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DVRA-SN: Neighbour Based Distance Vector Routing Protocols for Mobile Ad Hoc Networks

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***Abstract*— MANET has emerged as one of the most focused and trust research area in the field of wireless networks and wireless mesh networks. A major thrust of the protocol designers towards the development and deployment of distance vector routing based protocols, irrespectively in wired, wireless or even in ad hoc and sensor networks is primarily because of the conceptual and implementation simplicity and elegance coupled with the minimum information requirement by each node. A good amount of research has been done in the past towards the improvement of routing algorithms in MANET, but the area has not become stable till date. This paper proposes a neighbour based routing protocol that supports a mobile node as special neighbours in the network for making packet forwarding decisions and creates route only when desired by the source node as in case of reactive routing protocol.**

***Keywords*— MANET, Distance Vector Routing, DVRA-SN, Special Neighbours, Neighbouring Table Algorithm.component**

I. Introduction

MANET is a collection of mobile devices denoted as nodes, which can communicate between themselves using wireless links without the need or intervention of any infrastructure like base stations, access points etc [1],[2]. A node in a MANET, which is equipped with a wireless transmitter and receiver (transceiver) and is powered by a battery, plays the dual role of a host and a router as well. Two nodes willing to communicate with each other need to be either in the direct common range of each other or should be assisted by other nodes acting as routers to carry forward the packets from a defined source to a destination in the best possible routing path [3], [4].

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Internet Engineering Task Force (IETF) activity has standardized several routing protocols for MANET. Routing protocols are the backbone to provide efficient services in MANET, in terms of performance and reliability. Designing routing protocol in MANET is quite difficult and tricky compared to that of any classic or non-ad hoc (formal) network due to some inherent limitations of the MANET like dynamic nature of network topology, limited bandwidth, asymmetric links, scalability, mobility of nodes limited battery power and alike. Moreover, the intrinsic nature of the nodes to move freely and independently in any arbitrary direction by potentially changing ones link to other's on a regular basis, is really an exigent concern while designing the desired routing algorithm. MANET is IP based and the nodes have to be configured with a free IP address not only to send and receive messages, but also to act as router to forward traffic to some destination unrelated to its own use.

The main challenge to setup a MANET is that each node has to maintain the information required to route traffic properly and thus designing a routing protocol for MANET has several difficulties. Firstly, MANET has a dynamically changing topology as the nodes are mobile. However, this behavior favors routing protocols that dynamically discover route, Associativity Based Routing (ABR) [5]-[7] over conventional distance vector routing protocols (DVR) [8],[9]. Secondly, the fact that MANET lacks any structure and thus makes IP subnetting inefficient. Thirdly, limitation of battery power and power depletion of nodes due to large number of messages passed during cluster formation. Links in mobile networks could be asymmetric at times. If a routing protocol relies only on bi-directional links, the size and connectivity of the network may be severely limited; in other words, a protocol that makes use of unidirectional links can significantly reduce network partitions and improve routing performance. DVRP is one of two major routing protocols for communications approach that use packets which are sent over IP [9]. DVRP required routing how to report the distance of various nodes within a network or IP topology in order to determine the best and most efficient route for packets.

Finally, this new neighbour based DVR routing protocol is analyzed in this paper.

II. Background Details

Distance Vector Routing Protocol [10] is a dynamic, distributed, asynchronous and iterative routing protocol where the routing tables are continuously updated with the information received from the neighbouring routers [10],[11] and operates by having each node j maintains a routing table, which contains a set of distance or cost $\{D_{ji}(x)\}$, where i is the neighbour of j. Neighbour j treats the neighbour k as the next hop for data packet destined for node x, if D_{jk}=mid i{(D_{ji})}.

As a distributed dynamic routing algorithm which is expected to adapt to changes in topology and traffic. The existing DVRA, though simple and conceptually elegant, suffers from some well-known problems like Count-to-Infirmity (CTI), slow convenience, looping, frequent route oscillation. Out of all these, the CTI is more vulnerable, which actually, made practical DVR out of race.

