Study of Various Energy Conservation Techniques for Wireless Sensor Network

Birdevinder Kaur
Department of Physics, Guru Nanak College, Bodhlada, Punjab, India

***Abstract*—**A network is a wireless computer network comprising of spatially appropriated independent gadgets utilizing sensors to agreeably screen physical or natural conditions. Essential operation in WSNs could be sensing the environment and reporting the same to a base station or handing-off data for different hubs while remote ad-hoc system is a self-designing system of portable switches associated by remote connections. In this paper, a review of various methods of the WSN systems has been reviewed with the brief overview of the wireless sensor network overview and its key aspects.

***Keywords*—** *Sensor Network; cluster head; Network lifetime; Energy efficient; Routing Protocols in WSN*

I. INTRODUCTION

Many announcement protocols for WSN have been developed. While main research was concentrate on energy efficiency, wireless link reliability [7], real-time capabilities [8], or quality-of-service. All research is considered to the variety of future submissions to replace or augment the conventional wire-based networks. But for the reason of sensor nodes just can use mobile as their power reserve in WSN, and the power is quite limited. So, energy efficiency investigation is the key subject in design sensible wireless sensor network routing protocols. Wireless Sensor Networks are fundamentally used for meeting information needed by smart environments but they are particularly useful in unattended circumstances where terrain, climate and other conservational constraints may hinder in the deployment of wired/conventional networks. Rather the individual sensors are battery operated and the lifetime of the individual sensors and thus the overall network be contingent seriously on duty cycle of these sensors. Analysis on WSNs shows that communication module is the main part which ingests most of the sensor energy and that is why energy conservation is the major optimization goal. Since routing etiquettes and MAC protocols straight access the communication module therefore the design of protocols in these two areas should take into explanation the energy conservation goal.

In this paper, we discuss different state-of-the-art protocols both in MAC and direction-finding areas that have been proposed for WSNs to achieve the overall goal of prolonging the system lifetime. The direction-finding protocols in WSNs are generally categorized into three groups – data centric, ordered and location-based but we attention on only the first two categories because location-based routing protocols normally require a previous knowledge about sensors location which most of the times is not available due to random deployment of the sensors. A wireless sensor network is an ad-hoc infrastructure of sensing, communicating elements that gives the ability of perceiving, reacting in detailed environment. The environment can be an information technology framework, the physical world or an organic system. This paper defines the study of various energy efficient routing protocols in WSNs which are significant for their scheming purpose so as to meet the various resource constraints.

Wireless Sensor Networks (WSNs) encompass of small nodes with distinguishing, reckoning, and wireless interchanges abilities. Numerous routing, power organisation, and information dispersal agreements have been particularly intended for WSNs where energy awareness is a critical outline issue[3]. On the other hand, the attention has given to the routing protocols which may contrast relying upon the request and network organizational engineering. A Wireless Sensor Network (WSN) contain hundreds or thousands of these instrument nodes. These sensors can transport either amongst one another or specifically to an outer base-station (BS).

A more remarkable number of sensors takings into account sensing over larger topographical regions with more prominent accuracy. Fig. 1 shows the diagram of sensor node machineries. Basically, every sensor node involves sensing, processing, broadcast, mobilizer, location finding framework, and power units (some of these components are optional like the mobilizer).

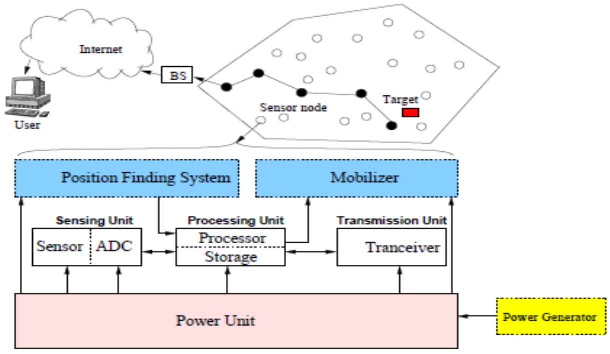

Fig. 1: The components of a sensor node

The same figure shows the announcement architecture of a WSN. Sensor nodes are frequently distributed in a sensor field, which is an area where the sensor nodes are organised. Each sensor node bases its choices on its mission, the material it currently has, and its information of its computing, communication, and energy properties. Each one of these distributed sensor nodes has the ability to gather and route information either to dissimilar sensors or back to an outside base station. A base-station may be a fixed node or a mobile node capable of marrying the sensor system to a current transportations framework or to the Internet where a user can have access to the reported data.

