ADV MATH SCI JOURNAL
Advances in Mathematics: Scientific Journal **9** (2020), no.9, 6715–6723
ISSN: 1857-8365 (printed); 1857-8438 (electronic)
https://doi.org/10.37418/amsj.9.9.29 Spec. Issue on CAMM-2020

PERFORMANCE EVALUATION OF WIRELESS SENSOR NETWORK BY SCALING THE NETWORK

POONAM RANI[1] AND AVINASH SHARMA

ABSTRACT. Wireless Sensor Network (WSN) consists of large number of sensor nodes (SN's) dispersed over the sensing field. These SN's transmit sensed data to their reporting station. Transmission of data to Base Station (BS) is governed by the routing technique. But enhancing quantity of SN's in the network by freezing rest of the parameters impacts on the lifetime of the network. This paper works on lifetime comparison of cluster and Minimum Spanning Tree(MST) based routing protocol. Afterwards it checks the number of packets delivered by varying number of SN's in the deployed region. An exponential growth in delivery of packets is observed in cluster based routing while increasing SN's in the network.

1. INTRODUCTION

A WSN is reached out in different applications for a more extended timeframe. In the absence of support of SN's and rebuilding of their power sources sensors nodes are self configurable. Every SN [1] in the system deplete power, not solely in detecting event, however in preparing information and broadcasting this fused data for routing. Subsequently, a routing convention encircled for specific network [2] ought to revere with the end goal that power usage at each phase of the routing should be minimised. Likewise, the system continuance to be kept most important by utilizing the energy of the SN's[3]. A routing [4] convention for WSN should be magnificently impact, having constrained computational multifaceted nature, effective [5], expert enough in power use, will

[1]*corresponding author*

2010 *Mathematics Subject Classification.* 05C85, 11-04, 15A15, 68W99.
Key words and phrases. WSN, Routing, Clustering, Scalability, MST.

have updated continuance and having least inactivity for information transmission from the SN to sink. In [6] authors, presented the routing protocol confined for WSN be ordered positioned on way determination. Placed on network architecture, the different routing protocols are categorised into different categories. The data centric detected being recognized nearby traits changing with precise applications. It's in perception with routing protocols it is accepting base station (BS) to be fixed and information should be imperative to be moved to BS as it were. Not being enrolled in a dissemination of information as being joined by direct dispersion. Different types of routing techniques exist in the literature [7, 8] which depends on the connectivity structure of the nodes. In this paper only two types of routing are taken into consideration viz. cluster based & MST based. For analysing the scalability of the network cluster based technique is taken into consideration.

2. Literature Survey

A lot of proposals are exists in the literature presenting for routing information in WSNs. These protocols had considered the qualities of SN's alongside the application and engineering prerequisites [7]. After Direct Transmission, LEACH [9]: the cluster based routing protocol that outperforms the lifetime of the network. After this protocol many enhanced versions of cluster based routing were proposed in the literature. Along with cluster based technique many different hierarchical, flat, Scalable, Quality based routing were also proposed. Aim of all techniques was focused on improving lifetime of the protocol. Many of those technique was application based i.e. were used for the specific task to be performed. EECHS [10] also works on selection of CH by enhancing work done by LEACH. It proposes a model for even load distribution among all SN's of the network. So the governed model is based on remaining vitality and cost required for transmitting data & area under observation.

Few algorithms are also based on fuzzy model for CH selection. In [11] authors propose a power reduction algorithm for WSN which considers Cluster-centric distance, remaining vitality, degree & count of nodes for electing CH. Another fuzzy model based CH election algorithms were proposed in [12] which considers neighbour nodes, remaining vitality as an input for the fuzzy system. Output of the system is possibility of a node to serve as a CH. A node with higher probability will has greater influence to be elected as CH.

Network Setup performance evaluation. This part of the paper describes the Algorithm, Network Assumptions and Simulation Setup for the implementation of the cluster based technique.

Algorithm:

i. Set value of n as desired number of nodes to be scattered in the network area.
ii. Scatter n nodes randomly in area of interest.
iii. Set BS far away from the network.
iv. Initialize node parameters like initial energy, communicating distance, transmission energy required etc.
v. Create CH's among sensor nodes after advertising.
vi. Based on signal strength received, SN's will join to a CH forming a cluster.
vii. All normal SN's will transmit data to their respective CH.
viii. At every round sum up the packets received at CH's w.r.t. number of nodes deployed at that round.CH's will in turn transmit the data to BS.
ix. Keep on repeating this process until the network is alive.
x. Repeat the network operation from first step by changing the value of n.

