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Secure Opportunistic Routing to Maximize Network Lifetime in Wireless Sensor Networks

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ABSTRACT: Energy savings improvement is one of the significant worries in the remote sensor system (like WSN) directing convention plan, because of the way that most sensor hubs are outfitted with the restricted non-rechargeable battery power. In this work, minimizing vitality utilization and boosting system lifetime has been engaged. Since sensor nodes are usually static, their unique information, such as the distance between the sensor node and the sink node, their residual energies are difficult to find the optimal transmission distance. Hence, we need to consider all these factors for making decisions in opportunistic routing. In opportunistic routing, it selects a forwarder set and prioritizes nodes in forwarder set according to their effective optimal transmission distance. Nodes in this forwarder set that has highest priority can be selected as forwarder candidates. In this work a key generation mechanism is carried in order to improve network security, secure opportunistic routing across the nodes of network. Broad reproductions in NS2 results demonstrate that the proposed calculation can altogether enhance the system execution on vitality sparing and remote availability in correlation with other existing WSN directing plans.

KEYWORDS: Energy efficiency, Total Transmission Energy, Opportunistic routing, Security, Network lifetime, TMA (Traffic Management Authority), 1-D queue network.

I. INTRODUCTION

The greater part of the current customary movement data obtaining frameworks are actualized without force sparing administration. With the requests of different maintainable improvements in brilliant city, a vitality sparing advancement answer for keen movement data obtaining ought to be considered.

In our answer, when a movement occurs sensor hub distinguishes a vehicle in its detecting range, it will obtain activity data, for example, activity volume, vehicle speed and activity thickness etc,. Sensor hubs will send the gathered information to transfer sensor hubs, and afterward the hand-off sensor hubs forward movement data along the vitality productive way to the sink hub that is one or more bounces away. At long last, far reaching activity data will be built up by the sink hub and sent to the movement administration focus such as TMA (Traffic Management Authority).

In the meantime, movement administration focus will choose proper data and offer it to the customers through the system. This savvy movement data securing arrangement can be utilized to develop the lifetime of system in the need of vitality sparing in WSN-based Information Technology (IT) foundation.

The primary motivation behind vitality productive calculation is to augment the system lifetime. These calculations are not simply identified with expand the aggregate vitality utilization of the course additionally to augment the life time of every hub in the system to build the system lifetime. Vitality proficient calculations can be founded on the two measurements: i) Minimizing complete transmission vitality ii) Augmenting system lifetime. The primary metric spotlights on the aggregate transmission vitality used to send the bundles from source to destination by selecting the extensive number of bounces criteria. Second metric spotlights on the leftover player vitality level of whole system or individual battery vitality of a hub [1].

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II. RELATED WORK

Prior works [2] and [3] discussed the probability of connecting two specific nodes and the whole network. Some other work in [4], [5] scrutinized on consistent and individualistic distribution based on the presumption that the transmitting range is unchanged among sensor nodes. In [6] and [8] energy efficient mechanism has been investigated, since transmission of data requires more energy than other tasks such as receiving and processing data, so it is necessary to find the optimal energy path in between source node and sink node in case of wireless sensor networks. The work in [6], discussed about the theoretical analysis of optimal forwarding distance and optimal power control of every single hop. Based on the trade-off between the utilization of maximum power and long hop distance and utilizing minimum power and shorter hop distances, minimum energy consumption can be reached when an optimal transmission distance is calculated by each sensor node to the other nodes in the multi hop dense wireless network. The Most Forward within Range (MFR) [7] routing mechanism considers One Dimension (1-D) queue network, where the far neighbouring node is selected as the next node to forward the data and this results in less multi-hop delay, minimum power consumption.

Another approach suggested in [8] decreases the total energy consumed based on two optimization objects, such as bit allocation and path selection. Packets with the optimum size are broadcasted by the sensor node to the fusion node in the best intermediate hops. But the gain of optimal bit allocation among the sensor node is not discussed in One Dimension (1-D) queue networks. In order to overcome the problem of routing in unreliable wireless links in wireless sensor networks, the Opportunistic Routing (OR) concept was proposed in [9]. Compared with old traditional optimal path routing, opportunistic routing, such as Extremely Opportunistic Routing (ExOR) [10], Geographic Random Forwarding (GeRaF) [11], and Efficient QoS-aware Geographic Opportunistic Routing (EQGOR) [12], take advantage of the broadcast nature of the wireless medium, where multiple neighbours overhear the transmission and participate in forwarding packets.

