Detecting and Punishing the Selfish Node and Its Behavior in WSN

Sujit Kumar Das, Pinaki Sankar Chatterjee, Monideepa Roy

Kalinga Institute of Industrial Technology, Department of Computer Science & Engineering, Bhubaneswar, Odisha, India

Abstract- In Wireless Sensor Network (WSN) communication, every node transmits data packets to further nodes and spend its resources like battery power, CPU time and memory. In ideal situation all the nodes forward packets to other nodes according to their requirements .Presence of selfish nodes is a very big issue in WSNs. A selfish node doesn't forward packets and utilize to its own profit but it is hesitating using personal resources for others. If such activities occurs within most of the nodes in the network, the network is disrupted. Selfish behavior detection and punishment is an essential requirement in wireless sensor networks. In our paper we have described an efficient algorithm for detection and punishment of a selfish node and the necessary action to be taken if the node is a critical node.

Keyword- WSN, Selfish node ,Critical node, Replica Allocation , Retransmission Numbers.

1. INTRODUCTION

Wireless Sensor Networks (WSNs) and Mobile ad hoc networks (MANETs) are groups of mobile nodes which are accountable for swapping packets over a wireless transmission medium. The Wireless Sensor Network(WSN) is the construction of nodes , from a few to several hundreds or even thousands, where each node is associated with single or several sensors*[1],[4]*. Each such sensor network node has characteristically several parts: a radio transceiver with an internal antenna or linking to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, regularly a battery or an embedded form of energy reaping. WSNs are gatherings of mobile nodes swapping packets over a wireless transmission medium. Since packet transferring charges extra energy and bandwidth, balanced nodes may attempt to gather energy and bandwidth by greedily refusing to dispatch packets. Prevention, recognition and justification of selfishness among MANET and WSN nodes have recently received extensive attention. A wireless sensor network (WSN) is made of spread sovereign sensors to check physical or environmental circumstances, like temperature, pressure, sound, etc. and to simultaneously the data is passed in the course of the network to a major location. WSN has the benefits of minor volume, little power consumption, small cost, and dispersed, self-organizing features. Since a universal sensing technology, the WSN is measured to be one of the 10evolving technologies of the future living which has great likely for many applications such as military investigation, Industrial manufacture procedure nursing, environment nursing, disaster prediction, medical attention and harsh environment nursing and other fields.

Mobile ad hoc networks are widely used and they are infrastructure less . It can be installed without base station and dedicated routers and don't rely on extraneous fixed infrastructure .It can be established when it is required*[7],[5]*. Each node in MANET, works as a router and maintain communication with other nodes. It is a multihop network . There are many MANET application in the world , for example , it can be used in natural disasters , battle fields etc. .Due to presence of the selfish node MANET is affected during communication of data packets in case of accessibility of data. In these network , the nodes have limited battery power and bandwidth and each node needs the assistance of others for packet forward.

When a node becomes selfish as well as critical node , the network is divided according to the position of the critical node .The presence of the critical node , decomposes the network into two or several sub networks*[7]*. Critical node problem is a N P-Complete . The critical node is an element or position, whose disruption is immediately degrades the performance of the network. The nodes of one network can't forward data packets to the nodes of another network. so the network is divided and the communication is disrupted. Critical nodes consume all the network recourses like battery power , bandwidth etc. If a selfish node becomes a critical node , the network is divided and to overcome the problem of data accessibility among nodes need the replica allocation of data in memory space of other nodes.

A selfish enjoys all the resources of the network but it never gives away its own resources to other node . When most of the node behave like this disorder of network*[5]* happens. The selfish node utilizes the network resources like battery power , bandwidth etc. for its own profit. If such a selfish behavior happens in the network , the network seems to be inactive.

