A STUDY ON WIRELESS SENSOR NETWORK

Asha. G.R, Research scholar, Department of Computer Science and Engineering, Jain University, Bangalore, India.

Abstract

Wireless Sensor Networks have gained wonderful growth and becomes an emerging research area in Internet of Things. The sensor nodes are capable of sensing the surrounding information, actuating, and controlling the collected data. As a sensor node is usually -powered by battery devices, the critical concern is how to reduce the energy consumed by the node, so that the lifetime of the network can be extended to reasonable times. The paper we give a comprehensive insight into energy saving techniques at physical, mac network and cross layer level.

Introduction

A wireless sensor network (WSN) [1]are autonomous sensors which are spatially distributed to monitor environmental or physical conditions[2], such as temperature, humidity, sound, pressure, etc. These sensors have to co-operatively pass their data through the network to a main base location. The motivation for the growth of wireless sensor networks was by military applications such as battlefield surveillance; nowadays such technologies are used in many wide-ranging consumer and industrial applications.

The WSN is built of "nodes" which range from a few to several hundreds or even thousands in number, where each node is connected to one or s many sensors.

Figure 1. The components of a sensor node and WSN [5]
Each such node in the wireless sensor network in fig-ure1 has generally several parts: a microcontroller, a radio trans-

ceiver with an internal antenna or an external antenna, an electronic circuit for connecting with the sensors and an energy source, usually a battery or any other form of energy harvesting. A sensor node may vary in dimension from that of a shoebox down to the size of a coin. The cost of sensor nodes is also variable, ranging from a few to hundreds of dollars, provisional on the complexity of the individual sensor nodes. The constraints on sensor nodes are on resources such as energy, memory, processing speed and communications bandwidth. The topology of the WSNs can vary from a simple star network to a multi-hop wireless mesh network. The propagation technique between the hops of the network can be routing or flooding [3, 4]. WSN collects data from target area and then forwards towards a base station (BS) A BS and/or sensor nodes may be a mobile or fixed [5].

WSN application include Health care monitoring, Environmental/Earth sensing (Air/water pollution monitoring, Landslide detection, Forest fire detection, Natural disaster prevention), Area monitoring, Industrial monitoring (Machine/ appliance health monitoring, Data logging, Water/Waste water monitoring, Structural health monitoring), military target tracking and surveillance, etc.

We list out the types of WSN in section 1. We brief out the importance of energy conservation by describing the network lifetime in section 2. In section 3 we outline the discussion on techniques of energy conservation at node, Mac, Network and cross layer level.

1. Types of sensor networks

[6-12]Author abstract WSNs can be deployed on land, underground, and underwater based on application. Depending on the surroundings, a sensor network faces di-verse challenges and constraints. There are five types of WSNs:

i) Terrestrial WSNs typically consist of hundreds to thousands of low-cost wireless sensor nodes deployed in a given region, are in either a ad hoc or in a pre-planned manner. Battery power is limited and may not be re-chargeable, terrestrial sensor nodes can still be equipped with a secondary power source such as solar cells.

ii) Underground WSNs consist of some numbers of sensor nodes that are buried underground or placed in a cave or mine used to monitor underground conditions. Other sink nodes are positioned above ground to relay data from the underground sensor nodes to the base station. An underground WSN is more costly than a terrestrial WSN. Underground sensor nodes are costly because of appropriate equipment parts must be selected to guarantee reliable com-
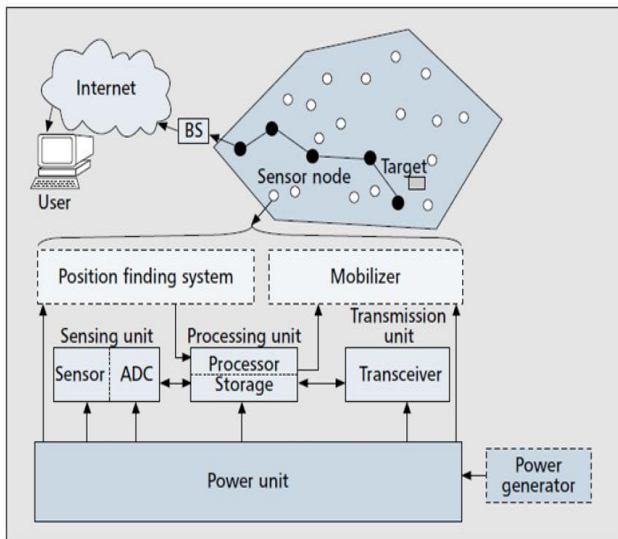
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munication through rocks, water, soil and other mineral contents. It is a challenge to make proper wireless communication in the underground environment because of high levels of attenuation and signal losses. Energy is an important concern in underground WSNs as sensor nodes are equipped with a battery power and once deployed into the ground, it is hard to recharge or substitute a sensor node's battery.

