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Techniques to Improve Network Lifetime of Wireless Sensor Networks -A Survey

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***Abstract*:** In recent years, the use of wireless sensor networks for industrial applications has been rapidly growing and wireless sensor devices are generally battery operated devices which have limited battery power. Since sensor nodes are small in size, cost-efficient, low-power devices, and have limited battery power supply. Wireless Sensor Networks (WSNs) are mostly deployed in a remote working environment, once deployment is done; it is not possible to replace the battery and energy. A fundamental challenge in the design of Wireless Sensor Network is to enhance the network lifetime. In this paper different techniques are discuss.

***Keywords*:** wireless sensor network, network lifetime, energy conservation, sensor node.

1 INTRODUCTION

Wireless sensor networks (WSNs) lies on the top when we consider its popularity; it is possible due to its innovative and interesting applications in almost all fields ranging from environment monitoring to battlefield scenario. In computing and communication platforms, it sets a new level for monitoring different environments. It concerned to remote geographical area where human intervention is not possible [2]

Wireless sensor devices consist of low power embedded processor, limited memory, low data rate radio transceiver, low data rate sensor, global positioning system and battery (Fig.1 shows a typical sensor node structure). These are generally battery operated and the lifetime of the battery is finite. Once deployment is done, it is not possible to change the battery in hostile environments. Energy harvesting is not practically feasible in most of the cases. So optimal use of battery is a challenge in Wireless sensor networks.

Generally more energy is spent while transmitting data, so there is need for efficient routing protocol which optimally use battery as well as increase the network life time of all sensor nodes. Shortest path routing generally consumes less battery but always forwards the traffic in same route from source to destination as a result of which only some nodes are overused. Many nodes in the network with higher battery capacity are used less. There should be an approach to use these nodes whose residual energy is more[3].

A network of wireless sensor nodes can be formed by densely deploying a large number of sensor nodes in a given sensing area, from where the sensed data from the various nodes are transported to a monitoring station (called as sink node or base station), often located far away from the sensing area. The transport of data from a source node to the monitoring station can be carried out by multihop routing or flooding. By having more than one Base stations the average number of hops between data source sink pairs can get reduced. This will reduce the energy spent by a given sensor node for the purpose of relaying data from other nodes towards the base station, which in turn, can potentially result in increased network lifetime as well as in larger amount of data delivered during the network lifetime[4].

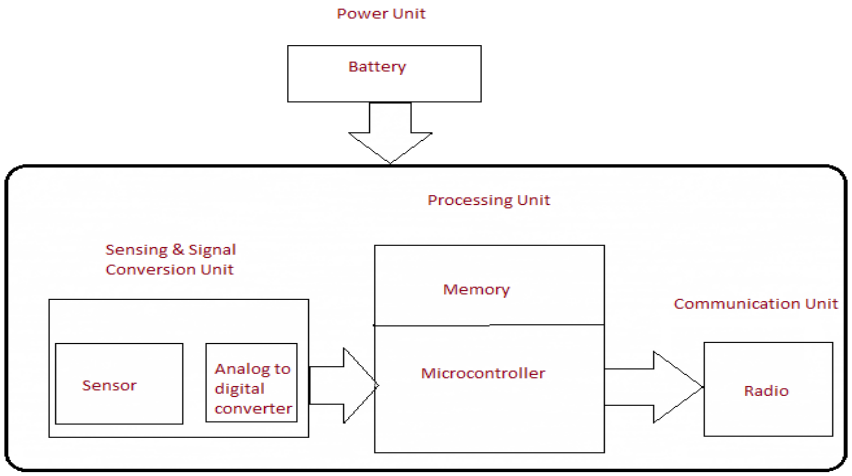

Fig1.1 A typical sensor node structure

1.1 **Wireless Sensor Network Challenges**

The WSNs posesses the unique network characteristics. Therefore, the design of WSN presents many challenges, which covers the following main aspects:

• **Energy Constraints :** This is the major challenge in WSN [9], since the Sensor nodes are battery powered, thus possess very limited energy capacity. The energy is required by the sensor nodes for many purposes like data collection [10], data processing, data communication, also continuous listening to the medium for packet receiving and transfer requires large amount of energy. The batteries supplying energy needs to be changed or recharged after some time. This is not possible in many cases where the sensor nodes are deployed remotely. The constraint of energy presents many new challenges in the development of hardware and software protocols for WSNs. To prolong the operational lifetime of a sensor network, energy efficiency should be considered in every aspect of sensor network design, not only hardware and software, but also network architectures and protocols.

