TIME SYNCHRONIZATION USING INTELLIGENT HYBRID MAC PROTOCOL FOR WIRELESS SENSOR NETWORKS

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ABSTRACT

Accurately synchronized clocks are crucial for many applications in sensor networks. The Intelligent Hybrid Mac Protocol (IH-MAC) is designed to provide accurately synchronized clocks between neighbors. IH-MAC works in a completely decentralized fashion. Every node periodically broadcasts its time information. IH-MAC is the combination of both Q-MAC and Z-MAC. IH-MAC achieves high channel utilization during high traffic load. IH-MAC provides the internal synchronization which means consistent view of time across all nodes that makes robust against link and node failures. Due to high load it switches from broadcast scheduling to link scheduling. It uses the time synchronization method to allocate the time slots. IH-MAC uses Request to send and clear to send handshakes for low energy consumption. The objective of this paper is to increase the quality of service Hybrid MAC (IH -MAC) is used. The transmission power, throughput, delay and packet delivery fraction are measured. The IH-MAC protocol is simulated on the network simulator 2 setup.

Keywords: sensor networks, IH-MAC, Q-MAC, Z-MAC.

INTRODUCTION

A wireless sensor network is a promising novel tool for observing natural phenomena at large scale or high resolution. Without doubt, time is a first class citizen in wireless sensor networks. Without accurate time (and similarly location) information, sensed data often loses valuable context. Although one can imagine applications where the sensed data is of no great concern, a majority of applications will prefer to tag the measured data with a timestamp. Such timestamp will only be meaningful if the nodes in the wireless sensor network manage to have an adequate agreement of time. Indeed, there are sensor networks that can estimate the location of an event, simply by using trilateration on an acoustic signal. In addition, time synchronization is significant as sensor network protocols make use of time in various forms. Media access control using TDMA needs accurate time information, so that transmissions do not interfere. Similarly, to save energy, sensor network protocols often employ advanced duty-cycling schemes, and turn off their radio if not needed. An accurate time helps to save energy by shortening the necessary wake-up guard times.

Although each sensor node is equipped with a hard-ware clock, these hardware clocks can usually not be used directly, as they suffer from severe drift. No matter how well these hardware clocks will be calibrated at deployment, the clocks will ultimately exhibit a large skew. To allow for an accurate common time, nodes need to exchange messages from time to time, constantly adjusting their clock values. Although multi-hop clock synchronization has been studied extensively in the last decade, there are still facets which are not understood well, and eventually need to be addressed. One such issue is locality: Naturally, one objective in clock synchronization is to minimize the skew between any two nodes in the network, regardless of the “distance” between them. This is known as clock skew minimization. To achieve this goal, each sensor networks is required to record the time at which it detected the target object and exchanged this information with its neighboring nodes. The estimated velocity of the target object can be calculated by dividing the difference of the detection times by the distance between the sensor nodes. As can be observed, the smaller the synchronization error is between the neighboring nodes, the more accurate and hence the velocity is estimated. There are many synchronization protocols, many of which do not differ much from each other. IH-MAC protocol is used in Sensor Networks. These two protocols are the major timing protocols currently in use for wireless networks. There are other synchronization protocols, but this covers both a sender to receiver synchronization as well as receiver to receiver. Also, they cover multi hop synchronization schemes.

RELATED WORKS

F. Kuhn, C. Lenzen, T. Locher, and R. Oshman, (July 2010) has the limitation that the algorithm minimizes the number and size of messages that need to be exchanged in a given time period. Moreover, only a small number of bits must be stored locally for each neighbor. So the true message is not received absolutely.

L.L. Schenato and F. Fiorentin (2011) has the limitation that the topology of the network is not changed and it is constant so the packet received is not accurate if topology is changed. R. Wattenhofer (2010) has the limitation that the Reference broadcast synchronization is used. So the main drawback is only receiver to receiver communication.

PROPOSED SYSTEM

Time Synchronization in wireless networks is extremely important for basic communication, it al provides the ability to detect movement, location, and proximity. Intelligent Hybrid MAC (IH-MAC) consists of two MAC [3].

1) Q-MAC (Quality of service MAC)
2) Z-MAC (Zebra MAC)

IH-MAC combines both broadcast scheduling and link scheduling [18]. IH-MAC classifies the packets and stored the packets into the appropriate queue [20].

