Low Redundancy and Energy Efficient New Routing Approach in Wireless Sensor Networks

Ghaihab Hassan

ghaihab.aday@uobasrah.edu.iq

Computer Science Department, College of Computer Science and Information Technology, University of Basrah

ABSTRACT

Wireless sensor networks are quite different from their wired counterpart of networks and are composed of nodes with constrained bandwidth and energy. One of the main limitations of wireless sensor nodes is their inherent limited energy resource, besides maximizing the lifetime of the sensor node, it is preferable to distribute the amount of energy throughout the wireless sensor network in order to minimize maintenance and maximize overall system performance**.** This paper proposed a new approach in WSN routing protocols focus on minimizing end to end latency and energy efficiency as primary design objectives of routing protocols for WSN without the overhead of other design factors.

KEYWORDS

Wireless Sensor Network (WSN), Low Redundancy and Energy Efficient Routing Approach (LREE), Node ID, Sink.

1. Introduction

A Wireless Sensor Network (WSN) is actually composed of a large number of very small in size, low-cost, low-power, multifunctional sensor nodes that are densely deployed either inside the phenomenon or very close to it, and they are capable of communicating freely in short distances nodes with sensing, computation, and wireless communications capabilities[1].

Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue; they can be classified into several routing strategies as shown in the figure below[2].

1. Flat-based Routing: -

One class of routing protocols adopts a flat network architecture in which all nodes are considered peers. Flat network architecture has several advantages, including minimal overhead to maintain the infrastructure and the potential for the discovery of multiple routes between communicating nodes for fault tolerance.

2. Hierarchical-based Routing: -

A second class of routing protocols imposes a structure on the network to achieve energy efficiency, stability, and scalability. In this class of protocols, network nodes are organized in clusters in which a node with higher residual energy, for example, assumes the role of a cluster head. The cluster head is responsible for coordinating activities within the cluster and forwarding information between clusters. Clustering has potential to reduce energy consumption and extend the lifetime of the network.

3. Data Attribute Routing: -

A third class of routing protocols uses a data-centric approach to disseminate interest within the network. The approach uses attribute-based naming, whereby a source node queries an attribute for the phenomenon rather than an individual sensor node. The interest dissemination is achieved by assigning tasks to sensor nodes and expressing queries to relative to specific attributes. Different strategies can be used to communicate interests to the sensor nodes, including broadcasting, attribute-based multicasting, geo-casting, and any casting.

4. Location- based routing: -

A fourth class of routing protocols uses location to address a sensor node. Location- based routing is useful in applications where the position of the node within the geographical coverage of the network is relevant to the query issued by the source node. Such a query may specify a specific area where a phenomenon of interest may occur or the vicinity to a specific point in the network environment.

.

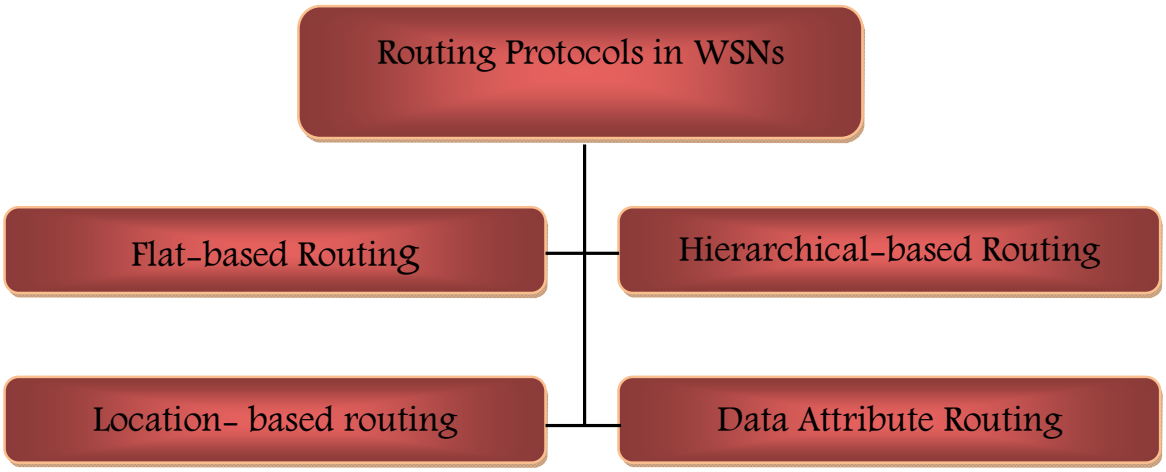

Figure 1: The general classification of WSN routing protocols.

2. Addressing in Wireless Sensor Networks

For communication in the Internet and many other networks the Internet Protocol Suite is most often used. The two most important protocols from this family are the Transmission Control Protocol (TCP) and the Internet Protocol (IP). Those two protocols are commonly referred to as TCP/IP and they are the de-facto standard protocols for Internet communication.

