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Detection and Elimination of the Selfish Node in Ad-Hoc Network Using Energy Credit Based System

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Abstract: Nodes in the wireless Ad-hoc network act as router for forwarding of packet from source to destination. During the forwarding of the packet, energy present in the node is utilized. More energy is spent in transferring the packet than on receiving the packet in the network. Forwarding of the packets is a common activity of the nodes in wireless Ad-hoc network. Packets are dropped by link failure, less bandwidth, collision, etc. Nodes will not forward the packet to its neighbouring node as a result packet drops. This happens due to the presence of selfish nodes in the Ad-hoc network. Selfish nodes preserve their energy for their own utilization. Identification and elimination of the selfish node is done using Energy Based Credit System (EBCS). The routing protocol used is dynamic source routing. The implementation is done on the NS2 simulator. The result is verified for performance parameters like packet delivery ratio, through put, and end-to-end delay.

Keywords: Energy credit based system, End-to-End delay, Packet delivery rate, Selfish node, Throughput.

I. Introduction

In wireless Ad-hoc network, nodes are self-configured for transmission of the packet from one location to the other. Behaviour of the nodes is of different forms in Ad-hoc network. The node behaviour is classified into two types [1]. One of the behaviour is normal and other is misbehaviour. Normal nodes forward the packet to their neighbouring nodes, as soon as they receive the packet from the source or the neighbouring node. They act like router. Misbehaving nodes will affect the entire network by false routing, delay, dropping of the packets and draining the buffer.

There are different types of misbehaving nodes. The overloaded nodes lack CPU cycles, buffer space or allowable bandwidth for forwarding of the packet. Broken node have fault in their respective software which prevents in forwarding the packets [2]. Malicious nodes launch a denial of service attack by dropping packets. Selfish nodes are misbehaving nodes, in which nodes will not forward packet in order to utilize their own resource. This resource can be utilized by the node for its own benefit [3]. Energy is the important resource, which is used by the node for receiving and forwarding of the packets.

The forwarding of the packets is done by routing algorithm. Dynamic source routing protocol is used, in which source first determines the route from source to destination [4]. By sending request message and in turn acknowledgement is sent after the nodes in the respective path acknowledge the request. In DSR routing protocol, the packet holds the information of the next node to forward the packet and as a result routing tables are not needed. DSR routing protocol allows multiple paths to reach the destination. It gives full control to the source to select the path to reach the respective destination.

Network Simulator Version 2, widely known as NS2, is an event-driven simulation tool that is useful in studying the dynamic nature of communication networks. In general, NS2 provides users with a way of specifying such network protocols and simulating their corresponding behaviours [5]. The proposed energy credit based system for identification and elimination of selfish node using dynamic source routing protocol is run on NS2 simulator.

In this paper, identification and elimination of the selfish node in static wireless Ad-hoc network is considered. Rest of the paper is organized as follows: proposed method of EBCS for identification and elimination of the selfish node in section II, followed by section III result and analysis of the proposed system, and finally in section IV conclusion.

II. Proposed Energy Based Credit System (EBCS)

An Ad-hoc network is infrastructure-less network in which nodes will forward the packet from one node to the other until the packet reaches the destination. In this paper, two types of static wireless Ad-hoc network architecture are designed. The first architectural design has no selfish node identification and elimination, and in the second architecture EBCS is considered.

A. Ad-Hoc Network without Any Selfish Node Checking System

Fig. 1 shows the Ad-hoc network without energy based credit system. The packets are dropped by the nodes in the Ad-hoc network. There are two reasons for dropping of the packet. One reason is the presence of selfish node in the network and other due to bandwidth, link failure, congestion, etc. Selfish node, if present in the Ad-hoc network, cannot be detected as no mechanism is present for checking. The other forms of failures can be detected.