Routing in WSNs is extremely difficult task due to the essential qualities that recognize these systems from different other wireless systems like mobile ad hoc networks or cellular systems. Interacting unattended sensor nodes may have thoughtful effect on the efficacy of many military and civil submissions such as board field imaging, intrusion detection, climate checking, security and tactical surveillance, distributed computing, detecting ambient circumstances such as temperature, undertaking, sound, light, or the presence of certain objects, inventory control, and tragedy management.

A. Wireless Sensor Network V/S Wireless Ad-Hoc Network

A wireless sensor network (WSN) is a wireless processer network containing of spatially distributed autonomous devices using sensors to supportively monitor physical or environmental conditions.

Primary operation in WSNs could be sensing the environment and reporting the same to a base station or relaying material aimed at other nodes whereas wireless ad-hoc network is a self-configuring network of mobile routers associated by wireless links. The routers are free to move randomly and organize themselves arbitrarily. Thus, the network's wireless topology may modification quickly and unpredictably. Though many existing protocols, techniques and concepts from wireless ad-hoc networks are applicable and still used in wireless sensor network, but there are also many important differences which lead to the need of new protocols and techniques. Some of the most important characteristic differences are abridged below:

- Number of nodes in wireless sensor network is much higher than wireless ad-hoc network. Possibly a sensor network has to ruler number of nodes to thousands. Additionally a sensor network might need to encompass the supervised area and has to increase quantity of nodes from time to time. This needs a highly climbable explanation to ensure sensor network operations without any problem.
- Due to large number of sensor nodes, addresses are not dispensed to the sensor nodes. Sensor networks are not address-centric; in its place they are data-centric network. Procedures in sensor networks are centred on data instead of individual sensor node.
- Wireless sensor networks are environment driven, while data is generated by humans in wireless ad-hoc networks. The sensor network generate data when situation changes. As a result the traffic pattern changes dramatically from time to time.

II. ROUTING CHALLENGES AND DESIGN ISSUES IN WSNS

In spite of the innumerable consumptions of WSNs, these systems have a few quarantines, e.g., unnatural energy supply, controlled processing influence, and restricted bandwidth of the wireless influences assembly sensor nodes. One of the belief outline purposes of WSNs is to complete information communication while attempting to interruption the lifetime of the system and prevent connectivity degradation by exploiting aggressive energy organisation techniques. The outline of routing etiquettes in WSNs is affected by frequent testing variables. These elements must be overcome before productive e-mail can be attained to in WSNs. we abridge a portion of the steering problems and outline issues that influence routing process in WSNs.

- **Energy feasting without behind accuracy:** Sensor nodes can go through their inhibited supply of energy accomplishment cunnings and transmitting information in a wireless troposphere. As such, energy- conserving forms of message and processing are essential. Sensor node lifetime determines an in quantity reliance on the freestyle lifetime [4]. In a multi-hop WSN, each node assumes a double part as information sender and material switch. The breaking down of selected sensor nodes because of power failure can effect in huge topological vagaries and may oblige deflecting of packets and redisposition of the system.

- **Sensor settings:** Another test that antagonises the configuration of routing procedures is to deal with the areas of the radars. The vast mainstream of the proposed resolutions expect that the devices either are supplied with worldwide putting framework (GPS) beneficiaries or utilize some constraint approach [5] to find out about their areas.

- **Exposure:** In WSNs, every instrument node acquires a certain viewpoint of nature. A given sensor's standpoint of nature is unnatural both in extent and in exactness; it can just cover a delimited corporeal range of the earth. Thus, region scope is additionally an essential conformation parameter in WSNs.

- **Security**: A sensor network should introduce operative security apparatuses to prevent the data information in the network or a sensor node from unlawful access or malicious attacks.

- **Fault Tolerance**: Some sensor nodes may fail or be blocked due to lack of authority, physical mutilation, or environmental interferences .It may require actively adjusting broadcast powers and signaling rates on the standing links to reduce energy feeding, or rerouting packets through districts of the network where more vigor is offered.

- **Scalability:** The figure of sensor nodes deployed in the identifying area may be on the instruction of hundreds or thousands, or more. Any routing outline must be able to work with this huge number of sensor nodes. IN addition, sensor network routing protocols should be climbable sufficient to respond to events in the environment.

- **Quality of Service**: In many applications, maintenance of energy, this is directly related to network lifetime. As energy is depleted, the network may be required to reduce the quality of results in order to reduce energy debauchery in the nodes and hence increase the total network lifetime.