To improve the accessibility of data between nodes , the data present in owner node is replicated to other nodes as well*[6]* known as replica distribution. In

the replica distribution technique , the data present in memory space of one node copy to memory space of another node. So that the node transfers data to other neighboring nodes successfully .The CONFIDANT algorithm to arrangement with selfish nodes*[10]* , the algorithm achieved the reputation value and in use to remove network method to punish non-cooperative nodes, the method exists a problem of malicious nodes failure behavior . Watchdog mechanism is a faulty mechanism for detection of selfish node and become the selfish node into normal node. Previously , all the algorithms are very much complex to detect selfish node and its behavior and the main problem is that making the selfish node into cooperative.

In order to appropriate detect selfish nodes and punish the nodes of refused cooperation, this paper proposes a new approach for cooperation of node's selfish behavior mechanism .

2. RELETED WORK

When a node becomes selfish, the network doesn't appropriately work in instance of relocating data in wireless sensor network. The nodes are not supportive in nature in case of relocating data because of selfish behavior.

A selfish node utilizes the total network resources for its individual profit. When these behavior happens among most of the nodes in the network, it may finally escort to disruption of network. This section*[1]* studies the influence of selfish nodes attentiveness on the superiority of service in MANETs and WSNs.

Features of selfish nodes *[1]:*

•It doesn't not add in routing procedure: A selfish node abandon routing post or it may change the Route demand and Reply packets by altering TTL value to minimum probable value.

• It don't answer or transmit hello messages: A selfish node may not reply to hello messages ,so other nodes may not be capable to sense its existence when they want it.

• Deliberately delay the RREQ packet: A selfish node possibly interrupt the RREQ packet up to the highest upper limit time. It will definitely escape itself from steering ways.

• Abandoning of data packet: Selfish nodes possibly be part of the routing mail but may not broadcast data packets.

The cost of a packet is decided by numerous parameters such as essential overall transmission power and the battery status of the intermediate nodes. The method to deal with this selfish behavior should be dependent on their concentration intensity in the network because of the impact they have on the network commotion will be different at different level of their concentration.

The difficulty of selfish nodes can be similar in ad hoc networks and WSN *[1]*. The major purpose for the selfishness is the deduction of power with time. As the time passes away the nodes consume their battery power and in a disaster hit area or battle field area restoring is not technically feasible.

The selfish node is concerned to lessen data accessibility and create soaring communication cost in terms of inquiry dispensation *[6]*.Various selfish node discovery approaches are there to identify the nodes which don't contribute in packet forwarding but they fall short to detect the selfish nodes which does not allot replica for the reason of further nodes. The methods are able to detect selfish nodes as assigning replica to other nodes. The methods are divided like detecting the selfish nodes and decreasing the effect of that nodes in mobile ad hoc network. The major attributes are counted as the selfish nodes and number of replica share techniques. The selfish node detection algorithm that considers partial selfishness and novel replica allocation techniques to properly cope with selfish replica allocation.

Reliability computation of large scale MANETs is an NP computational problem, and this complexity can be concentrated by recognizing critical nodes in a network. The identification of critical nodes itself is a computationally hard problem *[7]*.

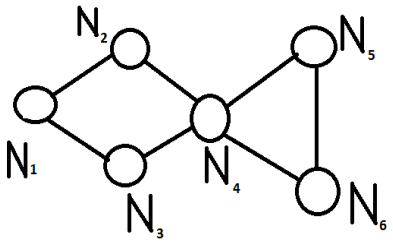

Figure 1: Sample Topology G

The consequence of selfish nodes concentration [0-100%] on the various Quality of Service (QoS) parameters*[1]*. The QoS parameters is taken into contemplation are as follows:

• Throughput: Proportion of packets acknowledged by the target to the number of packets directed by the source.

• Hop count: Stated as the number of hops present between cause and goal.

•Packet dropped: Amount of packets abandoned by the routers for many reasons.

• Probability of Reachability: Division of probable accessible routes to the all likely routes among all different sources to all different destinations.

