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Energy Efficient and Secured Dynamic Real Time Routing Protocol in Wireless Sensor Networks

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ABSTRACT: An energy efficient and secured real time routing protocol for wireless sensor networks is proposed.It takes care of void node problem (VNP) in 3D organization by adjusting the packet forwarding region(PFR).Packet forwarding region determination depends on the system thickness around each of the sending nodes, which lessens the quantity of excess packages transmission, crashes and blockage. To make this protocol energy efficient and secured, asymmetric cryptography is utilized in which the key used for encryption is not same as the key used for decryption. By this the security of information cannot be hacked.

KEYWORDS: Security, energy efficient, void node problem, packet forwarding region.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) have prompted a fast advancement in time sensitive applications, for example, in smart grid, mechanical control, and process computerization. Such applications require packets to be delivered with minimal overhead and realiability[1]. There are two types of routing protocols namely

1.Geographical routing protocols

2.Topological routing protocol.

Geographical routing protocols (GRPs)needn't bother with route maintenance and discovery plans like topological routing protocol; consequently they can deal with dynamic changes in the system much superior than topological routing protocol. In real WSN arrangements, sensor nodes are situated in a three dimensional (3D) space, for example, in sea checking, timberland fire detecting, mining and unmanned elevated vehicle (UAV) systems[4],[5]. For such applications, GRPs must use three dimensional area data for exact operation. Two dimensional (2D) GRPs can work in 3D space, they don't use the maximum capacity of the system on the grounds that the packet may take longer way to destination due to the 2D projection of a 3D space[3].

A major concern in GRPs is to give area data to nodes. Global Positioning System (GPS) can be utilized to get the area data in three dimensional directions (Latitude, longitude, height). Furthermore, there are limitation techniques which can give situating without GPS. For indoor applications, there are various restriction strategies in time of arrival and signal strength.

Initially,the 3D geographical protocol (3DRTGP)[12] is proposed for 3D deployed WSNs, which gives a delicate continuous capacity. The ongoing operation is accomplished by the protocol utilizing a packet forwarding region (PFR) and choosing quick sending nodes in the PFR. The objective of PFR is to restrict the quantity of sending nodes towards the destination, which lessens blockage brought by unnecessary forwarding. Altering the forwarding likelihood of the nodes based on their queue length enhances the delay experienced by packets and enables the protocol to provide delay ensures. Secondly, a successful solution for the VNP in 3D WSNs is provided. The solution permits the proposed protocol to have a reliable operation in case of having void regions. Thirdly, tuning procedures for 3DRTGP [16]is given to make the protocol meet the delay and miss proportion applications of utilizations.

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Security is one of the major concern in wireless sensor networks. In conventional wireless security mechanisms, the transmitted data is encrypted with keyed symmetric or asymmetric encryption algorithm. The wireless sensor networks prefer the asymmetric algorithm for minimal overhead and lower energy consumption. Asymmetric uses RSA algorithm in which two keys are generated. One is the private key and other is the public key. The asymmetric algorithm is used encryption and authentication algorithm[15].The key used for encryption is different from the key used for decryption. The pair of numbers (e,N) is known as the public key and can be published. The pair of numbers (d,N) is known as the private key and must be kept secret. The asymmetric algorithm involves three steps

1. Key generation
2. Encryption and
3. Decryption

Algorithm involves multiplying two large prime numbers through additional operations deriving a set of two numbers that constitutes the public key and another set that is the private key. Once the keys have been developed, the original prime numbers are no longer important and can be discarded. Both the public and the private keys are needed for encryption or decryption but only the owner of a private key ever needs to know it. Using the asymmetric algorithm, the private key never needs to be sent across the network. The private key is used to decrypt text that has been encrypted with the public key**.**

II. RELATED WORK

S. F. Al Rubeaai et al**.** in the paper "Game theoretic energy balanced (GTEB) routing protocol for wireless sensor networks,"[2] presents a novel game theoretic energy balanced (GTEB) geographical routing protocol to extend lifetime of wireless sensor networks (WSNs) by ensuring that forwarding nodes run out of energy approximately at the same time[14]. In order to achieve this objective, the transmission region around a sender node is divided into a set of forwarding regions based on network density. Evolutionary game theory (EGT) is used to determine the amount of traffic to be forwarded to those regions based on their available energy. Within a forwarding region, one forwarding node is selected to forward a packet using classical game theory (CGT).The disadvantage of this is the energy consumption.

