Simulation of Reducing Broadcasting Protocol in Ad Hoc Wireless Networks

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Abstract— Ad hoc wireless networking is an important research area in the field of wireless networking applications. Mainly I used some wireless topologies, where a temporary peer-to-peer network set up is used to meet immediate need. I have tried to show the best case between the existing system and our proposed system in Mobile Ad hoc network (MANET). In the case of unreliable broadcasting we can use flooding technique. No acknowledgement is needed in flooding technique; only the obligation is to rebroadcast the message from one source to another source in the Mobile ad hoc networks. But some problems may arrive, such as data redundancy, contention and collision. And that's why I use reliable broadcasting technique. I can cut down the redundancy in this broadcasting technique. My proposed system may work better in case of receiving message without losing data. According to this method we can minimize the cost and power consumption for the establishment of this networks.

Index Terms— broadcasting, contention, collision, eigenvalue, flooding, mobile Ad hoc network, redundent.

1. Introduction

THE MANET is my primary focus of attention to construct a network infrastructure. It does not need any base station and it can establish network within the mobile host, this technique made me very impressed and it was so interesting.

Ad hoc wireless network is such a basic service set of wireless network without an Access point. Several challenges in this area include redundant, contention and collision problems. Counter based scheme, Distance based scheme etc. are widely used in recent times to address the above mention problems. As in flooding problems the major target is to reduce the number of rebroadcast. So i tried to measure the optimal performance from the above schemes Ad hoc network are classified as isolated ad hoc network with large and small sizes, integrated ad hoc network in various scenarios and cellular ad hoc for the future mobile access network. Small size ad hoc network with the global internet can be reenlisted by ad hoc gateways traffic performance of a cellular ad hoc network is very promising, indicating that cellular ad hoc networking seems to be a promising solution to fulfill the requirements of future wireless communication systems. All these features are very important and interesting.

There are lots of great opportunities in future applications using MANET. I can invest minimum amount of cost but the output of MANET is more beneficial. And also in many other perspectives I can use MANET and that's why I develop more reliable broadcasting protocol for ad hoc wireless networks.

Different research groups proposed different approaches in ad hoc wireless networks issue. In the early 1990s, Charles Perkins from SUN Microsystems USA, and Chai Keong Toh from Cambridge University separately started to work on a different Internet, that of a wireless ad hoc network. Perkins was working on the dynamic addressing issues. Toh worked on a new routing protocol, which was known as ABR or Associativity-Based Routing. [1] Perkins eventually proposed DSDV - Destination Sequence Distance Vector routing, which was based on distributed distance vector routing. Toh's proposal was an on-demand based routing, i.e. routes are discovered on-the-fly in real-time as and when is needed. ABR [2] was submitted to IETF as RFCs. ABR was implemented successfully into Linux OS on Lucent WaveLAN 802.11a enabled laptops and a practical ad hoc mobile network was therefore proven [2] to be possible in 1999. Another routing protocol known as AODV was subsequently introduced and later proven and implemented in 2005.[3] In 2007, David Johnson and Dave Maltz proposed DSR – Dynamic Source Routing.[3].

The first method is based on the counter based scheme. Here I have measured the number of rebroadcast against different values of threshold counter. But I cannot be satisfied. So I have experimented on distance based scheme. Here I also measured the number of rebroadcast against different values of minimum threshold distances and here I have got a little bit better result than the counter based scheme.

2. Different Types of Wireless Network

The GSM network is divided into three major systems which are the switching system, the base station system, and the operation and support system (Global System for Mobile Communication (GSM). The cell phone support station; it then connects to the switching station where the call is transferred where it needs to go (Global system for Mobile communication (GSM)). This is used for cellular phones, is the most common standard and is used for a majority of cellular providers.

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PCS (Personal Communications Service) is a radio band that can be used by mobile phones in North America. Sprint happened to be the first service to set up a PCS.

