SECURE ENERGY EFFICIENT COMMUNICATION IN CLUSTERING FOR WIRELESS SENSOR NETWORKS

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Abstract- Wireless sensor network consist of large number of nodes and each node has limited energy resource, and thus the lifetime of the network is one of the most critical issues. Energy saving is the crucial issue. Clustering sensors into groups, so that sensors communicate only through cluster heads and then the aggregated information is sent to the base station, which saves energy. The paper gives an energy efficient randomized clustering schema in which energy, packet delivery ratio, throughput and delay is evaluated for the various clustering protocols. Security factor has been proposed for a secure energy efficient communication in WSN. This paper emphasis is given on optimizing the energy of the network and increasing the lifespan of network.

Keywords- Wireless Sensor Network (WSN), Cluster Head (CH), Low-Energy Adaptive clustering Hierarchy (LEACH), Energy-Driven Adaptive Clustering Hierarchy (EDACH), Base Station(BS), Wireless Sensor Network Trusted System (WSNTS), Energy Efficient Secure Clustering Hierarchy (EESCH).

I. INTRODUCTION

Wireless sensor networks have been evolving it is been used widely used in military and social applications for various purpose target tracking, surveillance, and security management. There are hundreds and thousands of low-cost, low power, multifunctional small sensor nodes. The sensor nodes are lightweight and small. They have limited energy. Therefore energy consumption is a very critical issue. The sensor node in a network is deployed to perform a given task.WSN is used as an integral part of communication. Intelligence, surveillance, targeting system, military, etc.[2]

WSN is consisting of a large number of sensor nodes and a base station. The base station processes and stores the information it receives from the sensor nodes [1]. The sensor nodes are usually deployed randomly in the region of interest. A sensor node, contains a limited energy, processing capability and memory, collaborates with other sensor nodes, queries the physical environment, collects the received data and transmits the information to the BS. The sensor node has capabilities for monitoring and control; the network can provide a fine global picture of the target area through the integrating the information collected from many nodes and transmitting the data in the network [5]. Since sensor nodes has a limited power supply which cannot be recharged or replaced, hence operation of sensor nodes needs to be energy efficient. The lifespan of the entire network is affect by d limited energy of the sensor nodes, so it is crucial to have an energy efficient network. To resolve the issue various protocols and algorithm have been developed in WSN [1].

Cluster-based routing technique is effective for prolonging the lifespan of WSN [10]. A cluster consists of collection of sensor nodes and each cluster has cluster-head and other sensors are nodes. The cluster-heads can form another hierarchy among them. The clustering approach allows a WSN of high scalability and less consumed energy. Hence clustering increases lifetime for the whole network. This is due to the fact that most of the sensing, data processing and communication activities are performed within the clusters. The energy consumption at a cluster head is maximum and greater than that at other nodes as the CH is responsible for transmitting all the aggregated information to the sink node. This problem can be relieved by rotating the role of cluster-head among all nodes.

The protocol called low-energy adaptive clustering hierarchy (LEACH) [7] is a cluster-based protocol proposed to solve the energy consumption problem. The energy consumption is equally distributed in network among the sensor nodes which in turn increases the lifespan of the network. In LEACH, however, a cluster-head can cause a failure because of energy deficiency. The energy-driven adaptive clustering hierarchy (EDACH) approach is another protocol in which it puts more number of cluster-heads in the region relatively away from the BS. The number of member nodes in their clusters will be smaller than that of other clusters. This compensates the larger energy consumption because of large distance to the BS.

The proposed EDACH scheme significantly reduces energy consumption and increase the lifetime of the sensor network compared to the previous schemes. Due to the uniformly distributed cluster heads, the proposed scheme balances the energy consumption

among the sensor nodes. The simulation result shows that the proposed scheme effectively and efficiently increases the network lifetime compared with the existing schemes. Comparison between LEACH scheme (leach protocol) and proposed clustering mechanism with EDACH protocol is done on various parameters and output is shown using graphs. And the Qos parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated and the output is shown using graphs.[1]

II. RELATED WORK

Kyung Tae Kim, Man Youn Kim, Ji Hyeon Choi, Hee Yong Youn in [1] describes the energy efficient and optimal randomized clustering protocol. Authors have give comparison between different clustering algorithms. LEACH is Low-Energy Adaptive clustering Hierarchy [7] which is one of the clustering schemes. In LEACH sensors are organized into clusters consisting of sensor nodes and cluster head. The CH in the cluster is responsible of aggregation of data and transmitting them to the base station. The existing LEACH protocol the energy dissipation is around 5 percent of the total nodes act as CHs which has been evaluated. The working of LEACH protocol consists of two rounds. The first round is the set-up phase and the second round is steady-state phase. In the setup phase each node decides whether it becomes the cluster head or not. As the CH is chosen the CH broadcasts as an advertisement message to the all the other nodes. The nodes decide, to belong to a particular CH for that round depending on the received signal energy strengths. In the second round ie. steady state phase, the member nodes start sensing and transmitting data to the CHs, and the fused information by the CH is sent to the BS.

