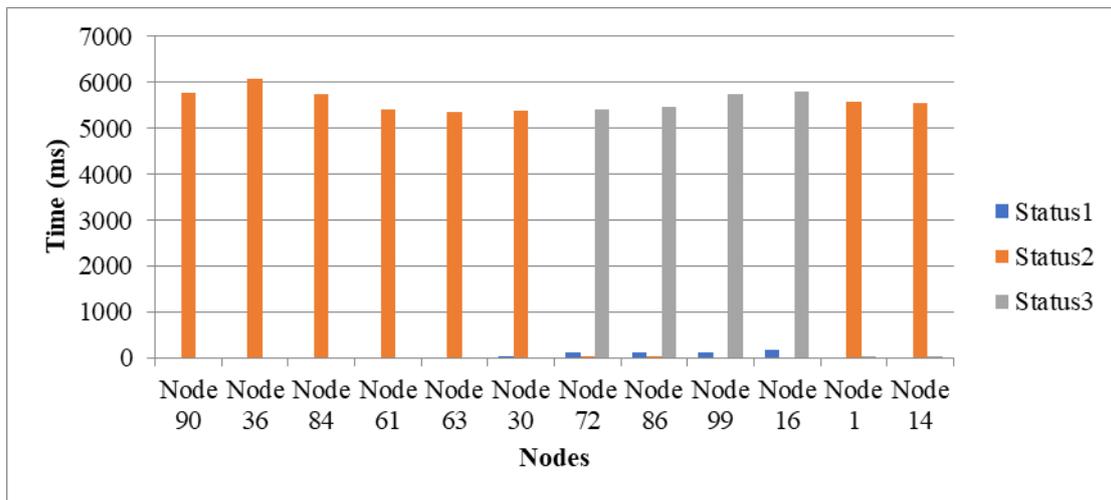

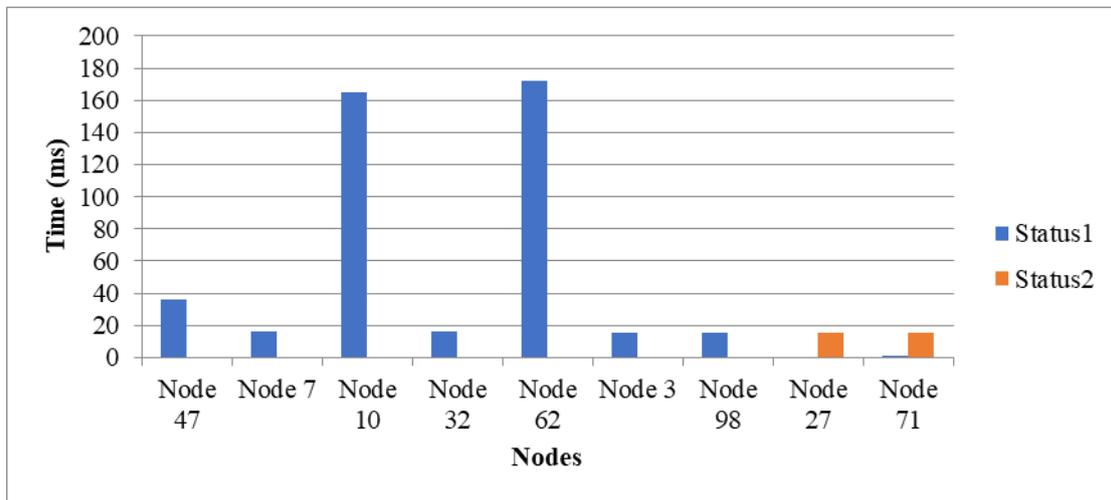**Figure 9 Aggregate Packet delivery time through WPM Cluster 1 [K-means]**

Figure 10 Packet delivery time through WPM Cluster 2 [K-means]

