Energy Aware Routing In Mobile Ad-Hoc Network

Komal Amrutkar

Department of Information technology, Padmabhooshan Vasantdada Patil Institute of Technology, University of Pune, India

Abstract: *In a wireless sensor network mobility along with energy efficiency inflicts important tasks for MAC (medium access control) protocol design. An real MAC protocol for Wireless Sensor Networks must consume less power, evades mashes, can be implemented with memory requirements and small code size. static sensor nodes which decreases network performance in case of mobile sensor nodes are accepted by most of the MAC protocols for wireless sensor networks. Our main agenda in this paper is to introduce a mobility aware and energy efficient medium access control protocol (MEMAC). Activation and deactivation of sensor nodes to save energy is informed by MEMAC protocol which is combination of TDMA and CSMA. Dynamic adjustment of frame size is done to control change in mobility and traffic. MMAC is excellent in terms of energy consumption, packet delivery ratio and average packet delay than MEMAC protocol.*

Keywords: MAC protocol, CSMA, Enactment Study, LEACH protocol, Mobile Sensor Network, Energy Efficiency, Movement Behavior, TDMA, RWP.

1. Introduction

Collection of nodes organized into supportive networks termed as wireless sensor network. Each node consist of handling capabilities just like one or more microcontrollers, CPUs or DSP chips, it also may contain numerous types of memory like program, data, flash memories, and just have RF transceiver usually with single Omni-directional aerial, have power source like solar cells, batteries and acquires various sensors and actuators. Communication between the nodes with each other is carried out wirelessly and often self-organized after being established in an ad-hoc manner.

WSN means distributed real time system. MSNs are advance version of WSN. MSN have the similar design of immobile sensor networks but only varies in the mechanism that allows devices to move in space. The arrangement of MSN enclose highly movable (high velocity devices) , stationary scenario in which devices move with low velocity in shop floor like robots and hybrid which contains both classes mentioned above.

There are various advantages of MSNs over the static WSNs. MSNs offer- i) Dynamic Network Coverage- the area where you can't reach e.g. Space, oceans, rainforests. ii) Data Routing Repair:-replacement of unsuccessful routing nodes and change the operation of network. iii) Data Muling : – Collecting data from stationary nodes which are out of range. iv) Staged Data Stream Processing- continuous processing in network to answer the questions. v) User Access Points enabling connection to devices that are out of range from communication areas.

Efficient handling of mobility in all layers of sensor network protocol proves to be the advantages of the MSN. In terms of energy consumption of sensor nodes in both stationary as well as mobile state we require a protocol for effectiveness in both stationary and mobile network which will work effectively. Protocol should be alert of mobility and hustle of mobile sensor nodes. MAC protocol plays important role in controlling the usages of radio unit where radio transceiver unit is major power consumer unit in sensor node. In MAC protocol scheme for WSN accept that sensor nodes are motionless in mobile environment which causes

performance deprivation. Presentation of an adaptive mobility aware and energy efficient MAC protocol for wireless sensor network is studied in this paper (briefly MEMAC). Combination of channel access mechanisms such as Time Division Multiple Access (TDMA) and Carrier Sense Multiple Access (CSMA) is carried out in the study of MEMAC protocol. In MEMAC we use TDMA and CSMA for differentiation among data and control messages. TDMA slot assigns for the long data messages while CSMA is for the short control messages. Reduction of total energy consumption and limits message collision can be done by using radio transceiver.

2. Related Work

The main duty of MAC protocol is to control uses of medium this is done through channel access mechanism. It is way to split resources among nodes and radio channel, by changeable use of it.

Protocol itself tells every node whether to transmit or send the data. MAC protocol in WSN can be classified into three groups: scheduled, unscheduled, hybrid protocols. In scheduled MAC protocols communication between sensors nodes are carried out in ordered way. The most common scheduling method is Time Division Multiple Access. Generally in TDMA, managing the nodes is the responsibility of the base station. The channel displays time distributed into the time slots of fixed size. Transmission of data is done through the allocated certain number of slots, which are allocated to each and every node. Slots are arranged in frames and they are repeatedly organized. Base station specifies in managing the frames which is arranged in organized manner. The instructions of base station are blindly followed by the node. The frame is organized as base station to node and node to base station slots. The communication has to pass through the BS. Through the connection request message it asks a node to request for connection formation. The slots also have possibility of separate channel and the above mentioned frames are of different frequencies. IP is connectionless whereas TDMA is connection oriented which are used in fix sized packets. To

reduce collision and message retransmission is organized by TDMA.

Unscheduled protocol effort to preserve energy by allowing nodes to function independently with minimum complication. In count it does not share info or uphold states. Combining of the advantages of scheduled and unscheduled MAC protocol is done by hybrid.

