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Minimizing End to End Delay in MANET

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ABSTRACT

This paper addresses the issues of routing in Mobile adhoc Networks (MANET) related to broadcasting such as node interference and latency delay in Ad-Hoc networks. Broadcasting is an inevitable operation in wireless networks. Broadcasting is the process of transmitting the packets that will be received by every device on the network. Broadcasting relies mainly on routing protocols in Mobile Ad Hoc Networks. As network size increases, latency and delay also increase. To reduce delay and latency, many such powerful protocols had been invented. The idea is when we tune the MAC layer; we could reap certain performance benefits. One such protocol is DARP. DARP considerably decreases latency, delay thereby increasing the approximation ratio and overall throughput. These problems could be overcome by the proposed algorithm DARP (Directional Routing Protocol with approximate value) which is mainly inspired by the existing on-demand directional routing protocol DRP. DRP is also similar to DSR. Existing directional routing schemes either assume a complete network topology previously or simply use Omni-directional routing schemes to forward packets in underlying directional environment. DARP is a reactive protocol that combines the effect of DRP (Directional Routing Protocol) and the result approximation that finds the optimal solution for broadcast problems. The duo pack will considerably decrease the end-to-end delay and latency giving out significant performance benefits, thereby substantially increasing the throughput. We have successfully implemented DARP protocol in network simulator. The proposed DARP considerably reduces packet latency and delay and thus the result is represented in the form of graphs.

INTROCUTION

Broadcasting is the process of transmitting the packets that will be received by every device on the network. Many types of antennas are used for broadcasting. One such type is omnidirectional antennas. Omni directional antennas are capable of wide angle signal transmission. Compared with omnidirectional antennas, its successor directional antennas have come up with significant advantages of reducing packet redundancy and interference by gaining higher signal-to-noise ratio. One older technique for broadcasting is flooding where every node in the network transmits messages to its next hop after receiving it, which is considered to be an expensive operation that can tremendously have an adverse impact on the networks leading to interference and packet flooding. As proposed by Hrishikesh (Rajiv Gandhi, *et al.*, 2012), in such case if directional antennas are used, that forms a beam towards the destination (Ramanathan, R., 2001), thereby reducing power consumption and redundancy. There are many issues regarding directional routing approaches. One solution is that using approximation algorithm finds optimal solution for broadcasts problems. DARP is a powerful routing protocol, a combo effect of DRP and approximation algorithm that reduces interference and collision to maximize the throughput.

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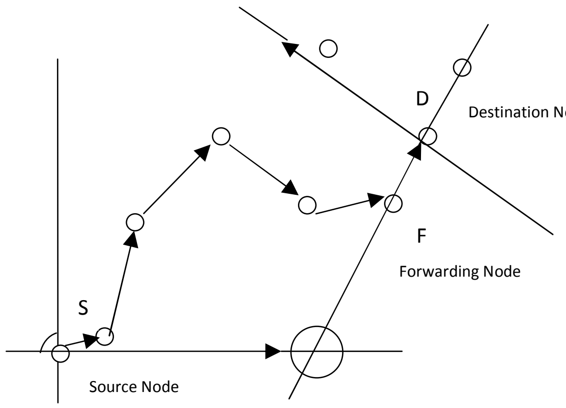

Fig. 1: DARP Routing Protocol

From figure 1, suppose source node S wishes to send packets to a destination node D. Since both node S and D have their own notions of orientation, if the source S sends packets in four orthogonal directions and the destination D does the same thing, these packets will eventually intersect at least two points. By forwarding packets to the forwarding node R, node S ensures connectivity with D while maintaining very little state. Without a location discovery scheme (which as we mentioned incurs rather large overhead), making no assumptions on node orientation (Both node S and D have their own concept of “north”), geographic position (Node S and D have their own perception of where they are physically), and position to address mapping, traditional geographic based routing protocols would be at a loss on how to perform the task. DARP reconciles this issue by utilizing an inherent property of Euclidian planes: that two unparalleled lines intersect, and builds the routing scheme based on the intersection point.

Objective:

There are some major problems in network broadcasting. They are,

Delay:

The delay of a network specifies how long it takes for a bit of data to travel across the network from one node or endpoint to another. It is typically measured in multiples or fractions of seconds. Delay may differ slightly, depending on the location of the specific pair of communicating nodes. Delay may be divided into following:

Processing delay - time routers take to process the packet header.