Network Assumptions:

i. All the nodes are assumed to be fixed.
ii. Non-CH nodes send the sensed information to their respective CH's which further forwards the aggregated data to Sink.
iii. A node can send packet to any other node of the network.
iv. Network is scaled up from 10 to 1000 nodes in the network with the deployed nodes by simulating with fix position of earlier deployed nodes.
v. Each node is capable of acting as CH of the network.

Simulation Setup:

- To evaluate the performance of the cluster based network, the simulation is performed in MATLAB by varying the value of n (number of deployed nodes) based on the parameters as depicted in table 1. For simulation of this technique, first order radio model [13] is referred.

3. Results and Discussion

This paper works on two different routing techniques (Cluster based and MST based) for transmission of data to BS. For the first implementation scenario network lifetime of the two different techniques calculated based on the scenario

TABLE 1. Simulation Parameters

Parameter	Value
Transmission and Receiving energy	50nJ/bit
Amplification Energy for free space	10pJ/bit/m2
Amplification Energy for multi path	0.0013pJ/bit/m4
Nodes initial Energy	0.5J
Packet Size	4000 bits
Number of nodes	10-1000
Network Size	100*100
Base Station	(0,-100)

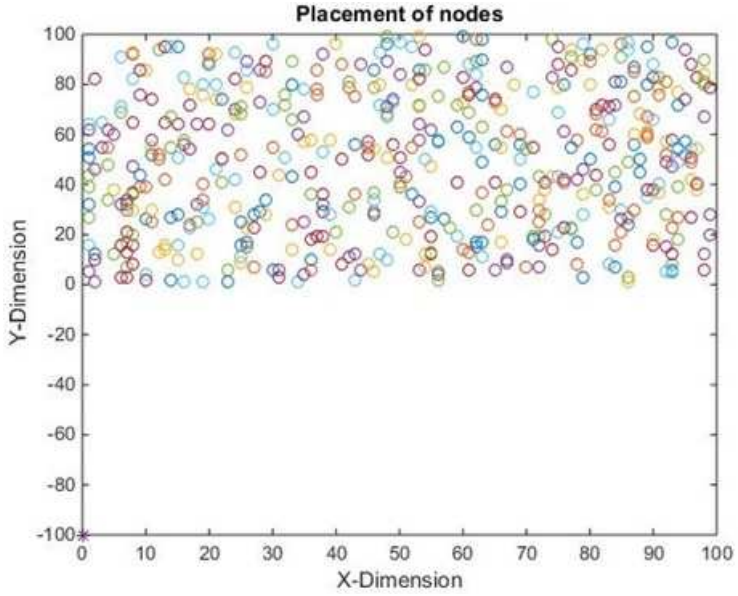

FIGURE 1. Network Set up cluster based routing

as depicted in table 1. In both of techniques nodes are randomly dispersed in the region. Figure 1 shows the random placement of nodes and that of BS far away from the network.

Figure 2. Shows the lifespan of the network for the given scenario i.e. the round in which numbers of SN's are operating. As the network operation goes on, all sensor nodes start losing some amount of energy as per their respective cost of transmission and receiving. So, network starts fading slowly. Initially up to certain level all nodes were operating and produces network most reliable

data. Then few nodes deplete their energy and becomes non-operational. Lifetime of the nodes w.r.t. round numberis plotted in figure 2. Network setup