iii) Underwater WSNs contain of a number of sensor nodes and vehicle like devises deployed underwater. A sparse deployment of sensor nodes is placed underwater. Underwater wireless communications are achieved through transmission of acoustic waves. The limited bandwidth, long propagation delay, and signal fading are the issues/ challenge faced by underwater acoustic communication. Another challenge is failure of sensor node because of harsh environmental conditions. Underwater sensor nodes must be capable to self-configure and adjust to tough ocean environment. These nodes are equipped with a battery power which cannot be recharged or re-placed.

iv) Multi-media WSNs are defined as wireless network that enable monitoring, keep track of the events in the form of multimedia such as audio/ video/ image. Multi-media WSNs consist of a number of low cost sensor nodes connected with microphones and cameras. These sensor nodes internally connected with each other over a wire-less connection for the purpose of data retrieval, processing, correlation, and compression. Multi-media sensor nodes are positioned in a pre-planned manner in the environment so that it guarantee connectivity and coverage. Challenges/issues in multi-media WSN include high bandwidth demand, provisioning quality service (QoS), processing data and compressing methods, and consumption of high energy.

v) Mobile WSNs comprise of a pool of sensor nodes that can travel on their own and interact with the physical/external environment. Mobile nodes have the ability of sensing information, computing it, and communicate like static nodes. A key difference is mobile nodes have the ability to relocate and organize themself in the network. These nodes have capability to start off with some initial deployed location and then nodes can spread out to collect information. Information gathered by a mobile node can be communicated to other mobile node when they are within same range of each other. Another key difference is data distribution. Fixed routing or flooding is used to distribute data in a static WSN whereas data can be distributed using dynamic routing in a mobile WSN. Challenges in mobile WSN include deployment, self-organization, localization, navigation and control, coverage, energy, maintenance, and data process.

2. Network lifetime

The wireless sensor node is subjected to various resource constraints like energy, bandwidth, memory and processing ability. Comparing among them, energy is of main concern, as it is relentlessly constrained at sensor nodes and it is not practical to either replace or recharge the batteries of sensor nodes that are often deployed in hostile environment. The foremost differences between the wireless sensor network and the traditional wireless network is that sensors are very much effected by energy consumption. Moreover, the performance of the sensor network applications extremely depends on the lifetime of the network. Adopting a common lifetime definition as the time when the first sensor node dies. An alternative lifetime definition that has been used is the time at which a definite percentage of total nodes energy drain out. This explanation is rather similar in nature to the one we use here. In a well-designed network, the sensors in a certain area exhibit similar behaviors to achieve energy balance. In other words, when one sensor dies, it can be anticipated the neighbors of this node will also drain out of energy very soon, since they will have to take over the duties of that sensor and we expect the lifetime of several months to be several years [13].

3. Energy conserving techniques

As the main objective in the design of WSNs is communication of data while trying to extend the network's lifetime. At a very general level, we identify few techniques that can conserve energy.

