A Fuzzy Based Grid Maintenances and Load Balancing Technique for Feature Applications

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ABSTRACT: In a Mobile Ad Hoc Network, this article suggests a Fuzzy dependent power scheduling and load balancing strategy for ZRP (MANET). The duty-cycles of border nodes are adaptively modified using this method, which takes into account the queue condition, expected residual capacity, and distance to border nodes. The nodes are active throughout each round and then go into sleep mode depending on the calculated duty-cycle time. When the load reaches a certain threshold, the zone leaders (ZL) are updated adaptively.

Keywords: border node, duty cycle, fuzzy, load balancing, power schedule, queue state, Residual energy

Abbreviations: MANET, mobile adhoc network; ZRP, zone routing protocol; ZL, zone leader.

I. INTRODUCTION

MANET is a group of active, automated and radio fortified nodes deprived of any substructure. MANET need every single intermediary node to perform as forwarders, getting and advancing data to every another node. This sort of network is commonly positioned in numerous situations in which immediate connectivity turns out to be the on-going need, either in alternative circumstances such as a calamitous emptying condition or in an unplanned gathering for performances [1]. Due to frequent node mobility, network disconnections and link failures are common in this network [2]. Hence, routing becomes a critical job in MANET [3].

ZRP [14] combines the best features of constructive and reactive routing protocols to solve problems [4].But still, many issues exist in ZRP which are to be solved. Data forwarding is performed by each node with maximum power thus ignoring its position in the zone. If the difference between the source and destination is a significant factor node is minimum, it leads to power wastage. On the other hand, if the distance is high, the destination may lie outside the zone radius. While increasing its broadcast attempts to determine the border node, the bandwidth consumption of source node will increase [5].

Location Based Topology Control approach was proposed by Niranjan Kumar Ray et al [6]. It combines topology control and power management techniques to reduce the transmission power of each node. Nodes are put into sleep mode based on the traffic load such that the network is not disconnected.

Zone based Collision Guided (ZCG) protocol has been developed by Shadi S. Basurra et al [7]. ZCG uses parallel and broadcasting techniques for route determination. The determined routes have high connectivity and lesser energy consumption. It separates the network into areas where trustworthy representatives are chosen.
A new routing algorithm was proposed by Indrajit Bhattacharya et al [8], which uses ZRP and Minimum Estimated Expected Delay (MEED) protocols. In this algorithm, the data is transmitted to the destination, within a specific deadline
The routing protocol proposed by Bency Wilson et al [9], combines both proactive and reactive routing methods. Like ZRP, it applies proactive routing inside the zones and reactive routing outside the zones. The speed and locations of each node are monitored continuously. This approach results in increased bandwidth utilization, reduced power consumption and less routing overhead.

Nassir Harrag et al [10] have proposed an algorithm Particle swarm optimization (PSO)and ZRP, to adaptively adjust the zone radius of each node. It enhances the performance of ZRP by reducing the delay, increasing the delivery ratio and reducing the control overhead.

A Genetic Zone Routing Protocol (GZRP) was proposed by Sateesh Kumar et al [11]. It applies Genetic algorithm for IERP and BRP components of ZRP. It determines multiple paths to the destination to perform load balancing. GZRP outperforms the existing ZRP to provide scalability and robustness.

An improved ZRP has been proposed by XueqinYanga et al [12]. It divides the networks into various clusters and proactively selects the cluster head in each cluster. .

An enhanced IERP has been proposed by YuriaOigawa et al [13]. The node id of each zone is stored in a Bloom filter, which is exchanged between the border nodes. The bloom filter assists in forwarding the routing packet to the specified link, thereby reducing the control overhead.

II.MATERIALS AND METHODS

This paper proposes Power management & load balancing dependent on fuzzy logic technique aimed at ZRP in MANET. In this technique, the duty-cycles of the border nodes are adaptively adjusted based on the queue state, predicted residual energy and distance to border nodes. During each round, the nodes are in active state and then enter into the sleep mode based on estimate duty-cycle length.
Then the zone leaders (ZL) are adaptively changed whenever its load exceeds.

