Journal of Theoretical and Applied Information Technology
20th July 2014. Vol. 65 No.2

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

DYNAMIC SENSOR RELOCATION TECHNIQUE BASED LIGHT WEIGHT INTEGRATED PROTOCOL FOR WSN

[1].J.JOY WINSTON, [2].Dr.B.BALAN PARAMASIVAN
Ap/Pet Engg College Vallioor. India
Prof/Cse, National Engineering College,Kovilpatti. India
Email :[1]. joywinston47@gmail.com, [2].b_paramasivan@yahoo.co.in

ABSTRACT

In the past few years, it is observed and noticed that we are utilizing Wireless Sensor Networks with greater interest for various popular and crucial applications. It represents an emerging set of technologies that will have profound effects across a range of Medical, Industrial, Scientific and Governmental Applications. This Wireless Sensor Network is made up of a group of Sensor Nodes or Devices and each device possesses the ability to monitor some aspect of its environment and each is able to communicate its observations through other devices to a destination where data from the network is gathered and processed further for our requirements. Sensor Nodes are operating autonomously even in unattended environments and potentially in large numbers and that too we could not be deployed manually in a hostile or harsh environment. Hence, we could deploy randomly those large numbers of Sensors in Hostile / Harsh Environment and it leads coverage issue, which is leading to connectivity loss and moreover, sometimes, the Sensor Nodes may failure which too causes Connectivity Loss and hence for sensitive services we couldn't use this. Thus, while deploying Sensor Nodes for sensitive services, we need to focus both the Coverage and Connectivity. As we are unable to deploy Sensors manually, the Sensor Relocation Scheme had proposed earlier, where the Sensors themselves moving towards required position to make proper Coverage and Connection. As it is one of the smartest techniques, this research work has studied Dynamic Sensor Relocation Scheme thoroughly and implemented. From our experimental results, we noted that this work achieves good coverage when Nodes getting failure or becoming communication holes. But however this approach consuming more Energy for continuous migration, which minimizes the lifetime of Sensor Networks. And also it is identified that, this approach fails to focus Connectivity issue due to node migration and Secured Communication too, which may compromise our collecting data. To address these serious issues, this research work has proposed an efficient Dynamic Sensor Relocation Technique based Lightweight Integrated Protocol(LIP), which is addressing Secured Coverage, Connectivity, Communication and urity. We have implemented our proposed work and studied thoroughly..

Keywords : *Coverage, Connectivity, Energy Efficiency, Key Management and Sensor Relocation, and Topology ControlS*

1. INTRODUCTION

Recent advances in Wireless Network Technologies have made the development of small, inexpensive, low power distributed devices, which are capable of local processing and wireless communication and those devices are called as Sensor Nodes. Sensors are generally equipped with limited Data Processing and Communication Capabilities and are usually deployed in an Ad-Hoc manner to in an area of interest to monitor events and gather data about the environment. Among various challenges faced while designing Wireless Sensor Networks, maintaining Network Connectivity, Coverage and Maximizing the Network Lifetime standout as Critical Consideration. The Connectivity and Coverage issues are generally met by deploying a sufficient number of Sensor Nodes or using Specialized Nodes with long-range capabilities to maintain a connected graph [4,11,12].

The Network Life Time can be increased through Energy Conservation Methods by using Energy Efficient Protocols and Algorithms. Due to various factors, such as the inaccessibility of the terrain, scale of the network and etc., optimal deterministic deployment of the sensor network is often infeasible. A common scenario envisioned for deployment is that of randomly scattering of sensor

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

devices over the field of interest [5,13,15]. Thus, it makes the task of guaranteeing coverage much harder.

As an alternative, Mobile Sensor Nodes can be used to heal coverage holes in the network so that the randomness in sensor deployment can be compensated. Mobile platform are already available in many deployment scenarios, such as

soldiers in battlefield surveillance application, animals in habitat monitoring applications, and buses in traffic monitoring applications. In other scenarios mobile devices can be incorporated into the design of the WSN architecture [4]. Failures in Sensor Networks [6, 7,11,14] are common and can be cured by using the redundant nodes in the network i.e. moving mobile redundant nodes to overcome the failure of Sensor Nodes or activate any sleeping redundant node in the group. Sensor Nodes failure may cause connectivity loss and in some cases network partitioning.

