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An Enhance Approach of Modified MAC Using Energy & Latency Factor in Wireless Sensor Network

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Abstract: The WSN is built of "nodes" – from a few to several hundreds or even thousands, where each node is connected to one (or sometimes several) sensors. Each such sensor network node has typically several parts: a radio transceiver with an internal antenna or connection to an external antenna, a microcontroller, an electronic circuit for interfacing with the sensors and an energy source, usually a battery or an embedded form of energy harvesting. MAC layer is concern with the sharing physical connection to the network among several computers. It is responsible for moving data packets to and from one Network Interface Card (NIC) to another across shared channel. The main purpose of MAC is to provide addressing, framing, and perhaps error detection for the type of the media that will be used. MAC protocols are used in MAC sub layer. There are two different types of MAC protocols: the fixed assignment channel access methods which assign nodes onto different time slots to avoid collision (TDMA), and the contention-based channel access methods in which nodes compete for the wireless communication channel, an example such as carrier sense multiple access (CSMA) but in MOD-MAC use energy parameters before sent data based on the energy value, data rate and location information each node participate in communication. MOD-MAC also check criticality of each mode- energy mode and critical mode base on energy threshold. Using this approach we can improve energy consumption, delay and throughput of network with NS2 tool.

Index Terms **– Sensor Network, Data link layer, MAC, CSMA, TDMA, NIC.**

I. INTRODUCTION

Wireless sensor network is Collection of tiny nodes, Node - A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable [1]. Sensor nodes cooperate to collect and forward data. Wireless sensor network (WSN) is a wireless network consisting of distributed autonomous devices using sensors to monitor physical or environmental conditions[2]. A Sensor is a device that responds and detects some type of input from both the physical or environmental conditions. The output of the sensor is generally an electrical signal that is transmitted to a controller for further processing[3].

There are four types of WSNs:

- Terrestrial WSN
- Underground WSN
- Underwater WSN
- Multi-media WSN

1.1 TERRESTRIAL WSN:

This type of WSNs is typically consist of hundreds to thousands number of cheaper sensor nodes deployed in given area. There are two types of deployment manner unstructured or structured manner. In an unstructured mode, the sensor nodes are randomly distributed within the target area where in structured deployment there is a grid placement, optimal placement, 2-d and 3-d placement and models.

1.2 UNDERGROUND WSN:

In this type of WSNs numbers of sensor nodes are entombed underground to monitor underground conditions. Additional sink nodes are located above the ground to gather information from sink nodes to base stations. Underground environment for a WSNs is a challenge due to signal losses.

1.3 UNDERWATER WSN:

In this type of WSNs nodes are deployed by vehicles. These sensor nodes are more costly. Autonomous underwater vehicles are used for gathering data from sensor nodes. A challenge in underwater communication is limited bandwidth, long propagation delay. Another challenge is sensor node failure due to environmental condition.

1.4 MULTI-MEDIA WSNS:

These types of sensor networks are consisting of number of low-cost sensor nodes. Multimedia wireless sensor networks have been proposed to enable track and monitoring of events in the form of multimedia, such as imaging, video and audio. These networks consist of low-cost sensor nodes equipped with microphones and cameras.

II. MAC PROTOCOL:

This section contains some theoretical background of Medium Access Control (MAC) protocol in Wireless Sensor Networks. This section describes how different MAC protocols are works in different environment.

2.1 INTRODUCTION OF MAC PROTOCOL

Data Link Layer the second layer of OSI model contains two sub layers Logical Link Control (LLC) and Media Access Control (MAC). Three main functions of Data Link Layer are handling of transmission errors, regulates flow of data and interface to the network layer. Data Link Layer having two sub layers.

1) DATA LINK LAYER HANDLING

- Transmission errors
- Data flow
- Interface to network layer

2) MEDIA ACCESS CONTROL (MAC)

- Responsible for access to the shared medium.
- Responsible for moving data packets.
- In wireless sensor network, the MAC protocols play a very important role in energy conservation [4].
- Framing: Frames are the streams of bits received from the network layer into manageable data units. This division of stream of bits is done by Data Link Layer [5].
- Physical Addressing: The Data Link layer adds a header to the frame in order to define physical address of the sender or receiver of the frame [5].
- Flow Control: A flow control mechanism to avoid a fast transmitter from running a slow receiver, this Prevents traffic jam at the receiver side [5].
- Error Control: Receiver to inform the sender of frames lost or damaged in transition an coordinates for retransmission [5].