For each node in ZRP, a routing zone (RZ) with radius r remains established. Individually. (ie) Each zone consists of nodes within r hop distance at the maximum. Hence zones may overlap each other. ZRP contains a proactive and reactive routing module: IntrA-zone Routing Protocol (IARP) &IntEr-zone Routing Protocol (IERP). IARP manages a routing table for all nodes which belongs to its RZ. IERP applies route discovery technique to set up routes aimed at the nodes which are outside the zone.

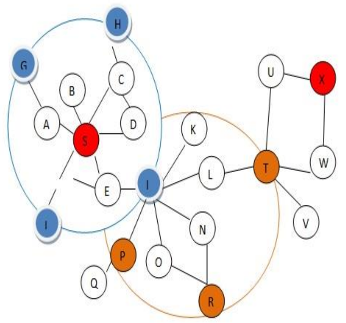

Figure 1 ZRP architecture

For example.let is consider the network depicted in Figure 1. In this network, R is fixed as two hops. S and X indicate the sender and receiver nodes and their routing zones are marked in blue and brown circles, respectively. S examines the routing table, whether X belong its zone. In this figure, since X is exterior to the RZ of S, the route request is broadcast towards the border nodes G,H, I & J (marked blue color in figure). When node I receives the request, it broadcasted to its boundary nodes P, R, &T once more (marked brown color in figure).Since the destination X belongs to routing zone of T, it includesroad towards X from itself. Then X sent path answerwhich containsreverseroute to S.

Fuzzy logic is used to determine the optimum duty cycle period by Taking into account the expected residual energy as well as the gap to the ZL parameters, as input. Depending on the output of fuzzy logic, duty cycle is adaptively adjusted. The distance from the node $N_i$to ZL is denoted as D_{iZL} .When estimating the residual energy on nodes in a path, the traffic load of the nodes has to be considered. The total energy consumed by a node N_i at time is then given by

$$TEC_i(t) = QL(t).EC \qquad (1)$$

Where EC is the energy consumption required to transmit a single packet, which is given by

$$EC = (E_{tx} + E_{rx}) \qquad (2)$$

Where,

$E_{tx}$is the energy utilized for transmitting a packet
$E_{rx}$is the energy utilized for receiving a packet
$QL$is the queue load at time t which depends on the queue size of the node and estimated using the following Eq.

$$QL_i(t) = [\frac{Q}{Q_{max}}] \qquad (3)$$

where Q denotes the queue's number of packets
andQ_{max}remains the maximum size of the queue

Then the predicted residual energy of N_i after transmitting n packets can be computed by

$$RE_p = CRE_i(t) - n.TEC_i(t) \qquad (4)$$

Where $CRE_i(t)$ is the current residual energy of N_i at time t.

Let RE_{max} be the maximum remaining energy of a node.

Then the sleep duty cycle of the receiver is computed as

$$Time_{sleep} = Int_{sl} + w.(RE_{max} - RE_p) \qquad (5)$$

Where Int_{sl} is number of sleep intervals and $w$is a weighting constant.

The value of $w$is adaptively adjusted using Fuzzy logic, as explained in the next section.

The FLD model is illustrated in Figure 2.

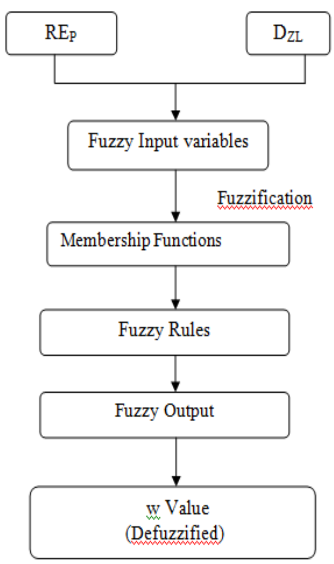

Figure 2 FLD Model

The FLD model involves the following phases: Fuzzification, rule evaluation, Fuzzy rules aggregation and Defuzzification.