D-AMPS, which are stands for Digital Advanced Mobile Phone Service, is an upgraded version of AMPS but it is being phased out due to advancement in technology. The newer GSM networks are replacing the older system.

Wi-Fi is a commonly used wireless network in computer systems which enable connection to the internet or other machines that have Wi-Fi functionalities. Wi-Fi networks broadcasts radio waves that can be picked up by Wi-Fi receivers that are attached to different computers.

2.1 Broadcasting in wireless network

In computer Broadcast network a packet can be sent simultaneously from the receiving end and will be received by all other recipients in the network. In this case the same cost is needed for transmitting a packet to one receiver or two or more receiver. In practice, the scope of the broadcast is limited to a broadcast domain.

Broadcasting is a useful feature in e-mail systems, or message writing in any chartroom where one message can be received by all other recipients in the room.

In networking, a distinction is made between broadcasting and multicasting; Broadcasting sends a message to everyone on the network whereas multicasting sends a message to a select list of recipients. There is some real application of broadcast network such as, satellite TV, radio etc.

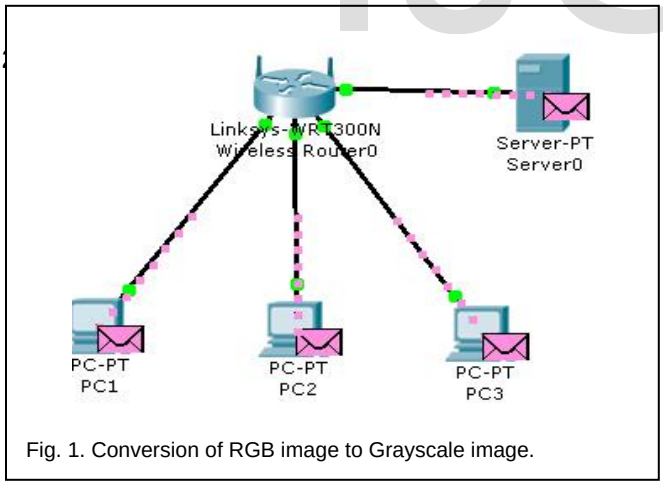

Fig. 1. Conversion of RGB image to Grayscale image.

2.2 Ad hoc Wireless Networking

On wireless computer networks, ad hoc mode is a method for wireless device to directly communicate with each other. Operating in ad hoc mode allows all wireless devices within range of each other to discover and communicate in peer-to-peer fashion without involving central base station.

A mobile ad-hoc network (MANET) [4] is a kind of wireless ad-hoc networks, and is a self-configuring network of mobile routers (and associated hosts) connected by wireless links-the union of which from an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus the network's wireless topology may change rapidly and unpredictably.

3 Protocols

A mobile ad-hoc network (MANET) is a kind of wireless ad-hoc networks , and is a self-configuring network of mobile routers (and associated hosts) connected by wireless links - the union of which form an arbitrary topology. The routers are free to move randomly and organize themselves arbitrarily; thus, the networks' wireless topology may change rapidly and unpredictably. Such a network may operate in a standalone fashion, or may be connected to the larger internet. A MANET can be defined as "network of nodes (computers) that just happen to be near each other having no fixed infrastructure". Mobile ad-hoc networks became a popular subject for research as laptops and 802.11/Wi-Fi wireless networking became widespread in the mid-to late 1990s.

TABLE 1
VARIOUS PROTOCOLS

Protocol	Release Date	Data Rate (Max)	Range (Indoor)	Range (Outdoor)
Legacy	1997	2Mb/s	~25 meters	~75 meters
802.11a	1999	54 Mb/s	~30 meters	~100 meters
802.11b	1999	11 Mb/s	~35 meters	~110 meters

3.1 Broadcasting in wireless network

Each mobile hosts of this specific network acts as a router. A source cannot send a packet directly to final destination due to the limited transmission range. The source host sends the packet to the intermediate host and intermediate host forward this packet toward the destination. In broad casting technique I can broadcast through using MANET either in a single-hop fashion or a multi-hop fashion. But due to considerations such as radio power limitations, channel utilization and power saving concerns a mobile may not be able to communicate directly with other host in a single-hop fashion.