The specificity of UAANETs is that they are formed by small and medium sized Unmanned Aerial Vehicles (UAVs) also known as drones. In UAANETs as well as in MANETs, geographic J.-D. M. M. Biomo et al. proposed that the Unmanned Aeronautical Ad Hoc Networks (UAANETs) are a type of Mobile Ad Hoc Networks (MANETs) which are infrastructureless and self-organizing networks routing is widely used[6].Geographic routing relies on Greedy Forwarding (GF), also called Greedy Geographic Forwarding (GGF). GGF fails when a packet arrives at a node that has no neighbour closer to the destination than it is. The node in this situation is referred to as a void node. The paper "Routing in unmanned aerial ad hoc networks: A recovery strategy for greedy geographic forwarding failure," propose a strategy that salvages packets in void node situations. We thereafter append this strategy to a protocol that features GGF. Simulations in OPNET show an increase in packet delivery ratio of about 2% at virtually no additional cost[18].In this the packet delivery ratio need to be increased.

D. Pompili et al. in the paper "Three-dimensional and two-dimensional deployment analysis for underwater acoustic sensor networks,"proposed that the deployment strategies for two-dimensional and three-dimensional communication architectures for underwater acoustic sensor networks, and a mathematical deployment analysis for both architectures is provided[7],[9].The objective is to determine the minimum number of sensors to be deployed to achieve optimal sensing and communication coverage, which are dictated by application requirements; provide guidelines on how to choose the optimal deployment surface area, given a target body of water; study the robustness of the sensor network to node failures, and provide an estimate of the number of redundant sensor nodes to be deployed to compensate for potential failures[4],[5]. The disadvantage of this is it is not robust and performance need to be increased.

A. A. Ahmed and N. Fisal proposed that the WSN demands real-time forwarding which means messages in the network are delivered according to their end-to-end deadlines (packet lifetime). The paper "A real-time routing protocol with load distribution in wireless sensor networks," proposes a novel real-time routing protocol[8] with load distribution (RTLD) that ensures high packet throughput with minimized packet overhead and prolongs the lifetime of WSN[17].The routing depends on optimal forwarding decision that takes into account of the link quality, packet delay

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time and the remaining power of next hop sensor nodes. In this the end to end delay need to be minimized, throughput need to be increased, packet overhead need to be minimized and network performance should be increased.

J. A. Stankovic et al. in the paper "A spatiotemporal communication protocol for wireless sensor networks", present a spatiotemporal communication protocol for sensor networks, called SPEED[14]. SPEED is specifically tailored to be a localized algorithm with minimal control overhead. End-to-end soft real-time communication is achieved by maintaining a desired delivery speed across the sensor network through a novel combination of feedback control and nondeterministic geographic forwarding. SPEED is a highly efficient and scalable protocol for sensor networks where the resources of each node are scarce. In this the performance of the network need to be increased.

A. A. Ahmed and N. Fisal in the paper "A real–time routing protocol with mobility support and load distribution for mobile wireless sensor networks," proposes a novel idea of real-time that provides mobility and load distribution (RTMLD) for MWSN[8][11].RTMLD utilised corona mechanism and optimal forwarding metrics to forward the data packet in MWSN. It computes the optimal forwarding node based on RSSI, remaining battery level of sensor nodes and packet delay over one-hop. RTMLD ensures high packet delivery ratio and experiences minimum end-to-end delay in WSN and MWSN compared with baseline routing protocol. In this the end to end delay need to be minimized, Packet delivery ratio need to be increased and power consumption is more

K. Saleem et al. in the paper "Empirical studies of bioinspired self-organized secure autonomous routing protocol,"proposed a novel biological inspired self-organized secure autonomous routing protocol (BIOSARP) enhances SRTLD with an autonomous routing mechanism[13],[20].In the BIOSARP mechanism, an optimal forwarding decision is obtained using improved ant colony optimization (IACO). In IACO, the pheromone value/probability is computed based on the end-to-end delay, remaining battery power, and link quality metrics. The proposed BIOSARP has been designed to reduce the broadcast and packet overhead in order to minimize the delay, packet loss, and power consumption in the WSN. The disadvantage of this is packet overhead,power consumption and network performance.

