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A NEW SCHEDULING BASED ENERGY EFFICIENT SCHEME FOR WSNS

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ABSTRACT

In recent years, Wireless Sensor Networks are the most popular networks among the other networks. It is a collection of sensor nodes where it contains infrastructure or no infrastructure. It is widely used in military, search and rescue operations etc. Due to the mobility of nodes, packets are dropped without organizing scheduling priority. So, the performance of the networks is totally degraded. To overcome this issue, we proposed New Scheduling based Energy Efficient Scheme (NSEES). It attains both throughput and network connectivity while keeping the nodes moving in dynamic manner. The scheme consists of 4 phases. In first phase, we propose the mobility model where the nodes are moving in a rectangular lattice. In second phase, the multipath routing is used to provide load balancing to improve the throughput. In third phase, the scheduling algorithm was proposed. Here the sensor nodes are assigned with the constant codewords and different time slots. In fourth phase, we proposed new packet format. It consists of scheduling status and connectivity status. We also introduced the energy conservation model to attain minimum energy level to the sensor nodes. By using the extensive simulation results using the discrete event simulator, the proposed NSEES achieves higher packet delivery ratio, connectivity ratio, less overhead and delay than the existing scheme like NMRA, SBYaoGG and AFTMR.

Keywords: *Wireless Sensor Networks)WSN, New Scheduling based Energy Efficient Scheme (NSEES), Smart Boundary Yao Gabriel Graph(SBYaoGG), Adaptive Fault Tolerant Multipath Routing (AFTMR), Scheduling priority, , end to end delay, and mobility model.*

I. INTRODUCTION

A. Wireless Sensor Networks

A sensor network is composed of a large number of sensor nodes, which are densely deployed either inside the phenomenon or very close to it. The position of sensor nodes need not be pre-determined. This allows random deployment in inaccessible terrains or disaster relief operations. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities. Another unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor nodes are fitted with an on-board processor. Instead of sending the raw data to the nodes responsible for the fusion, sensor nodes use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data.

B. Need For Scheduling In WSNS

A Wireless Sensor Network consists of group of nodes called sensor nodes. Each one of these has an embedded processor, a radio and one or more sensors. These nodes operate together in the area being monitored and collect physical attributes of the surroundings. Data gathered by these sensor nodes can be utilised by various top level applications such as habitat monitoring, surveillance systems and systems monitoring under various natural phenomenon. Sensor nodes have limited battery life. In some applications the sensors are placed in difficult locations, expecting manual intervention for renewal of battery is impractical. In fact, with advances in technology it is expected that in near future these sensor nodes will be disposable and will only last until their energy drains away. The node has to sustain itself on its battery's limited energy resources and without power management it can last only for a short period of time.

To minimize the energy consumption, there is a need of scheduling in sensor networks. For that we

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proposed multipath routing based scheduling mechanism to make a correct balance between the network connectivity and energy efficiency.

2. PREVIOUS WORK

Tian et.al [1] proposed a node-scheduling scheme, which can reduce system overall energy consumption, therefore increasing system lifetime, by turning off some redundant nodes. The coverage-based off duty eligibility rule and backoff-based node-scheduling scheme guarantees that the original sensing coverage is maintained after turning off redundant nodes. In the scheduling scheme, the operation was divided into rounds. Each round begins with a self-scheduling phase, followed by a sensing phase. In the self-scheduling phase, nodes investigate the off-duty eligibility rule. Eligible nodes turn off their communication unit and sensing unit to save energy. Non-eligible nodes perform sensing tasks during the sensing phase. To minimize the energy consumed in the self scheduling phase, the sensing phase should be long compared to the self- scheduling phase.

Jing deng et.al [2] proposed the Balanced-energy Scheduling (BS) scheme in the context of cluster-based sensor networks. The BS scheme aims to evenly distribute the energy load of the sensing and communication tasks among all the nodes in the cluster, thereby extending the time until the cluster can no longer provide adequate sensing coverage. Two related sleep scheduling schemes, the Distance-based Scheduling (DS) scheme and the Randomized Scheduling (RS) scheme were also studied in terms of the coefficient of variation of their energy consumption. A sufficient number of sensor nodes were deployed over a sensing field such that some sensor nodes can go into the sleeping mode without degrading the sensing coverage of the network. Static circular cluster associations were assumed in the sensor network. Each sensor node belongs to the same cluster throughout its lifetime.

