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# Bandwidth Efficient Broadcast Protocols in MANETs: A Review

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***Abstract—*** Mobile ad hoc networks has been facing problems, when nodes are transmission in multi-hop nodes that time a contention and congestion due to node mobility, the network has unpredictable characteristics; its topology changes and signals strength fluctuates because of the broadcast nature of radio transmission. The broadcast operation is very important in MANETs and major challenges to reducing redundant, rebroadcast and broadcast latency problems. In this paper we comparative study of the DFCN and PEGSP algorithms for efficiently bandwidth utilize in multi-hop MANETs. Our validated simulation result shows that PEGSP algorithm is high reliability and high efficiency, channel's bandwidth is efficiently utilized in wide area networks context of low speed of mobile nodes. The DFCN protocol operates well in high density and low density networks, it well in high speed mobile nodes. Nodes are high reachability within transmission range of the network, this protocol is advantages for energy conservation in multi-hop mobile ad hoc network.

***Keywords—***Broadcast latency, Bandwidth, Reachability, Reliability and Efficiency.

## 1. Introduction

An ad hoc wireless network is a collection of wireless mobile nodes to form a temporary network without support of base stations and aid of any centralized administration. In such networks, each mobile node operates as a host or router [1]. When two nodes that is out of one another's transmission range, they want to communicate with each other, they need the support of the intermediate nodes for relaying the packets. Broadcast operation has the important role in mobile ad hoc wireless networks because of broadcasting nature of the radio transmission, when a sender transmits a packet, all neighbor nodes of network within the senders transmission range will be affected by this transmission. The benefit of this nature is that one packet can be received by all neighbor nodes; the disadvantage is that when node sending the packets it will interfere with the sending and receiving of other transmissions, in such situation two problem has occurred, one as hidden terminal and second as exposed terminal problems [2]. In broadcasting is a process of transmitting a packet so that each node in a network receives a copy of this packet. Blind flooding, where every node in the network forwards the packets exactly once. Devices are generally mobile which means that the topology of networks may change quickly in a high mobility environment, simple flooding ensures to achieve the full coverage of all the network; that is, the broadcast packet is guaranteed to be received by every node in the network, providing there is no packet collision caused by the MAC layer of the communication channel is error free during the broadcast process [1]. The main focus of this paper, when high mobility of nodes communicated to each other in the network on that situation mobile nodes take a right decision where the packet to forward.

Section 1 contains introduction of Mobile ad hoc networks and broadcasting process in multi hop nodes. In Section 2 we have discussed the problem statements in ad hoc wireless sensor networks. Section 3 contains methodology of DFCN and PEGSP algorithms. Section 4 explains the simulation configuration setups and simulation result analysis with different metrics. Last section is conclusion , we compare the both protocols simulation results performance.

## 2. Problem Statements

The main challenges in MANET are reliability, bandwidth, security, interference, battery power and routing protocols. Due to node mobility, the network has unpredictable characteristics; its topology changes, signal strength fluctuates with environment and time [3]. The communication routes break and new ones are formed dynamically. Broadcast algorithm is necessary in mobile ad hoc network for reliable communication. The problem can be characterized by causing a lot of contention, redundancy, rebroadcasts and collisions. First, when each node rebroadcasts a message it is highly likely that the neighboring nodes have already received the broadcast, which results in the flooding algorithm creating a large number of redundant messages. Second, since all nodes in the area are trying to rebroadcast the message at approximately the same time there will be a significant number of nodes contending for access to the wireless channel. Third, a high number of collisions will occur without the use of the RTS/CTS exchange, because the hidden terminal problem will still exist [4].

## 3. METHODOLOGY

This section we review the Delayed Flooding with Cumulative Neighborhood Protocol with Proposed Enhanced Generic Self-Pruning Protocol. Both broadcast protocols is how much effectiveness and reliable in multi hop ad hoc networks in high density and low density network. If self-prune condition is their in the network on that situation which protocols take a right decision to movement of messages.