Queuing delay - time the packet spends in routing queues.

Transmission delay - time it takes to push the packet's bits onto the link.

Propagation delay - time for a signal to reach its destination.

Latency:

The term *latency* refers to any of several kinds of delays typically incurred in processing of network data. A so-called *low latency* network connection is one that generally experiences small delay times, while a *high latency* connection generally suffers from long delays.

Throughput:

Throughput or Network throughput is the average rate of successful message delivery over a communication channel. This data may be delivered over a physical or logical link, or pass through a certain network node. The throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second or data packets per time slot.

System throughput or aggregate throughput is the sum of the data rates that are delivered to all terminals in a network.

Approximation Ratio:

Approximation ratio is defined as the ratio at which it could solve the NP-problem.

It is essential to overcome these problems:

Blind flooding is a fundamental operation in broadcasting which can also lead to broadcast storm. Broadcast storm leads to bandwidth contention, redundancy and collision problems. When switches are interconnected for redundancy, a broadcast originating from a node connected to any switch can cause the circulation of broadcasts around the network and can saturate the network, consuming all available bandwidth known as BROADCAST STORM,(as said by Rajiv Gandhi (Hrishikesh Gossain, *et al*., 2006), chunyu hu (2003)) a serious network problem and can shutdown entire network in seconds.

Interference is a major threat to networking. If two or more nodes send a message to a common neighbor, the common node will not receive any of the messages which mean there exists collision at common node.

Sweeping is done frequently in networks. In order to perform a broadcast a transmitting node may do multiple transmissions from the antenna beams around it to cover the entire area of the network. There may be ‘n’ number of transmissions equal to the number of beams which causes RREQ packets to flood the network and results in data redundancy and collision in the network causing the entire system to shut down.

Methodology:

Directional Routing Protocol closely couples the routing layer with the MAC layer and assumes a cross-layer interaction between some of the modules. DRP maintains only the index of the node ID in a forwarding path, DRP also maintains node indices and the beam IDs used by the nodes to receive a packet in the forwarding path. The beam ID stored in the DRT helps the source node to estimate the angular position of its destination relative to itself. DRP uses the beam ID kept in the DRT to do an efficient route recovery (Hrishikesh Gossain, *et al*., 2006).

To minimize the effect of deafness and hidden node problems in directional environment, MAC layer of DRP employs a special form of sweeping of both RTS and CTS, namely, the Diametrically Opposite Directions (DOD) procedure. The DOD mechanism includes two major enhancements over sweeping, firstly, RTS and CTS packets are transmitted in DOD which ensures maximum coverage; secondly, these packets are only transmitted through the antenna beams with neighbors. In addition, the Enhanced Directional Network Allocation Vector (EDNAV) mechanism incorporated in MDA considerably improves performance.

DRP enforces discovery by broadcast optimizations proposed to reduce packet redundancy and route discovery latency. Whenever a node receives a RREQ packet it starts a delay timer. If the same RREQ packet is received again before the expiration of this timer, the node makes a note of all the beams where that packet arrived from. The node forwards (or sweeps) the packet in only those beams/directions other than those in which the packet arrived. Amongst the selected beams, DRP initiates a rebroadcast in the beams which are vertically opposite to the beams where the node received the broadcast packet. Next, the beams which are adjacent to these vertically opposite beams are chosen. This shall continue till all the selected beams are covered.

ONE-TO-ALL problem:

The one-to-all broadcast aims to disseminate a message from one special node to all the other nodes. It is also called as pipelined broadcast scheduling.

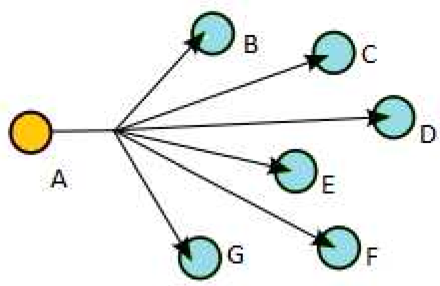

Fig. 2: One to all broadcast

In figure.2 Node A transmit message to all the other nodes in the network.

ALL-TO-ALL problem:

All to all broadcast is also known as gossip total exchange, every node in the network will transmit the message to every other node in the network. During this process a large amount of redundant data will flood the network.