3.1.1 Flooding

Flooding is a static algorithm. The usual approach for broadcasting is trough flooding. Flooding is well suited for MANET as it requires no topological knowledge. It consists in each node rebroadcast a message to its neighbors upon receiving it for the first time.

3.2 Problems in Flooding

In flooding there are different types of problems. Each and every node of a network acts as a source and destination. In this network every nodes wants to broadcast and re-broadcast as a source and destination and that's why radio signals are likely to overlap with others in a geographical area, a straightforward broadcasting by flooding is usually very costly and will result in serious redundancy, contention, and collision.

3.3 Analysis of major problems in broadcasting

Broadcasting is a technology at which message is delivered to all host in the network. Acknowledgement for the received message is not required. In a broadcast network broadcasting a message to any hosts is as expensive as broadcasting a message to all hosts in the network.

3.4 Redundant Problem

Redundant Problem occurs because at the receiving end every host has the obligation to rebroadcast the message for the first time. Because of this characteristic a node or a neighbor receives same message from different hosts. Though a node receives same message from different host's so it is called message redundant problem. This is I worst case for memory space, time requirement, executing performance etc.
source and destination and that's why radio signals are likely to overlap with others in a geographical area, a straightforward broadcasting by flooding is usually very costly and will result in serious redundancy, contention, and collision.

3.4.1 Analysis on Redundant Re-broadcast

From the point of view message redundancy is the worst case for memory space. As for example only one copy of a book for a student will be enough for a specific subject. But more than one copy of that same book will be worst case that means only wastage of money. Similarly more than one message's will be needed more memory space than one. So it will be the worst case for more memory space which is so costly and worst.

3.4.2 Analyze in mathematically of redundant problem

In MANET hosts is roaming around each other. Each host can communicate with destination host in a single hop fashion or multi hop fashion. If there is several host between them the message broadcast by source host are relayed by the intermediate nodes while reaching destination host. There is chance of large number of duplicate packets in this process.
Neighbors of host may have the same messages. Therefore rebroadcast, Unknown it if the host try to rebroadcast the message then redundancy occurs. "When a mobile host decides to rebroadcast a broadcast message to its neighbors, all its neighbors already have the message".

3.4.3 Analysis on redundancy

The expected additional coverage EAC(k) (divided by ∏r2) after a host heard a broadcast message k times. This is the analysis of the EAC or extra additional coverage area. The probability of a host to re-broadcast a message from receiving it once to many. I see that the additional coverage area (EAQ is decrease as the number of broadcast message receives. Thus also the probability of rebroadcast the message is reduces. In this figure I have taken two hosts as example. Host A and host B. They are covered by host A and B is denoted SA, SB covered by a circle where r is the radius of the circle A broadcast a message and B receives it , The additional coverage area that can benefit from B's rebroadcast , is the subtraction of area of SB-A. Now I can easily derive $|SB-A| = |SB|-|SA \cap B| = \prod r^2 - INTC(d)$, Where d is the distance of center of two circles and INTO (d) is the intersections are of two corresponding circles. We assume that d=r wherever the coverage area is largest.

3.5 Contention Problem

If we think of a bridge which is so narrow and at time only one man can cross over the bridge. But at any moment two or more men want to cross over the bridge simultaneously then it will be very difficult to decide who will doss the bridge at first. This type of competitive situation is called contention.
Similarly after broadcasting a message by a host, if it's all other neighbors decides to rebroadcast that message simultaneously then it will be very difficult to decide that which node will get priority as first or earlier accordingly. And when this competitive situation arrived then it is called contention problem in broadcasting.

3.6 Collision Problem

Collision occurs if a number of nodes all start broadcasting at around the same time. It's such a traffic signal. Lots of cars create jam that means collision if there is no traffic rule applied. Similarly in broadcasting if all neighbors of a node initiated rebroadcast at the same time then it will create collision.