Ram Kumar Singh and Akanksha Balyan [3] mainly focussed on the energy efficient communication with the help of Adjacency Matrix in the Wireless Sensor Networks. The energy efficient scheduling can be done by putting the idle node in to sleep node so energy at the idle node can be saved. The proposed model in this work first forms the adjacency matrix and broadcasts the information about the total number of existing nodes with depths to the other nodes in the same cluster from controller node. When every node receives the node information about the other nodes for same cluster they communicate based on the shortest depths and schedules the idle node in to sleep mode for a specific time threshold so energy at the idle nodes can be saved.

Mohamed Lehsaini et.al [4] proposed a cluster-based efficient-energy coverage scheme Virtual Sensor (CSA_VS) to ensure the full coverage of a monitored area while saving energy. CSA_VS uses a novel sensor-scheduling scheme based on the k-density and the remaining energy of each sensor to determine the state of all the deployed sensors to be either active or sleep as well as the state durations. In this work, it is addressed that the k-coverage problem because in some applications, it is possible that some locations called sensitive regions in the monitored area are more important than others and need to be covered by more sensors to achieve fault tolerance and to deal with erroneous measurements collected by the sensors. The solution proposed can test whether a point within the monitored area is k-covered or not. To check k-coverage of this point, it the algorithm CSA_VS is applied and verified if each virtual sensor has at least k active sensors in its neighbourhood.

Babar Nazir et.al [5] presented a sleep/wake schedule protocol for minimizing end-to-end delay for event driven multi-hop wireless sensor networks. In contrast to generic sleep/wake scheduling schemes, the proposed algorithm performs scheduling that is dependent on traffic loads. Nodes adapt their sleep/wake schedule based on traffic loads in response to three important factors like the distance of the node from the sink node, the importance of the node's location from connectivity's perspective and if the node is in the proximity where an event occurs. Using these heuristics, the proposed scheme reduces end-to-end delay and maximizes the throughput by minimizing the congestion at nodes having heavy traffic load. The variable active durations are assigned to the nodes based on node distance from the sink node, node topological importance, and occurrence of event in its vicinity. It will enable the nodes to gracefully handle the traffic, as nodes are dynamically assigned active durations according to their expected traffic load. It minimizes delay at the nodes near to the sink node, node having critical topological position, and nodes in vicinity of event occurrence. This ensures rapid dissemination of data to the sink node and hence reduces the end-to-end delay.

Dimitrios J. Vergados et.al [6] proposed a Scheduling Scheme for Energy Efficiency in Wireless Sensor networks. The basic concept of this scheme is to try to maximize the time each sensor node remains in sleep mode, and to

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minimize the time spent in idle mode, taking into account not only the consumed power, but also the end-to-end transmission delay. This is accomplished through the synchronization of the wake up times of all the nodes in the sensor network. More specifically, the gateway gathers the available connectivity information between all the nodes in the network, and uses existing energy-efficient routing algorithms to calculate the paths from each node to the gateway. Then, the gateway constructs a TDMA frame which ensures the collision avoidance. This schedule is broadcasted back to the sensor nodes, allowing every sensor to know when it can transmit and when it should expect to receive a packet.

Rakhi Khedikar et.al [7] explored the lifetime of wireless sensor network. The research of the network lifetime for wireless sensor network is analyzed to introduce some scheduling the methods of the researchers' uses. The proposed work is focussed on increasing the lifetime by scheduling. Depletion of these finite energy batteries can result in a change in network topology or in the end of network life itself. Hence, prolonging the life of wireless sensor networks is important.

Sounak Paul and Naveen Kumar Sao [8] proposed the work which is based on hierarchical cluster based homogeneous wireless sensor network model. The sensor nodes are virtually grouped into clusters and cluster head may be chosen according to some pre defined algorithm. Clustering architecture provides a convenient framework for resource management, such as channel access for cluster member, data aggregation, power control, routing, code separation, and local decision making. The aim of the proposed work is to dynamically balancing energy consumption and to enhance the functional lifetime of the network by dynamically scheduling a percentage of nodes to go for a sleep in each round.

Ming Liu et.al [10] proposed a mathematical method for calculating the coverage fraction in WSNs. According to the method, each active node can evaluate its sensing area whether covered by its active neighbours. It is assumed that the network is sufficiently dense and the deployed nodes can cover the whole monitored area. In this scenario, if a node's sensing area is covered by its active neighbour nodes, it can be treated as a redundant node. Based on this idea, it is proposed a lightweight node scheduling (LNS) algorithm that prolongs the network lifetime of the sensor network by turning off redundant nodes without using location information. The performance of LNS is independent of the location information of the sensor node. As a result, it can not only save considerably energy for obtaining and maintaining the location information, but also reduce the cost of sensor node. According to the desired coverage fraction required by application, LNS can dynamically adjust the density of active sensor nodes so that it will significant prolong the network lifetime.