TCP/IP is one reason why the Internet has become a big success story and is nearly ubiquitous today [3]. However, due to the various reasons (TCP/IP) is not mainly used for WSN communication, the most important reason is, due to the relatively large number of sensor nodes, it is not possible to build a global addressing scheme for the deployment of a large number of sensor nodes as the overhead of ID maintenance is high.

Thus, traditional IP-based protocols may not be applied to WSNs. Furthermore, sensor nodes that are deployed in an ad hoc manner need to be self-organizing as the ad hoc deployment of these nodes requires the system to form connections and cope with the resultant nodal distribution, especially as the operation of sensor networks is unattended. In WSNs, sometimes getting the data is more important than knowing the IDs of which nodes sent the data [4].

But on the other hand WSN still need to have a unique identification for each node in the network in the header of every packet. In fact, routing protocols need to, uniquely, identify the final destination of each packet as any node in the network can be a potential destination.

Several routing protocols use attribute-based routing and, therefore, can use attributes as global identifiers [5].

3. Goals and motivation

In wireless sensor networks there are a few basic facts which can be mentioned here:-

- High sending operations means more power spent, leading to node dying [6] and minimize the lifespan of whole network.
- In WSNs is not efficient thing for routing a message along the least cost or shortest path to the Sink [7].
- Same data have been sensed and sent by different packet that are travelling inside the network means redundant data received at the base station [8].

The goal of this research is to develop a routing strategy that is from the flat-based routing category, it is simple and do not rely on costly network topology maintenance and complex route discovery algorithms, also, there is no need here for additional equipments. This paper represents the idea that simplicity is the best solution rather than clustering (as have been thought). This approach will support simplicity in implementation, reliability under the condition of high node failure ratio, resource awareness, and flexibility to fit in various delay and power-consumption constraints.

Low Redundancy and Energy Efficient routing approach (LREE) is a new strategy solve the problem in some previous strategies such as Flooding protocol [9], Gossiping protocol [9,10], Flossiping protocol [11] and Sensor Protocols for Information via Negotiation (SPIN) [12] by using simple and basic ideas. First, limiting the number of packets that each node sends to its neighbor to one copy, by this way we avoid the implosion problem, resource blindness and duplicating the packet at final destination. Second, by using several forwarded options we create a good load balance among the nodes within the network that's mean give maximum lifespan to the network, in other hand, prevent packet from being routed to wrong direction that's leading to prevent high latency. Third, prevent any two nodes from keep passing the same packet back and forth, which cause high delay.

4. Low Redundancy and Energy Efficient Routing Approach

As have been mentioned earlier, high sending operations lead to minimize the lifespan of the network. In this paper we trying as possible as to minimize the operation of sending data packet to saving energy.

The basic idea is that when each node sensing specific event generates a packet and send it randomly to one chosen node depending on a specific system divided all nodes into Even Ids and Odd IDs nodes, when the packet delivered by the neighbor node it resend the packet to any chosen node have an opposite ID and except the node that sent the packet at the beginning. In the case that there are more than one neighbor node in rang, the strategy of choosing appropriate node will be depending on IDs if they odd or even then,

chose one of them randomly. For example the (figure 2) represents some cases for selection.

What should mentioned here, the (LREE) assume there is a single unique Sink while, in the real wireless sensor networks there are more than one Sink distributed in different positions inside the network to insure packets receiving [13]. The idea for one single Sink here is to get the worst circumstances to check the new approach. In (LREE) the Sink will have the largest ID inside the WSN no matter it is odd or even, any node have the Sink in its neighbor table will forward the packet to the Sink as a high priority operation.

