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A CBNR: New DVR - Based Routing Approach in Mobile Ad Hoc Networks

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Abstract - In Distance Vector Routing (DVR), each node maintains a list of all destinations that only contains the cost of getting to that destination, and the next node to send the messages to. Thus, the source node only knows to which node to hand the packet, which in turn knows the next node. This approach has an advantage of massively reduced storage costs compared to link-state algorithms. DVR algorithms are easier to implement and required less amount of required storage space and the actual determination of the route is based on the Bellman-Ford algorithm. Our motive was primarily intended to remove the weaknesses inherent in the widely used DVR based algorithm, which was established on the well-known Bellman-Ford shortest path algorithm. In this paper, we proposed a new routing approach named as component based neighbour routing (CBNR) that uses to create the distance vector routing table (DVRT) that would be truly dynamic, robust and free from the various limitations that have been discussed.

Keywords - *Distance Vector Routing, Special Neighbours, SCCN, MCCN, MCNbCN, CBNR.*

1. Introduction

A Mobile Ad-hoc network 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][3]. 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]. 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 have several difficulties. Firstly, MANET has a dynamically changing topology as the nodes are mobile. However, this behavior favors routing protocols that dynamically discover routes (e.g. Dynamic Source Routing [5], TORA [6], Associativity Based Routing (ABR) [7] etc.) over conventional distance vector routing protocols (DVR) [5][6][8].

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.

2. Background

Distance Vector Routing Protocol (DVRP)[10,13] is one of two major routing protocols for communications approach that use packets which are sent over IP [14]. 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.

DVRP is a dynamic, distributed, asynchronous and iterative routing protocol where the routing tables are continuously updated with the information received from the neighbouring routers [13, 14] and operates by having each node j maintains a routing table, which contains a set of distance or cost {Dji(x)}, where i is the neighbour of j. Where neighbour j treats the neighbour k as the next hop for data packet destined for node x, if Djk=mid i{(Dji)}.

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.
There are few drawbacks in distance vector routing as follows:

2.1 Slow Convergences

When there is an increase in the cost of any link or there is a link failure between two neighbouring nodes in a network or internetwork, the algorithm, in the worst case, may require an excessive number of iterations to converge or to terminate.

Compared to Dijkstra algorithm, Bellman-Ford requires multiple passes of the cost information. In a network with quickly changing topology, this can lead to situations where the link states have changed before an optimum route has been setup.

2.2 Count to Infinity

The DVR does not work well if there are topological changes in the network (or the internetwork). This is primarily due to the fact that the distance vector sent to the neighbours does not contain sufficient information about the topology of the internetwork.

As stated earlier, though considerably simple and elegant in concept, the DVR suffers not only from the problem of slow convergence but also from the more serious problem of Count to infinity which sometimes occurs following a link or router failure, due to unending routing loops involving two or more routers.

The essence of the problem is that if a node B tells the node A that it has a route to the destination, node A does not know if that route contains node A (which would make it a loop).

There are various proposed methods to overcome this drawback of DVR protocol. However, all of the proposed methods are designed based on the topology of the network. This statistic results is not absolutely solving of the problem for any arbitrary network topology and most of the proposed methods increase the complexity of the routing algorithms

3. Proposed Approach

The Single connected neighbour (SCN) is a node in the network graph having a degree 1, i.e., a router which is connected only to a single router, is called a Single-Connected Neighbour (SCN) of the sole router to which it is connected. The sole router recognizes its SCN as a Pendant Node (PN) in the network, Multi-Connected Neighbour is a neighbour which is not a SCN, is a Multi-Connected Neighbour (MCN) of each of its neighbouring routers.

Multi-connected component Neighbour by Co-neighbour (MCCNbCN) is a special kind of MCCN. MCNbCN detection subroutine is used by a router R_j for identifying its neighbourR_k as belonging to out of the following three other special neighbour categories.