Shan-shan Ma and Jian-sheng Qian [11] proposed a method to determine some boundary nodes only using the minimum cost of nodes and the neighbours. The inequality sleep problems were studied in location-unaware networks. To solve the problem that the boundary nodes may run out of their energy faster than other sensors, it is proposed a method to determine some boundary nodes only using the minimum cost value of each node and the neighbours' distance without any location information.

Gaurav Bathla et.al [12] developed proposed algorithm with data aggregation & fusion which is used to minimize reduction in system energy by first generating Minimum Spanning Tree between all sensor nodes so as to minimize their transmission energy with in network and after that a node of highest energy among the top tier will transmit the aggregated data of whole network to base station. They have kept network topology same till any node of network dies another highest energy node from top most rank tier is chosen to communicate with Base Station.

Yuping Dong et.al [13] proposed energy efficient routing algorithm for WSN. In this algorithm, they have divided the sensor nodes into several scheduling sets and let them work alternatively. In this way, the sensors do not have to be active all the time which saves a lot of energy. When choosing the next sensor to forward the information to, they considered both the distance from the base station to the sensor and its current energy level. So the network power consumption will be distributed among the sensors. When the network does not have enough sensors that have sufficient energy to run, it generates new scheduling sets automatically.

K. Vanaja and R. Umarani [14] deals with the fault management to resolve the mobility induced link break. The proposed protocol is the adaptive fault tolerant multipath routing (AFTMR) protocol which reduces the packet loss due to mobility induced link break. In this fault tolerant protocol, battery power and residual energy are taken into account to determine multiple disjoint routes to every active destination. When there is link break

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in the existing path, CBMRP initiates Local Route Recovery Process.

Tapiwa et.al [15] proposed the new distributed topology to enhance the energy efficiency and radio interference to preserve the global connectivity. The drawback of the approach is lack of balancing the energy consumption and security. It does not provide better authentications to the information carried by the packets. To overcome this issue, our scheme enhances the cross layer based multipath routing to achieve the correct balance between the energy consumption and network connectivity.

In my previous work [16], a New Multipath Routing Approach is developed which attains energy model, maintenance of optimal energy path, multipath construction phase to make a correct balance between network life time, energy consumption and throughput to the sensor nodes. In the first phase of the scheme, construction of multipath is implemented. In second phase, the optimal energy path is maintained. In third phase, residual energy consumption is increased using energy model. It uses following factors called distance , residual energy, mobility factor, mobility factor and data correlation to favour packet forwarding by maintaining high residual energy consumption for each node.

3. IMPLEMENTATION OF NSEES ALGORITHM

In our proposed technique, scheduling based energy efficiency for improving network connectivity and maximizing throughput using the multipath approach. Likewise, there are several existing work focussed on improving the throughput and network connectivity but our scheme introduces the connectivity of the nodes based on interference ratio and channel model. The proposed scheduling algorithm comprises two models. In first phase, the scheduling algorithm attains the highest network connectivity while choosing the link between the mobile nodes with high scheduling priority. We have chosen the Cluster model to determine the highest connectivity ratio and throughput. In cluster model, the cluster head is being chosen for managing the whole node and network connectivity.

A. Mobility Model

In the proposed algorithm, the system is considered as a discrete-time system. Here, it is assumed that the pairs (mobile nodes) move at the beginning of each time slot, and stay still within a time slot. The mobility model of each mobile nodes is Markovian with Random mobility model and over a discrete rectangular-lattice rectangular region. It means that the next location of a mobile node is determined by its current location but does not depend on the other history information (previous route history and routing). Then it is assumed that the distance a mobile node can move at the beginning of a time slot is no more than maximum speed. Again, it is assumed that the mobility processes are dynamic and uniform distribution over the rectangular area It is also assumed that the distance between a source mobile node and destination mobile node is D, which is fixed for all time t. The results can be easily extended to the case where the distance between a sender and its receiver is time-varying, but upper and lower bounded. We denote by $SM_l[t]$ the location of the source node l at time slot t, and $RM_l[t]$ the location of destination node l at time slot t.