However, such situation can be corrected by injecting a few mobile nodes in the network which can move to desired locations and repair broken network or using redundant nodes in the network to heal the network failures. Utilization of redundant mobile nodes plays an important role in prolonging network life time. However, reallocating mobile Sensor Nodes has many challenges and special requirements. First, movement in Sensor Networks involved communication and can be very expensive in terms of energy. Mobility in WSN would also require network reconfiguration. When a node moves in the network its relation to the environment and neighboring nodes will change and thus, cause the network to reconfigure. As a result mobility will add additional overhead to the network, in terms of communication messages and reconfiguration.

Therefore, an energy efficient strategy is required to adopt mobile nodes in the network. Second, the reallocation of redundant mobile Sensor Nodes should have minimum effect on network sensing topology. Third, reallocation should be localized to achieve quick response time. For example; failure of Sensor Nodes monitoring a patient should be replaced immediately. To address the above discussed challenges, Muhammad Asim and et.al. proposed Distributed Cellular Architecture that partitioned the whole network into a virtual grid of cells. The initial design of the Cellular Architecture[3] was proposed by Asim and et.al, where a Cell Manager is chosen in each cell to perform management tasks. These cells combine to form various groups and each group chooses one of their Cell Managers to be a Group Manager. This model was used in [1]. However, from our Research work, we have realized that the modified Cellular Architecture[1] consuming more Energy, which minimizes the lifetime of Sensor Networks. And also it is identified that, this approach fails to focus Secured Communication, which may compromise our collecting data. To address these serious issues, this research work has proposed an efficient Sensor Relocation Technique based Lightweight Integrated Protocol(LIP).

2. RELATED WORK

Mobility and its effects on the Sensor Network operation have been extensively studied and emerged as an important requirement for Wireless Sensor Networks. Wang and et.al. [8] presented a proxy-based Sensor

Relocation Algorithm for the Sensor Networks composed of both static nodes and mobiles. Mobile from nearby locations moves to fill the coverage hole. This results in the emergence of new holes. Thus, more and more sensors are involved in relocation. This approach relies on flooding for replacement and uses a direct relocation method that can produce inconsistent relocation delay. Wang and et.al. [9] presented a grid-quorum based relocation protocol for mobile Sensor Networks. In this Protocol, the network field is geographically partitioned into grids. In each grid, a node as grid head runs the quorum-based location service to fund the redundant Sensor Nodes in the network. Then the discovered replacement is relocated along a carefully selected path in a cascaded way. ie in the shifted way. Muhammad Asim and et.al. [1] has proposed Sensor Relocation Scheme which consists of two main phases namely i. Identifying Redundant Nodes and ii. Sensor Relocation. In this model, the Cell Manager is responsible for collecting information of its cell members and determines the existence of redundant sensors based on their location. For redundant sensors located on the boundary of the cells, the Cell Managers coordinate to make decisions. The Cell Manager can also monitor its cell members and initiate a relocation process in case of new event or sensor failure.
Redundant Nodes may be sent to a sleep mode to save or conserve energy. In other words, in some cell areas, there may be more Sensor Nodes than

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

others and hence need to maintain nodes intensity. ie some nodes can be sent to a sleep mode to adjust the cell size. Cell size is affected by factors such as the transmission range of the transmitter or the transmission power and the sensing range of the Sensor Nodes. Varying the cell size in the network affects the lifetime of the network.

In this Cellular Architecture[1,14,15], the cell size is a user defined parameter, which can be adjusted to meet the required Cell-head density. Also, to keep the hierarchical structure efficient, load for each cluster head should be equivalent. Thus, the cluster size is a key parameter to achieve balanced load among clusters.

Cell-head density will be defined according to application requirements. Appropriate cell-head density plays an important role in maximizing the performance of the network. However,

for most Sensor Networks application, it is important to support fast delivery of Important and Urgent Data.