Fuzzification: The input variables are represented as fuzzy sets of three values: large, medium, and low during this process.Figures 3, 4 and 5 show the fuzzy sets and membership functionsof the input & output variables.In our model, we use a triangular fuzzy package.

For Re_p, Low = 0 to 4 joules, Medium = 2 to 6 joules, High=4 to 8 joules

For D_{ZL}, Low = 0 to 4 hops, Medium = 2 to 6 hops, High =4 t0 8 hops

For w,   Low = 0 to 2, Medium = 1 to 3, High = 2 to 4.

Fuzzy rules aggregation: Table 1 shows fuzzy decision rules, based on the membership functions. The outcome of each rule is combined to derive a fuzzy decision.

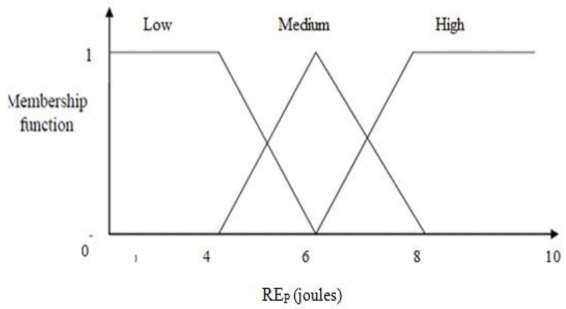

Figure 3 Membership Function ofRE_p

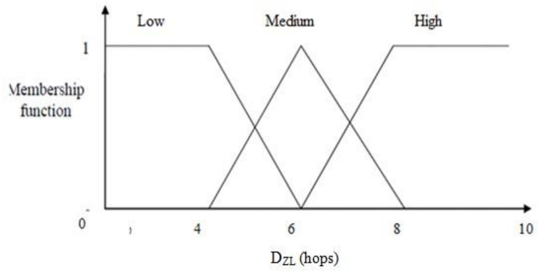

Figure 4 Membership Function of D_{ZL}(hops)

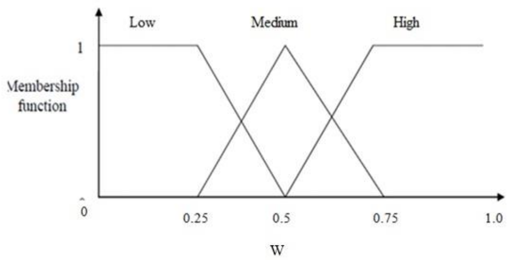

Figure 5 Membership Function of$w$

Table 1 Fuzzy decision rules

Rule no.	RE_P	D_{ZL}	w value
1	Low	Low	Medium
2	Low	Medium	High
3	Low	High	High
4	Medium	Low	Medium
5	Medium	Medium	Medium
6	Medium	High	Medium
7	High	Low	Medium
8	High	Medium	Low
9	High	High	Low

When a node's RE_p is negative, it is unable to forward packets to ZL, forcing it to sleep for longer periods of time. If the node is closer to ZL, though, it must be active a little sooner. As a consequence, w is assigned as Strong in rule 2, 3, and Medium in rule 1. Regardless of the distance to ZL, if $RE_p$is medium, the w is given a Medium rating. As a result of rules 4, 5, and 6, w is given a medium importance. Finally, if RE p is large, the node will stay in active mode for longer periods of time. As a consequence, the w value in rules 8 and 9 is set to Tiny. If the distance to ZL is less than that, the w value is set to

Defuzzification

For obtaining the crisp value from the fuzzy output set, the ***Centroid of Area***defuzzification technique is applied, which is given by the following equation

$$FC = [\sum_{allrules} f_i * \alpha(f_i) / \sum_{allrules} \alpha(f_i)] \qquad (6)$$

Where FC is the fuzzy cost function, $f_i$and $\alpha(f_i)$are the fuzzy rules and their membership functions, respectively.Here, FC returns the crisp value of the output.

