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Performance Analysis for Node Recovery and Forward Node Move Algorithm on Channel Models

Deepak v Biradar, Nataraj K.R

Abstract— ***in the current world, the sensor nodes are of a minimized size and are available at a cost-effective value. The WSN contains a set of sensors that can be traced in the format of Linear, Grid or Random deployment patterns. The applications of WSN spans a large base varying from enemy detection, sensing for weather forecast and is having constraints like bandwidth, energy, and coverage. When the nodes are involved in route discovery or packet delivery process then energy is consumed by the nodes and eventually after a certain period of time dead node occurs in the network. This lead to packets dropped. In this paper, a method is proposed which categorizes nodes into up-threshold and under-threshold nodes and picks the best node during the routing process. The proposed Node Recovery and Forward Node Move (NRFNM) method makes use of sink relocation and restoration of dead nodes using genetic so that network lifetime is improved and throughput is increased. The proposed method is then analyzed on various channel models like HATA Model Sub Urban Channel Model, HATA Model Urban Channel Model, Clutter Factor Channel Model, Free Space Channel Model, and Walfish Channel Model***

Keywords—***sink relocation, node recovery, propagation models***

I. INTRODUCTION

The network planning is needed by wanton and standard formation teams before the installation is done so that efficient amount of coverage is achieved and also to have minimal interference. Fading and multipath effects the propagation of radio signal. One way of decreasing the inefficiency during installation of WSN network is to make use of radio propagation models in order to estimate proper interference and radio level parameters.

The time factor and monetary factor can be improved with the help of propagation models. Moreover the models can be used to solve the contradiction between users and also can be used in cognitive radio applications [1].

In a sensing environment the sensor nodes detect the activity and propagate the information to a special node [2] which renders the information to the internet. The nodes who participate in the sensing paradigm will lose their energy drastically with respect to time. When the data is transmitted hop by hop there will be holes created in the path which increases the packet drop ratio in the network.

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Many approaches present in the literature which work on sleep scheduling, data collection techniques in order to reduce the energy consumption and help in improving the lifetime of the network. One more approach is to relocate the node from an area which has more number of under threshold nodes.

The proposed method will first perform the classification of nodes, pick the best node and only if all the nodes are having there battery levels under threshold then node relocation process is triggered. The proposed method also performs the execution of genetic algorithm which is responsible for recovery of dead nodes in the network which improves the network lifetime. The performance of the proposed method is also analyzed under various radio propagation channel models. The proposed method is also compared with existing techniques namely one step, stationary and EASR method.

II. BACKGROUND

The nodes that are used in the network can be idle position nodes or moving nodes. In the idle position nodes case the nodes sense data and then send the data towards the base station. In this use case the node lose energy for sensing and relaying data. In the moving nodes kind of network the sensor or the sink node can move from an inefficient area to improve the network lifetime. The relocation can be done using a predefined steps or an automated steps approach.

The different trajectory can be used for movement of sink like circular path or hexagonal path. In both the approaches the sink node waits at specific locations, move with a certain velocity and then collect data from nodes [3].

Due to rapid growing of real estate the agricultural lands are converted into buildings and this has led to very less land available for agriculture. It becomes necessary to increase the agriculture land based on nutrients. WSN can be used to sense information like water quantity and other factors. This sense data has to be reported to the centralized server by a set of nodes in a hop by hop fashion and hence drain out energy thereby reducing the lifetime ration which can be improved by using clustering and relocation techniques [4]

The wireless communication system can have inter symbol interference (ISI) along with lightning noise can cause signal distortion. Delaying the ISI and modeling of noise can improve the performance of wireless communication system [5]. The deployment of wireless communication network requires the evaluation of channel model and then placement of access point so that transmission can be done in indoor environments [6].

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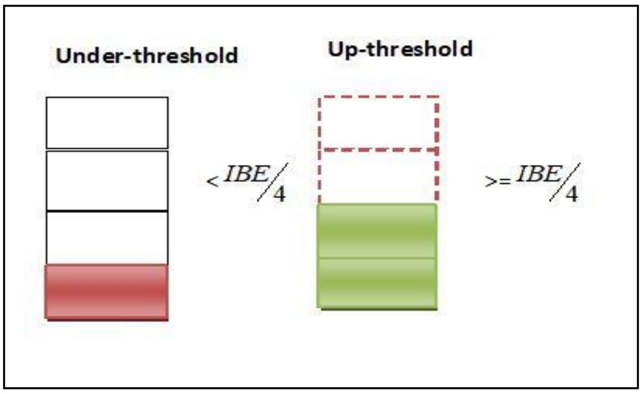
Wireless Sensor Networks deployment is expensive to process and requires a lot of budget computation. The Signal Power Path Loss (SPPL) estimation requires stochastic or a deterministic process. For the first approach, a set of predefined values are used to classify the environment into Urban, suburban and rural areas category [7].

