Reducing the Number of Forward Nodes from 1-Hop Nodes to Cover 2-Hop Nodes with Network Coding

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***Abstract*—All neighbors of a node can receive a data packet conveyed by a broadcasting node in an ad-hoc wireless network. In this way, the no. of forwarding nodes is utilized as the cost criterion for propagation. Among different estimation approaches, the researcher uses 1-Hop nodes to cover entire 2-Hop nodes utilizing 2-hop region information to decrease repetitive communicates. We dissect a few deficiencies of this approach and propose an improved algorithm along with the network coding concepts in this paper. Our algorithm utilizes 2-hop neighborhood more successfully to lessen excess communicates. The Simulation results of applying this algorithm demonstrate performance improvements. Nowadays the scientists are acquainting the idea of Network coding to neighbour topology aware protocols that beats the excess number of broadcast by victimization the using XOR of data packets. We have made an endeavor to seek out the network coding gain. We've shown simulation, implementation and breakdown of result in various circumstances.**

***Index Terms*—Broadcasting; Broadcast Storm Problem; Collision; Contention; Flooding; MANET; Network Coding; Redundancy.**

I. Introduction

The Wireless medium is creating numerous fortuity for nodes to get packets when they are not the anticipated beneficiary. MANET is such a sort of specially appointed Network that getting extraordinary conspicuousness inside the general public. Message broadcasting is a basic function in wireless Ad-hoc network in which a node passes on a message "m" to all neighbors, thus causing redundant broadcast which is called as Broadcast storm Problem in which every node will be obligated to re-broadcast the data packet every time it gets the data packet for the 1st time [1], [7]. In MANETs, flooding of messages will bring about numerous repetitive correspondences. Figure 1 demonstrates a topology of a MANET. At the point, node "u" broadcasts a packet, node "v" and node "w" receives the packet, At that point, node "v" and node "w" will rebroadcast the packet to each other.

Misleadingly the two communications may bring thoughtful broadcast storm problem, where these redundant packets cause collision & contention.

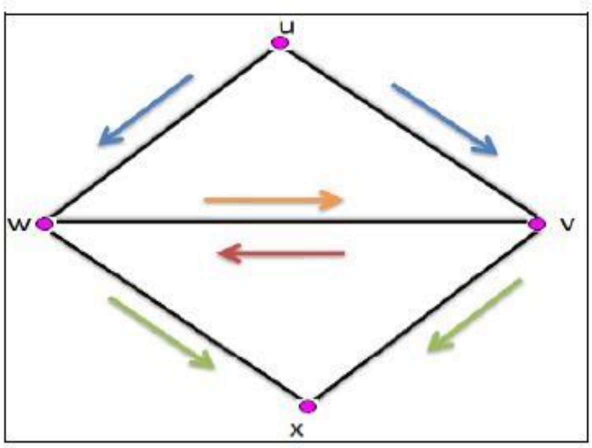

Figure 1: Flooding in MANET

In a CSMA/CA network, disadvantages of flooding are:

1. Redundant rebroadcasts - When a host adopts to re-broadcast a message "m" to its neighbors, They already have that broadcast message "m".
2. Contention - Later a mobile host communicates a message "m", if large number of its neighbors choose to re-broadcast the message "m", these broadcasts may ruthlessly contend.
3. Collision - They are more probable to happen and to produce more harm because of the inadequacy of back-off mechanism, the non-existence of CD and the absence of RTS/CTS dialogue.

In Figure 2, Bits m_1 and m_2 need to be transferred to both receivers R_1 and R_2. Every link transmits only a bit. Message m_1 and m_2 can be received either on the right or on the left side.

Solution: Compute XOR (i.e. Apply network coding) in the middle link and both sides get m_1 and m_2. Table 1 clearly demonstrates this. Intermediate nodes will further send packets which are XORed of previous received bits [2].