The following algorithm shows the steps involved in the fuzzy based adaptive duty cycle scheduling.

Algorithm-1

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1. For each source $S_i = 1,2, \dots N$
2. For each intermediate node $N_j, j = 1,2 \dots . K$
3. N_j estimatesRE_P and D_{iZL}
4. RE_P and D_{iZL}remain passed as input variables towards Fuzzy Logic Decision(FLD) typical
5. The input and output variables are fuzzified.
6. Table 1 shows how fuzzy laws are implemented and fuzzy production is recovered.
7. Defuzzificationremains performed then the value w is returned.
8. Estimate the duty cycle of N_j based on the output w, using Eq.(5)
9. $N_j$is set towards sleep for a period$Time_{sleep}$
10. End For
11. End For

Load Balancing

Let $L_j^1, j = 1,2 \dots K$ are the zone leaders along the zone radius of source S_1.

Let P_1 be the route from S_1 to D

Let PC_j be the path counter which stores the number of paths that pass through ZL_j^1

Let PC_{max} be the maximum number of paths that can be handled by ZL_j^1 without overload

Let $OLrate_j$ be the rate of overloaded incoming traffic atZL_j^1

Let C_{max} is the maximum capacity of ZL_j^1

Algorithm- Load Balancing at Zone Leaders

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1. For each S transmitting data to D
2. For each ZL_j^1
3. $PC_j = 1$
4. If another source S’ tries to

transmit data through ZL_j^1 ,
then
5. $PC_j = PC_j + 1$
6. End if
7. If $PC_j >$ PC_{max} then
8. ZL_j^1 is overloaded
9. Transmission though ZL_j^1 is stopped
10. Determine $OLrate_j$ as

$$OLrate_j = QL_i - C_{max}$$

11. ZL_j^l transmits $OLrate$ value as a feedback to S_2.
12. S_2 transmits the overloaded part of the traffic through another ZL.

13.End if
14. End For
15. End For

III.RESULTS AND DISCUSSION

FSLBZRP is implemented in NS2 and contrasted against PSO-IZRP [11] protocol.Theexperimental settings are given in Table 2.

Table 2 Experimental settings

Number of nodes	25 to 100
Topology size	800m X 800m
MACprotocol	IEEE 802.11
Traffic type	Constant Bit Rate (CBR)
Number of connections	5
Type of propagation	TwoRayGround
Antennamodel	OmniAntenna
Assigned energy	20Joules
Transmitpower	0.8 watts
Receivepower	0.5 watts
Data sending rate	250Kb/s
Speed of nodes	5m/s to 25m/s

Case -1 Varying thenodes

In first test case, the network sizeisincreased from 25 to 100 nodes.

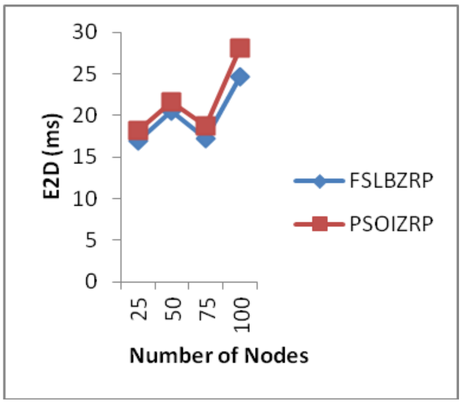

Figure 6 E2D for case-1

Figure 6 shows the results of E2D for case-1. As per the figure, the delay of FSLBZRP, varies from 16.8 ms to 24.6 ms and delay of PSOIZRP varies from 18.2 ms to 28.1 ms. Hence FSLBZRP achieves 8% lesser delay than PSOIZRP.