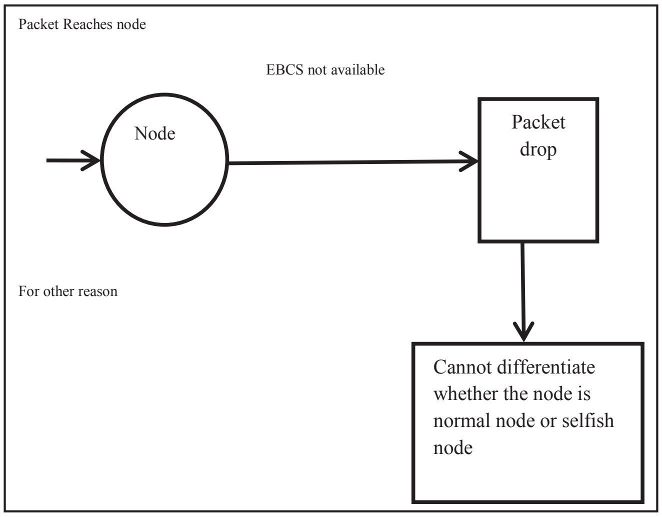

Fig. 1: Ad-Hoc Network without Energy Based Credit System

B. Ad-Hoc Network with EBCS Checking System for Selfish Nodes

Fig. 2 shows the EBCS. The node receives the packet, if the packets are dropped due to other reason like bandwidth, link failure, congestion, etc. If the nodes are selfish and dropping the packets. The energy based credit system checks the threshold energy of the node. The threshold energy is present in every node. Threshold energy is fixed energy for some value on reaching this the regular nodes start behaving as selfish nodes.

If the node is regular and forwarding the packet to the neighbouring nodes, as boost for forwarding the packet ECBS increments the energy of regular nodes involved in forwarding. ECBS identifies the selfish node when the node's energy is below the threshold energy and dropping of the packet is done by these nodes.

C. Working Principle of Energy Based Credit System

The sequence diagram (Fig. 3) shows the working of energy based credit system for the identification of node in selfish node or regular node.

