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Implementation and Verification of low Latency and Low Power MAC Protocol for Wireless Sensor Networks

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ABSTRACT: *In wireless sensor network (WSNs), the strategies of periodical sleep and contention to use the channel for transmission are efficient in term of packet delivery ratio and channel utilization. However the overhearing of the control packets and increased transmission latency. In this paper, we propose to use transmission pipelining method to reduce transmission delay. In the implementation of node grouping, there are several groups in a WSN, where nodes in different group wake up at different times. Each sensor node initially set to packet during the groups. In contrast to the situation in which all nodes hear the control packets during the contention period, node grouping, reduce the number of nodes that overhears the control packets at the same time to reduce power consumption, To establish communication between nodes belongings to different groups, we assign a group table to each node. The group table in a sensor node, a sender can wake up at group time of the receiver. As a result, two nodes belonging to different groups can communicate with each other.*

With regard to transmission delay of a multi-hop path in WSNs, if a sender transmits data to the receiver and the receiver cannot send the data to the next receiver right now, the transmission delay increase. To reduce the transmission delay, we propose the transmission pipelining method. Transmission pipelining makes the group number of the nodes on a path to be continuous. Therefore, the sensor node is thus able to transmit data to the sink node pipelining. From the simulation results, the power consumed in transmitted a byte (mJ/byte) and the transmission delay,bandwidth,throughput, in our proposed design are better than those of SMAC ..

Keywords: *Wireless sensor networks (WSNs),MAC, Low power, Transmission delay, Latency.*

I. INTRODUCTON

A wireless sensor network consists of a mass of sensor nodes that detect data and relay the detected data to the sink node using the multi-hop wireless transmission. The application of a wireless sensor network[2] can be used in monitoring disaster areas, monitoring patients, assisting disable patients, helping the military and so on. Because a sensor network comprises a large number of sensor nodes that are equipped with batteries, the sensor nodes should have the characteristics of low, hardware cost, low power consumption, small rapid deployment, and self-organization.

In wsns, power consumption in MAC protocols[3] are as follows:

- **Collisions:** when a node receiver transmission signal from two or more nodes at the same time, collision occur. When collisions occur, the sender has to retransmit the packet the packet again, resulting in more power consumption.
- **Overhearing packets:** in traditional wireless network, nodes listen to all transmission from their neighbors, even when the packets are not sent to them.
- **Control packet transmission:** A message n network will be divided into several fragments, and there will be an RTS/CTS/DATA/ACK[8] handshaking process for each fragment of that message, which result n control message overhead and higher retransmission penalty.
- **Idle listening:** idle listening occur when a node keeps listening on the channels in order possible traffic that is not sent. Measurement have shown that ideal listening consumes 50-100% of the energy required for receiving.

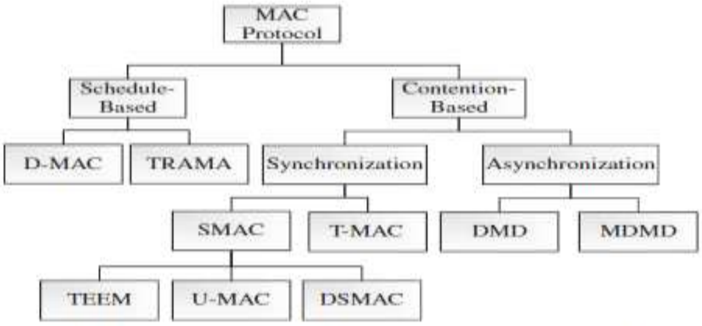

Fig. 1. Classification of MAC protocols in wireless sensor networks.

II. EXISTING SYSTEM

2.1 S-MAC:

In this section, we introduce previous studies on power-aware MAC protocols and low power MAC protocols[3]. In power-aware MAC protocols design, sensor MAC(SMAC) makes all sensor nodes sleep and contend with each other periodically to reduce the power consumed from overhearing data transmission and ideal listening, as shown in below figure.1

In the SMAC protocol[16], all nodes keep listening during the listening period. During this period, a node can send a RTS[8] packet to contend for the channel. At the end of the listening period, all nodes, except the sender and the receiver nodes, change their status to the sleep mode to save power. At the same time, the sender transmits data to the receiver.