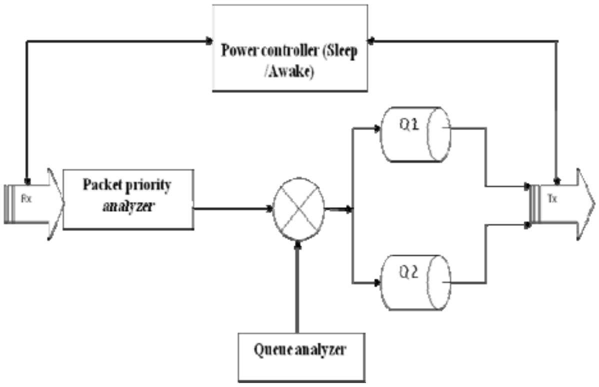


Figure-1. Block diagram of Q-MAC.

Figure-1 illustrates that when packet is received from the node, the packet priority analyzer takes the decision that which packet should be moved according to the priority queue that is Q1 or Q2. Power controller makes the sleeping node as awaken node. Queue analyzer consists of two techniques.

1) Pre-emption.
2) Non Pre-emption.

Pre-emption technique describes here that when two nodes starts sending the packet at the same time. Node1 starts sending the packet and make the node 2 to resume. After synchronization is made with node 1, now the node 2 is get synchronized [14]. Non Pre-emption technique describes here that when two nodes starts sending the packet at the same time. Node1 stop sending the packet and wait for the node 2 to finish [16].

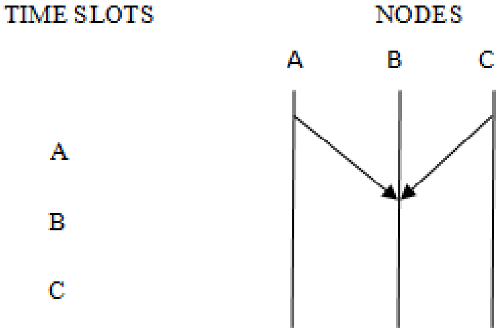


Figure-2. Working of Z-MAC (condition1).

Figure-2 illustrates that Collision occurs when packets starts sending from node A to B and from C to B. To avoid this Z-MAC is used.

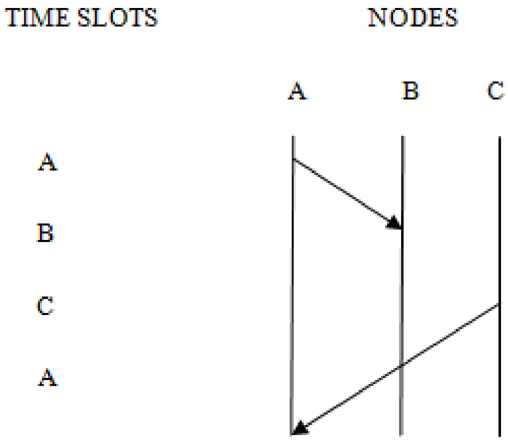


Figure-3. Working of Z-MAC (condition 2).

Figure-3 illustrates that Packet starts sending data from A-B and C-A. So there is no transmission in B. So B is in sleep mode

To avoid these conditions Z-MAC is used. Z-MAC is a slot stealing technique consists of time slots it checks the data based on priority. It posses high throughput under low contention. Z-MAC checks its own data and also availability of other data. Based on the availability that data is used. Combination of Q-MAC and Z-MAC transmission power, packet delivery ratio, delay are calculated.

3.4 Synchronization phase

The basic concept of the synchronization phase is two-way communication between two nodes. As mentioned before this is a sender to receiver communication.

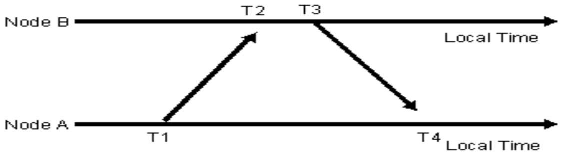


Figure-4. Two way communication between nodes.

Figure-4 illustrates the two-way messaging between a pair of nodes. This messaging can synchronize a pair of nodes by following this method. The times T1, T2, T3, and T4 are all measured times. Node A will send the synchronization pulse packet at time T1 to Node B. This packet will contain Node A's level and the time T1 when it was sent. Node B will receive the packet at time T2. Time T3 is when Node B sends the acknowledgment packet to Node A. That packet will contain the level number of Node B as well as times T1, T2, and T3. By knowing the drift, Node A can correct its clock and successfully synchronize to Node B. [1] this is the basic communication for GTSP and EGSYNC. The synchronization process is again initiated by the root node. It broadcasts a time sync packet to the level one node.

These nodes will wait a random amount of time before initiating the two-way messaging. The root node will send the acknowledgment and the level one nodes will adjust their clocks to be synchronized with the root nodes.

