Energy Efficient Power Aware Multipath Dynamic Source Routing

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ABSTRACT
The versatile uses of Mobile Ad Hoc Networks have elicited everyone's attention and offer a lot of challenges to the researchers. Due to absence of central coordinators in Ad hoc Networks all the necessary actions are played by the individual node. Nodes major responsibility is routing and many routing protocols play very important role in it. As packets are sent from source to destination through many intermediate nodes; it becomes a very costly process which consumes a lot of power. But many traditional routing protocols the path is chosen on basis of minimum hop count and don't concern about the energy consumption of the individual node. Very often the minimum hop count leads to high power consumption. As the traditional routing protocol don't bother about the node's residual energy, and if a single intermediate node dies out of energy then the whole communication may be interrupted due to network partition which may increase the number of retransmission of packets, packet loss results in high bandwidth consumption and hence poor performance. Because all these nodes are operated on limited battery power it has to be used efficiently so that the life time of the network can be enhanced without degrading the performance. This paper proposed an Energy efficient power aware multipath dynamic source routing protocol by modifying one of the most popular routing protocols that is Dynamic Source Routing (DSR) protocol which is not at all concerned about power consumption. This Dynamic source routing-Power Aware routing DSR-PSR uses the basic concept of traditional DSR through which it not only enhances the life time of the network but also increases the overall performance of the networks.

General Terms
Energy Efficient algorithm for Dynamic source routing protocol.

Keywords
Dynamic source routing protocol, DSR, energy efficient routing, Energy efficient dynamic source routing

1. INTRODUCTION

Ad hoc networks are the autonomous systems consist of mobile nodes that communicate with each other using wireless communication. Here a node can be a PDA, a laptop, a mobile phone or another communication device with some characteristics that are limited storage capacity, limited bandwidth and ,limited battery power. An ad hoc network typically refers to any set of networks where all devices have equal status on a network and are free to associate with any other ad hoc network devices in link range.[1][2]

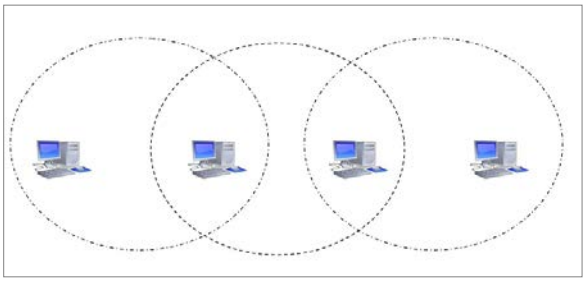

Figure 1 Ad hoc network with four nodes

Ad hoc network do not have any pre-existing infrastructure. They are self-organized, self-configured, and self-controlled networks. This type of network can be set up or deployed anywhere and anytime because it poses very simple setup and no or minimal central administration. The network is characterized by the absence of central administration devices such as base stations or access points. Furthermore, nodes are free to move in any direction, and therefore will change its links to other devices frequently. The primary challenge in building a wireless ad hoc network is to equipping each device to continuously maintain the information required to properly route traffic. This means if link breakages occur the network has to stay operational by building new routes.

2. DESCRIPTION OF SELECTED ROUTING PROTOCOL

Mobile networks have attracted significant interest in recent years because of their improved flexibility and reduced costs.
Compared to wired networks, mobile networks have unique characteristics like frequent network topology changes, varying link capacity because of the impacts from transmission power, receiver sensitivity, noise, fading, and interference. Additionally, wireless mobile

Manuscript received August 5, 2014
Manuscript revised August 20, 2014

networks have a high error rate, power restrictions, and bandwidth limitations [1]. Routing is the process of selecting paths in a network along which network traffic can be sent. [2] In a mobile ad hoc network arbitrarily motion of nodes results in unpredictable and frequent topology changes. Additionally, since nodes in a mobile ad hoc network normally have limited transmission ranges, nodes cannot communicate directly with each other. Hence, routing paths in mobile ad hoc networks contain multiple hops, and each node in mobile ad hoc networks has the responsibility to act as a router. Because of the importance of routing protocols in dynamic multihop networks, a lot of mobile ad hoc network routing protocols have been proposed in the last few years. Routing protocols of MANETs fall into two main categories. First are Proactive protocols which are also known as table driven routing protocol in which every node periodically exchange the routing information and maintain network topology information in form of tables.