3.1. Energy saving at Node Level

[14]The means in which energy savings can be affected at node level is at Device Level. To achieve low energy consumption in a wireless sensor node Selection of an appropriate hard-ware component and their configuration is mandatary. The architecture of the node can be designed based on the following conditions:
- Criteria for selection of component is based on the end goal of saving energy
- A feasible combination of components that fulfill the end criteria
The central module for the calculation in a wireless sensor node is a processor. This part of the node helps to govern the scheduling of task, to compute energy, to define communication protocols, to make appropriate coordination, and for data manipulation and data transfer. The processor is therefore the most significant part, so is why it is important to pick a suitable processor for WSN which is energy efficient. The power used by the processor mainly depends on how long it supports sleep mode because sleep mode has a straight connection with the operation of node. The power consumption of node also depends on operating voltage, duty-cycle internal logic and above all on proficient manufactures technology.

The major consumer of energy in the sensor network has proven to be the Radio transmission and reception. In most of the sensor networks, energy conservation is made possible by two methods i) to minimize communication overhead by configuring MAC and networking layer. In the first method for which communication nodes in the multi-hop setup switch off their radios when they are not in use (Adaptive duty cycle). The second method is data reduction and data aggregation where is to decrease the size of data by exploiting the correlation in the data and so also reduce the communication cost.

The selection of diverse transceivers is made based on their key features such as:
_ requirements of Power consumption
_ throughput
_ Ease of interface with the microcontrollers
_ current in receiving/transmitting mode, transmitted power
_ Availability of modes to support low power operation Range etc.
Sensor nodes are designed such that they to run on ordinary AA batteries. It is vital to estimate the power consumption needs of the sensor node. At the design phase appropriate selection in the of the transceiver and microcontroller will make guaranteed hardware platform on which the sensor node is built is aware of power, and this will be useful in management of power in the system.

Paper [30] Researchers advocate a physical layer driven approach to protocol and algorithm design for wireless sensor networks. Hooks and knobs like components in the physical layer is considered to construct protocols and algorithms for better energy-efficiency and they demonstrated how non-idealities of the hardware can be mitigated by making simple protocol design choices.

Paper [31] Researchers investigate the problem of energy-efficient data transmission considered over a channel which is noisy, focusing on the setting of physical layer parameters. They arise with a metric so-called the energy per successfully received bit, which specifies the expected energy required to transfer a bit successfully over a particular distance assumed a channel noise model. By minimizing this metric, they find, for different schemes of modulation, the energy-optimal relay distance and the optimal transmit energy as a function of channel noise level and path loss exponent. The results obtained may allow network designers to select the, transmit power hop distance and/or modulation scheme that increase network lifetime.

3.2. Energy saving at MAC Level

Chief sources of wastage of energy in WSNs

Energy is a very limited resource for wireless sensor systems and has to be managed cleverly so as to extend the sensor nodes lifetime for the period of a particular mission. The consumption of energy in a sensor node could be due to either useful or wasteful sources. Useful energy consumption can be due to receiving or transmitting data, processing of query requests, and forwarding queries and data to neighboring nodes. Wasteful energy consumption can be because to one or more of the following reasons.
Idle listening - energy waste in idle listening occurs, as it is listening to an idle channel in or-der to receive possible traffic.
Collision- collision is where when a node receives more than one packet at the same time then these packets are termed collided, even if they coincide only partially. Requires more energy consumption as all packets that caused the collision have to be discarded and retransmissions of these packets has to happen.
Overhearing- overhearing is when a node obtains packets that are intended to other nodes.
Control-packet overhead- is that minimal number of control packets should be used to make a data transmission [13].
Over-emitting- over-emitting is caused by the transfer of a message when the destination node is not ready.