SIMULATION OF PROPOSED WORK

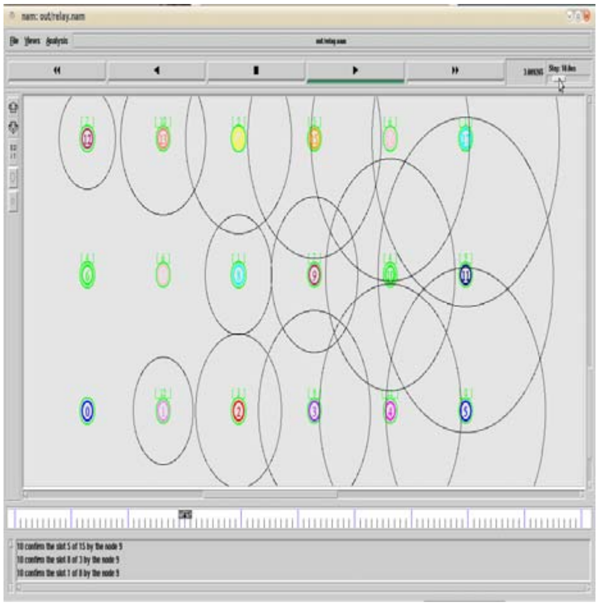
The above explained method is tested in ns-2 environment

The wireless channel is chosen and it simulates the physical media (air) for wireless communication. It keeps a list of all nodes on this channel (mostly, all the nodes participate the simulation). The list is sorted based on the X-dimension values of nodes before it can be used. The propagation model used here is two-ray radio propagation model. The propagation models are used to compute the received power. When a packet is received, the propagation model determines the attenuation between transmitter and receiver and computes the received signal strength. If the signal strength is lower than the Carrier Sensing Threshold, CS Thresh, the packet is discarded by the physical layer. This threshold simulates the effect of the receiver sensibility. Erroneous packets are delivered to the MAC layer so that it can detect a packet collision where multi-packets are received simultaneously. In this case the MAC layer determines the ratio between the strongest received signal strength and the sum of the other signal levels. It is worth noticing that ns2 uses a threshold to determine if a packet is received correctly or not, without considering a more correct bit error rate computation.

The physical network interface type is used. The data in packet header is used by the propagation model in receiving network interface to determine if the packet has minimum power to be received or captured or detected (carrier sense) by the receiving node.MAC type 802.11 is used in physical layer management information base (MIB) such as the minimal and maximal size of contention window is noticed. Cross link layer is chosen for the variable link quality and the fact that the wireless medium should be shared by multiple users. In order to properly reflect these features in the protocol stack, the methodology of cross layer design has been adopted. In short, the cross-layer methodology allows certain important information to influence decisions in a layer that is originally not defined to use that information (e.g., the SNR information at the link layer or the queue size at the baseband module).

The motivation for this special issue is the observation that a cross-layer approach is particularly important when designing protocols at the physical (PHY) and medium access control (MAC)/link layer. This is because the defining wireless features listed above have their strongest impact on these layers and their interaction. In recent years, the importance of the cross-layer design at the PHY/MAC/link layer has been reiterated through the emergence of many innovative techniques, such as opportunistic communication, rate adaptation, cross-layered scheduling. Drop tail queue type is used to provide simple queue mechanism that is used by the routers that when packets should be dropped. In this mechanism each packet is treated identically and when queue filled to its maximum capacity the newly incoming packets are dropped until queue have sufficient space to accept incoming traffic. Link layer used for mobile node, has an ARP module connected to it which resolves all IP to hardware (MAC) address conversions. Normally for all outgoing (into the channel) packets, the packets are handed down to the link layer by the Routing Agent. The LL hands down packets to the interface queue. For all incoming packets (out of the channel), the MAC layer hands up packets to the link layer. Omni directional antenna having unity gain is used by mobile nodes.

RESULTS AND DISCUSSIONS



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10 confirm the slot 5 of 15 by the node 9
10 confirm the slot 8 of 3 by the node 5
10 confirm the slot 1 of 8 by the node 5
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Figure-5. Routing discovery of the nodes.

Figure-5 shows routing discovery for the nodes. It consists of source nodes and reference node.

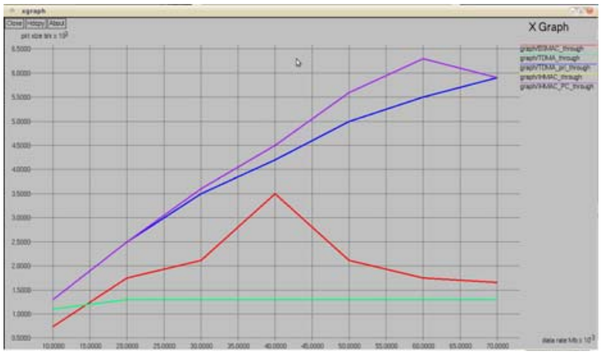

Figure-6. Throughput graph for IH-MAC.

