IJCES International Journal of Computer Engineering Science , Volume1 Issue2, November 2011
ISSN : 2250:3439
https://sites.google.com/site/ijcesjournal
http://www.ijces.com/

Study of Route Reconstruction Mechanism in DSDV Based Routing Protocols

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Abstract: Ad hoc networks are infrastructure-less collection of mobile nodes, characterized by wireless links, dynamic topology and ease of deployment. Proactive routing protocols maintain the network topology information in the form of routing Tables, by periodically exchanging the routing information. Mobility of nodes leads to frequent link breaks, resulting in loss of communication and thus the Information in the Table may become stale after some time. DSDV routing protocol follows proactive approach for routing and uses stale routes in case of link break, which is the major cause of its low performance as mobility increases. We have focused on two variants of DSDV namely Eff-DSDV and I-DSDV, which deals with the broken link reconstruction and discussed in these protocols, the process of route reconstruction due to broken links. To analyze this route reconstruction mechanism, we have used a terrain of size 700m × 800 m with 8 nodes placed randomly. Analysis shows that both Eff-DSDV & I-DSDV, perform better than DSDV in Packet Delivery Ratio and Packet Loss with slight increase in Routing Overheads.

Keywords: Route Reconstruction, Packet Loss, Packet Delivery Fraction, DSDV

1 Introduction

Ad-hoc network is a collection of self organizing, autonomous mobile nodes. The nodes in the network can move randomly and arbitrarily, to form a dynamic topology in the absence of pre-established infrastructure or central coordinator. The network utilizes multihop wireless links to forward the packets to the destination with the help of intermediate nodes.

On the basis of routing information update mechanism there are three categories of routing protocols for ad-hoc wireless networks [8], namely, proactive (Table driven), reactive (On-demand) and hybrid routing protocols. Proactive routing protocols constantly maintain the network topology information through periodic exchange of routing information, namely DSDV [10], WRP [12], CGSR [2] etc. On the other hand, reactive protocols create routes on-demand basis. Few of the on-demand protocols are DSR [2], [4], AODV [11], TORA [9], ABR [13] etc. Hybrid Protocols combines the features of both proactive & reactive protocols, example includes ZRP [3], SLURP [1] etc.

Destination-Sequenced Distance Vector (DSDV) routing protocol [10] for mobile ad-hoc networks (MANET), is a Table driven routing scheme, based on Bellman Ford algorithm. The main contribution of the algorithm is to solve routing loop problem by associating each node with a sequence number. It follows hop-by-hop routing, in which the route to a destination is distributed in the next-hop of the nodes along the route. Packets are transmitted between the nodes using route tables stored at each node. Each node maintains routing table with entry for every other node in the network. Route table entries are: Dest_addr, Dest_seq_no, next-hop, hop_count, and install_time. Sequence numbers are even if a link is present; else, an odd number is used to maintain the consistency of the route tables in a dynamically varying topology, each node relies on periodic exchange of routing information. It uses stale routes in case of link break due to mobility, which is the major cause of its low Packet Delivery Ratio and higher Dropped Packet rate.

2 Recent Works

The limited resources in MANETs have made designing an efficient and reliable Routing strategy a very challenging problem. An intelligent routing strategy is required to efficiently use the limited resources while at the same time be adaptable to the changing network conditions such as network size, traffic density, and network partitioning. Several variants of DSDV have been proposed [5], [6], [7], [14] in order to increase the performance of the DSDV protocol.

In Eff-DSDV Khan et. al. [5], presents broken link route reconstruction scheme to overcome the problem of stale routes, and thereby improving the performance of DSDV. In this protocol, when an immediate link from any node ‘S’ to the destination say ‘T’ breaks, the node ‘S' suspends sending packets and creates a temporary link through a neighbor which has a valid route to the destination node ‘T’. The temporary link is established by sending one-hop ROUTE-REQUEST and ROUTE-ACK messages. They implemented the protocol on NCTUns Simulator and performance comparison was made with DSDV protocol using performance metrics such as Packet Delivery Ratio, End-to-End delay, Dropped Packets, Routing Overheads, and route length by varying the number of nodes in the network and the mobility speed of the ad-hoc nodes. They observed from the simulation results that the performance of Eff-DSDV is better than DSDV with respect to all the said metrics except the Routing Overheads. The Routing Overhead is bound to be higher for Eff-DSDV due to the extra route requests and route reply messages which otherwise is not present in the DSDV protocol.