- **Production Costs:** Since the sensor networks involve of a large figure of device nodes, the cost of a single node is very imperative to justify the overall cost of the systems and hence the charge of each device node has to be kept low.

III. APPLICAIONS OF WSNs

Some of the latent diverse applications of WSNs are as follows: habitat monitoring, Home networks, Emergency situations, Physical world , Medical and health , military, physiological monitoring, precision agriculture, forest fire detection, nuclear, chemical and biological attack detection and transportation. WSNs can reform information gathering in a variety of situations. Some of the applications are discussed below in detail [11].

Habitat Monitoring: Habitat monitoring provides a wide collection of sensing modalities and environmental conditions. The primary modalities are video [12] (imaging) and audio (acoustics) to path species or singularities based on sound, or video information. The sensor nodes for this purpose must be deployable in remote positions that lack the power and the announcement facilities, motivating the need for low-energy wireless message. Along with these fees, the sensor nodes also have the ability to connect with the internet, which allows remote users to display and control the atmosphere.

Military Applications: Martial command, regulator, intelligence, surveillance, and targeting systems can be benefited from WSNs. Because of quick disposition, self-configuration, self-healing and [13] fault-tolerance characteristics, WSNs are very useful to monitor and control military systems. If some nodes are destroyed by the enemy, it doesn't affect the overall military operation since WSN are consisting of many rapidly deployed low cost sensor nodes. Martial commanders and leaders can use the facility of WSNs to monitor the situation of their troops, the status and the availability of the equipment in battleground. Sensor friendly to every troop, vehicle, and equipment can report the status by their own. This information can be gathered into the sink nodes or base places and sent to the command leaders.

Smart Parking: (a).Traffic observing - to calculate the normal speed of the vehicles which transit over a roadway by taking the time mark at two different points [14,15] .(b). Flow and congestion control. – Understand the flow and congestion of vehicular traffic for well-organized road organizations in cities: reduce journey times, reduce emissions and save energy .

Environmental Monitoring: (a). Prevention and Control Radiation Sensor Network. : It is formed by dozens[16] of sensor devices deployed in the environs of the nuclear power plant and attainment the closest cities. Sensor nodes are installed in street lights and leaves and take influence from the internal battery which, at the same time is recharged using a small stellar panel giving infinite lifetime to the system.
(b). Emergency radiation sensor network. : If a radiation leakage occurs in a place where there is not a previously installed contamination sensor network, an emergency disposition can be done in just a couple of hours. Refuge corps just needs to spread the sensor nodes on the ground at certain places.

Medical and Health : Wireless sensors are used in medicinal and heath area for measurement of blood flow, breathing rate , ECG(electrocardiogram), pulse oxymeter, blood pressure and oxygen extent .

IV. ROUTING PROTOCOLS IN WSNs

Routing in wireless sensor networks differs from conformist routing in fixed systems in various ways. There is no infrastructure, wireless links are untrustworthy, sensor nodes may fail, and routing protocols have to meet strict energy saving requirements [17]. Many routing algorithms were advanced for wireless networks in general.

A. Data Centric Protocols

Data-centric protocols differ from traditional address-centric protocols in the method that the data is sent from source sensors to the sink. In address-centric protocols [18] , each source sensor that has the suitable data responds by sending its data to the sink independently of all other sensors. However, in data-centric procedures, when the source sensors send their data to the sink, intermediate sensors can perform some form of accumulation on the data originating from numerous source sensors and send the aggregated data toward the sink. This procedure can consequence in energy savings because of less transmission required to send the data from the sources to the sink. In this piece, we review certain of the data-centric routing protocols for WSNs.

Directed Diffusion: Directed dispersion [8] is a data-centric routing procedure for sensor query dissemination and processing. It meets the main necessities of WSNs such as energy efficacy, scalability, and strength. Directed diffusion has various key elements namely data naming, interests and gradients, data proliferation, and underpinning. A sensing capability can be confirmed by a number of attribute-value pairs. In the focused diffusion method, in the beginning, the sink specifies a low information rate for future events. After that, the sink can reinforce one particular sensor to send events with a advanced data rate by resending the original interest notice with a smaller interval. Likewise, if a neighbouring [19] sensor receives this attention message and finds that the sender's interest has a higher data rate than before, and this data rate is developed than that of any prevailing incline, it will reinforce one or more of its neighbors [20].