Though good amount of research has been done in the past towards the improvement of the basic DVRA [11], none of the proposed techniques like Hold-Down, Split Horizon and Poison Reverse have been able to satisfactory solve the problems in the DVRA. The routing table gives the shortest path to each destination and which route to get update and to keep the distance set in the table updated, each router exchanges routing table (RT) with all its neighbours periodically.

III. Proposed Routing Scheme-DVRA-SN

Let us assume, when a router R_j after booting, joins a network, it first builds its own routing table $DVRT_j$ and then, after achieving stable routes, proceeds for the next operation of creating its own neighbour table NT_j. Towards this it calls a subroutine NT_Creation(), which has as its input, all the DVRTs received from the neighbours along with $DVRT_j$ itself. The subroutine NT_Creation() is a very important module in the DVRA-SN, which is used by the router Rj to identify all its neighbours, such as FN, DN, CN, CDN, PN, LDN etc.[11], [12] and enters their identities in NT_j under the appropriate column for each category of special neighbour. It is to be noted that a particular neighbour R_k of R_j may come under multiple special neighbour categories. In order for the router Rj, to identify a neighbour R_k under the special neighbour category it belongs to, the NT_Creation module calls the following algorithms/subroutines.

The following algorithm named as DNT_Creation, called by NT_Creation, is created and maintained by a router R_j, after it joins a network, to create its own Dependent Neighbour Table (DNT) which shows the DNs and CDNs of Rj for all destinations except the neighbours. Unlike the NT, which is a neighbour-specific table, the DNT is a destination-specific table which keeps information regarding DN and CDN for each destination router in the network. The structure of the routing table and DNT was shown in Table 1 and Table 2, while illustrating the process of detection and utilization of special neighbours. As shown in Fig. 2, the DNT_Creation algorithm, in turn, calls DN_Detection and CDN_Detection subroutines to identify which neighbours of R_j are its DNs and which neighbours are its CDNs for reaching which destination.

TABLE 1: STRUCTURE OF THE ROUTING TABLE OF ROUTER K ($DVRT_K$)

DEST	DIST	NH

DEST: Destination, **DIST**: Distance, **NH**: Next hop router, **DN:** Dependent Neighbour, **CDN:** Co-dependent Neighbour, **FN:** Forwarding Neighbour, **PN:** Pendent Neighbour, **LDN:** Lost Destination Neighbour, **SN:** Sole Neighbour. **RT**: Routing Table, **PU:** Periodic Update, **TU**: Triggered update.

TABLE 2: STRUCTURE OF THE DEPENDENT NEIGHBOUR TABLE OF ROUTER K (DNT_K)

DEST	DN's of k	CDN's of k

A DVRT has N entries one corresponding to each known router in the N-node network. Each entry has 3 fields, namely, the identity of a destination router, the estimated distance (metric) of this router and, finally, the identity of the next-hop (NH) router, i.e., the FN in case of any remote router, for reaching that destination. In this paper we shall normally consider delay as the metric since the MDVRA [14] is expected to be fully adaptive, i.e., adaptive in respect of both topology and traffic. The short-form notations $DEST_i$, $DIST_i$ and NH_i will represent the values in the three fields of the i-th entry, i=1, 2, 3, …………, N in the DVRT of each router. The DVRT of the router R_j will be denoted by $DVRT_F$. It should be reiterated that the NH_i field will identify either the destination itself or the FN, depending upon the $DEST_i$ being a neighbour or a non-neighbour.

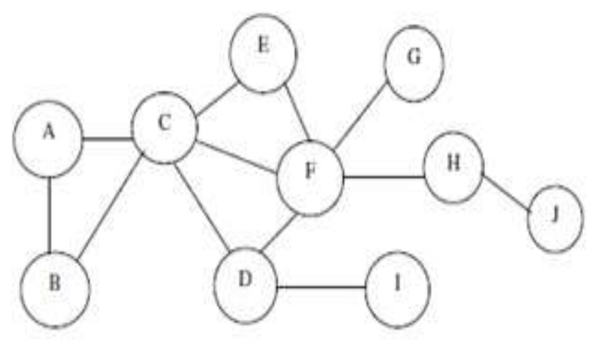

Fig. 1: Sample Network to be used in discussing the special neighbours of router F.

