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A Review on Energy Efficient Resource Allocation in Wireless Sensor Networks

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Abstract: Wireless Sensor Network (WSN) is a most important technique in 21st century in which sensing, processing and communication are the three key elements whose combination in one tiny device generally called nodes which integrate with sensors, processors and Tran receivers with limited energy resources. Nodes are generally depends on small low capacity battery for energy source which are not replaced and repowered after ones deployed. So, energy efficiency plays a vital role in the design of WSN network for implementation and used of application in real world. Therefore an efficient energy resource allocation should be needed very much. This paper discuss about the various energy efficient resource allocation technique in wireless sensor network which prolong the network lifetime, minimized energy consumption and maximized the resource utilization.

Keywords: Wireless Sensor Network, Nodes, Battery power, Energy Efficiency, Network lifetime.

I. INTRODUCTION

The design of Wireless Sensor Networks (WSN) was inspired by military applications like surveillance in war zones. Today WSNs consist of distributed independent devices that use sensors to monitor the physical conditions, movement and temperature as well as sound. It has a global objective in today's real world. The nodes in wireless sensor network are miniature devices each of which carries microprocessor (with an energy efficient operating system), one or more sensors (e.g. light, acoustic) or(chemical sensors), a low power and low bit rate digital radio transceiver and also a small battery. Each sensor in WSN monitors its environment and the objective of this network is to deliver some global information or an inference about the environment to an operator who could be located at the periphery of the network or they could be remotely connected to the sensor network. An example is the deployment of such a network in the border areas of a country to monitor intrusions, to equip a large building with a sensor network comprising devices with strain sensors in order to monitor the building's structural integrity after an earthquake and also the use of sensor networks in monitoring and control systems such as those for the environment of an office building or a large chemical factory.
Wireless sensor network (WSN), also known as Ubiquitous Sensor Networks (USN), is identified as one of the 21 most important technologies for the 21st century by Business Week (1999) and one of 10 emerging technologies that will change the world by MIT Technology Review (2003). Eventually, it is felt by most of the research community that it will pervade into daily life like the cell phone technology. WSNs may either connect to the rest of the world through the cellular network or through the wired internet. In any type of technique WSN impact on the traditional networks is likely to be transformative, simply by taking into account the amount of data that will enter or leave as machines talk to enterprises and other machines. WSNs have a major role to play in cyber-physical systems, pervasive computing, Body Networks and Internet of Things. In recent years WSNs are beginning to be deployed at an accelerated pace and is expected that the world will be covered with wireless sensor networks with access to them via the Internet. Mobile wireless sensor networks (MWSNs) are a particular class of WSNs in which mobility plays a key role in the execution of the application in real world. This new MWSN technology is exciting with unlimited potential for numerous application areas including environment, medicine, military, crisis management, transportation, homeland defense, entertainment and smart spaces.
Wireless communications consume significant amounts of battery power i.e energy and that's why energy efficient operations are critical to enhance the life of such networks and also some amount of power is lost even when a node is in idle mode. A recent study shows that the more power will consumed in transmitting and receiving data or packet in standard Wave LAN cards range from 800 mW to 1200 mW. Therefore during the last few years, there has been increasing interest in the design of energy efficient protocols for wireless sensor networks. Most mobile nodes in a wireless sensor network are powered by energy limited batteries; the limited battery lifetime is a hindrance to network performance. Thus energy efficiency is of vital importance in the design of protocols for the applications in WSN and efficient operations are critical to enhance the network lifetime for better used. Since the Nodes in WSN are generally battery-powered; thus energy is a precious resource, that has to be carefully used by the nodes in order to avoid an early termination of their activity, and hence the study and implementation of energy-efficient algorithms for wireless sensor networks, quite constitutes a vast area of research in the field of WSN.

The remainder of this paper is organized as follows: Section 2 gives a literature survey of all existing energy resource allocation technique in WSN. Section 3 compares the different technique used for efficient energy resource allocation of wireless sensor networks. And finally section 4 concludes the paper.

II. LITERATURE SURVEY

Author Jing-hui Zhong et al [3] was proposed a novel local wake-up scheduling (LWS) strategy to prolong the network lifetime with full coverage constraint. Based on the LWS strategy, author presents an mc-ACO method based on ant colony optimization, for to maximize the network lifetime. The LWS strategy divides sensors into a first layer set and a successor set. Sensors of the first layer set are activated when the network starts working, while other sensors are scheduled into sleep mode to conserve energy. Once an active sensor runs out of energy then some sensors in the successor set will be activated to satisfy the network requirements where as other sensors remain in active mode. In the proposed mc-ACO technique two different construction graphs are designed to guide the search. The first construction graph is with pheromone trails deposited on vertexes used for finding a first layer set. On the other hand the second construction graph also with pheromone trails deposited on edges, used for finding successor cover sets.