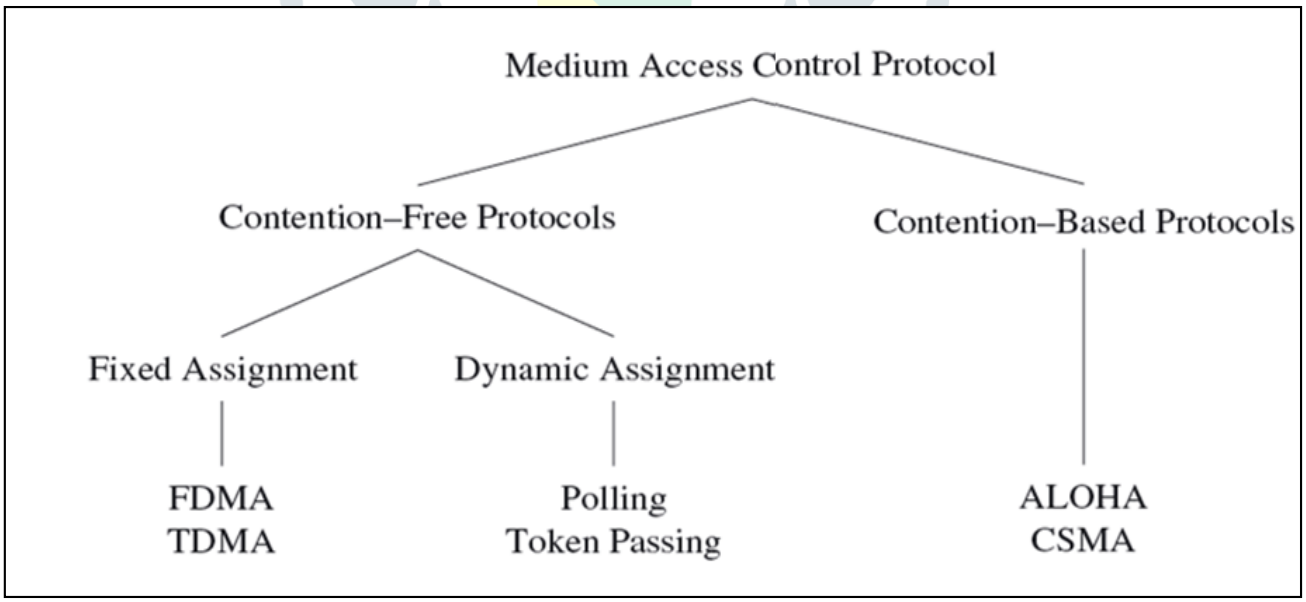

Figure 1: Classification of MAC Protocol

Contention-free:- The contention free MAC protocols allow each station to access the channel by a predetermined time slot [6].

Contention-based:- The Contention based MAC protocols allow the stations to access the channel randomly when they are ready to transmit. As a result, packet collision is detected. [6]

2.2 FIXED ASSIGNMENT

1) **FDMA:**

- Radio spectrum broken into frequency bands (channels)

- Each channel allocated to a different user (only 1 user per frequency band)
- Channels can be assigned on-demand when a user needs to communicate.
- Each user can only be assigned 1 channel, if not enough users for the number of channels, the radio spectrum is unused (i.e., wasted)

2) **TDMA:**

- Only 1 user can transmit or receive data per slot.
- Users access entire radio spectrum for a given time slot.
- Channels can be assigned on-demand when a user needs to communicate
- Mobile devices can save battery power by turning off transmitter and receiver during slots when not transmitting or receiving data
- Cheaper than FDMA.

2.3 DYNAMIC ASSIGNMENT.

1) **POLLING[7]**

- The mechanism of polling in a controller sends a message to each node in turn. All nodes receive the message, only the addressed node (pre-defined) responds and then it sends data, If there is no data, usually a "poll reject" message is sent back. In this way, one after the other, the first node is again polled when the controller finishes with the remaining nodes.
- The polling scheme one nodes may be given higher priority than others. In other words, priority of access can be easily implemented.