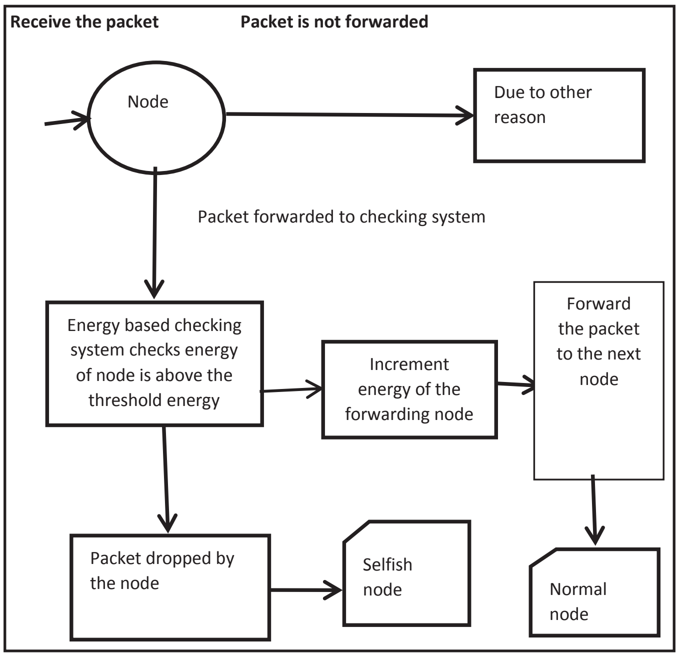

Fig. 2: Ad-Hoc Network with Energy Credit System

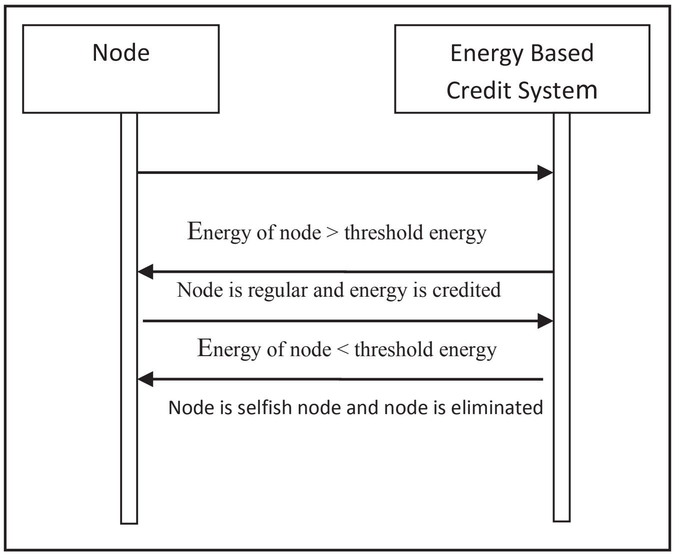

Fig. 3: Sequence Diagram for Identification of Node is Selfish Node or Normal Node

The energy based credit system is going to check the each and every node in the Ad-hoc network, for identifying whether the node is selfish or normal node. This module is embedded within the each node.

The sequence diagram shows the working principle of EBCS. The node after receiving the data packet passes the information to energy based credit system, which checks the energy threshold. If the energy is greater than the threshold energy, the energy base credit system module justifies that the node is normal node and boosts the node by crediting energy to it. If the energy is below the threshold level, node is selfish. This node is eliminated from Ad-hoc network.

III. Results and Discussion

NS2 simulator is used for the implementation of the proposed system. The setup of the NS2 simulator is given in the Table I ten nodes are present in the AdHoc network, simulation time is the time NS2 simulator is run, here it runs for 10 milliseconds, the packet size considered for forwarding of the packet is 1500, the queue limit is 50 packet it can hold in the buffer. The agent which is used is TCP and the routing protocol considered here is DSR.

Table I: Simulation Parameter Consider in NS2

Simulation Parameter	Value
Number of Nodes	10
Simulation Time	3.0 or 10.0
Packet Size	1500
Queue Limit	50
Agent	TCP
Routing Protocol	Dynamic Source Routing

A. Topology of Ad-Hoc Network

The snapshot shows that it has 10 static wireless Ad-hoc networks. This snapshot shows the way the nodes are arranged in the NS2 simulator. Blue colour node0 shows the source node and destination node is having the node8. The other nodes in green colour are intermediate nodes which are normal nodes. Refer Fig. 4.

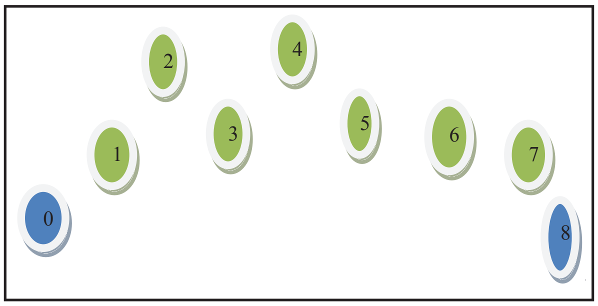

Fig. 4: Static Wireless Ad-Hoc Network Before Detection of Selfish Nodes

The snapshot in Fig. 5 shows the node3 and node4 are nearing the threshold value of the energy as they are turning to yellow colour. During this stage, the node3 and node4 will forward the packet to the next node in the Ad-hoc wireless network.

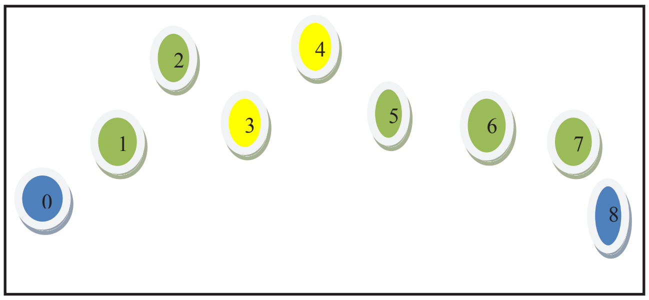

Fig. 5: Static Wireless Ad-Hoc Network, Node Nearing the Threshold Energy

The snapshot in Fig. 6 shows that the node4 has turned red in colour. This indicates that the node4 is the selfish node present in the static wireless Ad-hoc network. Now after turn to selfish node the node4 which was normal node earlier will stop forwarding the packet to the neighbouring nodes. DSR, the routing algorithm, will find a new route to reach destination eliminating the selfish node4 from the network.

