International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 9, November- 2012

# Multipath Dynamic Source Routing Protocol For Mobile Adhoc Networks

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***ABSTRACT----With the advance of wireless communication technologies, small-size and high-performance computing and communication devices like commercial laptops and personal digital assistants are increasingly used in daily life. After the success of second generation mobile systems, more interest was started in wireless communications. This interest has led to two types of wireless networks: infrastructure wireless network and infrastructure less wireless network, it is also called Mobile Ad-Hoc Network (MANET). The Mobile Ad Hoc Networks are essentially suitable when infrastructure is not present or difficult or costly to setup or when network setup is to be done quickly within a short period. They are very attractive for tactical communication in the military and rescue missions. They are also expected to play an important role in the civilian fora such as convention centers, conferences, and electronic classrooms.***

***Keywords*—Mobile Adhocc Networks, DSR, MPSR.**

## I. INTRODUCTION

The nodes in the MANET are typically powered by batteries which have limited energy reservoir. Sometimes it becomes very difficult to recharge or replace the battery of nodes; in such situation energy conservations are essential. The lifetime of the nodes show strong dependence on the lifetime of the batteries. In the MANET nodes depend on each other to relay packets. The lost of some nodes may cause significant topological changes, undermine the networkoperation, and affect the lifetime of the network. Hence the energy consumption becomes an important issue in MANET. Hence Multipath Dynamic Source Routing (MDSR) protocol is implemented, which balances node energy utilization to increase the network lifetime, it takes network congestion into account to reduce the routing delay and increases the reliability of the packets reaching the destination.

Multipath Dynamic Source Routing Protocol is based on standard on demand routing protocol i.e. Dynamic Source Routing (DSR) and it uses new power aware metric i.e. minimum node cost to find the optimal paths. Due to ondissemination of routing information throughout the networkis also eliminated because that will consume a lot of the scarce topology changes rapidly and it also works well when network size increases. It reduces the overhead during broadcasting of route requests using a novel approach, which in turn induces little bit overhead to carry node's cost in route quest.

The mobile ad-hoc network is a collection of two or more wireless nodes which might be mobile and able to communicate with each other either directly within radio range or by multi hop data forwarding operation if they are not directly within radio range. The wireless ad-hoc network is formed by any wireless devices which have networking capability and they are within radio range without any support of central administration and infrastructure. In such way, ad-hoc network has been created, organized and administered by wireless node itself on the fly. None of the wireless node has right of administration and control to support the network. Only interaction among them is used to provide such functions in a network.

According to the wireless nodes movement, ad-hoc network is classified in two major categories: Static ad-hoc network and Mobile ad-hoc network. In static ad-hoc network, location of mobile node is not frequently changed once network is deployed. In mobile ad-hoc network, all nodes are free to move without any restriction and topology of network is changing dynamically without any prior notice. This kind of network is abbreviated as MANET.

A "mobile ad hoc network" (MANET) is an autonomous system of mobile routers (and associated hosts) connected by wireless links. The routers are free to move randomly and organize themselves arbitrarily; thus, the network's wireless topology may change rapidly and unpredictably. Such a network may operate in a stand-alone fashion, or may be connected to the larger Internet.

MANETs create a network among themselves dynamically without the need for any infrastructure or support from some other wired entity. Hence, we can say that Ad hoc networks are self-organizing, self-creating, self-administering and autonomous in their function. If a direction connection between one mobile node and another cannot be established, then other intermediate nodes act as routers or relays. Hence each node in a MANET acts as a host, a router, a receiver and a transmitter. In current large-scale wireless systems, this feature is absent. The enormous benefit and the potential of MANET lie in the fact that there are no costs or the need to setup an infrastructure to form such a network. Setting up traditional networks is very costly. Take the example of telephone systems where we need local loops, trunks, exchanges, which all need to be interconnected. For cellular networks, we have a number of base stations, each of which covers a small geographical area and these base stations have to communicate with a Mobile Switching Office (MSO), which acts a centralized control centre. For mobile ad hoc networks, no such costs are involved. Further, in situations like a disaster recovery site or remote areas where the fixed infrastructure based services are either not available or cannot be relied on, MANETs are the only possible solution.