Opportunistic routing (OR) [13]is a contemporary routing approach for wireless multi-hop networks. The broadcast nature of wireless network is not used in the traditional routing mechanism which is accomplished in the opportunistic routing approach. The considerable characteristic of opportunistic routing is choosing of forwarding nodes from the forwarder set and co-ordination between the nodes to deliver the packets to the sink node. Hence, OR works efficiently in wireless multi-hop networks such as mesh or sensor networks with maximum node density. OR enables dynamic relay node selection across multiple routes, thus it obtains higher link reliability and maximum transmission range.

III. PROPOSED ALGORITHM

A. *Design Considerations:*

- Deployment of nodes using traffic scenario
- Selecting Vehicular nodes
- Deployment of Traffic Management Authority(TMA)
- Key Generation by the TMA for all the nodes for security purpose.
- Initial Battery Energy (IBE) is 50Jules for each node.
- Nodes are able to calculate its residual battery energy (RBE).
- Relay Node Selection based on Optimal Path
- Considered all possible paths at beginning.
- Receiving energy is not considered.
- The time when no path is available to transmit the packet is considered as the network lifetime.

B. *Description of the Proposed Algorithm:*

Aim of the proposed system to make use of OpportunisticRouting algorithm and Secret key generation method to is to maximize the network lifetime by minimizing the total transmission energy using energy efficient and optimal distance relay nodes,and to provide secure network to transmit the data. The proposed algorithm is consists of four main steps.

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Step 1: Calculating Transmission Energy:

It is important to calculate transmission energy of each node based on this calculated energy the nodes are selected for forwarding the packets. The transmission energy (TE_{node}) of each node relative to its distance with another node is calculated by using eq.(1)[14].

$$TE_{node} \ \alpha d^{n}$$

$$TE_{node} = k\, d^{n} \qquad \text{eq. (1)}$$

Here, k is constant
n is path loss factor which is generally between (2-4) [14].

Step 2: Secret Key Generation:

After the energy is calculated of individual nodes, the traffic management authority is going to generate the secret key for all the deployed nodes. The key is used for verifying whether the nodes are registered with the TMA or not, which is mainly used for the finding the intrusions in the network.

Key Generation Algorithm:

Key generation is an important part where we have to generate both public key and private key. The sender will be encrypting the message with receiver's public key and the receiver will decrypt its private key. Now, we have to select a random number 'n' within the range of 'r'.
Using the following equation we can generate the public key:
Q = n * P
n = The random number that we have selected within the range of (1 to r-1). P is the point on the curve.
'Q' is the public key and'n' is the private key.

<u>Encryption</u>
Let 'm' be the message that we are sending. This has in-depth implementation details. Randomly select 'k' from [1 – (n-1)].
Two cipher texts will be generated let it be CP1 and CP2.
CP1 = k*P
CP2 = M + k*Q
CP1 and CP2 will be send.

<u>Decryption</u>
We have to get back the message 'm' that was send to us,
M = CP2 – n * CP1
M is the original message that we have send.
Step 3: Relay Node Selection Criteria:

For relay node selection we need to consider two basic metrics that is the residual energy of the node and the optimal distance between the relay node and the sink node.

The Residual Battery Energy (RBE) of the Relay node should be higher than the transmission energy (TE_{node}) for transmitting data to the later node in the network to finally reach the sink node. This is the condition that should be satisfied by all the nodes in the network while transmitting the packets, if in case any of the node in particular route is not satisfying this constraint then it will be not considered as a workable solution. Only the nodes with acceptable amount of residual battery energy are considered as a workable solution. If both the residual battery energy and transmission energy are equal in a node then the node enters sleep mode. This principle maximize the lifetime of the network by avoiding the network partition. Here an attempt is made to prevent the utilization same path. However in some case we need to consider the energy efficiency when there is a route with minimum consumption of energy although it is previously utilized and a route with high energy consumption that is not utilized. Uncertainly up to this point utilization of imitated paths are prevented to maximize the life time of network. Based on the distance between two nodes in a route the Transmission energy between them is calculated and the below equation shows the calculation of Total Transmission Energy (TTE_R) for that route [14].