### 3.1. DELAYED FLOODING WITH CUMULATIVE NEIGHBORHOOD (DFCN) PROTOCOL

Delayed Flooding with Cumulative Neighborhood (DFCN) Protocol. This protocol enables bandwidth efficient broadcasting in wide area network. It is composed of large number of mobile devices and bandwidth of channel is properly utilized [5]. In this protocol if we increase density of nodes in the network it does not consume more bandwidth, hence reduces redundancy and rebroadcast in the network. The DFCN protocol aims at minimizing the number of emissions (reflecting the network throughput) and at maximizing the coverage in the network [5].The general principle of broadcasting in MANETs of DFCN protocol starting from a source node a message needs to be forwarded to all nodes in the network. The strategy for selecting the nodes, who forward the messages in the intermediate nodes and the nodes those make minimum network use, is applied here. This is an enhanced version of the protocol presented in [6]. If we are using this protocol advantage for energy conservation in multi-hop mobile ad hoc network. The DFCN protocol operates well in high density and low density networks and well in a high mobile node. So this protocol will cover 100% nodes within transmission range of the network.

#### *3.1.1. Requirements*

For being able to run the DFCN protocol, the four following assumptions must be met:

1. DFCN requires the knowledge of 1-hop neighborhood. One way of obtaining this information is using "HELLO" packets. We denote the set of neighbors of the nodes by *N(s)*.
2. Each message m embeds in its header the set of IDs of the 1-hop neighbors of its most recent sender. We refer to this set as *T(m)*.
3. Each node maintains local information about all messages received. Each instance of such information consists of three items:
   I. The ID of the message received;
   II. The set of IDs of the nodes that are known to have received the message, referred to as *K(m)*;
   III. The decision of whether the message should be forwarded or not, referred to as *a(m)*.
4. DFCN requires the use of a random delay before possibly reemitting a broadcast message *m*. We call it Random Assessment Delay (RAD). Its goal is to prevent packet collisions. More precisely, when a node emits a message *m*, all the nodes in *N(s)* receive it at the same time. It is then likely that all of them forward *m* simultaneously. This simultaneity entails network collisions. The RAD aims at randomly delaying the retransmission of *m*. As every node in *N(s)* waits for the expiration of a different RAD before forwarding *m*, the risk of collisions is reduced. The RAD for a message *m* is referred to as *r(m)* [5].

#### *3.1.2. An event-driven protocol*

##### *3.1.2.1. The benefit of forwarding*

When a node receives a message, the forward decision may depend on different parameters (RAD, neighborhood etc).We introduce the notion of benefit as a new parameter allowing the adaptation of the broadcasting service to the customer application.

As previously mentioned in the "DFCN requirements" (section 3.1.1), a nodes maintain for a message *m* a list *K(m)* which contains the IDs of the nodes that are known to have already received *m*. The list *K(m)* is managed in this way: When *s* sends an *m* to its neighbors, it know that all of them will receive (unless some collisions occur) *m*. If ever the same situation happened (if *s* had the same neighborhood), then *m* would not been forwarded again, as all the nodes around are already known to have received it. When a node *n* receives a message *m* from one of its neighbor's *b*, it also adds the entire neighbor's *b* in *K(m)*, as all of them have received *m* as well [5]. The benefit is defined as the ratio between the number of neighbors of *s* which do not belong to *K(m)*, and the number of neighbors of *s*: benefit = $|N(s) - K(m)| / |N(s)|$. The smaller is the benefit, the less DFCN will be restricted in emitting messages, hence the greatest throughput it will generate. The behavior of DFCN is driven by three events. These events are:

- The reception of a message referred to as reactive behavior.
- The expiration of the RAD of some messages.
- The arrival of a new neighbor referred to as proactive behavior.

When one of these three events occur, DFCN reacts by behaving in a specific manner.

##### *3.1.2.2. Message reception event*

If a message *m* is received for the first time, *K(m)* is equal to *T(m)* and a RAD is then assigned to *m*. Otherwise the set *T(m)* and id of the sender node are added to *K(m)*.