The environment in which the deployment of WSN is done is a sports complex without any kind of obstacles and there exists a direct line of sight between the TX and RX. The path loss is modeled with the help of narrowband measurements and then a power delay profile is used for Ultra wideband measurements so that the data related to the multipath of the channel can be obtained [8].

III. PROPOSED WORK

The proposed method is divided into multiple stages

1. Classification of Cover Set Nodes
2. Forward Node Pick
3. Node Relocation



4. Node Recovery using Genetic

A. Classification of Cover Set Nodes

The nodes which are within transmission range of the initiator node are divided into under-threshold and up-threshold nodes. Let IBE represents the initial battery energy then count of set of counts whose energy is below 4 times the IBE is considered as under –threshold and vice versa. Fig1. Shows the classification of cover set nodes

B. **Fig1. Classfication of Cover Set Nodes**

C. Forward Node Pick

The subsets of the cover set nodes which are up-threshold are taken. The residual energy of all the nodes in the subset is found out and a node which is having the highest residual energy is chosen as the next hop node in the network.

If all the nodes are of under-threshold then the current node is relocated from a dead zone. A dead zone is a zone in which all the nodes in the cover set are under- threshold.

D. Node Relocation

The entire region surrounding the current node transmission zone is divided into different directions and the node is shifted by a distance equal to transmission range in the direction of destination node. After the 1- hop distance if the node again encounters dead zone then the process is repeated otherwise forward node pick mechanism is triggered.

E. Node Recovery using Genetic

The genetic process is triggered periodically as it is costly operation and performs the balancing act between the network lifetime and radio frequency cost. Consider that there are 50 nodes in the network after certain period of time the set of under-threshold nodes are {7,9,12,22,23,35,40,45,55,60}

The following steps are followed for the genetic process

1. Find the number of under-threshold nodes in the network
2. The chromosomes are generated randomly with the binary configuration whose length will be equal to number of under threshold nodes in the network. For the given set of under threshold nodes {7,9,12,22,35,40,45,55,66} the four chromosomes can be defined as below
CS1={0,0,1,0,1,1,0,1,1,0}
CS2={1,1,0,0,0,1,0,1,0,1}
CS3={0,0,1,0,1,1,0,1,1,1}
CS4={1,1,0,0,1,1,0,1,1,0}
3. Among the various chromosomes two set of chromosome which has the highest number of zeros is taken. For example CS1 has 5 zeros, CS2 has 5 zeros, CS3 has 4 zeros and CS4 has 4 zeros. Hence CS1 and CS2 are filtered as they have highest number of zeros
CS1={0,0,1,0,1,1,0,1,1,0}
CS2={1,1,0,0,0,1,0,1,0,1}
4. The two chosen chromosomes undergo a process known as crossover in which each of the two chromosomes are divided equally and then last bits are exchanged to generate new population set. Fig.2 shows the crossover process in which CS1 and CS2 are divided into equal halves and generates new population set.
5. After obtaining the crossover objects the positions of 0 bits are found out in the two crossover objects
6. One of the bits is randomly exchanged from 0 to 1 in each of the two crossover objects and this process is called as mutation. Fig.3 shows mutation process in which 0 bit is replaced with 1 bit for one of the chromosome

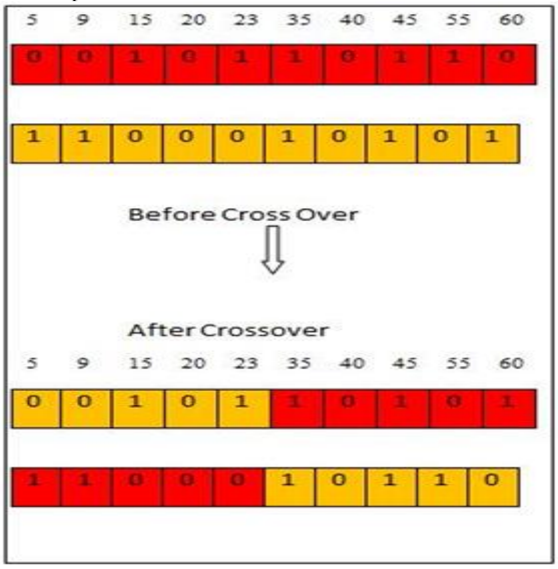


FIG2.CROSSOVER PROCESS

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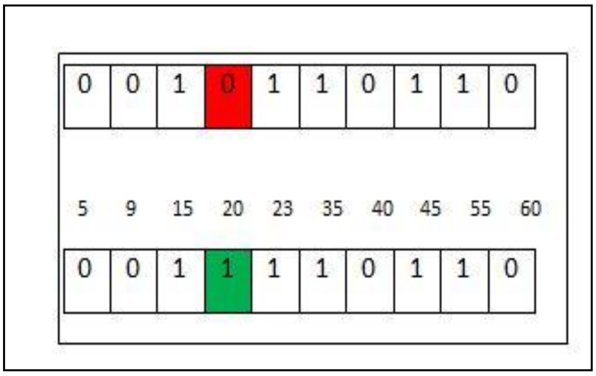

FIG3. MUTATION PROCESS

The advantage of node recovery process in the proposed method is that not all under threshold nodes will be recovered instead a few of them will be recovered so that balance between network lifetime and cost of the network is maintained.

