AN ENERGY EFFICIENT SYSTEM FOR WIRELESS SENSOR NETWORKS

Dr.M.Paul Danie[l], Dr.P.Sreenivasulu[2],Dr Seelam Koteswararao[3],Daggubati Sunil[4]

Professor, Mechanical Engineering, Narayana Engineering College, Gudur,
daniel.matcha7@gmail.com[1]
Professor in ME department, Gokula Krishna college of Engineering, Sulluripeta
sreenupothula@gmail.com[2]
Professor, Dept of ECE, Kallam haranathreddy of Institute Technology, Chowdavaram,
drkrseelam@gmail.com[3]
Assistant professor, Mechanical Engineering, Narayana Engineering College
sunildaggubati43@gmail.com[4]

ABSTRACT:

This paper describe a unique method for energy-aware management of sensor networks, one that extends the useful lifetime of sensors while keeping in place all the desirable quality-of-service qualities associated with the delivery of sensed data. This paper also uses dynamic route setting and medium access arbitration to reduce sensor burnout and prolong battery life. It provides an introduction to dynamic source routing and details a MAC based on time division multiple access (TDMA). As a result, the proposed APCRP-MAC Protocol increases the longevity of sensor networks while decreasing their power requirements.Our extensive results in the Network Simulator (NS2) demonstrate that the new clustering and routing algorithms scale effectively and converge quickly for large-scale dynamic sensors.

Keywords: APCRP, TDMA, MAC, Energy Aware, NS-2.

I. INTRODUCTION

WSNs are constructed by hundreds or thousands of nodes that act as sensors and relay data to a central hub, or "sink," node. Sensor networks differ from more conventional wireless networks in that they are extremely limited in terms of power, compute, and memory [1].One of the most notable technological developments of the 2010s has been the proliferation of sensor networks. Though the ideas of sensors and actuators, wireless communications, and embedded computers are not novel, the recent, low-cost, large-scale integration of computation, communication, and sensing into "wireless sensor networks" has piqued the interest of many academics. With the help of sensor networks, we can now see the physical world in unprecedented detail. It relies on a huge number of low-cost, low-capacity sensor nodes to form its infrastructure. If you want it to last as long as possible, you need to minimize the amount of energy it consumes. This method may increase the battery life of WSNs used in monitoring applications. The concept has been verified by simulation studies using the Network Simulator (NS-2).

Environment monitoring, defense, smart spaces, scientific applications, medical systems, robotic exploration, target tracking, intrusion detection, wildlife habitat monitoring, climate control, disaster management, etc. are only some of the possible applications of wireless sensor networking. Since batteries are used as the sole energy source for the sensor nodes in wireless sensor networks, energy efficiency is a major concern in this technology [2].There are primarily three energy-intensive processes happening in a sensor node. Sensing, computing, and radio operations are the three in question. The greatest of these three is radio operation energy loss.

Connected sensors: Each node in a sensor network typically carries a battery, a small microprocessor, and a radio transceiver or other wireless communications device in addition to one or more sensors.

Characteristics: Power consumption constraints for nodes employing batteries or energy harvesting capacity to handle node failures are among the most distinguishing features of a WSN. The Node Mobility, Topology Change, and Disruptions in communication, Node heterogeneity, Large-scale deployment scalability, strength to endure adversity in the natural world[3].
Transmission Control Sublayer Layer 2 of the seven-layer Open Systems Interconnection (OSI) model specifies the Media Access Control (MAC), data communication protocol sub-layer, often known as the Medium Access Control. It allows for communication between multiple terminals or nodes in a multi-point network, such as a LAN or MAN, by providing addressing and channel access control techniques. A Medium Access Controller is the piece of hardware responsible for carrying out the MAC protocol. The Media Access Control (MAC) layer is responsible for relaying information between the Logical Link Control (LLC) layer and the physical layer of a network. In a point-to-multipoint network, the MAC layer acts as a full-duplex logical communication channel [7]. This channel has the potential to serve as both a unicast and a multicast medium.

In computing and telecommunications, a communications protocol is a formal explanation of the formats and rules for exchanging digital messages. Power management concerns in MAC protocols inspired the concept of decentralizing protocol development in WSNs.

