Energy Efficiency in Wireless Sensor Networks

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Abstract— Collection of sensors which can communicate between themselves. Sensors are tiny devices, which can sense their residing environment's various activities due to their special manufacturing features. Energy efficiency is the most required quality in a sensor network where each node consumes some energy with each transmission over the network. Energy efficiency is required to improve the network life. This paper discussed the same issue and various existing protocols which help to improve network life time.

Keywords—*Sensor networks, protocols, energy efficiency*

I. INTRODUCTION

A wireless sensor network is a network which consists of a number of sensor nodes that are wirelessly connected to each other. These small, low-cost, low-power and multifunctional sensor nodes can communicate in short distances. Sensor nodes consist of sensing, data processing, and communication components. Large number of these sensor nodes collaborated forms a wireless sensor networks [1].A WSN usually consists of tens to thousands of such nodes that communicate through wireless channels for information sharing and cooperative processing. To ensure scalability and to increase the efficiency of the network operations sensor nodes are often grouped into clusters [2] [3].

The sensors must be placed in exact locations since there are a limited number of nodes extracting information from the environment. The deployment of these nodes and cables is costly and awkward requiring helicopters to transport the system and bulldozers to ensure the sensors can be placed in exact positions. There would be large economic and environmental gains if these large, bulky, expensive macro-sensor nodes could be replaced with hundreds of cheap micro-sensor nodes that can be easily deployed. This would save significant costs in the nodes themselves as well as in the deployment of these nodes. These micro-sensor networks would be fault-tolerant as their sheer number of nodes can ensure that there is enough redundancy in data acquisition that not all nodes need to be functional. By using wireless communication between the nodes would eliminate the need for a fixed infrastructure.

Wireless micro-sensor networks represent a new paradigm for extracting data from the environment. The conventional systems use large expensive macro-sensors that are often wired directly to an end-user and need to be accurately placed to obtain the data. Like the oil industry uses large arrays of geophone sensors attached to huge cables to perform seismic exploration for oil. These sensor nodes are very expensive and require large amounts of energy for operation. The most difficult resource constraint to meet is power consumption in wireless sensor networks. The use of wireless sensor networks is increasing day by day and at the same time it faces the problem of energy constraints in terms of limited battery lifetime. As each node depends on energy for its activities, this has become a major issue in wireless sensor networks. Failure of one node can interrupt the entire system or application. Every sensing node can be in active, idle and sleep modes. In active mode, nodes consume energy when receiving or transmitting data. In idle mode, the nodes consume almost the same amount of energy as in active mode. While in sleep mode, the nodes shutdown the radio to save the energy. Energy constraints end up creating computational and storage limitations that lead to a new set of architectural issues. A wireless sensor network platform must provide application. Support for a suite of application-specific protocols that drastically reduce node size, cost, and power consumption for their target applications.

Following steps can be taken to save energy which is caused by communication in wireless sensor networks.

- To schedule the state of the nodes (i.e. transmitting, receiving, idle or sleep).
- By changing the transmission range between the sensing nodes.
- Using efficient routing and data collecting methods.
- Avoiding the handling of unwanted data in the case of overhearing.

In WSNs, the only source of life for the nodes is the battery. Communicating with other nodes or sensing activities consumes a lot of energy in processing the data and transmitting the collected data to the sink. In many cases (e.g. surveillance applications), it is undesirable to replace the batteries that are depleted or drained of energy [4]. Many researchers are therefore trying to find energy-aware protocols for wireless sensor networks in order to overcome such energy efficiency problems as those stated above.

All the protocols that are designed and implemented in WSNs should provide some real-time support as they are applied in areas where data is sensed, processed and transmitted based on an event that leads to an immediate action. A protocol is said to have real-time support if and only if, it is fast and reliable in its reactions to the changes prevailing in the network. It should provide redundant data to the base station. The base station or sink using the data that is collected among all the sensing nodes in the network. The delay in transmission of data to the sink from the sensing nodes should be small, which leads to a fast response.

II. ROLE OF ENERGY EFFICIENCY IN WIRELESS SENSOR NETWORK

Energy is required in each small scale or real operation of an application. Sensors are outfitted with batteries, however these batteries do have a restricted life time, e.g. in the submerged situation, there are no module attachments to give the power according to the requirement. The battery innovation is as yet falling behind the microprocessor technology. Energy-Efficient networking protocols are required these days.

Directing strategies in WSNs need to manage various difficulties and configuration issues. Regardless of headway in innovation, sensor hubs in WSNs still have limitations, for example, restricted battery control, transmission capacity requirement, constrained registering force and restricted memory. It makes the need for directing conventions to be exceptionally versatile and asset mindful. A portion of the difficulties of directing convention are:

1. Hub arrangement in either irregular or pre-decided way.
2. Data reporting method which can be a period driven, occasion driven, question driven or a half breed all of these strategies.
3. Exchange off between vitality utilization and precision of information accumulated.
4. Hub disappointment resistance of the system.
5. Adaptability, where directing strategy ought to have the capacity to work with expansive systems.
6. Directing strategy ought to be versatile for portable sensor hubs.
7. Should bolster information collection to lessen repetitive information.