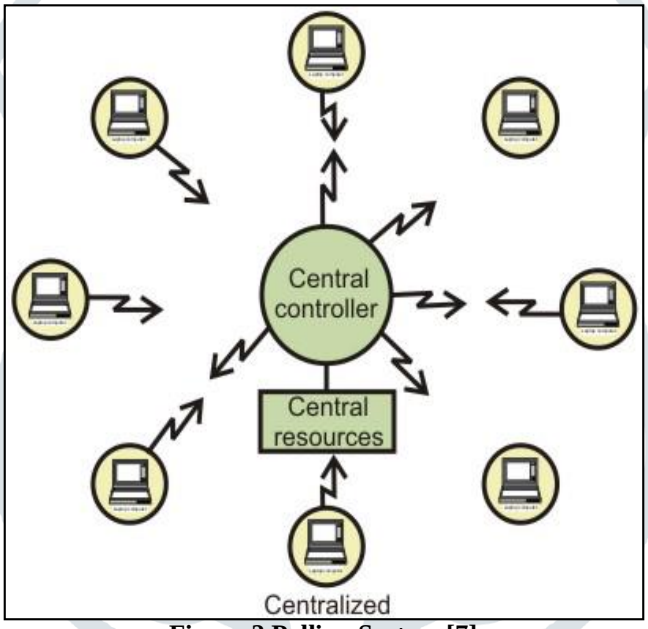

Figure 2 Polling System [7]

2) **TOKEN PASSING[7]**

- A token is a special bit pattern or a small packet, which circulate from node to node.
- When Node has got data to send, it removes the token and transmits the data and then forwards the token to the next node in the ring.
- If a node currently holding the token has no data to send, it simply forwards the token to the next node.
- The token passing scheme is efficient compared to the polling technique.

There exists a number of potential problems, such as lost token, duplicate token, and insertion of a node, removal of a node.

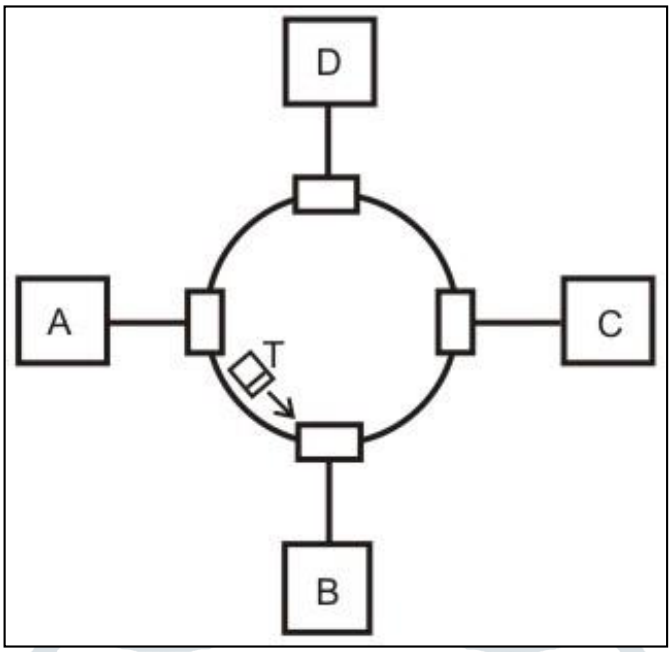

Figure 3 Token Passing System [7]

2.4 CONTENTION-BASED PROTOCOL

1) Aloha:

- Aloha was one of the first attempts to design the MAC protocol for regular networks. Its main idea is that the transmitter sending packets whenever it wants without coordination between nodes[8].

2) Pure Aloha:

- In the pure Aloha protocol nodes transmit messages whether the channel is available or not. The pure Aloha protocol is useful when traffic in the channel is low and collisions are rare. When the traffic load in the channel increases, collisions become more frequent and the channel become congested[8].

3) Slotted Aloha:

- The slotted aloha protocol is an improved version of the pure Aloha protocol by dividing a channel into time slots in which nodes can transmit. Here the node waits for the beginning of a slot for transmission. By using an efficient collision detection mechanism when collision is detected the transmission can immediately be stopped and the energy can be saved[8].

4) Carrier Sense Medium Access:

- Carrier Sense Medium Access with Collision Avoidance (CSMA/CA) is widely used in wireless networks. When nodes want to transmit data, they first listen if the medium is free. Then node sends RTS (Ready to Send) packet to its neighbor and waits for the CTS (Clear to send) packet. After successful coordination, the node is cleared to send data [8].

