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Energy Efficient Routing in Wireless Sensor Network

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Abstract*— Wireless Sensor Networks (WSN) has realized the benefit of considerable research in recent times because of their multidimensional applications in both civilian and military purposes. However, providing a flexible service using the wireless sensor network is difficult because they usually contain a large number of resource constraints sensing nodes with small memory, less processing capacity and life of the extremely limited battery. This paper presents a comprehensive survey of existing routing systems and proposes an effective approach to data communications such limited resources for sensor network. The most important characteristic of a routing protocol in order to be effective for sensor networks is energy consumption and extending the term system life. In recent years, much energy efficiency routing protocols have been proposed for sensor networks.

Keywords*— Wireless Sensor Networks, Power Consumptions, Data Communication, Energy Efficiency, Routing, Cluster Coordinators.

I. INTRODUCTION

Wireless sensor networks (WSN) mostly includes large number of small battery powered devices ultra low cost that few energy resources, low computing power, limited storage, and weak communication skills [1], [13]. Due to different applications like agricultural monitoring, and network fire detection sensors are deployed in no of areas to sense events of interest and provide more multi-hop data paths reports wirelessly to the destination. Engineering and data management is necessary for these critical applications to work in unsupervised and even hostile environments. WSNs can be used for data collection in situations like environmental monitoring, habitat monitoring, monitoring, structural monitoring, diagnostic equipment, disaster management and response to emergency [1], [2], [5] and [13].

Since then, a lot of work in the field of sensor networks was carried out resulting in the development of sensor networks on a wide variety of applications and systems with significantly different requirements and features. The different routing protocols of energy efficient are developed for sensor networks to support the effective delivery of data to their destinations. Thus, each energy-efficient routing protocol may have specific features depending on the application and the network scenario. Sensor networks are used in a no. of activities of daily services. In the area of monitoring, WSN is deployed on a region to monitor a mechanism. Experimentally use of sensor network could be a military use sensors to detect intrusions of the enemy. In case the sensors sense an action (change in heat or high blood pressure), and then the action is at a time given to the base station, which takes the action (send a message over the Internet or a satellite). Same use area may be detecting air pollution where sensor networks are deployed in several cities to control the concentration of dangerous gases to citizens. A WSN can be used for the monitoring of forest fires to control when a fire started. The nodes will be equipped with sensors to detect temperature, humidity and gases that are generated by the fire in the vegetation. An important field of use of above mentioned is the health area. The sensor networks can give significant cost savings and enable new features that will help seniors who live along the house or people with chronic disease on daily works. The installation of a sufficient number of sensors in wired system is often limited by the cost of the wiring. Last inaccessible areas, rotating parts, restricted areas, and mobile assets can be possible with wireless sensor.

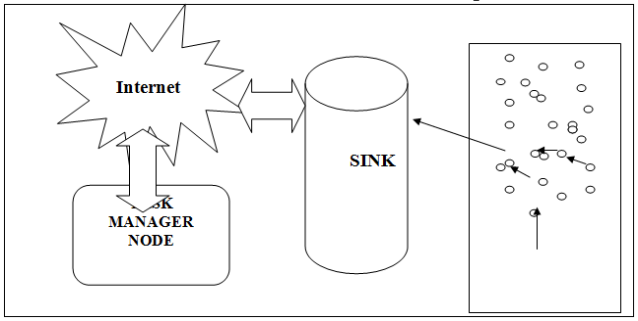

Figure 1. General Sensor Network

As the main use of a wireless sensor network is to be used in data collection and monitoring of the action, it is very useful for sensor networks to effectively communicate data using minimum resources, including the power consumption of battery, bandwidth, internal storage and the processing speed. So, any data routing sensor network should focus on

issues including simple processing, low communication load at least reduced storage consumption and thus ensure reduced energy consumption.

