A Comparative Study of Power Aware Routing Protocols of Ad Hoc Network

Shilpa Mehta
EI DEPTT, TITS BHIWANI

Tamanna
CSE DEPTT, TITS BHIWANI

Mukesh Kumar
ECE DEPTT,UIET,KUK

ABSTRACT

An adhoc mobile network is a collection of mobile nodes that are dynamically located in a manner that interconnections between nodes are capable of changing on continual basis . In order to provide communication within network different power aware routing protocols to discover routes between nodes . The main goal of such routing protocols is to establish a route between a pair of nodes so that messages can be delivered in a proper manner .

Keywords

PAMAS ,PARO, PRS.

1. INTRODUCTION

Ad hoc networks have limited power capabilities mainly owing to the nature of the Infrastructure they use. Power required by each mobile host can be classified into two categories Namely Communication-related power, Non-communication-related power.

The communication related power can have two parts: First, processing power; Second, transceiver power. Transceiver power Each mobile host spends some processing power to execute network algorithms and run applications. Transceiver power refers to the power used by the radio transceiver to communicate with the other mobile hosts. In mobile wireless communication, each protocol layer is closely dependent on the other layers. For example, if a routing protocol requires frequent updates of routing information, it is difficult to implement sleep mode at the data link layer. How the various layers deals with power are described as:

Three Layers are involved in communications

A) Physical layer

Transmission power should be at a minimum level to maintain links. It should allow to adapt to changes in transmission environment. Excessive transmission power can cause interference to other hosts.

b) Data Link Layer

Energy conservation can be achieved by using effective retransmission request schemes and sleep mode operation. It is important to appropriately determine when and at what power level a mobile host should attempt retransmission. Node's transceiver should be powered off when not in use.

c) Network Layer

In wireless network it is important that the routing algorithm select the best path from the View point of power constraints as part of route stability. Routing algorithm that can evenly distribute packet-relaying loads to each nodes to prevent nodes from being overused.

2. LOW POWER ROUTING PROTOCOLS

Reference [9] proposes a routing algorithm based on minimizing the amount of power (or energy per bit) required to get a packet from source to destination The main focus of research on routing protocols in MANETs has been network performance. There has been some study on power aware routing protocols for MANETs. Presented below is a brief review of some of them.

3. BATTERY-COST-AWARE ROUTING

The main disadvantage of the problem formulation of the previous approach (1) is that it always selects the least-power cost routes. As a result, nodes along these routes tend to "die" soon because of the battery energy exhaustion. This is doubly harmful since the nodes that die early are precisely the ones that are needed most to maintain the network connectivity (and hence useful service life).Therefore, it is better to use a higher power cost route if it avoids using nodes that have a small amount of remaining battery energy. This observation has given rise to a number of "battery cost-aware routing" algorithms as described next.

1. Minimum battery cost routing algorithm that minimizes the total cost of the route. It minimizes the summation of inverse of remaining battery capacity for all nodes on the routing path .

2. Min-Max battery cost routing algorithm is a modification of minimum battery cost routing. This metric always tries to avoid the route with nodes having the least battery capacity among all nodes in all possible routes. Thereby, it results in fair use of the battery of each node

3. Conditional Max-Min battery capacity routing algorithm proposed in . This algorithm chooses the route with minimal total transmission power if all nodes in the route have remaining battery capacities higher than a threshold; otherwise routes including nodes with the lowest remaining battery capacities are avoided. Several experiments have been done in to compare different battery cost-aware routing in terms of the network lifetime. The result showed that the first node in "Shortest Path routing" metric died sooner than all the battery -cost-aware routing but most of the other nodes had longer expiration time. In that result Minimum battery cost routing showed better performance than Min-Max routing in terms of expiration time of all nodes. Conditional Max-Min routing showed different behavior that depended on the value of chosen threshold.

4. POWER AWARE ROUTING PROTOCOLS

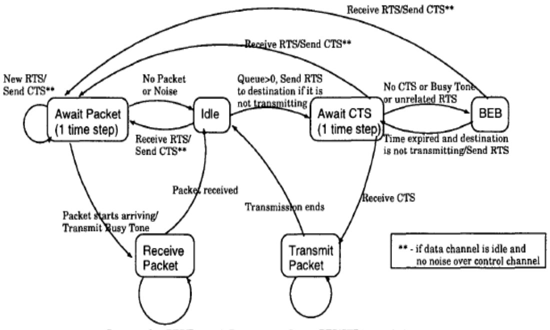
The objective of Power-aware Source Routing (PSR)[30,34] is to extend the useful service life of a MANET. This is highly desirable in the network since death of certain nodes leads to a possibility of network partitions, rendering other live nodes unreachable.