III. Proposed work

In the design of this protocol, it is accepted that a WSN comprises of η number of uniformly randomly distributed homogeneous nodes. These nodess are station and are conveyed in a 3D volume of V . It is accepted that the transmission range is r and is radiating roundly. 3DRTGP, being a GRP, accept that each node knows its own particular area, and the source node know the area of their destination node. In most WSN organizations, the destination (or base station) node is situated in a predefined position and this area data can be prearranged to all sensors. The protocol uses three lists, namely,

1.Broadcast list: BroadcastList stores the identification number of the packets (packet.id) to check if the received packet has been already transmitted by the node.

2.Rretransmit list: Retransmit List stores the recently transmitted packets, which may be retransmitted in case of VNP.

3.Void node packet list: Finally Void Node Packet List keeps track of the packets received from the same sender multiple times, which indicates VNP and makes the receiving node adjust its PFR.

These lists are used to keep track of the packets so that the node can make decision when and how to participate in forwarding...

A. *Block diagram of 3DRTGP*

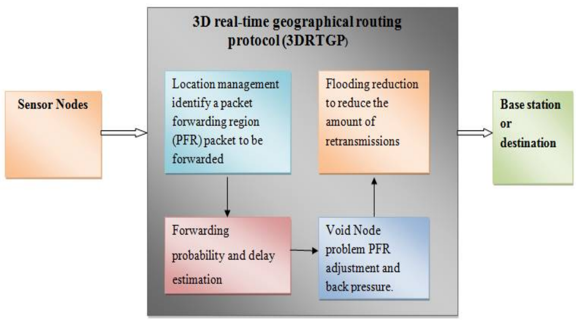

Fig.1.Block diagram of 3DRTGP

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Fig.1 illustrates the block diagram of 3DRTGP and these functions are given as follows:
A. Location management.
B. Forwarding management.
C. VNP handling.
D. Flooding reduction.
The location management function determines whether the node is located in the PFR or not The forwarding management function decides if the node forwards the packet or not according
to its forwarding matrices.. VNP handling is responsible for identifying if the node experiences a void region and activates the VNP handling algorithm to divert the traffic to an alternative PFR. VNP can be also experienced if the nodes in the PFR are congested and cannot meet the packet deadline. For this reason, VNP handling is important in selecting alternative routes to meet the delay deadlines necessary for real-time operation. The flooding reduction function identifies if the received packet has already been broadcast or not.

B. *Flow diagram*

Fig.2 illustrates the flow diagram of transmission of packets from sensor nodes to destination. Firstly the sensor nodes undergoes self organisation. The sensor nodes transmits the packets to the nearby nodes to know which nodes has received the packets. Then it checks whether the packets has been broadcasted or not. If it is broadcasted, the node will be in void node packet list and it identifies the relative PFR and transmits the data. The forwarding probability and delay estimations of those nodes are calculated and checks whether the packet is experiencing VNP. If in case of VNP retransmission of packets takes place. Then the nodes finds that the packet is in their own VNP List, and double their β to expand their PFR. Flooding reduction process takes place to reduce the number of retransmission and the packet is delivered to the destination.

Pseudocode given in Figures.3, 4 and 5 gives the receiver and sender in every sensor node. Here, The receiver and sender functions, as well as necessary global variables and lists is given. The Receiver function, given in Fig. 3, is the key function in the 3DRTGP. This function allows nodes to make right choices or to call other self-association elements of the protocol. At the point when a node gets a packet, it manages it just if the packet due date has not terminated. From there on, the node checks the likelihood of having VNP by examining the packet's flag field. Once, a packet experiences VNP, the receiver node gets back to a weight capacity, which is like the one in receptive topological routing protocol, for example, AODV. The next step in the receiver capacity is to recognize if this packet has as of late been prepared by checking either retransmit list or broadcast list. In the event that the packet is found in retransmit list, then this is a verifiable affirmation of an effective sending by the following jump, which flags the hub that it finished the treatment of this bundle right now and it can store the packet.id in broadcast list. In the event that the got packet is in broadcast list, this implies this packets has as of now been transmitted before and there is no compelling reason to manage it. Be that as it may, if the packet has no past history since it is not in any of the previously mentioned records, the node instantly calls the area administration work. Something else, the hub alters its PFR then it calls the area administration capacity to reassess its sending qualification. Once the location management function identifies that the node is in the PFR, then the hub turns into a qualified sender and the sender capacity is called. The eligible sender makes its decision, to forward or not forward, based on the experienced delay, τreq, and the sending likelihood.