Thus with the rise in attentiveness of selfish nodes:

i. The average hop count may increase

ii. The packet drop rate may increase

iii. The average throughput may decline

iv. The probability of reach ability may decline

The paper gives an overview of replica allocation techniques*[6]*. The elasticity causes regular network partition, hence data accessibility in WSN and ad hoc networks is lesser than the fixed networks. The nodes which are not enthusiastic to broadcast

packets and reveal their remembrance space are called self-centered nodes. The selfish node that doesn't allocate information for other node's purpose is called selfish imitation allocation *[6].*

The selfish nodes assign data stuff that are highly retrieved by it and don't believe other nodes throughout replica allocation. Selfish nodes lessen the data availability of extra nodes in query processing. The selfish nodes don't mollify neighbor nodes by giving mandatory information to them. The nodes can be divided into three types *[8]* they are,

1. Non selfish nodes
2. Fully selfish nodes
3. Partially selfish nodes

Non selfish nodes assign their reminiscence space entirely for the use of additional nodes. Selfish nodes don't assign their reminiscence space for the use of other nodes. partly selfish nodes assign a least bit of their reminiscence space for the use of other nodes and residual for the advantage of personal node[9]. Diminishing the property of selfish nodes will be significant to surge the data availability between the nodes.

Replica allocation procedures are employed to lower communication cost, while achieving good data availability.

In Wireless sensor network, the characteristic data of nodes selfish behavior including throughput, delay time, retransmission numbers *[3]*.

when an insufficient number of grouping packets are received at the destination node, so that the destination cannot reproduce the original packets forward by the source . The retransmission is basically alike with Automatic repeat request (ARQ) and it is the resending of packets which have been either dented or gone. It is a term that points to one basic mechanisms used by protocols working over a packet switched computer network to make available dependable communication.

3.PROPOSED SYSTEM

In the network where selfish behavior happens, are usually defective, there is no warranty that they will not holdup, break, or make the packets , or take them out of order. Protocols those offer trustworthy communication over those networks use a mixture of acknowledgments, retransmission of missing or broken packets, and checksums to provide that reliability. In this paper we are using retransmission number of nodes to detect a selfish node. Each node itself retransmission numbers before successfully sending a packet(NAj , j=1,2,…n)and records of retransmission numbers(n) within a certain period (recordnum), using NAj and n to calculate the average retransmission numbers (NAi) of each node itself; after that looking for the maximum value of average retransmission numbers (NAmax) in the period; Finally, it is judged whether retransmission numbers of node i to meet the equation (1), when it is satisfied the condition indicates that the node is a normal node, and if not, the node is a selfish node; continually repeating this process until the end of the result.

$$NA_i = \frac{\sum_{j=1}^{n} NA_j}{n} \quad , j=1,2,.....n$$

NA_{max}-NA_i< Threshold ----------(1)

Threshold value depends on the amount of nodes present in the network. It varies according to the presence of nodes.

If NA_j=0 ,there is no successful packets forwarded to other nodes. It absorbs all the required packets for its own profit.

3.1 Punishing the selfish node and make the selfish node into cooperative nature:

To decrease the hop count and to increase the percentage of reachability of packets for transmission of packets in WSN due to selfish behavior of node , replica allocation technique is very efficient for cooperating the selfish node to other nodes.

The replica allocation technique is used to make the selfish node cooperative in nature to other nodes .When a network is disrupted , the nodes are not responsible for forwarding packets. In this technique all nodes are having data items of other nodes. where nodes N1; N2;... N6 contain their memory space M1; M2;...M6, respectively in figure 2. When the data transmits from one node to another nodes , sharing of memory space of each node is responsible for transmission. If one node is selfish in the network , the memory space of selfish node doesn't take the data items of other neighbor . For forwarding packets through the selfish nodes , simply copy the data items of neighbor nodes into the memory space of selfish node explicitly and make the selfish node cooperative to other nodes.