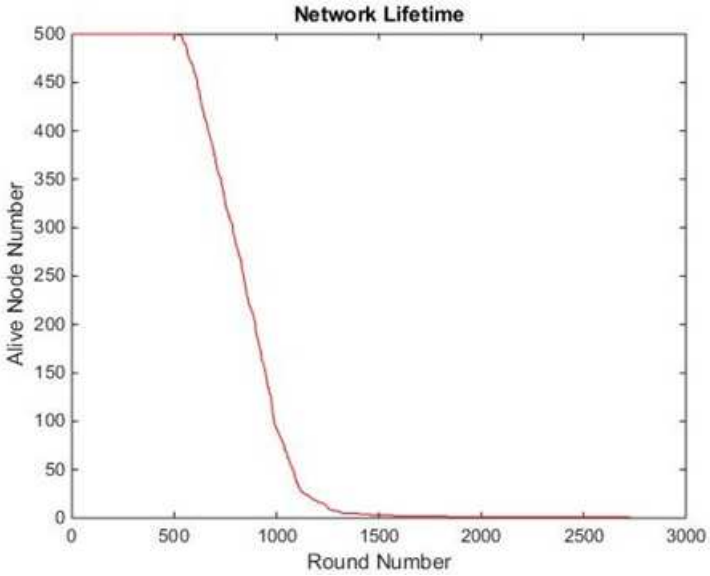

FIGURE 2. Lifetime of Cluster based network

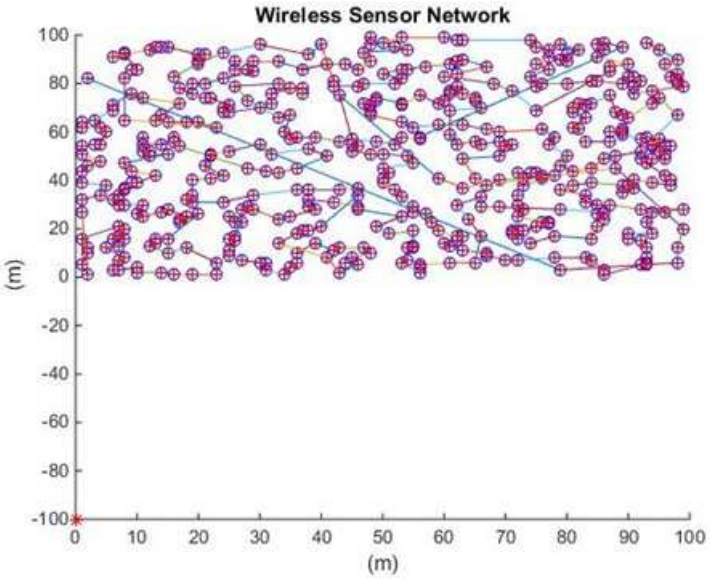

FIGURE 3. Network Setup for MST based routing

of nodes in case of MST based connectivity is shown in figure 3. All the nodes

are connected via MST based connection with each other forming overall least cost for transmission. Simulation parameters for this technique are kept same as described in Table 1. The lifetime outcome of the MST based scheme in context

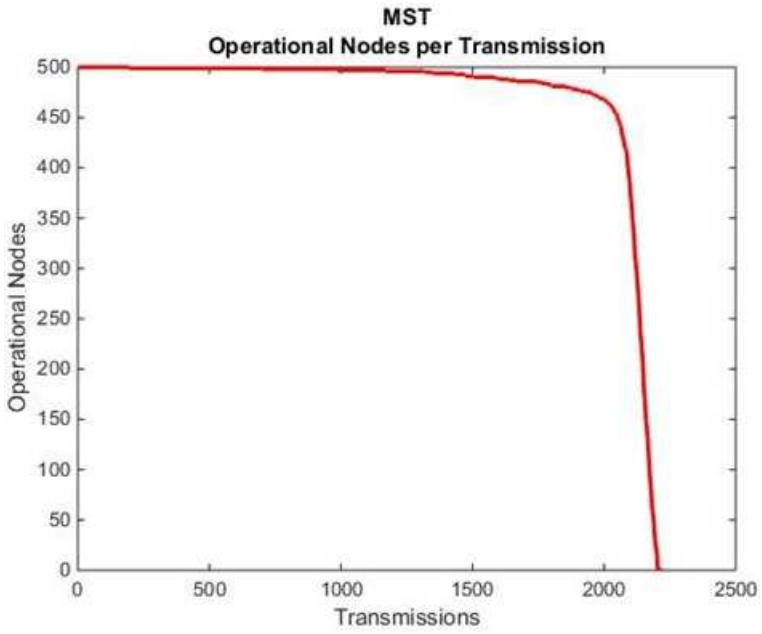

FIGURE 4. Lifetime of MST based network

of network lifetime is shown in figure 4 (with 500 nodes deployed). The figure shows number of transmissions (network operational rounds) vs. operational nodes at that instant of time.