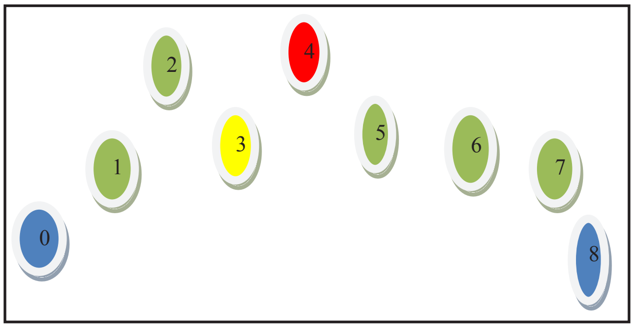

Fig. 6: Static Wireless Ad-Hoc Network, Node Reaching Threshold Energy

B. Performance Analysis of Ad-Hoc Network with Energy Based Credit System

The result obtained after running the NS2 simulator with and without presence of energy based credit system is discussed in this section.

Table II shows 10 iteration carried on for packet delivery ratio, throughput and end-to-end delay. Here, energy based credit system is not considered. Result obtained in Table II shows degrading of values in the static wireless Ad-hoc network.

Performance parameter with the EBCS is shown in Table III. Table III shows slight improvement by considering the checking system in all the parameters of the performance of the wireless static Ad-hoc network.

Table II: Performance of Different Parameter without

ENERGY BASED CREDIT SYSTEM

Iteration	PDR	Throughput[kbps]	End-to-End Delay[ms]
1	78.5873	600.12	110.075
2	62.15556	320.63	400.576
3	60.6702	315.29	429.869
4	57.6854	300.44	437.482
5	30.2802	220.23	449.236
6	25.7916	210.44	512.331
7	19.33014	100.48	520.638
8	12.0805	95.71	550.373
9	10.8426	54.39	579.258
10	9.7854	45.908	660.56

TABLE III: PERFORMANCE OF DIFFERENT PARAMETER WITH ENERGY BASED CREDIT SYSTEM

Iteration	PDR1	Throughput1[kbps]	End-to-End Delay1[ms]
1	79.5673	678.15	94.89
2	68.2556	348.55	379.345
3	58.5854	340.62	415.56
4	55.6502	330.67	4120.9
5	29.2902	256.45	425.78
6	21.7616	243.78	486.56
7	17.33014	185.78	510.789
9	8.8426	155.78	430.98
10	7.7854	148.78	549.54

The packet delivery ratio is improved in theAd-hoc network have the EBCS than without.

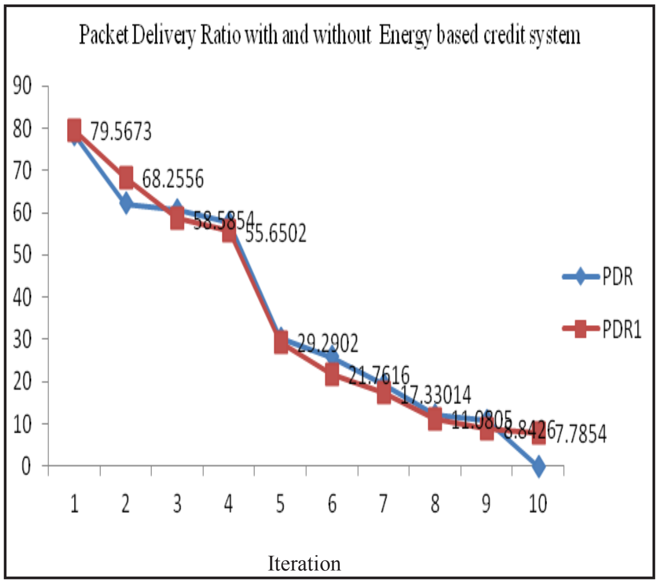

Fig. 7 shows the packet delivery ratio with and without EBCS.