The slot request is send and the conformation of slot is also taken and the slot is allocated to all the nodes.

It can be inferred from Figure-6 that throughput is increased for IH-MAC than other protocol. The X-axis in the graph shows the data rate and the Y-axis in the graph shows the packet size.

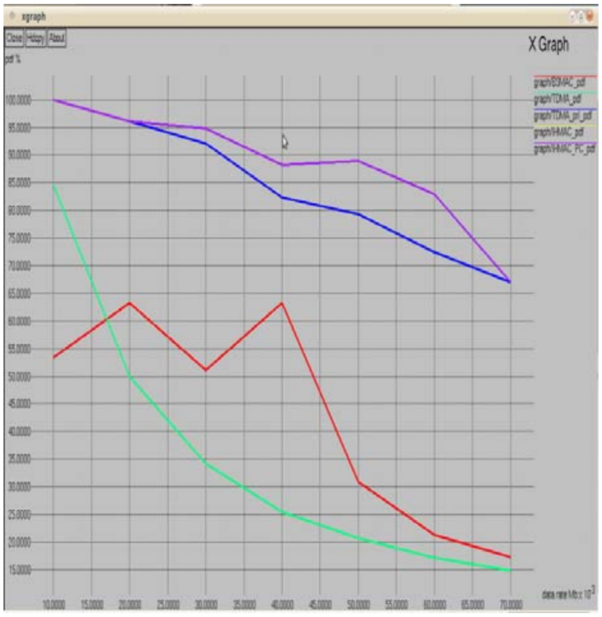

Figure-7. Packet delivery ratio graph for IH-MAC.

Figure-7 shows the packet delivery ratio is increased for IH-MAC than other protocol. The X-axis in the graph shows the data rate and the Y-axis in the graph shows the number of packets received.

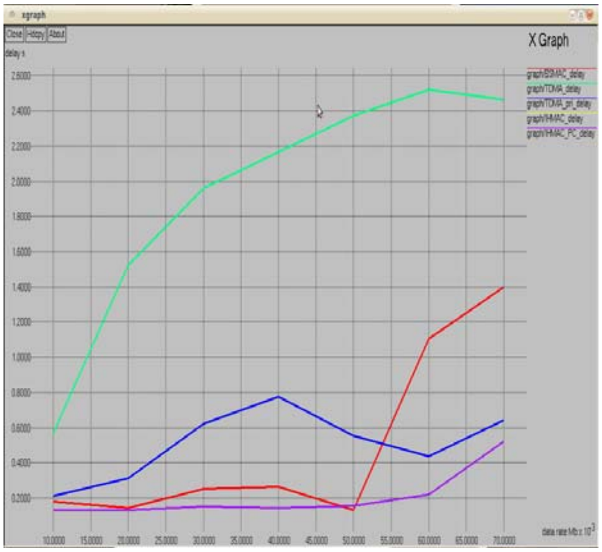

Figure-8. Delay graph for IH-MAC

It can be inferred from Figure-8 that delay is decreased for IH-MAC than other protocol. The X-axis in the graph shows the data rate and the Y-axis in the graph shows the delay in receiving the packets.

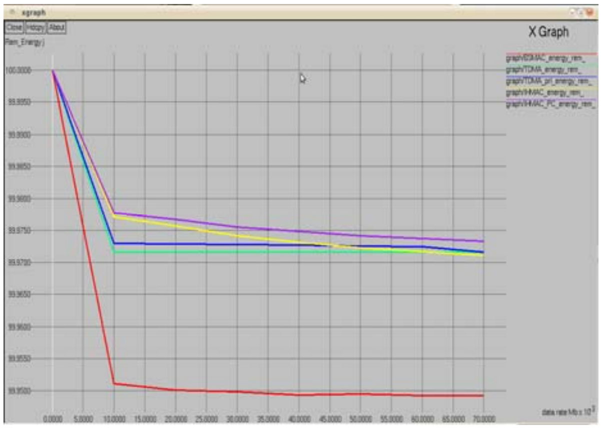

Figure-9. Energy consumption graph for IH-MAC.

It can be inferred from Figure-9 that power consumption is decreased for IH-MAC than other protocol. The X-axis in the graph shows the data rate and the Y-axis in the graph shows the consumption of power for the packets.

CONCLUSION AND FUTURE WORK

Sensor network applications can greatly benefit from synchronized clocks to perform data fusion or energy efficient communication. The perfect clock synchronization fulfils a handful of different properties at the same time precise global and average skew rate synchronization.

IH-MAC relies on local information making it robust to node failures and changes in the network. IH-MAC provides a good synchronization externally and the packet delivery ratio, throughput, delay and power consumption is also measured.

Future work includes comparing the IH-MAC with FTSP.

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