In view of the said reasons, a suitably de-signed protocol need be considered to stop these energy wastes. To tackle these issue and power failure, numerous methods have to be used. Authors identify two main enabling techniques namely: duty cycling and data-driven (which is discussed in network layer section) approaches.
Duty cycling: Typically, a sensor radio operates in 4 modes: transmission, idle listening, reception and sleep. It is analyzed and Measurement's showed that most power consumption is due to transmission and in most cases; the consumption of power in the idle mode is almost similar to receiving mode. On the contrary, the energy consumption in sleep mode is much lower. Duty cycling is principally focused on the networking subsystem, here the most effective energy-conserving operation is putting the radio transceiver in the sleep mode (low-power) whenever communication is not required. Ideally, as soon as there is no more data to send/receive the radio should be switched off and should be restarted as soon as a new data packet becomes ready. In this way, nodes alternate between active and sleep periods depending on network activity. Duty cycle is defined as the fraction of time sensor nodes which are active for the duration of their lifetime.

Duty-cycling can be achieved through two diverse and complementary approaches.
i) In sensor networks it is typical to have node redundancy exploiting this possibility and adaptively choosing only a lowest subset of nodes to stay active for keeping connectivi-

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ty. In specific applications (e.g., event detection), the events are typically infrequent and hence sensor nodes spend a most of their time in the idle period which lessens the lifetime and the usefulness of the sensor networks. Nodes that are not presently needed for ensuring connectivity can go to sleep mode and thus save energy. Topology control scheme does the finding of the optimum subset of sensor nodes that promise connectivity.

ii) Active nodes (i.e. nodes selected by the topology control protocol) need not maintain their radio continuously on. The radio can switched off (i.e. put it in the low-power sleep mode) whenever there is no activity in the network, thus toggling between sleep and wakeup phases. we will refer power management as to duty cy-cling operated on active nodes . Thus, duty cycling is implemented with different granularity in complementary methods topology control and power management.

Topology control protocols can be broadly classified in the following two categories:

i) location driven protocols define which node to be turned on and when and it is based on the location of sensor nodes which is supposed to be known as a Geographical Adaptive Fidelity (GAF) [20], Geographic Random Forwarding (GeRaF) [21, 22]. Location driven topology control protocols clearly require that sensor nodes to recognize their geographical position. This is generally achieved by providing sensors with a GPS unit.

ii) Connectivity driven protocols activate/deactivate sensor nodes dynamically so that complete sensing coverage or network connectivity is fulfilled. On-demand protocols are Span [23] is a connectivity-driven protocol and Adaptive Self-Configuring Sensor Networks Topologies (AS-CENT)[24].

Power management protocols can be executed as independent sleep/wakeup protocols running above the MAC protocol. Numerous criterions can be also used to decide which nodes to activated/deactivated and when.

Power management protocols can be classified as follows under two categories:

i) Sleep/Wakeup Protocols which are further classified as

a. On-demand protocols: take the most instinctive approach to power management. The plain idea is that wake up of sensor node should happen only when another node needs to communicate with it. The main problem associated with on-demand schemes is how to inform the sleeping node that some other nodes are willing to communicate with it. To this end, such schemes typically use multiple radios with altered energy/performance compromises (i.e. for signaling a low-rate and low power radio and for data communication a high rate but extra power ambitious radio).

b. Scheduled rendezvous approach: The simple idea of scheduled rendezvous schemes is that each node in the net-

work should wake up at the same time as its neighbors. Normally, nodes wake up according to a schedule for wakeup and remain active for a short interval of time to communicate with their neighbors. Then, nodes go to sleep until the next rendezvous/ wakeup time.

c. Asynchronous schemes: The basic idea is of the scheme is to allow each node to wake up independently of the other nodes by guaranteeing that neighbor nodes always have an over-lapped active periods within a specified number of sleep/ wakeup cycles.

ii) MAC Protocols with Low Duty-Cycle: [15]The design of Medium Access Control (MAC) protocols plays a significant role in achieving an energy efficient network, since it can directly control wireless communication which is known to be the most energy consuming part in the sensor node