B. Intervention Model

If two links like l,k interfere with each other, simultaneous transmissions on the two links (m,n) will lead to a collision and no information can get through the links. So it is considered that the pair l, the transmission of pair m will interfere with the transmission of pair l.

C. Multipath Routing

The concept of proposed multipath feature is towards broadcasting the traffic load among two or more routes. Load delivery is to avoid the congestion problems in the network and to increase data throughput rate. The proposed multipath system in figure1 uses multi-path routing in order to select the route with the best maximum data throughput rate.

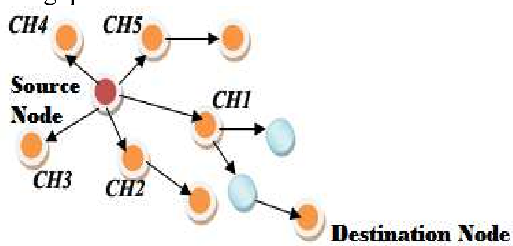

Figure 1. Multipath Routing Approach

In the proposed multipath routing scheme, the network is organized as a collection of Cluster node. Each cluster has its own cluster head. The cluster head is chosen based on the higher priority depends on communication status among the nodes, bandwidth, frequency, energy level. If two

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cluster participant nodes wants to communicate between different regions, they need to get permission from CH_1, CH_2. In the proposed scheme, certain constraints are to be followed.

- The node in Cluster (C), only if the hop count is below the node's hop value.
- Each node should have minimum four multiple paths to reach the particular destination D.
- The energy level of the clusters is determined based on the energy level of cluster nodes. The threshold energy level is calculated by cluster head (CH).
- The RREQ message is transmitted when the source node is reached and to create a new entry in the local routing neighbor table.

D.Scheduling algorithm

According the mobility model, each node is assigned with different time slots and common code word. Here D_{max} is the maximum node connectivity, w is the code weight, q is the number of codewords with different weights and N is the number of mobile nodes participated in the network.

Step1 : Initially set the code weight $w = D_{max} + 1$.
Step 2: Determine the distance from source to destination node.
Step 3: Set the initial link schedule $S = \{s_h \mid h \in A\}$ is set to zeros. Compute the scheduling priority $S_{p,h}$ of the vertices v_h for $h \in A$.
Step 4: Choose the highest link scheduling priority u =arg max $h \in A$ $S_{p,h}$
Step 5: Compute ON (t_{ON})and OFF time (t_{OFF}).
Where t_{ON} is the maximum time for the node to sleep thoroughly before the routing establishment, also it is the minimum time to reach the destination node with the maximum speed.

$$t_{ON} = \frac{f - r}{v_{\max}} \quad (1)$$

t_{OFF} is the maximum time for the node to pass by the node's transmission range, but if the node moves out of the region with a shorter time than the expected passing by time, the scheduling can be recovered, thus

$$t_{OFF} = \min\left\{\frac{f + r}{v_{\min}}, t_{\exp}\right\} \quad (2)$$

t_{exp} is time expiration that node move out of the cluster.
V_{min} is the minimum speed of the node.
Step 6: Each node in CH_1 is assigned with a unique codeword in Q_1 and each node in CH_2 is assigned with a unique codeword in Q_2.
Step 7: Compute the included angle ϕ between the root node connection line and the instant velocity v.
Step 8: Compute maximum network connectivity ratio DC_{max}. DC_{max} will increase as the node's instant speed and the direction probability increase. For the normal distribution model,

$$DC_{\max} = \frac{e.v}{\sqrt{2\pi(pv+q)}} \exp(-\frac{\theta^2}{2(pv+q)}) + k \quad (3)$$

e – energy of the node
V-vector
θ - Inclined Angle
p,q - Axes
k - Approximate value
Step 9: Each node transmits its data packets only at its assigned slots determined by its codeword.
Step 10: Once the scheduling is complete, the active links will transmit data according to the scheduling result.

E. Determination of Energy Conservation Ratio

The proposed algorithm determines the energy conservation rate based on the above three factors and also the total number of bits transmitted per energy.

$$E_{CR} = \sum (T_{mb}, T_{tv}, DS_{\min}) + \frac{\chi_{BR}}{\sum \delta_{es}(t)} \quad (4)$$

χ_{BR} - Number of bits transmitted (bits).

$\sum \delta_{es}(t)$ - Total energy consumed (Joules).

T_{mb} – Trust Mobility factor

T_{tv} – Trust threshold vector value

DS_{min} - Minimum Digital Signature

By limiting the factors like mobility, malicious activities, unauthenticated node occurrence and bits transmitted per energy, the node energy consumption can be reduced.