ISSN: 2278-0181
Vol. 1 Issue 9, November- 2012

## II. Assumption

We assume that all hosts wishing to communicate with other hosts within the ad hoc network are willing to participate fully in the protocols of the network. In particular, each host participating in the network should also be willing to forward packets for other hosts in the network.

Refer to the number of hops necessary for a packet to reach from any host located at one extreme edge of the network to another host located at the opposite extreme, as the *diameter* of the network.

Hosts within the ad hoc network may move at any time without notice, but we assume that the speed with which hosts move is moderate with respect to the packet transmission latency and wireless transmission range of the particular underlying network hardware in use. In particular, we assume that hosts do not continuously move so rapidly as to make the flooding of every packet the only possible routing protocol.

Assume that hosts can enable a *promiscuous* receive mode on their wireless network interface hardware, causing the hardware to deliver every received packet to the network driver software without filtering based on destination address. Although we do not require this facility, it is common in current LAN hardware for broadcast media including wireless, and some of our optimizations take advantage of it. Use of promiscuous mode does increase the software overhead on the CPU, but we believe that wireless network speeds are more the inherent limiting factor to performance in current and future systems. We believe that portions of the protocol are also suitable for implementation directly in hardware or within a programmable network interface unit to avoid this overhead on the CPU.

## III. Basic Operation

To send a packet to another host, the sender constructs a *source route* in the packet's header, giving the address of each host in the network through which the packet should be forwarded in order to reach the destination host. The sender then transmits the packet over its wireless network interface to the first hop identified in the source route. When a host receives a packet, if this host is not the final destination of the packet, it simply transmits the packet to the next hop identified in the source route in the packet's header. Once the packet reaches its final destination, the packet is delivered to the network layer software on that host.

Each mobile host participating in the ad hoc network maintains a *route cache* in which it caches source routes that it has learned. When one host sends a packet to another host, the sender first checks its route cache for a source route to the destination. If a route is found, the sender uses this route to transmit the packet. If no route is found, the sender may attempt to discover one using the *route discovery* protocol. While waiting for the route discovery to complete, the host may continue normal processing and may send and receive packets with other hosts. The host may buffer the original packet in order to transmit it once the route is learned from route discovery, or it may discard the packet, relying on higher-layer protocol software to retransmit the packet if needed. Each entry in the route cache has associated with it an expiration period, after which the entry is deleted from the cache.

While a host is using any source route, it monitors the continued correct operation of that route. A route will also no longer work if any of the hosts along the route should fail or be powered off. This monitoring of the correct operation of a route in use we call *route maintenance*. When route maintenance detects a problem with a route in use, route discovery may be used again to discover a new, correct route to the destination.

### A. Route discovery

Route discovery allows any host in the ad hoc network to dynamically discover a route to any other host in the ad hoc network, whether directly reachable within wireless transmission range or reachable through one or more intermediate network hops through other hosts. A host initiating a route discovery broadcasts a *route request* packet which may be received by those hosts within wireless transmission range of it. The route request packet identifies the host, referred to as the *target* of the route discovery, for which the route is requested. If the route discovery is successful the initiating host receives a *route reply* packet listing a sequence of network hops through which it may reach the target.

In addition to the address of the original initiator of the request and the target of the request, each route request packet contains a *route record*, in which is accumulated a record of the sequence of hops taken by the route request packet as it is propagated through the ad hoc network during this route discovery. Each route request packet also contains a unique *request id*, set by the initiator from a locally-maintained sequence number. In order to detect duplicate route requests received, each host in the ad hoc network maintains a list of the initiator address, request id pairs that it has recently received on any route request.