DEST	DIST	NH
C	D_{FC}	C
E	D_{FE}	E
G	D_{FG}	G
D	D_{FD}	D
H	D_{FH}	H
I	D_{FI}	D
A	D_{FA}	C
B	D_{FB}	C
J	D_{FJ}	H

TABLE 3: ROUTING TABLE OF ROUTER F ($DVRT_F$)

For each class of the special neighbours, we present the procedure for its identification (detection) and the method of its utilization cases of both topological and traffic, as may be significant. On the example network shown in the fig. 1 and view of this network as taken by taken by router F through the PU and TU of its DVRT coupled with exchange of DVRTs with its neighbours. We can also have two more tables namely, Neighbouring Table and Dependent neighbouring table for keeping track of special neighbours. Routing table of $DVRT_F$ shown in Table 3.

IV. DVRA-SN Algorithm

The proposed routing algorithm, named as DVRA-SN which is Distance Vector Routing Algorithm with Special Neighbours towards Dependent Neighbour Detection (DN_Detection) for a router k works in following steps:

Step 1: after it joins a network, to create its own Dependent Neighbour Table (DNT) which shows the DNs and CDNs of R_j for all destinations except the neighbours.

Step 2: unlike the NT, which is a neighbour-specific table, the DNT is a destination-specific table which keeps information regarding DN and CDN for each destination router in the network.

Step 3: the DNT_Creation algorithm, in turn, calls DN_Detection and CDN_Detection subroutines to identify which neighbours of R_j are its DNs and which neighbours are its CDNs for reaching which destination.

Step 4: after receiving the $DVRT_k$ from its neighbour R_k, R_j checks each entry in the $DVRT_k$ one by one. If in the entry for destination R_i ($R_i \neq R_j$) R_j finds that the NH is R_j itself, then R_j identifies R_k as its DN for reaching R_i and enters this information in DNT_j

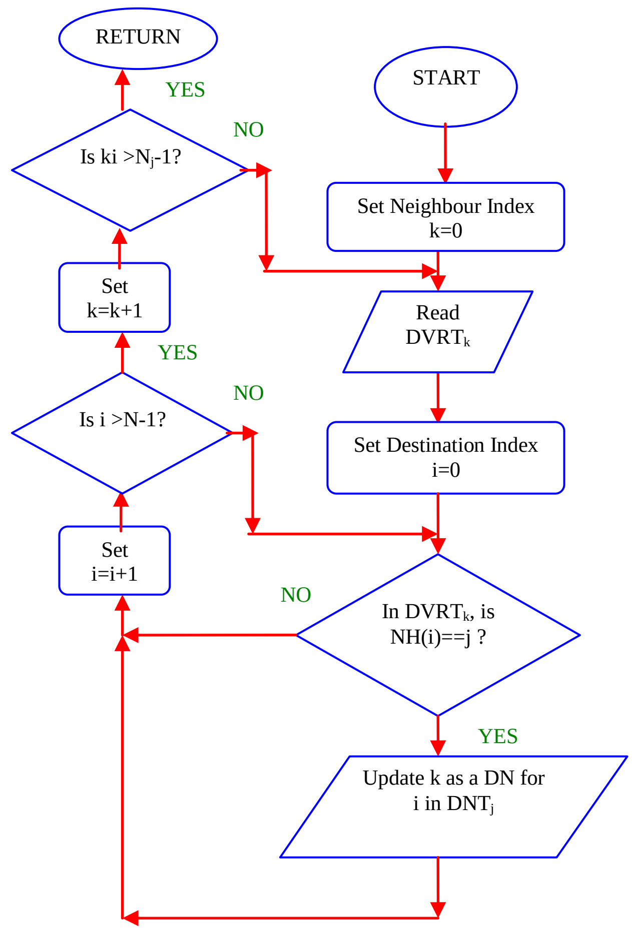

Fig. 2: Shows the Flowchart on Neighbouring Detection for a router k

A. Illustration 1

Let us consider in Figure 3 the failure of the link N_3-N_4 or of the router N_4 itself. In either case, router N_3 will simply not search for an alternative path for reaching N_4, since, its DNT shows that its only other neighbour N_2 is a DN of N_3 for reaching N_4, router N_3 will simply accept the truth immediately without wasting time and, accordingly, advertise the bad news (link failure of N_3, N_4 or has become infinity) to its only neighbour N_2 through $DVRT_{N3}$.