Nodes continuously evaluate routes by flooding routing information across the network to all other reachable nodes and attempt to maintain up-to-date and consistent routing information. Therefore, a source node immediately gets a routing path when it needs one. On the contrary, reactive protocols build paths on-demand and Dynamic Source Routing (DSR) is an on demand routing protocol. The routing protocols that fall under this category do not maintain the network topology information. They obtain the necessary path when required. Hence they do not periodically exchange any routing information. [6] A route discovery operation invokes a route determination procedure. This discovery procedure terminates either when a route has been found or no route is available after examination for all route permutations. In a mobile ad hoc network, active routes may be disconnected due to node mobility. Therefore, route maintenance is an important operation of reactive routing protocols [1]. So DSR employs flooding to discover paths (Section A). Then, to manage situations in which current routes are broken, DSR implements a separate route maintenance procedure (Section B).

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A. ROUTE DISCOVERY Route discovery consists of two sub-procedures: Route Request (RREQ) and Route Replay (RREP). Route discovery is the mechanism by which a node wishing to send a packet to a destination node finds a route. Route discovery is used only when a node attempts to send a packet to another node and does not already know a route to that node. [7]

- Let consider a node S which want to send packets to node D. S will check its “Route cache” if route is present. If no route is found, it will have to start a route discovery protocol to find a route to the destination. Else the cached route is used to send packet.
- Now node S will initiate Route Request and will broadcast RouteRequest (RREQ) packet with a unique identification number. This RREQ is flooded throughout the network. Each node on receiving the RREQ packet rebroadcast the packet to neighbour nodes except some conditions like if the node has forwarded this packet already or if the node is destination node or time to live has exceeded. Each node before forwarding appends its own address to packet.
- Now how the nodes will check if it has forwarded the packet already? Solution to this is also given that each RREQ packet has a unique identification number generated by source node and path it has traversed. A node on receiving the RouteRequest packet checks the sequence number in routing table to check the duplicate request. Duplicate request is discarded.

B. ROUTE MAINTENANCE Route maintenance is the mechanism by which node S is able to detect the change in network topology, such that if it is not able to use its route to D because a link along the route no longer works. Route maintenance is used only when S is actually sending packets to D. When route maintenance indicates a source link is broken, S attempts to use any other route it know to D, or invokes route discovery again to find a new route.
Using route discovery S will get the RouteReply from D. Now when there is a path from S to D and S can send packets to D via selected route. Now when S will send packets and if the intermediate node C moves from its position and cause wireless link breakage. RouteError (RERR) message will be sent by intermediate node B to initiator S. Then source node S reinitiate route discovery for reestablishment of new route. The entries cached at intermediate nodes are removed when they get RERR message

3. PROBLEM FORMULATION

Ad hoc networks are the autonomous systems consist of mobile nodes that communicate with each other using wireless communication. The highly dynamic natures of the mobile nodes create frequent and unpredictable

network topology changes. These topology changes increase the routing complexity among the mobile nodes within the network. There for several traditional routing algorithms are not sufficient to the successful routing in Adhoc network. Routing in an Adhoc depends on many other factors including topology, selection of routers, and location of request initiator and specific underlying characteristics that could serve as a heuristic in finding the path quickly and efficiently. This makes the routing area perhaps the most active research area within the Adhoc domain.

Especially over the last few years, numerous routing protocols and algorithms have been proposed and their performance under various network environments and traffic conditions closely studied and compared.

In order to facilitate communication within an Adhoc network, an efficient routing protocol is required to discover routes between mobile nodes. As in ad hoc networks mobile devices are battery operated and the battery technology has not been improving rapidly. Therefore power consumption is likely to remain an issue in mobile wireless network routing.

Since communication between two nodes depend on other intermediate nodes as transmission range of nodes are not much capable to communicate directly. Lack of central administration in ad hoc network burden the nodes to maintain all routing information. Since nodes have limited energy they get out of energy which results in interruption in communication link and decrease network lifetime. The death of a small set of nodes because of depleted power might cause partitioning of the network result less network lifetime.