(a) for detecting whether the neighbour$R_k$is SCN of R_j

(b) for detecting whether the neighbourR_k is a MCN of R_j

(c) for detecting whether the neighbourR_k is a MCNbCN for R_j

The characteristics for a neighbour$R_k$of R_j to become an Single-Connected Neighbour(SCN), Multi-Connected Neighbour(MCN), or a Multi-connected component Neighbour by Co-neighbour(MCNbCN) of R_j,

The composite subroutine SCN_MCN_MCNbCN detection has been developed in such a way that it is totally by itself, capable of identifying a neighbourR_k as belonging to one of the three special neighbor categories, namely, SCN_MCN_MCNbCN. The detailed flowchart for SCN_MCN_MCNbCN detection algorithm is given in Figure 1.

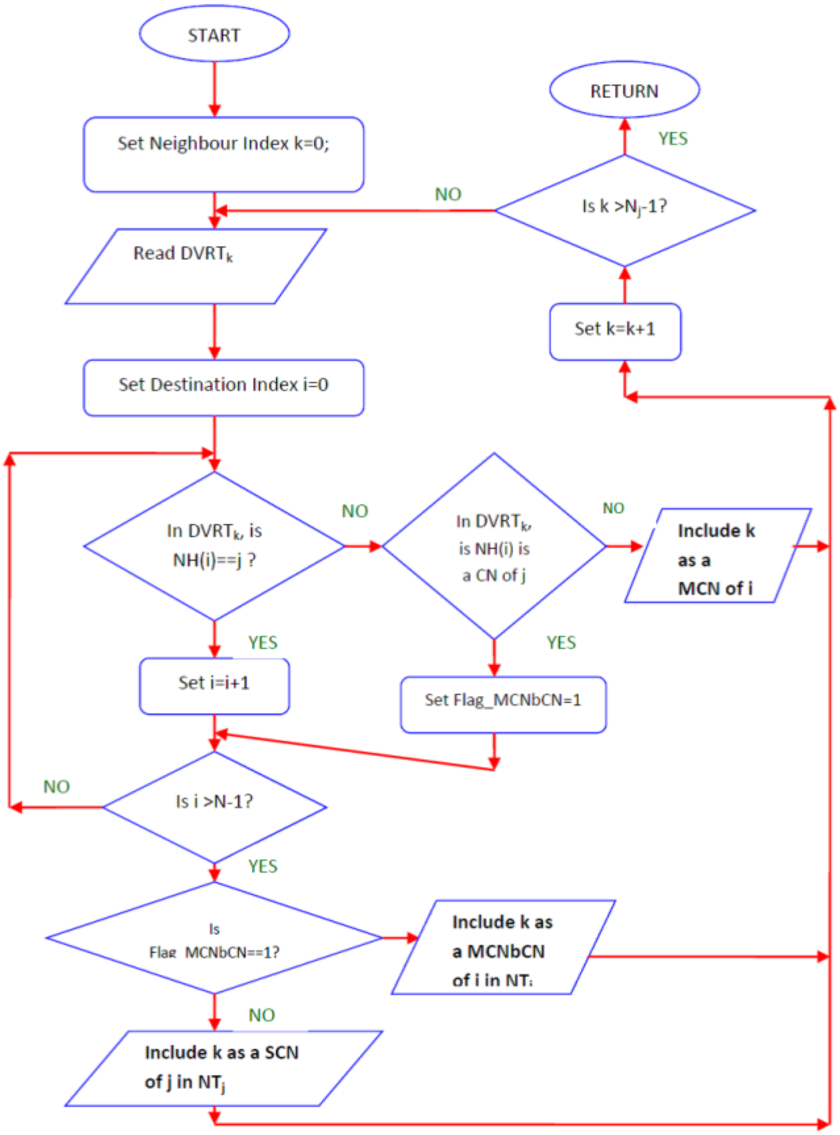

Fig. 1Flowchart of SCN_MCN_MCNbCN_Detection for Router j

3.1 SCN_MCN_MCNbCN_Detection Algorithm

3.1.1 Single-Connected Component (SCC) and Single-Connected Component Neighbour (SCCN)

In a N-node network, a router R_j having a set of neighboursS_{nj} containing $N_j$neighbours, may, at view the entire network around itself (excluding itself) as being composed of at most $N_j$components, based on its current routing strategy via the $N_j$neighbours (N_j is total number of neighbour of j) . All nodes contained within the particular component C_{jk} are reached by $R_j$via its all neighbouring router $R_k \in C_{jk}$, $R_k \in S_{nj}$. In other words, the set of nodes contained within the component C_{jk} may be viewed as a subset $S_N(j,k) \in S_N$ of nodes (destinations) that R_j reaches via its neighbourR_k, ($R_k \in S_{nj}$, $R_k \in S_N(j,k)$), (S_N is set of all nodes in the network and Snj is set of all neighbour of j) including R_k itself. The component C_{jk} must contain at least 2 nodes including R_k itself which will be called a component neighbour of R_j. Obviously; this implies that a component neighbour of R_j must act as the forwarding neighbour (FN) of at least one remote node of R_j. For example, the routers R_k (neighbouring router of j or R_j)