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F. Proposed packet format

Source ID	Destination ID	Scheduling Status	Network Connectivity Status	Energy Conservation Ratio	CRC
2	2	4	4	4	

Figure 2.Proposed Packet format

In Figure 2 the proposed packet format is shown. Here the source and destination node ID carries 2 bytes. Third one is scheduling status of the node. The scheduling status induces the whether the transmission of packets are travelled with highest link priority and least hop distance. In fourth field, the network connectivity status is indicated. It determines how much of the connection status between various clusters with the current cluster. It also determines whether packet is assigned with correct time slot. In fifth, the energy conservation ratio is allotted to ensure minimum energy consumption. The last filed CRC i.e. Cyclic Redundancy Check which is for error correction and detection in the packet while transmission and reception. The flow chart is illustrated in Figure 3.

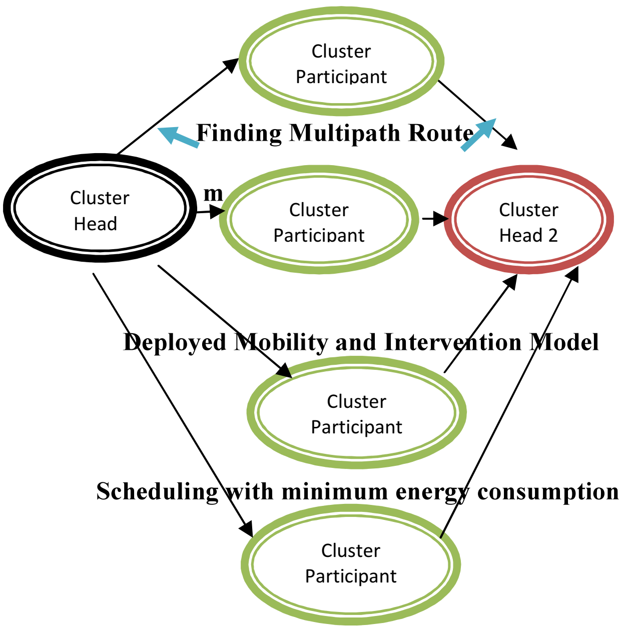

Figure 3. Flow chart of Proposed Scheme

4. PERFORMANCE ANALYSIS

Network Simulator (NS 2.34) is used to simulate our proposed NSEES algorithm. Network Simulator-2(NS2.34) is used in this work for simulation.NS2 is one of the best simulation tools available for Wireless sensor Networks. We can easily implement the designed protocols either by using the OTcL (Tool command Language) coding or by writing the C++ Program. In either way, the tool helps to prove our theory analytically.

In our simulation, 200 mobile nodes move in a 1200 meter x 1200 meter square region for 60 seconds simulation time. All nodes have the same transmission range of 500 meters. Our simulation settings and parameters are summarized in table 1.

A. Performance Metrics

We evaluate mainly the performance according to the following metrics.

End-to-end delay: The end-to-end-delay is averaged over all surviving data packets from the sources to the destinations.

Packet Delivery Ratio: It is defined as the ratio of packet received with respect to the packet sent.

Throughput: It is defined as the number of packets received at a particular point of time.

The simulation results are presented. It is compared the proposed scheme NSEES with existing schemes like AFTMR [14], SBYaoGG [15] and our previously proposed scheme NMRA [16] in the presence of energy consumption.

Table1. Simulation Settings And Parameters Of NSEES

No. of Nodes	200
Area Size	1200 X 1200
MAC	802.11
Radio Range	500m
Simulation Time	60 sec
Traffic Source	CBR
Packet Size	512 bytes
Mobility Model	Random Way Point
Protocol	LEACH

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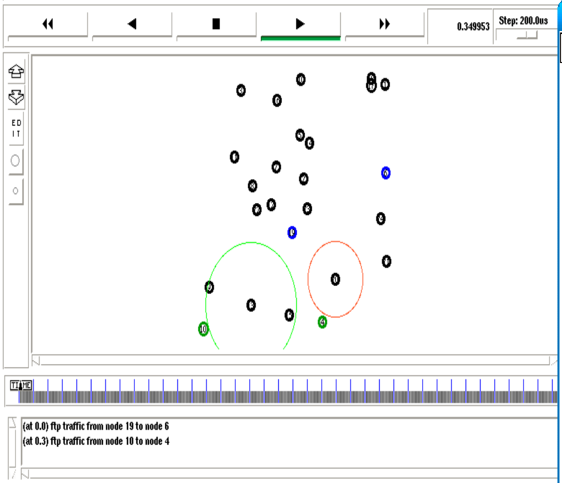

Figure 4 Topology of the proposed scheme

Figure 4 shows that the proposed scheme topology for ensuring the multipath routing. Source node sends the packet to destination node via intermediate nodes. In case if the node failure occurs, the node choose the alternative path to reach correct delivery of packets.