Energy Conservation:

- Execute the transceiver when not required.
- Utilize shorter information packets for the correspondence.
- Various ways could be inferred and used to achieve the goal, to expand the system life saver.
- Information ought to be transmitted by the source hub just when the goal hub is prepared, so information could be come to without blunder at the lead position.
- Stay away from collisions between nodes.
- Hub sit out of gear tuning in and catching ought not to occur in the system working.
- Multi-hop information exchange can spare a ton of energy in the sensor arrange working.

At the network layer, energy usage can be minimized by:

- Efficient routing: Routing is the process of finding the path from the source node to the destination node. An efficient established path could save a large amount of network energy and increase its productivity.
- Reliable communication among sensor nodes: In a network when sensor nodes collect the data, the collected data needs to be sent to a master collector. The source node sends the data to the master collector acting as the destination node either directly or through relay. Reliable communication will save the energy that can be consume in data re-sending and data checking.

III. EXISTING ENERGY EFFICIENT ROUTING PROTOCOLS

Directed Diffusion: It is Data- centric protocol which was used to diffuse the data through sensor hubs by utilizing the naming plans for information. By naming plan, vitality is spared as it maintains a strategic distance from pointless operations of the network layer. Under the naming plan, it utilizes attribute-value pairs for the information. By utilizing these sets sensors are questioned on request premise. An interest is defined with the attribute-value pairs, for example, time term, geological area and so forth. The gradient is an answer connects with a neighbour from which the scheme was gotten. By interest and gradients, ways are built up amongst source and data collector node. Different ways have been built up and out of them, one is chosen by the source hub for the data passing.

*LEACH (Low Energy Adaptive Clustering Hierarchy):*It forms clusters to minimize energy distribution. The operation of the convention is separated into two sections: - Set-up stage and the Steady stage. The unfaltering stage is the longer term to limit the overheads. In the former stage, after the choice of cluster head, it promotes to the greater part of its essence. After advertisement, the other sensor hubs choose whether they need to some portion of this cluster head's bunch or not, in view of the signal strength of the promotion. Cluster-head assign the timetable to the sensor hubs of its group in view of the TDMA approach. At the demonstrated time the hubs can send information to the group head. In the Steady-up Phase, sensor nodes begin detecting and transmitting information to group heads. Group head totals every one of the information and sends to the base station. After a specific timeframe, the system goes again to Set-up stage and again begins another round of group head determination.

E-Leach (Energy-LEACH): This protocol was the improvement over the LEACH protocol. Change the bunch head determination method. At the point when first time (at first cycle), a group go to be picked, every one of the nodes has a similar likelihood to be cluster head. After the first round, hubs' energy is likewise considered in group head determination. A hub with high leftover vitality is picked as bunch head.

TL-Leach (Two-Level Leach): Sends information to the base station in two bounce. Group head gathers information from alternate hubs. Group head sends the gathered information to the base station through another bunch head that lies in the middle of it and base station. The TL-LEACH uses the following techniques to achieve energy and latency efficiency:

- Randomized, adaptive, self-configuring cluster formation.
- Localized control for data transfers.

The use of two-levels of clusters for transmitting data to the base stations leverages the advantages of small transmit distances for more nodes more than in the original LEACH. In this way less nodes are required to transmit far distances to the base station and it is particularly true in networks where the density of nodes is high. The use of clusters for transmitting data to the base station leverages the advantages of small transmit distances for most nodes, requiring only a few nodes to transmit far distances to the base station.

M-Leach (Multi-Hop Leach convention): Information is transferred to the base station in the multi bounce. This convention tends to the issue of information transmission from the far bunches to the base station. Group head sends the gathered information to the base station through another bunch heads that lie in the middle of it and base station. Due to multi-bounce correspondence, a great deal of vitality is spared at the group head hub. The limiting number of transmissions along with efficient cluster head replacement mechanism that preserve energy globally and multi power level for inter and intra cluster communication. In MLEACH, number of transmissions are confirmed only when a pre-described change in sensed data is achieved. This limits number of transmissions to preserve residual energy of a sensor node (numbers of transmissions are inversely proportional to energy of sensor node).

Leach C (Centralized Leach protocol): This introduces the centralized cluster formation algorithm. During set-up stage, nodes send their residual energy and area to the sink. After that sink runs an incorporated group arrangement calculation and forms the cluster for that stage. In each round, new bunches are framed by the sink. This convention disperses the group heads all through the system in view of the hubs vitality and area, henceforth may create better outcomes.