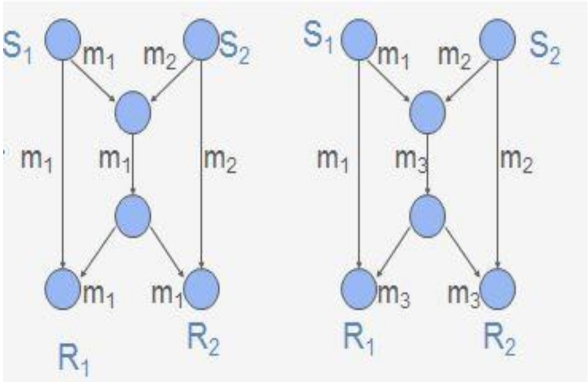

Figure 2: Butterfly Network; Source S_1 and S_2 multicast m_1 and m_2 to both receivers

Table 1
XOR operation between m_1 and m_2

m_2	m_1	$m_3 = m_2 \oplus m_1$	$m_2 = m_3 \oplus m_1$	$m_1 = m_3 \oplus m_2$
1	1	0	1	1
0	1	1	0	1
1	0	1	1	0
0	0	0	0	0

II. Related Work

In general, once a flooding data packet is received by a node then it elects whether or not to relay it to its neighbor. The Neighbor topology primarily approach to escape the broadcast redundancy in MANET's. We here determine the minimum no. of the forwarding node set which forms a minimum connected dominating set. It could be a set of nodes if each node is either within the set or the neighbor is in this set. The task is to pick out a tiny set of forwarding nodes within the deficiency of global network information. The researchers have done substantial work to seek out Connecting Dominating Set two ways, namely 2-hop & 1-hop neighbor information [4], [5].

Many broadcast algorithms besides blind flooding have been proposed [10]-[16]. Typical global [17], [18] and quasi-global [19] broadcast protocols use either global or partial global information to consensus a small forward node set. To reduce the effect of the broadcast storm problem, we should prevent redundant retransmits of the broadcast packet and differentiate the timing of retransmits. Ensuing this recommendation, numerous schemes, called the location-based, distance -based and counter-based were derived.

They are dependent on many mechanisms to support a host to assert the redundancy of a rebroadcast and choose whether to rebroadcast or not. Results display that these can efficiently reduce the side effects of broadcast storm problem [8].

Figure 3 shows the cluster-head based broadcast algorithm.

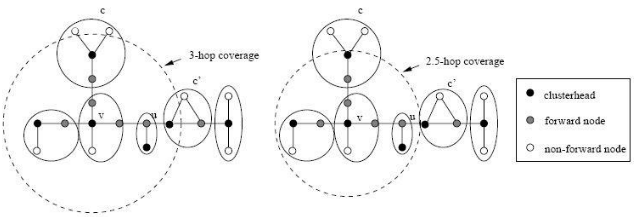

Figure 3: Cluster-head based broadcast algorithm

Figure 4 shows that removal of node "u" will not eliminate all paths between nodes "x" and "y" [21].

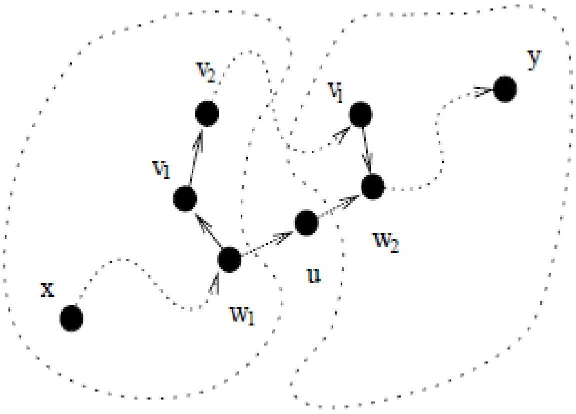

Figure 4: Removal of node "u" will not eliminate all paths between nodes "x" and "y".

Figure 5 shows the failure of dominant pruning algorithm [22] since node "C" and node "B" are dismissed in 2nd iteration of communication when they already exists in the sender list of node "A"