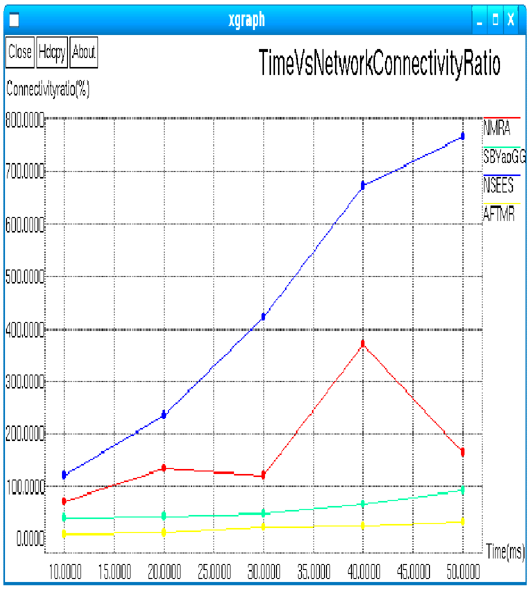

Figure 5 Time Vs Network Connectivity Ratio

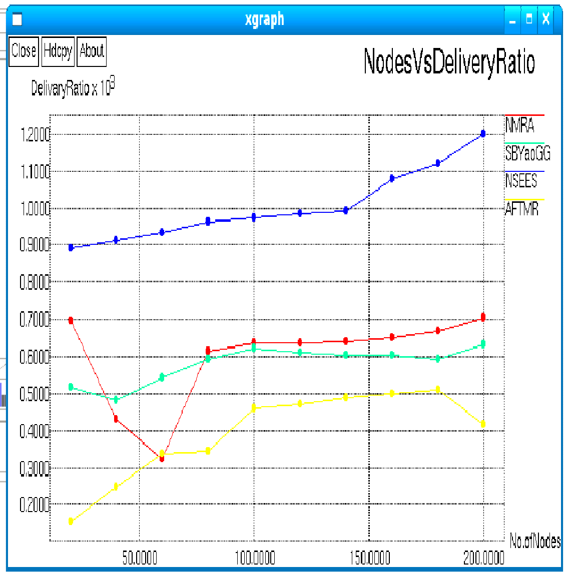

Figure 6 No.Of Nodes Vs Packet Delivery Ratio

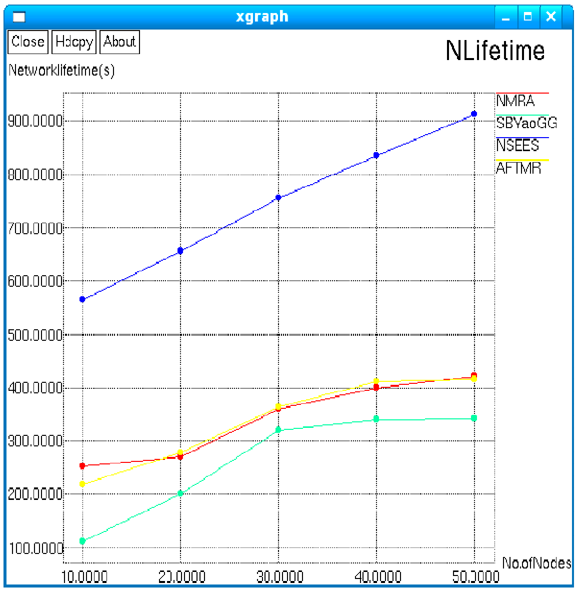

Figure 7. No.Of Nodes Vs Network Lifetime

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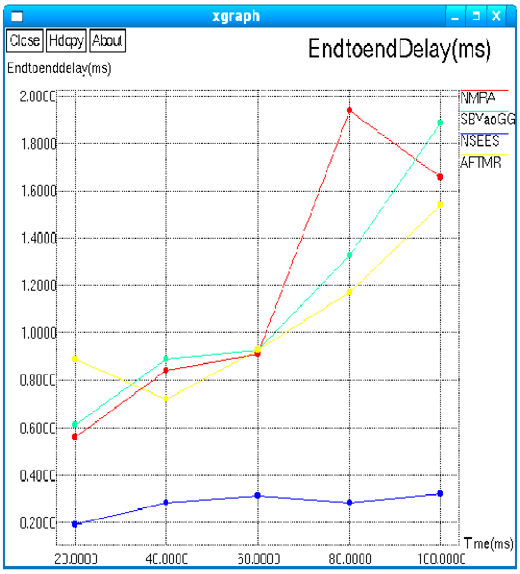

