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Trustworthy Link Failure Recovery Algorithm for Highly Dynamic Mobile Adhoc Networks

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***Abstract*—**The Trustworthy link failure recovery algorithm is introduced in this paper, to provide the forwarding continuity even with compound link failures. The ephemeral failures are common in IP networks and it also has some proposals based on local rerouting. To ensure forwarding continuity, we are introducing the compound link failure recovery algorithm, even with compound link failures. For forwarding the information, each packet carries a blacklist, which is a min set of failed links encountered along its path, and the next hop is chosen by excluding the blacklisted links. Our proposed method describes how it can be applied to ensure forwarding to all reachable destinations in case of any two or more link or node failures in the network. After simulating with NS2 contains lot of samples proved that the proposed protocol achieves exceptional concert even under elevated node mobility using Trustworthy link Failure Recovery Algorithm.

***Keywords*—**Wireless Sensor Networks, Predistribution Scheme, Cryptographic Techniques.

I. Introduction

RADITIONAL routing protocols may fail in a Mobile Adhoc Network (MANET) due to unpredictable network disconnectivity caused by mobility of the similar type of nodes [1]. Therefore, Opportunistic routing protocols have been initially proposed. Opportunistic routing [7] selects a best forwarder at each hop according to some metrics such as distance to the intention, link steadiness and throughput with high performance. To prevent routing information from becoming stale Geographic routing [8] is used to exploit the one-hop neighbour's information about the spatial details. A modified routing hole is about to be implemented when no forwarders are found [10]. Hence, a back-up mode algorithm is required to enable routing around the hole in an effective and efficient manner [9].

II. Review of Literature

Several Geographic Opportunistic routing protocols that enhance reliability have been proposed earlier. The main methods which are proposed are discussed in the following:

A. Simple Opportunistic Adaptive Routing Protocol (SOAR)

Rozner, Seshadri et al. proposed Simple Opportunistic Adaptive Routing Protocol (SOAR) [2] which selects the default path and a list of forwarding nodes based on Expected Transmission Count (ETX). This protocol achieves high throughput and deals efficiently with equality. Nevertheless, intervallic capacity and distribution of link quality drains node energy.

B. Geographic Opportunistic Routing (GOR)

Kai Zeng et al. analysed Geographic Opportunistic Routing (GOR) using the one-hop throughput metric, namely Expected One-hop Throughput (EOT) [3]. The disadvantage is that the proposal fails to discuss the effect of retransmission of packets.

C. Virtual Routing Protocol (VRP)

Luiz Carlos P. Albini et al. proposed the Virtual Routing Protocol (VRP) [4] which defines a logical structure over the physical network to build routes. Although the protocol is found to achieve high packet release probability, Virtual Routing Protocol performs very poorly under huge traffic conditions.

D. Greedy Perimeter Stateless Routing (GPSR)

Brad Karp and H.T. Kung proposed Greedy Perimeter Stateless Routing (GPSR) [5] protocol which makes greedy forwarding decisions using one-hop information. When greedy forwarding is unworkable, the GPSR algorithm recover by routing around the boundary of the section. This protocol has a small number of disadvantages. The beacons result in a constant level of routing protocol traffic and location lookup increases the overhead of GPSR.

E. Extremely Opportunistic Routing Protocol (ExOR)

Sanjit Biswas and Robert Morris proposed Extremely Opportunistic Routing Protocol (ExOR) [6], which chooses the forwarder with the lowest remaining cost to the final target node. Though it transmits each packet fewer times causing less interference, the ExOR header grows with the batch size and many transfers may only have a few packets.

III. Proposed Routing Protocol

Best Forwarder Selection Opportunistic Routing protocol is designed to achieve maximum reliability in a mobile adhoc network by attractive the packet delivery ratio.

Fig. 1 shows the architecture design of Best Forwarder Selection Opportunistic Routing Protocol. For randomly deployed nodes, the distance and link metrics calculations enable best forwarder selection. On delivery a forwarding failure signal, a Trustworthy Link Failure Routing Algorithm is used for the link failure between source and the destination nodes dynamically. When a probable forwarder is to create the

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normal Best Forwarder Selection Opportunistic Routing algorithm is invoked.

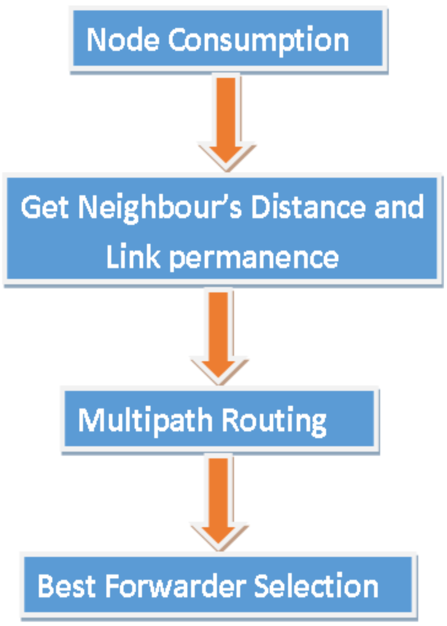

Fig. 1 Architecture Design of Best Forwarder Selection Opportunistic Routing

Distance calculation between any source or destination nodes, say node a and node b is based on Euclidean distance given by (1):

$$d = \sqrt{(a-b)^2 + (c-d)^2} \qquad (1)$$

where a and b are the x-coordinates of nodes a and b respectively and c and d are the y-coordinates of nodes a and b respectively.