3.6.1 Analysis on collision problem

CSMA/CA stands for: Carrier Sense Multiple Access with Collision Avoidance. CSMA/CA is used in 802.11 based wireless LANs. One of the problems of wireless LANs is that it is not possible to listen while sending; therefore collision detection is not possible. In CSMA/CA, a station wishing to transmit has to first listen to the channel for a predetermined amount of time so as to check for any activity on the channel. If the channel is sensed "Idle" then the station is permitted to transmit. If the channel is sensed as "busy" the station has to defer its transmission. This is the essence of the "collision avoidance" part of the protocol.
The CSMA/CA mechanism requires a host to start aback off procedure right after the host transmitted a message, or when a host wants to transmit but the medium is busy and the previous back off has been done [4]. To perform a back off, a

counter is first set to an integer randomly picked from its current back off window. If the channel clear assessment (CCA) mechanism of the host detects no channel activity during the past slot (a fixed period), the counter is decreased by one. When the counter reaches zero, the back off procedure is finished.

Now consider the scenario where several neighbor hosts hear a broadcast from host X. There are several reasons for collisions to occur. First, if the Surrounding, medium of X has been quiet for enough long, all X's neighbors may have passed their back off procedures. Thus, after hearing the broadcast message (and having passed the DIES period), they may all start re-broadcasting at around the same time. This is especially true if carriers cannot be sensed immediately due to such as RF delays and transmission latency. Second because the RTS/CTS forewarning dialogue is not used in a broadcast transmission, the damage of collision is more serious. Third, once collision occurs, without collision detection (CD), a host will keep transmitting the packet even if some of foregoing bits have been garbled. And the longer the packet is, the more the waste.

4 Reduce Flooding Problems

4.1 Generalizing Different Algorithm to Reduce Flooding Problems

From the previous chapter we got sonic serious types of flooding problems like 'Redundancy, Contention, and Collision'. One approach to alleviate the broadcast storm problem is to inhibit some hosts from re-broadcasting to reduce the redundancy, and thus contention and collision. In the following, we present five schemes to do so. These schemes differ in how a mobile host estimates redundancy and how it accumulates knowledge to assist its decision.

4.2 Probabilistic scheme

- On receiving broadcast message (msg) for the 1st time: rebroadcast with probability
- A few slots delay before rebroadcast should be added (to reduce collisions)
- P = 1 equals flooding.

4.3 Probabilistic scheme

- Rebroadcast message may be blocked
  -Busy medium,
  -Back off procedure,
  -Other queued messages
- Counter c keeps track of repeated arrivals of the same message
- If a certain counter threshold C is reached (→EAC (k) too low), the rebroadcast is canceled.

4.3.1 Algorithm for counter based scheme

S1: Initialize counter c = 1 when a broadcast message msg, is heard for the first time. In S2, if msg is heard again, interrupt the waiting and perform S4.

S2: Wait for a random number of slots. Then submit msg for transmission and wait until the transmission actually starts.

S3: The message is on the air. The procedure exits.

S4: Increase c by one. If c < C, resume the interrupted waiting, in S2. Otherwise c = C, proceed to S5.

S5: Cancel the transmission of C if it was submitted in S2. The host is prohibited from re-broadcasting msg. Then exits.

4.4 Distance-based scheme

Relative distance d between hosts decides whether rebroadcast is dropped or not.

Larger d → larger additional coverage.

If msg is heard more than once: distance from the nearest host (d_{min}) is used. If distance is below threshold D, rebroadcast is canceled.

4.4.1 Algorithm for distance based scheme

S1: When a broadcast message msg is heard for the first time, initialize d min to the distance to the broadcasting host, If d min < D, proceed to S5. In S2, if msg is heard again, interrupt the waiting and perform S4.

S2: Wait for a random number of slots. Then submit msg for transmission and wait until the transmission actually starts.