Fig. 8 shows the comparison between throughput and throughput1. Throughput values are obtained without having energy based credit system and throughout1 values are obtained by implementing energy based credit system. The values of throughput1 are slightly greater than throughput.

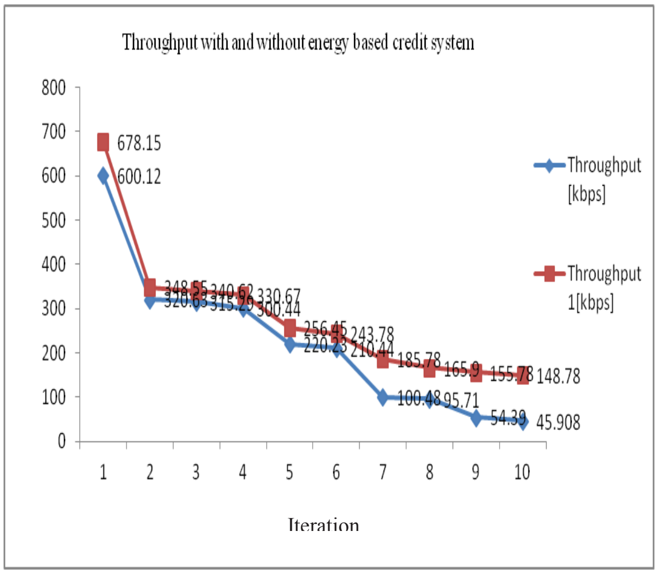

Fig. 8: Throughput with and without EBCS

Finally, the end-to-end delay with and without EBCS obtained from running the NS2 simulator. Fig. 9 shows that the end-to-end delay is less in static Ad-hoc network with energy based credit system.

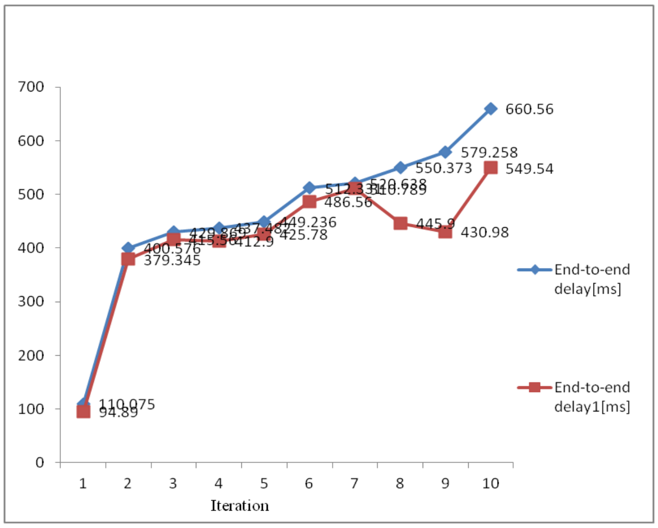

Fig. 9: End-to-End Delay with and without EBCS

IV. CONCLUSION

In Ad-hoc network, the performance will degrade in the presence of selfish node. In this paper, detection of selfish node using energy based credit system is done. This system will eliminate the selfish node from packet transferring. The nodes which are normal are identified and energy is credited to them by the energy based credit system. The energy based credit system checks the threshold level of energy in all the nodes suspected as selfish nodes. The performance of Ad-hoc network is improved in the presence of energy based credit system. In future work, we can consider how to make the selfish node as regular node and include them also in the forwarding of the packet.

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