1) PAMAS

PAMAS(power aware multi access) protocol for adhoc network modifies the MACA [1,5,32] protocol by providing separate channels for control(RTS/CTS) and data packets. A mode with data packets to transmit sends an RTS(request to send) and await the CTS(clear to send) from the receiver. If it receives CTS then it send the data packet over the data channel otherwise it enters a handoff(or sleep) state .The receiver node sends a 'busy tone' over the control channel to let other nodes know the data channel is busy hence these nodes may turn off their wireless interfaces. Use of a separate control channel Nodes have to be able to receive on the control channel while they are transmitting on the data channel And also transmit on data and control channels simultaneously and solve the hidden terminal problem[38] A node (such as C) should be able to determine when probe responses from multiple senders collide .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). Each sleeping node always knows how long to sleep by watching the control channel .This may not be useful when hardware is shared for the control and data channels .It may not be possible turn off much hardware due to the sharing. Several enhancements are possible to the basic PAMAS protocol we have described. The benefits includes that each sleeping node always knows how long to sleep by watching the control channel and the drawback includes

- Use of a separate control channel
- Nodes have to be able to receive on the control channel while they are transmitting on the data channel And also transmit on data and control channels simultaneously.
- A node (such as C) should be able to determine when probe responses from multiple senders collide.

Pamas has the following characteristics:.It has a very good power conserving behaviour the ideas of power awareness that we have developed can be used to make other multi access protocols power conserving as well.



As indicated in the figure, a node may be in any one of six states - Idle, Await CTS, BEB (Binary Exponential Back off), Await Packet, Receive Packet, and Transmit Packet. When a node is not transmitting or receiving a packet, or does not have any packets to transmit, or does have packets to transmit but cannot transmit (because a neighbor is receiving a transmission) it is in the Idle state. When it gets a packet to transmit, it transmits a RTS and enters the Await CTS state. If the awaited CTS does not arrive, the node goes into binary exponential back off (the BEB state in the figure). If a CTS does arrive, it begins transmitting the packet and enters the Transmit Packet state. The intended receiver, upon transmitting the CTS, enters the Await Packet state. If the packet does not begin arriving within one round trip time (plus processing time), it returns to the Idle state. If the packet does begin arriving, it transmits a busy tone over the signalling channel and enters the Receive Packet state. Let us now look at the functioning of the protocol in some more detail 1 .When a node in the Idle state receives a RTS, it responds with a CTS if no neighbor is in the Transmit Packet state or in the Await CTS state. It is easy for a node to determine if any neighbor is in the Transmit Packet state (by sensing the data channel). However, it is not always possible for a node to know if a neighbor is in the Await CTS state (the transmission of the RTS by that neighbor may have collided with another transmission over the control channel). In our protocol, if the node heard noise over the control channel within T 2 of the arrival of the RTS, it

does not respond with a CTS. If, however, it does not hear a packet transmission begin within the next T, it assumes that none of its neighbors is in the Await CTS state anymore. Now consider a node that is in the Idle state and has a packet to transmit. It transmits an RTS and enters the Await CTS state. If, however, a neighbor is receiving a packet that neighbor responds with a busy tone (twice as long as a RTS/CTS) that will collide with the reception of the CTS. This will force the node to enter the BEB state and not transmit a packet. If no neighbor transmits a busy tone and the CTS arrives correctly, transmission begins and the node enters the Transmit Packet state. Say a node that transmitted a RTS does not receive a CTS message. It enters the BEB state and waits to retransmit a RTS. If, however, some other neighbor transmits a RTS to this node, it leaves the BEB state, transmits a CTS (if no neighbor is transmitting a packet or is in the Await CTS state) and enters the Await Packet state (i.e., it waits for a packet to arrive). When the packet begins arriving, it enters the Receive Packet state. If it does not hear the packet in the expected time (i.e., round trip time to the transmitter plus some small processing delay at the receiver), it goes back to the Idle state. When a node begins receiving a packet, it enters the Receive Packet state and immediately transmits a busy tone (whose length is greater than twice the length of a CTS). If the node hears a RTS transmission (directed to some other node) or noise over the control channel at any time during the period that it is receiving a packet, it transmits a busy tone. This ensures that the neighbor transmitting the RTS will not receive the expected CTS. Thus, the neighbors transmission (which would have interfered with the node receiving a packet) is blocked.

2) PMAW

Power and Mobility-Aware Wireless protocol (PMAW), is a substantial extension of Power Aware Multi-Access protocol with Signaling for Ad Hoc Networks (PAMAS). the shortcomings of PAMAS as lacks an acknowledgement mechanism and has, therefore, no ability to recover from data collisions. Second, PAMAS assumes a static ad-hoc network and will quickly run into data collisions when mobile nodes are introduced. PAMAS has no ability to predict when problems may occur and therefore is unable to avoid them. To address the shortcomings of PAMAS and to provide a substantial extension in functionality a new MAC protocol that we term Power and Mobility-Aware Wireless protocol for Mobile Ad Hoc Networks (PMAW) arises, In PMAW control signals are placed into slots in a control frame.