 

**Algorithm 1**: The algorithm executed upon message reception.
**Data**: *m*: The incoming broadcast message
**Data**: *s*: The node which has sent *m*
**IF** *m* is received for the first time **THEN**
$K(m) \leftarrow T(m)$
$rad(m) \leftarrow$ random $\in$ [0, maxRAD]
**ELSE**
$K(m) \leftarrow K(m) \cup T(m) \cup \{s\}$
**END**

*3.1.2.3. RAD expiration event*

When the RAD of a message expires, its hosting node computes the ratio of neighbors that did not yet receive it. If the ratio is greater than the threshold minBenefit, the message is forwarded, otherwise it is dropped. If the message is emitted, then $N(s)$ is added to $K(m)$[5].

**Algorithm 2**: The decision function defines if a given message is worthwhile to be forwarded or not.
**Data**: The broadcast message *m*, the candidate to immediate emission.
**Data**: s: the node that receives *m*.
Benefit $\leftarrow |N(s)-K(m)| / |N(s)|$
$a(m) \leftarrow$ benefit $\geq$ minBenefit
**IF** $a(m)$ **THEN**
$K(m) \leftarrow K(m) \cup N(s)$
**END**

*3.1.2.4. New neighbor event*

Each time a node s gets a new neighbor, the RAD for all messages is set to zero. Messages are hence immediately candidate to emission (Refer section 3.1.2.3).
If $N(s)$ is greater than the threshold density Threshold, this behavior is disabled.
**Data**: *s*: the node which has a new neighbor.
The algorithm executed upon message reception. $M(s)$ is the set of messages received and not yet expired by the node s.
**IF** $|N(s)|$ < density Threshold **THEN**
**FOR** each $m \in M(s)$ **DO**
$rad(m) \leftarrow 0$
**END**
**END**

## 3.2. PROPOSED ENHANCED GENERIC SELF-PRUNING (PEGSP) ALGORITHM

If the host has to compete for limited communication bandwidth then the excessive network traffic could cause a significant delay in packet transmission. Generic algorithm is more powerful than others such an algorithm achieves high efficiency but low reliability [6]. The advantage of this algorithm is that it is well operating in low mobility and has disadvantages in other situations. Some algorithms achieve high reliability but low efficiency and vise versa. The main objective of proposed enhanced generic self-pruning algorithm is to achieve high reliability with highly mobile networks. This can be done into two ways: either improve the delivery ratio of an efficient algorithm or reduce the number of forward nodes in a reliable algorithm. The proposed algorithm that overcomes the problem of poor consideration of the reliability by using hello messages to sense the high mobility of nodes, using the separate set of messages called location information messages and using timers to detect link failure [6].

Some nodes in 1-hop of node (*v*) will depend on node (*u*) in forwarding the broadcast packet as long as node (*u*) is still in 1-hop of node (*v*). These nodes will not forward the broadcast packet. If node (*u*) moves fast with high mobility, node (*v*) may not detect the link failure between node (*v*) and node (*u*). So, all nodes that depend on node (*u*) make a wrong decision by not to forward the broadcast packet and make their neighbors not to receive the broadcast packet, and that causes the reduction of the reliability. The advantage of algorithm is, in high mobile nodes more reliability is attained by proposing algorithm in the network [6]. The nodes to take low power consumption communication from one point to other points and no delay in the network. If we increase degree size on the network has traffic control facility and nodes are taking own decision making communication.

*3.2.1. Problem Statement*

The enhanced generic algorithm suffers from such a situation of not detecting the link failure in high mobility and that leads to reduce the reliability. Moreover, it suffers from making a node takes a wrong decision according to other situation, that is loosing the hello message. This may lead to make another node to forward instead of the node with the lost hello message. It is possible that this node is still in the 1-hop but its hello message just lost. When another node forwards the broadcast packet, the efficiency is reduced and traffic will be high. The proposed enhanced generic algorithm is in order to achieve high reliability with high efficiency in highly mobile networks.