EDACH is Energy-Driven Adaptive Clustering Hierarchy [1] which increases the lifespan and reliability of sensor network even in the presence of faults at the cluster head. K. T. Kim and H. Y. Youn describes this clustering protocol. In this protocol a proxy node is selected which plays the role of the current cluster head in one round of operation. The CH node is efficiently selected by detecting the faults in the faulty cluster head. The protocol is reliable and improves in the stability of the network. It reduces the overhead of re-clustering. The EDACH protocol increases the lifespan and solves the energy issue in WSN. The network shows trustworthiness of sensor network even in the presence of faults at the cluster heads. The EDACH protocol is based on detecting and handling the defects in the CH.

Table I. Literature survey.

Paper Name	Technique	Advantages	Disadvantages
An Energy Efficient and Optimal Randomized Clusterisng for Wireless Sensor Networks	Energy efficient and optimal randomized clustering protocol	Energy efficient clustering	Limited lifetime of network
Energy- Efficient Communication Protocol for Wireless Micro-sensor Networks	Low-Energy Adaptive Clustering Hierarchy	LEACH is completely distributed	LEACH assumes all cluster heads pay the same energy cost
Energy-Driven Adaptive Clustering Hierarchy (EDACH) for Wireless Sensor Networks	EDCACH protocol	Evenly distributes the energy dissipation	If subjected to attack the lifetime decreases
A Novel Algorithm for Optimized Cluster Head Selection	BEC-LEACH protocol	Effectively balance the energy consumption of nodes	Better than LEACH but not as efficient as EDACH

In the Table I the paper An Energy Efficient and Optimal Randomized Clustering for Wireless Sensor Networks gives comparision between various protocols. The Energy- Efficient Communication Protocol for Wireless Micro-sensor Networks paper gives an clustering protocols to reduce the communication cost of the WSN. The Energy-Driven Adaptive Clustering Hierarchy (EDACH) for Wireless Sensor Networks paper studies on how to maximize the network lifetime and is better than existing protocols such as LEACH and PEACH. The A Novel Algorithm for Optimized Cluster Head Selection paper gives comparison of LEACH and BEC-LEACH. BEC-LEACH protocol prolongs the lifetime of network.

III. SYSTEM DESIGN

3.1 Problem Formulation:

Energy consumption at a cluster head is significantly larger than that at other ordinary sensor nodes because cluster-head is responsible for delivering aggregated data in its cluster to the BS. This problem can be relieved by rotating the role of cluster-head among all nodes. In WSN, each node has limited energy resource, and thus the lifetime of the network is one of the most critical issues.

3.2 Clustering:

The optimal number of clustering is done by the cluster-based protocol using a simple hierarchical path selection approach which does not need any information about the location of the sensor nodes. Every sensor node is been selected as CH with the same probability. Thus the load can be balanced. There are few issues that need to be resolved. Initially, the optimum number of clusters i.e k needs to be decided. In a condition in which the number of

clusters is smaller than k, in such case some nodes may exhaust its energy for transmitting data to the CH which is located away. If the number of clusters is more than the optimal number then the nodes will quickly loss their energy due to direct communication to transmit data to the BS. LEACH protocol as default sets k value as five percent of the nodes. The second issue is that, each node has equal chance to become a CH. If a node of low energy is selected as a CH. This may cause is in quickly deplete of energy due to the heavy load of CH. These factors reduce the network lifetime.

3.3 Cluster-head selection:

LEACH uses a random principle for selection of cluster head. Any node at random is elected as the CH and all the others are then turn by turn selected to be the CH. This leads to balanced energy consumption of all nodes, which in turn increases the lifetime of the network. If the CHs are unevenly located then it will lead to unbalanced energy utilization and decreases the lifetime of the network. The proposed EDACH protocol solves this problem in which it stochastically selects the CH using three aspects. The following are the three parameters:

1. Energy ratio between the current energy verses initial energy.
2. The number of rounds.
3. The count that the node has been selected as the CH.

3.4 Data Collection and Transmission:

The data collection and transmission process is the second stage which goes on until the information transmission of all the nodes is completed fully.