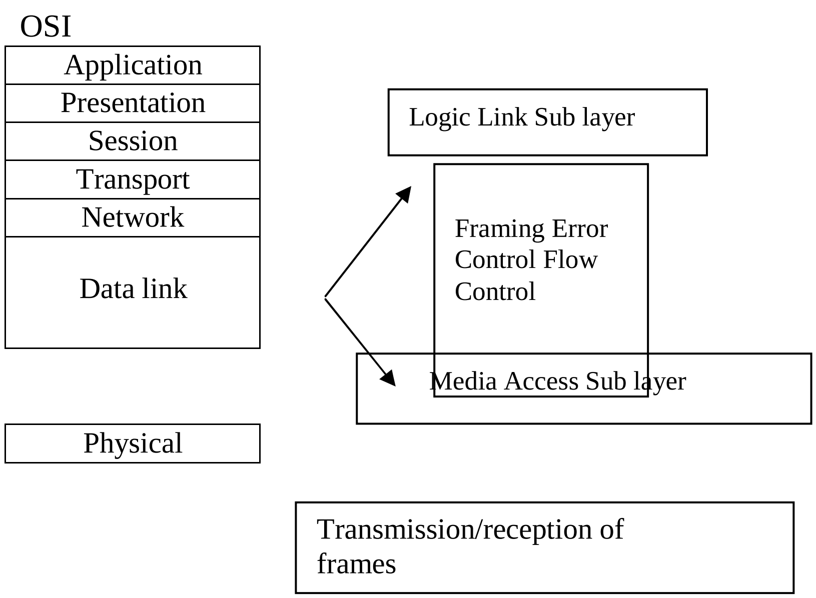


Fig 1.Layers of MAC Layer

II. **Causes of Energy Waste**

Energy Savings: A multi-hop RF network offers significant energy savings over a single-hop network for the same distance due to the particular attenuation properties of Radio Frequency (RF) transmissions. When only RF energy is taken into account, a greater N results in a greater reduction in power consumption. However, this research does not take into account the power consumed by the rest of the RF circuitry[4]. The cost and energy requirements of these supplementary RF components also rise as more nodes are used. In actuality, an optimal design compromises between the two competing criteria in order to maximize both cost effectiveness and energy efficiency [6]. There may be arguments against having too many relay nodes based on latency and robustness.
Collisions, idle listening, overhearing, and control packet overhead are the primary contributors to

power consumption at the MAC layer [8]. When there is any sort of data corruption during transmission, collision is inevitable. Retransmission, caused by collision, raises both delay and power consumption. Idle-listening refers to the practice of monitoring a slack channel for signs of activity. Most energy-efficient protocols, rather than sitting idle, put their network interface into a sleep state [9]. Over-hearing occurs when a node intercepts a transmission intended for another. When more than a certain threshold is reached in the use of control packets, an overhead is incurred. Using a higher total number of control packets has a multiplicative effect on both energy usage and the efficiency with which available bandwidth is exploited. In addition to data packet collision and hidden/exposed terminal issues, carrier sensing is a key source of energy waste. Collision due to random access and the ensuing retransmission: It's preferable to prevent collisions if possible, as retransmission after a collision wastes resources and adds delay. Avoiding collisions between transmitting nodes is a fundamental requirement of any medium access control (MAC) system. Code division multiple access (CDMA), time division multiple access (TDMA), and frequency division multiple access (FDMA) are the simplest methods for collision avoidance in a generic network. However, there are numerous unique challenges that must be met when designing a MAC protocol for mobile ad hoc networks [5]. Idle listening has been proposed as part of energy-aware MAC protocols, which would require nodes to enter sleep mode occasionally. Nodes can be in a state of neither transmit nor receive until they are awakened up from sleep mode into idle mode, at which point they can begin attending trace relay. There is a power savings of more than an order of magnitude when switching to sleep mode from idle. As a result, significant energy savings can be achieved by intelligently entering sleep mode whenever possible. When wireless nodes overhear the transmissions of their neighbors, they use extra power. In a regular broadcast setting, this is a common occurrence. When sending out small packets, it's very important to minimize control and protocol overhead [10]. Small packets incur disproportionately high energy costs because of the considerable channel acquisition overhead. To save power, packets can have their headers compressed to make them shorter. Because the mobile radio uses a lot of power cycling between transmit and receive modes, reducing the header overhead through packet aggregation is a good idea. Reduced control overhead for reservation is possible when mobile nodes request numerous transmission slots in a single reservation message [11]. The low power usage is made possible in part by allocating consecutive transmission or reception slots in order to decrease the turnaround.