Ting Liu et. al. [7], presented I-DSDV, to improve the Packet Delivery Ratio of DSDV routing protocol in mobile ad-hoc networks with high mobility. They proposed that, when a route becomes invalid due to link breakage, the node that detects the link breakage tries to create a new loop-free route through message exchange with its neighbors. Further when route reconstruction in one-hop area is not accomplished; the area of message exchange for invalid route reconstruction is enlarged gradually on-demand. On the basis of simulation results they observed that

I-DSDV, reduces the number of Dropped Data Packets with little increased Overheads at higher rates of node mobility.

In OPR: DSDV based new proactive routing protocol [6], the authors made an attempt to reduce the control traffic flowing in the network. Each OPR node periodically determines its 1-hop neighbors and 2-hop neighbors using hello messages. Any change in the topology only needs to be propagated to the neighbors, thus reducing the amount of processing and storage required at each node.

S-DSDV [14], postulates that each node creates two-way hash chains in relation to each node in the network, including itself. One is used for guarding against the decreasing metric attack and the other for against increasing metric attack.

3 Reconstruction of Broken Link

Link break can be very frequent in MANETs due to mobility of nodes, which is the major cause of lower Packet Delivery Ratio & higher Dropped Packet Rate of routing protocols. In DSDV routing protocol, link break affects the entire network due to periodic/event triggered route update at each change of neighborhood and broken link is reconstructed through periodic updates, which is a time consuming process and degrades the performance of the protocol.

In this paper we have made an attempt to analyze the mechanism of reconstruction of broken links through periodic routing update as in DSDV protocol, through 1-hop route-request & route-ack messages as in Eff-DSDV and through message exchange with neighbors as in I-DSDV.
We have considered the Ad-hoc network scenario of 8 nodes which are placed randomly, in a terrain of size 700m * 800m The initial node positions of the nodes are taken as: (100,700), B: (250, 600), C: (400, 500), D: (600, 500), E: (300, 300), F: (450,350), G: (550, 400) and H: (500, 600) as shown in Figure 1.To illustrate the process, let node ‘A’ be the source node and node ‘D’ is the destination. Further suppose during transmission, link from node ‘C’ to destination node ‘D’ breaks.

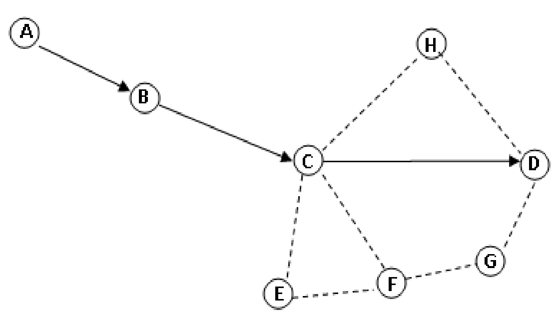

Fig. 1. An Ad-Hoc Network considered

Initially, route tables are developed for the entire network as in DSDV**.** For example the routing tables for the nodes ‘B’, ‘C’ and ‘E’ are shown in Table1, Table2, Table3 respectively.

Table 1. Route Table of Node ‘B’

Destination	Next Hop	Hop-count	Seq. No.
A	A	1	100
B	B	0	150
C	C	1	206
D	C	2	310
E	C	2	412
F	C	2	250
G	C	3	500
H	C	2	334

Table 2. Route Table of Node ‘C’

Destination	Next Hop	Hop-count	Seq. No.
A	B	2	100
B	B	1	150
C	C	0	206
D	D	1	310
E	E	1	412
F	F	1	250
G	F	2	500
H	H	1	334

Table 3. Route Table of Node ‘E’

Destination	Next Hop	Hop-count	Seq. No.
A	C	3	100
B	C	2	150
C	C	1	206
D	C	2	310
E	E	0	412
F	F	1	250
G	F	2	500
H	C	2	334

3.1 Reconstruction of Broken Link (Through periodic routing update) Using DSDV Protocol

a) As node ‘C’ detects link break to destination ‘D’ as shown in Figure 2, it updates its route table, increases sequence number of node ‘D’ by 1 (only case when Seq. No.

is incremented by the node other than the destination node) and updates hop-count for ‘D’ to infinity as shown in Table 4.