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$$TTE_R = \sum_{i=1}^{m} TE \qquad eq.(2)$$

Here 'm' is the number of hops in the route.
$TE = TE_{node}$ is the transmission energy between the nodes.
The route having minimum total transmission energy i.e. min (TTE_R)will be selected as energy efficient route[14].

The residual energy of the node after transmission of packet can be calculated, where the current residual battery energy of a node is the difference between the Initial Battery Energy(IBE) and Transmission Energy(TE_{node}) of that particular node[14].

$$RBE = IBE - TE_{node} \qquad eq.(3)$$

In opportunistic routing[15] a forwarder set will be created in which a node that has higher residual energy and optimal distance to the sink node will be given the highest priority and that node will be selected as relay node for forwarding the packets to the TMA. If this node fails to transmit the packets to the TMA then the next highest priority node will be selected to relay node to transmit the packets to the TMA.

Step 4: Finding the Optimum Path:

Once the relay node is selected we are going to select the optimum path for reaching the traffic management authority for transferring the data. In this work whenever a node senses a vehicle movement in its sensing range, it has to forward the information to the sink node which is the TMA. Here the selected relay node has to find optimal path to the sink node, the Dijkstra's algorithm can be used to find the shortest route between that selected relay node and every other node. It is also used to find the optimal route from a single node to a single sink node by stopping the algorithm, once the optimal path to the sink node has been reached.

IV. PSEUDO CODE

Step 1: Deploy the nodes
Step 2: Calculate the TE_{node} for each node of each route using eq. (1).
Step 3: Calculate the secret key for all the nodes for identifying the nodes.
Step 4: Check the below condition for each route till no route is available to transmit the packet.
    if (RBE < = TE_{node})
        Make the node into sleep mode.
else
        Select all the routes which have active nodes
Step 5: Calculate the total transmission energy for all the selected routes using eq. (2).
Step 6: Select the relay nodes for transferring of data to TMA.
Step 7: Calculate the RBE for each node of the selected route using eq. (3).
Step 8: go to step 3.
Step 9: Data will be transferred to the TMA
Step 10: Check for the key of the node sending the data.
Step 11: if key is matching
        Accept the data packet
    else
        Drop the packets and notify it as attacker or malicious node
Step 12: End.

V. SIMULATION RESULTS

The simulation results show the deterministic topology of traffic network with 50 nodes that is as shown in Figure1. The proposed opportunistic energy efficient algorithm is implemented using NS2.35 simulator. Proposed system we have considered two metrics Total Transmission Energy and Maximum Number of Hops to reach sink node, network lifetime and energy consumed by each node in the path. We considered the simulation time as a network lifetime. Simulation time is calculated through the CPU time function of NS2. Our results shows that the throughput, delay time taken for transmission and key generation time taken analysis through the network.

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The Network Topology

In Figure 1, the traffic management scenario in 1-D (One Dimension) queue network platform is displayed. Here the nodes are deployed with relay nodes monitoring the traffic. In this whenever a sensor hub senses the movement of the vehicular node, it starts transmitting the information to the TMA through an optimal path. If in case any of the relay node fail to transmit the data the next higher priority node will transmit the packets to the TMA. In the above figure the square shaped node indicate relay node and the TMA node, whereas the hexagon shaped node indicates moving Vehicle nodes and the circles represents the sensing range of the relay nodes.

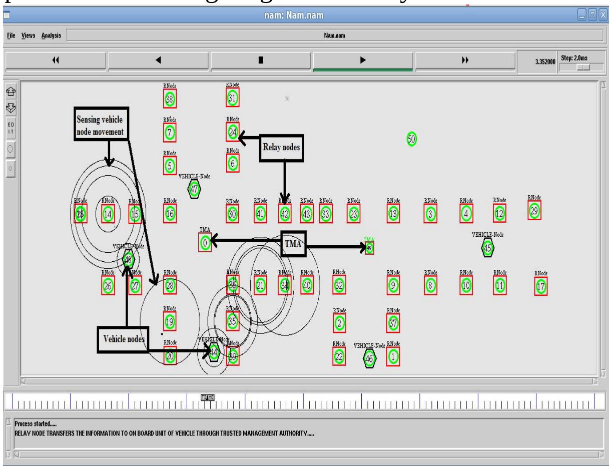

Figure 1: Wireless Sensor Network of 50 Nodes.