IV. PROPOSED METHOD ANALYSIS ON PROPOGATION MODELS

This section describes various propagation models which are present in the literature which have been used for the analysis of performance of proposed method.

A. Clutter Factor Model

There are multiple paths available between the TX and RX which can be direct path or a reflection path. Both are considered during the computation of path loss. The Clutter factor [9] path loss equation is described in (1)

$$PL = 40\log_{10} d - 20\log_{10} h_{txn} - 20\log_{10} h_{rxn} \quad (1)$$

Where,

d = distance between the nodes

h_{txn} = height of transmitting node

h_{rxn} = height of recieving node

B. Channel Model With Free Space Consideration

If there are no obstacles present in the sensing environment then Line Of Sight communication happens with diffraction and reflection constraints in communication and path loss [10] for such a use case is defined in equation (2)

$$PL = 20\log_{10}(d) + 20\log_{10}(f_{oper}) + 92.5 \quad (2)$$

Where,

d_v = distance between two nodes

f_{oper} = operating frequency of antenna

C. Channel Model for Urban Area

The path loss [11] for the urban kind of areas can be defined as per equation (3)

$$PL = A_l + B_l \log_{10} R_l - E_l \quad (3)$$

Where,

$$A_l = 69.55 + 26.16\log_{10} f_{cf} - 13.82\log_{10} h_{\tan}$$

$$B_l = 44.9 - 6.55\log_{10} h_{\tan}$$

$$E_l = (1.1\log_{10} f_{cf} - 0.7)h_{ran} - (1.56\log_{10} f_{cf} - 0.8)$$

Where,

f_{cf} = carrier frequency of antenna at the node

$h_{\tan}$ = height of transmitting antenna node

h_{ran} = height of recieving antenna node

D. *Walfisch-Ikegami-Bertoni model*

The natural processes like scattering and reflection occurs in both Line of Sight (LOS) and Non-Line of Sight (NLOS) kind of communications in an urban environment. The antenna height is taken between 4 to 50m for the node for an area of size 5km. The path loss for Walfish-Ikegami-Bertoni [12] model is defined in equation (5)

$$PL = 42.6 + 26\log(d/1km) + 20\log(f_{oper}/1MHz) \quad (5)$$

Where,

d = distance between two nodes

f_{oper} = operating frequency of antenna node

E. *Okumura Hata Model*

The data transmission behavior for cellular transmission can be predicted using HATA model. It takes into consideration city structures which undergo diffraction, reflection and scattering. The path loss [13] is defined in equation (6)

$$PL = 69.55 + 29.16\log_{10} f - 13.82\log_{10} h_B - C_H + |44.9 - 6.55\log_{10} h_B|\log_{10} d \quad (6)$$

Where,

f = Frequency of transmission

h_B = Height of Node1 antenna

C_H = Antenna Height Correction factor

d = distance between nodes

$$C_H = 0.8 + (1.1\log_{10} f - 0.7)h_M - 1.56\log_{10} f \quad (7)$$

h_M = Height of Node2 antenna

V. SHORT NOTES ON COMPARISON ALGORITHMS

This section describes the algorithms with which the proposed method is compared with stationary algorithm, one step moving scheme and Energy Efficient Sink Relocation

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A. *Stationary Method*

The data gathering happens at a place where single or multiple sink nodes are placed. When a stationary sink is used the nodes which are within the coverage range of sink Node has lot of relay packets from far away nodes along with data of its own. This causes a hotspot to occur and packets can no longer be relayed after certain period of time. This problem can be solved by moving the relay packets towards nodes which has high memory buffer [14]- [15].

B. *One Step Moving Scheme*

The fields inside data packets can contain record of energy levels, position of nodes. When the data packet is transmitted the intermediate nodes can change this information based on this residual energy levels. Once the sink nodes receive the data packets it has information about the residual energy of nodes in the network. The selection of a node which has highest residual energy is done as a moving node. The selection of the moving node [16] is updated based on new values related to energy and location distributions.

C. *Energy Effcient Sink Relocation*

Energy Efficient Sink Relocation (EASR) [17] consists of two phases. The first phase is sink transmission and the second phase is Sink relocation.