The categorizations of these three types of MAC protocols are schedule-based, contention-based and hybrid-based

a. Schedule-based: The process of this type of protocol is time-scheduled so that each working state of the sensor node can be accurately computed to avoid unnecessary collision, overhearing and hidden node problems for energy saving. Usually, a TDMA scheme [25] is used, where time is periodically divided into a certain number of time slots, and each node is assigned to one or more slots, in which a node can perform different channel access tasks (such as transmission, reception, listening) based on the schedule algorithm. Sometimes, such time slots can be dynamically assigned by the selected cluster-head in the multi-hop network scenario. TRAMA, μ-MAC are Schedule-based.

b.Contention-based: Contention-based protocols are the most commonly used MAC protocols in WSNs. They introduce flexible and random channel access mechanisms to reduce the consumption of energy on collision. B-MAC (Berkeley MAC) [26], one of the most well known contention-based MAC protocols, is designed based on CSMA scheme [25] and especially for low power WSNs. In order to reduce energy consumption, BMAC provides clear channel assessment (CCA), CSMA back off scheme and optional ACK for the transmitter to efficaciously handle network conditions. At the receiver, a low power listening (LPL) mechanism is used to attain a low duty cycle, so sensor nodes wake up periodically to check activities on the channel. If any activity is detected, the sensor node can be awake for a explicit time for the coming packet and then goes back to sleep mode. If no packet is received in this period, then after a timeout the node can also return to sleep mode for energy conversation. To assure the reliability of data receiving, the B-MAC data packet consists of a long preamble and a pay-load. It is essential that the duration of preamble is bigger than the check interval so that the node can always detect ongoing activities on the channel. The long preamble frame can save the cost synchronization, which in turn can increase energy consumption on transmission of packet as

well as the packet latency. S-MAC (Sensor-MAC), T-MAC (Timeout MAC) is other proto-cols.

c. Hybrid-based: The basic idea of hybrid-based MAC pro-tocols is to accomplish better energy performance by con-joining the advantages of schedule- and contention-based elements. The IEEE 802.15.4 standard [27] is one of the most interesting examples in this category.

3.3. Energy saving at Network Level

3.3.1 Design issues/Challenges in WSN

[5][32]In WSNs the design of routing protocol is influ-enced by a number of challenging issues as briefed below:

i)Node deployment: In WSNs node deployment can be ei-ther dynamic or static as per requirement of applications. The design of the routing protocol, clustering, energy con-servation in WSN, node life, etc. gets affected by node de-ployment .

ii)Network dynamics: BS or sensor node dynamic nature of has greater effects on connectivity and coverage of WSN. The change in connectivity between sensor nodes becomes one of the challenging issues for stability and route finding. This problem becomes more difficult in the when both BS and sensor nodes are mobile.

iii)Energy conservation: During the establishment of an in-frastructure, the process of setting up the routes is greatly influenced by considerations of energy [8, 9, 10]. In several cases, multi-hop communication saves energy of sensor nodes compared to one hop communication and hence caus-ing in life prolongment. But this creates another kind of seri-ous problem like quick drainage of power of forwarding nodes as com-pared to nodes at last layer in multi hop com-munication, hierarchical communication. On the other hand, major overhead due to network management and medium access control occurs in multi-hop routing.

iv)Fault tolerance: Even when some of the sensor nodes fail the network need to work fine. This is can be achieved by design of routing and MAC protocols.

v)Scalability: Many sensor nodes may not be working due to physical damage, power drain-age etc. Holes get created in the existing WSN. Certain times this splits the network into two or more partitions. In such situation, adding extra sensor nodes are necessity. Design of WSN must support scalabil-ity.

vi)Hardware constraint: With minimum energy, low compu-tational capacity, low communication range, it becomes one of the significant design issues related to power saving, qual-ity of service etc. MAC layer protocols may be de-signed in to take care of synchronizing the wake and sleep time with application requirement [11].

vii)Sensor network topology: It must be maintained well even with very high node density. Managing the topology in

the scenario of mobile nodes becomes one of the important and necessary issues.

viii)Environment: Sensor nodes must be functional even in hostile/ non-conducive environment.

ix)Transmission media: in WSN usually, radio frequency or infrared wireless communication is used. Both have well known characteristics and associated problem like fading, reflection, re-fraction, multi-path propagation, inter symbol problem, high error rate etc. Operation of WSNs is affected by these.