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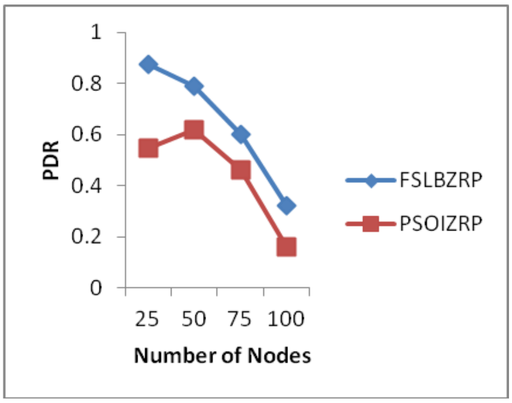

Figure7PDR for case-1

Figure 7 shows the results of PDR for case-1. As per the figure, the PDR of FSLBZRP, decreases from 0.87 ms to 0.32 and PDR of PSOIZRP decreases from 0.54 ms to 0.16. Hence FSLBZRP achieves 33% higher PDR, than PSOIZRP.

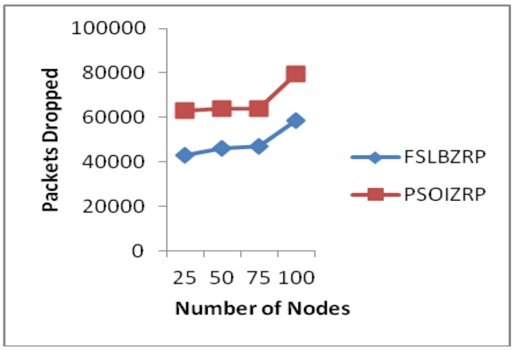

Figure 8Number of packetdrops for case-1

Figure 8 shows the number of packet drops aimed atcase-1. As per the figure, the number of droppedpackets for FSLBZRP increases from 43090 to 58372 and the same for PSOIZRP increases from 62975 to 79615. Hence FSLBZRP achieves 28% lesser packet drop than PSOIZRP.

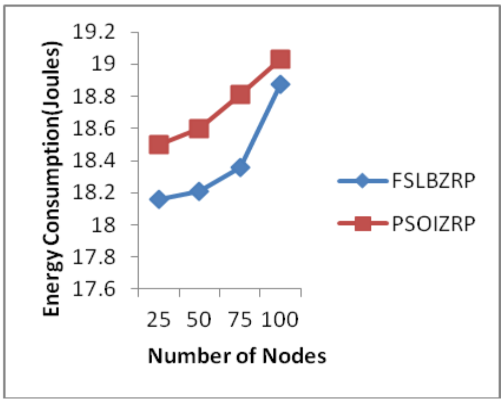

Figure 9 Energy Consumption for case-1

Figure 9 shows results of average energy consumption for case-1. As per the figure, consumedenergy of FSLBZRP varies from 18.1 joules to 18.8 joules and consumed energy of PSOIZRP increases from 18.5 joules to 19 joules. Hence FSLBZRP achieves 2% lesser energy consumption than PSOIZRP.

Case-2 Varying the nodespeed

In second test case, speed of the mobile node is varied from 5 to 25 m/s.

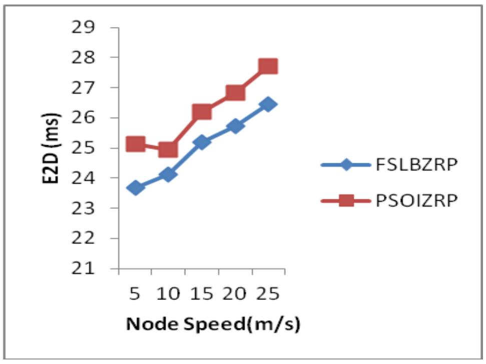

Figure10 E2D for case-2

Figure 10 shows the results of E2D for case-2. As per the figure, the delay of FSLBZRP, varies from 23.6 ms to 26.4 ms and delay of PSOIZRP varies from 25.1 ms to 27.7 ms. Hence FSLBZRP achieves 4% lesser delay than PSOIZRP.