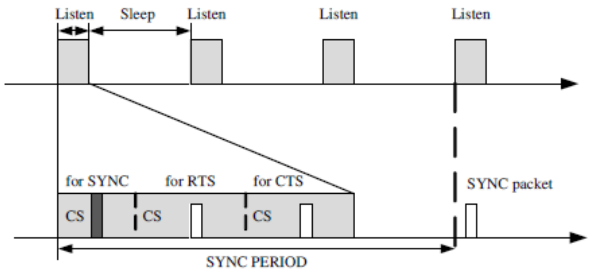

Fig.2: A period sleep schedule and frame structure in SMAC

S-MAC suffers the problems[16]:

- Overhearing
- Idle listening
- Decreases efficiency

II. PROPOSED SYSTEM

In order to solve the problem of power consumption and transmission delay in contention-based MAC protocol, in this paper, we present a new protocol called **GroupMac** (**GMAC**). GMAC[1] uses the grouping method to reduce the number of nodes that overhear control packets in the contention period to save power. However, the proposed grouping method causes the problem of nodes in different groups not being able to communicate with each other. In order to enable nodes in different groups to communicate with each other, GMAC makes each nodes keep a node keep a group table of neighboring node. Therefore, when a node (a sender) would like to send data to a neighbor (a receiver) belonging to a different group number of the receiver and wake up at the group time of that neighbor. As a result, the sender can send data to the receiver in the group time of the receiver.

With regard to transmission delay[1] in WSNs, data transmission using multiple-hobs often takes place. However, when a sender transmits dad to the receiver and the receiver cannot immediately send the data to the next receiver, transmission delay increases[10]. To reduce the transmission delay, we propose using transmission pipelining to make the group number of the nodes on the path continuous. As a result, the data in the can be transmitted to the sink using pipeline behavior to reduce the transmission delay.

3.1 Node Grouping

In contention-based MAC protocol, all nodes have to awake in the contention period to sense the control signals[1]. However, at the end of the contention period, at most only one pair of nodes can communicate with each other while the other nodes consume power for overhearing and ideal listening

We propose the grouping[15] method to reduce power consumption during the contention period. We randomly set the sensor nodes into different group, as shown in fig 3(a). Each group has a different group period (contention period plus transmission periods), and there is no overlap in time among the different group periods, as shown in fig 3(b). As a result, when a group is in the active mode, other groups can be in the sleep mode to save power[12].

The power consumed by the overhearing of control signal can be efficiently reduced when the grouping method is used and the probability of using the channel is the same as that in the case when the grouping method is not used. However, there is a problem of how nodes in different groups communicate with each other. In the next section, we propose a method to solve this problem.

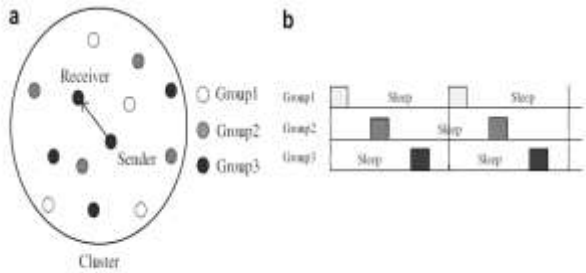

Fig.3: (a) distribution of nodes from three groups in a cluster.
(b) schedules of three groups in the node grouping method in GMAC

3.2 Group Table and Group Frame Structure

In this section, we present the method of using a group table in a node to enable nodes in different groups to communicate with each other. In addition, we also show the structure of group frame, including the group contentions period and the group sleep period[10]. To enable the node in different groups communicate with each other, each node has a group table that records the group number of the one-hop neighboring nodes. When a node (a sender) would like to transmit data to a neighboring node (a receiver), it looks up its group table to obtain the group number of the receiver. The sender than remains in the awaken state in the receiver's contention period to contend for using the channel. After the sender completes its data transmission and has no more data to transmit, the sender remains in the awaken state only in its own group contention period. With group table, nodes in different groups communicate with each other.