S3: The message is on the air. The procedure exits.

S4: Update d min if the distance to the host from which msg is heard is smaller. If d min < D, proceed to S5. Otherwise, resume the interrupted waiting in S2.

S5: Cancel the transmission of msg if it was submitted in S2. The host is inhibited from re-broadcasting msg. Then exits.

4.5 Location-based scheme

Exact locations of broadcasting hosts used (e.g., 3D-coordinates with GPS)

Additional coverage AC can be calculated with higher precision

Coverage threshold A to decide whether the host should rebroadcast or not.

4.5.1 Algorithm for location based scheme

S1: When a broadcast message msg is heard for the first time, initialize AC to the additional coverage provided by the host's rebroadcast. If AC<A, proceed to S5. In S2, if msg is heard again, interrupt the waiting and perform S4.

S2: Wait for a random number of slots. Then submit msg for transmission and wait until the transmission actually starts.

S3: The message is on the air. The procedure exits.

S4: Update AC. If AC < A, proceed to S5. Otherwise, resume the interrupted waiting in S2.
S5: Cancel the transmission of msg if it was submitted in S2. The host is inhibited from re-broadcasting msg. Then exits.

4.6 Generalize Algorithm

Step# 1 (Initialization): When a broadcast message is heard for the first time then initializes sonic parameters. Where parameters like counter = c, minimum distance = d additional coverage area = AC. Then proceed to S2. It' any value of the parameters fulfill pruning criteria then proceed to S5. If same message is heard again, interrupt the waiting and perform S4.
Step#2(Waiting): Wait for a random number of slots. Then Submit message for transmission and wait until the transmission actually.
Step#3(Transmitting): The message is on the air. The procedure will exit after completing job.
Step#4(Update): Update the Values of the specific parameters. If any parameter fulfills the pruning criteria then proceed to S5.
Step#5(Discard): Cancel the Transmission of message. If it was submitted in S2, the host is prohibited from rebroadcast message. And then exits.

4.7 Pruning Criterions

counter = c ;
minimum distance = d_{min} ;
additional coverage area = AC

5 Broadcasting Technique

5.1 Types of Broadcasting Technique

There are two types of broadcasting technique one is reliable and another one is unreliable technique. But the most common technique is blind flooding. But there is some storm problems cause blind flooding technique. To solve those problem I would like to mentioned these two broadcasting technique.

5.1.1 Reliable broadcasting Technique

In the case of reliable broadcasting technique each host is called router and we can regard broadcast as the multicast. So in the case of multi hope scenario when the source cannot send a packet directly to a final destination due to the limited transmission range, the source host sends the packet to intermediate host & the intermediate host forward the message. This technique can find out the optimal path and reduce unnecessary transmission by utilizing the neighborhood information exchanged between mobile nodes. According to this routing technique we can construct optimal multicast tree by two heuristic flooding methods called self-pruning and dominant pruning method. And both methods utilize neighbor information to reduce redundant transmission.

5.3 Unrelaiable Broadcasting Technique

In the case of unreliable broadcasting technique each mobile host acts as a source and destination and each host in the MANET share a single common channel with CSMA. That's why no acknowledgement mechanism will be used. A host may miss a broadcast message because it is off-line or it is temporarily isolated from the network and message may be damaged because of repetitive collisions due to lack of Acknowledgement such RTS / CTS. But the Acknowledgements cannot be used because it may cause serious medium contention.

5.2 Full Work Flow

I have developed a simulator based method depending on the existing counter based scheme & distance based scheme. As reducing the no of rebroadcast is the main objective so our proposed method finds the neighbor list and by some calculation it gives permission some nodes to rebroadcast and some to be become dead or inactive.
Implementation of my program starts by taking some random nodes then the neighbor list for each node is calculated by finding the Euclidian distance between source nodes to each node.