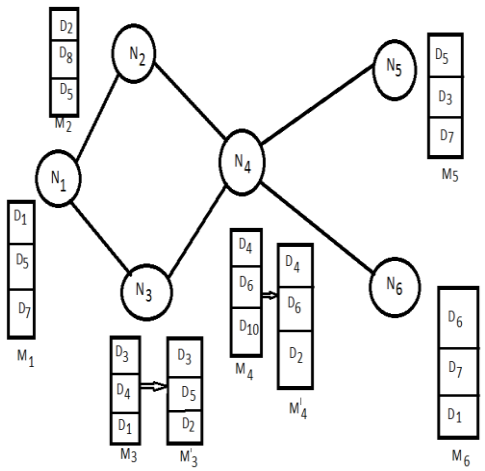

Figure 2: Replica allocation to nodes in network G

To overcome the selfish behavior of a node in a network G , replica allocation helps to make the selfish node cooperative with neighbor nodes and other nodes. If the selfish node becomes fully selfish node , the node doesn't forward any packets to other nodes. For cooperation , the selfish node makes replica of other neighbor nodes and store the data items into its memory space.

3.2 Proposed Algorithm

1. Detection of selfish node algorithm
2. Replica allocation algorithm

//Algorithm for Detection and Punishment of a Selfish node//

Selfish_node_detection (NA_{max} , NA_i)
{

// NA_{max}= maximum value of average retransmission numbers in the period

// $NA_i = \frac{\sum_{j=1}^{n} NA_j}{n}$, j=1,2,.....n

1. for(each joined node N_k in G)
2. if (NA_{max}- NA_i< Threshold)
3. {
4. N_k = non-selfish node;
5. }
6. else
7. N_k = selfish node;
8. if(NA_j= = 0)
9. {
10. N_k is fully selfish node;
11. }

}

// To improve the performance of the network//

Replica allocation()
{
1. for(each connected node N_k from N_i)
2. {
3. store replica of N_k into N_i ;
4. ND^k_i=the total number of allocated replica;
5. SS^k_i= the total size of allocated replica;
6. }
7. if(N_i has not allocated replica to N_k)
8. {
9. ND^k_i=0;
10. SS^k_i=0;
11. }
12. else
13. {
14. ND^k_i=1;
15. SS^k_i= size of the data item;
16. }

}

Here from step (1) to step (11) determines whether the node is a selfish node and also is a fully selfish node or it is a normal node according to the consideration of retransmission numbers of each nodes by the formula given in equation(1) .
And the second part from step (1) to step (16) gives how the selfish node become cooperative with other nodes by the technique of replica allocation. In this technique , adjacent nodes are considered for replica allocation where N_k having the size of shared memory space and it is denoted as SS^k_i and shared data items of N_k's is denoted as ND^k_i ,observed by N_i. For selfish behavior removal where data items of one node creates a replica of data items of another neighbor node and store in its memory space.

4. EVALUATION

To get optimal results, detection mechanisms need the larger detecting rate . So the *Threshold* value is set to be 1 and the *recordnum* take 1500. The simulation process is done by MAT Lab . We arrange the nodes in a grid approach in the network. In this , one set of nodes is named as source (S) and another set of nodes is named as destination (D) as shown in figure 3. All the nodes forward packets to another nodes.

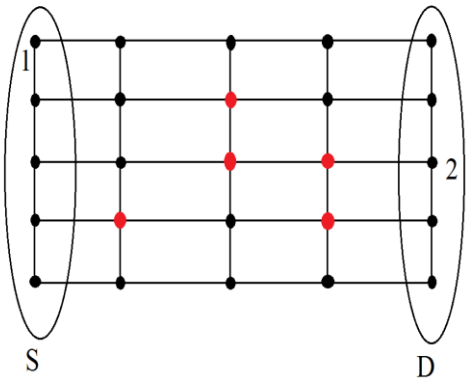

Figure 3: nodes are arranged in grid approach

The red dots are selfish nodes present in the network as shown in figure 3. When nodes from source(S) communicate data packets to nodes of destination(D) , it goes either through normal nodes or one or many selfish nodes. First time, one node of source(S)

forward data packets to other nodes of destination(D) and check every possible path to reach at the destination node. Next time , 2nd node of source(S) forward packets to other nodes of destination(D) and check every possible path to reach at the destination node. This process continues for every node of source to destination and give the result of the selfish node present in the network in the form of retransmission number of each node. Performance of the selfish node present in the network as shown in figure 4.

