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ENERGY EFFICIENT ROUTING PROTOCOL FOR REDUCING ROUTING OVERHEAD IN MOBILE AD HOC NETWORKS

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ABSTRACT

Mobile Ad hoc Networks (MANETs) is a highly dynamic and infrastructure less network, in which mobile nodes communicate with each other autonomously. Link changes occur frequently and there is a limited bandwidth that makes the communication challenge-able. The existing routing protocol like DSR, AODV selects the shortest path between the source and destination. It won't check the stability of the link for flooding. So there is a chance of link failure. Recovering from the failure of the link in MANET leads to more energy consumption. The problem of link failure can be overcome by an approach called Link Stability and Energy aware routing. The proposed protocol is Delivery Probability based Route Stability Protocol (DPRSP). The key idea of the protocol is to find the link quality, maximize energy and reduce delay. Reflection of these factors increase packet delivery ratio, throughput's and reduce end to-end delay. The proposed protocol is simulated using NS-2.

Keywords: MANET, AODV, DSR, DPRSP

1. INTRODUCTION

Mobile Ad-hoc Network is a collection of independent mobile nodes, network which is created, operated and managed by the nodes themselves. Manet is an infrastructure less, self-organized and spontaneous network where the nodes help each other by passing data and control packets from one node to another node. Each mobile node has features like autonomous terminal, limited battery power, dynamic topology etc. The mobile node transfers packet directly to another node or through some intermediate nodes. Routing in MANET is extremely challenging because of MANETs dynamic features, and its limited power energy. Due to nodes constantly moving, efficient routing of packets is a primary challenge in MANET.

The MANET is a special type of wireless mobile network in which mobile host can communicate without any aid of established infrastructure and can be deployed for many applications. Mobile Ad hoc networks (MANETs) consist of a collection of mobile nodes which can move freely. These freely moving nodes without any fix infrastructure can dynamically self organized into arbitrary topology network. This ad hoc topology may modify with time as the nodes move or adjust their transmission and reception parameters [6]. The characteristics of these networks are summarized as follows: Communication via wireless means.

- Nodes can perform the roles of both hosts and routers.
- Bandwidth-constrained, variable capacity links.
- Energy-constrained Operation.
- Limited Physical Security.
- Dynamic network topology.
- Frequent routing updates

2. REVIEW OF LITERATURE

In a MANET, in order to propagate routing-related information, several routing protocols have depended on broadcasting The broadcasting protocols can be classified into four families such as simple flooding, probability based methods, area based methods and neighbor knowledge methods[5].

- Each node should rebroadcast all packets in simple flooding.
- In order to assign a probability to a node to rebroadcast, probability based method use some basic understanding of the network topology.

- Area based methods assumes that nodes have common transmission distances. If the rebroadcast reaches sufficient additional coverage area, then only the node is capable to rebroadcast.
- Through "Hello" packets neighbor knowledge methods maintain state on their neighborhood which is used in the decision to rebroadcast.

Energy is an important resource that needs to be preserved in order to extend the lifetime of the network, on the other hand, the link and path stability among nodes allows the reduction of control overhead and can offer some benefits also in terms of energy saving over ad hoc networks. The conventional on-demand routing protocols use flooding to discover a route. They broadcast a Route Request (RREQ) packet to the networks, and the broadcasting induces excessive redundant retransmissions of RREQ packet and causes the broadcast storm problem, which leads to a considerable number of packet collisions, especially in dense networks. Therefore, it is indispensable to optimize this broadcasting mechanism. However, as will be shown in this contribution, the selection of more stable routes under nodes mobility can lead to the selection of shorter routes. This is not always suitable in terms of energy consumption. Some solutions to routing have been presented also for these cases, starting from the basic epidemic routing, where messages are blindly stored and forwarded to all neighboring nodes, generating a flood of messages. Existing routing protocols (AODV, DSR) are must take to a "store and forward" approach, where data is incrementally moved and stored throughout the network in hopes that it will eventually reach its destination [3].