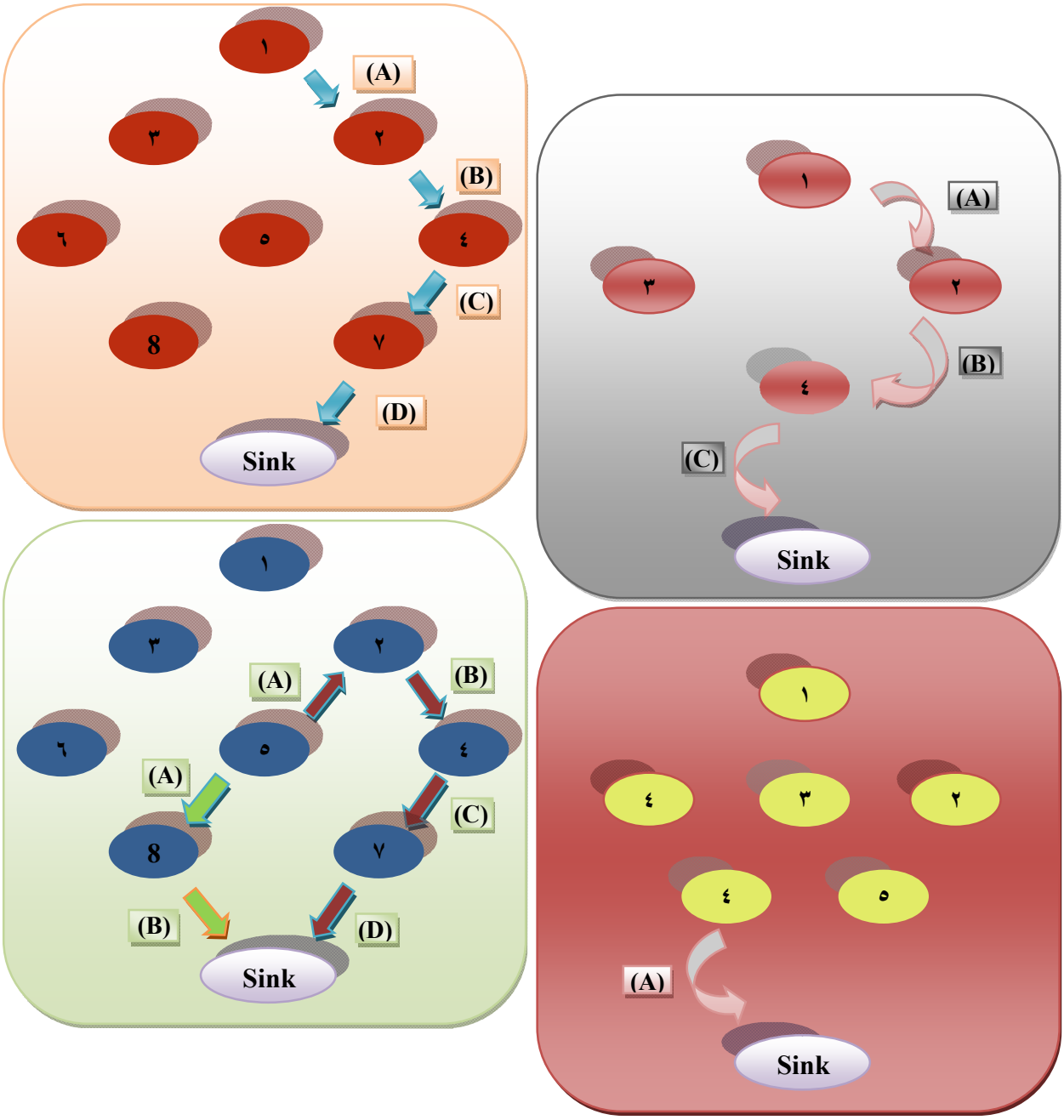

Figure 2: The Decision Selection in LREE.

For simplicity it can be divide nodes into source node and intermediate node, GRP steps in these nodes can be summarized by using Pseudo code :-

LREE Algorithm (behavior): On Source Nod (Generator)

```
\BEGIN
   \IF THE NODE SENSING SPECIFIC EVENT \THEN
      \BEGIN
         BUILD MESSAGE\\
         \IF THE NODE IN THE RANGE OF SINK \THEN
            \BEGIN
               SEND MESSAGE DIRCTLY TO THE SINK\\
            \END
         \ELSEIF THE NODE ID IS ODD NUMBER \THEN
            \BEGIN
               SELECT NODE RANDOMLY FROM NEIGHBORS TABLE (EVEN ID)\\
               SEND MESSAGE TO AN EVEN ID INTERMEDIATE NODE\\
            \END
         \ELSE
            \BEGIN
               SELECT NODE RANDOMLY FROM NEIGHBORS TABLE (ODD ID)\\
               SEND MESSAGE TO AN ODD ID INTERMEDIATE NODE\\
            \END
      \END
\END
```

LREE Algorithm (behavior): On Intermediate Node

```
\BEGIN
   RECEIVING MESSAGE\\
   \IF THE INTEERMEDIATE NODE IN THE RANGE OF SINK \THEN
      \BEGIN
         RESEND MESSAGE DIRCTLY TO THE SINK \\
      \END
   \ELSEIF THE SENDER NODE ID IS ODD NUMBER \THEN
            \BEGIN
               SELECT NODE RANDOMLY FROM NEIGHBORS TABLE (EVEN ID)\\
               RESEND MESSAGE TO AN EVEN ID INTERMEDIATE NODE\\
            \END
   \ELSE
            \BEGIN
               SELECT NODE RANDOMLY FROM NEIGHBORS TABLE (ODD ID)\\
               SEND MESSAGE TO AN ODD ID INTERMEDIATE NODE\\
            \END
   \END
\END
```