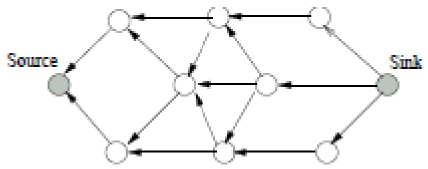

Fig. 2(a): Propagate Interest

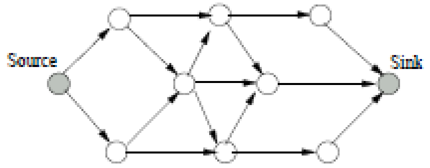

Fig. 2(b): Set up Gradients

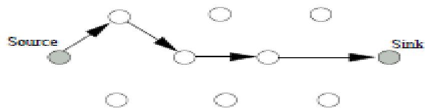

Fig. 2(c): Send data and path Reinforcement

Fig. 2: An example of interest diffusion in sensor networks

Rumor Routing: Rumor routing is a logical [21] compromise between query flooding and event flooding app schemes [22]. Rumor routing is an effectual protocol if the number of queries is between the two intersection points of the curve of rumour routing with those of enquiry flooding and event flooding. Rumor routing is based on the concept of *agent*, which is a long-lived packet that negotiates a network and informs each sensor it encounters about the events that it has cultured during its network traverse. An instrument will travel the network for a certain number of hops and then die. Each sensor, counting the agent, maintains an event list that has event-distance pairs, where every entry in the list comprises the event and the actual detachment in the number of hops to that event from the currently visited sensor. Therefore, when the agent meeting a sensor on its path, it synchronizes its event list with that of the sensor it has met. Also, the sensors that hear the agent update their event lists according to that of the agent in order to preserve the shortest paths to the events that occur in the network.

Cougar: The cougar [23] routing protocol is a database method to tasking sensor networks. The Cougar approach provides a user and application programs with declarative questions of the sensed data produced by the source sensors. These queries are suitable for WSNs in that they abstract the user from knowing the performance plan of its queries. In other words, the user does not know which sensors are contacted, how detected data are treated to compute the queries, and how final results are sent to the user. The Cougar approach uses a query layer where every sensor is associated with a query proxy that lies between the network layer and application layer of the sensor. This query proxy provides higher level services through queries that can be issued from a gateway node. Furthermore, the [24] Cougar approach services in-network processing to reduce the total energy consumption and enhance the network lifetime. .Cougar is more valuable if a set of sensed data could be amassed or fused into a lone one that is more representative and thus noteworthy to the user. The cougar being database approach, it faces few challenges. A network can be viewed as a huge dispersed database stem, where every sensor possesses a subset of data. Hence, current distributed management approaches cannot be applied directly, but need to be modified accordingly.

B. Hierarchical Protocol

Hierarchical or cluster-based routing, initially proposed in wire line networks, are well-known techniques with special compensations related to scalability and well-organized communication. As such, the concept of hierarchical routing is also utilized to achieve energy-efficient routing in WSNs. In a graded architecture, higher energy nodes can be used to process and send the evidence while low energy nodes can be used to perform the sensing in the proximity of the target. This means that formation of clusters and assigning special tasks to cluster heads can greatly contribute to overall system scalability, generation, and energy efficiency. Hierarchical routing is an efficient way to lower energy consumption within a collection and by accomplishment data aggregation and fusion in order to decrease the number of transmitted messages to the BS. Ranked routing is mainly two-layer routing where one layer is [25] used to select cluster heads and the other coating is used for routing. However, most systems in this category are not about routing, rather on" who and when to send or development/combined" the info, channel allocation etc., which can be orthogonal to the multichip routing function.