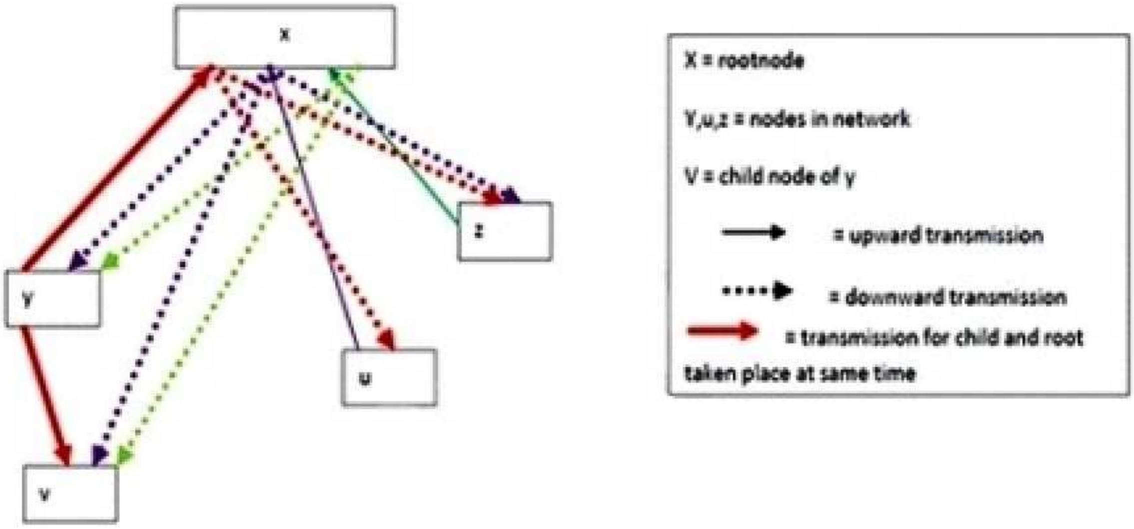

Fig. 3: All to All Broadcast (34 approximation algorithm)

Solutions:

There is an algorithm which could solve all-to-all broadcast problems namely ICDA – Interleaved Collect and Distribute Algorithm. Every node in the network abruptly participates in broadcasting to minimize the latency. The main idea is that: consider a node that receives a message forwarded originally from its descendants in the broadcast tree and relays it to its parent to deliver message to its root node. Parallel broadcasting is possible without waiting for the root node. We also, define 'super step' – collection of k time slots. In each super step, every node transmits almost one message. Both upward and downward transmissions are combined, giving priority to the upward transmission first Scheduling is done by the following set of guidelines.

(1) All terminal nodes send messages to their parents first.

(2) In each super step, primaries are scheduled before secondary.

(3) Transmissions from primaries are scheduled based on a vertex coloring.

(4) Each node can receive at most one upward message from its children. Therefore, a node can perform an upward transmission only if its parent has not received an upward message in the super step. Otherwise, it performs a downward transmission.

(5) For secondary, the nodes are considered in the same order as the broadcast tree is constructed. Upward transmissions are scheduled before downward transmissions.

(6) Once all upward transmissions for nodes are scheduled, the remaining nodes perform downward transmissions if there is any message to be sent.

Product Perspective:

DARP is an on-demand directional routing protocol, and closely couples the routing layer with the MAC layer and assumes a cross-layer interaction between some of the modules. The DARP will maintain the node indices and the beam ID used by the nodes to receive a packet in the forwarding direction. This helps the source node to estimate the angular position of its destination and route recovery phase.

Directional antenna:

Directional antennas usage is getting increasing acceptance in wireless networks. With the help of directional antennas both transmission range and spatial reuse can be substantially enhanced by having nodes concentrate transmitted energy only toward their destination's direction, thereby achieving higher signal to noise ratio (SNR).A transmitter can use this higher SNR to either increase its transmission range or transmit at higher data rate. Because of these underlying benefits of directional communications, there is a recent interest in the research community to use directional antennas for Mobile Ad Hoc Networks (MANETs). However use of directional antennas in MANETs creates new types of hidden terminal problems and node deafness. In addition, fundamental issues such as determination of a node's neighbors have to be properly handled.