The transmission of data will be done by nodes which can consume less energy during the transmission phase. There can be normal nodes and advance nodes. Advance nodes are those nodes that can transmit data to a father distance. The Received Signal Strength is measured using a heterogeneous method and then clustering is performed with cluster head following the three conditions (1) average distance with respect to all nodes (2) lower routing overhead and (3) low energy consumption factor.

VI. SIMULATION RESULTS OF WSN

In this section simulation results related to proposed method i.e NRFNM and its comparison with respect to existing techniques like Stationary, One Step and EASR are presented. The parameters related to simulation setup are described in TABLE1

TABLE I. SIMULATION SET UP

Parameter Name	***Parameter Value***
Numbe of Nodes	100
Tranmission Distance	40m
Tranmission Energy	20 mJ
Generation Energy	10 mJ
Attunuation Factor	0.7
Topology Generation	Random
Number of Iterations	100
Intial Battery Energy	3000 mJ

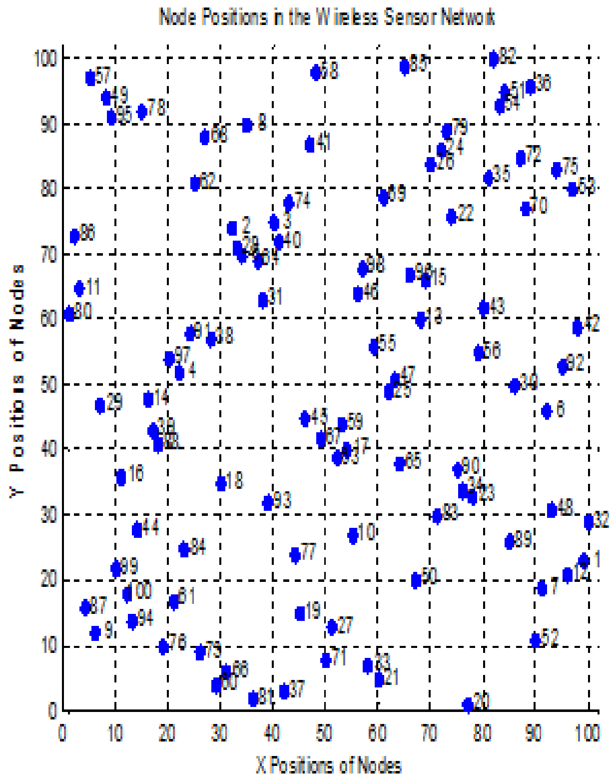

Fig4. Node Deployment Algorithm

Fig 4 shows the nodes deployment in an area of 100*100 m,As shown in the fig Node 9 will be present at the location (9,11) and Node 82 is present at the location (82,100). In a same way all nodes have there own unique position

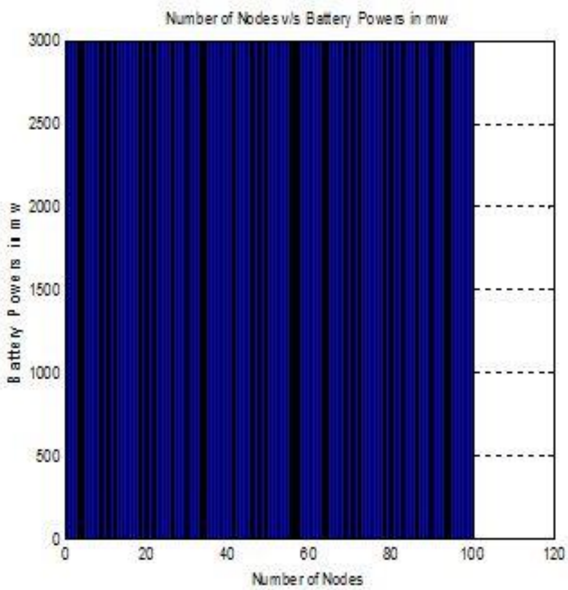

Fig5. Battery Initialization for Nodes

Fig5. Shows the battery nitialization of all the nodes in the network. As shown in the fig all the 100 nodes have been initialized with a value of 3000 mJ.

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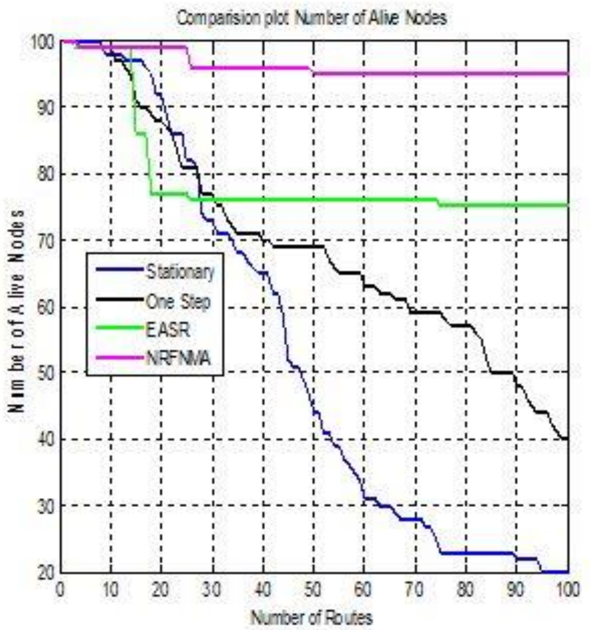