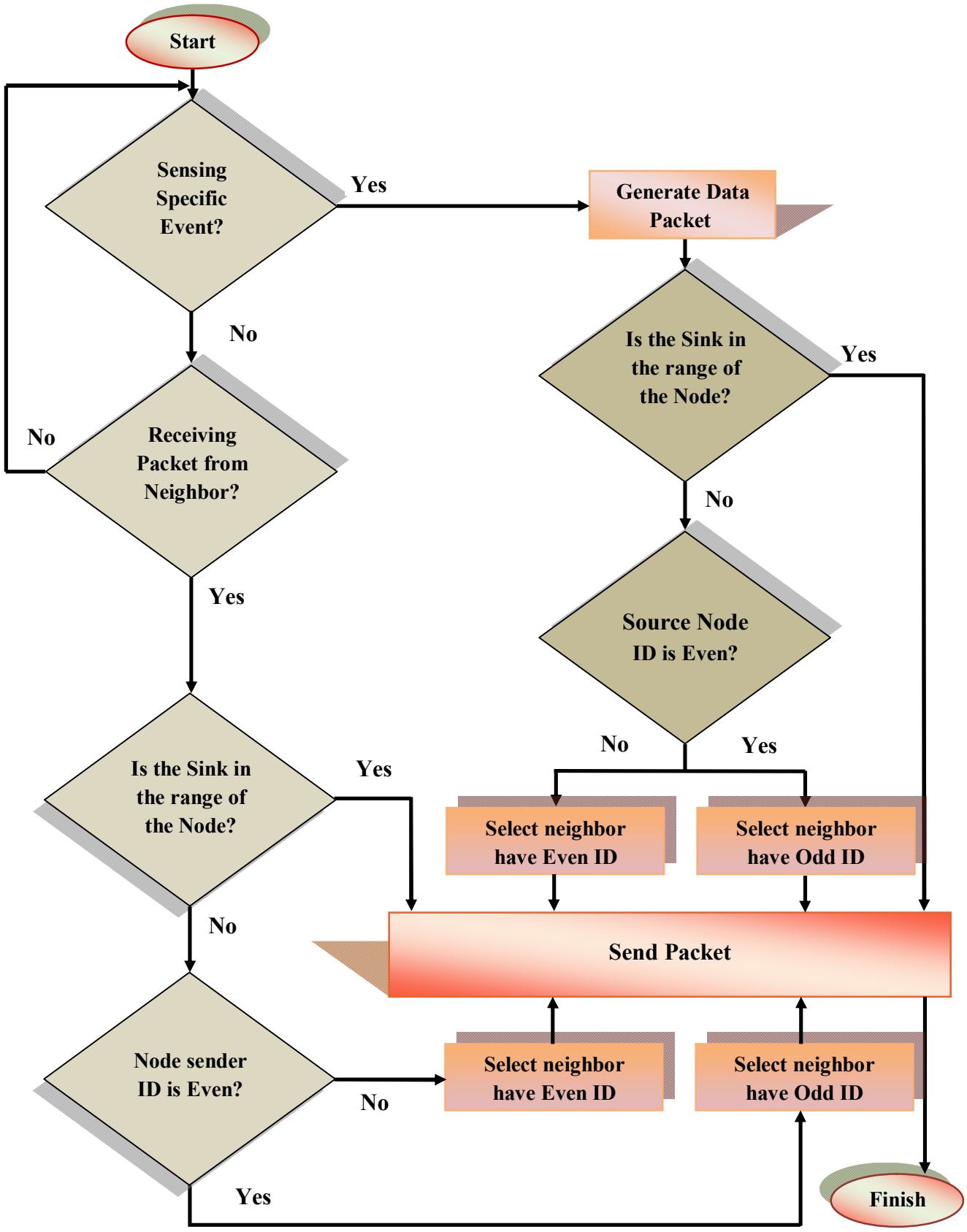

Figure 3: The general activities of any node in LREE.

5. Simulation

For the simulation of our scheme, we choose an object-oriented modular discrete event network simulator OMNeT++ 3.2. This simulator can be used for traffic modeling of telecommunication networks and protocol modeling [14]. Using the simulator we built three different topologies with different number of nodes (8, 15 and 24 sensors). Each grid have been built, we make it used the Flooding protocol, then Gossiping and LREE approaches with several runs (twenty runs with Gossiping and LREE, each run has different seed to generate random number depending on Twister method to generate a random number generation).

Average hop count and arrival time for the packet give us indications about the amount of delay or latency for delivering a packet within three approaches. The average of sending message for whole network will be used to measure and compare the lifespan of our approach (LREE) with two old strategies.

Flooding as a propagation and dissemination protocol is the faster strategy but it kills the power in all sensors in a short time. Gossiping has a worst time in packet delivering because it depends absolutely on the random Decision to pick up next node. As shown from the simulation results, Low Redundancy and Energy Efficient Routing Approach has the best average sending pack which means a high lifespan for the hole network, because we minimize the choices in random selection depending on divided the nodes IDs into even and odd IDS. Also LREE has good hop count and arrival time.

