International Journal of Computer Networking,
Wireless and Mobile Communications (IJCNWMC)
ISSN(P): 2250-1568; ISSN(E): 2278-9448
Vol. 5, Issue 1, Feb 2015, 19-26
TJPRC Pvt. Ltd.

SEEHR: SECURE AND ENERGY EFFICIENT HIERARCHICAL ROUTING IN WIRELESS SENSOR NETWORKS

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ABSTRACT

Energy limited characteristic like energy consumption and energy efficiency are the main issues between sensor nodes of the wireless sensor networks. To increase the lifetime of the whole WSN and make network energy efficient a proper routing protocol may research. Hierarchical Cluster-Based approach is being used for continuous monitoring. Non-Centralized hierarchical routing select Cluster Head CH on the basis of random number not consider the residual energy. Centralized Hierarchical routing used the Base Station for the selection of the cluster head CH for cluster-based hierarchical routing protocol. Proposed work is design an energy efficient routing protocol which is hierarchical in nature ana also compare it with the respective hierarchical based protocols.

KEYWORDS: Secure WSN, WSN, Energy Efficient WSAN, Cluster Head, Hierarchical Routing Protocols

INTRODUCTION

Wireless sensor networks is a collection of small compact device or sensor nodes that communicate wirelessly. Network structure routing in wireless sensor network can be flat-based, location-based and hierarchical cluster-based routing. A large number of these sensor nodes collaborates to form a wireless sensor network.For information sharing and for cooperative processing such sensor nodes communicates through wireless channels. To increase the efficiency and ensure the scalability of the network operations, these sensor nodes are grouped into clusters. These wireless nodes may be mobile or stationary and may be located randomaly on a dynamic changing environment. The routing selection strategies is an important issue for the efficient delivery of sensor data packet to its destination. In the wireless sensor network the respective nodes may collect the respective information or data from its surrounding nodes or send it to the base station, sensor node to sensor node that called multi hop,or may be directly to the base station called single hop. These low rate sensor nodes has resulted to the development of many potential application area like to monitor large or hostile field, industries, forests etc. In many large scale application area sensor network operates for long period of time, and the energy consumption for these sensor nodes as a whole network is the main issue. Secure energy efficient is a common concern for any network system, but in wireless sensor networks this energy efficiency is of great importance to ensure its application success. Energy Efficiency is the ability of the network to operate at extremely low power levels. Sensor network also used in many potential applications like traffic monitoring, industrial automation, robot control etc.

SECURE HIERARCHICAL ROUTING IN WSN

The major design attribute of the sensor network is scalability. In hierarchical cluster-based routing,each cluster is managed by a set of associates and an energy efficient clusters that are retained for a longer period of time. In Hierarchical cluster-based routing many algorithms ana approaches may used by the base station BS for determine the cluster

formation. For randomly deployed sensor node in hierarchical cluster-based used to generates the energy-efficient clusters.

- **Proactive Network Protocols:** Efficiently maintain the energy consumption of sensor nodes is the main aim of Hierarchical routing by involving these sensor nodes in multi-hop communication within a particular cluster of nodes.The formation of cluster is typically based on the energy reserve of sensors to the cluster head.
- **Reactive Network Protocols:** Hierarchical routing protocols in WSN which groups the sensor nodes into clusters with each cluster led by the cluster head CH. The sensor nodes with the cluster reports the sensed data to the respective cluster head CH.

In Hierarchical Cluster WSN's, sensor node to node direct communication not possible due to the distance and obstracles between the Base Station BS and the respective Cluster Head CH.So, to overcome this multihop data communication is being used. The protocols like SET-IBS and SET-IBOOS that are hierarchical clustering protocols used the multihop routing algorithms, to secure the transmission of data and make it energy efficient.