Figure 8 Time Vs End To End Delay

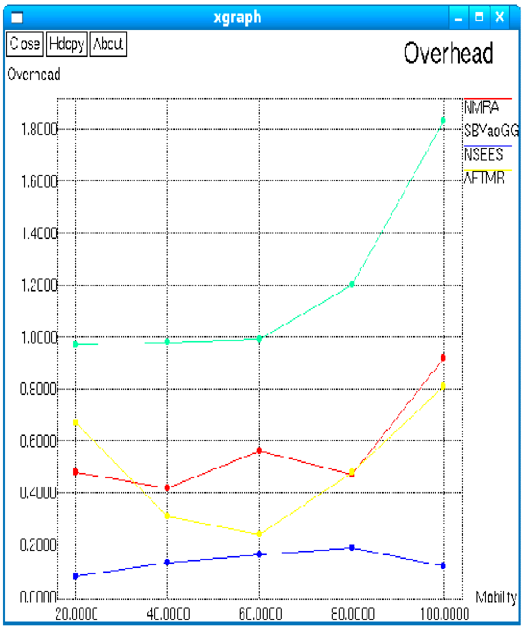

Figure 9. Mobility Vs Overhead

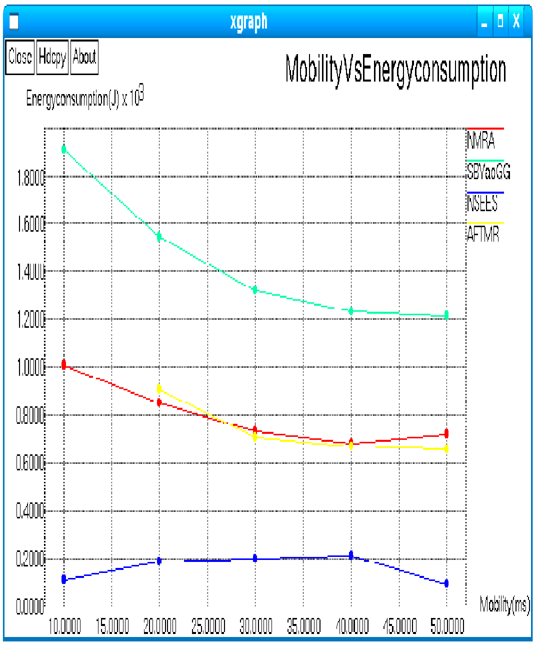

Figure 10. Mobility Vs Energy Consumption

From Figure 5 to Figure 10 it shows that the Network Connectivity, Packet Delivery Ratio, Network lifetime, End to end delay, overhead and energy consumption are better compared to the previous scheme NMRA and existing schemes such as SBYaoGG, AFTMR

Table2. Analysis Of Proposed Method And Existing Methods In Terms Of Different Parameters

Metrics	NSEES	NMRA	SBYaoGG	AFTMR
Energy consumption	114 - 90 Joules	1009-721 Joules	1907-1209 Joules	907-646 Joules
PDR (pkts)	890 – 1197	695 – 704	518-633	156-417
Network L_time (Secs)	564-912	252 - 421	111-342	218-415
End to end delay (msec)	0.20-0.36	0.59-1.63	0.61-1.87	0.9-1.59
Overhead	0.08–	0.48–	0.97-1.83	0.67-

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(pkts)	0.12	0.92		0.81
NCR (%)	121-764	71-164	45-91	10-31

5. CONCLUSION

In WSNs, the nodes are totally distributed in a random manner. The control may be issued by base station or without any base station. Here we focussed on to improve the scheduling link priority to avoid the packet drop and to improve energy efficiency. So we propose NSEES scheme to provide the multipath routing based scheduling to maximize the network connectivity ratio and throughput. In first two phases both mobility model and multipath routing is proposed. Here the load balancing is well improved. In third phase, each packet attains the time slots which are sent through the highest link scheduling priority. The scheduling status, connectivity status and energy conservation ratio is verified using our proposed scheme. By using NS2, a discrete event simulator, our scheme achieves high connectivity ratio and delivery ratio, low overhead, low end to end delay and minimum energy consumption while varying the time, throughput, number of nodes and mobility than the existing scheme NMRA, SBYaoGG and AFTMR.