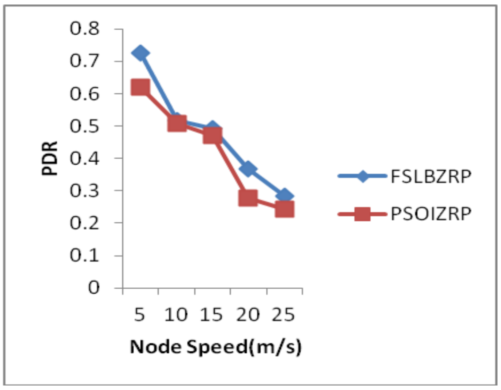

Figure 11 PDR for case-2

Figure 11 shows the results of PDR for case-2. As per the figure, the PDR of FSLBZRP, decreases from 0.72 ms to 0.28 and PDR of PSOIZRP decreases from 0.62 ms to 0.24. Hence FSLBZRP achieves 11% higher PDR, than PSOIZRP.

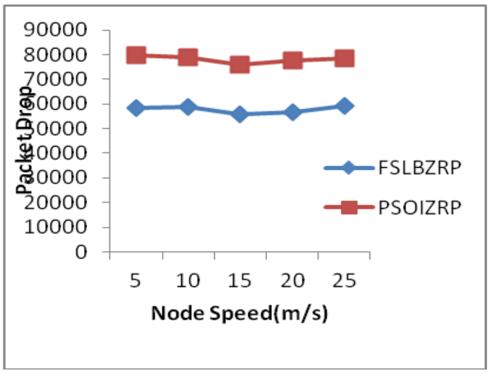

Figure 12Number of packetsdropped for case-2

Figure 12 shows the packets dropped for case-2. As per the figure, the number of packet dropsfor FSLBZRP increases from 58372 to 59115 and the same for PSOIZRP increases from 79615 to 78503. Hence FSLBZRP achieves 26% lesser packet drop than PSOIZRP.

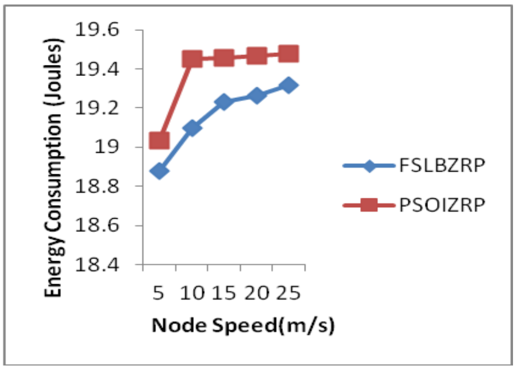

Figure 13 Energy Consumption for case-2

Figure 13 shows results of average energy consumption for case-2. As per figure, consumed energy of FSLBZRP varies from 18.8 joules to 19.3 joules and consumed energy of PSOIZRP varies from 19.0 joules to 19.4 joules. Hence FSLBZRP achieves 2% lesser energy consumption than PSOIZRP.

IV. CONCLUSION

In this work, Fuzzy based power scheduling & load balancing technique for ZRP (FSLBZRP) has been proposed. In this protocol, thesleep time period of zone member nodes is adaptively adjusted. Then the zone leaders (ZL) are adaptively changed whenever its load exceeds. The proposed FSLBZRP technique is implemented in NS2 and its performance is compared with PSO-IZRP protocol. Simulation results have shown that FSLBZRP attains increased PDR with reduced energy consumption.

V. FUTURE SCOPE

Future work focus on integrating some location based routing protocols over zone routing protocols.

Conflict Of Interest:

There are no conflicts of interest among the publishers.

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