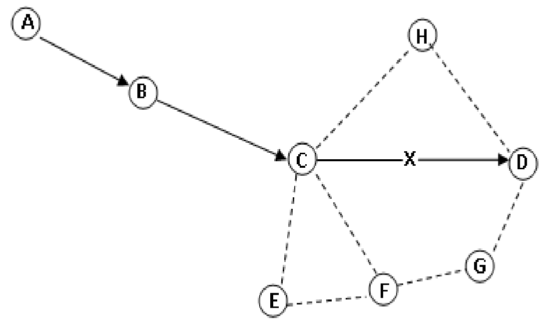

Fig. 2. Link from Node ‘C’ to ‘D’ breaks

Table 4. Updated Route Table of Node ‘C’

Destination	Next Hop	Hop-count	Seq. No.
A	B	2	100
B	B	1	150
C	C	0	206
D	D	∞	311
E	E	1	412
F	F	1	250
G	F	2	500
H	H	1	334

b) Node ‘C’ advertises its updated route table to local neighbors ‘B’,’E’, ‘H’, and ‘F’, to inform about link break to destination ‘D’. Meanwhile Node ‘H’ and ‘F’ also receives periodic route update from their neighbors, containing valid route for destination ‘D’ as shown in Figure 3.

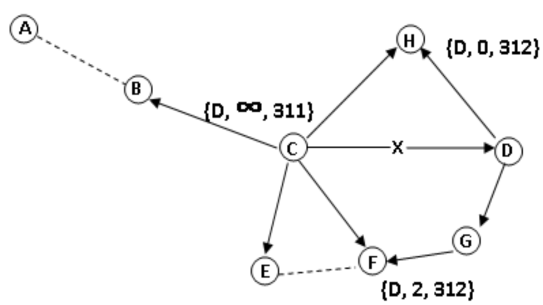

Fig. 3. Node ‘C’ advertises link break

c) Neighbors ‘B’ and ‘E’ had route to ‘D’ only through node ‘C’ (which is the broadcasting node), so they update their route tables with broken link information for destination ‘D’ as shown in Table 5 and Table 6. On the other hand, node ‘H’ and ‘F’ compares the update received from the node ‘C’ to the route information available in their route table and found that node ‘C’ has stale route information and sequence number of the available route for destination ‘D’ is higher than the route update received from node ‘C’. So, node ‘H’ and ‘F’ does not update their route tables with broken link information, as they have fresh route available to destination ‘D’.

Table 5. Updated Route Table of Node ‘B’

Destination	Next Hop	Hop-count	Seq. No.
A	A	1	100
B	B	0	150
C	C	1	206
D	C	∞	311
E	C	2	412
F	C	2	250
G	C	3	500
H	C	2	334

Table 6. Updated Route Table of Node ‘E’

Destination	Next Hop	Hop-count	Seq. No.
A	C	3	100
B	C	2	150
C	C	1	206
D	C	∞	311
E	E	0	412
F	F	1	250
G	F	2	500
H	C	2	334

d) Nodes ‘H’ and ‘F’ advertise their loop free route for destination ‘D’ to their neighbors as shown in Figure 4.