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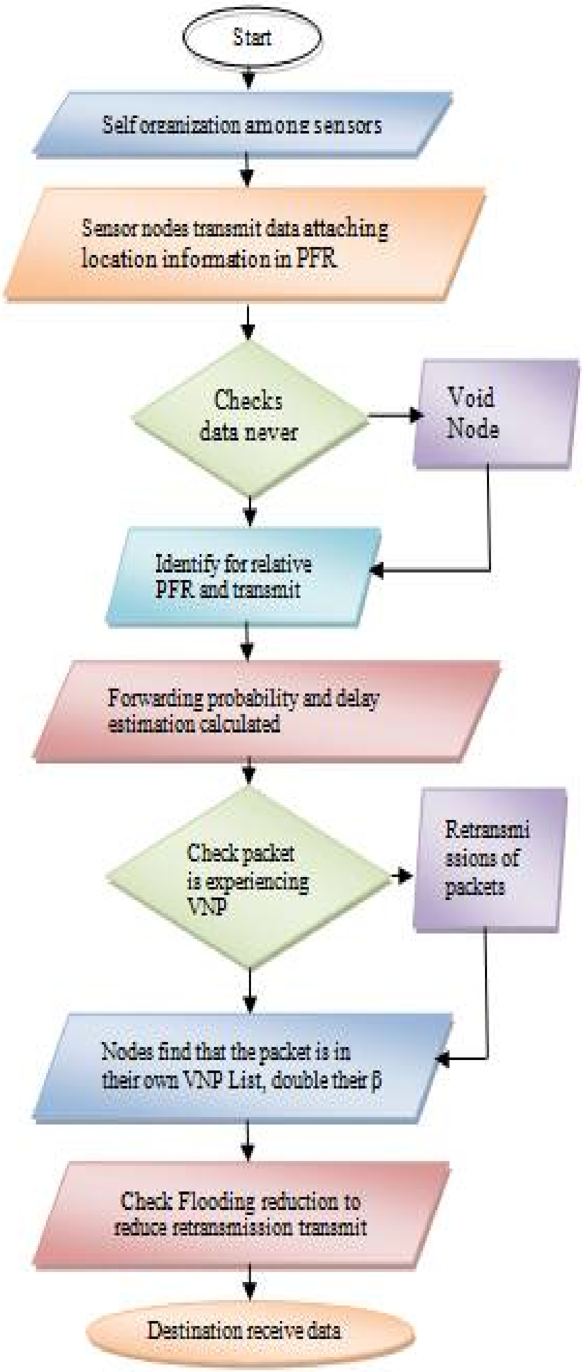

Fig.2.Flow diagram

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Receiver

```
Function RECEIVER(packet)
    if packet. deadline ≤ current time then
        drop packet
        Exit
    end if
    if packet.flag ≠ 0 then BACKPRESSURE()
    else if packet ε retransmit list then
        Drop packet
        Cancel τ_w
        Delete packet from retransmit list
        Store.id ε broadcast list
    else if packet.id ε broadcast list then
        Drop packet
    else if packet.id ε void node packet list then
        LOCATION MANAGEMENT()
        B= 2 * β /*VNP handling*/
        LOCATION MANAGEMENT()
    end if
end function
```

Fig.3.Receiver function

Sender

```
Function SENDER(packet)
    Compute τ_req / * per equation (3)*/
    if τ_req ≤ (packet.deadline -current ) then
        FORWARDING PROBABILITY()
    end if
end function
/ * Forwarding probability function */

function FORWARDING PROBABILITY()
    Generate Rand
    Compute p /*per Equation (5) * /
    If p≥ Rand then
    Store packet in retransmit list
    Transmit packet
    set timer with τ_w
    else
    Drop packet
    end if
```

Fig.4. Sender function

Location management and retransmit function

```
Function LOCATION MANAGEMENT()
    Compute θ / * per equation (1)*/
    if θ ≤ β/2 then SENDER()
else if packet ε void node packet list then
    store packet in void node packet list
    data packet
    end if
end function
/ * Retransmit function*/
function RETRANSMIT()
    if β * number of retransmit ≤360 then
        Transmit packet
        Number of Retransmit +1
else
        Set packet.flag 1
        Store packet in Broadcast list
        Transmit packet
    end if
end function
```

Fig.5. Location management and retransmission function

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IV. Simulation Results

Table I shows the comparision of simulation parameters of different authors that used to simulate in NS2. The performance of 3DRTGP was evaluated and graphs of the simulation are given.

