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Energy Consumption on Varying Nodes of IEEE 802.11 MAC Protocol on Adhoc Network

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ABSTRACT

With the popularization of Internet, the wireless technologies provide remarkable impact on Internet and Communication Technologies. These technologies have support a technique known as Adhoc Network Ad hoc network is a network formed without any fixed substructure or centralized administration, which consists of mobile nodes that are connected via wireless links to send packet data, and mobile nodes are free to move randomly in which each node work as a router. Energy Consumption in Wireless technology is one of the main challenges for researchers. Most of the work is done over the MAC layer of network in which different kinds of MAC protocol used by sensor networks. Most commonly used standard is 802.11. Especially energy consumption is most important because all the nodes are battery powered. Failure of one node may affect the entire network. In the previous paper we implemented IEEE 802.11 MAC protocol in Ad-hoc network through various parameters. The approach based on throughput and minimum access delay on varying nodes of IEEE 802.11 MAC protocol. In this paper we evaluate the total energy consumption by each node of IEEE 802.11 protocol which is a standard MAC protocol. The accuracy of the analytical result is verified by ns-2 software tool.
Keywords: Wireless sensor network (WSN), IEEE 802.11 standard,NS-2

I. INTRODUCTION

Understanding Effect Of Energy Consumption On Network

Mobility is useful for reducing energy consumption. Packets coming from sensor nodes traverse the network towards the sink by following a multihop path. When the sink is static, a few paths can be more loaded than others, depending on the network topology and packet generation rates at sources. Generally, nodes closer to the sink also have to relay more packets so that they are subject to energy depletion, even when techniques for energy conservation are applied. On the other hand, the traffic flow can be altered if a designated mobile device makes itself responsible for data collection (mobile data collector). Nodes are waiting for the message of the mobile device to route messages towards it, so that the communication with mobile data takes place in proximity. As a consequence, ordinary nodes can save energy to reduced link errors, contention overhead and forwarding. In addition, the mobile device can visit the network in order to spread more uniformly the energy consumption due to data communication. [12] It is seen that in multi hop transmission consumes less energy than single hop. In large environmental setup sensor nodes are distributed pervasively, begin at same energy storage and create clusters. Some of the clusters utilize more energy dissipation due to the far away from the base station and rest of the clusters operates at less energy consumption. Therefore, after the some successful rounds there will be a significant variation in nodes energy consumption. Finally, the network performance will be turn down because the distribution of the live and dead nodes within the network. Furthermore, during the setup phase, nodes short messages are collide to each other due to the nodes communication ranges are to each other and uses same frequency band. The network performance will be degrading partially; some of the nodes have not maintained the cluster membership and lost the network connectivity [13], multi hop routing strategy implies to reduce the energy consumption between the sensor nodes. During the time of each frame all member sensor nodes forward the data to cluster, then cluster combined and discard the unnecessary data and finally send the compact data to base station.[13] The energy expenditure of the sensor nodes occurs during the wireless communication, the environment sensing and the data processing. Therefore, most of the routing protocols in WSNs aim mainly at the attainment of power conservation. Most of the protocols use clusters in order to provide energy efficiency and to extend the network lifetime. Each cluster first select a node as the cluster head (CH), and then, the remaining nodes in every cluster send their data to their own cluster head. The cluster head sends its data to the base station. This data transfer can be performed in two alternative ways. Either directly, in this case the cluster head is located close to the base station, or via intermediate cluster heads. Moreover, in order to achieve balanced energy consumption and extend the network's lifetime, the election of the cluster heads should be performed in turns. In multi-hop, relay techniques being used which transmit data packets from the source node toward the direction of the sink. Relay techniques are used nodes as a temporary medium to transmit the packet from one node to the others [14].