HIERARCHICAL WIRELESS SENSOR PROTOCOLS

- **Low-Rate Adaptive Clustering Hierarchy Centralized (LEACH-C)**

This LEACH-C protocol is the enhancement over LEACH protocol.For the cluster formation this protocol mainly utilizes the Base Station i.e the centralized clustering algorithm. LEACH-C used the cluster heads formation technique for data transmission and produce the better performance throughout the wireless sensor network.In the set-up phase each node send the information about the residual energy and its location to the sink of network or the respective cluster. To produce better clustering, the sink node ensure that the energy load is evenly distributed among all the nodes of clustered network. For this the sink calculate the average node energy, and check which node have energy below this average energy. A cluster head ID for each node is obtained by broadcasts a message from the sink after checking the cluster head and the cluster. If node ID is matched with the cluster head ID, this node become the cluster head, otherwise the node determines its TDMA slot for data transmission and goes to sleep mode until its time to send data. Other phase i.e steady-state phase is identical to the LEACH protocol. Centralized LEACH has better performance because here, the base station utilizes the global knowledge of the network to produce better clustering and also require lesss energy for the transmission of the data. In LEACH-C the number of cluster head in each round is determined by the optimal value.

- **IBS Scheme for Clustered Wireless Sensor Networks (IBS CWSNs)**

This IBS Clustered Based WSNs method mainly consist of four respective processes:

- **Setup at BS:** *msk* master key and a public parameter *param* created by the BS to generate the (PKG) private key generator, that may checked by all the sensor nodes of network.
- **Extraction of Key:** Given an ID string,with that ID a private Key sekID generated by the sensor node by means of master key parameter *msk.*
- **Signature Signing:** Message M, a time stamp t and signing key θ, a signature SIG created by the sending node.
- **Verification at Receiving Nodes:** With the given SIG, ID and the message M, an *Accept* message being received with the valid SIG, otherwise output *Reject* message.

- **IBOOS Scheme for Clustered Wireless Sensor Networks (IBOOS CWSNs)**

  This IBOOS Clusterded Based WSNs mainly consists of four operations or processes:

  - **Setup at BS:** *msk* master key and a public parameter *param* created by the BS to generate the (PKG) private key generator,that may checked by all the sensor nodes of network
  - **Extraction:** (Same As IBS) Given an ID string, with that ID a private Key sekID generated by the sensor node by means of master key parameter *msk.*
  - **Offline Signing at CHs:** With given time stamp t and public parameter,the respective Cluster Head CH generate an Offline Signature SIGoffline,and send it to the respective leaf of that Cluster Head.
  - **Online Signing at CHs:** Online signing of the data sending nodes –From SIG offline, message M and Private Key SekID, a leaf node create an online signature SIGonline.

RELATED WORK

In [1], presents the energy efficient hierarchical routing mechanism for the sensor network. Aim is to better understanding the current energy efficient hierarchical routing protocols, for the respective wireless sensor network. Lifetime of the routing protocol is extended by keeping the sensors alive to maximum time. Reduce the energy consumption while transmitted the data.Check the perfomance of LEACH protocol with respect to the sensor network in terms of security of energy efficiency. Compare their performance with other hierarchical routing protocols in WSN. Check the hierarchical cluster-based routing in both the model that is reactive and proactive model of CWSN. Other hierarchical routing protocols like PIEGASIS, TEEN, APTEEN also compared with each other in terms of data flow and energy consumption rate.

In [2], the author present the three different routing protocols in WSN:LEACH, PEGASIS and VGA. These sensor networks are then simulated by using the Sensoria simulator. The simulation mainly analyze the performance of these protocols on the basis of power consumption and the network performance. Using same limited sensing range value,the simulations results show that PEGASIS over perform all other routing protocols,the LEACH has better than the VGA.The paper mainly investigate the power consumption of all the respective protocols.VGA totally depend on the sensing range during power consumption. The simulator results shows that the PEGASIS greatly prolong sensor network lifetime while farther the transmission range, these early death of nodes may reduce the network coverage badly.

In [3], presented a survey that mainly focused on the energy consumption based on hardware components of the wireless sensor nodes. In these survey the sensor nodes divides into four main components: a sensor based subsystem that includes one or more sensors for data acquisition, a radio subsystem for wireless data communication, a processing sensor subsystem that include a memory for local data transmission and a micro-controller and a power supply unit. Power breakdown and the architecture of these network are the main directions to energy conservation in WSNs. The main focused of the paper is to description of the advantages and characteristics of the taxonomy of energy conservation schemes. The authors basically focus on energy-efficient protocols and also discuss the weaknesses and strengths of each protocol.