The simulations were performed on MATLAB environment keeping the same parameters for both of the techniques. Locations of the nodes were generated randomly for 10-1000 nodes. For lesser number of nodes, first n locations of the nodes were used as was allocated in 1000 nodes scenario. Lifetime of cluster based technique is better than that of MST based routing especially when number of deployed nodes is less. This is because of in case of MST based routing, nodes have to transmit data at a long distance this require more amplification energy and hence more transmission cost. While in case of cluster based routing only few nodes (CH's) require to transmit data at long distance rest nodes are transmitting data locally. So lifetime of cluster based routing behaves longer. Lifetime comparison of cluster and MST based technique is shown in figure 5. In terms of analysing scalability of the network, only cluster based routing can be analysed because MST based routing is flat routing in which a chain is formed

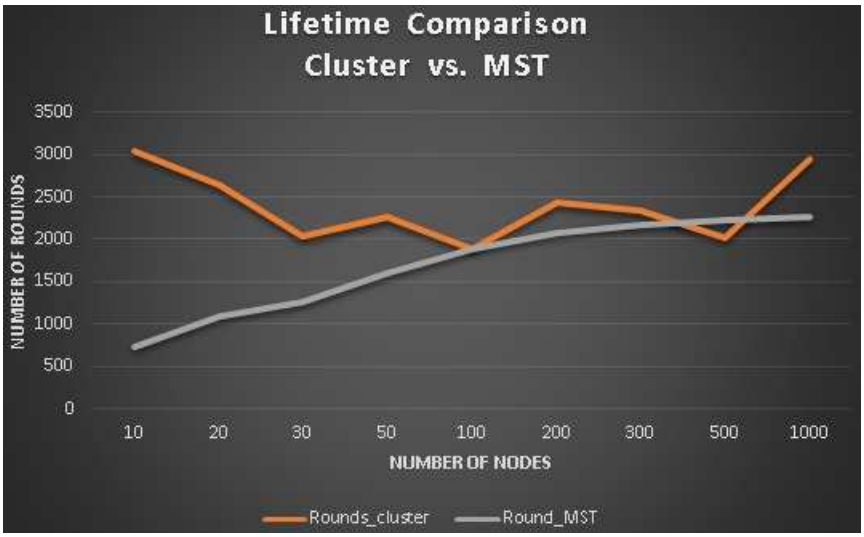

FIGURE 5. Lifetime Comparison of cluster and MST based routing technique

among SN's which will transmit data to next node only. So in this fashion only a single packet is expected to reach at BS. So while varying nodes, count of packets is calculated in each network lifetime w.r.t. number of deployed nodes. By this, average numbers of packets are calculated in each round by using the formula:

$$\text{Average number of packets delivered} = \frac{\text{Total packets delivered}}{\text{operational rounds}}.$$

On the basis of average packets delivered in each round % age of packets delivered are calculated as:

$$\% \text{ age of packets delivered} = \frac{\text{Average number of packets delivered}}{\text{Number of nodes}}.$$

On the basis of above defined calculations a graph is plotted between % age of packets delivered vs. number of nodes of the network. While increasing SN's, exponential rise in delivered packets is observed.This is shown in figure 6.

4. CONCLUSION

This paper works on two different techniques viz. cluster based and MST based routing. Both techniques were compared in terms of lifetime of the network. Based on the results obtained through simulation, cluster based technique is proved to be better than MST based technique. Then heading towards

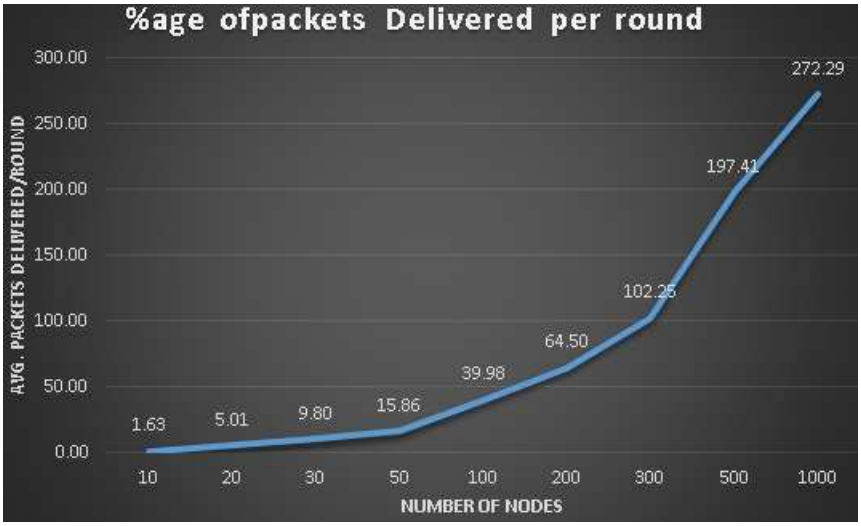

FIGURE 6. Average number of packets delivered in network lifetime by varying number of nodes

the main objective of the paper, delivery of the packets rises exponentially while there is increase in number of the nodes of the network.