While multi-hop can solve the problem in large communication area, it has the capacity to improve energy efficiency in sensor nodes because multi-hop techniques requires transmission on neighbouring nodes which are very close with each other thus decreasing the transmitter functionality. Routing in wireless sensor network has always been a problematic issue of concern mainly due to several factors ranging from unfriendly deployment conditions, network topology that change repeatedly, network failures, resource constraints at every sensor node to designing of routing protocol issues. Therefore, the implementation of routing protocols is affected by several underlying features which must be taken into consideration before any attempt at designed routing are implemented, because these factors might prevent the successful design and implementation of routing protocol if these challenges are overlooked. The main goal of the routing protocols is efficient delivery of information between sensor nodes and the sink. Thus, energy consumption is a major concern in the design of routing protocol in WSNs. Due to the limited energy resources of sensor nodes, data need to be delivered in the most energy efficient approach without compromising the accuracy of the information content. Hence, many conventional routing metrics such as the shortest path algorithm may not be appropriate. Instead, the reasons for energy consumption should be carefully investigated, and new novel energy-efficient routing metrics developed for WSNs The major reasons of energy consumption for routing in WSNs can be classified as Neighbourhood discovery and Communication vs. Computation.[15]

Neighbourhood discovery: Many routing protocols involve every node in order to exchange information between its neighbours. The information to be exchanged can differ according to the routing methods. While most geographical routing protocols involve knowledge of the locations of the neighbour nodes, a data-centric protocol may require the information content of the observed values of each sensor in its surrounding. In each case, nodes consume energy in exchanging this information during the wireless medium, which increases the overhead of the protocol. In order to improve the energy efficiency of the routing protocols, local information exchange should be minimized without hindering the routing accuracy [15].

Communication vs. Computation: The computation is greatly cheaper than communication in terms of energy consumption. Moreover, in WSNs, the approach is to deliver message instead of individual packets. Consequently, in addition to the conventional packet switching techniques, computation should also be integrated with routing to improve energy consumption. An example, data from multiple nodes can be aggregated into a single packet to decrease the traffic capacity without hindering the information content. Similarly, computation at each relay node can be used to suppress redundant routing information. For most networks, routing of incoming packets is normally concentrated in the network layer. In multi-hop networks the source node does not communicate directly to the sink, sensor nodes does the relaying of packets, so the protocols features a routing table which enables the touting algorithm to assist in the creation and maintenance of packet source and destination. [15].

II. METHODS AND MATERIAL

A. Standard MAC 802.11 Protocols

A MAC protocol provides slightly different functionality depending on the network, device capability, and upper layer requirements, but several functions exist in most MAC protocols. In general, a MAC protocol provides [3]:

1) **Framing:** Define the frame format and perform data encapsulation and decapsulation for communication between devices.
2) **Medium Access:** Control which devices participate in communication at any time. Medium access becomes a main function of wireless MAC protocols since broadcasts easily cause data corruption through collisions.
3) **Reliability:** Ensure successful transmission between devices. Most commonly accomplished through acknowledgement (ACK) messages and retransmissions when necessary.
4) **Flow Control:** Prevent frame loss through overloaded recipient buffers.
5) **Error Control:** Use error detection or error correction codes to control the amount of errors present in frames delivered to upper layers.

Several aspects of sensor networks differentiate the MAC protocol design from MAC protocols in other networks. First, sensor nodes conserve energy by turning off unneeded hardware because most hardware, even when not active, consumes a non-negligible amount of energy. Thus, each sensor node must somehow coordinate with its neighbour to ensure both devices remain active and participate in communication. Sensor network MAC protocols most often performers actively participate in this functionality so upper layers have only an abstract concept of viable links or topology information. Several techniques, such as schedule-based clustering and separate wakeup communication, exist and we mention them when used in the discussed protocols. Secondly, sensor networks produce traffic that differs from the communication patterns that exist in other networks. The application of sensor network is Environmental monitoring. Sensor nodes monitoring a particular environmental characteristic periodically send data to a central entity for collection and analysis. These sensor node so individually produce traffic at periodic rates with small payloads. Both the data characteristics, which may exhibit strong periodic generation and high spatial correlation, and the small payload size, which increases the impact of protocol overhead, differentiate sensor networks from other networks. Third, the limited resources available to a sensor node prevent the use of common MAC protocol techniques. Much wireless MAC protocols constantly listen to the wireless channel for activity either for reception or before transmitting. However, a transceiver that constantly senses the channel will quickly deplete the sensor node energy resources and shorten the network lifetime to Unacceptable levels.