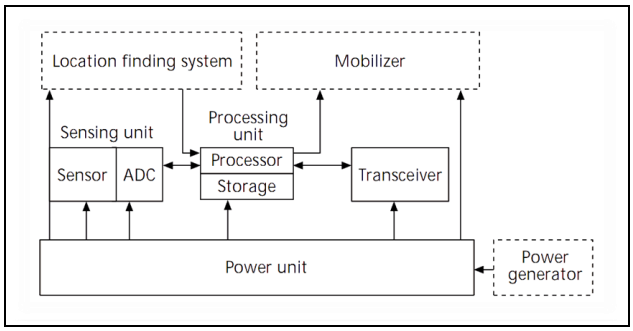

Figure 2. Components of a Sensor Network

II. RELATED WORK

This section provides an overview of the basic network concepts of wireless sensors and data compression in the investigation of the need for data compression for wireless sensor networks.

A. Sensor Networks

Wireless sensor networks are usually composed of hundreds and thousands of nodes of individual tiny sensors that are often densely deployed in extensive fields. These nodes have the capability to collect data and send data to other nodes or adjacent components involved in serving the common goal of the network system. Each sensor node having four basic generic components: monitoring unit, the processing unit, a transceiver unit and the power unit. Monitoring units consist of two subunits one is the sensors and second is an analog-to-digital converter. The analog signals generated by the sensors on the basis of the detection objects and pattern detection and are converted into digital signals by the analog-to-digital converter. These digital signals are then entered into the processing unit which is generally associated with storage unit small portion aspects of calculation. The processing unit handles applications and procedures that make the sensor node collaborate with other nodes to complete assigned tasks monitoring. Transceiver unit is used to connect the node to the network. One of the very important parts of a sensor node is the power unit which can be supported by the power scanning devices like solar cells. There are further units that are used as Location tracking system and power generation systems are often integrated with the sensor nodes to achieve functionality. Sensor networks are routing strategy adopted is also considered as a design criterion. That is, each routing algorithm considers the subjects of observation and also provided at the same time, the internal architecture of the sensor. However each routing technique considered more common and essential characteristics as ensuring maximum life of the sensor by minimizing the energy consumption by reducing the transmission of redundant data. The action of maintaining roads in sensor networks is not trivial that the restrictions of energy and sudden changes in the node status cause frequent and unpredictable topology changes. [1]

B. Sensor Networks and Ad hoc-Networks

Although the sensor network applications require ad hoc technical wireless network, there are several differences between the sensor network and ad-hoc networks. In general, a large number of small sensor nodes which are limited in power, processing capacities and storage are densely deployed in the field of interest while in the case of an ad-hoc network normally the number of nodes is normally not so huge. The sensor network topology changes frequently and the nodes are prone to failures which make it comparable sensor network in ad-hoc network. In addition, in case of sensor nodes of the communication paradigm is mainly diffused or semi-broadcast communication, whereas in the case of ad hoc point to point communication networks are the most probable.

C. Advantages and disadvantages of sensor networks

There are many advantages that make a huge sensor network of interest. Firstly, the sensors are extremely small in size, which makes it usable in various places for various applications. Since network configurations can be made without fixed infrastructure, it is considered as an ideal solution for hard-to-reach places like through deserts, mountains, deep forests, the sea, rural areas and so on. In addition, sensor networks are not only flexible node additions, removal, but also cheap to implement and develop. So, there are several challenges in sensor networks, including security, energy consumption, speed and configurations. Since then, the network can be formed independently; it is extremely vulnerable to attackers. Since power consumption is the most important issue for wireless sensor networks, processing capacity and speed are often compromised.

III. ROUTING IN WSN

A sensor network design is influenced by many factors, including fault tolerance; scalability; production costs; operating environment; sensor network topology; material constraints; transmission media; and energy consumption [2]. There are several routing techniques for wireless sensor networks. Most recent routing approaches proposed energy aware routing. These routing techniques can be classified according to different points of view. However, most of the literature differentiates routing algorithms into three main categories, including data centric approaches based

hierarchical cluster routing techniques and location-based routing. To transmit data in sensor networks, flooding and gossip are two basic mechanisms. In the event of flooding, each sensor node receiving a data packet broadcasts to all its neighbors that continues until the packet reaches the destination or the maximum number of hops for the packet is reached. On the other hand, gossip is a slightly improved version of flooding where the receiving node sends the packet to a randomly selected neighbor instead of whole nodes, which taken at random another neighbor to transmit the packet to and so Following [1].