On demand routing protocols for ad hoc networks discover and maintain routes on a reactive, "as-needed" basis. These protocols are attractive for their low routing overheads. We develop a technique to make these protocols energy aware in order to increase the operational lifetime of an ad hoc network. The quality of service support in mobile ad hoc networks depends not only on the available resources in the network but also on the mobility rate of such resources. This is because mobility may result in link failure which in turn may result in a broken path. Furthermore, mobile ad hoc networks potentially have fewer resources than fixed networks. Therefore, more criteria are required in order to capture the quality of the links between nodes. Quality of service routing is a routing mechanism under which paths are generated based on some knowledge of the quality of network, and then selected according to the quality of service requirements of flows. Thus, it is evident that both the aforementioned parameters (i.e., link stability associated with the nodes mobility and energy consumption should be considered in designing routing protocols, which allow right trade off between route stability and minimum energy consumption to be achieved**.**

3. PROPOSED MODEL

Delivery Probability Based Route Stability Protocol (DPRSP)

The Delivery Probability based Route Stability protocol describes the node mobility and energy efficiency in the network. Here the stability of the link is determined by the residual energy of the nodes in the network. So the chance of the link failure is reduced and the energy of the nodes is saved. Energy efficiency is one of the main problems in a mobile ad hoc network, especially designing a routing protocol. The proposed model aims at discovering an efficient energy aware routing scheme in MANETs. Although this scheme can somewhat enhance the latency of the data transfer but it results in a significant power saving and long lasting routes. This scheme is one of its types in adhoc networks which can provide different routes for different type of data transfer and ultimately increases the network lifetime.

In the proposed model any node in the network always selects the nodes that have a maximum energy value. It means that it solves the problem of link breakages in network. The problem in normal energy efficient routing is that nodes in the network are not aware about the energy values of nodes. If the sender has selected the low energy value node which has not trustful for communication then in that case the session between the nodes are suddenly break it links.

DPRSP Algorithm

if (node = = source)
then broadcast(RREQ) with route list;
else if(received RREP
then sort(routes);
using [link_Quality (strong),
Maximum (min_re_energy) and

Minimum (delay)];
else rebroadcast(RREP);
endif //go to 2
if (node == intermediate node)
calculate remaining energy
calculate delay;
update in route list;
broadcast(RREQ) with route_list;
endif //go to 3
3 if (node == destination)
then stop broadcast(RREQ);
update as advertised_hop_count = 0;
Calculate overall delay, link quality;
Update route_list,
reply (RREP) with route_list;
endif

Prediction and evaluation context information in DPRSP

- Each host calculates its delivery probabilities for a given set of hosts
- This process is based on the calculation of utilities for each attribute describing the context.
- .The calculated delivery probabilities under current status are periodically sent to the route request neighbor for updating of route information.
- .Each host maintains a logical forwarding table of tuples describing the next logical hop and its associated delivery probability for all known destinations.
- Each host uses local prediction of delivery probabilities between updates of information.
- Each host selects the best forwarding node among list of neighbor's on the basis of the highest stability value.

Remaining Battery Energy

Node remaining energy can be calculated as follows:
Node remaining Energy = Node fully energy-Node spent energy.
Here, node spent energy for sending and receiving the messages (RREQ, RREP and data packets).
Transmission energy can be calculated as follows:

Tr (Energy) = Tr (Power) X (Packet Size/bandwidth

Here, Tr(Power) = Energy consumption * using voltage for transmission.