• **Limited Hardware and Software Resources :** The WSN consists of thousands of sensor nodes. So it is preferred to be light weight and low cost [18]. It has limited processing and storage capacities, and thus can only perform limited computational functionalities [11]. Therefore, the flash memory is mostly used in Sensor nodes. The central processing unit (as shown in figure1.1) which consists of microprocessor and microcontroller is responsible for determinig the energy consumption and computations. For making the CPU more more light weight and cheap a large number of microcontrollers, microprocessor chips and Field Programmable GATE arrays (FPGA) are used A field-programmable gate array (FPGA) is an integrated circuit (IC) that can be programmed in the field after manufacture. FPGAs are similar in principle to, but have vastly wider potential application than, programmable read-only memory (PROM) chips. Further the energy consumption of FPGA is high which cannot be reduced, the radio range has to be high between 1 to 5 kms. These gives rise to the challenges in developing algorithms and protocols which must consider not only the energy constraints in sensor nodes but also the processing and storage capacities of sensor nodes.

• **Massive and Random Deployment** and repair by itself [7,8]. Most sensor networks consist of a large number of sensor nodes, ranging from hundreds to even thousands or even more. These sensor nodes are deployed remotely and are expected to work without human intervention.Node deployment is usually application dependent, which can be either manual or random. The sensor nodes must autonomously organize, configure, adapt and maintain and repair themselves [12] in a hostile environment.

• **Dynamic and Unreliable Environment :** A sensor network usually operates in a dynamic and unreliable environment. On one hand, the topology of a sensor network may change frequently due to node failures, damages, additions, or energy depletion. On the other hand, sensor nodes are linked by a wireless medium, which is noisy, error prone, and time varying. The connectivity of the network may be frequently disrupted because of channel fading or signal attenuation.

• **Operating System:** OS design for WSN deviates from traditional OS Design [13] Operating System for WSN should be less complex than the general operating systems. It should have an easy programming methodology. Application developers should be able to concentrate on their application logic instead of being concerned with the low level hardware issues like scheduling, preempting and networking. Various Operating Systems developed for Sensor nodes include TinyOS [14], Contiki, Mantis Nano-RK, LiteOS Operating System [13] and Nano-Qplus [13].

• **Security :** Remains an open problem for additional research and development as currently proposed routing protocols for WSNs are insecure but vital. The literature review of various security mechanisms states that Link layer encryption and authentication mechanisms provides reasonable defense for mote-class outsider attacks, the Cryptography is inefficient in preventing against laptop-class and insider attacks. They faces critical challenges since the existing infrastructure is already starving for resources such as Communication bandwidth, Power supply, Computational power etc. Building multi-hop routing topology proves to be the boon for the to intruders . Various security services has been provided such as Link-layer encryption and authentication, Identity verification Bidirectional link verification, Authenticated broadcasts. Requirements for WSN security spoofed, altered and replayed routing information [17] Selective Forwarding Sinkhole attacks, The Sybil attack, Wormholes. Thus designing the protocols for such a non predictive environment is really a big challenge [16, 17]

• **Diverse Applications : The WSNs have** a wide range of diverse applications [18] and the requirements for different applications varies significantly. There is no such algorith or program or protocol invented yet which can fulfill all the requirements of all the applications, since the design of sensor networks is application specific. The new middleware for WSNs, called Motley middleware [15] have made it possible to enable a shared infrastructure and multi-application support for WSNs. The Motley middleware achieves this by providing the services for the dissemination, installation and scheduling of applications with diffrent QoS requirements.

This paper is organied in the following manner. Section 1 reviews the related work on energy conservation issues in wsn by different authors. Section 2 shows the comparative analysis of the different techniques stated by different authors (Table 1). Section 3 concludes the paper.