Also, maximizing cell head density may put extra burden on Cell Manager for certain operations i.e. data aggregation. Therefore, it is extremely important for the performance of sensor network to carefully define cell size and cell-head density.

The average number of static sensors needs to cover a cell is represented by p and is maintained by the Cell Manager[1]. However, some cells may contain fewer sensors than p due to the randomness in deployment or node failures. If a cell I contain static nodes (Ni) < p, mobiles nodes need to move into the cell to fill in the vacancies. The Cell Managers within the same group represent a virtual grid structure towards their Group Manager. Instead of flooding subscribe/publish messages across the network and polling information from hundreds of thousands nodes, the Cell Manager contacts its Group Manager in the virtual grid structure to track the redundant mobile nodes. This design minimizes the number of communication messages, and thus conserve node energy. Our proposed framework is based on finding redundant Sensor Nodes in a localized fashion. We believe that adopting localization to a certain degree reduces network traffic whenever possible. Addionally, such an approach also has a quick response to events that occurred in the network. Each Group Manager[1] maintains information about the publisher cells within its group and shares this information with closest neighboring Group Managers only. This supports the short distance movement of mobile Sensor Nodes. If the mobile sensor node travels a long distance to replace a faulty node or fill the coverage, it may run out of power and create a new coverage hole. When a cell has redundant Sensor Nodes, the Cell Manager propagates this information to its Group Manager. When a cell wants more sensors, the Cell Manager only needs to contact its Group Manager. Group Manager will first look for redundant Sensor Nodes with in a group and if there are no redundant nodes within its group, it then searches which nearest group has redundant Sensor Nodes.

For example, as shown in the Figure 1, suppose Cell 3 and Cell 9 have redundant sensors, while Cell 4 needs information to their Group Manager. The Cell Manager of cell 4 puts forward its demand for more sensors to its Group Manager.The Group Manager finds the distance between the subscriber cell and all possible publishing cells. The publishing cell with the shortest distance to the subscribing cell will get the priority. The Group Manager will notify the selected publisher cell to move its redundant Sensor Nodes to the subscriber cell.

From our Literature Survey, we concluded that the Sensor Relocation Scheme proposed by Muhammad Asim and et. al. [1] is the best model, which defined the problem of sensor relocation that can be used to deal with sensor coverage holes or sensor failures[10]. This Cellular Hierarchical Architecture located redundant mobile Sensor Nodes with minimum message complexity. Information about the redundant Sensor Nodes is only available at some intermediate nodes. This helps to reduce message complexity through message filtration and avoid message flooding and it reduces the energy consumption also.

3. IDENTIFIED PROBLEM

Though this Sensor Relocation Scheme reduces the message complexity through message filtration and avoid message flooding and it reduces the energy consumption, this model couldn't address the important Sensors Networks Challenges such as Connectivity and Network Security. ie this model couldn't achieve fair connectivity as the Sensor Nodes are involving migration from one Cell to another Cell for achieving Coverage. The mobility pattern also to be considered to provide assured Connectivity. This is one of the major issues to be

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

addressed. And the second one, as the Nodes are moving from one cell to another cell, this model might be compromised and vulnerable to System Security. To address these issues, this research work is proposed an efficient Lightweight Integrated Protocol (LIP) which is integrated with the existing Sensor Relocation Scheme, that is focusing both the Connectivity and Security as well. This proposed Sensor Relocation Technique based Lightweight Integrated Protocol(LIP) addressing Secured Coverage, Connectivity, Communication and Path Security.

4. PROPOSED DYNAMIC SENSOR RELOCATION TECHNIQUE BASED LIGHTWEIGHT INTEGRATED PROTOCOL (DLIP)

As discussed in the previous section, we have understood that the Sensor Relocation Scheme couldn't support for ensuring Connectivity and Security. Thus this Research Work has proposed an efficient Lightweight Integrated Protocol (DLIP) which is Integrated with the Sensor Relocation Technique. This Section briefly describes the Principle and the Procedure of our Proposed Technique.