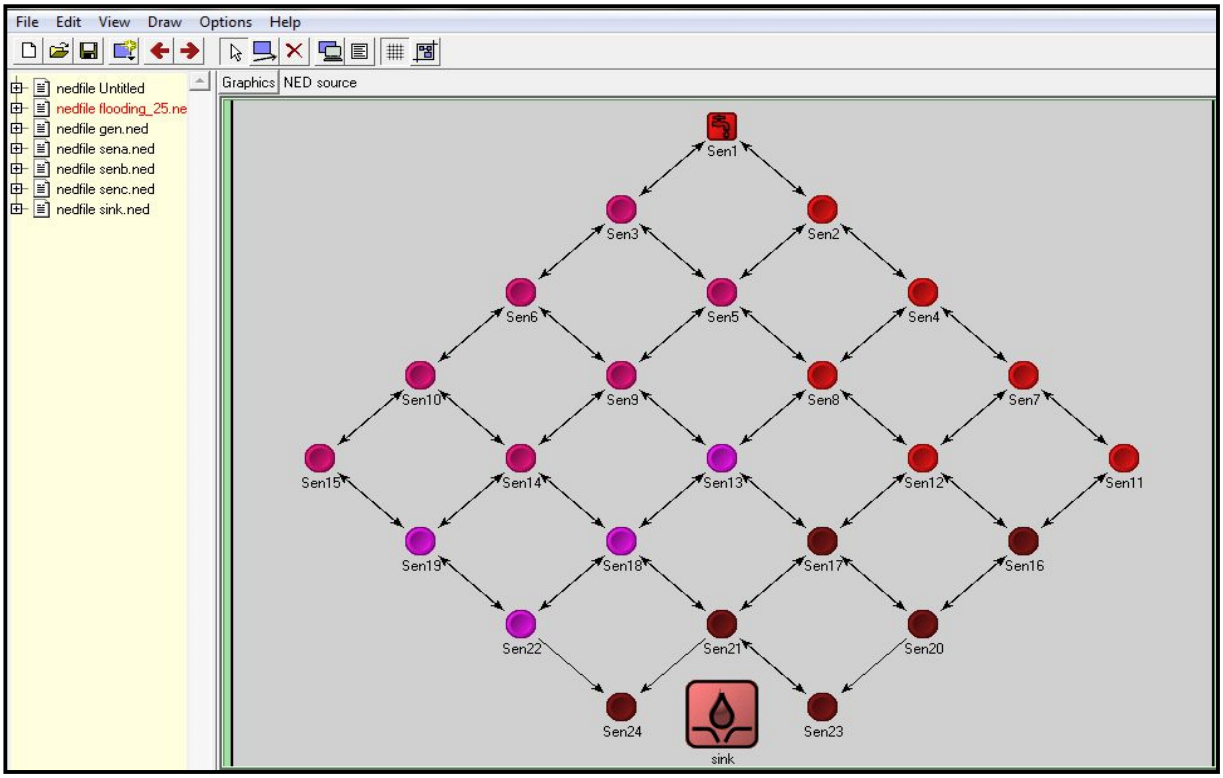

Figure 4: Structured Grid with 24 Sensors and Single Sink in Omnet Simulator.

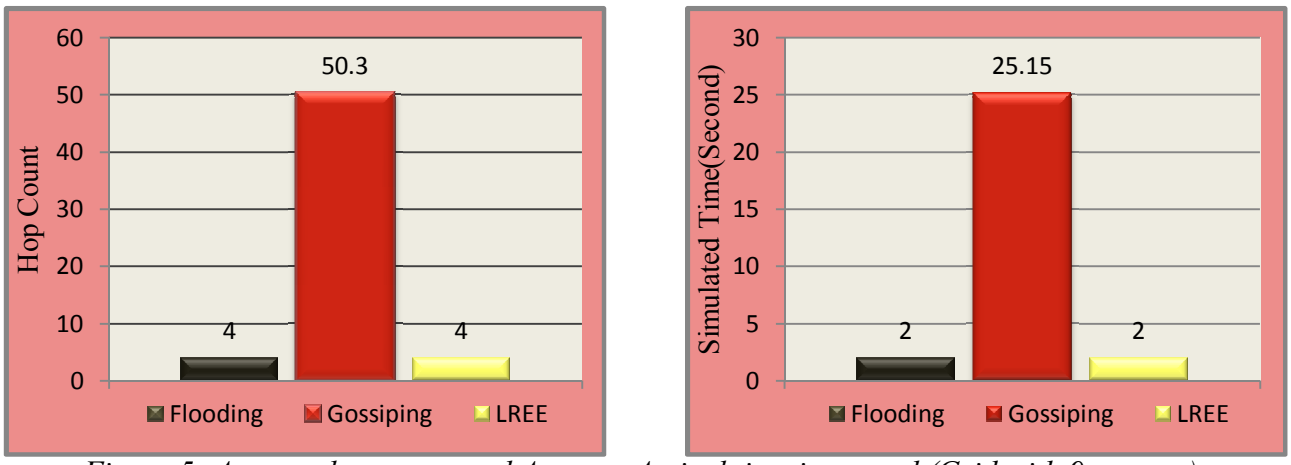

Figure 5: Average hop count and Average Arrival time in second (Grid with 9 sensors).