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and R_n are the component neighbours of the router R_j in figure 2. The 12-node network shows in figure 3 that, based upon shortest path routing with hop count used as the metric, for simplicity, D creates for its three neighbours, B, G and J, their respective components, namely, C_{DB},C_{DG} and $C_{DJ,}$ containing the subset of nodes S_N(D,B)={A,B,C}, S_N(D,G) = {E,F,G,H} and S_N(D,J)= {I,J,K,L} respectively. It is evident that if the component C_{jk} contains N_{jk} nodes and each neighbor of $R_j$is a component neighbor, then we can have following formula.

$$\sum_{i \in S_{nj}} N_{ji} = N-1 \quad (1)$$

Table 1. DVRTs of router D, B, G and J

Dest	NH	Dest	NH	Dest	NH	Dest	NH
A	B	A	A	A	A	A	D
B	B	B	-	B	-	B	D
C	B	C	C	C	C	C	D
D	-	D	D	D	D	D	D
E	G	E	C	E	C	E	D
F	G	F	C	F	C	F	D
G	G	G	D	G	D	G	D
H	G	H	D	H	D	H	D
I	J	I	D	I	D	I	I
J	J	J	D	J	D	J	-
K	J	K	D	K	D	K	I
L	J	L	D	L	D	L	L

Now a component C_{jk} is a Single-Connected Component (SCC) of R_j and, accordingly, the concerned neighbourR_k is a SCC Neighbour(SCCN) of $R_j$if the failure of the link R_jR_k, connecting R_j to C_{jk}, physically divides the entire network into two disjoint parts, namely, C_{jk} and the rest of the network which includes $R_j$itself. Obviously, under such a failure condition, no router in C_{jk} will be able to communicate with any router in the other part, i.e., in the rest of the network, and, vice-versa.A router views a SCC as a “Pendant Component” (PC) just like it views a SCN as a pendent neighbour (PN).

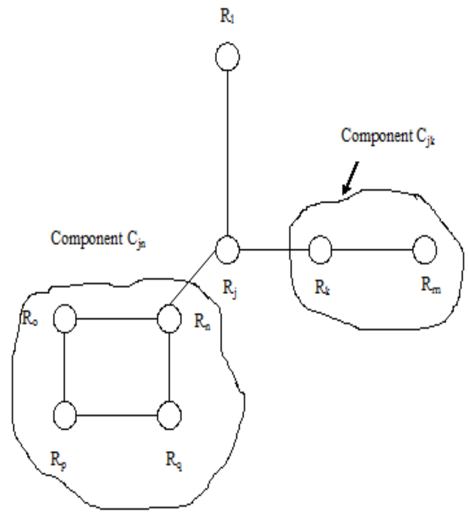

Fig. 2. A network showing the component neighbours$R_k$and R_n of router R_j

3.1.2 Multi-Connected Component (MCC) and Multi-Connected Component Neighbour (MCCN)

If, in the context of the neighbour-based partitioning scheme as explained and illustrated above, a component C_{jk} is a not a SCC of R_j, then it is a MCC of $R_j$and, accordingly, R_k is a MCCN of R_j. An MCC C_{jk} of router R_j does not get isolated from the rest of the network (this includes R_j) even if either the link R_jR_k or the router R_k fails because there is at least one more link that connects one router in C_{jk} with one router in any component of R_j other than C_{jk}. In Figure 3, the component C_{DB} and C_{DG} are MCCs of D (because of the link CF) and, accordingly, the concerned neighbours B and G, unlike the neighbour J, are its MCCNs.