Deafness is defined as the phenomenon when a node X is unable to communicate with node Y, as Y is presently beam formed in a different direction. In such an event, X perceives Y to have moved out of its range, thereby signaling its routing layer to take actions, hence affecting the network throughput. Deafness and hidden terminal issues have been extensively studied in a one hop scenario, but no solution has been provided. Although there is plethora of literature, towards designing efficient directional MAC schemes, a complete design of a routing protocol tuned to the underlying directional environment still requires to be explored. Here, the routing protocol specifically tuned to the underlying MAC layer can reap interesting performance benefits. In directional routing, a source node can exploit the antenna beam information towards its destination for an efficient route recovery. We have proposed a Directional Routing Protocol (DRP) for MANETs.

Algorithm specification:

The algorithm used to approximate the value is proposed by Huang *et al* (2007) termed IGA shortly works similar to Collect and Distribute Algorithm (CDA). The algorithm works as follows: transmissions may be upward or downward. There are two phases involved in it, they are

In the first phase, a simplified data collection algorithm is followed. A node 'a' collects all messages using data collection algorithm. A BFS tree is constructed from 'a' and messages are sorted in non-decreasing order. Messages close to 'a' is sorted first.

In the second phase, we first construct a broadcast tree and describe a transmission scheduling algorithm. For each message, root node collects all messages and performs one-to-all broadcasting. to make the scheduling collision free. We propose vertex coloring technique , such that nodes with same color can broadcast a message without collision . Results show that 17 colors are enough to obtain collision free schedule.

The scheduling for a graph can be computed using vertex coloring. Let h1 and h2 be the graphs. Vertex coloring is done for h1 and k1 number of colors is needed. . Vertex coloring is done for h2 and k2 number of colors are needed. k=k1 + k2, a group of consecutive time slots k is called as super step . Depending on the BFS levels, secondary nodes are divided into three sets. Each set is divided into four non interfering groups.

As proposed by Rajiv Gandhi (2007), Each node creates its own broadcasts tree and schedule transmissions greedily. In this algorithm, each source s of the message computes a broadcast tree rooted at itself. Message i is broadcast along tree rooted at s. Message i1 gets priority over i2 iff i1< i2.This priority is enforced by scheduling i1 before i2.

In all-to-all broadcasting strategies, an all-to-all algorithm called Interleaved Gossiping Algorithm (IGA) is proposed, which works similar to CDA except for the transmission schedule of secondary nodes. In IGA, secondary nodes are divided by three sets depending on their BFS level. Then, each set is divided into four noninterfering groups by running Iterative Minimal Covering algorithm (Huang, S.C.H., *et al*., 2008), which results in the bound of 12 time slots for secondary nodes. Gandhi *et al*. present an all-to-all algorithm (which we call MSB). In MSB, each node creates its own broadcast tree and schedules transmissions greedily in this technique; we consider two algorithms, namely: "Multi-Source Broadcasting, Collect and Distribute Algorithm". Topology with more number of nodes from 25, 50, 75, 100, transmission is done using All-to-all technique implemented using CDA and MSB technique.

Comparison between DARP AND DRP:

An Approximation ratio is developed and based on that comparison is made between DARP and DRP. To choose a best protocol, that finds optimal solutions to the problems we considered. Topology with more number of nodes from 25, 50, 75, 100, transmission is done by new proposed method of APPROXIMATION SCHEME to improve one-to-all and all-to-all technique considering the parameters: Delay, Throughput, Latency and Approximation ratio.

Directional Routing Protocol with Approximate value:

Topology with more number of nodes from 25, 50, 75, 100, transmission is done by new proposed method of APPROXIMATION SCHEME to compare with Directional Routing Protocol, considering the parameters: End to End Delay, packet delivery ratio, Routing overhead. The best algorithm chosen above is used to approximate the value of Directional Routing Protocol, which works similar to Dynamic Source Routing. There are two essential tables maintained in DRP which is, Directional Neighbour Table (DNT) and Directional Routing Table (DRT).