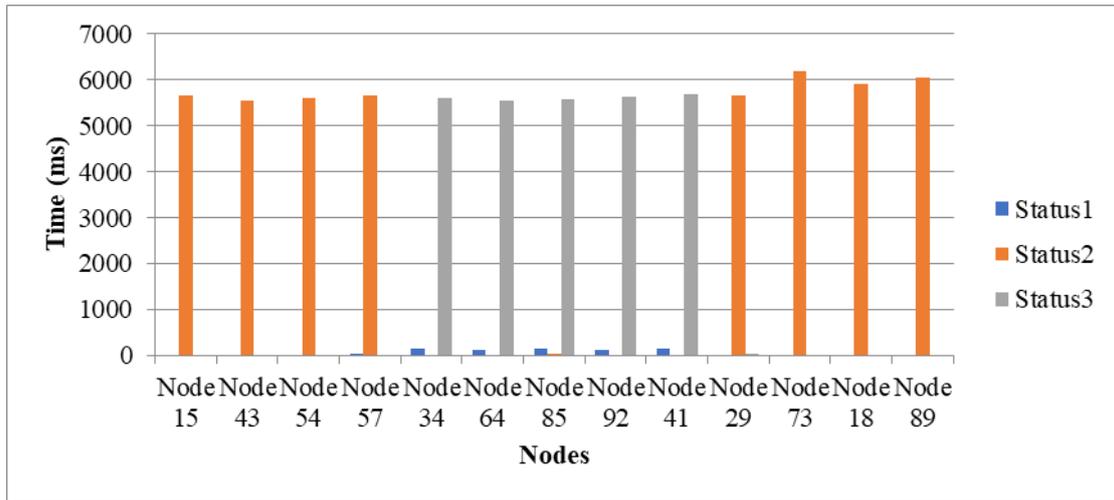# Cluster Head Selection and Packet Delivery Estimation Based on K-Means and FCM

Figure 11 Aggregate Packet delivery time through WPM Cluster 2 [K-means]

Figure 12 Packet delivery time through SAW Cluster 1 [FCM]

Figure 13 Aggregate Packet delivery time through SAW Cluster 1 [FCM]

Figure 14 Packet delivery time through SAW Cluster 2 [K-means]

Figure 15 Aggregate Packet delivery time through SAW Cluster 2 [FCM]

Figure 16 Packet delivery time through WPM Cluster 1 [FCM]

