Power and Mobility Aware Protocol for Ad Hoc Network

Divya Sharma and Ashwani Kush

***Abstract*—A recent trend in ad hoc network routing is the reactive on-demand philosophy where routes are established only when required. Most of the protocols in this category, however, use single route and do not utilize multiple alternate paths. Major hurdle in communication via Ad hoc networks is their power limitations. As most of them use battery power and also are moving so there is always limitation of battery power. This Paper proposes a new scheme designed to minimize power consumption and to increase network lifetime. This will be incorporated on PAMAS as an extension to existing scheme.**

***Index Terms*—Ad Hoc Network, Routing protocol, Power, PAMAS**

I. Introduction

A network is a series of interconnected nodes and Wireless networking is an emerging technology that allows users to access information and services electronically, regardless of their geographic position. Mobile Ad-hoc Network (MANET) is a collection of mobile nodes, which communicate with each other using wireless links in an infrastructure less network with no centralized administrative support. The end units in such networks are computers used to communicate among units on the move and need to reliably furnish this capability in the face of natural and man-made hostile environment [6, 7, and 12]. Commercial scenarios for ad hoc wireless network include conferences/meetings, Emergency services, Law enforcement. Main application of MANET is in emergency rescue operation and battle fields and many of the small combatants rely on communication devices that run on batteries, there is clear need to make MAC protocols both power and mobility aware [2,11,17,18]. Nodes in such network are highly mobile or stationery. Most work on Power efficient Protocol considered only static ad-hoc network. But in military application mobility is expected, so it is important that protocol should be power and mobility aware [9]. Current challenges in Power Aware protocols are following:

- Multicast[13]
- QOS Support [16]
- Power -aware routing[2]
- Location-aided routing[14]

In a MANET, wireless communication involves usage of a transceiver at the source, intermediate, and destination nodes. The transmitter sends control, route request and response, as well as data packets originating at or routed through the transmitting node. The receiver is used to receive data and control packets - some of which are destined for the receiving node and some of which are forwarded. A wireless network interface has five possible energy consumption states (six including the off state).

a) Transmit state for transmitting data, control and routing packets

b) Receive state is for receiving data, control and routing packets.

c) In the idle state, which is the default state for ad hoc environment, the interface can transmit or receive packets.

d) The sleep state has extremely low power consumption as the interface can neither transmit nor receive in this state.

e) Lastly, a card can enter a reduced energy discard state while the media carries uninteresting traffic.

The decision to enter the reduced energy discard state is made by the non-destination nodes in the range of the sender. This decision is based on the packet size information in the RTS (request to send) control packet that is exchanged between the sender and the receiver at the start of packet transfer. The reduced energy state uses slightly less power than the idle state, but significantly more than that used in the sleep state [19].

An effort has been made in this paper to provide some improvement for PAMAS protocol. The algorithm will improve power saving feature of PAMAS. Rest of the Paper is organized as: In Section 2, A brief review of the two existing protocols have been done. Section 3 emphasizes the problem faced in the existing PAMAS protocol. In section 4 modifications to PAMAS has been proposed. Conclusion is given in the last section.

II. Recent Work

The Power Aware Ad hoc routing protocol enables dynamic, multi hop routing between participating nodes wishing to establish and maintain an ad hoc network. They allows mobile nodes to maintain routes to destinations with more stable route selection but designing power aware routing protocols has attracted a lot of attention for prolonged network operational time. Design objective of power aware protocols is to select energy efficient routes and simultaneously minimizing the overhead incurred in the selection of the routes. Some routing algorithms given by [20, 21] can optimize the energy use with a global perspective. But these algorithms cause expensive overheads for gathering, exchanging and storing the state information of a node. These algorithms can be improvised in order to make them scalable .Karn[1] Proposed Multiple Access with Collision Avoidance [MACA] for use in packet radio as an alteration to the traditional Carrier Sense Multiple Access[CSMA] media access scheme[1]. MACA is

Manuscript received October 26, 2010

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somewhat similar to the protocol proposed in [4] and also to that used in Wave LAN, and both resemble the basic APPLE Local Talk Link Access Protocol [5]. MACA is one improvement over CSMA/CA protocol with removal of hidden terminal problem [1]. To increase the performance in congestion, MACA improve version is made, that is Media Access Protocol for Wireless LANs (MACAW) [3]. It modified the back off algorithm [1] that is now the packet header which also contains the back off counter value and nodes which wants to transfer data checks back off counters and selects packet with minimal waiting time. It also adds new control packets: Acknowledgment (ACK), Data send (DS), RRTS (Request for request to send). This protocol performs better in congestion [3].