Easy and rapid adaptability to traffic condition which save significant amount of energy is the main advantage of hybrid protocol. The simple ethics of CSMA are attending before talk and argument. This connectionless, delivering a best facilities struggle but no bandwidth and expectancy security. Its key benefit is that it is TCP network protocol attains variable form of traffic and is healthy in contrast to interference. when we talk about wireless it leads to collision avoidance instead of detection and when we consider wired transmission then it is possible to detect collision. Initially protocol take note of the channel and if it is establish to be idle then only it sends first packet to transmission line. In case the node is busy; the node waits at the end of present broadcast and then starts contention. On occasion of contention timer terminates and channel is still idle, for well transmission of packet node selected shortest contention delay.

The other node just waits for next contention because the contention is arbitrary number and completed for each packet, each node is given equivalent chance to access the channel. The supremely used MAC protocol for ad-hoc network is SMAC protocol.

It comprises low duty cycle operation in multimode WSN. Most of time of the node is spend in sleep mode to decrease energy consumption. Probability of collision increases with increase in network size and weight is the main disadvantage of SMAC. The MS-MAC protocol is an enhanced form of SMAC protocol. MS MAC protocol handles the movement by using modest mobility valuation process which witnessed the mobility of adjacent node. This can be completed by determining modification in acknowledged signal from neighborhoods. It can also be useful to estimate speed of mobile node. The main disadvantage of MSMAC protocol is it leads to great energy intake in situation of communication amongst the mobile nodes. MMAC is an enhancement of TRAMA (Traffic Adaptive Medium Access) protocol TRAMA works on static time frames which make mobile node to wait long time to join the network. The problem can be resolved by MMAC protocol which alters the frame size in accord to mobility in network. The disadvantage of MMAC protocol is its extremely composite scheduling algorithm. MEMAC is hybrid protocol which covers the drawbacks of the MMAC protocol it uses CSMA (contention slot) for short control message and TDMA (scheduled slot) for data messages. The energy efficiency in MEMAC protocol is attained by letting transmission to only that node to which data has to be sent.

3. MEMAC Protocol

In the Wireless sensor network, there may be possibility of nodes failure because of draining of the power or if new nodes added or may be change in location of nodes. So to accommodate such types of dynamic changes in sensor nodes hybrid scheme of contention based presents by MEMAC protocol and scheduled based scheme of previous MAC protocol used to overcome the drawbacks. For the mobility handling of sensor nodes MEMAC and previous SEHM protocol are differentiate by acquiring length of frame according to mobility conditions.

The issues which related to designing of MAC protocols are frame errors in mobility network, schedule inconsistency, probability of collisions increases in MAC protocol which is contention based and requires retransmission, lack of mobility information and unable to choose mobility model. So there is necessity to cope with errors in frame and adjusting frame time.

To avoid energy consumption and collision it must uses information of mobility and acquires schedule according to conditions of mobility and for real life setting it also needs proper designing of mobility model. Now let us see the actual difference between both systems is.
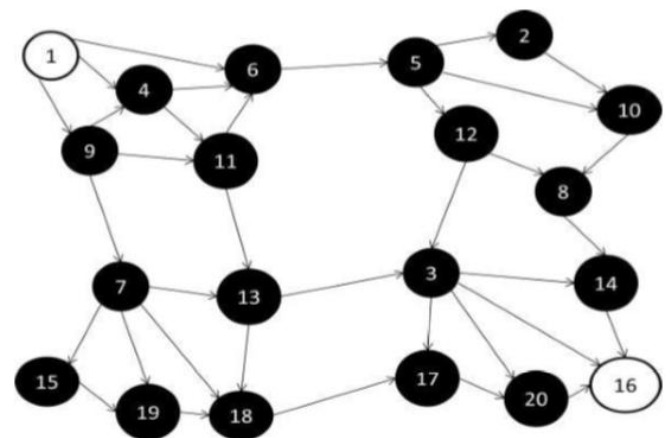
Figure 1: General message transfer