IV. RELATED WORK

Quintero et al., presented the impact of improving the energy conservation techniques and extending the battery life of the sensor nodes. By using Bayesian inference, more specifically particle filtering, it was shown that the state of charge can be accurately estimated within the linear region of the voltage-SOC curve. Battery discharge experiments were compared to simulations of the voltage-SOC evolution behaviour using a state-space representation model, which showed good agreement between the results. The SOC estimation obtained by the particle filter yields essential information that can, and should be incorporated into MAC protocols. From the data obtained, two battery power consumption profiles are studied and compared taking two criteria in account: first, a continuous battery usage which gives us a baseline to establish the worst-case scenario where the sensor node continuously transmits (drawing constant current), therefore discharging at the quickest rate possible.

The second profile is generated to establish a usage that is representative of expected transitions between the operating modes of the sensor node.

Le et al., proposed a Wake-up Variation Reduction Power Manager (WVR-PM) to solve issues. This PM is applied for wireless nodes powered by a periodic energy source (e.g. light energy in an office) over a constant cycle of 24 hours. Not only following the ENO condition, power manager also reduced the wake-up interval variations of WSN nodes. Based on this PM, an Energy-efficient protocol, named Synchronized Wake-up Interval MAC (SyWiM), is also proposed. Validations on a real WSN platform have also been performed and confirm the efficiency of our approach. The power manager was able to provide a regular data rate suitable for monitoring applications using autonomous nodes. The main improvement of WVR-PM is that the average number of wake-up variations is significantly reduced, which is amenable for multi-hop communications.

Chang et al., the network spectral efficiency increases monotonically in traffic load, while the optimal network energy efficiency depends on the ratio of the sleep-mode power consumption to the active-mode power consumption of base stations. If the ratio is larger than a certain threshold, the network energy efficiency increases monotonically with network traffic load and is maximized when the network is fully loaded. Otherwise, the network energy efficiency firstly increases and then decreases in network traffic load. The optimal load can be identified with a binary search algorithm. It is notify that as the network load increases, the average link spectral efficiency decreases while the network spectral efficiency increases. The network energy efficiency is strictly quasi-concave on the network load and the relative power consumption in the sleep mode plays a key role. For small sleep-mode power consumption, the energy efficiency would first increase and then decrease as the network load increases. If the sleep-mode power consumption is larger than a threshold, the energy efficiency would monotonically increase as the network load increases and the maximum energy efficiency is achieved when the network is fully loaded.

Chai et al., proposed cooperative hybrid routing protocol (CHRP) combining advantages of proactive and reactive routing protocols by letting them work cooperatively, which can adapt to features of both routers and clients. In CHRP, in order to make a proper route selection, channel condition, interference and constrained energy of clients were considered in the node-aware routing metric. Besides, a cross-layer approach was used in CHRP. Both gateway and client oriented data flows were considered comprehensively. The simulation results using ns-3 show the advantage of the proposed CHRP in terms of average packet loss rate, average latency, average network throughput, and average energy consumption of clients and the minimum residual energy of clients.

Thevar et al., in this paper design of an angular function and private key administration framework verified by bunch pioneer for the transmission of a hub was proposed. In this, the gathering was separated into divisions. The movement of the hub was connected with the edges to the gathering pioneer, which was the premise of the proposition. The hubs development and movement ought to be followed. The proposed conspire achieves high availability and security with the assistance of the directional transreceiver. The lifetime of a hub was expanded, and it empowered a hub to travel through the system and to transmit information to its neighbours

Le et al., in this,, another Reconfigurable Directional Antenna based Receiver-Initiated Cycled Receiver (RDA-RICER) MAC (Medium Access Control) protocol was proposed for WSNs nodes furnished with exchanged reception apparatuses. A low complexity and energy efficient examining process were installed in RDA-RICER to distinguish the bearing giving the most astounding RSSI (Received Signal Strength Indicator) between two hubs. OMNeT++ simulation comes about for a single hop demonstrate that information crash rate can be definitely diminished contrasted with related MAC conventions, prompting a critical decline in energy consumption.

Nguyen et al., in this paper an ERI-MAC a new receiver-initiated MAC protocol for energy harvesting sensor systems was proposed. ERI-MAC use the advantage of collector started and bundle connection to accomplish great execution both in latency and energy productivity. Also, ERI-MAC utilizes a queing mechanism to alter the operation of a sensor hub following the vitality gathering rate from the encompassing condition. The broad recreation brings about ns-2 demonstrate that ERI-MAC accomplishes great system execution, and in addition, empowers infinitive lifetime of sensor systems

V. CONCLUSION

Energy is an essential and important factor in the lifetime of sensor network. The main purpose of network establishment is sharing of information through communication and energy is the key required for this communication. In this paper, wireless sensor networks along with their applications and issues have been discussed. Study of the energy efficient routing protocols for global sensor network has been provided. Energy-ware protocols for sensor networks contribute to save energy and hence help to have more and greener communication networks and systems. So, in future there is a need to develop a new energy efficient protocol which will resolve the existing issues.

VI. REFERENCES

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