Evaluation and Simulation:

Graphs: Packet Delivery Ratio:

The simulations are entirely carried out in NS-2

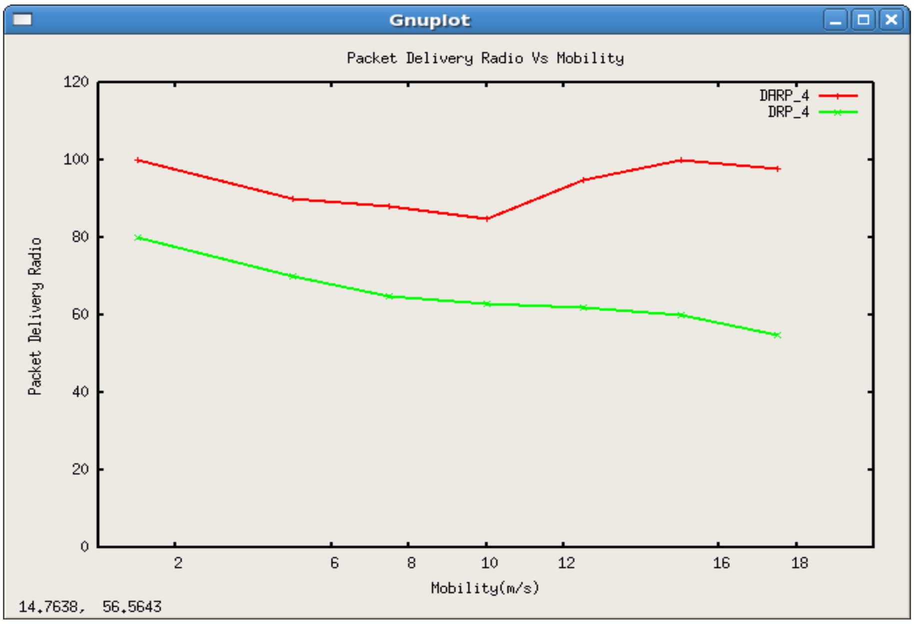

Fig. 4: Packet delivery ratio of DARP and DRP.

In figure 4, the above graphical representation determines that the DARP can send and receive high data packets. DARP with 4 beam antenna can achieve more than 95% of successful data delivery.

Routing Overhead of DARP and DRP:

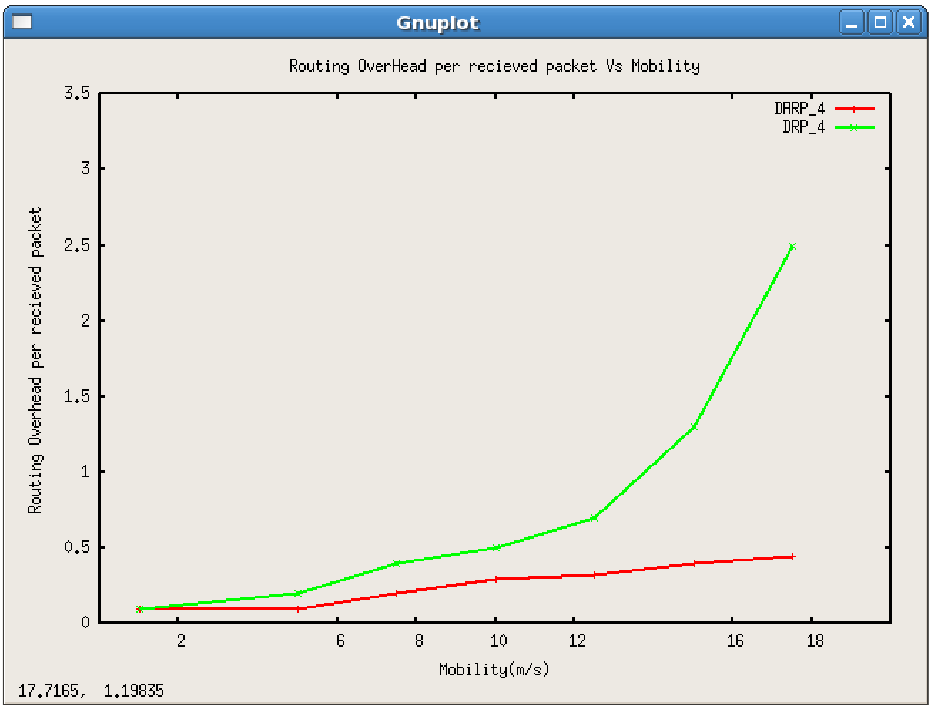

Fig. 5: Routing Overhead of DARP and DRP.