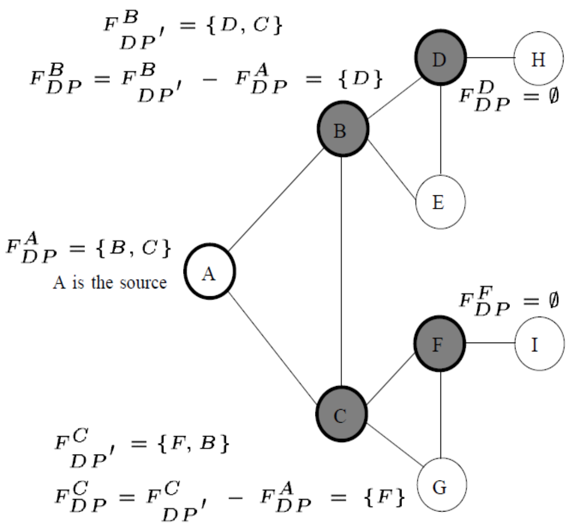

Figure 5: Failure of dominant pruning algorithm

III. Proposed Algorithm

The main task of the proposed algorithm is to identify the nodes which will perform forwarding of the network coded packets and at the same time the no. of such kind of nodes has to be getting reduced and how to perform this based on local information that to be without consulting with rest of the nodes.

Figure 6 shows the elimination of node E and F from the broadcast list of node A since they got the similar data bit or message from neighbor B and C, respectively. Such kind of nodes needs to be eliminated out to reduce the number of forwarding nodes.

The parameters are:

1. Single path forwarding - Only one path is employed in order to forward traffic to routed destination [3].
2. Multicopy- Each packet is replicated on all available paths employing in this way the maximum possible redundancy.

3. Multipath - Each packet is assigned on a specific path with different packets of a flow being assigned on different paths. It employs zero redundancy.

Table 2 shows the simulation environment parameters which are considered.

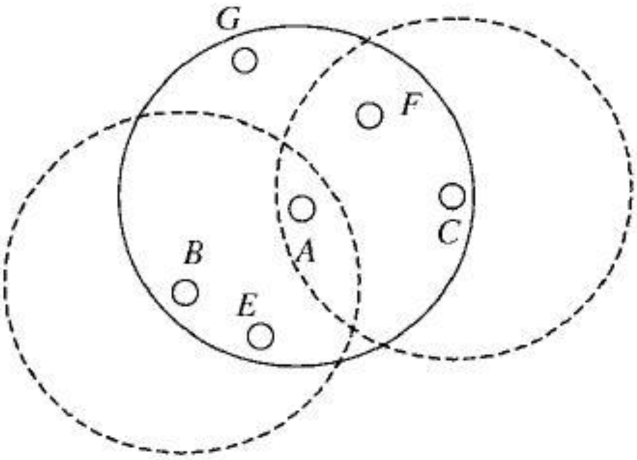

Figure 6: Elimination of neighbor node E and F from the list of Node A.

Table 2
Simulation Environment

Simulation Parameter	Value
Tool Used	NS - 2
Topological size	900m * 900m
Range of Transmission (m)	300
Bandwidth (Mbps)	2.5
Speed (m/s) - Max	5.2
Speed (m/s) - Min	1.2
Pause time	0 s
Packet Rate (packets/sec)	4
Packet size (bytes)	512
No. of CBR Connection	15
Traffic Type	Constant Bit Rate
Interface Queue Length	60

Figure 7 is considered for the explanation purpose of our algorithm.

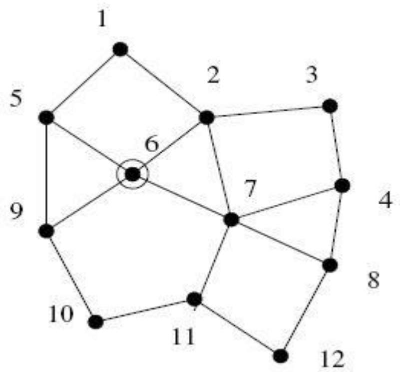

Figure 7: Network of twelve nodes with node 6 as source node

In Figure 7:

s = Sender (Node 6)
r = Receiver
N (r) = neighbors of node v
N(N(r)) = neighbors of N (r)
U(s , r) = 2-hop neighbor set
F (s , r) is the forward node list

Table 3 shows the 1-hop and 2-hop neighbor-hood information. It appears to be normal to allow a node with additional no. of neighbors transmit prior, as the substantial number of secured nodes will more probably render other booked retransmissions repetitive [9].