Power Aware Multi-Access protocol with Signaling for Ad Hoc Networks (PAMAS)[2] is a modification of Karn's MACA protocol[1] with an additional focus on Power Saving[12]. In PAMAS and other [1, 3, 15] ad hoc network MAC layer protocols, a sequence of message exchange (RTS-CTS) precedes transmission of packet.

It saves 40-70% of battery power by turning off radios when they cannot transmit or cannot receive packets. When there is a transmission from node A to node B, Node C keeps itself off. In this way, Node C conserves its power [10]. Specific conditions under which nodes keep themselves off in PAMAS are: (a) A Node Power offs itself if it is not transferring any packet and if it is overhearing a transmission. (b) If at least one neighbor node is busy in transmitting and at least one neighbor is receiving. Because of fear of interference with the neighbor reception it keeps itself off and (c) If all the neighbors are transmitting and the node is not a receiver, the node then power itself off.

III. Critique of MACA and PAMAS

MACA [1] handles collisions through its exponential back off scheme. But it lacks acknowledgment mechanism. MACA improved version is MACAW [3] which perform better in congestion but it does not solve the problem of exposed terminal problem and it performs poorly on multicasting system also. The problem with PAMAS [2] is that when nodes power itself off but it is not known for how long a node can remain in this state. A node can power itself off exactly when one of the above three condition satisfy. But a node has to estimate time that how long it remains powered off because when it is powered off, It cannot sense carrier so it has no way of knowing when a transmission has completed.

Singh [2] suggests that in MAC layer protocol, nodes attempt to use the channel by sending and receiving RTS/CTS (Request to Send/Clear to Send) messages. Sender sends an RTS signal to the node with which it wants to transmit. If receiver receives uncorrupted RTS, then it replies with CTS message. Then the node after receiving CTS is ready for the transmission. This RTS/CTS message takes place on separate signal channel to remove 'hidden terminal problem'. This RTS/CTS message contains the length of the packet the sender will send. Thus, a node will know the length of time for which it can power off. But the disadvantage of this protocol is that it uses a separate control channel. Nodes have to able to receive on the control channel while they are transmitting on the data channel and also transmit on data and control channels simultaneously. There is another proposal in PAMAS with its pros and cons, which says, to avoid the probing, a node should switch off the interface for data channel, but not for the control channel (which carries RTS/CTS packets). Advantage is that each sleeping node always knows how long to sleep by watching control channel. But its disadvantage is that this may not be useful when hardware is shared for the control and data channels-as it may not be possible to turn off much hardware due to the sharing. The main disadvantage of PAMAS is that use of separate control channel is required. Nodes have to be able to receive on the control channel while they are transmitting on the data channel and also transmit on the data and control channel simultaneously. Some of PAMAS characteristics are:

- PAMAS can save energy by shutting down radios but it has no idea about the entire packet transmission path.
- If the counting protocol chooses a high power consuming route, the savings by PAMAS might be sacrificed by this routing inefficiency in energy, but in conclusion we need both.
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TABLE-1 Provides an Extensive Survey of Existing Scheme.

Features	MACA	MACAW	PAMAS
Hidden Terminal Problem	Removed	Removed	Removed but in some cases
Algorithm Used	Back Off Algorithm	Modified Back Off Algorithm	Binary Exponential Algorithm
Transmission	Unicast	Multicast	Multicast
Message Exchange	Uni-directional	Bi-directional	Bi-directiona l
Acknowledge ment	No	Yes	No
Power awareness	No	No	Yes
Performance in non homogeneous Traffic	Bad	Good	Good

IV. Proposed Plan

Basic idea behind proposed algorithm is to avoid packet loss by avoiding collisions while transferring data from source to destination and to increase power efficiency. As in PAMAS, there are separate channels for control and data transmission in proposed algorithm and they can individually turn on and off themselves and nodes have access to both of them. The use of control channel [2] allows mobile node to determine when and for how long to power off. Control signals are placed into slots in a control frame. It is assumed to be of same length as the data frame, which holds one packet and can send more than one control message at a time. Control Frame is split into following slots: RTS (Request to send), CTS (Clear to send), BUSY, ACK (acknowledgment).