The advantage of this method is that it can completely utilize the residual energy of sensors even when sensors have different lifetime. And also it does not require the sensors changing working mode frequently. The network connectivity constraints and the routing strategy is an issue in this technique.

Author Bo Jiang et al. [6] is proposed sleep scheduling algorithm called SSMTT to support multiple target tracking sensor networks. When a node wakes up, it changes its sleep pattern according to the scheduled result and then sets the wakeup timer for the subsequent wake-up. On this active period, it may detect a target or receive an alarm message and corresponding interrupt handlers for them will be released for execution.

SSMTT can achieve better energy efficiency and suffer less performance loss than single target tracking algorithms. In this technique future work include further enhancement in energy efficiency on the alarm message transmission with collaboration among the sub areas of multiple targets and discuss the energy efficiency given specific tracking performance requirements.

Author Ye et al. [9] proposed Sensor-MAC (S-MAC), a contention-based protocol that divides time into large frames and each frame consists of two parts first is active part and second one is sleeping part. The node turns ON its radio and can communicate with its neighbors during the active part as well as send messages queued during the sleeping mode. On the other hand a node turns OFF its radio during the sleeping part and cannot immediately communicate with its neighbors. In S-MAC the neighboring nodes form virtual clusters so as to set up a common sleep schedule.

It is noted that two neighboring nodes in two different virtual clusters wake up during the listening periods of both clusters. The implications of S-MAC are that throughput is reduced because of the active part of the frame is used for communication and latency is increased as a message-driven event could occur during the sleeping period. Besides, there is other possibility in which that neighboring nodes in two virtual clusters follow two different wake-up and sleep schedules which resulting in more energy consumption.

Author Dam and Langendoen [11] proposed Time-Out MAC (T-MAC) protocol to improve the weak results of S-MAC during variable traffic densities. In sensor networks variable loads are expected since the nodes which are closer to the sink must relay more traffic and traffic may change over time. If any communication does not occur during a particular period of listening time i.e., timeout interval (TA) in T-MAC then the node goes into sleeping mode. When upon waking up there is no activation event before expiration of threshold set for time-out then an active period ends. T-MAC is more flexible and energy efficient than S-MAC.

Author V. Rajendran et al. [12] Proposed a Traffic Adaptive Medium Access Protocol (TRAMA) is an example of scheduling protocol and its a TDMA-based protocol which increase the utilization of classical TDMA in an energy efficient manner. In TRAMA, contention-free “scheduled access” and contention-based “random-access” are performed alternatively. The data transmissions take place in the scheduled access slot and neighbor information exchange is performed in a random access slot. The radio turns ON periodically in low power listening technique. This approach works at the physical layer based on the PHY Header.

The receiver of upcoming messages intimates with the header. The receiver periodically turns radio ON to sample for the incoming messages, ones if the preamble is detected, it continues listening for the normal message transfer if not then it turns OFF radio till next sample. By this fact more than one sender may want to send packets to a receiver at the same time, such nodes need to contend for the transmission medium to avoid collision. The main advantage of TRAMA over S-MAC is the improvement in channel utilization and less traffic overload but there is a trade-off in longer delay and higher energy consumption.

Author Abayomi M. Ajofoyinbo et.al [14] proposed a novel PDV-MAC protocol based on duration value in transmitted packets of the sender. The duration value was randomized that means using no repeating randomly generated integer values corresponding to the number of neighboring nodes of the receiver. The random values which are obtain by randomized duration values used to broadcast to the neighboring nodes of the receiver. By implication, this forces on ordered sleep or wake-up schedule on the neighboring nodes of the receiver as nodes wake up at different times when their Network Allocation Variable (NAV) values becomes zero.

It forces an ordered sleep or wake-up time on nodes and forces ordered access to the receiving node; thereby eliminating collision. Ones completed ongoing transmission; a neighboring node with NAV of value zero and with data to transmit may exchange Request to Send (RTS) and Clear to Send (CTS) with the receiver, and commence transmission. As long as a node is receiving, all neighboring nodes continue to sleep (or remain in idle mode) and then will wake up at different times. This eliminates the idle listening. The implication of all this things is show that collision and idle listening are eliminated and the proposed PDVMAC protocol can indeed be implemented to improve energy efficiency in wireless sensor networks.

Author Muhammad Asghar Khan et.al [16] introduce a new topology control algorithm which is “Color Based Topology Control Algorithm” for reducing the numbers of neighbor nodes and numbers of links between sensor nodes. An identifier that is “color flag” is used inside the code area of the sensor node and denotes the color of that node. Different five color flags are used i.e. blue, red, white, black, and green. All the sensors nodes are sensitive for some particular application, i.e. temperature ,humidity or pressure etc. A communication is done between those nodes that sense the same color flag of another node in its coverage area. The topology control is supposed to be used in two scenarios one is Uniform Deployment and other is Random Deployment of nodes.