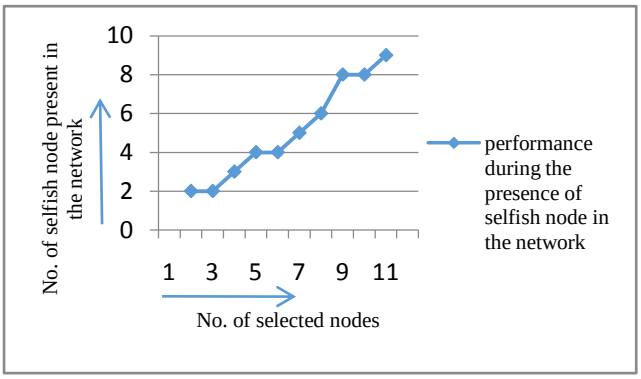

Figure 4: performance analysis of selfish node vs. transmission of data in nodes.

In this figure 4, the result shows that when we transfer data between two nodes in every possible path for successful transmission , we found two selfish node. When we transfer data between five nodes, we found three selfish node present in the network.

For punishing the selfish node , simply change the strategy of the selfish node by replica allocation. In replica allocation , we use contention window (CW) for sharing of data items. We use 12 nodes where node 0 is the central coordinator node and remaining 11 nodes to build a 11 link simulation scenario.

6.CONCLUSION

We have designed an algorithm which will improve the detecting rate as well as improve the performance of the network .The selfish behavior of nodes results in deterioration of the performance of the whole network in the wireless sensor networks. The selfish node detection and punishment is very important issue and makes the nodes cooperative in nature in case of transferring data. When the selfish node becomes critical node , it will have a major impact on the network and the network is divided. To overcome the problem of network partitioning and forward packets between nodes successfully , replica allocation technique is used. Replica allocation technique gives better result for communication of data packets between nodes.

REFERENCES

[1] Shailender Gupta, C. K. Nagpal and CharuSingla, Impact of Selfish node Concentration in MANETs, *International Journal of Wireless & Mobile Networks (IJWMN)* Vol. 3, No. 2, April, 2011.

[2] Jerzy Konorski and RafałOrlikowski, A Framework for Detection of Selfishness in Multihop Mobile Ad Hoc Networks, *Journal of Telecommunications & Information Technology*, February,2009.

[3] Bo Chen, Jian-Lin Mao, NingGuo, Guan-Hua Qiao, Ning Dai, An Incentive Detection Mechanism for cooperation of Nodes Selfish Behavior in Wireless Sensor Network , *25th Chinese Control and Decision Conference (CCDC)*, China, 2013.

[4] L. M. Sun, J. Z. Li, Y. Chen, H. S. Zhu, Wireless Sensor Networks, *Tsinghua University Press*, Beijing , China, 2005.

[5] Bo Wang , SohraabSoltani, Jonathan K. Shapiro, Pang-Ning Tan, Local Detection of Selfish Routing Behavior in Ad Hoc Networks, *IEEE*, Oct 2005

[6] K.Indumathi, N.Jayalakshmi, S.Kartiga**,** Selfish node detection using replica allocation techniques and SCF Tree in MANET, *IJARET*, Mar 2013

[7] Majid Ahmad,Durgesh Kumar Mishra, Critical Node Detection in Large Scale Mobile Ad hoc Networks, *International Journal of Computer Applications* ,Nov 2013.

[8] Y. Yoo and D.P. Agrawal, "Why Does It Pay to be Selfish in a MANET," *IEEE Wireless Communication*., Volume. 13, No. 6, December. 2006

[9] Jae-Ho Choi Kyu-Sun Shim, Sang Keun Lee, and Kun-Lung Wu, Fellow, "Handling Selfishness in Replica Allocation over a Mobile Ad Hoc Network*" IEEE Transaction on Mobile Computing*, Volume 11, No.2, February 2012.

[10] S. Buchegger, J. Y. Le Boudec, Performance Analysis of the CONFIDANT Protocol (Cooperation of Nodes: Fairness in Dynamic Ad-hoc Networks), *Proceedings of 3rd ACM International Sysposium on Mobile Ad Hoc Networking and Computing* , 2002.