x)Data delivery models: Data delivery may be categorized in to following types: query-driven , event driven, proactive, reactive, hybrid. Choosing one data delivery model is fun-damental requirement of the WSNs application.

xi)Node capabilities: Depending on the application, a node can be dedicated to a particular special functionality such as sensing, relaying and aggregation however engaging these three functionalities at the same time on a node may rapidly drain out the nodes energy.

xii)Data aggregation/fusion: the fact is that more battery power is used during data communication. So is, data aggre-gation/fusion helps in decreasing number of communications by using some aggregate functions like suppression (du-plicate elimination), min, max and average.

xiii) Quality of service: quality of service is the level of ser-vice provided by network to end users. As WSNs are used in large number of areas which include military and as well as civil applications, QoS is attained the considerable weight-age in situation of utmost importance. Re-source / Band-width utilization, Traffic management etc. are QoS factors which can be maintained by appropriate protocol designs at mac and network layer. Sequential Assignment Routing pro-tocol is the first QoS based protocol.

xiv) Security: WSNs are generally deployed in tough envi-ronments. Owing to limitations on communication and com-putation capabilities, these sensor networks are more suscep-tible to at-tacks. Hence, security in a WSN is very challeng-ing issue. Designers' makes their efforts from initial phases of applications development to the develop and integrate security by designing routing protocols enabled with security features, incorporating Symmetric key cryptography, Intru-sion detection systems.

Optimal choice of communication methods and protocols to minimize energy consumption. [14]The network layer is responsible for routing of information through the sensor network, which also finds the most efficient route for the packet to travel on its way to a destination specified. Data transmission: The transmission of data depends on the appli-cation type and varies from application to application; it can be of any of the following types:

Continuous- Data is transmitted periodically from each sen-sor node to base station.

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Event driven (query driven) - The transmission of data is initiated whenever there is an occurrence of event or query by the base station

Hybrid – the combination of both the above-mentioned circumstances [45] included in some networks.

3.3.2 Basic Routing Protocols

i)Direct: In the direct protocol, each individual sensor in the network sends data directly to base station so, if the base station is nearby to nodes in the system the energy consumed for transmission is low. In some applications, where in the line-power supplied base station is considered and the receiving data requires large amounts of energy, this protocol is quite sufficient. Though, if the conditions mentioned above are not pre-sent and base station is distant away from nodes then the power requirement for transmission increases and nodes could run out of power quickly.

ii)Minimum-energy routing protocol: In minimum-energy routing protocol the nodes in a network behaves as a router for other nodes. Transmission of data to the base station from one node occurs through intermediate nodes. The energy dissipation of the receiver is ignored in some of the protocol [7] and only transmitter energy is taken into consideration. The choice of midway nodes is finalized in such a way that transmission energy is minimized. This routing protocol possibly consumes extra energy than direct routing algorithm as the energy consumed by each intermediate node in order to receive and then transfer data could result in the increase of total energy consumption.

iii)Self-organizing protocols: In the architecture of heterogeneous sensors types' that is either stationary or mobile forwards the information to a set of nodes which acts as routers. These nodes are stationary and are the most important part of the communication. Information gathered are forwarded by these nodes which perform as routers to the sink nodes which are much more powerful. Router nodes must be in range with each sensing nodes and that it is important to them to involve in the network. This protocol is described in [42].

iv)Hierarchical protocols: Clustering: In these algorithm, nodes in the network form a cluster. One node performs as a local base station and other nodes send data to this node which will then forward the data to the central base station. The local base station will be closer to all nodes in the cluster, by this grouping decreasing the distance of data transmission. The popular protocols are LEACH –Low Energy Adaptation Clustering Hierarchy and PEGASIS -Power Efficient Gathering in Sensor Information System

v)Data-driven approaches :[18]Data-driven approaches can be used to improve the energy efficiency even better. the fact that data sensing effects on sensor nodes' energy consumption in two ways: a) Unneeded samples, b)Sampled data generally have strong spatial and/or temporal correlations [11]. Consequently, there is no need to transfer the redundant data to the sink affecting to decrease the power consumption of the sensing subsection of network. Reducing the amount communication is not sufficient when the sensor itself is power hungry. In first situation unneeded samples result in energy consumption for useless task, even if the sampling costs are negligible, they cause in un-needed communications .The second issue arises whenever the power consumption of the sensing subsystem is not insignificant.