Fig6. Number of Alive Nodes

The Number of Alive Nodes is defined as the count of nodes whose remaining energy is greater than or equal to IB/4. As shown in the Fig6 the proposed method NRFNMA has the highest number of Alive nodes at the end of 100 iterations are around 96, followed by EASR algorithm which is around 76, For One Step method the number of alive nodes are around 40 and then for stationary scheme the number of alive nodes are around 20. Hence one can conclude that the proposed NRFNMA method exhibits the best performance as compared to EASR, One Step and Stationary scheme.

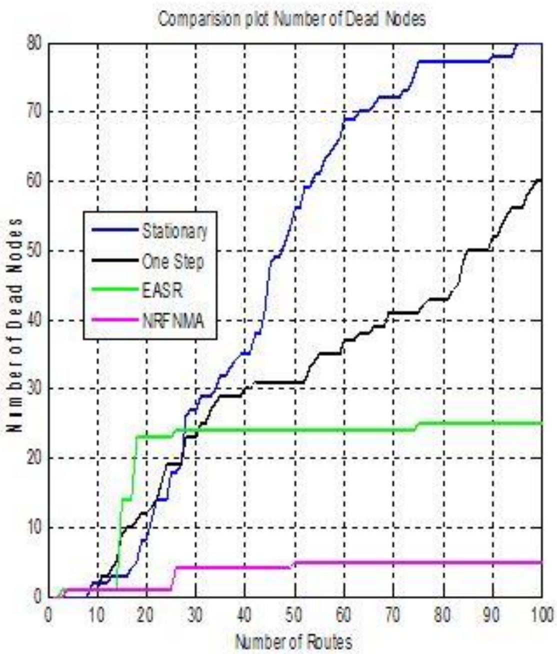

Fig7. Number of Dead Nodes

Fig.7 shows the performance analysis of proposed NRFNMA method along with other algorithms like EASR, One Step and Stationary scheme. At the end of 100 iterations the number of dead nodes is 4 for NRFNMA method, followed by EASR which has number of dead nodes as 22, followed by One Step which has number of dead nodes as 60 and then stationary method has highest number of dead nodes which is 80.

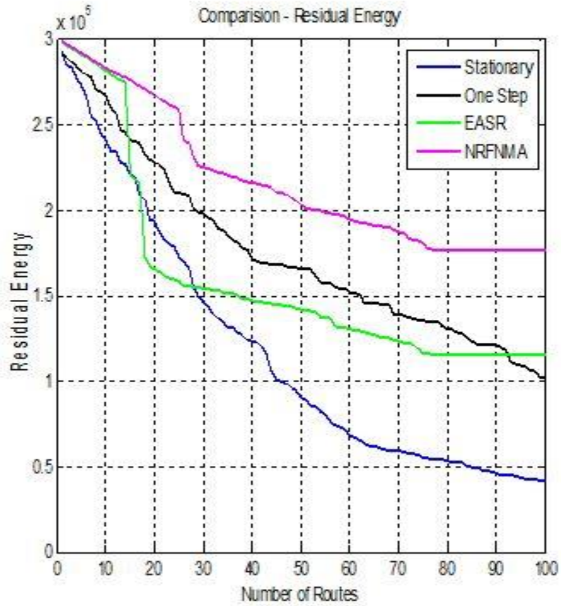

Fig8. Residual Energy for Nodes

Fig 8 shows the residual energy for nodes. As shown in the Fig the residual energy of the proposed method NRFNMA is highest followed by EASR, One Step and Stationary Scheme. The residual energy of proposed NRFNMA method is 1.8*10^5, followed by EASR which is 1*10^5, for One Step it is 1.2*10^5 and finally stationary method has the value 0.4*10^5 at the end of iterations.

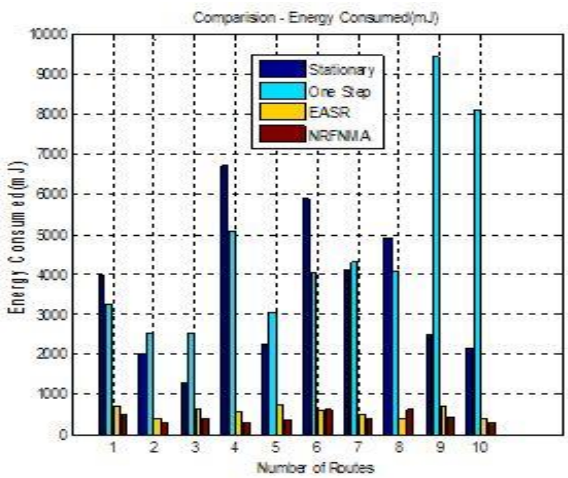

Fig9. Residual Energy for Nodes

Fig.8 shows the energy consumption comparison between the algorithms. The proposed NRFNMA method has the lowest energy consumption followed by EASR, One Step and Stationary Scheme.