The following formula is used to find the transmission power of particular path:

$$Pj = \sum_{I=1}^{n-1} P(Ni, Ni+1)$$

Here

Pj = Transmission power of path j
n = Number of nodes participated in path j

Link Quality

Here node measure the signal strength of the link and send Route Request to other node, after that intermediate node accept that packet compare the signal strength value of the link with Route Request packet, if it is less than packet value then its modified the packet value with minimum value and forwarded to other node until it reach to the destination, with the help of this approach weak link of the route is calculated ,after receiving Route Request by the destination node ,its send the Route Reply with minimum of the route to source then source node first select earliest established path to packets, then changes to the strongest signal strength path for long transmissions

The link quality is obtained by:

Link Quality = (Transmission Radius-Distance)/velocity;
Here, we can easily obtain distance using received signal strength of packets.

Velocity (V) between two nodes is:

$$V = \Delta d/\Delta t$$

Where, Δt is the time difference between the former packet receiving (time instant t1) and the next packet receiving (time instant t2) which means $\Delta t = t2-t1$. Δd is the distance difference between the distance d1 and d2 at, respectively, the time t1 and t2.After finding the link quality, if the link quality is greater than threshold value of strong link, then this algorithm consider to be the path selection or otherwise it will be rejected.

After predicting the link failure it performs following steps:

- **Dropping**: If the quality of link is severely damaged or the link is already broken, then this method drops packet.
- **Relaying**: In this technique, a node can become a relay node when both sender and receiver are in its neighbor table and forward the data between source and destination, if the link is fail between source and destination.
- **Selective forwarding**: In this technique, the intermediate node drops the packet if it comes from bad link.

4. IMPLEMENTATION OF THE PROPOSED MODEL

NS2- AN OVERVIEW

NS2 (Network Simulator version 2) is an object-oriented, discrete event driven network simulator developed at UC Berkeley, which is written in C++ and OTcl. NS is primarily useful for simulating local and wide area networks.

NS began as a variant of the REAL network simulator in 1989 and have evolved substantially over the past few years. In 1995, NS development was supported by DARPA through the VINT project at LBL, XEROX PARC, UCB, and USC/ISI. Currently NS development is support through DARPA with SAMAN and through NSF with CONSER, both in collaboration with other researchers including ACIRI. NS2 has always included substantial contributions from other researchers, including wireless code from the UCB Daedelus and CMU Monarch projects and Sun Microsystems.

a) NAM

NAM is the network simulation animator that animates the network simulation done by NS2. It provides a visual view of the network simulation. It enables the user to manipulate the NS scripts.

b) TRACE GRAPH

Xgraph is the program to plot graphs for NAM. However, it is worked only with UNIX. Trace graph is used to obtain statistics and produce graphical results. It shows the simulation and node statistics, plots graphs (2D, 3D, histograms) and saves all the analysis results.

c) OTcl

NS2 is written in C++, with an OTcl interpreter as a frontend. The simulator supports a class hierarchy in C++ and a similar class hierarchy within the OTcl interpreter. The two hierarchies are closely related to each other; from the user's perspective, there is a one-to-one correspondence between a class in the interpreted hierarchy and one in the compiled hierarchy. The root of this hierarchy is the class Tcl Object. Users create new simulator objects through the interpreter; these objects are instantiated within the interpreter, and are closely mirrored by a corresponding object in the compiled hierarchy. The interpreted class hierarchy is automatically established through methods defined in the class Tcl Class. User instantiated objects are mirrored through methods defined in the class Tcl Object. There are other hierarchies in the C++ code and OTcl scripts.

Performance metrics	AODV	NCPR	DPRSP
Packet Delivery Ratio	89	94	95
Energy Consumption	833	893	902
End-End-Delay	2.589	2.01	1.41
Throughput	248.14	257.21	342.62
Bandwidth	389.34	319.23	284.80

OTtcl is used for configuration, setup and for manipulating the existing Tcl objects. C++ is used for processing the packet flow and to change the behavior of the existing C++ class

The following parameters were employed for the simulation of NS-2 Protocol

No of nodes	100
Transmission range	150m
frequency	9MHZ
Traffic model	Constant bit rate
Packet size	512 bytes
Routing protocol	AODV
Mobility model	Random way point
propagation	Free space
Initial energy	1000joules

Table 1.1 Simulation Setup

5. COMPARATIVE STUDY

When compared to an AODV, NCPR, DPRSP gives better result in terms of optimized sleep scheduling technique method and introduction of clustering technique. By the comparative results it is clear that the NCPR is quite not efficient and scalable when compare to DPRSP. Throughput and Energy utilization is scalable and efficient in DPRSP.