Key Generation

In Figure 2, the Key Generation Time Taken for each node is displayed in the form of graph. In this graph the X-axis denotes the size of key generated in kilobits and the Y-axis denotes time taken to generate keys in milliseconds. In the graph the existing system consumes more time to generate the key for detecting unauthorized nodes whereas the proposed takes considerably less time this improves overall system performance.

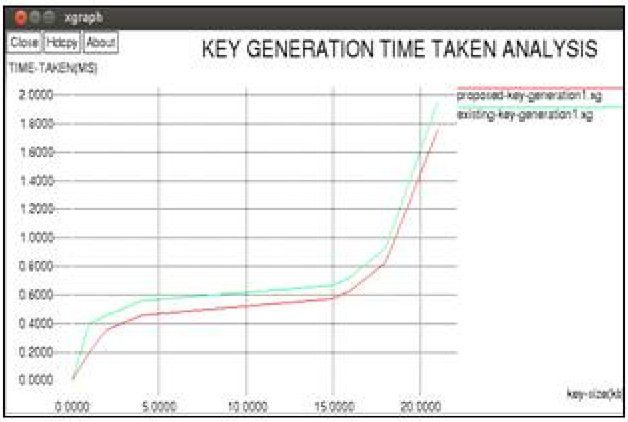

Figure 2: Key Generation Time Taken for each Node.

Performance Analysis (Delay)

In Figure 3,the performance analysis of the system is displayed in terms of delay time taken for the data transmission. In the graph below X-axis indicates the number of messages sent and Y-axis indicates the time in milliseconds. In the proposed system the delay for transmitting the packet is reduced which improves the performance of the whole system. Initially the delay increases gradually for less number of messages and further remains stable at significant point of time with increase in the message count.

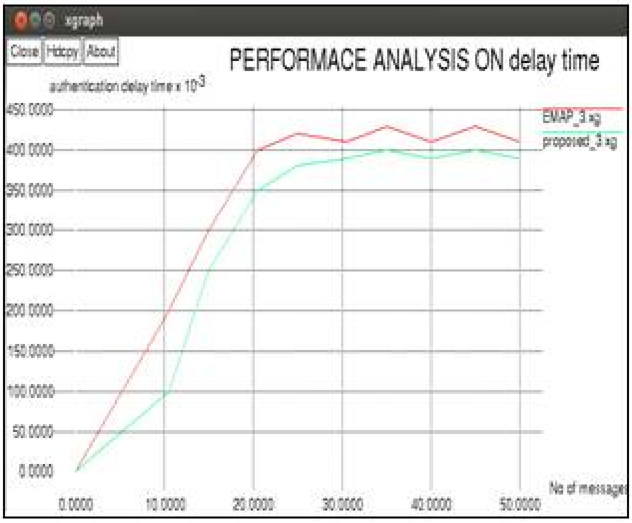

Figure 3: Performance Analysis on delay time.

Throughput

In Figure 4,the throughput of the system is shown; in the graph below X-axis represents the time and the Y-axis represents the throughput where the throughput of the proposed system is increased compared to the existing system. Our results show that the proposed system is better than the other systems considering the above analysis done.

Figure 4: Throughput of the system.

VI. CONCLUSION

In this project, we have considering to minimize the consumption of energy by the nodes and improve the lifetime of 1-D queue network in this project the sensor hubs locations are fixed and they cannot be changed. In this we apply the concept of opportunistic routing for selecting the relay nodes based on their residual energy and their location from the sink node. In this the relay nodes are predetermined and their location cannot be altered according to their optimal transmission distance. Since there is no any movement of the relay node it will maximize the lifetime if the network. The key generation mechanism improves the network security where the unauthorised node cannot participate in data transfer work. Therefore the main aim is to design an opportunistic routing system with optimal and secure energy

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efficient nodes that improve the throughput and performance of the system with lower power cost. The simulation results proves that the proposed method makes expressive growth in energy saving and network partition as compared with other existing routing algorithms.

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