With regard to the structure of a group frame, the group contention period (TRTS and TCTS)[7][8], data transmission period, data transmission acknowledgement period (TACK), and group sleep period (Tsleep) comprise a group period (Tgroup) as shown in equation. In addition, the nodes in the same group wake up at the same group time, and there is no overlap in time between different groups, thus avoiding collisions. An example is shown in fig. where there are three groups in the network, and the group periods of different groups do not overlap:

T_{group} =TRTS + TCTS + TDATA + TACK + Tsleep … (i)

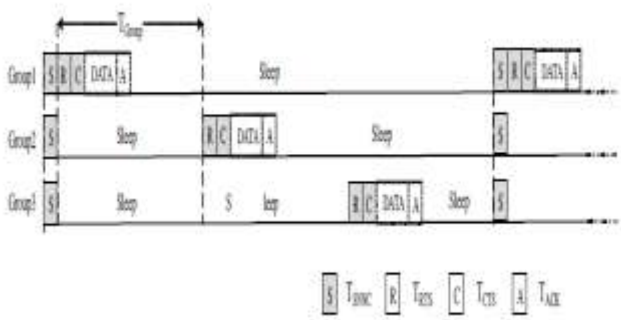

Fig.4: frame structure of three group

3.3 Transmission pipelining:

In this section, we present the transmission pipelining method to reduce the transmission delay[1] in our proposed node grouping method with the sleep mechanism, the duty cycle and the number of nodes in a group that contends for a channel can be reduced to save power. However, using the node grouping method may increase the transmission delay when the group numbers of the nodes on the path from the source to the sink are not sequential. We assume that there are three groups. The source node is node A and the sink node is node B. The intermediate nodes are B, C and D. When node A wants to transmit data to node B, node A will be in the awake state to content for the channel in the listen period of group 3, to which node B belongs. After node A transmits data to node B, node B would like to send the data to node C .However, node C belongs to group 2, so node B has to wait for the time of group 2 to content for the channel; that is ,node B has to wait for the group period time of group 1.This situation increases transmission delay. When the number of groups increases transmission delay increases. To solve this problem transmission pipelining method that the nodes on the path are able to be in the awaken state for one extra listening period such that the data can be transmitted with pipelining behaviour to reduce the transmission delay.

III. SIMULATION PROCEDURE

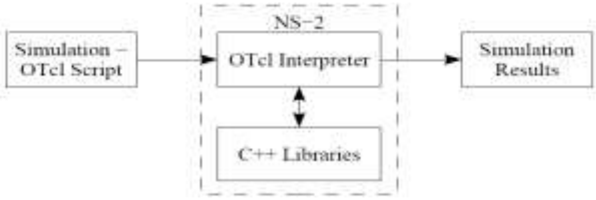

Fig.5 ns2 Block diagram

the proposed approach can be incorporated in to tcl scripting and then executing by using ns2 and verify the results as shown in fig.5

IV. SIMULATION RESULTS

In this section, we describe our simulation methods and the results. The C++ program language is used to simulate the SMAC and Group MAC (GMAC)[1] protocols. In our simulation, and 50 sensor nodes are generated in a 1000 * 1000 m2 area. The transmission range of a node is 140 m. Thus, a sensor node has 20 one-hop neighboring nodes on average. With regard to the routing method, the AODV routing protocol is used. we used ns2(network Simulator2)for results.

5.1 Simulation of Transmission Delay

In this section, we present the simulation results of the transmission delay in SMAC & GMAC. The transmission delay is evaluated by a path with 11 nodes (10 hops) where the contention and the collisions are considered. In addition, we also testing the factors that influence the transmission delay in terms of the network traffic, the sleep mechanism, and the number of groups in GMAC. Finally, the pipelining packet transmission method is also simulated in GMAC to show the reduction in transmission delay. the sleep mechanism may result in an increase in transmission delay. Compared to SMAC[14], GMAC shows better transmission delay than SMAC as shown in fig5.