III. **TDMA (Time Division Multiple Access)**

The temporal dimension in TDMA systems is segmented into a set number of frames. Time is further segmented inside each frame. A user's transmissions are restricted to their allotted time windows. In this manner, noise from nearby nodes is diminished. When comparing TDMA protocols to random access MAC protocols, the energy savings offered by the former is clear. This is because individual windows of time have been reserved for each user in advance. This means that running into obstacles and the associated costs can be avoided. But compared to a random access strategy, TDMA's scalability is subpar. For TDMA protocols to work in wireless systems like Bluetooth and LEACH, all nodes must cluster together for communication. When nodes are movable, as they are in MANETs, it is more difficult to regulate the communication and interference across clusters. Moreover, TDMA necessitates precise time synchronization between the transmitter and receiver, which is not easy to achieve. When designing something, designers must take into account things like clock shift, propagation delay, and timing differences [12].

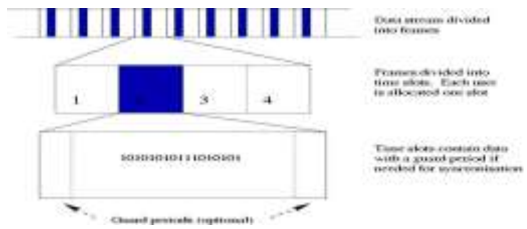


Fig 2.TDMA frame structure

IV. MAC Layer Protocol using TDMA

Even though the new routing protocol doesn't care which MAC layer protocol is used, picking the right one could improve performance. Energy efficiency in a wireless system can be improved by adjusting the medium access protocols. We decided to use a MAC layer based on time division multiple access (TDMA), with slot assignment handled by the gateway. The gateway notifies each node of the time slots it should use to receive transmissions from other nodes and the time slots it can use to send its own [13].The benefits of a TDMA MAC layer include: The TDMA protocol naturally incorporates clock synchronization. Remember that synchronization is required for the gateway to nodes rerouting decision and energy model refresh. Each node operates on its own schedule, reducing the likelihood of a collision [14]. The existence of communication failures might cause issues, such as the dropping of a packet containing the slot assignment. No collision will occur if a node that does not get the gateway decision just stops broadcasting.

RTS/CTS (Request to Send/ Clear to Send):It uses RTS/CTS mechanisms and these signals are transmitted over the control channelwhile the data are transmitted over the data channel. Node with packets to transmit sends a RTSover the control channel and waits for CTS. If no CTS arrive then the node enters aback-off state.

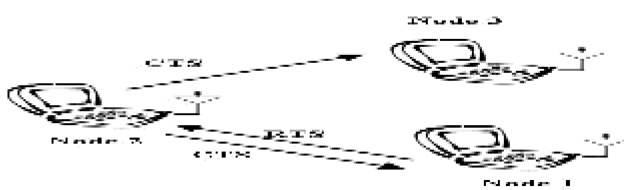


Fig 3.Flow Diagrams of RTS/CTS

However, if CTS is received then the node transmits the data packets over the data channel. The receiving node transmits a “busy tone” over the control channel for others to determine that the data channel is busy. The use of control channel allows nodes to determine when and how long to power off. If a node has no packets to transmit, that node ought to poweritself off.

Proposed Solution: Wireless medium is inherently broadcast in nature. When a node transmits data then multiple nodes (which are its neighbors) can receive the data. This paper aims at exploiting the broadcast nature of wireless medium and communication cost to reduce the energy consumption in the network. When a node detects an event, it knows whether any of its neighbors have already reported the same event or not. If reported then it refrains itself from reporting. So the number of packets sends to report the event reduces and hence energyconsumption in sensor nodes is also reduced. When an event is detected by a sensor node, it waits for a time period before reporting the event to the sink. This wait time depends on the following factors

- The intensity of the event detected
- Residual energy of the node
- Communication cost to the nearest neighbor on the route to sink

If the node can overhears more than N nodes reporting the same event during this wait time period, it abandons the attempt to report the event. Given for each of the above factors depending on whether it is more interested in precision of data or in reducing the energy consumption. This is only a broad outline of the solution and details of implementation of this scheme are yet to be worked out.

We have considered the industrial wireless sensor environment which consists of multiple source nodes and single sink node. The model is design for multi-hop and one hop situation. The simulation area is considered as 2500 meters by 1000 meters. The all other parameters which are considered formulation areas had shown in table no 1 and table no2.