Comparison table for AODV, NCPR and DPRSP

6. RESULTS ON PERFORMANCE EVALUATION

Energy Consumption

Energy consumption is a measure of energy spent for forwarding a packet to the destination via neighbor nodes.. NCPR consume more energy and each time it sends signal to all the available nodes in the path to the destination. NCPR could not cope up with the large group of network size. This problem is overcomes in the proposed research model DPRSP.

Table 1.2 Comparative Table

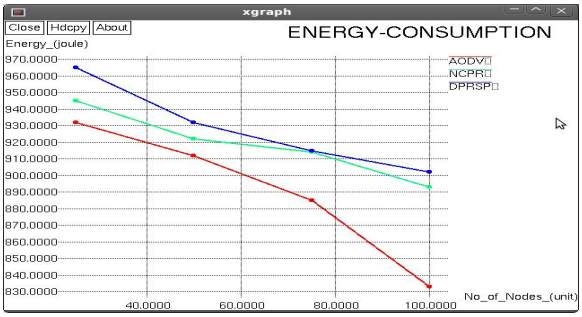

Figure 1.1Energy consumption

No of nodes(Units)	AODV(Energy in joules)	NCPR (Energy in joules)	DPRSP(Energy in joules)

25	**932**	**945**	**965**
50	**912**	**922**	**932**
75	**885**	**914**	**915**
100	**833**	**893**	**902**

Table 1.3 Energy Consumption

Packet Delivery Ratio

Packet Delivery Ratio (PDR) is the ratio between the number of packets transmitted lines by a source node and the number of packets received by a sink node. This measures the loss rate by transport protocols. It characterizes the efficiency and correctness of ad hoc routing protocols. Always a high packet delivery ratio is required by a network.

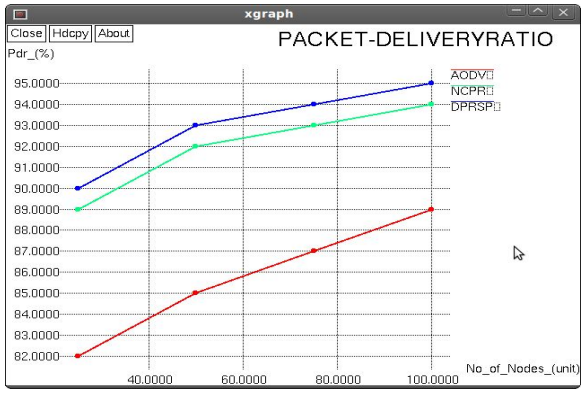

Figure 1.2Packet delivery ratio

No of nodes(units)	AODV (PDR in percentage)	NCPR (PDR in percentage)	DPRSP (PDR in percentage)
25	**82**	**89**	**90**
50	**85**	**92**	**93**
75	**87**	**93**	**94**
100	**89**	**94**	**95**

Table 1.4 Packet Delivery Ratio

7. CONCLUSION

In MANET node failure is the major problem. If nodes loss their energy then it will do nothing in the network then it will failure their communication capability they results in network partitioning, is serious problem in ad hoc networks.

Proposed DPRSP protocol solves the issues like, redundancy, routing overhead and fast neighbor search coverage and also it improves the overall data communication in highly prone network. Neighboring calculation has been discussed and the rebroadcasting mechanism helps to find the coverage by the radio frequency signal range.

Simulation results shows DPRSP protocol results in better performance while comparing with on-demand routing protocol.

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