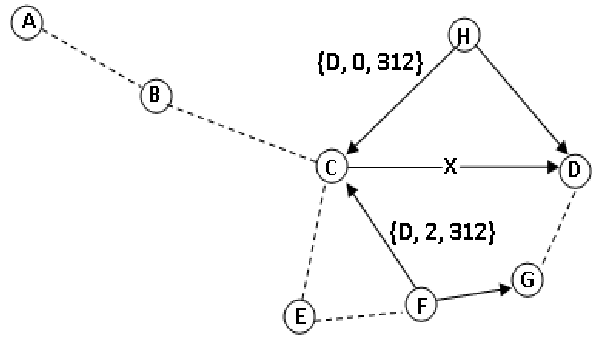

Fig. 4. Nodes 'H' and 'F' advertises their route to Node 'D'

e) Node 'C' receives one route from node 'F' and another from node 'H', to destination 'D'. After comparing the two routes, node 'C' found that both routes have same sequence number but the route through node 'H' has a better metric, so node 'C' update its route table with new route to destination 'D' via 'H' as shown in Figure 5.

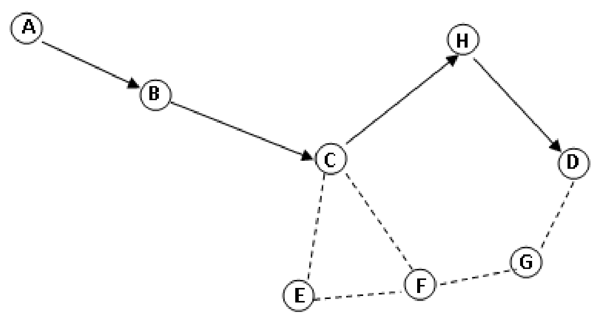

Fig. 5. Node 'C' reconstructs its route to 'D' via 'H'

3.2 Reconstruction of Broken Link (Through 1-hop Route-Request & Route-Ack) Using Eff-DSDV Protocol

a) When the Link from node 'C' to node 'D' breaks, node 'C' suspends sending packets as shown in Figure 2.

b) Node 'C' broadcasts Route-Request message to its 1–hop neighbors 'B', 'H', 'E' and 'F'. Route-Request packet includes the node ID and the destination as shown in Figure 6.

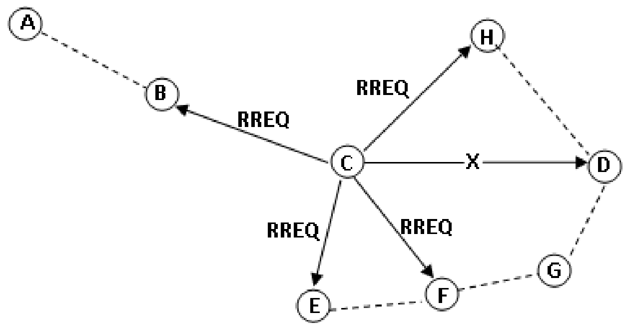

Fig. 6. Node ‘C’ Broadcasts 1-hop Route-Request to its Neighbors

c) Nodes ‘H’ and ‘F’ responds with Route-Ack packet along with the hop-count & route update time (indicates the freshness of a route) as shown in Figure 7. While nodes ‘B’ and ‘E’ do not respond as they have route to node ‘D’ through ‘C’, which is the broadcasting node. Table 7 shows the route update at node ‘C’.

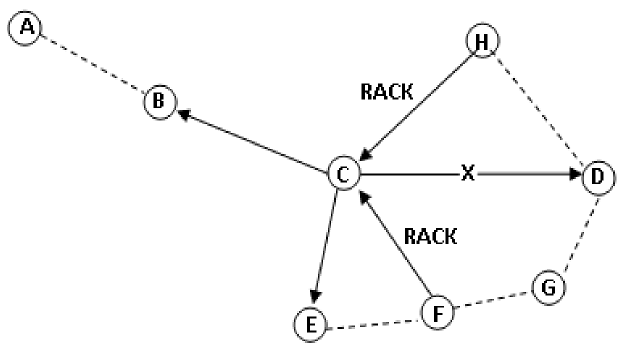

Fig. 7. Neighbors ‘H’ and ‘F’ respond with Route-Ack Packet

Table 7. Route Update at Node ‘C’

I-Hop-Neighbor	Next Hop	Hop-count	Update Time
F	G	2	940
H	D	1	1250

d) The node ‘C’ chooses the best neighbor, based on the least number of hops to the destination. If there is more than one node having the same number of hops, it selects the node with the latest routing update time. The packets are then forwarded using the latest route, found till, the routing table of node ‘C’ is updated by the conventional DSDV protocol. From the Table 7, it can be seen that the node ‘H’

IJCES International Journal of Computer Engineering Science , Volume1 Issue2, November 2011
ISSN : 2250:3439
https://sites.google.com/site/ijcesjournal
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has the minimum hop-count and latest update time so node 'C' resumes sending packets to destination 'D' through 'H' as a next-hop as shown in Figure 5.