Table 1.Simulation Parameters

Channel Type	Wireless Channel
Radio Propagation Model	Two Ray Ground
Antenna Model	Omni Antenna
Network Interface Type	Wireless Physical
MAC Type	802.11
Routing Type	APCRP
Interface Queue Type	PriQueue/CMU PriQueue
Buffer Size of IFq	50

Table 2.Node Configuration Parameters

Simulation area	250m*100m
Model	Energy
Initial Energy	100J
Transmitting Power	0.6mw
Receiving Power	0.9 mw
Transmission Range	250m

V. Simulation Results : The NS-2 software is used for the simulation.

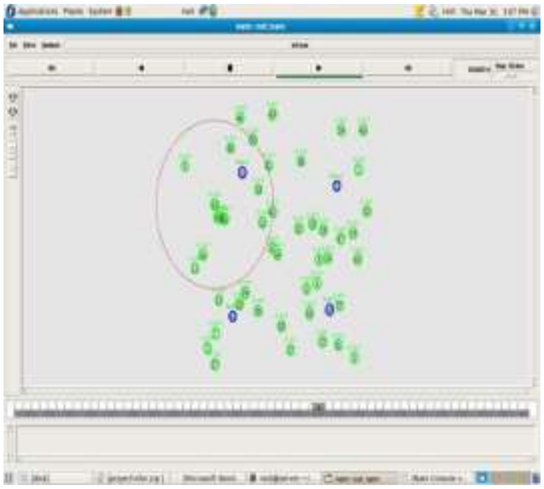


Fig 4.NAM output

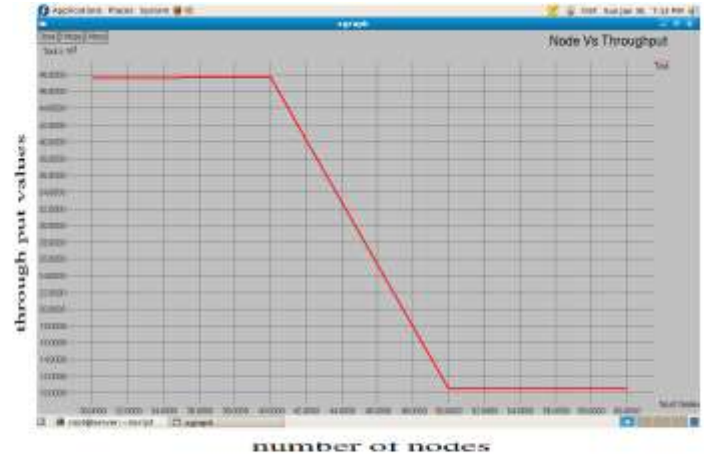
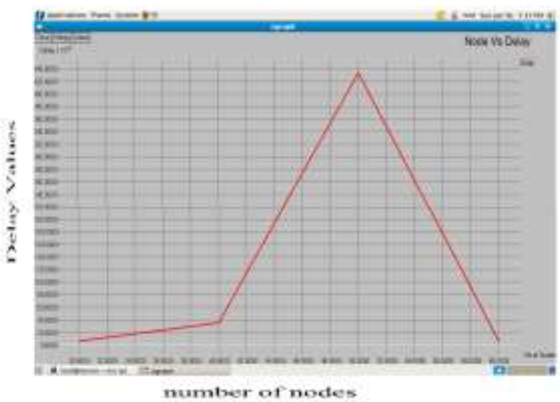
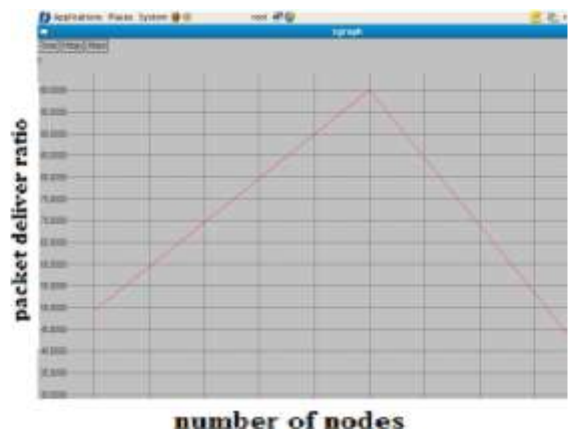


Fig 5.Node Vs Throughput





.

