Survey on Energy Saving Mechanisms for MAC Protocols in Adhoc Wireless Networks

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***Abstract*— In adhoc wireless networks the mobile nodes perform their operation mainly by using battery power. So energy management is an important issue. MAC protocol improves throughput and performance. In order to improve the energy efficiency, the energy saving mechanisms is adopted to improve the life time of the node. This paper aims to present a detailed survey on these energy saving mechanisms. And this paper also compares the energy consumption for a McMAC (multi-channel MAC) protocol which consists of multiple radio interfaces along with multiple channels are equipped for a node, and single channel MAC protocols.**

***Keywords*— MANET; MAC protocol; energy consumption;**

I. INTRODUCTION

Adhoc wireless networks are collection of wireless nodes which can be mobile. These nodes are able to communicate without the aid of infrastructure or any central administration. Each node is self-organizing and self-configuration and can be a source or a destination or a relay node. A MAC protocol in Adhoc wireless networks improves the throughput and performance by efficiently using the channelization in the wireless medium.

The mobile nodes in Adhoc wireless networks are depend on the battery power. The battery power is required for the communication purpose at each node. So the Adhoc wireless networks are constrained with battery power. The energy efficiency depends on the network protocol stack with multiple layers. So at every node the energy consumption is considered. Energy based routing protocols will minimize the energy consumption whereas at MAC layer some of the techniques are used to reduce the energy consumption during transmission and reception of packets and also at the intermediate nodes or relay nodes or by turning off radios when node is in idle state. So in Adhoc wireless network energy management is an important issue. And energy management can be done at battery, transmission power, and system power.

Battery Power Management mainly deals with improving the battery capacity by selecting the appropriate battery technologies. Transmission Power Management deals with the techniques to minimize the power level of a node. System Power Management deals mainly with minimizing the power required by hardware peripheral of a node.

II. ENERGY SAVING MECHANISMS

The following Energy saving mechanisms can be used to save the energy in MANET are energy conserving by controlling transmission power, energy conserving by power aware routing protocols and energy conserving by power management technique.

In Adhoc wireless networks some of the energy saving mechanisms have been discussed and compared in between the energy saving mechanisms adopted in MAC protocols and McMAC protocols.

A. Energy Saving Mechanisms in MAC Protocol:

Adhoc wireless networks are constrained with limited battery power the energy management is done to improve the life time of a node at various layers. Some of the energy saving mechanisms is listed in which how energy consumption at node is decreased.

1) Energy Efficient MAC Protocol (EE-MAC):

The EE-MAC protocol [1] is to select some of the nodes as master nodes and the remaining nodes are slave nodes in the network. The Master nodes kept awake all the time and these nodes act as a virtual backbone to route packets in the adhoc network. Slave nodes are kept in energy efficient mode i.e. sleep mode and periodically wake up and check whether they have packets to receive. The Master nodes don't operate in power saving mode and forward packets all the time, packet delivery ratio and packet delay can be improved. The performance of this protocol is mainly concern with the energy efficiency.

2) PAMAS Protocol:

The PAMAS protocol [2] includes a MACA protocol with separate signalling channel. The signalling channel separate from the data channel which includes RTS/CTS messages. The signalling channel in PAMAS protocol enables the nodes to determine when and for how long the nodes to be turn off themselves. There are two possible ways to turnoff the node itself are:

- when nodes do not have packets to transmit then node turns itself off for a period of time if neighbor nodes began transmitting the packets.
- The node turn itself off when two neighbor nodes in transmitting and in receiving states such that node is in idle state i.e. when node cannot transmit or receive in the network refers to be node is in idle mode.

This node can turn off for a period of time, l where l is the maximum transmission length this can be known by the node. And periodically checks the transmit queue. If the transmit queue is empty, the node turns itself off if it is not empty node transmits the packets. So PAMAS protocol do not change the characteristics like throughput or delay. This protocol efficiently manages the power up to 70%.

3) Autonomous Power Control MAC Protocol (APMC):

In this protocol [3], the transmission power for DATA/ACK packets and RTS/CTS packets are adjusted according to the network condition. In this protocol the power levels for transmission of RTS/CTS and DATA/ACK packets is adjusted such that energy consumption is reduced and network performance is not reduced.

In Adhoc wireless networks the network topology changes dynamically so this protocol adjusts power level for transmitting DATA/ACK according to the appropriate distances between the transmitter and its neighbor nodes or according to the signals i.e. RTS/CTS received by the nodes. In addition, the power level for transmitting next RTS/CTS is also adjustable proportionally to the power level of DATA/ACK packets received by the nodes. In this protocol by adjusting the appropriate distance, energy is saved and spatial reuse and collision reduction are some of the advantages.

4) Power Conserving Algorithm:

To conserve the energy, the power-conserving algorithm [4] is proposed. In this algorithm the Network Interface Card of the node is set to dynamically switch off when node neither have packets to trnasmit or receive the packets. This algorithm mainly depends on the RTS/CTS dialogue box, when a node detects the RTS/CTS dialogue box and if it is not the target node then waits until the neighbor nodes start communication then the node dynamically turns off the Network Interaface Card. This algorithm saves the energy up to 60%.

B. ENERGY SAVING MECHANISM IN McMAC PROTOCOL:

Energy consumption is more for multi-channel mac protocols because each node is equipped with two or more radio interfaces and the multiple channels are assigned dynamically. So energy management is done to improve the energy efficiency for a node.

1) Dynamic Channel Assignment with Power Control (DCA-PC):

In this protocol [5] consider both power control and multi-channel medium access by extending the DCA protocol. The DCA-PC protocol resolves three problems like channel access and medium access and power control. This protocol has features like:

- DCA-PC protocol assigns channels dynamically to mobile hosts in an on-demand style which means whenever a mobile host require a channel it follows RTS/CTS/RES dialogue to assign a channel after completion of transmission the channel is released.
- Next feature is because of first feature the fixed number of channels in a network do not depend on the network size, topology and degree.
- Last feature in this protocol is clock synchronization in between mobile hosts is not considered.

2) Distributed Power Level (DPL) Protocol:

To address the uncontrolled asymmetrical transmission power over multi channels this protocol is used. DPL protocol [6] do not require clock synchronization and in this protocol. Different channels are assigned with different transmission power levels and based on the received power the nodes search for idle channel so the selected data channel having power is larger than or equal to the received power. If the selected data channel is busy search for another channel and so on. Therefore, the interference in between channels is reduced. And there are two types of transmission modes; they are Symmetrical and Asymmetrical DPL protocols. In Symmetrical and Asymmetrical DPL protocols nodes transmit the same power level and lower or equal power level assigned to the selected channel respectively.

III. CONCLUSION

The energy saving mechanisms in MAC and McMAC protocols have great impact on energy consumption. Energy consumption at nodes is greatly reduced by using the Energy Saving Mechanisms. The energy consumption in McMAC protocol can be further reduced by using power management technique like one of the radio interface can be turned off in multi interface node whenever multi interface node is in idle state or when node do not have packets to receive or transmit for a period of time. Therefore, by using this kind of power management technique can have great impact on power consumption. The energy consumption at single channel mac protocols is less compared to multi-channel mac protocols.

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