To avoid Packet loss, the proposed scheme include Acknowledgment and low signal strength detection. If an

ACK Packet is returned from the receiver to the sender immediately upon completion of data reception and the acknowledgment is not required by the sender, then the data packet is scheduled for retransmission then it transmits an RTS with same packet number again and the receiver responds with an ACK instead of CTS. Receiving node also monitors the signal strength due to which we can avoid packet loss. Following is the proposed algorithm to send a packet from source A to destination B. The assumption used is: SS < 1 means signal strength is very bad. And SS>1 means signal strength is very good.

A. Node B sends an ACK signal to A and also monitors signal strength (SS).

1) If SS< 1, for a specified amount of time,

Then Node B goes to waiting state until it receives another packet in which case it returns to receive state or if a reasonable amount of time passes, in which case it moves into the idle state.

Else B will remove the portion of the message and return to idle state.

2) If SS> 1, Node B will return to transmit state and begin transmitting last ACK packet.

B. Node A does not receive an ACK signal; it will go to transmit wait state.

This Algorithm allows transmitting and receiving nodes pairs to delay transmission around periods of weak signal strength as well as allowing a data recovery mechanism also. Use of acknowledment will allow transmitting and receiving node pairs to delay transmission around periods of weak signal strength,as well as allowing a data recovery mechanism.It will allow node to end their transmission early if they are moving from from one another,hence saving power and time

Suppose there are four nodes A,B,C,D as shown in figure 1.

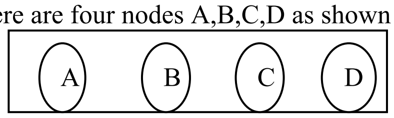

Figure 1 : transmission medium

If Node C is busy with the transmission of data to Node D and at the same time Node B is sending an RTS to Node A,then we can power off B's data interface to ensure that C's transmission does not result in power consuming at Node B. This methos has its own advantage is that each sleeping node always knows how long to sleep by watching the control channel.But the disadvantage is that this may not be useful when hardware is shared for the control and data channels because it may not be possible to turn off much hardware due to sharing[2].

Main characteristics of proposed scheme are:

- Power effiency can be increaed by turning power off the data interface of a node when its signalling interface is trying to acquire the channel.
- Collision can be avoided by detecting signal to noise ratio.If a node kept hearing the increased level of noise then that particular node can choose another node to transmit data.

By using Priorities:

We can use Priorities levels for messages,by this we can avoid collision of data. In this, RTS signal and the data messages carry the priority of the message. COMP-Complete signal, this signal is send by the transmitter to the receiver when the data is complete.

Let's suppose node A is Source and node B is Destination.

Algorithm:

1) If A is in idle state, it send packet to the intended recipients.

2) If a node B receives an RTS with higher priority then B sends an CTS to A and at the same time it sends waiting signal to its own destination node.

3) Then node A sends CTS back to node B and sends waiting signal to its own transmitting node.

4) After completion of transmission of data, node B sends COMP signal to A.

V. CONCLUSION

Ad hoc network have some limitations in terms of energy factors. The stable route should have better battery power capacity, less transmission power consumption, stability of routes, and so on. The major goal is to use each node fairly and extend its lifetime. An extension to the existing scheme has been proposed and efforts are on for simulation results. This paper describe algorithm that try to minimize the collision of nodes. The proposed algorithm uses signal strnegth to detect loss of packets. Power efficiency can be increased by switching off the data interface while its signaling interface is busy to acquire the channel. It is hoped that the scheme will work much better in denser mediums than sparse as more number of nodes with better battery status will be available. The proposed work aims at developing a power and mobility aware protocol for ad hoc network. It is hoped that the results will support the theory proposed and will be better than existing scheme.

FUTURE SCOPE

Efforts are on to simulate the given proposed scheme on NS2. Though an effort has been made to simulate it using latest version of NS3 but for some unknown reasons it was not successful in first attempt. The scheme will be compared with existing ones and results will be echo the power saving. More work is to carried out to implement the scheme on AODV or DSR to make it robust for stable routing as well.

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