Data-driven methods can be divided to data reduction schemes that address the situation of unneeded samples, whereas energy-efficient data acquisition schemes are predominantly aimed at reducing the energy used up by the sensing subsection of system(second issue). Data reduction can be divided to in-network processing and data prediction.

In-Network Processing: sensor nodes are distributed and cooperate in a WSN, in-network processing is responsible for such tasks as passing of packet, application pro-gram execution and data processing to make energy-efficient network conditions. Several techniques are classified by [16, 17]. Data aggregation: Data aggregation is done in some applications that are only interested in average, minimum or maximum values. In such cases, the sensor nodes do not have to transfer all the sensed data, since the sampled data produced in a period of time can be aggregated by the node for some necessary processing. Finally, only the required data is transferred and a huge amount of energy can be saved from the decrease of communication. Data compression/processing: This method is a conventional method that also targets to reduce in data in the communication process. Though, sometimes the computational efforts in data compression/processing before the transfer may become costly for a resource-limited sensor node microcontroller, which in turn can cause an in-crease in overall energy consumption. Thus, it is crucial to find different tradeoffs between local computation and wireless communication

Data prediction consists in building an abstraction of a sensed phenomenon, for example a model describing data evolution. The model is capable of predicting the values sensed data by sensor nodes within definite error bounds and exist in both at the sensors and at the sink. If the desirable accuracy is fulfilled, queries given out by users can be estimated at the sink node based the model without the necessity to acquire the exact data from sensor nodes. The first data centric protocol is SPIN [28]. Later, the popular protocol

direct diffusion [29] was developed and this has given rises to many more protocols.

3.4. Energy saving at Cross-layer level

Cross-layer design states the idea that parameters of more than one layer can be retrieved and/or changed in order to realize an objective of optimization [19]. These cross-layer protocols together optimize the performance of the different layers among physical layer (PHY), medium access control layer (MAC), Network layer (Routing) and Transport layers

[33] Authors discuss as Cross-layer methodology has so far been used in two main perspectives in WSNs. In several papers, the cross-layer collaboration is considered, where the traditional layered structure is kept intact, while each layer is informed about the conditions of other layers. Still, the mechanisms of each layer still stay in-tact. On the other way, there is still much to be extended by reconsidering the mechanisms of layers in the network in a united way so as to provide a solo communication module for efficient communication in WSNs. There are also cross-layer module designs, where functionalities of many traditional layers are melted into a functional module. Researchers developed Energy Optimization Approach (EOA) based on Cross-Layer for Wireless Sensor Networks [24], which consider the combined optimal design of the physical lay-er, medium access control layer (MAC), and routing layer. The prominence of EOA is on the routing, working out of optimal transmission power, and scheduling duty-cycle that optimize the WSNs energy efficiency. Researchers have designed an algorithm based on slotted ALOHA protocol , called a wireless sensor network (WSN) access control algorithm [25] to reduce energy consumption of WSN node. This algorithm assimilates the power control of physical layer, the transmitting probability of medium access control (MAC) layer, and the automatic repeat request (ARQ) of link layer. In this algorithm, an optimization of cross layer approach is implemented to decrease the power consuming per bit.

Conclusions

WSNs are designed for specific applications. Features and requirements differ for each application. Some of the challenges are discussed, to support the diversity of applications, the development of new communication protocols, algorithms, designs, and services are needed. WSNs make impact on our day to day activities of life there are tremendous opportunities of re-search on the way area of wireless sensor net-works.

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