Conventional routing protocols do not consider the power during route discovery and route establishment. As there are many routing protocol we are studying Dynamic source routing protocol for this research work, which is an on demand routing protocol. DSR Dynamic source routing protocol do not take care of energy factor. So we need to develop a routing protocol that considers energy an important factor during route discovery and route establishment. So that lifetime of network can be increased and decrease packet loss and delay in transfer of packets.

Our main motive is to analyse several power aware routing algorithms such as Minimum Total Transmission Power Routing (MTPR), Minimum Battery Cost Routing (MBCR) and load balancing routing protocol. Then we need to develop an Energy Efficient Power Aware routing protocol that taking the basic idea of DSR Dynamic source routing protocol.

4. PROPOSED DYNAMIC SOURCE ROUTING POWER AWARE SOURCE ROUTING (DSR-PSR)

The primary objective of DSR-PSR is to select the path for the specified source to destination in such a way that intermediate nodes have higher power. So idea is instead of following minimum hop count method during the route discovery phase, select those path using nodes energy level.

Following are the steps taken for this

DSR-PSR Algorithm

I. The Source Node which wants to send packet initializes the data transmission request.

II. First it checks the route cache for the particular destination; if destination found it uses that path to send data else route discovery process is initiated.

III. At the time of route discovery, a route request (RREQ) packet broad casted by the source. The header of the RREQ packet includes <source_id, destination_id>,

IV. Parameters on each node defined are Node Id, Battery Status B_S

Battery status is further divided into 3 categories:

If (Battery Status < 20%)

Then Set *B_S* = 1

If (20% <=Battery Status <=60%)

Then Set *B_S* = 2

If (Battery Status <60%)

Then Set *B_S* = 3

Value of Battery status B_S is updated at each node according to it.

V. Parameters Concerned during Route Search

T_B_S (Total Battery Status),W*Ns (number of weak nodes)* and *Node_ID*s.

Now according to Battery status B_S Total battery status T_B_S is calculated

If (B_Si == 3)

Then T_B_S = T_B_S + 3

Else-if (B_Si == 2)

Then T_B_S = T_B_S + 1

Else-if (B_Si == 1)

WN= WN + 1

Here WN represents a weak node which has the energy less than 20%.

VI. After threshold time T destination node check out the paths and find the path with small number of week nodes.

VII. Now the path taken out is the path with nodes having more energy but still there needs to make little changes as if Length of path chosen using DSR-PSR is greater than DSR then older path will be taken into action to save time for sending packets.

If(hopcount(path(DSR-PSR))>hopcount(path(DSR)))
Then
Use path(DSR)

5. SIMULATION AND RESULTS

This section presents the simulation environment, metrics and the results of the proposed DSR-PSR routing protocol. Simulation is done using Network Simulator NS2.25.

I. *Simulation Environment* An Adhoc network of 50 nodes with a simulation time of 100 seconds to 1150 seconds for different scenario is considered. The mobile nodes were placed on a 1200 X 1200 flat grid. DSR is used as the routing protocols. Thus, 50 different nodes are involved in the communication. The mobility of the nodes depends on the Random Way Point Model. Transmission Range of each node is 250 m. Receiving power of each node is 0.395 W. Transmitting Power is 0.660 W.

Following tables shows the parameters and values of parameters used in simulation.

Table1 Simulation Parameters

	PARAMETERS	VALUE
1	**Network Size**	1200X1200
2	**No. of Nodes**	50
3	**Simulation Time**	350 Sec-1150 Sec for different scenario
4	**Traffic Type**	Constant Bit Rate (CBR)
5	**Queue Type**	Drop Tail
6	**Propagation Model**	TwoRayGround
7	**Packet Size**	512 byte
8	**rxPower**	0.395 W
9	**txPower**	0.660 W
10	**MAC Protocol**	802.11
11	**Mobility Model**	Random Waypoint
12	**Routing Protocol**	DSR
13	**Observation Parameters**	First Dead Node, Percentage of all Dead nodes, Throughput