4.1 Principle of Dynamic Sensor Relocation Technique based Lightweight Integrated Protocol (DLIP)

A Wireless Sensor may consist of hundreds to thousands of Sensor Nodes and are usually deployed randomly and hence, this may result in some area may have more Sensor Nodes than others. Hence the proposed Sensor Relocation Scheme identifies the redundant nodes.

After locating the redundant Sensor Nodes, the Sensor Relocation Scheme moves the sensor to the new destination, where the density of Sensor Nodes are less. The Nodes are moving to destination as follows.

- Direct Movement, where Nodes are moving between two direct neighboring cells, which heal the coverage. But Connectivity is the Issue.
- Cascaded Movement, where Nodes are moving from one Cell to another remote Cell through neighbor Cell

While moving nodes, the above described procedure doesn't focus Location Aware and Connectivity Aware as well. Thus, the proposed Dynamic Lightweight Integrated Protocol is working along with the Sensor Relocation Scheme as follows.

- It divides the Sensor Networks into Virtual Rings of Optimal Width μ = Rc / 2.45. Here Rc is the Communication Range of the Node. This ensures that while moving Nodes from one node to another Node, the Connectivity is ensured
    - o Then to provide guaranteed Connectivity-Coverage, the distance between Nodes are maintained as $\min\{\sqrt{3}R_S\ ,\ R_C\ \}$ where RC and RS are the Communication and Sensing ranges of Nodes respectively
    - o It also divides the Communication Range in two different Threshold Levels namely Threshold Th1 and Threshold Th2. The Th1 at 40% and Th2 at 80% of R_C. Accordingly, nodes that receive a signal stronger than Th1 (i.e., they are within 40% of RC) make the first ring while nodes that receive a signal weaker than Th1 but stronger than Th2 (i.e., they are within 40% to 80% of RC) make the second ring. A third ring is possibly defined for nodes that receive a signal weaker than Th2 (i.e., they are beyond 80% of RC), which may be updated on receiving a stronger signal afterwards.
- The Sensor Relocation Scheme through LIP will move the Redundant Sensors only when the previous Step conditions satisfied. ie within the Virtual Ring 1 or Virtual Ring 2. Otherwise, this Scheme doesn't move the Sensor Nodes.
    - Instead of moving Sensor Nodes, this proposed scheme will change the state of Nodes as follows Sensing Only : Nodes in this state can sense their environment but cannot transmit or receive data as their transceivers are switched off. A very low energy is used by the nodes in this state.

Journal of Theoretical and Applied Information Technology
20th July 2014. Vol. 65 No.2

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

- Sleeping : Nodes in this state can neither sense their environment nor can they transmit and receive data. Sleeping nodes consume extremely low amount of energy.

S. No.	Simulation Parameters	Description
1	No. of Nodes	500
2	Topology	Random
3	Deployment Area	100m x 100m to 400 m x 400 m
4	Mobility Model	Random
5	Channel	Wireless
6	MAC	IEEE802.15.4/Zigbee
7	Transmission / Sensing Range	15m – 50m
8	Sensor's Initial Energy	2000 mJ
9	Involved Protocols	Cellular based Protocol (Grid-Quorum Based Protocol and Layered

4.2 Procedure of Dynamic Sensor Relocation Technique based Lightweight Integrated Protocol (DLIP)

After the Network Boots Up, all nodes in the network run the WSN-Security Server to register their IDs for getting Authentication while migrating to another Cell in future for communication

While migrating, Group Manager / Cell Manager will get Authentication from WSN-Security Server for permitting node to enter into any cell

Then these nodes run the Sensor Relocation Scheme as follows.