In [4], the authors represent a secure data transmission for the cluster-based WSNs, these clusters formed dynamically or may periodically. The paper represent two secure and efficient data transmission protocols(SET), called

SET-IBS and SET-IBOOS by using the technique of identity-based digital signature IBS and identity-based online/offline digital signature IBOOS respectively. SET-IBS check the network security on the basis of the Diffie-Hellman problem in a pairing domain of network. Furthur, SET-IBOOS reduce the computational overhead for security purpose, its security relies on the discrete logarithm problem. Author mainly concern feasibility of the SET-IBOOS and SET-IBS with respect the security against various attacks. The results show that the proposed protocols better performance than existing secure protocols of CWSNs, with respect to energy consumption and security overhead.

In [5], wireless Multimedia Sensor Networks (WMSNs) energy efficient routing technique are present in this paper.The main outline of the paper is to design routing protocols for WMSNs followed by the limitations of current techniques designed for non-multimedia data transmission. The classification of recent routing protocols for WMSNs is presented in this paper.

In [6], represented the issues of WSNs and classification of routing protocols are presented.Moreover, a few routing protocols are presented based on the characteristics and the mechanisms use in order to increase the lifetime of the network without providing any details on each of the described routing protocols.

In [7], proposed a secure and efficient framework for the multicast and broadcast the sensor nodes in WSN

also for the outsider user authentication, which check identity-Based cryptography with online/offline signature scheme IBOOS. This scenario also broadcast that the authenticated message verify the sender, receiver and content of that message. Proposed work also evaluates the efficient and secures identity-based signaturing.Control user privileges provide new IBOOS scheme for proper authentication in message broadcasting.

In [8], have been proposed a protocol, called Power Efficient Gathering in Sensor Information Systems (PEGASIS), which was focused over LEACH protocol. This protocol is a near optimal chain-based protocol. In PEGASIS each sensor node forms a pattern so that each node will receive from and transmit to a close neighbor. Each node takes turn being the leader for transmission to the base station so that the average energy spent by each node per round is reduced. PEGASIS out does LEACH'S performance following parameters (1) checked the over head of dynamic cluster formation, (2) decreasing the distance non leader-nodes must transmit, (3) reducing the number of transmissions among all nodes, and (4) using only one transmission to the base station per round. Principal goals in the operation PEGASIS are (a) augment the lifetime of each sensor node by using collaborative techniques (b) reducing the bandwidth of the communication by allow the local coordination among neighboring sensor nodes.

ALGORITHM

- Initially, base station is set up at the center of region and nodes are setup in that particular region and each node will have equal and same energy.

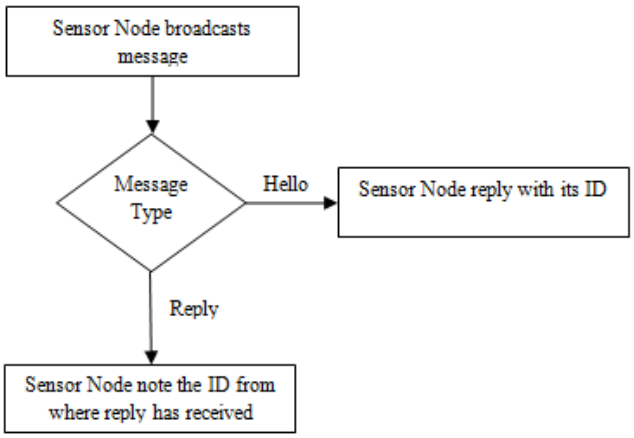

Figure 1: Node Collect Information About Their Neighbor

- In round 1, Cluster Head will be created according to probability condition.