3.3 Reconstruction of Broken Link (Through message exchange with neighbors) Using I-DSDV Protocol

a) Node 'C', detects that the link to one of its neighboring node 'D' breaks as shown in Figure 2, any route through that link is assigned with an invalid type as shown in Table 8.

Table 8. Route Update at Node 'C'

Destination	Type	Metric	Sequence no.
D	Invalid	1	311
A	Valid	2	100
B	Valid	1	150
C	Valid	0	206
E	Valid	1	412
F	Valid	1	250
G	Valid	2	500
H	Valid	1	334

b) Node 'C' broadcast an invalid route update (as shown in Figure 8), which contains the former metric & sequence number of the invalid route as shown in Table 9. Type of path and former metric are additionally used to identify the broken links other than infinite metric & an odd sequence no.

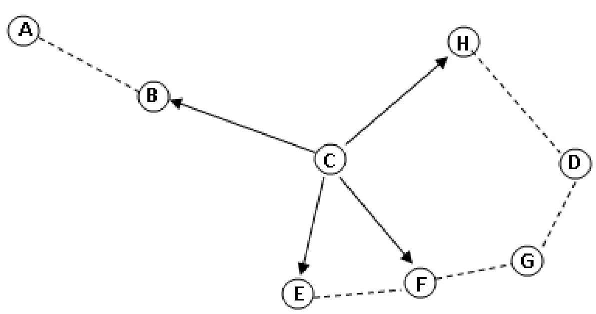

Fig. 8. Node 'C' broadcasts its invalid route update

Table 9. Invalid Route Update

Destination	Type	Former Metric	Sequence no.

D	Invalid	1	311

c) Upon receiving an invalid route update from node ‘C’, nodes ‘B’, ‘H’, ‘E’ & ‘F’ compares it to the existing route in their route table, if node has a valid route through node ‘C’ as the next hop to node ‘D’, then it replaces its own route with the invalid one. Otherwise if it has a valid route that has fresh sequence number or the same sequence number but a hop-count is less than or equal to J + 1, then it immediately broadcasts a route reconstruction message that contains its valid route information. Here, J is the metric that the invalid route update contains. Nodes ‘B’ and ‘E’ replaces their route to node ‘D’ with the invalid one, as they have a valid route through node ‘C’ as its next-hop. So nodes ‘B’ and ‘E’ do not respond as they have no other valid route to destination ‘D’ and in turn broadcast the invalid route information about ‘D’. On the other hand neighbors ‘H’ and ‘F’ broadcast their new loop free route to destination ‘D’, as shown in Figure 9.

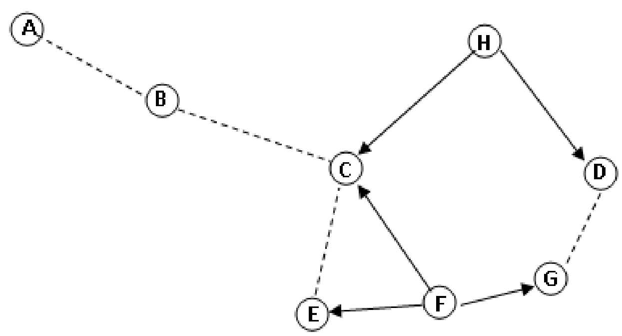

Fig. 9. Node ‘H’ & ‘F’ broadcast their new route to node ‘D’

d) Node ‘C’ receives two new loop free routes for destination ‘D’. One through ‘H’ with metric 2 and another through ‘F’, with metric 3 but with the same destination sequence number. On the basis of better hop-count node ‘C’, reconstructs its route to destination ‘D’ through node ‘H’ as shown in Figure 10.