Table 3
1-hop and 2-hop neighbor-hood information for Fig 2 network

r	N(r)	N(N(r))
12	12,11,8	12,11,10,8,7,4
11	12,11,10,7	12,11,10,9,8,7,6,4,2
10	11,10,9	12,11,10,9,7,6,5
9	10,9,6,5	11,10,9,7,6,5,2,1
8	12,8,7,4	12,11,8,7,6,4,3,2
7	11,8,7,6,4,2	12,11,10,9,8,7,6,5,4,3,2,1
6	9,7,6,5,2	11,10,9,8,7,6,5,4,3,2,1
5	9,6,5,1	10,9,7,6,5,2,1
4	8,7,4,3	12,11,8,7,6,4,3,2
3	4,3,2	8,7,6,4,3,2,1
2	7,6,3,2,1	11,9,8,7,6,5,4,3,2,1
1	5,2,1	9,7,6,5,3,2,1

Algorithm 1 :

1. U (s, r) = N (N (r)) – N (s) – N (r)
2. B (s, r) = N (r) – N (s)
3. Node r determines F (s, r). (F can be selected from B to cover U)

Table 4
Result of Algorithm 1

s	r	U	B	F
φ	6	11,10,8,4,3,1	9,7,5,2	9,2,7
6	7	12,10,3,1	11,8,4	4,11
6	2	11,8,4	3,1	3
6	9	11,1	10	10
7	11	9	12,10	10
7	4	12	3	[ ]
2	3	8	4	4
9	10	12,7	11	11

Result of Algorithm 1 clearly shows that the total numbers of forward nodes are 8 while total number of nodes are 12.

Algorithm 2 :

1. P (s, r) = N (N (s) ∩ N (r))
2. U (s, r) = N (N(r)) – N (s) – N (r) − P (s, r)
3. B (s, r) = N (r) − N(s)
4. Node r determines F (s, r). (F can be selected from B to cover U)

Table 5
Result of Algorithm 2

s	r	P	U	B	F
φ	6	φ	11,10,8,4,3,1	9,7,5,2	9,2,7
6	7	7,6,3,1	12,10	11,8,4	11
6	2	11,8,6,4,2	Φ	3,1	[ ]
6	9	9,6,1	11	10	10
7	11	φ	9	12,10	10
9	10	φ	12,7	11	11

Result of algorithm 2 clearly shows that the total numbers of forward nodes are 6 while total no. of nodes are 12.

Algorithm 3:

1. U (s, r) = N (N (r)) – N (N (s))
2. B (s, r) = N (r) – N (s)

3. Node r determines F(s, r). (F can be selected from B to cover U)

Table 6
Result of Algorithm 3

s	r	U	B	F
φ	6	11,10,8,4,3,1	9,7,5,2	9,2,7
6	7	12	11,8,4	8
6	2	φ	3,1	[ ]
6	9	φ	10	[ ]
7	8	φ	12	[ ]

Result of Algorithm 3 clearly shows that the total numbers of forward nodes are 5 while total number of nodes are 12.

Network coding integrated Algorithm 1, Algorithm 2 and Algorithm 3:

1. For source node, take out 1-Hop and 2-Hop Neighbors
2. Take out Forwarding Nodes by using Algorithm 1, Algorithm 2 and Algorithm 3 as illustrated earlier
3. Apply network coding concept algorithm 1, algorithm 2 and algorithm 3.
   a. For each node, FIFO queue of packets is created to forward packets.
   b. Keep a track of hash table also.
   c. The probability of each neighbor having that packet in output queue is shown by the table.
4. Select each forwarding node from forward list of Algorithm 1, Algorithm 2 and Algorithm 3. If forward probability of each packet is >= 0.5 then perform XOR of all packets and then broadcast.

At packet pool, each node keeps a copy of each packet it has received or sent. This progression is going ahead until all the nodes get all packets.

IV. Results

We have found out 1-hop and 2-hop neighbour nodes for every node. Random probability of the packets at the 1-hop nodes is additionally taken [6].