By using CBTC algorithm energy can be conserved. Time, energy and no. of packets the CBTC is better. And also the problem of coverage hole is resolved in CBTC by choosing node of other color within its coverage area, for sending its data or message.

Author Salim El Khediri et.al [18] proposed a new technique for the selection of the sensors cluster-heads based on the amount of energy remaining after each round. The new hierarchical routing protocol which is based on an energy limit value called “threshold” preventing the creation of a group leader and to ensure reliable performance of the whole network. The cluster-heads aggregate the data captured by the member nodes belonging to their own cluster and then sends an aggregated packet to the base station by this it reduces the amount of information transmitted to the base station. This protocol consists of two phases: The first is the set-up phase in which cluster heads are selected and clusters are formed, and in the second phase i.e. the steady phase, the data transfer to the base station is held.

In this paper author proposed an algorithm based on cluster topology to save energy consumed in the totality of network to increase its survival, reliability and efficiency. The total amount of data transmitted to base station is reduced which is not done in color based topology of energy efficient in WSN. It increases the speed of transmit ion of message with minimum energy.

Author Shalli Rani et.al [19] proposed protocol Energy Efficient Inter Cluster Coordination Protocol (EEICCP) for homogenous type of node in wireless sensor network. In this technique some cluster head sends data directly to the base station (Single hop) on the other hand some send by multi hop transmission. The EEICCP protocol works by starting the election phase in which the cluster heads are elected according to the distance based on RSS. A cluster id is assigned to each cluster head and the cluster coordinator, after election of cluster coordinators by the CHs. Each cluster transmitted this id to their nodes by the advertisement message and cluster co-coordinators (CCOs) also pass their own ids. Ones the transmission phase begins, the data is transferred to the cluster head and that data is passed to the base station with the help of CCOs. In first phase or round the data is collected by the CH of that cluster which has data to send and then in the other iterations the data is passed to the base station with the help of cluster co-coordinators (CCOs). And the path is set for the data transmission with the help of the cluster coordinators ids.

In EEICCP the energy consumption is less when the cluster heads are less and is increased by increasing the cluster heads. This protocol evenly distributes the energy load among the sensor nodes and uses the multi hop approach for the CHs. EEICCP has shown remarkable improvement over already existing LEACH and HCR protocols in terms of reliability and stability.

Author Konstantin Chomu et.al [20] proposed The Data Time Sending (DTS) protocol which is TDMA based protocol which support single hop and multi hop topologies. When a DTS-enabled WSN uses single hop topology, it is organized as a star network where every remote sensor node sends packets directly to the base station. On the other hand when it uses multi hop topology, it is organized as a cluster net-work where nodes are grouped in clusters. Each cluster has one cluster-head node.

The DTS protocol consumes approximately 30% less energy than IEEE 802.15.4 unslotted CSMA-CA protocol, and energy savings do not depend on the total number of remote sensor nodes. And also DTS protocol has constant and lower standard deviation of the energy consumption than IEEE 802.15.4 unslotted CSMA-CA, whose standard deviation of the energy consumption increases with larger number of remote sensor nodes.

III. COMPARISON of DIFFERENT TECHNIQUES

Technique	**Algorithm**	**Memory**	**Complexity**	**Latency**	**Energy consumption**	**Throughput**
Local wakeup scheduling	mc-ACO	√	×	√	√	√
Sleep scheduling		√	×	√	√	√
Contention Based MAC protocol	S-MAC Protocol	×	×	×	×	×
Contention Based MAC protocol	T-MAC Protocol	√	√	√	√	√
Scheduling MAC protocol	A	×	×	√	×	×

Duration value MAC protocol	Packet DV MAC	√	√	√	√	√
Topology control technique	CBTC	×	√	√	√	×
Cluster Head based	Hierarchical Routing protocol	√	√	√	√	√
Homogeneous cluster based network-cluster Head	EEICP	√	√	√	√	√
TDMA	DTS(Single and multiple hop topology)	√	√	√	√	√

IV. CONCLUSION

Wireless sensor network has a great potential in many application domains such as resource, environmental monitoring, defense applications, traffic systems, health care, precision agriculture, etc. The use of sensors in other domains is also increased attention such as cold chain management, security, infrastructure monitoring to scientific exploration. With the development of new application specific sensors along with the appropriate networking protocol, data aggregation model, routing and scheduling techniques sensors can invade all spheres of life to assist humans for better life. Therefore it needed efficient energy resource allocation techniques in WSN for achieving to maximize resource utilization by minimizing resource consumption. So the ultimate aim of developing sensor network systems which are both energy efficient and provide acceptable levels of service to the end user. Hence a widespread use of WSN is expected in the future.

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