Call the Publication Phase
Collect the Availability of Redundant Sensor Nodes through Publication Phase Call Subscription Phase
Find the Sensing Hole
Request the Redundant Nodes
Move towards Hole with the help of Group and Cell Managers if condition cdn satisfied Cdn :
Divide the Sensor Nodes into Virtual rings with its Width = μ = Rc / 2.45
Make move if distance between Nodes is $\min\{\sqrt{3}R_S, R_C\}$

Set Node to Fully Active

If Communication Range Level is less than Rc*.4, call Direct Move

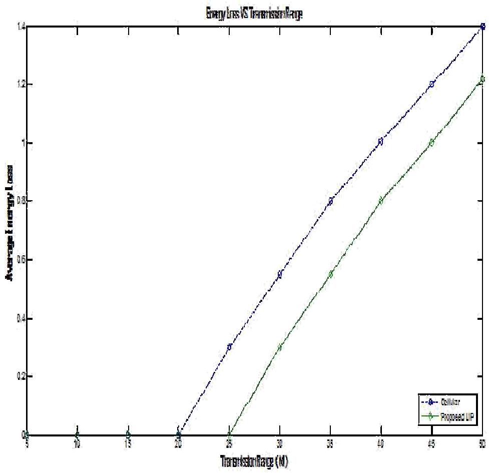
If Communication Range Level is greater than Rc*.4 and less than Rc*.8, Call Cascaded Move
Otherwise Restrict the Move
Change the Node State to Sensing or Sleeping State
If Redundant Nodes Broadcast Message within the Group and its Communication Range is $\{\sqrt{3}R_S\}$, Change State into Sensing
If Sensing Nodes receive same Broadcast Message(Sense) more than one time, then, Change State into Sleeping for period T

Move towards Hole with the help of Group and Cell Managers if condition cdn satisfied

The Dynamic Sensor Relocation Technique based Lightweight Integrated Protocol (DLIP) is executing Nodes as shown in the above Procedure.

From the Fig.1, it is observed that the Throughput of the proposed work is better and almost fair as compared with the existing Sensor Relocation Technique based Cellular Model. The proposed technique achieves higher Fair Throughput because, this system doesn't face any Connectivity Issues while moving from one cell to other. Ie before moving the Sensor, our proposed model examining the Transmission, Coverage and Sensing Range between two Nodes based on their distances.

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



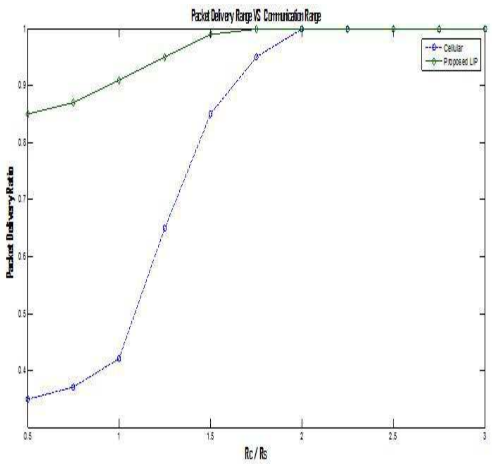


Fig. 1. Throughput(Packet Delivery)

Our proposed model saves considerable energy by restricting sensor movements between Cells. The proposed model permitting the Redundant Node to migrate from one Cell to another Cell to ensure Coverage provided if the system ensures Connectivity and hence the spending energy for migration won't be wasted. The Energy Consumption too is limited as the migrations of Nodes are restricted. Thus the proposed model has maximizing the Lifetime of Sensors and Sensor Networks, which is shown in the Fig.2..