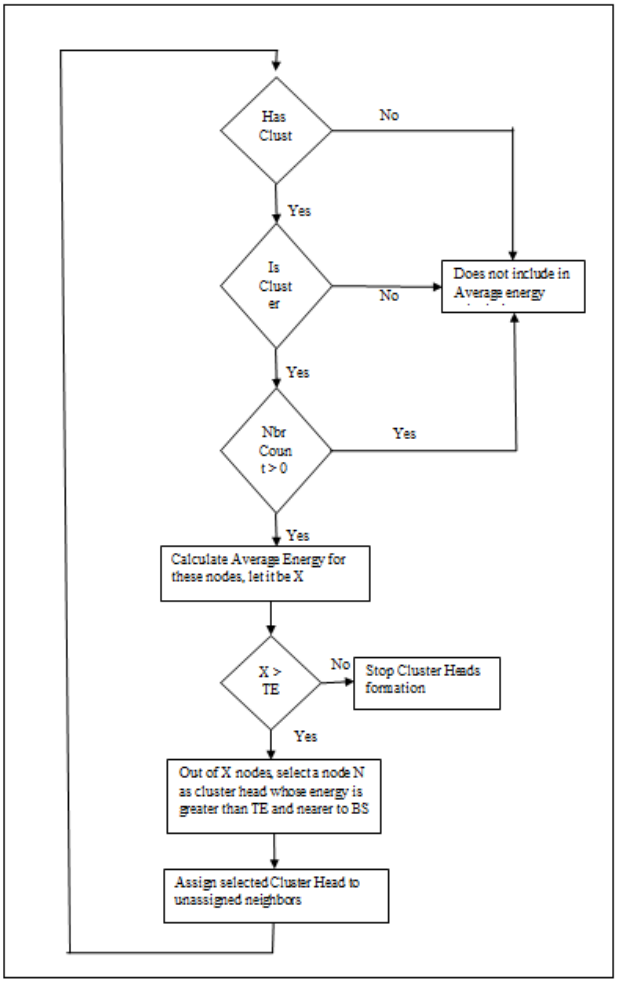

Figure 2

- The decision made by each node to become the cluster head of that respective cluster is based on the suggested percentage *p* of the cluster head node. Each sensor nodes of that cluster of nodes chooses *r* as a random number, between 0 and 1. Now during the comparision, if this random number value is less than that of threshold value,

T (n), then that node becomes a cluster-head for the current round of network. This threshold value is calculated on the basis of an equation that clearlly incorporates the desired percentage of node to become a cluster-head in that current round, and the rest set or number of nodes in the particular area that have not been selected for cluster-head in the last $\left(\frac{1}{p}\right)$ rounds of network, denoted by G.

$T(n)$ is given by:

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left(r \bmod \dfrac{1}{p}\right)} & if\ n \in G \\ 0 & otherwise \end{cases}$$

Now, the modified formula for choosing cluster head CH:

$$T(n) = \frac{p}{1 - p \times \left(r \bmod \left[\frac{1}{p}\right]\right)} \cdot \frac{E_{cur}(n)}{E_{init(n)}} \forall_n \in G_n$$

$$\mathrm{T}(n) = 0 \qquad \forall_n \ni G_n$$

Where, E_{cur} is current energy of a particular node and,

E_{init} Initial energy of a particular node.

- Then, Nodes sends the data to their respective cluster heads and energy consumption will be calculated.
- Cluster Head will aggregate the data and send it to the base station and energy consumption will be calculated for each node and cluster heads.
- In round 2, the nodes will become cluster heads according to probability condition i.e. according to minimum distance from base station and threshold energy.
- After selection of cluster heads, Nodes sends the data to their respective cluster heads, that will be selected according to the minimum distance of a particular node from cluster heads and energy consumption will be calculated.
- Cluster Head will aggregate the data and send it to the base station and energy consumption will be calculated.
- This process will be repeated until the whole network gets down or number of rounds finished.
- Performance will be evaluated according to parameters like network lifetime, energy dissipation, no. of data packets sent etc.