When any host receives a route request packet, it processes the request according to the following steps:

1. If the pair initiator address, request id for this route request is found in this host's list of recently seen requests, then discard the route request packet and do not process it further.

2. Otherwise, if this host's address is already listed in the route record in the request, then discard the route request packet and do not process it further.

3. Otherwise, if the target of the request matches this host's

ISSN: 2278-0181
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own address, then the route record in the packet contains the route by which the request reached this host from the initiator of the route request. Return a copy of this route in a *route reply* packet to the initiator.

4. Otherwise, append this host's own address to the route record in the route request packet, and re-broadcast the request.

The route request thus propagates through the ad hoc network until it reaches the target host, which then replies to the initiator. The original route request packet is received only by those hosts within wireless transmission range of the initiating host, and each of these hosts propagates the request if it is not the target and if the request does not appear to this host to be redundant. Discarding the request because the host's address is already listed in the route record guarantees that no single copy of the request can propagate around a loop. Also discarding the request when the host has recently seen one with the same initiator address, request id removes later copies of the request that arrive at this host by a different route.

In order to return the *route reply* packet to the initiator of the route discovery, the target host must have a route to the initiator. If the target has an entry for this destination in its route cache, then it may send the route reply packet using this route in the same way as is used in sending any other packet (Section 3.1). Otherwise, the target may reverse the route in the route record from the route request packet, and use this route to send the route reply packet. This, however, requires the wireless network communication between each of these pairs of hosts to work equally well in both directions, which may not be true in some environments or with some MAC-level protocols. An alternative approach, and the one we have currently adopted, is for this host to piggyback the route reply packet on a route request targeted at the initiator of the route discovery to which it is replying.

## B. Route Maintenance

Conventional routing protocols integrate route discovery with route maintenance by continuously sending periodic routing updates. If the status of a link or router changes, the periodic updates will eventually reflect the changes to all other routers, presumably resulting in the computation of new routes. However, using route discovery, there are no periodic messages of any kind from any of the mobile hosts. Instead, while a route is in use, the route maintenance procedure monitors the operation of the route and informs the sender of any routing errors.

Since wireless networks are inherently less reliable than wired networks , many wireless networks utilize a hop-by-hop acknowledgement at the data link level in order to provide early detection and retrans- mission of lost or corrupted packets. In these networks, route maintenance can be easily provided, since at each hop, the host transmitting the packet for that hop can determine if that hop of the route is still working. If the data link level reports a transmission problem for which it cannot recover (for example, because the maximum number of retransmissions it is willing to attempt has been exceeded), this host sends a *route error* packet to the original sender of the packet encountering the error. The route error packet contains the addresses of the hosts at both ends of the hop in error: the host that detected the error and the host to which it was attempting to transmit the packet on this hop. When a route error packet is received, the hop in error is removed from this host's route cache, and all routes which contain this hop must be truncated at that point.

If the wireless network does not support such lower-level acknowledgements, an equivalent acknowledgement signal may be available in many environments. After sending a packet to the next hop mobile host, the sender may be able to hear that host transmitting the packet again, on its way further along the path, if it can operate its wireless network interface in promiscuous mode. For example, in Figure 1, host *A* may be able to hear *B*'s transmission of the packet on to *C*. This type of acknowledgement is known as a *passive acknowledgement*. In addition, existing transport or application level replies or acknowl- edgements from the original destination could also be used as an acknowledgement that the route (or that hop of the route) is still working. As a last resort, a bit in the packet header could be included to allow a host transmitting a packet to request an explicit acknowledgement from the next-hop receiver. If no other acknowledgement signal has been received in some time from the next hop on some route, the host could use this bit to inexpensively probe the status of this hop on the route.