III. LITERATURE SURVEY:

Table 1 Literature Survey

Various MAC protocol			
Protocol	**Type**	**Advantages**	**Disadvantages**
EERC MAC	CSMA	Provides fairness between source nodes without sacrificing the throughput.	In bigger network not give better throughput and energy reservation.
S-MAC	CSMA	one layer of the OSI stack is used in one or more other layers to improve the system.	physical layer and it will not improve in mac layer to improve lifetime of the system.
ASYM MAC	CSMA	higher packet reception ratio	Transmission delay is more, high overhead
DCD MAC	CSMA	Highly scalable and energy efficient	Does not fully handle the new challenges that come along with the directional antenna.

RP-MAC	CSMA	Active time of duty cycle is reduced and Size of pipeline is also reduced.	Lower performance in heterogeneous network.
XT-MAC	CSMA	Energy-efficient, accurate, and real-time target tracking system.	Does not track multi-target crossing in wireless sensor network.

IV. PROPOSED SYSTEM:

4.1 SIMULATION TOOL

The simulation tool used for this thesis is ns-allinone-2.35. NS2 simulator is based on two languages, a C++ object-oriented simulator and OTCL (an object-oriented extension of TCL) interpreter. It has two class hierarchies, the compiled C++ hierarchy and the interpreted TCL hierarchy having one to one correspondence. NS is a discrete event simulator.

4.1.1 NS (NETWORK SIMULATOR) BASICS:

The ns simulation starts with the command- "set ns [new Simulator]". This is the first line in the TCL script. This command instantiates a new class. It provides the use of TCL script to form trace file and NAM (network animation) file to record behavior and back-end logic for the nodes declared in the simulation. NS is an object-oriented simulator, written in C++, with an OTCL interpreter as a frontend.

4.1.2 TCL (TOOL COMMAND LANGUAGE):

The TCL is a language with simple syntax and allows integration easily with different languages. It has advantages of fast development, graphic interface, compatibility, flexibility, ease of use, etc. The variables used in TCL are not typed i.e., we need not specify what type of variables are used in the program with the help of values. The 'set' command is used to assign values and give filenames. Variables are manipulated using '$' and commented lines are written using '#'. Functions are invoked using the "proc" command. To declare a new class, the reserve word "class" is used. The word, 'super class's is used to show inheritance class TCL Object is the base class for most of the other classes in the interpreted and compiled hierarchies. Every object in the class TCL Object is created by the user from within the interpreter. An equivalent shadow object is created in the compiled hierarchy. The two objects are closely associated with each other.

4.1.3 TR (TRACE FILE)

Trace file is used to trace all the simulation from Network Simulator. There are numbers of columns in the trace file these columns are for different parameters like column 1 for event, column 2 for time, column 3 for node id, column 4 for level, column 5 for flag, column 6 for flow id, column 7 for packet type, column 8 for packet size, column 9 for MAC information, column 10 for ip information of nodes in communication.

4.1.4 AWK LANGUAGE SOURCE CODE FILE

Using this file we can search particular parameter from a trace file and generate parameter which we requested.

4.1.5 NAM (NETWORK ANIMATION)

This file is used to generating the animation of the network in NS2. Using this file we can know the nodes movement and also we can see the movement of information between different nodes of the network.

4.2 MAC PROTOCOL IMPLEMENTATION RESULTS

4.2.1 MAC/802.11

Table 2 Throughput of MAC

NODE	MAC	TDMA
25	96.5	63.35
50	97.57	32.82
75	97.43	32.39
100	94.30	30.21

Table 3 Goodput of MAC/802.11

NODE	MAC	TDMA
25	92.87	60.97
50	93.91	31.59
75	93.77	31.18
100	90.75	28.88

Table 4 Throughput (Kbps)

NODE	MAC-CSMA	MAC-TDMA
25	64.48	52.56
50	61.78	49.86
75	56.57	43.59
100	46.61	38.72

Table 5 PDR (%)

NODE	MAC-CSMA	MAC-TDMA
25	62.05	49.89
50	59.46	47.45
75	54.44	42.32
100	44.85	35.78

V. CONCLUSION:

From study of MAC, conclude that media access through sensor node using TDMA and CSMA technique of MAC. In a previous work only modify sleep and awake condition of MAC-CSMA but in MOD-MAC use energy parameters before sent data packet. Based on this energy value, decide criticality of node. Also check data rate and location information of each node participate in communication. Here we compare MAC-CSMA and MAC-TDMA protocol using NS2 tool and conclude that MAC-CSMA perform better compare to TDMA. MOD-MAC will improve performance of MAC-CSMA. Using above mention approach MOD-MAC will improve energy consumption, delay and throughput of network using NS2 tool.

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