2. RELATED WORK

Many researchers have contributed system to provide the ways to increase the lifetime of battery in Wireless Sensor Network. However sensor nodes are commonly distributed in inaccessible regions depending on the type of application, and the sink is located far away from sensor nodes. For this

reason, sensor nodes with the limited battery resource need to be operated during the assigned time without battery.

Energy harvesting concept and clustering technique applied for effective use of energy the reserchers N. Priyadarshini, J. Jena, S. Sahu explained the system where main challenge of increasing the field lifetime of sensor nodesl.This increases the field lifetime of the sensor nodes before their complete degradation [2].

K. Das, D. Malik and S. Padhi [3] described the system where they different routes instead of a same route to forward the network traffic, as a result the variance of power consumption of all nodes is less and it will increase the more life time of network (INLT) Algorithm .For more utilization the node which are less use give the chance while choosing the path in future. Due to sink nodes multihop distance between node-sink pair is reduced and energy efficient routing avoids the low energy node while routing packets and prevents it from dying early. So together they conserve energy which leads to prolonging the overall network lifetime as well as the lifetime of a sensor node[4] .Researchers J. Saraswat, N. Rathi, P. Bhattacharya described where they used photovoltaic cell for efficient power management in wireless sensor networks.Efficient battery usage techniques and discharge characteristics are then described which enhance the operational battery lifetime[5].

Some researchers also focuses on by turning off redundant nodes to sleep mode to conserve energy while active nodes can provide essential k-coverage, which improves fault-tolerance for that they use different scheduling algorithms. The scheduling algorithms can be implemented in centralized or localized schemes, which have their own advantages and disadvantages that turn off redundant nodes after providing the required coverage level k [6].

G. Anastasi, M. Conti, M. Di Francesco [7] proposes the protocol which dynamically adjusts the nodes to match the network demands, even in time-varying operating conditions. These protocol used for efficient power management in wireless sensor networks targeted to periodic data acquisition. In addition, the system does not require any a-priori knowledge of the network topology or traffic pattern. Under time varying conditions the protocol is able to adapt the duty-cycle of single nodes to the new operating conditions while keeping a consistent sleep schedule among sensor nodes.

Y. Peng, Zi Li, W. Zhang, and D. Qiao explain the design the such a system, which build a proof-of-concept prototype,to evaluate the feasibility and performance in small-scale networks, and conduct extensive simulations to study its performance in large-scale networks.The proposed system can utilize the wireless charging technology effectively to prolong the network lifetime through delivering energy by a robot to where it is needed [8].

3. COMPARATIVE ANALYSIS

Table 3.1 Comparative analysis of various techniques

Sr. No.	Method/Technique	Merits	Demerits
1.	Energy harvesting LEACH model [2]	-Significantly increases the lifetime of the network -Effective clustering technique balances the energy budget -Maintains the fault tolerance capability of the network.	Energy harvesting is not practically feasible in most of the cases.
2.	Increased Network Life Time (INLT) Algorithm for Wireless Sensor Networks [3]	-Selects the shortest path from S to D - Less power consumed nodes are utilize effective clustering technique balances the energy budget - Uses nodes whose residual energy is more as - The intermediate node to forward its traffic	ot suitable for large networks
3	Multiple sink node with energy efficient routing algorithm	- Reduces hot spot problem -Due to multi sink node energy consumption is reduced	-
4	Coverage preserving centralized node-scheduling scheme (Turning off the redundant nodes to sleep mode)	-Improves fault tolerance. -Reduces energy consumption because of less no. of redundant nodes.	Performs well when network size is small.
5	Adaptive Staggered sleep Protocol (ASLEEP)	-Does not require prior knowledge of the network topology. -Reduces average message latency. -Improves delivery ratio.	-
6	Wireless charging technology [8]	-This system is capable of extending the sensor network life time significantly. - Works well in large scale networks. - presents a different perspective by taking the advantage of the mobile charger.	-

4. CONCLUSION

Lifetime of node are big problem in wireless sensor networks. In this paper, different techniques (algorithms, protocols designed) are discussed as stated by different researchers in order to improve lifetime of network. All the proposed protocols has several prons and cons ,but they work well in own area. The section 3.1 shows the comparative analysis of all the techniques.

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