5.2.1 Experiment 1(Counter Based Scheme)

After finding the neighbor list I generate the parameter threshold counter-value for the number of message received. When the number of received message becomes more than the counter value then that corresponding node becomes dead or idle. Also the node which takes part in broadcasting also becomes dead. Other nodes take part in broadcast; this is how I have pruned the number of rebroadcast.

5.2.2 Algorithm for Counter Based Scheme

Step1: Initialize Threshold Distance, Adjacent List and Counter Value as Threshold Counter and Broadcast Count. Proceed to step 2.
Step 2: Initialize the neighbor list by checking, the condition- "If Euclidian distance <= Threshold distance". And put the node id in the FIFO/Queue and Proceed to step 3
Step 3: Until broadcast Count < Threshold Counter and the node is not broadcasted vet then the node broadcast the msg and proceeds to step 4. Otherwise proceed to step 5.
Step 4: Increase the broadcast counter value. Now if broadcast Count>=MaxBroadcast then make the node dead go to step 5 otherwise increase the node no and go to step 2.
Step 5: Cancel the transmission of message it was submitted in Step 2, the host is prohibited from rebroadcasting and then proceed to Step 6.
Step 6: If all nodes -are dead then exit otherwise Go to Step 1.

5.2.3 Experiment 2 (Distance based scheme)

After finding the neighbor list I generate the parameter minimum threshold distance. The nodes which are within the

range of minimum threshold distance will become dead and also the node which takes part in broadcasting also become dead. Other nodes, which arc away from the range of' minimum threshold distance but within the ram-ye of threshold distance take part in broadcasting; this is how I have pruned the number of rebroadcast.

5.2.4 Algorithm for Distance Based Scheme

Step1: Initialize max threshold & min threshold. Generate random number of nodes.

Step2: Initialize neighbor list for each node by calculating 'Euclidian distance' with respect to threshold value.

Step 3: If current node is alive (min threshold<d1st<max threshold) then go to step 4, else go to step 5.

Step 4: If the distance of current node from its adjacent list is less than minimum threshold distance then make it dead. Otherwise go to step 2.

Step 5: If all nodes arc dead then Exit; else go to step 3.

5.3 Analysis of Performance

I have developed a simulator using Quincy 2005 editor. Here I have taken some discrete nodes and defined some properties. With the change of some variables like threshold counter, threshold distance, number of node I have tried to analyze the performance of reducing flooding problem by using the Counter Based scheme and Distance Based scheme. My goal is to find out the total number of rebroadcast with changing the given variables.

5.3.1 Counter Based Algorithm

From the following figure shows the performance of the counter based scheme in the case of threshold counter versus number of rebroadcast. Here the counter value is taken 3 (maxbroadcast = 3). Whenever the counter value exceeds threshold counter value the node will be dead (current node is dead if BroadcastCount>=MaxBroadcast). That means the recipient node listens the message three or more times, otherwise the rebroadcast will be continued. Here I have taken 25 fixed nodes. To find out the adjacent list I have also taken fixed Threshold Value (25).

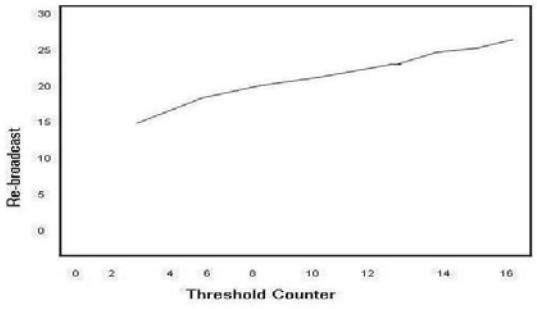

Fig. 2. Counter based algorithm for Threshold counter vs. no. of Broadcast

From the above figure, gradually I have increased the Threshold Counter Value and as a result the number of rebroadcast has also increased. Initially I have started taking 3 as the threshold counter. At 3 the number of rebroadcast shows the minimum value (14).When the counter value goes to 11 the number of rebroadcast shows maximum value (25) After 11 whatever I take as the counter value the number of rebroadcast remains same (25). This seems to be like blind flooding, this is because of increasing the threshold counter, and the number of message received goes higher, because the probability of being dead goes down, so the probability of rebroadcast increases. Here the threshold counter 3 is chosen as optional value because the cost increases with the increase the number of rebroadcast.