Each type of control message is always placed within the same slot in the control frame .the control frame is split into four slots: the first slot is used for RTS. the second slot for CTS, the third slot is used for BUSY,TPRI (transmit priority),RPRI (receive priority), TDEL (transmit delay).and RDEL (receive delay) signals, and the fourth slot for HB (heart-beat) and ACK signals. The control frame is assumed to be the same length as the data frame, which holds one packet. Since a message is generally more than one packet long, many control frames will be sent during the course of a message transmission .In PMAW receiving node sends an ACK signal to the transmitter for each packet received. The receiving node also monitors the signal strength of the data transmission.When a low signal strength is detected the receiver goes into a receive wait state until it either receives another packet, in which case it returns to the receive state, or a reasonable amount of time passes, in which case it moves into the idle state. While in the receive wait state. the receiving node sends an HB signal each control frame. If a transmitting node does not receive an ACK signal from the receiver, it will go into a transmit wait state.While in the transmit wait state the transmitter will listen for HB signals from the receiver. If the signal strength of the HB signal is acceptably strong, the transmitter will return to the transmit state and begin transmitting with the last unacknowledged packet. If the signal strength does not return to normal within a reasonable length of time, the transmitter will remove the portion of the message that was successfully sent from its message queue and return to the idle state where it will wait for the length of time contained in the RDEL signal, thereafter it will go back to the idle state. A receiving node that hears an RTS intended for it with a priority higher than its own data transmission will send a CTS back to the sender of the RTS and at the same time send a TDEL signal to the transmitting node of its data transmission. The TDEL signal contains the length of time the transmitter should delay to allow the higher priority message to complete. A transmitter that hears a TDEL signal intended for it will move into a transmit delay state for the length of time contained in the TDEL signal. thereafter it will return to the idle state. As compare to PAMAS in PMAW High priority levels for messages get preferences over low priority messages.and it has high data throughput and low energy consumption in a truly mobile environment.

3) PARO

PARO, which represents a new approach to dynamic power controlled routing that helps to minimize the transmission power needed to forward packets between devices in wireless ad hoc networks. Using PARO, one or more intermediate nodes called redirectors" elects to forward packets on behalf of source-destination pairs thus reducing the aggregate transmission power consumed by wireless devices .PARO is based on the principle that adding additional forwarding (i.e., redirectors) nodes between source-destination pairs significantly reduces the transmission power necessary to deliver packets in wireless ad hoc networks. We propose that intermediate redirector nodes forward packets between source-destination pairs even if the source and destination are located within direct transmission range of each other. PARO uses redirector nodes to shorten the length of individual hops, thereby reducing the overall power consumption. This approach is in direct contrast to MANET routing protocols (e.g., AODV, DSR and TORA) [3], which attempt to minimize the number of hops between source-destination pairs. The algorithm converges to the optimal number of redirector nodes in a sequence of iterations. In the first iteration, the source node directly sends the data packet to the destination without involving any redirector nodes. Any node on overhearing this packet transmission computes whether its forwarding can reduce the end-to-end transmission power in comparison to the original data exchange. If this is feasible, the intermediate node elects itself as the redirector and sends a route-redirect message to the source and destination informing them of a more power-efficient route for their communication. It consumed less power in order to find power efficient routes and Adding or removing redirector reduce the overall transmission power in the network in a simple and scalable manners . In [13], they present four variations of route selection algorithms to accomplish one or all of these goals. There are Minimum total transmission power routing (MTPR), Minimum battery cost routing (MBCR), Min-Max battery cost routing (MMBCR), and their proposed Conditional Max-Min battery capacity routing (CMMBCR)

PARO has 3 core algorithms: overhearing algorithm, redirection algorithm, and route-maintenance algorithm for mobility.

The overhearing algorithm handles packets that are received by the MAC successfully. When a node overhears a packet from its neighbor, it creates an entry in the “overhear table” or refreshes the entry if the entry for the neighbor already exists. The entry includes the minimum transmission power necessary to communicate with the neighbor based on the signal strength of the received packet and the power level at which the packet was sent. The information of the latter is included inside the packet by the sender.

The redirection algorithm performs the route optimization, which leads to discovering paths that require less transmission power to forward a packet. Using the overhearing algorithm, if a node finds a path that consumes less transmission energy, the node becomes a redirector and transmits a redirect message to the sender.

The route maintenance algorithm is designed for a network where nodes are mobile. PARO relies on data packets to maintain route information. In PARO, source nodes transmit. Route maintenance packets to destination nodes whenever there is no data packet to send for a fixed time interval named route timeout. When nodes receive or overhear these packets, they update routing information to maintain fresh routes.

Minimum Total Transmission Power Routing [5] mechanism makes use of simple energy metric which represents the total energy consumed in transmitting over the hop.

In MTPR, the remaining battery capacity of each host is a more accurate metric to describe the lifetime of each host[4].

In MMBCR[35], to make sure that no node will be overused ,the objective function of the previous algorithm is modified i.e. instead of summing the battery cost function of all nodes of the individual routes, select the battery cost which is maximum among all nodes of route. For each route, select battery cost function which having maximum value among all nodes in the route.

Comparison of power aware routing Protocol

Routing Protocol	Acknowledgement mechanism	Redirector node	Priority Preference	Scalability	Consumption of power
PAMAS	No	No	No	fair	More
PMAW	Yes	No	Yes	fair	less
PARO	No	yes	No	good	Very less

4. CONCLUSION

In this paper we explained about various power aware routing protocols related to ad hoc networks and how performance affected by the use of different protocols .

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