Frii's free-space equation [9] is used to obtain the free space reception power of a receiver antenna separated from a transmitting antenna by a distance d. When system loss L is included [10], the equation becomes,

$$P_r(d) = \frac{P_t\, S\, T\, w^2}{(4\pi d)^2 L} \qquad (2)$$

where, P_t = Power transmitted by transmitter; S = receiver gain of transmitter; T = receiver gain of receiver; w = Wavelength; d = Euclidean distance between the sender and receiver; L = System loss.

A link with maximum P_r is considered more stable compared to its neighbors and hence reliable for packet transmission.

The source node obtains the address of the destination from a location registration and lookup service. It attaches destination's address to the packet header. The node which makes positive progress towards the destination and with the maximum power for reception gets the highest priority to become the best forwarder. Candidate nodes are selected from the forwarding area. The candidate list is attached to the packet header and the packet is transmitted. The best forwarder nodes cache the packets which have to be delivered. If the best forwarder fails to transmit the packets within a threshold time, the candidate node with the next highest priority transmits the packet. All other nodes get suppressed on hearing the transmission and drop the cached packets.

Fig. 2 illustrates the Source node S and Destination node D. R is the radius of the broadcast range of source node S. The nodes in the area enclosed within the dashed arc make positive progress towards the destination. From unfailure source nodes, the one with maximum power for reception is chosen as node B is the best forwarder node.

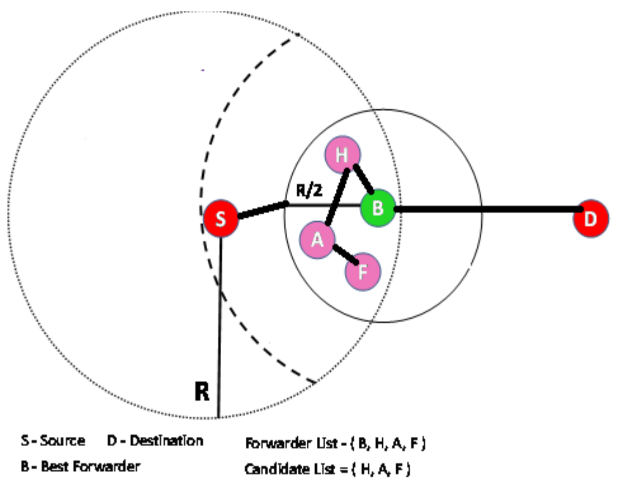

Fig. 2 Best forwarder and Candidates Selection

From the above diagram, the Forwarder List and Candidate List can be calculated using the Source and Destination nodes.

IV. Trustworthy Link Failure Recovery Algorithm

Trustworthy Link Failure Routing Algorithm is given below

Step 1. If any failure of link between nodes is detected then Go to Step 2

Step 2. Go to step 4 for link recovery

Step 3. Else data packet is transmitted from source to destination

Step 4. TLFR is activated

Step 5. The intermediate node receives RERR act as the source node

Step 6. Select the first entry in the RBT stack as the immediate node

Step 7. Create modified path using RBT information in each node

Step 8. Transmit data packets via modified path to destination

Step 9. Update the new route with replace the existing route to the source node.

V. Performance Evaluation

The performance of Best Forwarder Selection Opportunistic Routing is evaluated through a simulation study using NS-2.34.

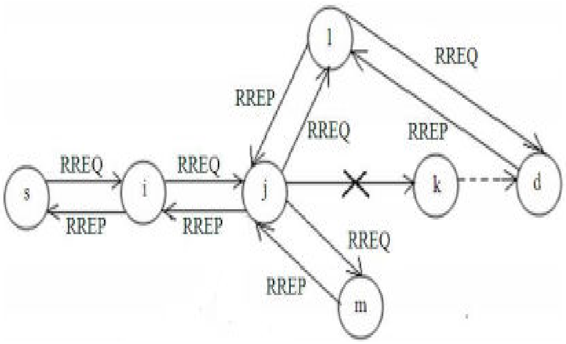

Fig. 3 Implementation of TLFR Algorithm

TABLE I
SIMULATION PARAMETERS

Parameter	Value
Number of nodes	160
Transmission range	225 m
Speed	10, 30, 50, 100 m/s
Network topology	800 x 800 m^2
Antenna model	Omni antenna
Transmitter antenna gain	1 dBi
Receiver antenna gain	1 dBi
System loss factor	1.0
Transmitter signal power	0.28 watts
Propagation model	Two-ray ground
Simulation time	200 sec