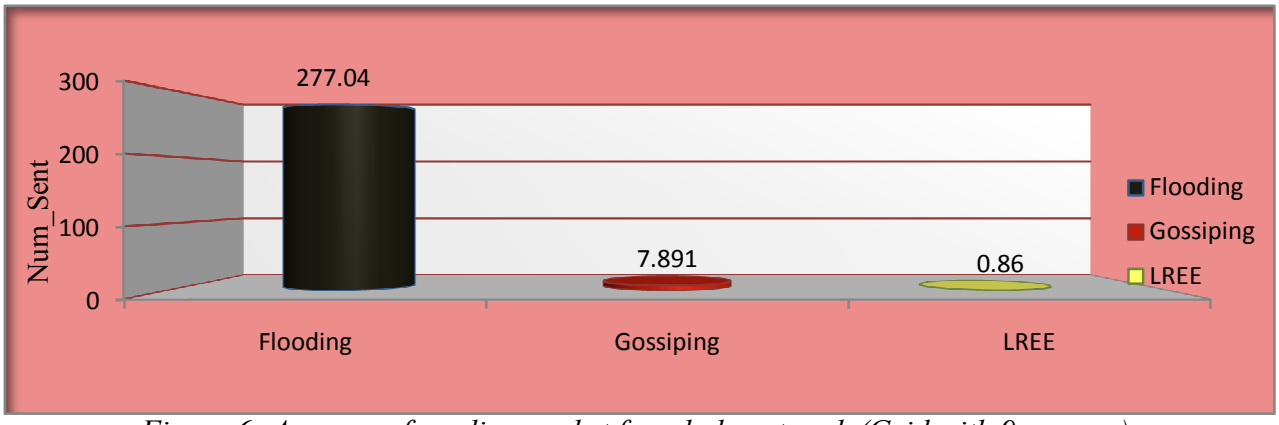

Figure 6: Average of sending packet for whole network (Grid with 9 sensors).

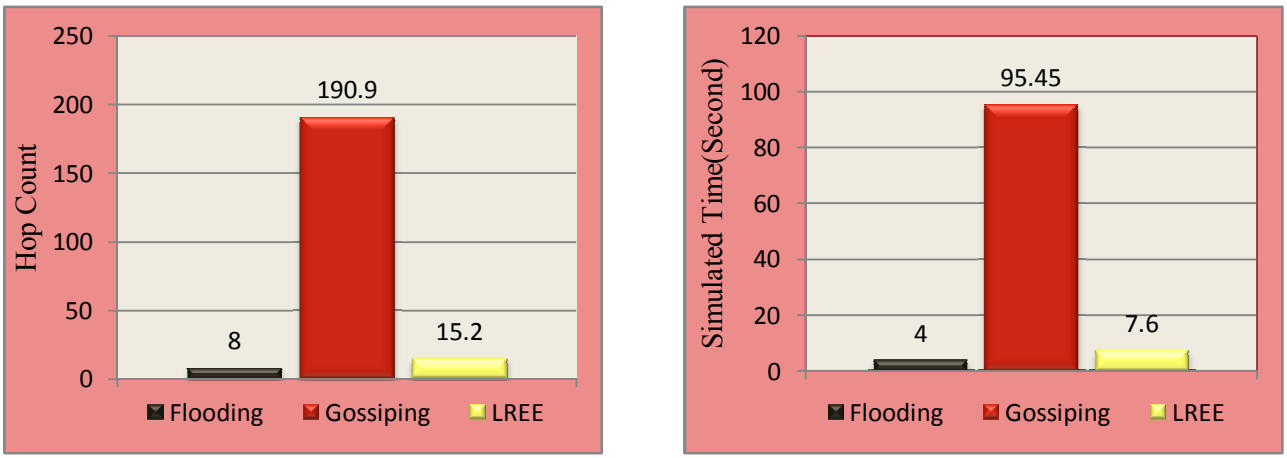

Figure 7: Average hop count and Average Arrival time in second (Grid with 16 sensors).