Basically in common Wi-Fi network if there are n no. of nodes in network which are actively participated in communication. Then if any node e.g node no 1 want to communicate with node no.16 then for this message transfer or communication or; firstly node 1 must connect with its neighbor nodes and so on; up to the destination node i.e node 16. Out of that it will refer shortest path to reach up to destination and then it will send message packets. Such process is happen in various wireless networks. But this system is fail due to some disadvantages to acquire reliability and proper flow control in energy efficient way. So MEMAC system used to overcome all this disadvantages.
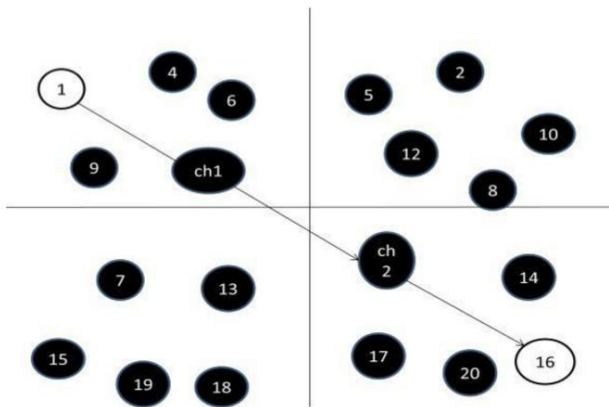
Figure 2: MEMAC protocol message transfer

In MEMAC system, for e.g. when node number 1 want to communicate with node no. 16, then node 1 firstly communicate with its own cluster head (here ch1).

After that communication between ch1 and ch2 which is cluster head of node no. 16 done and then finally ch2 transfer message which is come from node no 1 to destination node (i.e. node no 16). In this way in MEMAC system three way communication is happen. So it is faster and energy efficient system.

3.1 Mobility Handling

Various challenges in designing MAC protocol for portable sensor networks which are mainly responsible for avoidance of crash, communication, resolution and scheduling of packets. The issues which related to designing of MAC protocols are frame errors in mobility network, schedule inconsistency, probability of collisions increases in MAC protocol which is contention based and requires retransmission, lack of mobility information and unable to choose mobility model. So there is necessity to cope with errors in frame and adjusting frame time. To avoid energy consumption and collision it must uses information of mobility and acquires schedule according to conditions of mobility and for real life setting it also needs proper designing of mobility model.

When we consider the challenges of mobility situation then we can describe it as change in Location of node from one cluster to another or what happen when cluster head get detached or change in its own position in cluster. These all challenges overcome by MEMAC. MEMAC implementing clustering algorithm to handles mobility. Let S be MEMAC protocol system in which S={C, CH, N, A} Where c= set of clusters & C={C0, C1, C2,......., Cn}, CH= set of cluster heads & CH= {CH0, CH1, CH2,......., CHn}, n=set of sensor nodes & N={n0, n1, n2,......., nn}, A=Analyser. Algorithm will implement following functions to get required result..Efficiency depends on how many times function will execute in moment-Creation of Network, Navigating, Cluster Creation and Cluster heads Calculation.

3.2 Mobility Model

Mobility plays very major role in this protocol. As sensor node travels from one direction to the other having random speed and direction in the fixed range. So to designate mobility in the sensor network Random Waypoint movement model is used for designing sensor nodes. Movement of sensor nodes occurs either for constant distance or constant period. When nodes reaches to the destination, a new path and speed are chosen. Also when there is any change in the speed or path then for that specific moment a pause time is chosen.

4. Clustering and Data Transfer

According to traffic environment and dynamic frame size, Our MEMAC protocol is mixture of scheduled and unscheduled protocol which considers particular requirements of Ad-Hoc network. By considering address scalability issues MEMAC protocol partitions whole network in clusters.

Clusters which are dynamically created include all nodes in Ad-Hoc network permitted the content for position of cluster head. So MEMAC protocol completes task in two phases namely, Clustering Phase and Data Transfer Phase.

Clustering Phase
In Clustering Phase We use modified LEACH protocol to select cluster head in our MEMAC protocol where time is divided into rounds and only one node is cluster head (CH) for a given round. In the beginning probability P is use to determine CH which broadcast its decision. Each non-CH node determined cluster by deciding CH that can be reached using least communication energy. To preserve energy and balance the load the responsibility of cluster head is rotated among CH. The rotation is executed by getting each node to choose a random number "T" between 0 and 1. A node becomes a cluster head for the current rotation round if the number is less than the following threshold: ( ) ( )
T (n) =0, otherwise.

Where n is the give node, p is the priori probability of a node being selected as cluster head, r is current round number, if the node Einitial is initial energy of the node then Ecurrent is current energy and G is the set of that nodes which not being selected as cluster heads in the last $1/p$ rounds. The round r is defined as $r = k * t$ where t is the frame length, and k is an integer variable greater than one the no. of cluster head is said to be 5% of the total sensor nodes.