TABLE 1
SIMULATION PARAMETERS

Authors	**Number of nodes**	**Shadowing deviation**	**Data Packet size**
A.A.Ahmed and N.Fisal	100-1000	4.0	70 bytes
Adwan Alanazi and Khaled Elleithy	450	-	128 bytes
Proposed technique	'n' number of nodes	2.5	32 bytes

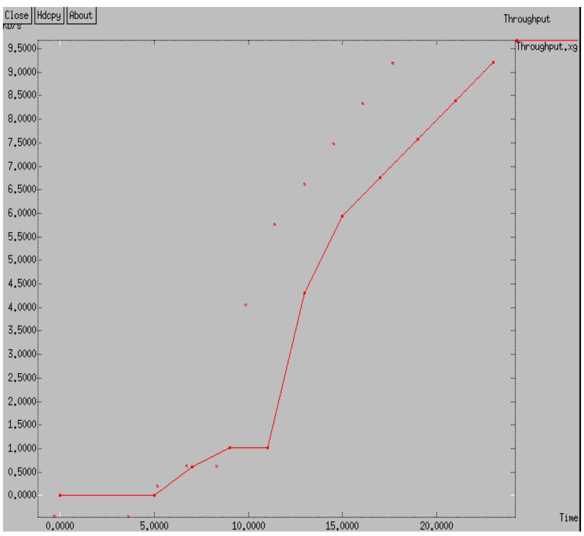

Fig 6.Throughput versus time

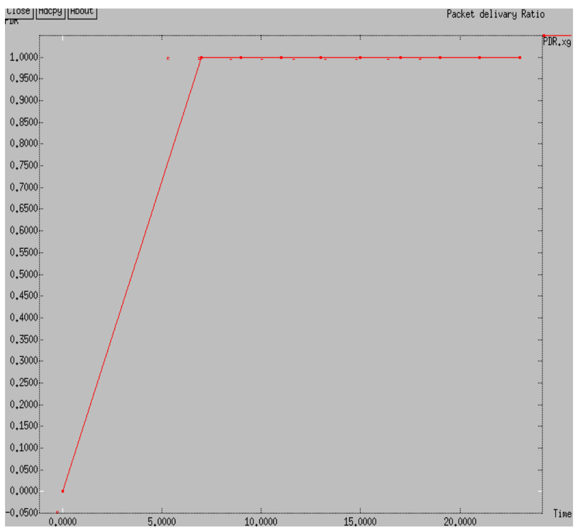

Fig 7. Packet delivery ratio versus time

1.*Throughput with time*

Fig 6. represents throughput increases gradually with respect to time.

2. *Packet delivery ratio with time*

From the Fig 7, it is observed that the packet delivery ratio of 3DGRP increases for a certain period of time and then will be constant for remaining time.

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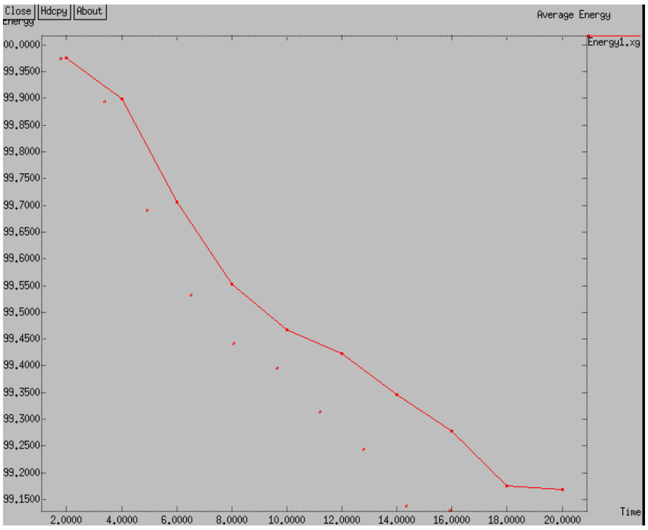

Fig 8.Average energy versus time

3. *Energy consumption with time*

Although the objective of the 3DRTGP design is to provide real-time operation, energy per packet consumption is also of primary concern for WSNs. Fig. 8 shows that the energy consumption of 3DRTGP .This set of experiments is conducted based on the average energy consumption of a packet while traversing through the network until it reaches the destination. In general, 3DRTGP reduces energy consumption because it does not require beacon messages to collect neighbours information.

V. CONCLUSION

In this paper, an energy efficient and secured dynamic routing protocol is proposed. This protocol is unique since it resolves VNP in WSNs deployed in 3D space. By using asymmetric algorithm the security and less energy consumption is achieved.

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