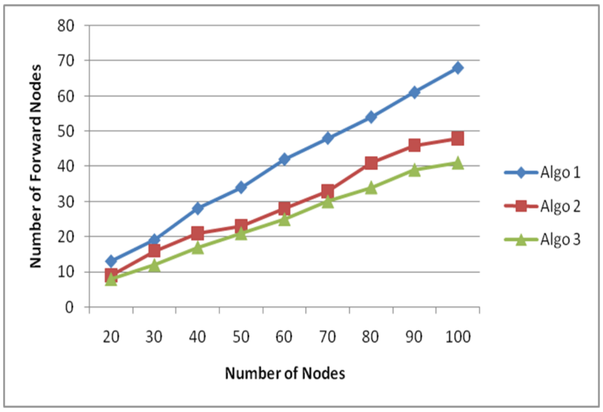

Figure 8: Result based on keeping transmitter range as 20

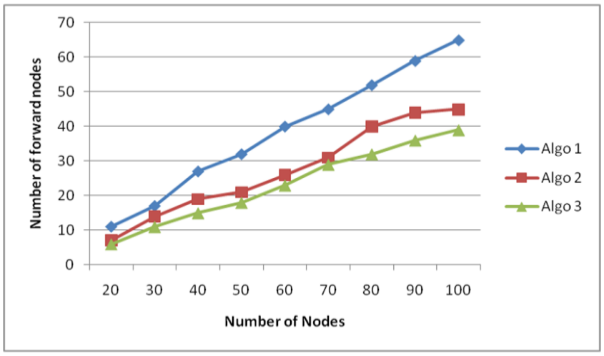

Figure 9: Result based on keeping transmitter range as 25

The result has been tested on the increasing number of total nodes, transmitter range and average node degree.

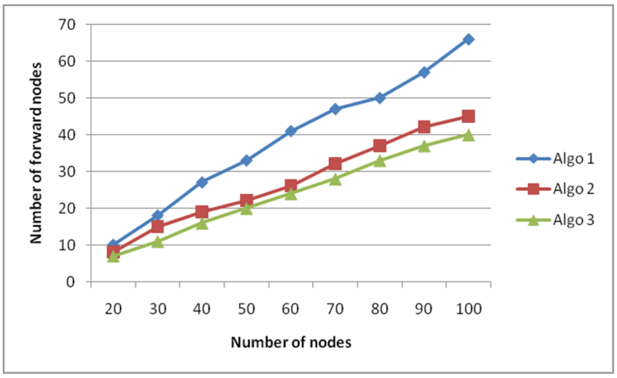

Figure 10: Result based on keeping Average Node degree as 5

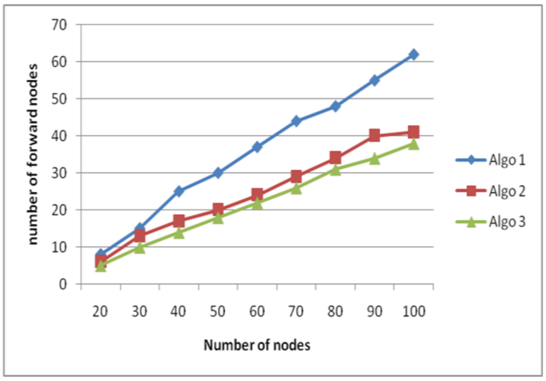

Figure 11: Result based on keeping Average Node degree as 10

The simulation shown within Figure 8 to 11 clearly states that Algorithm 3 requires minimum no. of nodes for network coding in comparing other two algorithm.

V. Conclusion

Broadcasting in a MANET has generally extraordinary attributes of that in different networks. It could bring about mindful redundancy, collision and contention. Network coding may affect the outline of the design of new networking and information dissemination protocols. The simulation clearly demonstrates that Algorithm 3 requires minimum no. of nodes when integrated along with the concept of network coding in contrast with other two algorithms (Algorithm 1 & Algorithm 2) to reduce number of forwarding nodes for reducing the effect of the broadcast storm problem.

We have learnt innumerable noteworthy lessons while taking a shot at this usage. Especially, it pays to be opportunistic. Rather than seeking to accomplish transmission capacity, nodes will utilize local information to detect coding opportunities and will endeavour them. The performance of the proposed algorithm to rectify the issue of battery power [20] of the selected node for network coding is left for future study. The productivity of broadcasting gives off an impression of being straightforwardly related to the construction of a connected dominating set of minimal size.

Unfortunately, finding a minimum connected dominating set is NP-complete for most graphs. Future research includes applying this proposed algorithm to make network coded routing more scalable. A challenge in our view is how to control a lot of overhead where our proposed algorithm is promising and avoiding any overhead. We might attempt to ensure collision free transmission with nearly higher probability.

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