In figure 5, the routing overhead derived from the Number of control packets send divided by Number of data's packet received. The above graph shows that our proposed DARP received less overhead if less number of control packets are used. This can be found out by comparing other protocols as illustrated above. DRP 4 formulate high control packets used for route maintenance.

Average End to End Delay:

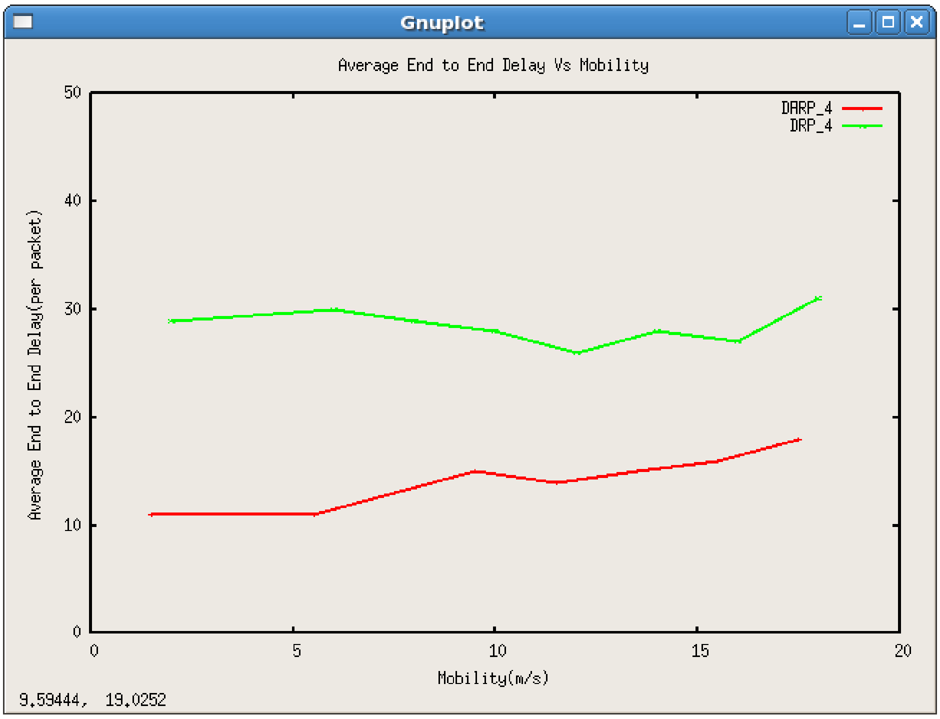

Fig. 6: Average End to End delay DARP and DRP.

In figure 6, the above graph shows the average end to end delay for each packet. If we increase the mobility of data, our proposed DARP makes less end to end delay by comparing DRP 4 protocol. The average end to end delay is proportional to increase mobility.

Initialization phase:

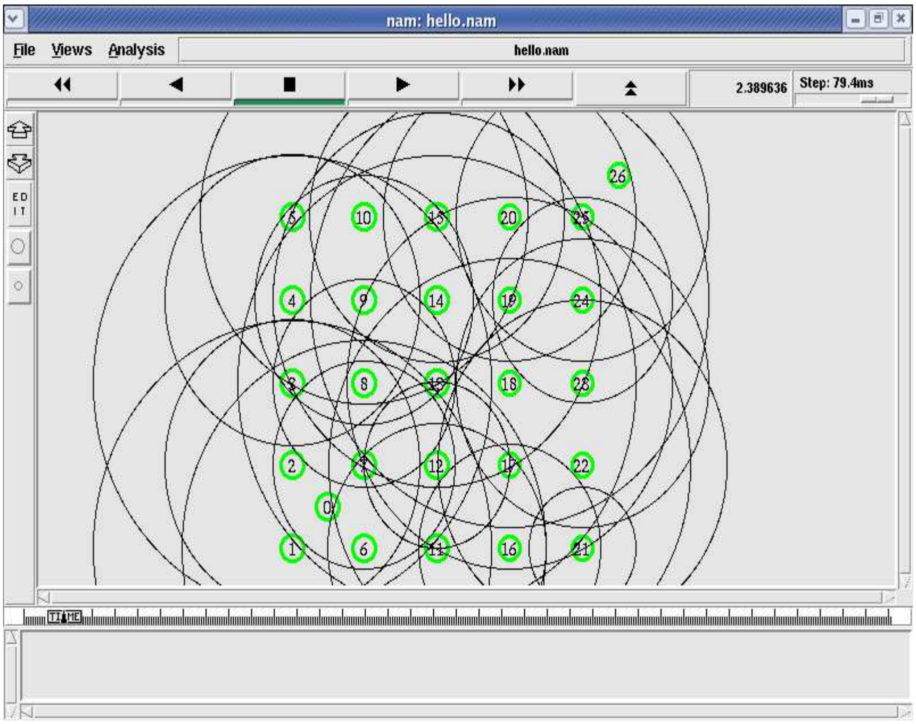

Fig. 7: Initialization Phase

In figure 7, In this result the effectiveness of DARP, performance analysis is made in comparison with real settings. The above NAM demonstrates the source and destination nodes with flat grid topology screen constructed with the area of 1000 X 1000 square meters area. Here 27 nodes build with the distance of 450 square meters for each node. All the nodes build their neighbors table during the initialization phase.

Data transfer:

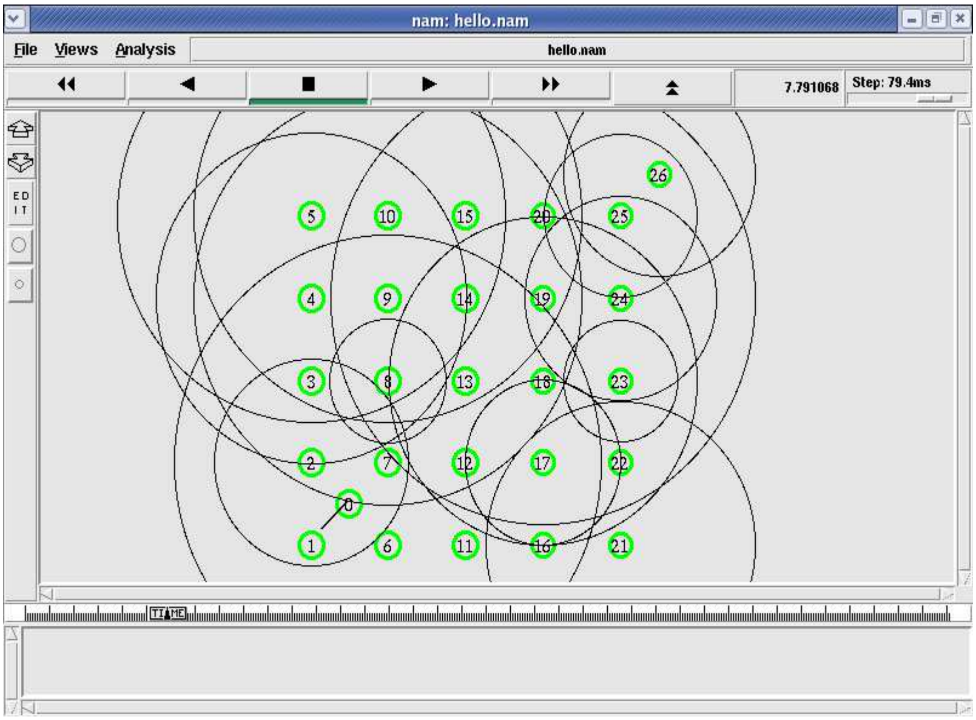

Fig. 8: Data Transfer

In figure 8, Node 1 initiates and start data transfer to 25th node. It updates routing table information and finds the forwarding node and passes the data to that node. Finally it will reach destination.

Conclusion and Future work:

In this paper, proposed a broadcast protocol for ad hoc network using directional antennas. This protocol, named DARP is a non trivial when compared to the existing on demand routing protocols. This paper considers the problem of end to end delay. This DARP protocol minimizes the end to end delay while broadcasting in multi hop wireless network. DARP for broadcasting can send and receive high data packets with 4 beam antenna and can achieve more than 95% of successful data delivery. These proposed schemes perform much better than the theoretical bound and achieves higher percent performance improvement over existing schemes. Thus the implementation of DARP protocol in network simulator assures that the DARP considerably reduces packet latency and end to end delay and thus the result is represented in the form of graphs.

In future we propose DARP algorithm which finds optimal solution for all broadcast problems by implementing various approximation algorithms in DRP protocol.

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