Data Transfer Phase
The data transfer phase begins immediately after completion of clustering phase and CH broadcasts its decision to be cluster head. MEMAC data transfer is based on frames. Responsibility of the CH is for controlling the channel access between nodes within the clusters and also retrieves data from them. The hybrid CSMA and TDMA scheme used to handle frames during distinguished phases.
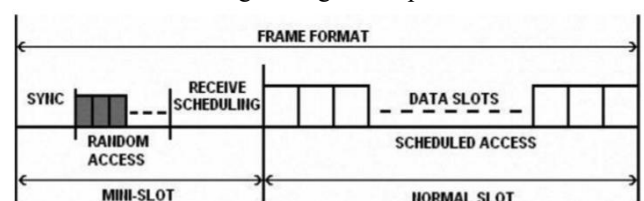
In above fig. each frame comprises of two slots: mini slot and dynamic normal slot. Mini slot mainly contain three parts namely frame synchronization (sync) , random access and receive scheduling. Mini slot is used to transmit and receive control signals. Dynamic normal slot report their data to cluster head through sensor nodes.

For the mobility and traffic situation frame length is made dynamic to make protocol sensitive (number of time slot is directly proportional to number of nodes that have data to send in case of increment or decrement). The MEMAC protocol handles channel access through the following 4 phases: synchronization phase, request\leave\join phase, schedule calculation and distribution phase and data transfer phase.

1) *Synchronization phase*-Initially, all sensor nodes should be in receive node to capture SYNC message that the head node broadcasts. The SYNC message contains the information regarding synchronization for the packet transmission.

2) *Request\Leave\Join phase*-In case of request or leave phase the contention period should be lengthy enough to enable all nodes that have data to transmit contain for the channel so as to acquire the access to send its request to Cluster Head as well as those nodes which are expected to leave or join the cluster should the CH by sending message of leave or join.

3) *Schedule calculation and distribution phase*-In this phase Cluster Head broadcasts the calculated schedule to the other node in the cluster. The schedule contains those nodes which have data to send only. The current schedule does not consider nodes that want to leave or join the cluster. If the no. of request message is greater than no. of join or leave messages, then frame length is enhanced otherwise diminished.

4) iv) *Data transfer phase*-In this phase TDMA slots transmit their data to Cluster Head or to communicate with their neighbors through nodes. Sensor nodes which have no traffic to transmit or receive data go into sleep node. Once data are reported to Cluster Head, the base station retrieves data from CH and is responsible for calculating and distributing time slot to CH and assume that random access period is deleted.

5. Conclusion

MSN have the same architecture of static sensor networks. But only varies in the mechanism that enables devices to move in space. WSN is distributed real time system. MSNs are advance version of WSN. An effective MAC protocol for WSN must consume less energy, avoid collisions, be executed with small code size and memory requirements.

In this paper we present an adaptive mobility aware and energy efficient MAC protocol for Ad-Hoc network (briefly MEMAC). MEMAC is a mix of MAC protocol which mainly Associations channel access mechanism such as Time Division Multiple Access (TDMA) and Carrier Sense Multiple Access (CSMA). MEMAC is mixture of contention based and scheduled based protocols to accomplish significant amount of energy saving. MEMAC regulates dynamically frame size of sensor nodes according to mobility information and the data is sent by number of nodes; this avoids Wasting slots by rejecting the nodes which are expected to join or leave the cluster and nodes which have no data to transfer from the TDMA schedule and to shift nodes to sleep mode when they are not involved in the communication process.

By implementing the MEMAC protocol, we have studied the performance of MEMAC protocol which deals with energy and congestion control mechanism which will reduce both the properties significantly by avoiding unwanted package generation and path control mechanism.

References

[1] Santosh Gore, "A reliable and flow control communication protocol for dynamic network coverage and data security having energy audit functionality in Mobile sensor network", IEEE transactions on network security, vol.21, no.7, July 2013

[2] Bashir Yahya will appear in Wiley series, "Energy efficient MAC protocols in Ad-Hoc Networks" in 2009

[3] D Zeinalipour-Yazti, H. Papadakis, M. D. Dikaiakos, "Mobile sensor network Data Management" Parallel processing letter journal, sept. 2008.

[4] Allred J., Hasan A.B. Gray P, Mohseni K., "SensorFlock: An Airborne Wireless sensor network of Micro-air Vehicles", in 2007.

[5] Nittel S., Trigoni N., Nural A., "A drift-tolerant model for data management in ocean sensor networks", in 2007.

[6] Dantu K., Rahimi M.H. "Robomote: Enabling mobility in sensor networks" in 2005

[7] Lingxuan Hu and David, "Localization for Mobile sensor networks", International conference on mobile computing and networking, 2004.

[8] T Dam and K Langendoen, "An adaptive energy efficient MAC protocol for Wireless Sensor Networks" in 2003

[9] K.T. Jin; D-H Cho, "A new MAC algorithm based on reservation and scheduling for energy limited ad-hoc networks", in 2003.

[10] W. Heinzelman and H. Balakrishanan, "An Application- Specific protocol Architecture for wireless Microsensor networks", IEEE Transaction on Wireless Communications, in 2002.