As with the return of a route reply packet, a host must have a route to the sender of the original packet in order to return a route error packet to it. If this host has an entry for the original sender in its route cache, it may send the route error packet using that route. Otherwise, this host may reverse the route from the packet in error (the route by which the packet reached this host) or may use piggybacking as in the case of a route reply packet. Another option in the case of returning a route error packet is for this host to save the route error packet locally in a buffer, perform a route discovery for the original sender, and then send the route error packet using that route when it receives the route reply for this route discovery. This option cannot be used for returning a route reply packet, however, since then neither host would ever be able to complete a route discovery for the other, if neither initially had a route cache entry for the other.

Route maintenance can also be performed using end-to-end acknowledgements rather than the hop-by- hop acknowledgements described above, if the particular wireless network interfaces or the environment in which they are used are such that wireless transmissions between two hosts do not work equally well in both directions. As long as some route exists by which the two end hosts can communicate (perhaps different routes in each direction), route maintenance is possible. In this case, existing transport or application level replies or acknowledgements from the original destination, or explicitly requested network level acknowledgements, may be used to indicate the status of this host's route to the other host. With hop-by-hop acknowledgements, the particular hop in error is indicated in the route error packet, but with end-to-end acknowledgements, the sender may only assume that the last hop of the route to this destination is in error.

## IV. critical evaluation of manet

We may evaluate mobile ad-hoc networks (MANET) comparing them with cellular networks, as they are wireless networks as well. The main differences between cellular networks and mobile ad-hoc networks are as follows.In cellular networks, routing decisions are taken in a centralized manner with more information about the available destination node; whereas in mobile ad-hoc networks those decisions are taken in the node due to absence of a base station. Consequently, nodes have to manage routing information and host information in a distributed manner.

It is clear from the above illustrations that MANETs are different from the wireless networks that are prevalent these days. Further another point needs to be emphasized. In MANETs, any device can communicate with any other device. Just like Blue tooth is on a small scale where a wireless network can be formed among various devices. Mobile phones can communicate with PDAs, laptops or any device, which is blue tooth enabled. Similarly in MANETs, communication between any types of device is possible as shown in the following figure.



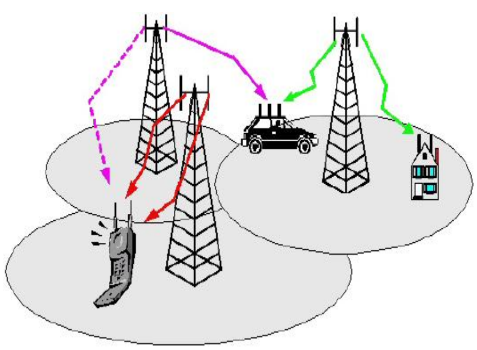


Figure 1: Illustration of Cellular networks

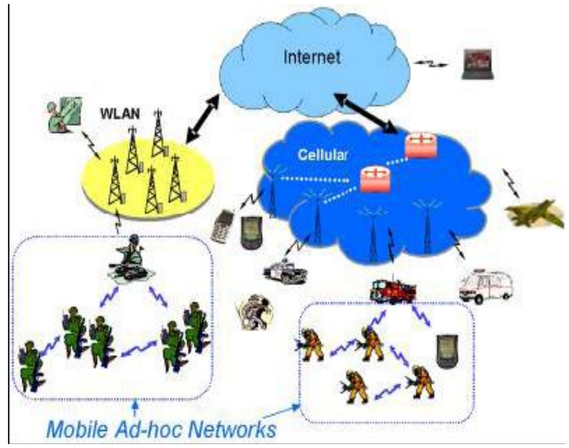



Figure.2: Comparison of MANET with other networks

It is clear from the above illustrations that MANETs are different from the wireless networks that are prevalent these days. Further another point needs to be emphasized. In MANETs, any device can communicate with any other device. Just like Blue tooth is on a small scale where a wireless network can be formed among various devices. Mobile phones can communicate with PDAs, laptops or any device, which is blue tooth enabled. Similarly in MANETs, communication between any types of device is possible as shown in the following figure.