IV. PROPOSED SYSTEM

Wireless topology with more number of nodes is created and transmission of packets is done using LEACH SCHEME (LEACH-PROTOCOL) and QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated. Wireless topology with more number of nodes is created and transmission of packets is done using PROPOSED clustering mechanism in the existing system is been implemented with EDACH protocol and QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated. Comparison between the protocols namely LEACH SCHEME (LEACH Protocol) and PROPOSED clustering mechanism with EDACH Protocol is done on various parameters.

The Enhancement to the existing system is done by adding security factor and maintaining the efficiency of the Wireless Sensor Network. The mechanism increases the lifespan of the network. The proposed protocol is an energy efficient secure clustering hierarchy (EESCH), which takes into consideration the security parameter in an wireless sensor network. Wireless topology with more number of nodes is created and transmission of packets is done using EESCH (the proposed PROTOCOL on existing system) and wormhole attack is deployed in the network and performance has been decreased and QOS parameters.

Wireless topology with more number of nodes is created and transmission of packets is done using ENHANCED watchdog mechanism with digital signatures (key generation technique) with PROPOSED mechanism and protocol and here attack has been detected and prevented in network with performance increased in QOS parameters. Comparison between LEACH SCHEME, PROPOSED SCHEME, EESCH with ATTACK and ENHANCED MECHANISM is done on various parameters and output is shown using graphs. In the Enhancement EESCH the worm hole attack has been deployed. When the attack is deployed on the EDACH protocol the performance of the WSN decreases by various factors like delay, packet delivery ratio, throughput, etc. But when the EESCH protocol is implemented using the watchdog technique and digital signature, even after attack in the system, the system works efficiently.

V. MODULES

5.1 MODULE 1:

Base file for creation of nodes and transfer of packets.

5.2 MODULE 2:

Wireless topology with more number of nodes is created and transmission of packets is done using LEACH SCHEME (LEACH-PROTOCOL) and QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated.

5.3 MODULE 3:

Wireless topology with more number of nodes is created and transmission of packets is done using EDACH protocol and QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated and the output is shown using graphs.

5.4 MODULE 4:

Comparison between LEACH SCHEME (LEACH Protocol) and PROPOSED clustering mechanism with EDACH Protocol is done on various parameters and output is shown using graphs.

5.5 MODULE 5:

Wireless topology with more number of nodes is created and transmission of packets is done using Proposed SCHEME (proposed PROTOCOL) and wormhole attack is deployed in the network and performance has been decreased and QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated and the output is shown using graphs.

5.6 MODULE 6:

Wireless topology with more number of nodes is created and transmission of packets is done using ENHANCED watchdog mechanism with digital signatures (key generation technique) with PROPOSED mechanism and protocol and here attack has been detected and prevented in network with performance increased in QOS parameters such as end to end to end delay, energy spent, packet deliver ratio, throughput is calculated and the output is shown using graphs. The proposed protocol is an energy efficient secure clustering hierarchy (EESCH), which takes into consideration the security parameter in a wireless sensor network.

5.7 MODULE 7:

Comparison between LEACH SCHEME,EDACH SCHEME, EDACH SCHEME with ATTACK and ENHANCED MECHANISM (EESCH) is done on various parameters and output is shown using graphs.

VI. PROTOCOLS

6.1 Low-Energy Adaptive Clustering Hierarchy (LEACH):

W.B.Heinzelman,[11] introduces a hierarchical clustering algorithm for sensor networks called the Low Energy Adaptive Cluster Hierarchy protocol (LEACH). It uses a random principle for selection of cluster head and is a very popular protocol. It forms clusters of sensor nodes so that the energy consumption is reduced. The cluster heads (CHs) of the cluster is used transmit the data to the BS. This saves energy of the network as the transmissions will only be done by CHs rather than all sensor nodes. The optimal number of CHs is given to be 5 percent of the total number of nodes [1]. All the data is aggregated and then transmitted which is done by the CH of the cluster. CHs are randomly selected and are changed turn by turn randomly over time. Which will balances the energy consumption of all the nodes.

LEACH protocol contains two states:
1. Cluster setup state and
2. Steady state.

In the first stage, clusters are formed and selection of CH is done, in second state, data is been transmitted.