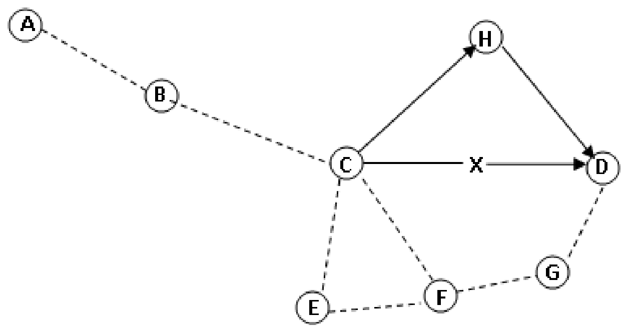

Fig. 10. Node ‘C’ reconstructs its route to Node ‘D’

e) Node ‘C’, broadcast new route information for destination ‘D’, to its local neighbors and neighbors in turn broadcast received information to their neighbors as shown in Figure 11.

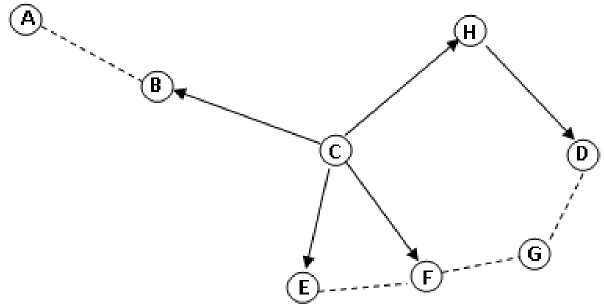

Fig. 11. Node ‘C’ broadcasts its new route to Node ‘D’

f) Node ‘B’ reconstructs its route to destination ‘D’ through ‘C’. Node ‘E’ compares the new route with the old one (through ‘F’) and would find that metric is same for the two routes but the sequence number of the route received from node ‘C’ is higher, so node ‘E’ also reconstructs its route through ‘C’ to destination ‘D’ as shown in Figure 12. Meanwhile, the node ‘F’ receives periodic route update to destination ‘D’ from node ‘G’, with same sequence number thus finds that metric of old route is better than the new route update. Therefore, it doesn’t update its route to destination ‘D’, through node ‘C’.

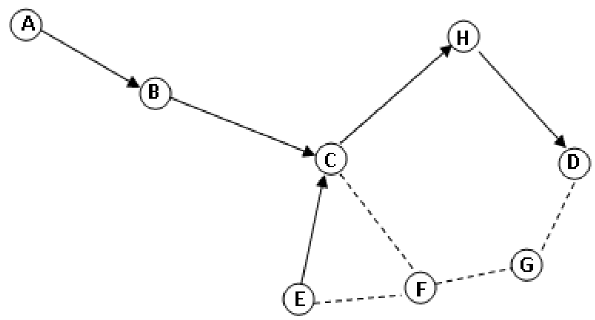

Fig. 12. Neighbors reconstruct their route to node 'D'

4 Conclusion

DSDV is a single path routing protocol and no immediate route is available with the node to transmit the remaining data packets as link breaks. New route is reconstructed through periodic exchange of routing information, which is very time consuming process and also consumes other Network resources. We have discussed the broken link route reconstruction process in DSDV and its variants Eff-DSDV & I-DSDV. On comparative study of Eff-DSDV and I-DSDV, it has been observed that in both these variants, Packet Delivery Ratio is improved, Dropped Packed Rate is reduced, Routing Overhead is slightly increased but End-to-End delay of I-DSDV is higher than DSDV as shown in Table 10.

Table 10. Qualitative Analysis of Eff-DSDV and I-DSDV

Performance Parameters	**Eff-DSDV**	**I-DSDV**
Packet Delivery Ratio	Higher than DSDV	Higher than DSDV
Routing Overhead	Slightly Higher than DSDV	Slightly Higher than DSDV
End-to-End Delay	Less than DSDV	Higher than DSDV
Packets Dropped	Relatively Lower than DSDV	Lower than DSDV

In future work we intend to implement multipath scheme in DSDV protocol and carry out simulation based comparisons among variants of DSDV and other routing protocols.

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