## V. MECHANISMS FOR IMPLEMENTATION

For implementing Multipath Source Routing Protocol, randomly the forty nodes are distributed in the area of size 100m x 100m. It is assumed that distributed coordination function of IEEE 802.11 at MAC layer and free space radio propagation model with 2 Mbps channel bandwidth. Each node is equipped with a single network interface card and has a transmission radius of r=14. All the nodes have the equal transmission range of 88 meters. All nodes operate in promiscuous mode, so it can overhear packets destined for others. It is assumed that the transmission power, receivingpower are fixed for all the nodes and two nodes can hear each other if their distance is in the transmission range.

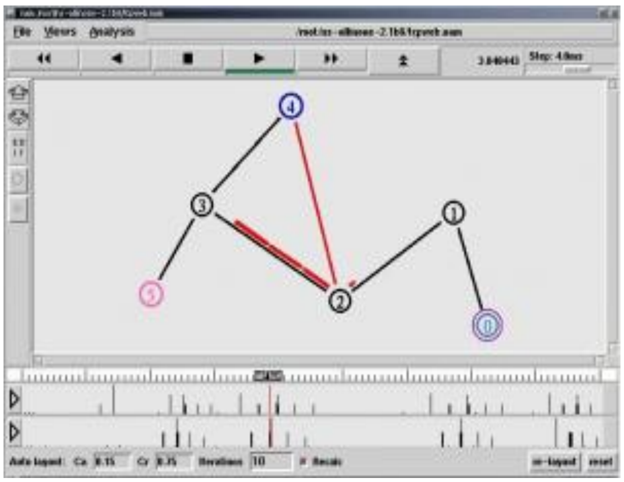
The speeds are uniformly chosen between the minimum and maximum speeds and are set to 0m/s and 3m/s respectively. When the node reaches its destination point, it stays there for a certain pause time, after which it chooses another random destination point and repeats the process. The simulation ends after 100s. All nodes are assumed to have the same amount of battery capacity with full energy at the beginning of the simulation. Initial energy of each node is set to 100 Joules. Three different weight factors 10, 20, 30 are chosen and randomly, a weight factor is assigned to a node.

Multipath source routing protocol implementation consists of four main mechanisms.

Route selection
Route Discovery

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 1 Issue 9, November- 2012

Maximization of Network lifetime and congestion control



## VI SIMULATION

Ad Hoc Mobile Network Formation:This module is used to generate a random network; inputs of this module are space, number of nodes, cell radius of each node, initial position of node. The output of this network is a random network.

Node Mobility Model: This model sets the speed, direction and pause time of each node and allows each node to move in a random direction, this module is called node mobility module. We use random way point mobility model with pause time of each node is 10 sec and speed of each node is 2m/10s.

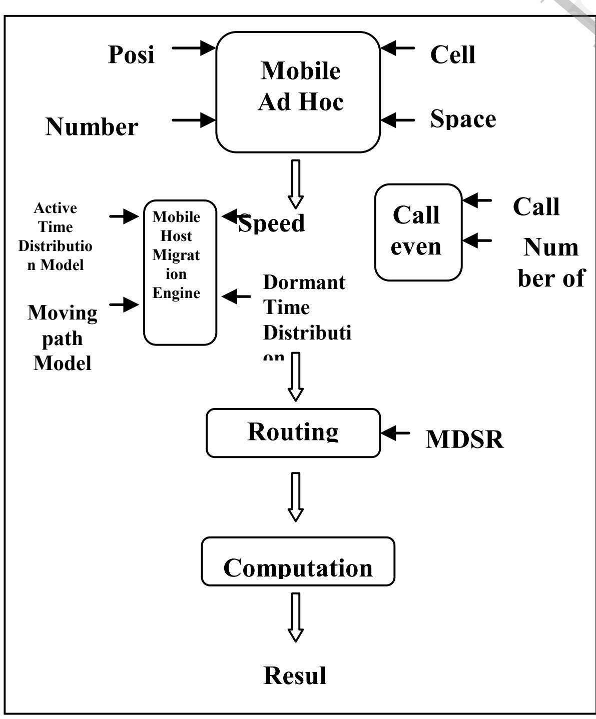



Figure 3: Simulation model

Route Requests Event Generator: This module accepts the number of requests from user, and then selects source and destination pairs randomly.