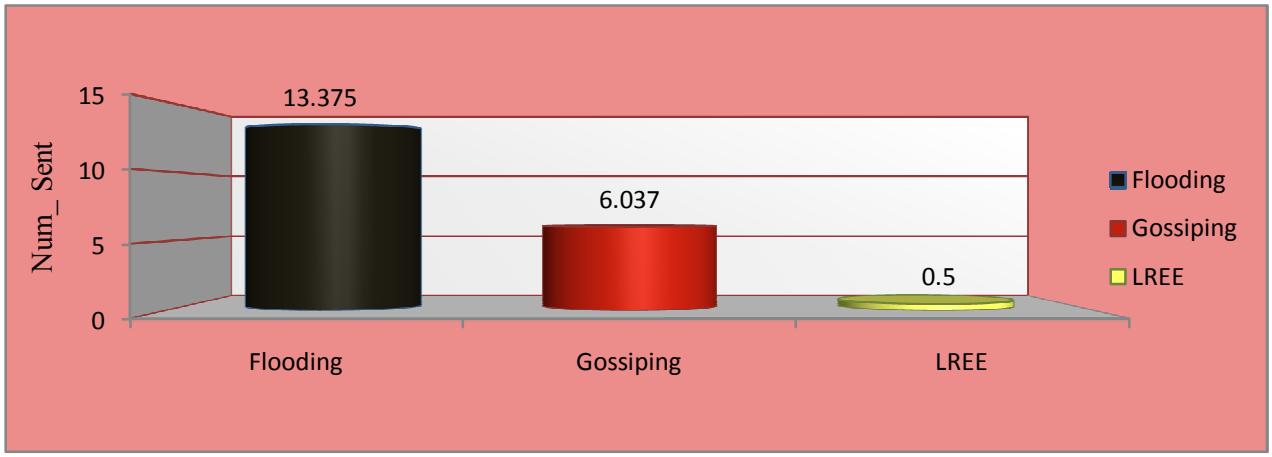

Figure ٨: Average of sending packet for whole network (Grid with 16 sensors).

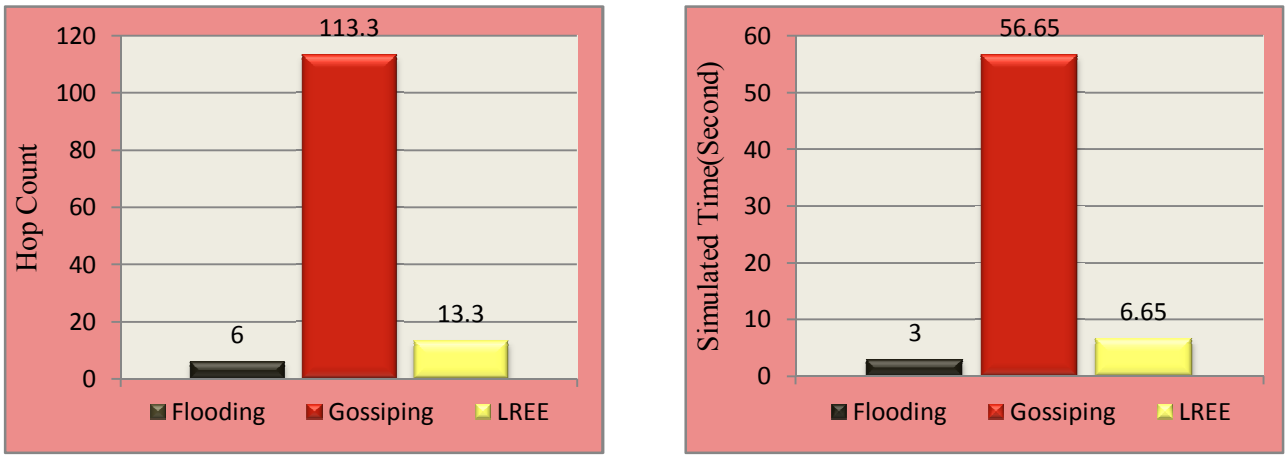

Figure 9: Average hop count and Average Arrival time in second (Grid with 25 sensors).

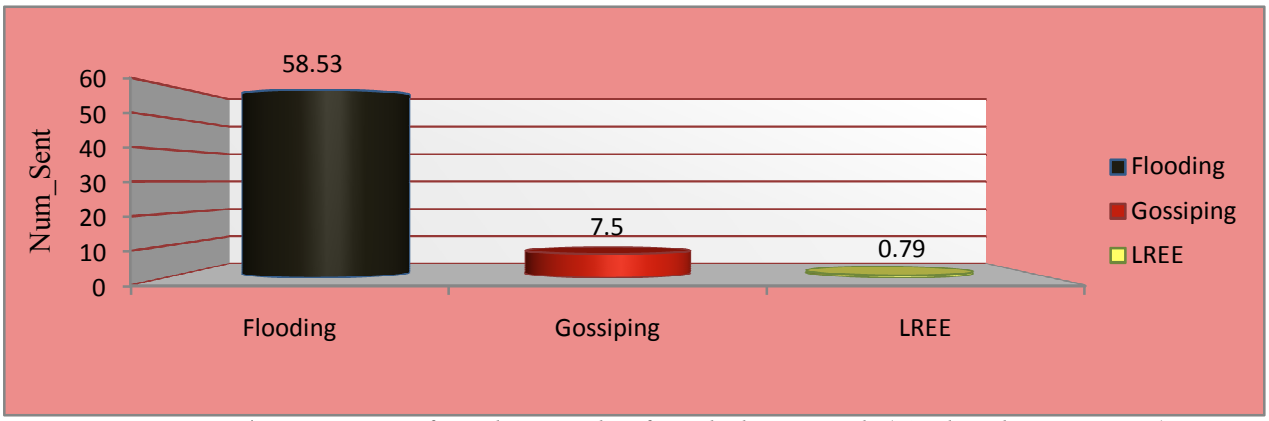

Figure ١٠: Average of sending packet for whole network (Grid with 25 sensors)

6. Conclusions

Clustering protocols in last few years has potential to reduce energy consumption and extend the lifetime of the network. But in the same time, it has a huge overhead. LREE is a strategy can be listed under Flat approaches; it is simple and very quick in deliver the packet to the Base Station. Depending on a simple system within WSN that giving all nodes an even and odd IDs with a simple random selection we get a high performance strategy. LREE take an advantage over Flooding, Gossiping and Floosping, it provide a sweet way to load balancing in power consumption among the nodes with minimum number of sending operation.