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The energy consumption depends on transmitter energy, reception energy , distance and environment factor.

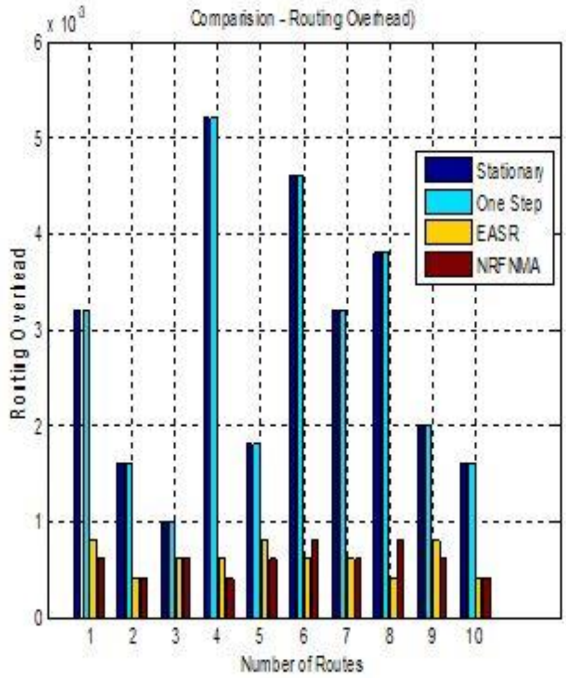

Fig10. Routing Overhead

Fig 10 shows that the proposed NRFNMA method has the lowest routing overhead followed by EASR, One Step and Stationary method. Routing overhead is defined as the ratio of number of control packets to the number of data packets.

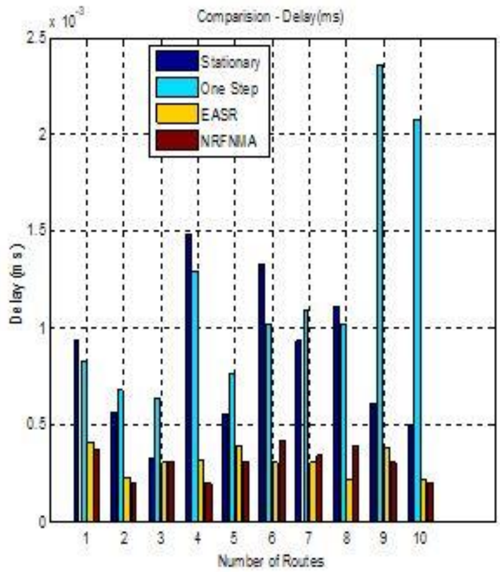

Fig11. Routing Overhead

Fig 11 shows the delay comparison between NRFNMA, EASR, One Step and Stationary method. The proposed NRFNMA method has the highest delay followed by EASR, One Step and Stationary Scheme.

VII. SIMULATION RESULTS PROPOGATION MODELS PERFORMANCE ANALYSIS

This section is responsible for finding the performance analysis of proposed NRFNMA method on the various radio propagation models

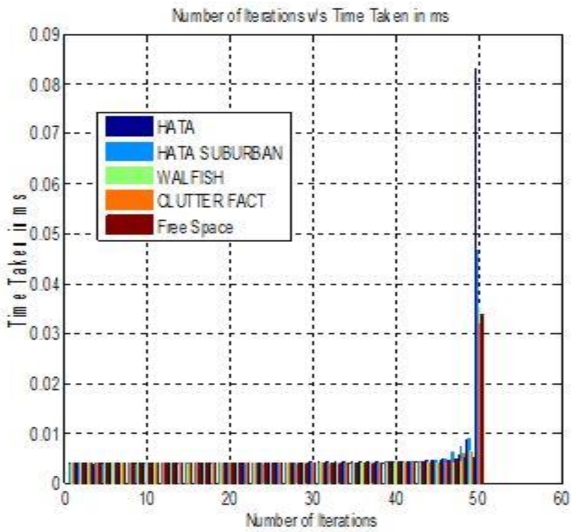

Fig12. End to End Delay

Fig 12 shows the delay performance profile of the proposed method. For the first 49 iterations the delay will be the same for Free Space, HATA, HATA SUBURBAN, WALFISH and CLUTTER FACT after that HATA model has highest delay as compared to Free Space channel model.