Cluster Head Selection and Packet Delivery Estimation Based on K-Means and FCM

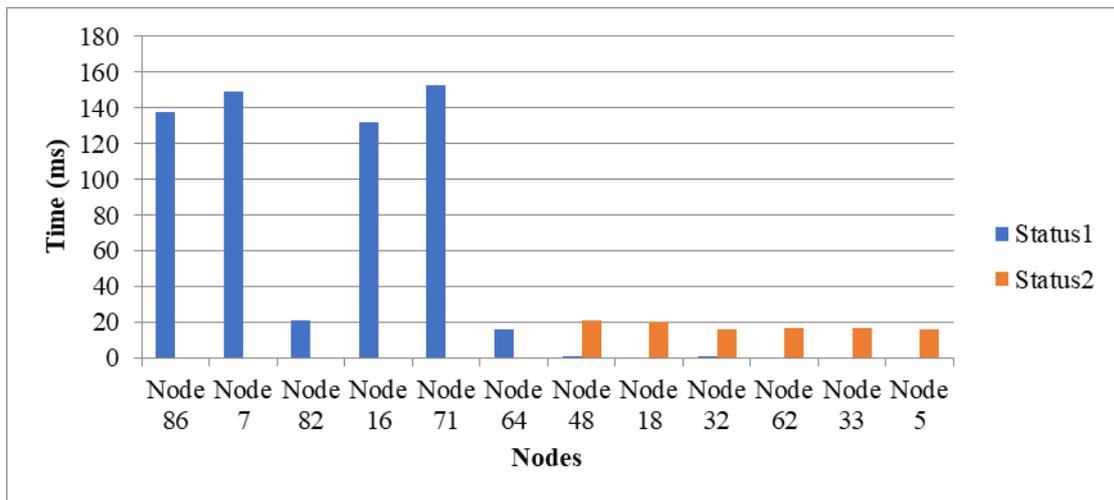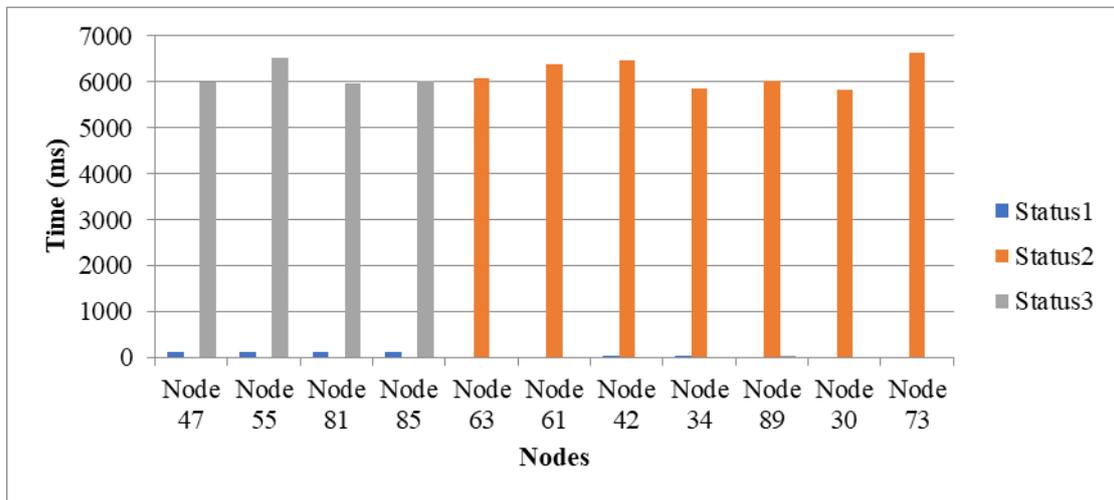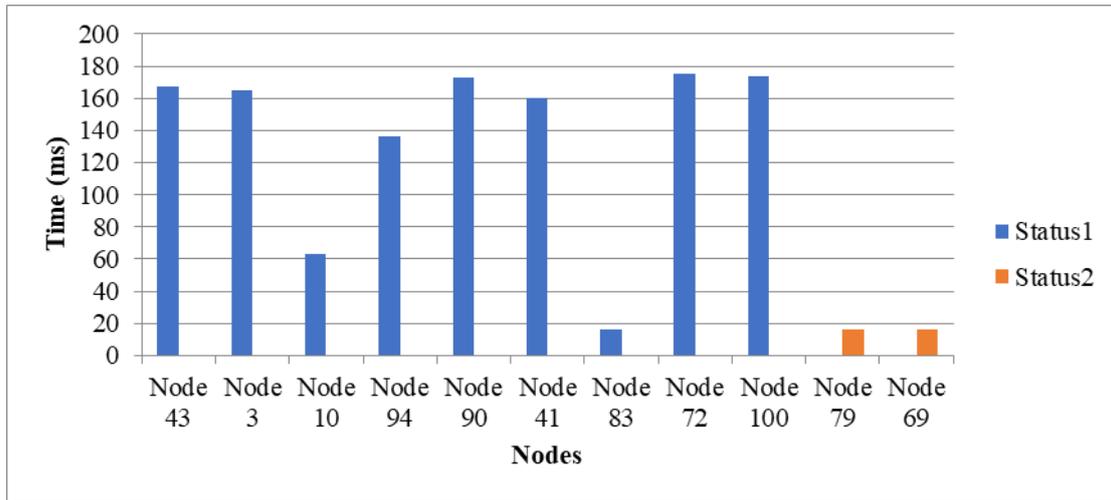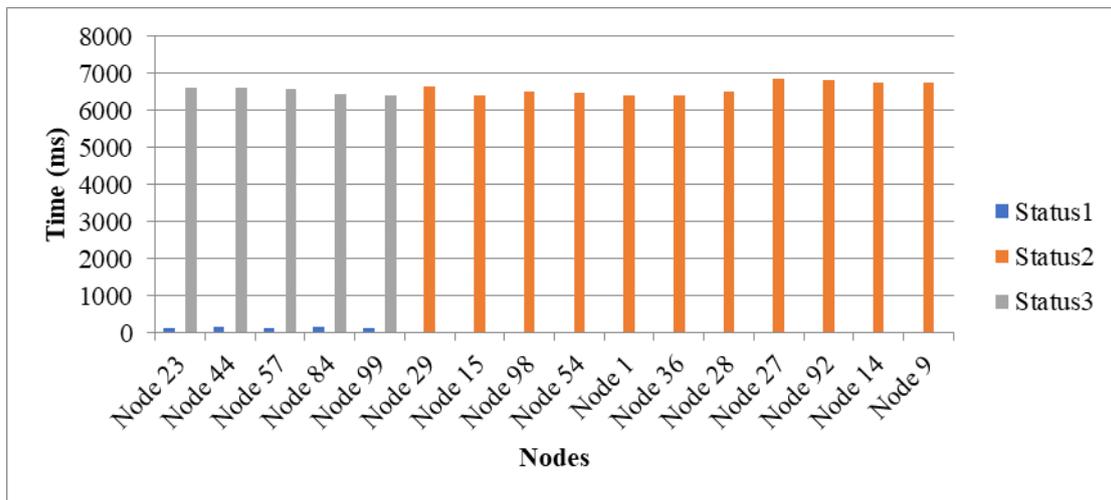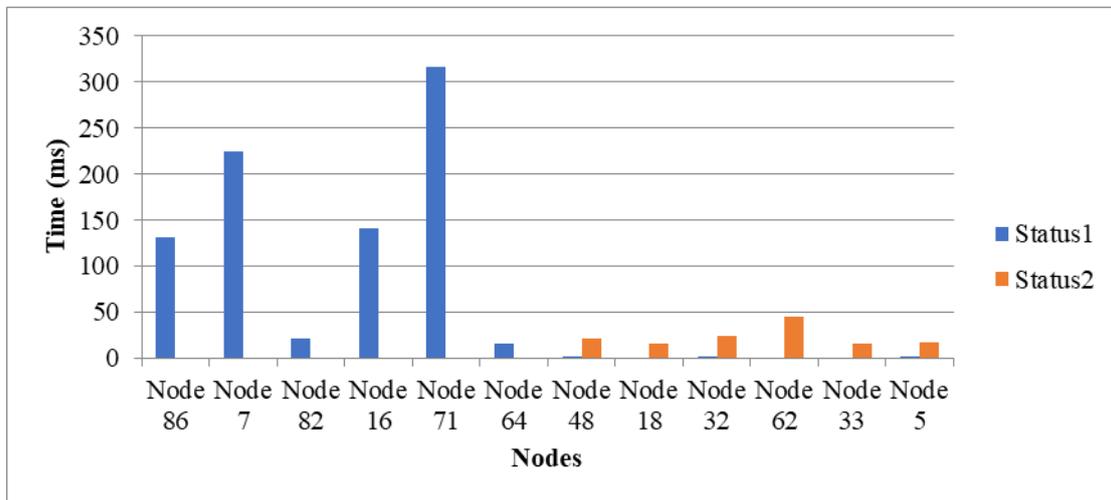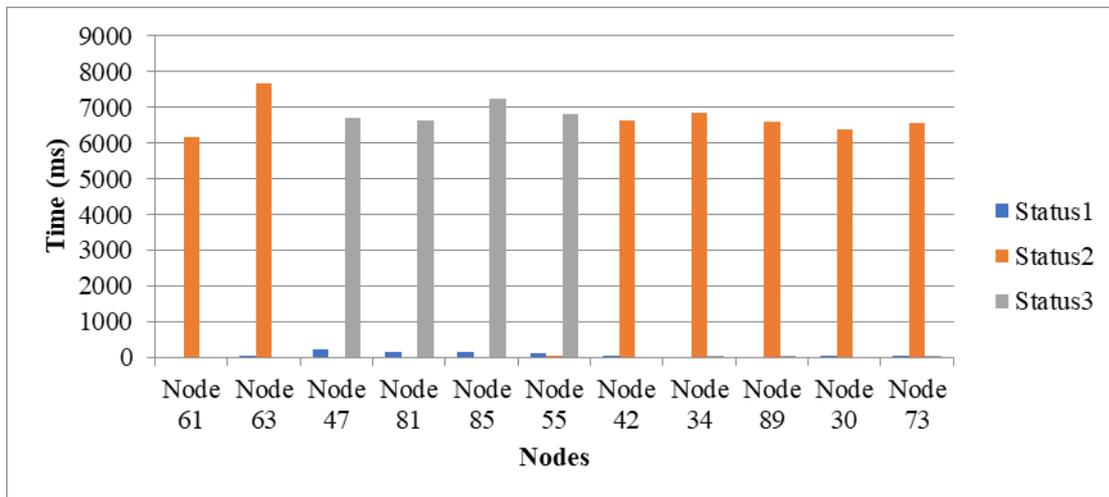**Figure 17 Aggregate Packet delivery time through WPM Cluster 1 [FCM]**
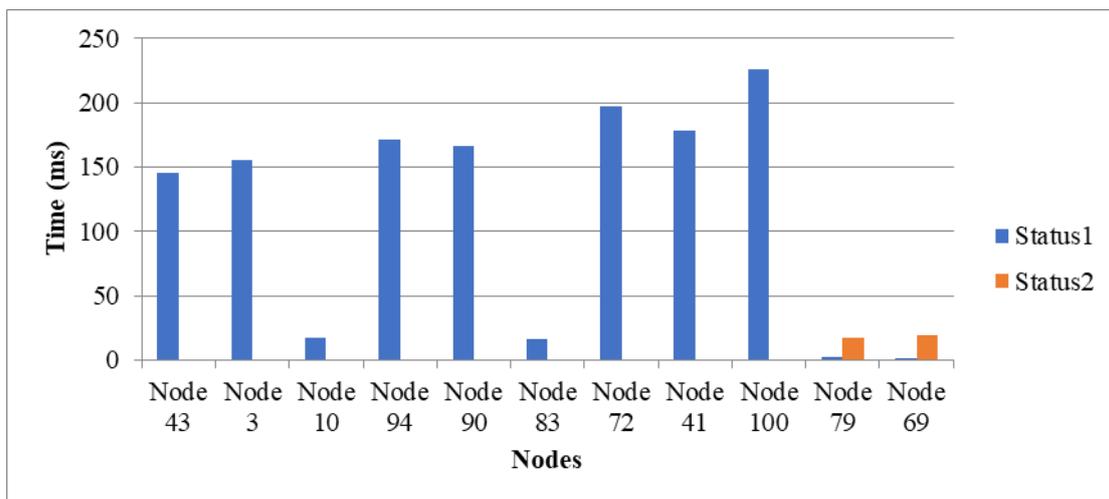