Fig 6 .No.of Nodes Vs Delay Values

Fig 7 .No.of Nodes Vs PDR

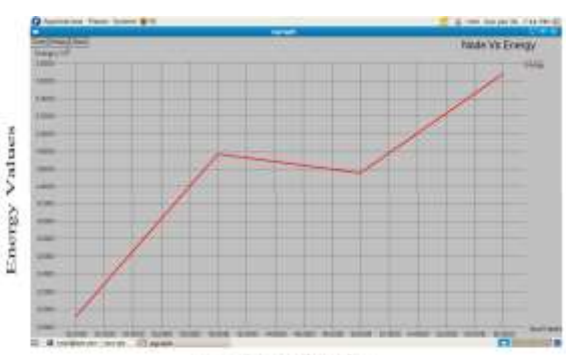


Fig 8 .No. of Nodes Vs Energy Values

VI. **Conclusion**

The APCRP protocol decreases power consumption and increases reliability while minimizing the number of route request packets sent and received. It also increases the packet delivery ratio and decreases end-to-end delays for data packets. hypotheses explored in the current work, Ns-2 (Network Simulator) simulations and corresponding solution implementations are being carried out. The MAC protocol can be simulated in great detail using Ns-2, an object-oriented event-driven simulator.

VII. **References**

1. F. Akyildiz, W. Su, et al, "A survey on sensor networks", Communications Magazine, IEEE, vol. 40,no. 8, pp.102- 114, 2002.
2. R. S. Chang, C. J. Kuo, "An Energy Efficient Routing Mechanism for Wireless Sensor Networks," Proceedings of the 20th International Conference on Advanced Information Networking and Applications, Vienna, Austria, pp.308-312, 2006.
3. W.Ye,J. Jeidemann,D. Estrin, An energy-efficient MAC protocol for wireless sensor networks,in:Proceedings of the IEEE INFOCOM ,2002.
4. P. Chen, B. O'Dea, and E. Callaway, "Energy efficient system design with optimum transmission range for wireless ad hoc networks," in Proc. IEEE ICC, 2002, pp. 945–952.
5. J. L. Gao, "Analysis of energy consumption for ad hoc wireless sensor networks using a bit-meter-per-joule metric," IPN Progress Report 42-150, August 2002.
6. R. Madan and S. Lall, "Distributed algorithms for maximum lifetime routing in wireless sensornetworks," IEEE Trans. Wireless Commun., vol. 5, no. 8, pp. 2185-2193, Aug. 2006.
7. Manish Kumar jha, Atul kumar pandey, Dipankar pal, "Energy–efficient multi-layer MAC (ML-MAC) protocol for wireless sensor networks" Int.J.Electron.Commun.209-216.
8. Wireless Sensor Networks: An information processing approach-feng zhao, leonidas guibas, ISBN:978-1-55860-914- @2004 by Elsevier Inc.
9. Tijs van Dam and Koen Langendeon "An Adaptive Energy Efficient MAC Protocol for Wireless Sensor Networks" , ACM-Proceedings of the 1st international conference on Embedded networked sensor systems,2003.
10. ECCRA: An energy-efficient coverage and connectivity preserving routing algorithm under border effects in wireless sensor networks; Yan Jin , Ju-Yeon Jo , Ling Wang , Yoohwan Kim , Xiaozong Yang,Computer Communications 31 (2008) 2398–2407
11. An energy-efficient, transport,-controlled MAC protocol for wireless sensor networks; Jaesub Kim *,Kyu Ho Park, computer Networks53(2009) 1879-1902 .
12. W. Wang, H. Wang, D. Peng, H. Sharif, An energy efficient pre schedule scheme for hybrid CSMA/TDMA MAC in wireless sensor networks, in: Proceedings of 10th IEEE Singapore International Conference on Communication Systems, 2006, pp. 1–5.
13. J. van Greunen and J. Rabaey. Lightweight Time Synchronization for Sensor Networks. In *Proc.2nd ACM Intl. Workshop on Wireless Sensor Networks and Applications (WSNA)*, San Diego, CA, September2003.
14. An adaptive CSMA/TDMA hybrid MAC for energy and throughput improvement of wireless sensor networks Mohammad Hossein Sedighi Gilani, Iman Sarrafi, Maghsoud Abbaspour (2011), doi:10.1016/j.adhoc.2011.01.005.