*3.2.2. Plan of Solution*

In this proposed algorithm the time interval between **"HELLO"** messages is reduced, the hello message and the 1-hop location information message is separated and use timer to detect link failure. The time interval between the hello messages is reduced to sense any fast mobility. Using timers at each node to detect any missing of the hello message that indicates the link failure. If the timer expired at node (*v*) without receiving the hello message from node (*u*), the 1-hop location information at node (*v*) is searched. If 1-hop location information is not found about node (*u*), node (*u*) is outside the 1-hop of node (*v*) and all nodes in this 1-hop must be informed to avoid taking wrong decisions about their status (forward/non-forward). If 1-hop location information is found about node (*u*), set the timer again. If the timer expired at node (*v*) without receiving the hello message from node (*u*) again, node ($u$) is considered outside the 1-hop of node ($v$) and all nodes in this 1-hop must be informed. In the proposed algorithm there are no wrong decisions before link failure detection where it prevents nodes to take wrong decisions about their status (forward/ no forward) in high mobility and the link failure detection is performed fast [6]. The proposed enhanced self-pruning algorithm nearly maintains the efficiency of the enhanced generic algorithm. The enhanced generic algorithm has a better efficiency but if we take the reliability into account, this efficiency is affected by wrong decisions. The efficiency of the proposed enhanced self-pruning algorithm is good because it enforces the reliability to be high and prevents nodes to take wrong decisions.

## 4. SIMULATION RESULTS

We had simulated the DFCN and PEGSP algorithms in GloMoSim v2.03 and compare the different metrics simulation results.

### 4.1. Simulation Configuration Setups

This section briefs about the simulation parameters and configuration file (config.in). In the simulation we have taken the physical terrain area in which nodes are being simulated as 3000 * 3000 m2. The simulation time is taken to be 600 seconds and the seed value is 1. The number of nodes varies among 150 to 3000 nodes. The node placement is taken as uniform. Where the physical terrain is divided into number of cells within each cell the nodes will be placed randomly. Mobility parameter is taken as dynamic and the nodes are free to move in the physical area of the network. The only available mobility model in GloMoSim v2.03 is the Random Waypoint Mobility Model (RWPM) [15]. In this model a node randomly selects a destination from the physical terrain, and then moves in the direction of the destination in a speed uniformly chosen between MOBILITY-WP-MIN-SPEED (0) and MOBILITY-WP-MAX-SPEED (10m/s to 240m/s). Once it reaches its destination, the node stays there for a MOBILITY-WP-PAUSE time period which is taken as 60seconds. For Path-loss model we have taken PROPOGATION-PATHLOSS TWO-RAY model. NOISE-FIGURE is 10.0 and TEMPRATURE at 290.0, RADIO-BANDWIDTH is 2mb/s, MAX PACKET IN IFQ 50 and edge 500m. To transmit and receive packets the RADIO-ACCNOISE standard radio model was taken into consideration. Radio packet reception model is SNR-BOUNDED. That is if the Signal to Noise Ratio (SNR) is more than the RADIO-RX-SNR-THRESHOLD which is taken as 10.0 (in dB), it receives the signal without error. Each nodes radio transmission power is defined at 10.0 dbm. Medium Access Protocol (MAC-PROTOCOL) is 802.11 and set PROMISCUOUS-MODE as “NO”. For NETWORK-PROTOCOL the only currently available default value is ‘IP’.

### 4.2 . Simulation Result Analysis

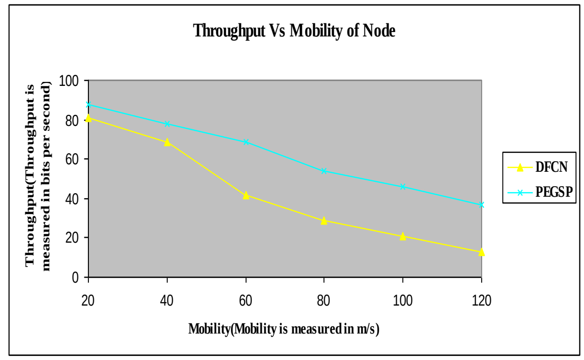


**Figure-1:** Throughput Vs Moblity of Node (Number of nodes is 150)

The above figure1 shows that throughput of the network with number of 150 nodes and we increase the speed of nodes from 20 m/s to 120 m/s , PEGSP algorithm is better than the DFCN algorithms. It can be seen that when we regularly increase the speed of the nodes then the throughput of the two algorithms decreased due to high mobility of nodes.
The throughput is calculated as :
Throughput= $|T(m)\text{-}R(m)|$ / $|N(s)|$----------(1)
(Where$T(m)$→Total Number of Transmission messages send on the network, $R(m)$→ The set of neighbor nodes have received the messages , $N(s)$→ Set of neighbor nodes ).