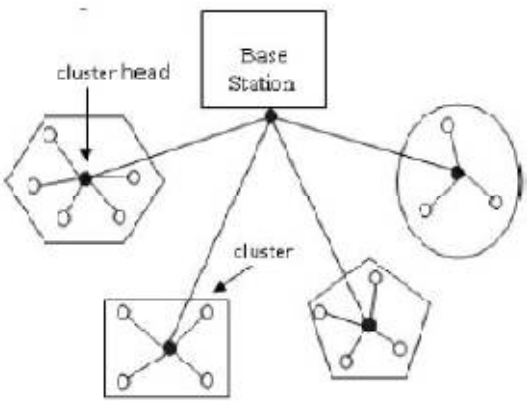

Figure 1. LEACH protocol

Shortcomings of LEACH Protocol [3][4] :

(1) It assumes that nodes always have data to send & the nodes including CH are started with the same initial energy.

(2) The number of CH is already defined from the total nodes. Approximately ranging between 5 to 10 percent of the total nodes. Hence,it may not cover entire area when sensor nodes are not uniformly distributed.

(3) The CHs are randomly selected rotationally and Residual Energy of the node is not considered for cluster formation, etc.

(4) CHs send aggregated data to BS in single hop manner so LEACH is not applicable to networks deployed in large regions.

6.2 Energy-driven adaptive clustering hierarchy:

Energy-driven adaptive clustering hierarchy (EDACH), is a protocol which is an enhanced version of the LEACH and PEACH scheme. The EDACH protocol has been discussed in detail in [9][10].EDACH consist of rounds, the round one of its operation consists of the following two phase namely the set-up phase and the self organized data collection and transmission phase. EDACH solves the possible problem of the CH by proxy node but in the LEACH approach it has insufficient energy for carrying out the task of a cluster-head. It, however, further improves the performance of PEACH by forming more clusters in the region far from the BS. Each round of EDACH begins with the set-up phase like the other protocols where the clusters are organized, followed by the self-organized data collection and transmission phase where data transfer to the base station occurs. The second phase also includes the proxy node selection process and Indicator Control Message (ICM) advertisement process.

EDACH protocol can be deployed in large area in the wireless sensor network. EDACH had less packet loss ratio and delay as compared to other randomized clustering protocol. Load balancing is done efficiently. Therefore, increases the lifetime of the wireless sensor network.

VII. MATHEMATICAL MODEL:

7.1 In the System and Energy Model:

The energy consumption model is described as follows. When a node transmits l bit over distance d, the energy it consumes is:

$$E_{Tx}(l,d) = E_{Tx\text{-}elec}(l) + E_{Tx\text{-}amp}(l,d) = \begin{cases} lE_{elec} + l\varepsilon_{fs}d^2 \ , d < d_0 \\ lE_{elec} + l\varepsilon_{mp}d^4 \ , d \geq d_0 \end{cases} \quad (1)$$

and a node receives l-bit data, energy it consumes is:

$$E_{Rx}(l) = E_{Rx\text{-}elec}(l) = lE_{elec} \quad (2)$$

7.2 Cluster-head selection:

The proposed EDACH protocol stochastically selects of the CH using three parameters:

$$T(n)=\left(\frac{p_{opt}}{1-p_{opt}\times(r \bmod \frac{1}{p_{opt}})}\left(\frac{E_{residual}}{E_{init}}\right)\right)\left(\frac{p_{opt}\sqrt{r}}{C_{ch} \bmod \frac{1}{p_{opt}}}+1\right)$$

VIII. SECURITY AND ATTACK

8.1 Wormhole attacks*:*

Wormhole attack destabizes the wireless sensor network.In a wormhole attack, an attacker recieves the packets at one point in the network and tunnels them to an distant location with less latency then the network,and then replays them there into the another point in the network.

8.2 Watchdog Technique:

Most of existing WSNs Trust System have adopted a so-called watchdog technique .Watchdog technique has been proved as a very effective approach to build up WSNTS's. It simultaneously saves energy and collect sufficient past behaviours for trust evaluation, an intelligent watchdog scheduler is highly required.[12] Optimizing watchdog techniques for WSNTSs to balance energy efficiency and security in WSN.

The watchdog technique which consists of two levels. In the first level the watchdog nodes are positioned and in the second level optimization of A watchdog task Wtij(watchdog sensor nodes) consists of a bidirectional communication. Watchdog node vi's point of view, we define a sensor node vj's trustworthiness in the context of a particular behaviour as the percentage of vj's behaviours that meet vi's expectation among all the vj's behaviours watched by vi in a time window N. Trustworthiness is denoted by Tij. Consume less energy to perform watchdog tasks to monitor vj and hence ensure the energy minimization goal.[12]

IX. RESULT GRAPHS

Average delay comparison graph is shown of LEACH and EDACH protocol. There is very less delay in EDACH protocol.