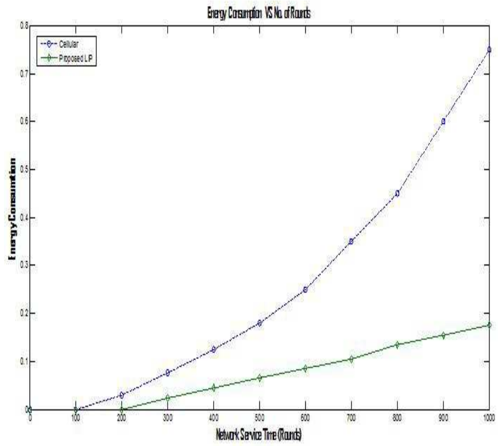


Fig. 2. Energy Consumption

5. CONCLUSION

This research work has studied Sensor Relocation Scheme thoroughly and implemented through QualNet5.0 Simulator. The experimental results established that this Dynamic Sensor Relocation Scheme performing better in term of coverage. It is found that this Scheme is consuming more Energy for Node Migration and it faces Connectivity issue too and it leads to minimize the lifetime of Sensor Networks. Respect to this issue, our research work has proposed an efficient Sensor Relocation Technique based Lightweight Integrated Protocol(DSLIP) and implemented. From our study, it is observed that our proposed work LIP performing better than the existing Sensor Relocation Scheme in terms of Network Connectivity, Coverage, Throughput, Packet Delivery Fairness, Energy Consumption, Energy Loss, Network Resiliency and Secured Communication. It is also noted that our proposed model maximizes the Lifetime of Wireless Sensor Networks.

REFERENCES

[1]Muhammad Asim, Hala Mokhtar, Muhammad Zahid Khan and Madjid Merabti, "A Sensor Relocation Scheme for Wireless Sensor Networks," International Conference on Advanced Information Networking and Applications (AINA-2011), Singapore, 2011.

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

[2]M. Asim, H. Mokhtar, and M. Merabti, "A cellular approach to fault detection and recovery in wireless Sensor Networks," in The Third International Conference on Sensor Technologies and Applications, SENSORCOMM 2009 Greece, 2009.
[3]M. Asim, H. Mokhtar, and M. Merabti, "A Cellular Self- Organization Architecture for Wireless Sensor Networks," in PG NET 2008 Liverpool, 2008.
[4]E. Ekici, Y. Gu, and D. Bozdag, "Mobility-based communication in wireless Sensor Networks," in IEEE Communications Magazine vol. 44, 2006, pp. 56-62.
[5]W. Wang, V. Srinivasan, and K. C. Chua, "Trade-offs Between Mobility and Density for Coverage in Wireless Sensor Networks," in Proceedings of the 13th annual ACM international conference on Mobile computing and networking Canada, 2006.
[6]M. Asim, H. Mokhtar, and M. Merabti, "A cellular approach to fault detection and recovery in wireless Sensor Networks," in The Third International Conference on Sensor Technologies and Applications, SENSORCOMM 2009 Greece, 2009.
[7]M. Z. Khan, M. Madjid, B. Askwith, and F. Bouhafs, "A Fault-Tolerant Network Management Architecture for Wireless Sensor Networks," in PGNet 2010 Liverpool, UK, 2010.
[8]G. Wang, G. Cao, and T. L. Porta, "Proxy-Based Sensor Deployment for Mobile Sensor Networks," in Proceedings of IEEE MASS, 2004, pp. 493-502.
[9]G. Wang, G. Cao, T. L. Porta, and W. Zhang, "Sensor Relocation in Mobile Sensor Networks," in IEEE INFOCOM. vol. 4, 2005, pp. 2305-2312.
[10]Muhammad Akhlaq, Tarek R. Sheltami and Elhadi M. Shakshuki, "An Integrated Protocol for Coverage, Connectivity and Communication (C3) in Wireless Sensor Networks," IEEE 27th International Conference on Advanced Information Networking and Applications, 2013.
[11]Y. Zhou and M. Medidi, "Sleep-based topology control for wakeup scheduling in wireless sensor networks," in Sensor, Mesh and Ad Hoc Communications and Networks, 2007. SECON'07. 4th Annual IEEE Communications Society Conference on, 2007, pp. 304–313.
[12]P. M. Wightman and M. A. Labrador, "A family of simple distributed minimum connected dominating set-based topology construction algorithms," Journal of Network and Computer Applications, 2011.
[13]S. Jauregui-Ortiz, M. Siller, and F. Ramos, "Node localization in WSN using trigonometric figures," in Wireless Sensors and Sensor Networks (WiSNet), 2011 IEEE Topical Conference on, 2011, pp. 65–68.
[14]K. Srinivasan and P. Levis, "RSSI is Under Appreciated," in In Proceedings of the Third Workshop on Embedded Networked Sensors (EmNets), Cambridge, MA, 2006.