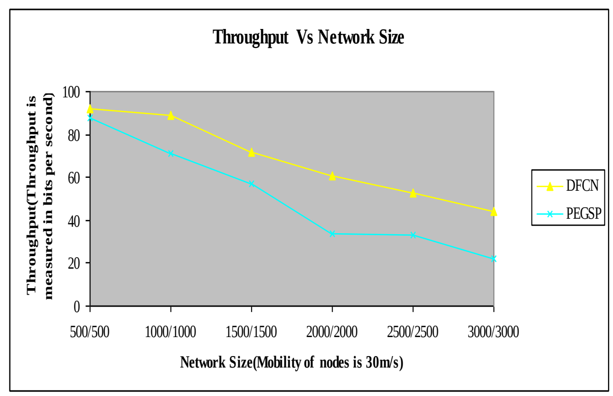


**Figure-2:** Throughput Vs Network Size (sq.m2)

In figure 2 shows that when the speed of nodes is 30 m/s and number of nodes is 500 and area is 2500 sq.m2 then the PEGSP algorithm’s throughput is less than the DFCN . If we increase network size and number of nodes regurarly then the both algorithms throughput will decreases. it can be concluded that the DFCN algorithm is better than PEGSP algorithm.

 

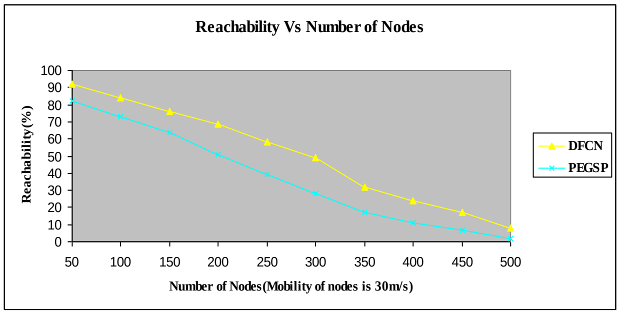


**Figure-3:** Reachability Vs Number of Nodes (Mobility of node is 30 m/s)

The above figure 3 simulation result shows that the reachability of DFCN algorithm is better than the PEGSP algorithms. When the number of nodes is 500 then the DFCN algorithm's result is slightly larger than the PEGSP algorithm's result. Reachability means the number of nodes that receive the broadcast packets.

The reachability is calculated as :

Reachability = |*r(m)*|/|*N(s)*|----------------- (2)

(Where *r(m)* → Number of Nodes that receive the broadcast packet, *N(s)* → Represents the total number of nodes).

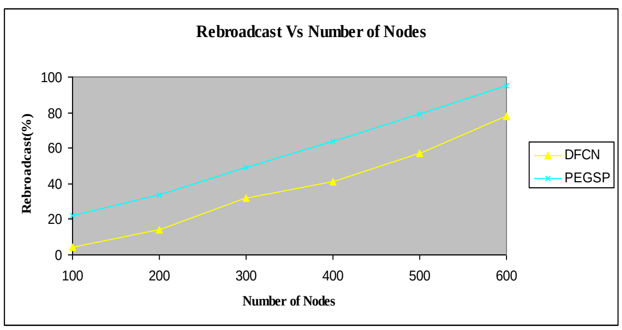


**Figure-4:** Rebroadcast Vs Number of Nodes (Mobility of nodes is 30m/s)

In figure 4, the result shows that DFCN algorithm is better than the PEGSP algorithms as it takes minimum rebroadcast ratio in the network.

The Rebroadcast calculated as:

Rebroadcast Ratio= *t*/*n* ---------------------------- (3)

(Where *t* is the number of nodes that actually retransmitted the broadcast packet and *n* is total number of nodes).

From figure 5, it is seen that if we increase number of nodes in the network then the broadcast latencies also increase. Average latency means the interval from the time the broadcast was initiated to the time the last host finishes its rebroadcast. The DFCN algorithm has higher broadcast latency than the PEGSP algorithm. We conclude it PEGSP algorithm is better than DFCN algorithm.