Routing Protocol Module: In this module MSR is implemented. This is core module that incorporates several functions like route discovery, route selection, route maintenance, congestion control and increasing network life time.

Computation Module:This module estimates the power consumption, residual energy, number of nodes expired, overhead, throughput, end-to-end delay.

Simulation tools: For the formation of a mobile adhoc network, network simulator is used which generates a trace file. From that trace file we have to take some multiple paths randomly. Power consumption, residual energy, number of nodes expired, throughput, end-end-delay,overhead can be calculated using C language.

Simulation Parameters:

| | |
|---|---|
| Simulation area | 100m*100m |
| Network size | 40 nodes |
| Transmission Range | 25m |
| Transmission power | 0.7 joules/packet |
| Receiving power | 0.3 joules/packet |

Node Mobility Model, Pause Time and Speed
Random way point mobility
Model, 10sec, 2m/10sec
Initial Energy, Maximum Battery capacity 100 joules,100J

| | |
|---|---|
| Weight factors | 10,20,30,40 |
| Threshold value | 5 joules |

Route request arrival rate(lambda) 5,10,15 per sec
Traffic type, Packet arrival rate, Maximum packet size---Constant Bit Rate (CBR), 20 packets/10sec, 512 bytes
Queue type and queue size Droptail, 512*20 bytes
Time out interval at intermediate node and total simulation time-----5 sec, 100 sec

Selected Optimal Paths

Selected Optimal paths for lambda=5 are:
1-2-16-17-18-29-30
3-4-5-19-15-18-29-30-33
6-7-20-21-24-34-35
11-12-25-26-39-40-36-38
12-25-26-39-34

Selected Optimal paths for lambda=10 are:
1-2-16-17-18-29-30
3-4-5-19-15-18-29-30-33
6-7-20-21-24-34-35
11-12-25-26-39-40-36-38
12-25-26-39-34
30-29-18-17-16-2
33-31-28-21-20-22
38-36-40-39-26-27
35-33-31-28-15
11-12-25-26-39-34

Selected Optimal paths for lambda=15
1-2-16-17-18-29-30

International Journal of Engineering Research & Technology (IJERT)
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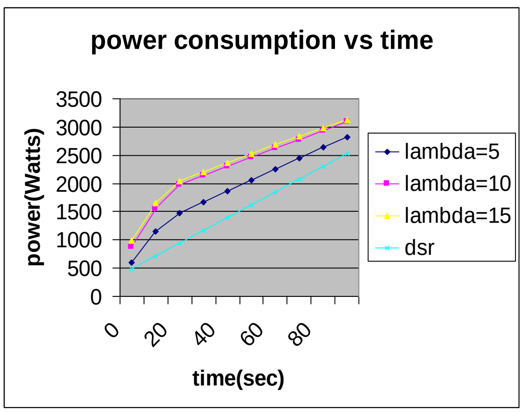
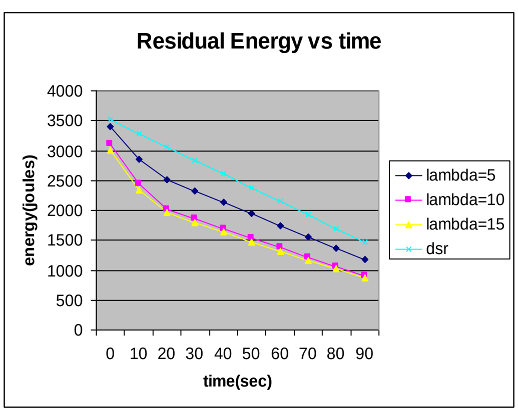
3-4-5-19-15-18-29-30-33
6-7-20-21-24-34-35
11-12-25-26-39-40-36-38
12-25-26-39-34
30-29-18-17-16-2
33-31-28-21-20-22
38-36-40-39-26-27
35-33-31-28-15
11-12-25-26-39-34
9-12-25-27
12-25-23-22
7-9-12-25-27
10-12-25-26-39
40-39-26-27

Graphs:Here, Power consumption, Residual Energy and Number of nodes expired are calculated for single path, 5 paths, 10 paths, 15 paths at different time intervals using C.