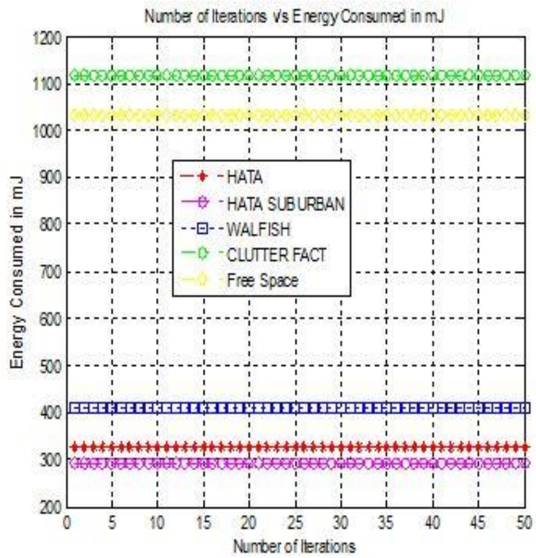

Fig13. Energy Consumed

Fig 13 shows the energy computation performance of the proposed method across the various radio propagation models. For HATA SUBURBAN model the energy consumed is least and for CLUTTER FACT model the energy consumption is highest.

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The range of energy consumption will vary between 248 mJ to 298 mJ for HATA SUBURBAN, the range of energy consumption for HATA model will vary between 300 mJ to 315 mJ, the range of energy consumption for WALFISH model will vary between 390 mJ to 410 mJ, the range of energy consumption for Free Space model will vary between 995 mJ to 1005 mJ and finally the range of energy consumption will vary between 1090 mJ to 1140 mJ.

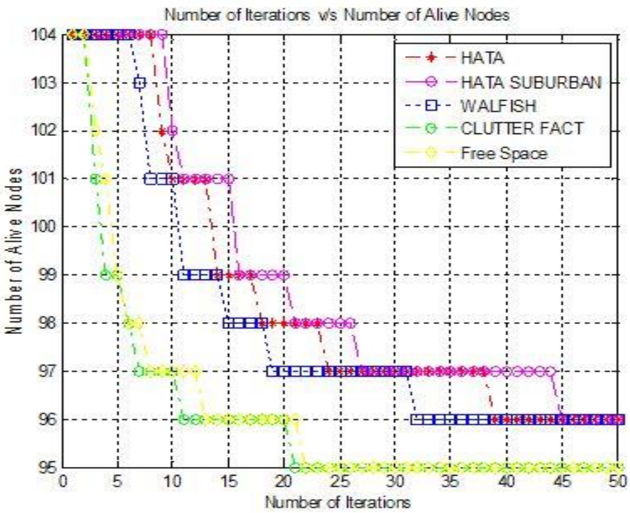

Fig14. Number of Alive Nodes

Fig14. Show the number of Alive Nodes performance for the proposed method. The HATA and HATA SUBURBAN method will have more number of alive nodes followed by WALFISH and then the number of alive nodes will be less for Free Space and CLUTTER FACT.

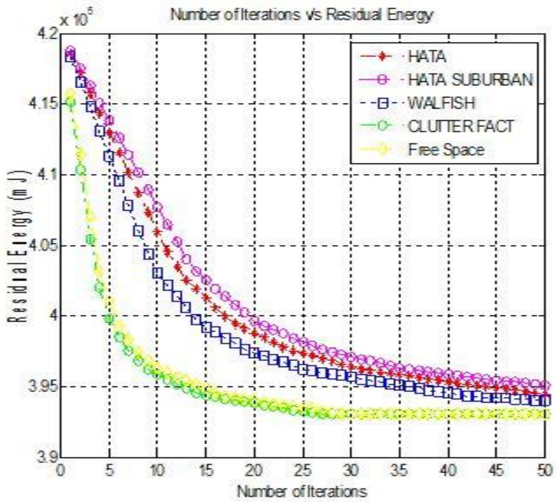

Fig15 Residual Energy of Nodes

Fig 15. Shows the residual energy performance for the various radio propagation models for the proposed method HATA SUBURBAN model has the highest value of residual energy followed by HATA, WALFISH, Free Space and CLUTTER FACT.

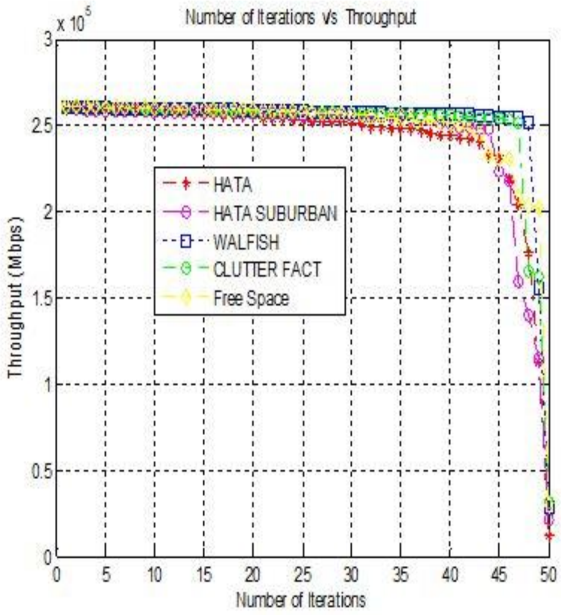

Fig15 Throughput Comparison radio propogation models

Fig 15. Shows the throughput performance for the various radio models. The proposed method exibits same performance for all the radio propogation models.