Figure 2.Average Delay graph

Energy Comparison graph of LEACH and EDACH protocol. Energy consumption in LEACH is greater than EDACH.

Figure 3. Energy Graph.

Packet delivery ratio comparison between LEACH and EDACH protocol shows EDACH is better data transmission than LEACH protocol.

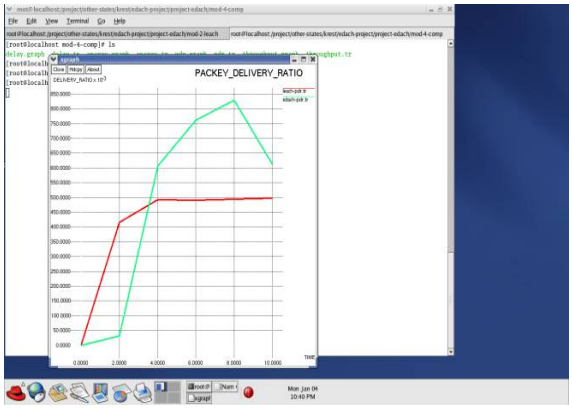

Figure 4. Packet Delivery Ratio Graph

Figure 4 shows that throughput in EDACH is better than LEACH protocol.

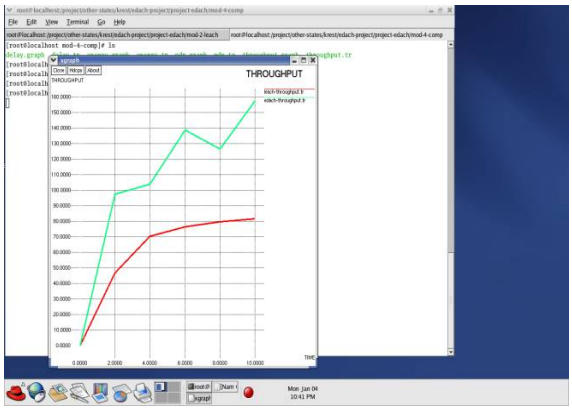

Figure 5. Throughput graph

Result with the enhancement is shown in the following two graphs after attack and attack under watchdog technique. Result graph shows that attack on EDACH degrades the performance of the WSN and when EESCH protocol even after the attack the performance of the system isn't affected much.

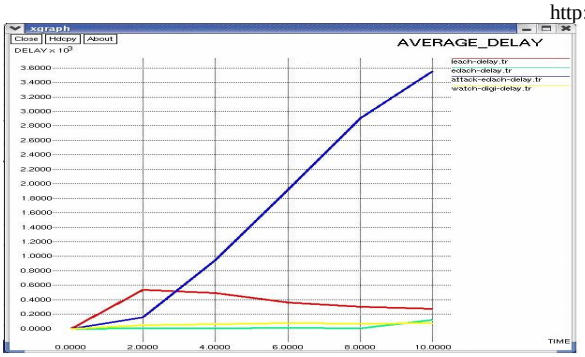

Figure 6. Average Delay Graph with attack.

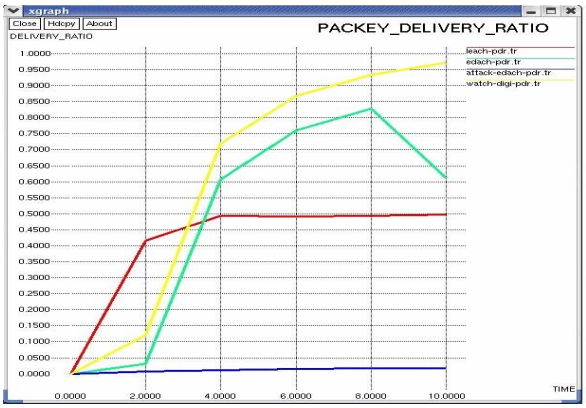

Figure 7. Packet Delivery Ratio with Attack Graph.

CONCLUSION

The project gives an energy efficient clustering protocol in wireless sensor network. The proposed EDACH protocol introduces a new threshold value which used in selecting the CHs in the network. The clustering mechanism reduces the energy consumption at the sensor node and increases the lifetime of the network. The minimization of energy dissipation, balancing of energy consumption and increasing the lifespan of the network is the key point over the existing system.

The security parameter is introduced for an efficient and trusted wireless senor network. Maximizing the network lifetime further more and securing the network from attacks using enhancement mechanism and digital signature. The Wireless Sensor Network Secure System sheds light on the design of energy-efficient WSNTS by optimizing the collection procedure of the trust's basic foundations.

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