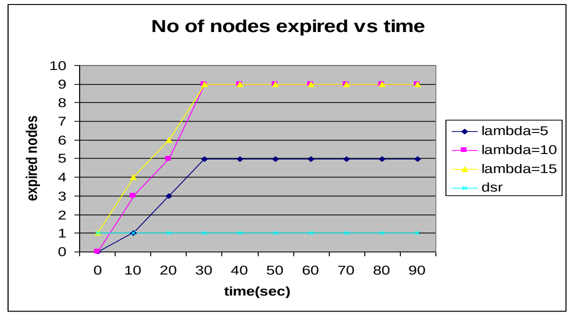
From the graph we can observe that the Power consumption is increasing with time as no of paths(lambda) are increasing.




From the graph we can observe that the Power consumption is increasing with time as no of paths(lambda) are increasing.




From the graph we can observe that the Residual Energy is decreasing with time as no of paths(lambda) are increasing.




From the graph we can observe that the number of nodes expired are increasing exponentially with time as no of paths(lambda) are increasing.

## VII CONCLUSIONS AND FUTURE WORK

In this paper, Multipath Dynamic Source Routing Protocol is implemented which is based on standard on demand routing protocol i.e. Dynamic Source Routing (DSR). It uses new power aware metric i.e. minimum node cost to find the optimal paths. Due to on demand nature, the maintenance of whole information about network topology in routing tables is eliminated and the dissemination of routing information throughout the network is also eliminated because that will consume a lot of the scarce bandwidth and power when the link state and network topology changes rapidly and it also works well when network size increases. It reduces the overhead during broadcasting of route requests using a novel approach, which in turn induces little bit overhead to carry node's cost in route quest.

For implementing Multipath Dynamic Source Routing Protocol, randomly the forty nodes are distributed in the area of size 1000m x 1000m and parameters such as speed, delay, etc. Tcl script is written taking multiple sources and multiple destinations, and a trace file is generated. From that file, number of paths from each source and destination are taken, from that minimal path which is having least cost is selected for each path. For that paths power consumption, residual energy and number of nodes expired are calculated using c language and compared with DSR. It is assumed that the transmission power, receiving power are fixed for all the nodes and two nodes can hear each other if their distance is in the transmission range. The speeds are uniformly chosen between the minimum and maximum speeds and are set to 0m/s and 3m/s respectively. When the node reaches its destination point, it stays there for a certain pause time, after which it chooses another random destination point and repeats the process. The simulation ends after 100s. All nodes are assumed to have the same amount of battery capacity with full energy at the beginning of the simulation. Initial energy of each node is set to 100 Joules. Three different weight factors 10, 20, 30 are chosen and randomly, a weight factor is assigned to a node.

From the results, it is observed that, Total power consumption is directly proportional to Total residual energy is indirectly propositional to the energy consumption. The Network life depends on the node expiration which in turn depends upon energy consumption and threshold value. The node life time is indirectly proportional to the energy consumption and it is also directly proportional to the threshold value of the node.

The Multipath Dynamic Source Routing Protocol significantly reduces the total number of Route Request packets, this result in an increased packet delivery ratio, decreasing end-to-end delay for the data packets, lower control overhead, fewer collisions of packets, supporting reliability and decreasing power consumption.

This project can be extended for measuring various other performance metrics and calculating various factors like network size, route requests arrival rate, packet arrival rate, packet size (header size and payload size), packet collision and retransmissions using network simulator.

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