VIII. CONCLUSION

The WSN has battery constraints. Sink relocation techniques can be used to increase the network lifetime. The proposed method makes use of relocation as well as genetic process to improve the network lifetime. From the simulation results NRFRMA method outperforms EASR, One Step and Stationary technique. The performance of NRFRMA method is also studied under different propagation models.

REFERENCES

1. Mohammed A. Alamoud,Wolfgang Schütz , "Okumura-Hata Model Tuning for TETRA Mobile Radio Networks in Saudi Arabia," 2nd international conference on Advances in Computational Tools for Engineering applications, December 2012.
2. Sonu Pant,Ramesh Kumar,Ajeet Singh, "Adaptive sink transmission and relocation to extend the network lifetime of wireless sensor network," 3rd International Conference on Advances in Computing,Communication & Automation (ICACCA) (Fall) September 2017.
3. S. Nandrajog and R. Gite, "Life time performance analysis of WSN by energetic data collection using mobile sink in NS2," 2017 International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, 2017, pp. 909-914.
4. Jeromina J and K. V. Anusuya, "Energy efficient cluster formation algorithm and sink relocation algorithm for precision agriculture," 2016 Online International Conference on Green Engineering and Technologies (IC-GET), Coimbatore, 2016, pp. 1-6.
5. Yu Zeng, Ming Feng, Wenjie Li, Wei Li, Guoquan Tan and Hua Ye, "Interference modeling and analysis for optical wireless communication," 2015 Seventh International Conference on Ubiquitous and Future Networks, Sapporo, 2015, pp. 135-138

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6. Y. Choi, "Performances and Feasibility of THz Indoor Communication for Multi-gigabit Transmission," 2013 1st International Conference on Artificial Intelligence, Modelling and Simulation, Kota Kinabalu, 2013, pp. 446-450.
7. Y. Egi and C. E. Otero, "Machine-Learning and 3D Point-Cloud Based Signal Power Path Loss Model for the Deployment of Wireless Communication Systems," in IEEE Access.March 2019
8. Briso, C. Calvo and Y. Xu, "UWB Propagation Measurements and Modelling in Large Indoor Environments," in IEEE Access. March 2019
9. Chizhik and J. Ling, "Propagation Over Clutter: Physical Stochastic Model," in IEEE Transactions on Antennas and Propagation, vol. 56, no. 4, pp. 1071-1077, April 2008.
10. O. Katircioğlu, H. Isel, O. Ceylan, F. Taraktas and H. B. Yagci, "Comparing ray tracing, free space path loss and logarithmic distance path loss models in success of indoor localization with RSSI," 2011 19thTelecommunications Forum (TELFOR) Proceedings of Papers, Belgrade, 2011, pp. 313-316.
11. Bačić, K. Malarie and E. Dumić, "Empirical channel model for communication in urban areas with a hilly region," 2015 57th International Symposium ELMAR (ELMAR), Zadar, 2015, pp. 69-72.
12. L. M. Correia, "A view of the COST 231-Bertoni-Ikegami model," 2009 3rd European Conference on Antennas and Propagation, Berlin, 2009, pp. 1681-1685.
13. R. Verma and G. Saini, "Statistical tuning of Cost-231 Hata model at 1.8 GHz over dense urban areas of Ghaziabad," 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, 2016, pp. 1220-1225.
14. J.N. Al-Karaki, A.E. Kamal, "Routing techniques in wireless sensor networks: A survey," IEEE Wireless Communications, vol. 11, pp. 6-28, 2004.
15. Niculescu, "Communication paradigms for sensor networks," IEEE Communications Magazine, 43(3): 116-122, March 2005.
16. Y. Bi, J. Niu, L. Sun, W. Huangfu and Y. Sun, "Moving Schemes for Mobile Sinks in Wireless Sensor Networks," 2007 IEEE International Performance, Computing, and Communications Conference, New Orleans, LA, 2007, pp. 101-108.
17. S. Pant, R. Kumar and A. Singh, "Adaptive sink transmission and relocation to extend the network lifetime of wireless sensor network," 2017 3rd International Conference on Advances in Computing,Communication & Automation (ICACCA) (Fall), Dehradun, 2017, pp. 1-4.

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