III. RESULTS AND DISCUSSION

We have implemented IEEE 802.11 protocol for WSN. Through paper [2]. Simulation of different networks according to the varying number of sensor nodes such as 10,20,30,40,50 are implemented and value of throughput an delay is calculated and from that implementation we evaluate the energy consumption in this paper.

Energy consumptions of IEEE 802.11 on varying nodes:

Another approach as total energy consumption by each node is to be calculated. From the simulation result of energy we obtained that the energy decreases with the increase in number of nodes. As the number of nodes increases the simulation time also increases because of collision.

Energy is the measurement of the reciprocal of the square of the distance between nodes.

$$\text{Energy} = \frac{1}{(\text{Distance between nodes})^2}$$

Distance can be calculated by the simulation time and speed of the data transfer. For example [2] if the number of nodes is 10 then its simulation time is 15 seconds and speed is 10 metre per seconds. Then, from speed, distance, and time we find distance as 150 metre.

Energy = 1/ $(150)^2 = 4.4*10^{-5}$
Similarly, for 20, 30, 40 and 50

TABLE I
Energy consumption by different nodes

Number of Nodes	**Simulation Time in seconds**	**Distance between the nodes in metre**	**Energy in joule**
10	15	150	$4.4*10^{-5}$
20	20	200	$2.5*10^{-5}$
30	25	250	$1.6*10^{-5}$
40	30	300	$1.1*10^{-5}$
50	35	350	$0.81*10^{-5}$

From the theoretical value of time and energy the Graph of energy versus time is shown in figure1. And from the simulation result the graph obtains is shown in figure 2.

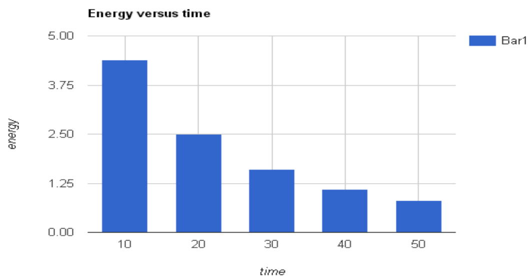

Figure 1: Energy versus time

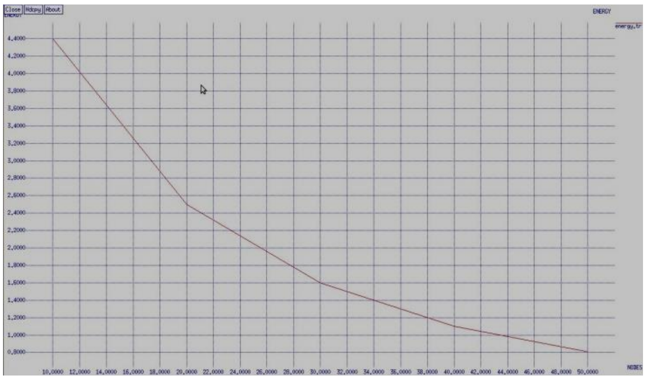

Figure 2: Energy versus time

As the number of nodes increases the simulation time also increases because of following reasons. The first one is collision. When a transmitted packet is corrupted, it has to be discarded, and follow on retransmissions that increase energy consumption. Collision increases latency as well. The second source is overhearing, meaning that a node picks up packets that are destined to other nodes. The third source is control packet overhead. Sending and receiving control packets consumes energy too. The last major source of inefficiency is idle listening, i.e., listening to receive possible traffic that is not sent. This is especially true in many sensor network applications. If nothing is sensed, nodes are in idle mode for most of the time. However, in many MAC protocols such as IEEE 802.11 ad hoc mode nodes have to listen to the channel to receive possible traffic. Measurements have shown that idle listening Consumes 50% -100% of the energy required for receiving.

IV. CONCLUSION

In this paper, we have implemented 802.11 MAC protocol in Ad-hoc network through energy consumption. The approach based on energy consumption by each node is to be calculated. From the above result we find that the energy decreases with the increase in number of nodes.

By investigating this research area further by CDMA it will eliminate collision, developing a technique for wide application of this in WSN will boost energy efficiency and hence network lifetime of WSN. Another approach is to implement a protocol that will increase the energy efficiency.

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