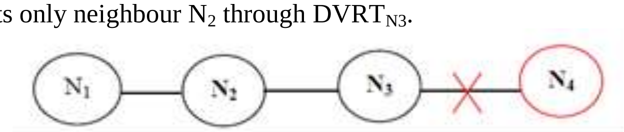

Fig. 3 An Example network for illustrating the utility of Co- Neighbour

B. *Illustration 2*

Similarly, router N_2, as well as router N_1 later, after receiving this bad news, will not look for any alternative path to reach N_4 and will simply update their own routing tables showing N_4 as unreachable. Thus, within a while, with only N_4 number of message transmissions (MT), the whole network comes to a stable state

(ii) As shown in in Figure 4, if at any point of time, N_2 finds that its neighbour N_3 has become unreachable which could be due to the failure of the link N_2 N_3 or due to failure of router N_3, Router N_2 assigns, as an interim measure, probable infinity route (PRI) to distance D_{N2N3} (i.e D_{N2N3}=PRI) in its own routing table $DVRT_{N2}$, and send this updated $DVRT_{N2}$ to all its neighbours, namely N_1 and N_2, thereafter N_2 waits until any reply in the form of DVRT arrives from both N_1 and N_6 within a stipulated time.

(iii) In the example network shown in figure 4, if the link N_1 N_2 fails, then the concept CDN in association with that of the DN.

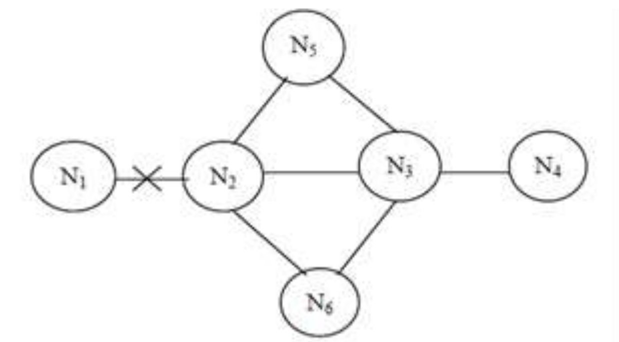

Fig. 4 An Example network for illustrating the utility of Co- Dependent Neighbour

Router N_2, after recognizing that N_1 has become unreachable, does not take help from any of its remaining neighbours since all of them are its DNs for reaching router N_1. Then N_2 advertises HTI distance to N_1 to all its neighbours, namely, N_3, N_5 and N_6, through $DVRT_{N2}$. Both N_5 and N_6, after receiving the bad news from N_2 through $DVRTN_2$, looks for help to router N_3 but gives up as N_3 is their CDN for reaching N_1, N_2 being their common FN. Hence both N_5 and N_6 update their respective DVRTs with HTI distance for router N_1. Router N_3, upon receiving this bad news from N_5 and N_6 regarding the unreachability of N_1, updates its own routing table $DVRT_{N3}$ by a HTI distance for node N_1 since its only other neighbour N_4 is a DN of N_3 for reaching N_1.

V. Conclusion

In this paper, we present a Special Neighbour-based Distance Vector routing protocol for MANETs, which mobile node can dynamically switch the running protocol between proactive and reactive modes. In this paper we studied the new approach which will result in less routing overhead than most of the routing algorithms.

Our future study will include algorithms for optimizing the node allocation and overcome certain network issues, like network-merging and network-partition. And evaluation of this protocol performance through simulator. We are now in the state of implementing this protocol in NS2.

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