REFERENCES

[1] A. BELLAACHIA, N. WEERASINGHE: *Performance analysis of routing protocols in sensor networks*, International Journal of Ad Hoc and Ubiquitous Computing, **3**(3) (2008), 167-173.

[2] M. CHU, H. HAUSSECKER, F. ZHAO: *Scalable information driven sensor querying and routing for ad hoc heterogeneous sensor networks*, International Journal of High Performance Computing Applications, **16**(3) (2002), 293-313.

[3] C. RAMACHANDRAN, S. MISRA, M.S. OBAIDAT: *A probabilistic zonal approach for swarm-inspired wildfire detection using sensor networks*, International Journal of Communication Systems, **21**(10) (2008), 1043-1047. https://doi.org/10.1002/dac.937

[4]

[5] D.F. MACEDO, L. H. A. CORREIA, A. L. DOS SANTOS, A. F. LOUREIRO, J. M. S. NOGUEIRA: *A proactive routing protocol for continuous data dissemination in wireless sensor networks*, 10th IEEE Symposium on Computers and Communications (ISCC'05), Murcia, Spain, 2005, 361-366. doi: 10.1109/ISCC.2005.15

[6] S. MISRA, P. DIAS THOMASINOUS: *A simple least-time and energy-efficient routing protocol with one-level data aggregation for wireless sensor networks*, The Journal of Systems and Software, **83** (2010), 852-860.

[7]

[8] S. BANDYOPADHYAY, E. J. COYLE: *An energy efficient hierarchical clustering algorithm for wireless sensor networks*, IEEE INFOCOM 2003. Twenty-second Annual Joint Conference

of the IEEE Computer and Communications Societies (IEEE Cat. No.03CH37428), San Francisco, CA, **3** (2003), 1713-1723. doi: 10.1109/INFCOM.2003.1209194

[9] N.A. PANTAZIS, S.A. NIKOLIDAKIS, D.D. VERGADOS: *Energy-efficient routing protocols in wireless sensor networks: A survey*, IEEE Communications Surveys & Tutorials, **15**(2) (2013), 551-591. doi: 10.1109/SURV.2012.062612.00084

[10] R. POONAM, S. AVINASH: *Cluster Based Data Aggregation Scheme in Wireless Sensor Network*, Journal of Computational and Theoretical Nanoscience, **17** (2020), 2681-2686.

[11] W.R. HEINZELMAN,A. CHANDRAKASAN, H. BALAKRISHNAN: *Energy-Efficient Communcation Protocol for wireless Microsensor Networks*, International Conference on Computational Intelligence and Security Workshops (CISW 2007), Heilongjiang, 2007, 550-553. doi: 10.1109/CISW.2007.4425555

[12] M. THEIN, T. THEIN: *An energy efficient cluster-head selection for wireless sensor networks*, 2010 International Conference on Intelligent Systems, Modelling and Simulation, Liverpool, 2010, 287-291. doi: 10.1109/ISMS.2010.60

[13] L. BAROLLI ET AL.: *Evaluation of an intelligent fuzzy-based cluster head selection system for wsns using different parameters*, IEEE Workshops of International Conference on Advanced Information Networking and Applications, Singapore, 2011, 388-395. doi: 10.1109/WAINA.2011.84

[14] Y. HU, X. SHEN, Z. KANG. : *Energy-efficient cluster head selection in clustering routing for wireless sensor networks*, 5th International Conference on Wireless Communications, Networking and Mobile Computing, Beijing, 2009, 1-4. doi: 10.1109/WICOM.2009.5303808

[15] G. BATHLA, R. RANDHAWA: *Mobility Based Routing Scheme for Wireless Sensor Networks*, International Journal on Future Revolution in Computer Science & Communication Engineering (IJFRSCE), **4**(3) (2018), 98-101.

MAHARISHI MARKANDESHWAR DEEMED UNIVERSITY, HARYANA, INDIA.
E-mail address: Poonamdabas.kuk@gmail.com

MAHARISHI MARKANDESHWAR DEEMED UNIVERSITY, HARYANA, INDIA.
E-mail address: asharma@mmumullana.org