The observation that should be mentioned here is that, as far as the number of nodes in WSN becomes larger, LREE give a high performance. On the other hand, LREE is work only with structured Topology (Mesh) that means each sensor node has a predetermined place and knows its neighbors. It is suitable for the monitoring applications in a civil environment.

References

[1] Arabinda Nanda, Amiya Kumar Rath, and Saroj Kumar Rout. (2010). Node Sensing & Dynamic Discovering Routes for Wireless Sensor Networks. IJCSIS) International Journal of Computer Science and Information Security, Vol. 7, No. 3.

[2] Kazem Sohraby, Daniel Minoli and Taieb Znati. (2007).Wireless Sensor Networks: Technology, Protocols, and Applications. Published by John Wiley & Sons, New Jersey, USA.366 pp.

[3] Oliver Gasser(2011). TCP/IP communication in a WSN. Network Architectures and Services.75_81.

[4] Prashant J Bagga and Prof. Nagendra P Gajjar. (2012). Requirements of Routing Algorithms for Sensor Networks . Journal of Emerging Trends in Computing and Information Sciences, VOL. 3, NO. 4, 660_701.

[5] El-Moustapha Ould-Ahmed-Vall. (2007). Algorithms For Self-Organizing Wireless Sensor Networks. PH.D. Dissertation in Electrical and Computer Engineering, Georgia Institute of Technology, USA, page: 10,188 pp.

[6] Shivashankar, Suresh H.N and Varaprasad Golla.(2013). Designing Energy Routing Protocol with Power Consumption Optimization in MANET. IEEE Transactions on Emerging Topics in Computing.

[7] Shaohua Wan.(2014). Energy-Efficient Adaptive Routing and Context-Aware Lifetime Maximization in Wireless Sensor Networks. International Journal of Distributed Sensor Networks, Volume (2014).

[8] Prof. Mrs. Urmila A. Patil, Smita V. Modi and Suma B. J.(2013). Performance analysis of MAC based Flooding Protocol for Wireless Sensor Networks.International Journal of Engineering Research & Technology (IJERT), Vol. 2 Issue 8.

[9] W. Heinzelman, J. Kulik and H. Balakrishnan.(1999). Adaptive Protocols for Information Dissemination in Wireless Sensor Networks. 5th ACM/IEEE International Conference on Mobile and Networking, Seattle, USA.

[10] Kemal Akkaya and Mohamed Younis. (2005). A Survey on Routing Protocols For Wireless Sensor Networks .Ad Hoc Networks, Volume: 3, Issue: 3.

[11] Yuecheng Zhang and Liaug Cheng. (2004). Flossiping: A New Routing Protocol for Wireless Sensor Networks. International Conference on Networking, Sensing Control Taipei, Taiwan, Proceedings of the IEEE, 1218 pp.

[12] A. H. Azni, Madihah Mohd Saudi, Azreen Azman, and Ariff Syah Johari.(2009). Performance Analysis of Routing Protocol for WSN Using Data Centric Approach. World Academy of Science, Engineering and Technology.

[13] L. Friedmann and L. Boukhatem.(2007). Efficient Multi-sink Relocation in Wireless Sensor Networks. Networking and services. ICNS, Third International Conference.

[14] A. Varga. (2005). OMNeT++, Discrete Event Simulation System. Version 3.2 user manual, http://www.omnetpp.org .

طريقة جديدة لتقليل التكرار وكفاءة في مصروف الطاقة في بروتوكولات التوجيه في شبكات الاستشعار اللاسلكية

غيهب حسن

قسم علوم الحاسوب _ كلية علوم الحاسوب و تكنولوجيا المعلومات _ جامعة البصرة

الخلاصـــــة

شبكات الاستشعار اللاسكلية تختلف تماما عن بقية انواع الشبكات حيث تتالف من مجموعة من العقد تكون عليها قيود في مفهوم الطاقة وعرض النطاق. احدى اهم التحديات الموجودة في شبكات الاستشعار اللاسلكية هي مصدر الطاقة المحدود بالاضافة الى الطموح لزيادة عمر الشبكة لابعد حد ممكن لذلك من المفضل دائما ان يتم توزيع مستويات الطاقة عبر عقد الشبكة لتقليل الصيانة لعقد الشبكة وزيادة اداء الشبكة عموما. هذا البحث يقدم استراتيجية جديدة في بروتوكولات توجيه البيانات تركز على الية لتقليل التاخير في تسليم البيانات وتوفر كفاءة في توزيع الطاقة وتوفيرها من دون ان يكون هناك تاخير اضافي او تعطيل.