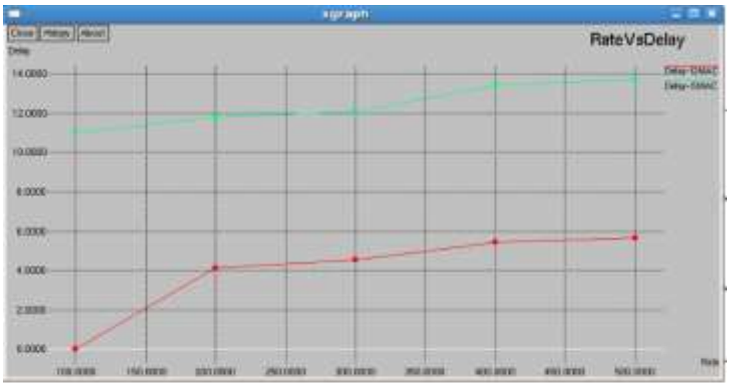

Fig5. Rate vs Delay

5.2 Simulation of Packet Delivery ratio(PDR):

In this section, we evaluate the Packet Delivery ratio in SMAC,and GMAC[16][1]where the PDR is measured by calculating the number of successful packets that is delivered to sink. The PDR of these protocols is shown and compared in Fig.6. GMAC has better throughput than the others because GMAC uses the grouping method to reduce the number of collisions in the contention period.

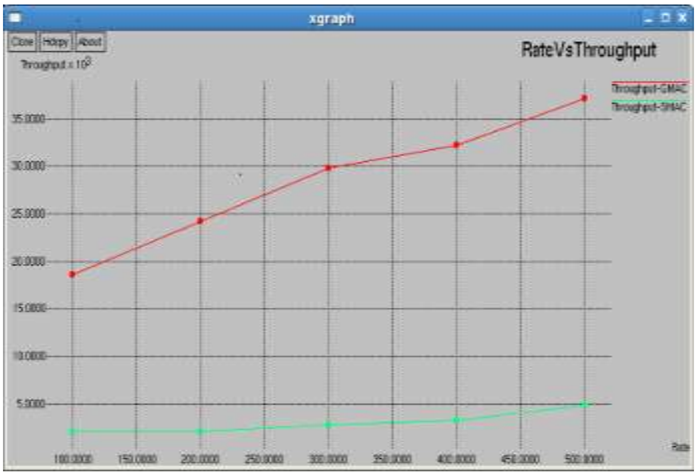

Fig6. Rate vs Delivery ratio

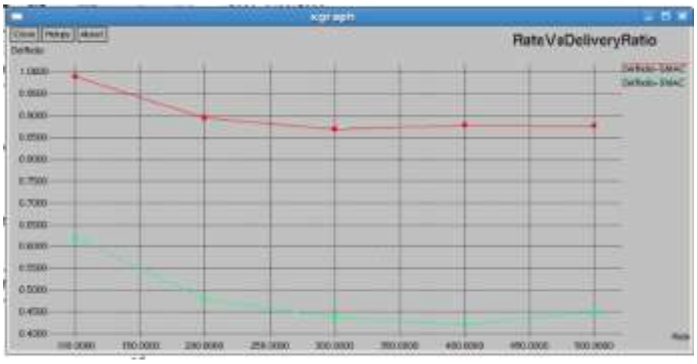

Fig7. Rate vs Throughput

5.3 Simulation ofThrogutput:

In this section ,we present the simulation results of the Throughput improvement in GMAC than SMAC as shown in fig7.