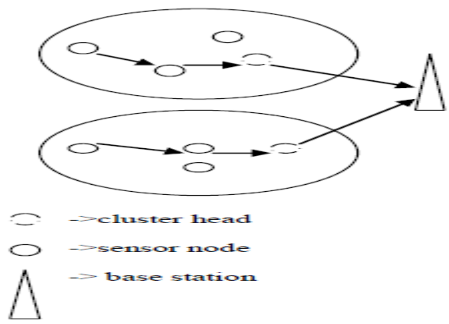

Fig. 3: showing the concept of Hierarchical Protocol

Low-energy adaptive clustering hierarchy (LEACH): LEACH [9] is the first and greatest general energy-efficient hierarchical clustering algorithm for WSNs that was proposed for reducing power consumption.[26] In LEACH, the clustering task is rotated among the nodes, based on duration. Direct message is used by each collection head (CH) to forward the data to the base station (BS). It uses clusters to extend the life of the wireless sensor network. LEACH is grounded on an aggregation (or fusion) technique that combines or collections the innovative data into a smaller size of data that carry only meaningful information to all individual instruments. LEACH divides the a system into several cluster of sensors, which are constructed by using localized coordination and control not only to reduce the amount of data that are transmitted to the sink, but also to make routing and data circulation more scalable and robust. LEACH uses a randomize rotation of high-energy CH position rather than selecting in static method, to give a coincidental to all sensors to act as CHs and avoid the battery depletion of an individual sensor and dyeing quickly. The action of LEACH is divided into rounds having two phases each namely (i) a setup phase to establish the system into clusters, CH advertisement, and transmission schedule creation and (ii) a steady-state phase for data accumulation, compression, and program to the sink.

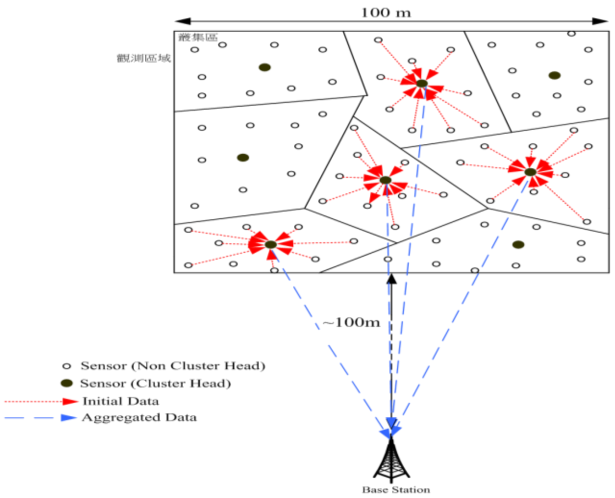

Fig. 4: Showing the Concept of LEACH

Power-Efficient Gathering in Device Info Systems (PEGASIS): PEGASIS is an extension of the LEACH protocol, which forms chains from sensor nodes so that each node spreads and receives from a neighbour and only one node is selected from that chain to communicate to the base station (sink). The data is gathered and moves from node to node, aggregated and eventually sent to the base station. The chain structure is performed in a greedy way. Unlike LEACH, PEGASIS avoids cluster formation and uses only one node in a hawser to communicate to the BS (sink) instead of using multiple nodes. A sensor transmits to its local nationals in the data fusion phase in its place of sending directly to its CH as in the case [27] of LEACH. In PEGASIS course-plotting protocol, the **building phase** assumes that all the sensors have global knowledge about the network, mainly, the places of the sensors, and use a greedy approach. When a sensor fails or dies due to low battery power, the chain is created using the same greedy approach by bypassing the failed sensor. In each round, a casually elected sensor node from the chain will transmit the gathered data to the BS, thus reducing the per round energy expenditure associated to LEACH. Simulation results showed that PEGASIS is able to increase the lifetime of the network twice as much the generation of the network under the LEACH procedure. Such performance gain is achieved through the elimination of the above caused by active cluster formation in LEACH and through decreasing the number of transmissions and greeting by using data aggregation. Though the clustering overhead is avoided, PEGASIS still requires dynamic topology adjustment since a sensor node requirement to know about energy status of its neighbours in order to know where to road its data. Such topology modification can familiarize significant overhead especially for highly utilized networks.

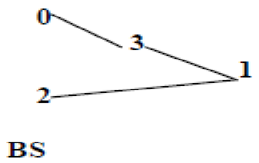

Fig. 5: Chain Construction using the Greedy Algorithm.

Fig shows node 0 connecting to node 3, node 3 connecting to node 1, and node 1 connecting to node 2 in that order. When a knob dies, the chain is reconstructed in the same manner to bypass the dead node.

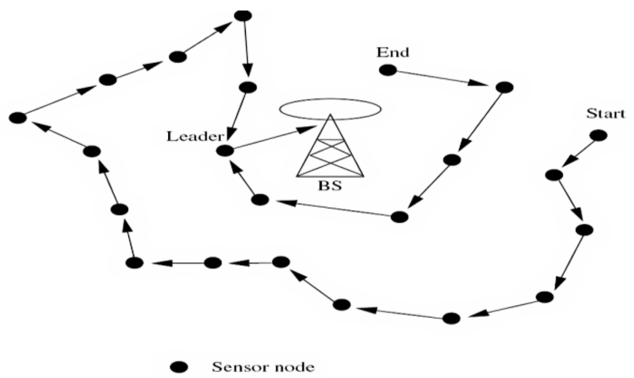

Fig. 6: Showing How PEAGSIS Works

C. Mobility-based Protocols

Mobility brings new challenges to routing protocols in WSNs. Sink movement requires energy effectual protocols to guarantee data delivery originated from source sensors toward mobile sinks. In this segment we discuss sample mobility-based routing protocols for mobile WSNs.