A. Performance Metrics

- *Packet Delivery Ratio*: This ratio of the number of data packets received at the destination to the number of data packets sent by source.
- *End-to-end-delay*: This time taken for a packet to be transmitted from the source to the destination.
- *Path Length:* This average end-to-end number of hops for successful packet delivery.
- *Packet forwarding times per hop*: The average number of times a packet is being forwarded to deliver a data packet over each hop given by,

$$\mathrm{FTH} = \frac{\mathrm{N_s}+\mathrm{N_f}}{\sum_{i=1}^{N_r}\mathrm{N_{hi}}} + \mathrm{t} \tag{3}$$

where $\mathrm{N_s}$ is the Number of packets at the source, $\mathrm{N_f}$ is the Number of packets at the forwarded, and $\mathrm{N_r}$ are the number of packets received at the destination respectively. $\mathrm{N_{hi}}$ is the number of hops for the i^{th} packet that is successfully delivered.

- *Packet forwarding times per packet (FTP):* The average number of times a packet is being forwarded to deliver a data packet from the source to the destination given by,

$$\mathrm{FTP} = \frac{\mathrm{N_s}+\mathrm{N_f}}{\mathrm{N_r}} + \mathrm{t} \tag{4}$$

B. Comparative Analysis

The performance of Best Forwarder Selection Opportunistic Routing is compared with Position-based Opportunistic Routing (POR) protocol. In Fig. 5 Best Forwarder Selection Opportunistic Routing is found to achieve high packet delivery ratio, therefore performs reliable delivery of packets.

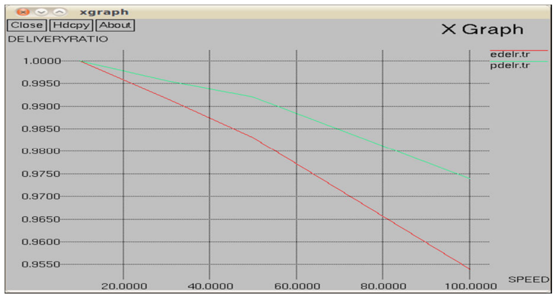

Fig. 4 Comparison graph for Packet Delivery Ratio

In Figs. 5 and 6, the packet forwarding times per hop and the number of forwarding times per packet are significantly reduced in Best Forwarder Selection Opportunistic Routing. The candidate nodes can be accounted for such an improved performance.

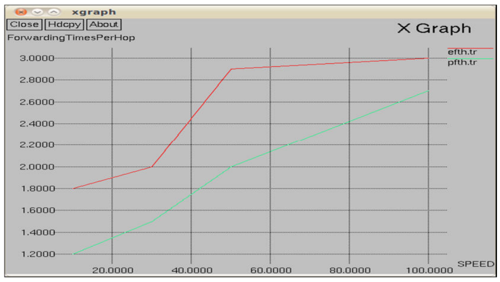

Fig. 5 Comparison graph for FTH

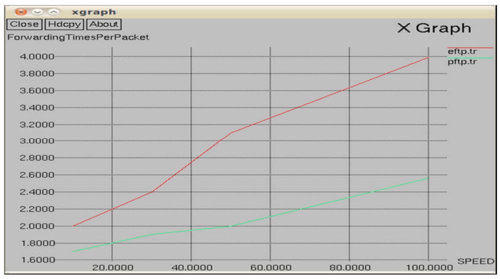

Fig. 6 Comparison graph for FTP

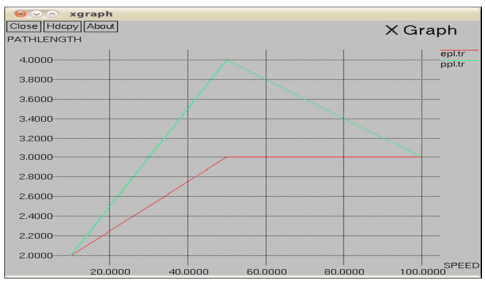

Fig. 7 Comparison graph for Path Length

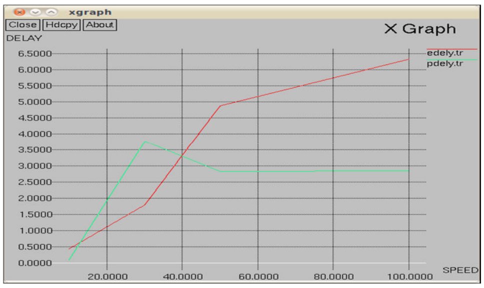

Fig. 8 Comparison graph for End-to-end delay

VI. Conclusion

Since distance metric has not been considered for forwarder selection for large number of nodes, the path length may not be always minimal causing a varying end-to-end delay. The Polynomial time for the Forwarded selection has been reduced. Using Trustworthy Link Failure Recovery Algorithm reduces the Number of Link Failures.

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