REFERENCES:

[1] Di Tian and Nicolas D. Georganas, "A Coverage-Preserving Node Scheduling Scheme for Large Wireless Sensor Networks", iSENSE Project, Communications and Information Technology Ontario, 2002, pp.1-12.

[2] Jing Deng, Yunghsiang S. Han,, Wendi B. Heinzelman and Pramod K. Varshney, " Balanced-energy sleep scheduling scheme for high-density cluster-based sensor networks", Elsevier, Computer Communication, Vo.28, 2005, pp.1631-1642.

[3] Ram Kumar Singh and Akanksha Balyan, " Matrix Based Energy Efficient Scheduling With S-MAC Protocol in Wireless Sensor Network", International Journal of Modern Education and computer science,2012, 4, 8-20

[4] Mohamed Lehsaini, Hervé Guyennet, Mohammed Feham, "Cluster-based Energy-efficient k-Coverage for Wireless Sensor Networks", Network Protocols and Algorithms, Vol. 2, No. 2, 2010, pp.89-106.

[5] Babar Nazir, Halabi Hasbullah and Sajjad A Madani, "Sleep/wake scheduling scheme for minimizing end-to-end delay in multi-hop wireless sensor networks", EURASIP Journal on Wireless Communications and Networking, Vol.1, No.92, 2011, pp.1-14.

[6] Dimitrios J. Vergados, Dimitrios D. Vergados and Nikolaos Pantazis, "An Energy Efficiency Scheme for Wireless Sensor Networks", PENED Project, GSRT, 2003, pp.1-12.

[7] Rakhi Khedikar, Avichal Kapur and Yogesh Survanshi, "Maximizing a Lifetime of Wireless Sensor Network by Scheduling", International Journal of Computer Science and Telecommunications, Volume 2, Issue 8, 2011, pp.1-6.

[8] Sounak Paul and Naveen Kumar Sao, "An Energy Efficient Hybrid Node Scheduling Scheme in Cluster Based Wireless Sensor Networks", Proceedings of the World Congress on Engineering, Vol.2, 2011, pp.1-5.

[9] Jungeun Choi, Joosun Hahn and Rhan Ha, "A Fault-tolerant Adaptive Node Scheduling Scheme for Wireless Sensor Networks", Journal of Information Science and Engineering (JISE), Vol.25, 2009, pp.273-287.

[10] Ming Liu, Yuan Zheng, Jiannong Cao, Wei Lou, Guihai Chen, and Haigang Gong, "A Lightweight Scheme for Node Scheduling in Wireless Sensor Networks", Springer, 2007, pp.579-588.

[11] Shan-shan Ma and Jian-sheng Qian, "Location-Unaware Node Scheduling Schemes Based on Boundary Nodes in Wireless Sensor Networks", Przegląd Elektrotechniczny, Vol. 89, 2013, pp.71-74.

[12] Gaurav Bathla and Gulista Khan, "Energy-efficient Routing Protocol for Homogeneous Wireless Sensor Networks", International Journal on Cloud Computing: Services and Architecture (IJCCSA), Vol. 1, No. 1, May 2011, pp.12-20.

[13] Yuping Dong , Hwa Chang, Zhongjian Zou and Sai Tang, "An Energy Conserving Routing Algorithm for Wireless Sensor Networks", International Journal of Future Generation Communication and Networking, Vol. 4, No. 1, March 2011, pp.39-54.

[14] K. Vanaja and R. Umarani, "An Adaptive Fault Tolerant Multipath Routing Protocol for Wireless Ad Hoc Networks", European Journal of Scientific Research, ISSN 1450-216X Vol.79 No.2 2012, pp.180-190.

[15] Tapiwa M. Chiwewe, and Gerhard P. Hancke, "A Distributed Topology Control Technique

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

for Low Interference and Energy Efficiency in Wireless Sensor Networks", IEEE Transactions on Industrial Informatics, Vol. 8, No. 1, February 2012, pp.11-19.

[16] Saira Banu and R.Dhanasekaran, " A New Multipath Routing Approach for Energy Efficiency in Wireless Sensor Networks", International Journal of Computer Applications, Volume 55, No.11, 2012, pp.24-30.