From the performance of counter based scheme in the case of number of node versus number of rebroadcast. Here I have plot the number of node versus number of rebroadcast against each threshold counter value. In the graph the color of each curve represents the certain number of threshold counter value where each curve represents the number of node versus number of rebroadcast for the corresponding threshold counter value. I have started 5 as the minimum number of node and gradually I have increased it. In each case for different number of node I have found different number of rebroadcast. In some cases the number of rebroadcast doesn't change with the change of number of nodes. Because the same number of rebroadcast is enough to cover the number of nodes (hosts) as recipients within their additional coverage area. Although the numbers of nodes are changed but optimal threshold counter value 3 is the optimal for every case.

5.3.2 Distance Based Algorithm

Figure 2 shows the performance of the distance based scheme in the case of threshold distance versus number of rebroadcast. Here the minimum threshold distance is taken from 0 to 19. If the distance between any node from the source is less than or equals to the minimum threshold distance value then the node will be dead (current node is dead if (GetDistance (curNode,i)<=MinThreshold). That means the probability of rebroadcast will be zero; otherwise the rebroadcast will be continued.

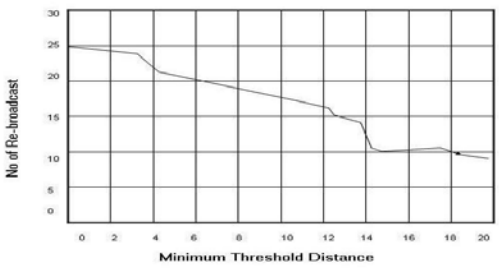

Fig. 3. Distance based algorithm for min threshold distance vs. no of re-broadcast

has decreased- Initially I have started taking 0 as the threshold Minimum threshold distance. At 0 the number of rebroadcast shows the maximum value (25).When the minimum threshold distance value goes to 19 the number of rebroadcast shows minimum value (9). In some cases the number of rebroadcast doesn't change with the change of minimum threshold distance value. Here I can say when the minimum threshold distance is too low like 0 or 1 it acts just like the blind flooding. Because according to the code every node is recognized to rebroadcast. Also I can observe that the optimal threshold value is 19.

From the performance of distance based scheme in the case of number of node versus number of rebroadcast. Here I have plot the number of node versus number of rebroadcast against each minimum threshold distance value. In the graph the color of each curve represents, the certain number of minimum threshold distance value where each curve represents the number of node versus number of rebroadcast for the corresponding minimum threshold distance value. I have started 5 as the minimum number of node and gradually I have increased it. In each case for different number of node I have found different number of rebroadcast. In some cases the number of rebroadcast doesn't change with the change of number of nodes. Because the same number of rebroadcast is enough to cover the number of nodes (hosts) as recipients within their additional coverage area. Although the numbers of nodes are changed but optimal minimum threshold distance value 19 is the optimal for every case.

6 Conclusion

In this paper I have introduced a unique technique to reduce the number of rebroadcast depending on the existing techniques (Counter Based Scheme and Distance Based Scheme). Compared to other related methods, this method has some advantage such as it is very simple, it gives almost accurate result and no additional devices are required for this method. It has some limitations as well. I have developed the method manually for some random number nodes and they were not large in number and there are sonic limitations also. As my proposed method can reduce the flooding problems so I can implement our method in the field where ad hoc network is hardly need to implement. The benefits of this method are

i. My methods can calculate distances between source nodes to any other nodes for different random number of nodes.

ii. They also can calculate the number of rebroadcast for any random number of nodes for different threshold value.

iii. These methods can compare the performance between Counter Based Scheme and Distance Based Scheme.

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