Scalable Energy-Efficient Asynchronous Dissemination (SEAD): SEAD [29] is self-organizing protocol, which was planned to trade-off between diminishing the forwarding delay to a moveable sink and energy savings. SEAD considers data distribution in which a source sensor reports its identified data to multiple moveable sinks and consists of three main machineries namely dissemination tree (d-tree) structure, data dissemination, and upholding linkages to mobile sinks. It undertakes that the sensors are aware of their own physical locations. Every source sensor builds its data dissemination tree rooted at itself and all the distribution trees for all the source sensors are constructed separately. SEAD can be observed as an overlay network that be seated on top of a location-aware steering procedure, for example, geographical forwarding [28].

D. Multipath-based Protocols

Considering data transmission between source sensors and the sink, there are two routing paradigms: single-path routing and multipath routing. In [30,31]single-path routing, each source sensor sends its data to the sink via the shortest path. In multipath routing, each source sensor finds the first k shortest paths to the sink and divides its load evenly among these paths. In this section, we review a sample of multipath routing protocols for WSNs.

E. Heterogeneity-based Protocols

In heterogeneity device network architecture, there are two types of sensors namely line-powered sensors which have no liveliness limitation, and the battery-powered sensors having limited lifetime, and hence should use their accessible energy proficiently by minimizing their potential of data communication and computation. . In this section we deliberate uses of heterogeneity in WSNs to encompass network lifetime and present a few routing protocols.

Information-Driven Sensor Query (IDSQ): IDSQ [30,31] addresses the problem of heterogeneous WSNs of maximizing information gain and diminishing detection latency and energy consumption for target localization and tracking through dynamic sensor querying and data routing. To progress tracking accuracy and reduce detection latency, communication between sensors is needed and consumes momentous energy. In order to conserve power, only subsets of sensors need to be active when there are interesting events to explosion in some parts of the network. The choice of a subset of active sensors that have the most useful information is balanced by the communication cost needed between those sensors. Useful information can be sought based on expecting the space and time interesting events would take place. In IDSQ protocol, first step is to choice a sensor as leader from the collection of sensors. This leader will be responsible for selecting optimal sensors based on some information utility measure.

Cluster-Head Relay Routing (CHR): CHR routing protocol [33] uses two types of devices to form a mixed network with a single sink: a large number of low-end sensors, denoted by L-sensors, and a small quantity of commanding high-end sensors, denoted by H-sensors. Both types of sensors are static and conscious of their places using some location service. Moreover, those Land H-sensors are uniformly and randomly distributed in the sensor field. The CHR procedure partitions the assorted network into groups of sensors (or clusters), each being collected of L-sensors and led by an H-sensor. Within a cluster, the L-sensors are in charge of sensing the underlying environment and advancing data packets invented by other L-sensors toward their cluster head in a multi hop fashion. The H-sensors, on the other hand, are accountable for data fusion within their own clusters and forwarding aggregated data packets invented from other cluster heads toward the sink in a multi hop fashion using only cluster heads. While L-sensors use short-range data transmission to their neighbouring H-sensors within the same cluster, H-sensors perform long-range data communication to other neighbouring H-sensors and the sink.

F. QoS-based Protocols

In addition to minimizing energy ingesting, it is also important to consider excellence of service (QoS) requirements in terms of delay, reliability, and fault acceptance in routing in WSNs. In this segment, we review a sample QoS based routing protocols that help find a balance between energy ingestion and QoS necessities.

V. CONCLUSION

One of the primary difficulties in the outline of steering conventions for WSNs is vitality productivity because of the rare vitality assets of sensors. A definitive goal behind the directing convention outline is to keep the sensors working for whatever length of time that conceivable, accordingly augmenting the system lifetime. The vitality utilization of the sensors is commanded by information transmission and gathering. In this way, directing conventions intended for WSNs ought to be as vitality effective as could be expected under the circumstances to drag out the lifetime of individual sensors, and subsequently the system lifetime. In this paper, we have studied an example of taking so as to steer conventions into record a few arrangement criteria, including area data, system layering and in-system preparing, information centricity, way excess, system elements, QoS necessities, and system heterogeneity. For each of these classes, we have examined a couple case conventions.

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