II. *Simulation Metrics*

5.1.1 First dead node: Comparing DSR with new proposed DSR-PSR simulation results shows that the first dead node in DSR-PSR comes later than DSR

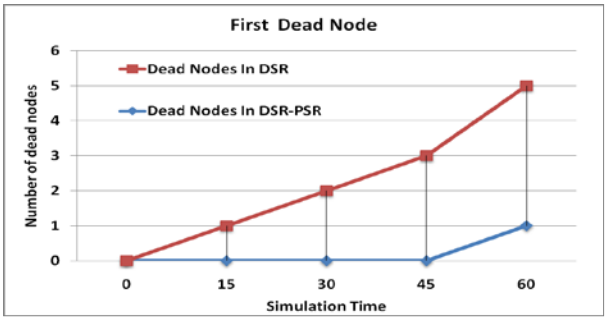

Figure 2 Comparison of First dead node in DSR and DSR-PSR

5.1.2 Percentage of Dead Nodes: Both the protocol DSR and DSR-PSR are compared by percentage of dead nodes during specified interval of time. It is found that when 98% of nodes in DSR were dead only 16% of DSR-PSR nodes were dead .this shows the efficiency of DSR-PSR over DSR.

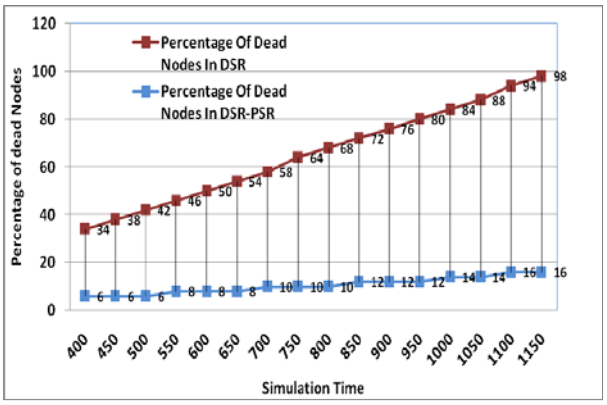

Figure 3 Comparison of percentage of dead nodes in DSR and DSR-PSR

5.1.3 Throughput: Throughput is defined as number of packets sent per unit of time. Comparing throughput we find that number of packets send per unit time in DSR-PSR is more than that of DSR.

6. CONCLUSION

The proposed protocol *"DYNAMIC SOURCE ROUTING POWER AWARE SOURCE ROUTING"* introduces power awareness into the routing decisions and finds path from source to destination.

- The best optimal path is chosen from the different path received by destination with in threshold time. The optimality of path is chosen on the energy factor. DSR-PSR is being compared with DSR (dynamic source routing protocol) which do not consider energy during path discovery.

- Proposed algorithm provides a significant increase in successful packet transmissions i.e. high throughput and less number of dead nodes as it considers energy during path selection, so nodes with less energy are not taken into account.

Also as if in some cases the hop count in DSR-PSR is more than in DSR it will consider the older DSR algorithm to find path which saves the time.

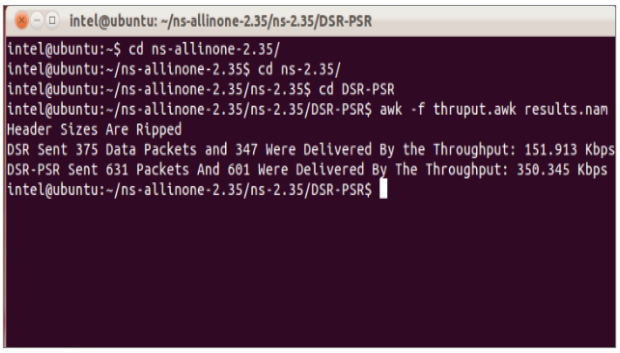

Figure 4 Throughput of DSR and DSR-PSR

7. FUTURE WORK

Future perspective of this research is as we have just introduced route discovery phase in it. Route management for broken links can be introduced. Also rather than choosing the simple shortest path first with energy factor we can use swarm optimization technique like ant colony optimization with primary factor energy to find optimal path from source to destination.

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