Figure 18 Packet delivery time through WPM Cluster 2 [FCM]
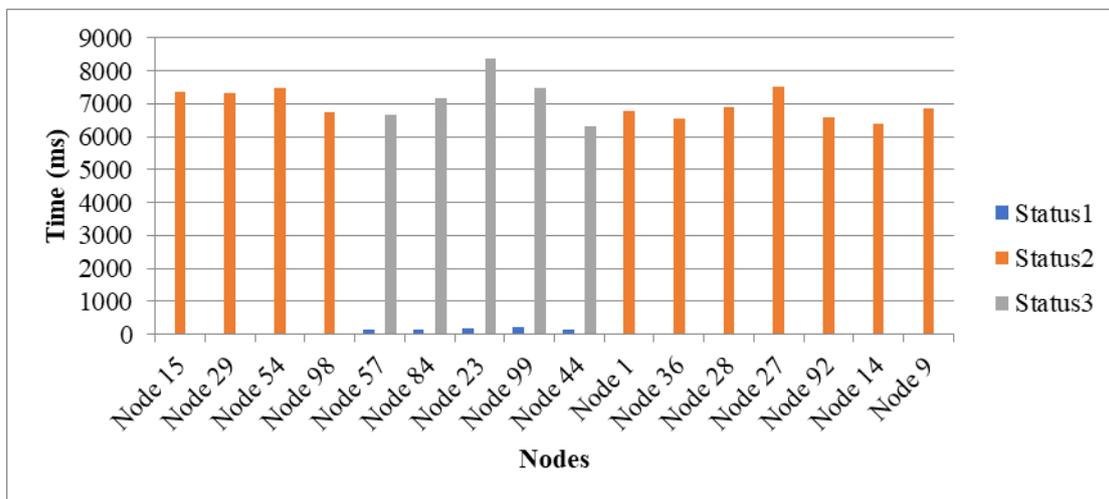
Figure 19 Aggregate Packet delivery time through WPM Cluster 2 [FCM]

IV. CONCLUSIONs

paper shows the complete explorative and computational aspects with experimentation through k-means and FCM algorithms for the cluster head selection based on k-means and FCM. The approach has been discussed with the clustering accuracy, variations in the algorithm along with the parameters for the evaluation. It has been observed that the nodes assignment after the clustering is different through

k-means and FCM because of the variant initialization mechanism of the k-means and FCM. Overall packet delivery time for k-means is found to be efficient as comparison to FCM.

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