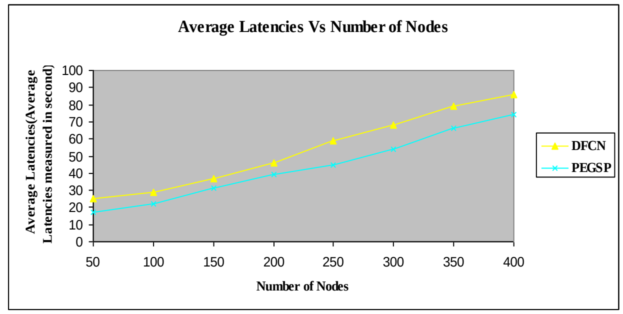


**Figure-5:** Average Latencies Vs Number of Nodes (Mobility of Nodes is 10m/s)

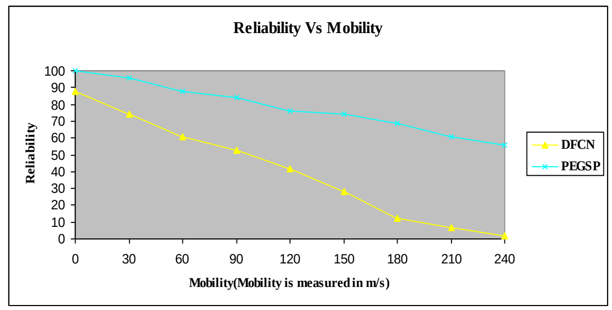


**Figure-6:** Reliability Vs Mobility (Number of nodes is 100)

The above figure 6 result shows that the PEGSP algorithm is more reliable than the DFCN algorithm. The reliability is measured in percentage of the number of nodes that receives the broadcast packet (delivery ratio).When we increase the speed of the mobile nodes from 0 to 240m/s then the reliability of PEGSP is higher than the DFCN algorithm.

In figure 7 result shows that the PEGSP algorithm efficiency level is higher than the DFCN algorithm in the network. Efficiency means percentage of the number of forwarded nodes in the network. From figure 7, it is seen that when we increase the speed of nodes is 30m/s at that time DFCN result is slightly less than PEGSP algorithm result. If we regularly increase speed of node then the PEGSP and DFCN algorithm result is degraded.

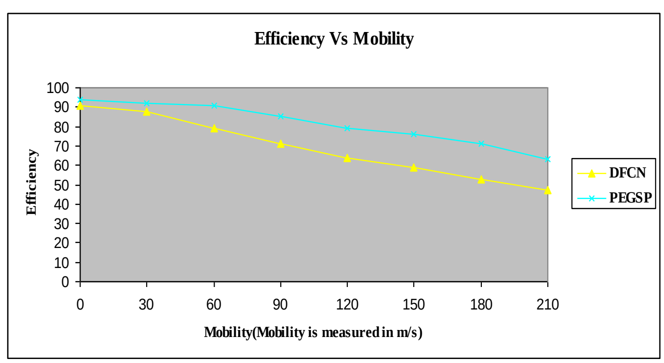


**Figure-7:** Efficiency Vs Mobility (Number of nodes is 150)

 

## 5. CONCLUSION

DFCN protocol is advantages for energy conservation in multi-hop mobile ad hoc network; it operates well in high density and low density networks. The disadvantage of this protocol is that the required bandwidth is not properly utilized due to the high mobility of the nodes. If we are increasing network size on the sparse network it is not reliable in the network. If we are increasing degree size there is no traffic control in the network. If emission is less due to the mobile nodes follow the selective strategy then maximum data is not transmitted in the network. The simulation result shows that Throughput Vs Network Size, Reachability Vs Number of Nodes and Rebroadcast Vs Number of Nodes are better result than PEGSP Protocol.

The advantages of PEGSP algorithm is that it is well operating in low mobility, high efficiency, low redundancy and high reliability. This protocol is better decision making communication in the wide area networks. The disadvantage of algorithm is that if the speed of mobile nodes is high then the efficiency of the network decreases. The node dependency is very high and it is not 100% node reachable within transmission range of the network due to high mobility. As per the simulation results output the context of Throughput Vs Mobility of Nodes, Average Latencies Vs Number of Nodes, Reliability Vs Mobility and Efficiency Vs Mobility is better performance of the DFCN Protocol.

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