(a) DVRTD (b) DVRTB (c) DVRTG (d) DVRTJ

3.1.3 Multi-Connected Component NeighbourbyCo-Neighbour (MCCNbCN)

If a router R_j has a MCCN $R_k \in C_{jk}$, such that R_k is connected to one or more CNs of R_j for R_k (besides being connected to R_j itself) and, additionally, these are the only connection(s) that make R_k a MCCN of R_j(rather than a SCCN), then R_k is a MCCNbCN of R_j. A MCCNbCN is a special kind of MCCN. It may be observed that in Figure 2, there is no MCCNbCN but the SCCN J of the router D would become its MCCNbCN if either a single new link BJ or GJ or two new links BJ and GJ are added to the network graph.

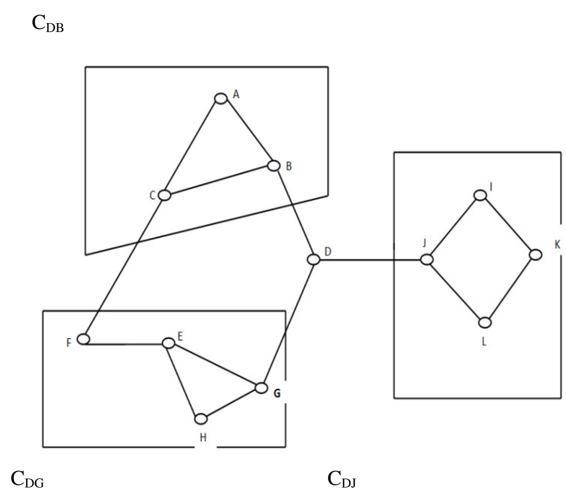

Fig.3View of the router D of the 12-node network as a set of 3 components, namely, C_{DB}={A, B, C}, C_{DG}={E, F, G, H} and C_{DJ} = { I, J, K, L }, respectively based around its three neighbours B, G and J.

Table II: NT_j showing three Component Neighbours based on its three neighbours B, G and J.

Components	Nbr	SCC	MCC	MCCN
C_{DB}	{A, B, C}	0	D	D
C_{DG}	{E, F, G, H}	0	D	D
C_{DJ}	{ I, J, K, L }	D	0	0

From the figure 2, we have three components namely C_{DB}, C_{DG} and C_{DJ} from which C_{DJ} is a SCC of D and, accordingly, J is a SCCN of D. C_{DB} and C_{DG} are MCCs of D so that B and G are MCCNs of D

Table III: NT_j showing Component Neighbours

Nbr	SCC	MCN	MCNbCN	SCCN	MCCN	C_{DB},C_{DG},C_{DJ}
B	0	D	0	0	0	(A, B, C} {E, F, G, H} { I, J, K, L }
G	0	D	0	0	0	
J	D	D	D	0	0	
D	J	0	0	J	B,G	
L	0	0	0	0	0	

From the table III, where N_{br} represents as neighbour, SCC is single connected component, SCCN is single connected component neighbour, MCN is multi connected component, MCCN is multi connected component neighbour, MCNbCN is Multi-Connected Component Neighbour by Co-neighbour.

4. Conclusions

Thus, it is evident from the above arguments and algorithm that in all of the above possible cases, a router j will always be able to detect whether any of its neighbours is an SCCN or an MCCN or a MCNbCN. Simulation experiment can be done for the above method. Thus our future work is to simulate the proposed methodology and will try to find more efficient, robust, dynamic algorithm as a solution to the scenarios of the component based component neighbours around its neighbours. Our present work is only on DVR based component neighbouring approach in ad hoc network.

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Bibilography

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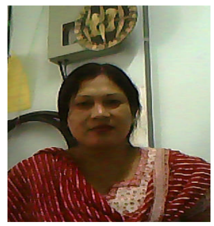

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