5.4 Simulation of Bandwidth

In this section, we present the simulation results of the transmission delay in SMAC & GMAC. Compared to SMAC, GMAC shows better bandwidth improvement for effective channel utilization as shown in fig.8

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Fig8. Rate vs Bandwidth

5.5 Simulation of Energy Consumption:

Fig9. Rate vs Energy Consumption

In this section ,we present the simulation results of the energy consumption of SMAC &GMAC, here GMAC shows better improvement of energy consumption as shown in fig.9

V. CONCLUSION

In this paper, we presented a MAC protocol called GMAC over SMAC that has the advantages of more packet delivery ratio, improved throughput, reduced Energy consumption and achieved low transmission delay and more band width. In the GMAC protocol, node grouping and transmission pipelining methods were proposed.This paper is being simulated and solutions are realized in Ns-2(Network Simulator) to prove assumptions considered in current work. Ns-2 is an object-oriented event-driven simulator with extensive support for simulation of MAC protocol

REFERENCES

[1]. Ching-wen chen, chuan-chi weng,chang-jung ku,Design of low power and low latency MAC protocol with node grouping and transmission pipelining in wireless sensor networks. Computer communications 31(2008)3725-3738

[2]. I.F.Akylidiz,W.Su,Y.Sankarasubramaniam,E.C ayirci,"A survey on sensor networks: a survey", IEEE personal communication magazine(2002)

[3]. C.Esroy, L.Demirkol, F.Alagoz, MAC protocols for wireless sensor networks., IEEE communication magazine(2006)

[4]. Z.Chen,A.Khokhar,TDMA based energy efficient MAC protocol for wireless sensor networks, in: IEEE SECON 2004,October 2004

[5]. W.R.Heinemann,AChandrakasan, H.B.Balarishnan,Energy-efficient communication protocols for wireless micro sensor networks,in:Proceedings of the Hawaii InternationalConferenceonSystems Sciences,January 2000.

[6]. G. Lu, B. Krishnamachari, C.S. Raghavendra, An adaptive energy-efficient and low -latency MAC for data gathering in sensor networks, in: Proceedings of 18th International Parallel and Distributed Processing Symposium, April 2004,pp. 224–231.

[7]. V. Rajendran, K. Obraczka, J.J. Garcia-Lua- Aceves, Energy-Efficient, Collision- Free Medium Access Control for Wireless Sensor Networks, in: Proceedings of the First ACM Conference on EmbeddedNetworkedSensor Systems(Sensys'03), November 2003.

[8]. Z. Chen, A. Khokhar, TDMA based energy efficient MAC protocols for wireless sensor networks, in:IEEE CON 2004, October 2004.

[9]. M. Stemm, R.H. Katz, Measuring and reducing energy consumption of network interfaces in hand-held devices, IEICE Transactions E80-B (1997) 1125–1131.

[10]. Kasten,Energyconsumption,Eldgenossische TechnischeHochschuleZurich,ASHTransceiver TR3000 Data Sheet [Online],Available: http://www.rfm.com/.

[11]. V. Shah Mansouri, M. Ghannad Rezaie, Dynamic scheduling MAC protocol for large scale sensor networks, in: Proceedings of the Mobile Ad-hoc and Sensor Systems Conference,2005.

[12]. K. Sohrabi, Protocols for self-organization of a wireless sensor network, in: Proceedings of the IEEE Personal Communications, October 2000

[13]. S.-H. Yang, H.-W. Tseng, E.H.-K. Wu, G.-H. Chen, Utilization based duty cycle tuning MAC protocol for wireless sensor networks, in: Proceedings of the IEEE Global Telecommunications Conference, 2005.

[14]. Suh, Y.-B. Ko, A traffic aware, energy efficient MAC protocol for wireless sensor networks, in: Proceedings of the IEEE International Symposium on Circuits and Systems, 2005.

[15]. T. van Dam, K. Langendoen, An adaptive energy efficient MAC protocol for wireless sensor networks, in: Proceedings of the First ACM Conference on Embedded Networked Sensor Systems, November 2003, pp. 171–180.

[16]. H. Pham, S. Jha, An adaptive mobility-aware MAC protocol for sensor networks (MS-MAC), in: Proceedings of the First IEEE International Conference on Mobile Ad-hoc and Sensor Systems, October 2004.

[17]. V. Shah Mansouri, M. Ghannad Rezaie, Modified distributed mediation device for low power consumption in large scale sensor network, in: Proceedings of the International Conference on IntelligentSensing and Information Processing, 2005, vol. 1, India, January 4–7, 2005, pp. 8–13.