IMPLEMENTATION AND RESULT

Parameter Used

Table 1

Network Field	100×100m
N (Number of nodes)	100
Initial energy	1 J
E_{elec} $(E.Dissipation$ for $ET_x \& ER_x)$	50 nJ/bit

Table 1	
εfs (free space)	10 pJ/bit/m^2
εmp (Multipath fading)	0.0013 PJ/bit/m^2
EDA (Energy Aggregation Data)	5 nJ/bit/signal
Esig	77.4 µJ/signature
Eoff	5 µJ/signature
Eon	12.37 µJ/signature
Data Packet Size	4000 bits
Tool used for implementation	MATLAB 7.6.0

RESULTS AND SIMULATIONS

The simulations results shows the comparision between the hierarchical cluster-based protocols with different measurements. As a result, we conclude that our research protocol that is SEEHR shows the best results with all respective scenarious.

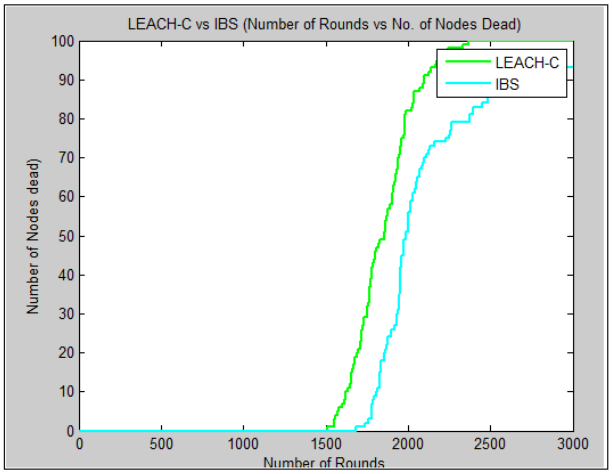

Figure 3: Number of Nodes Dead Vs Number of Rounds (LEACH-C AND IBS)

Figure 3, Shows the simulator result of comparative analysis between the two respective Hierarchical Cluster –Based WSNs i.e the Centralized-Low Rate Adaptive Clustered Hierarchy (LEACH-C) and Secure and Efficient Data Transmission IBS protocol(SET-IBS). This show that, IBS secure protocol produce the better result as compare with the LEACH.

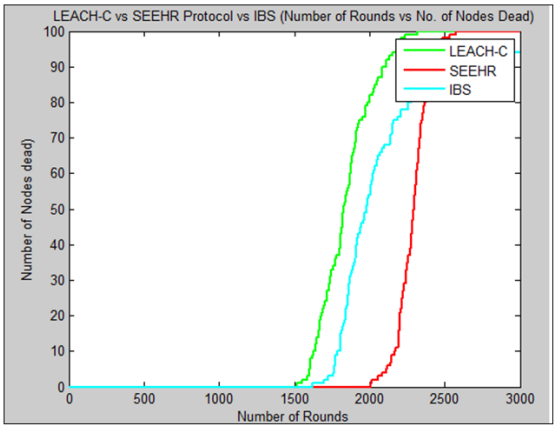

Figure 4: Number of Rounds Vs Number of Nodes Dead (LEACH-C, SEEHR, IBS)

In Figure 4, simulator result graph shows that the SEEHR protocol is produce the best result as we compare with the two respective hierarchical clustered protocols i. e the Basis LEACH-C and SET-IBS protocol, in terms of the number of rounds and the number of nodes dead in that respective round.

CONCLUSIONS

The proposed research protocol Secure and Energy Efficient Hierarchical Routing SEEHR Protocol that is Hierarchical Cluster-Based Routing, whose whole control is totally on the base station BS, it is basically base assistant protocol. Non-Centralized Hierarchical routing in WSNs is totally self-configure for the formation of cluster head CH. But in this configration of hierarchical routing the related sensor nodes are totally unaware about the logical structure of the network WSN. SEEHR is a base oriented protocol so its concern about logical structure of the network and also concern the residual energy of each node in that cluster of round. By comparing the related protocol we conclude that the SEEHR protol provide the better or best result in terms of network lifetime and with all other scenarious.

In Future scope, we may produce an Extended SEEHR a secure protocol by applying the respective genetic algorithms and relates the position of nodes and base station in that particular protocols.

ACKNOWLEDGEMENTS

The authors would like to thanks the anonymous reviewers for the respected comments and the suggestions.also like to thanks the associates editors.

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