A. Based Data Centric flat routing protocols

In approaches routing data centric normally the WSN is considered stable network since all nodes have the same role in the collection and reporting of data. Hierarchical protocols are designed to form clusters and selecting proper ammunition heads on the basis of certain criteria so that the cluster leaders can do some aggregation and data reduction to save energy and also maintain data integrity. If location-based protocols, relative position information is taken into account to communicate data to desired regions rather than the whole network and maximize sensor lifetime and [1]. Data centric routing protocols, SPIN (Protocol information via negotiation sensor) and Directed Diffusion are two widely adopted plans. The main advantage of a database that is centered routing dish is that the overall approach is very simple and does not focus on specific nodes and also tends to minimize energy consumption. However, the problem with a data-centric approach is that it works well for static nodes, but these approaches are not designed to handle mobility or nodes or the sink. Apartment based routing systems cannot handle complex queries. Scalability and data aggregation is also a point of limitation for data-centric approaches.

A.1. SPIN (Protocol sensor information via negotiation)

The concept of SPIN (Protocols sensors for information via negotiation) is mainly based on the naming of data using high-level descriptors or metadata. Before transmission, meta-data is exchanged between the sensors using a direct mechanism of advertising data. When a node receives new data, he announced ADV (advertising) message to its neighbors and interested neighbors. Here interested neighbors are defined as nodes that do not have data. Nodes interested send a request message to retrieve the data. The main advantage of SPIN is, it makes it much easier in achieving energy efficiency because the metadata negotiating proposed SPIN solves the classic problems of flooding such as redundant information passing overlapping detection zones and blindness resources. SPIN second feature is that the topological changes are localized for each node needs to know that its single-hop neighbors. The main criticism is data advertisement SPIN mechanism cannot guarantee data delivery. As the distribution of data is based on neighbors and interested neighbors, if the actual nodes that are interested in the data are far from the source node and the nodes between the source and destination are not interested in this data, these data will be not delivered to the destination at all.

A.2. DD (Directed Broadcast)

Directed Diffusion is essentially improved SPIN. If Directed Diffusion, the sink node request of the interested data broadcasting a request message to the nodes. This request message is delivered to a fashionable node in a multi-hop and each node is informed of the request of the sink. Each node also maintains a gradient to the node from which it received interest. When the data reaches the sensor (s) is intended, and in particular the detection is performed, data is sent to the sink. When there are multiple paths to the sink, some performance metric is used to decide on the optimal path. This decision by the intermediate nodes perform some data network processing tasks such as data aggregation based on the name and value attributes hearing some energy savings. Although this is a point of advantage, it also raises the issue of some power consumption during data aggregation.

A.3. Transfer active query in sensor networks (ACQUIRE)

Transfer active query in sensor networks (gain) is a basic question Technical floods that maintains a clear distinction between the distribution of request and response steps of collecting is to some extent similar to previous regimes. The main idea behind ACQUIRES lies in the visualization of sensor network as a distributed database and thus broadens the scope to work with complex queries that may consist of several sub-queries. For questions raised by the sink each node first tries to respond using their pre-cached information and then sends it to other nodes neighboring sensors. For nodes that do not have updated data, the node gathers data from their neighbors in look-ahead earrings. Here can go to the network size to any lower value. The request is to travel more hops to any lower value of d. When the query is solved completely, it is returned to the sink or through the reverse path or via the shortest path node to the sink. The underlying impetus for ACQUIRE handles one-shot queries with jurisdiction where the answer may consist of many nodes. Although the establishment of as the maximum (ie equal to the network size) allows ACQUIRE behave like generic flood approaches, varying parameter makes it much more efficient system by limiting flooding to treatment of one-shot queries.

B. The Routing Rumor

The protocol is a rumor energy efficient routing protocol based on a diffusion scheme directed. This technique is used for the sensor network include densely distributed of the fixed infrastructure, and there are bidirectional links. When geographic information is not available, the routing rumor is also a prime candidate. The packet routing algorithm rumored long-term use, called agents floods through the network. After detecting an event, it adds such event to its local table known as the event table name, and generates an agent. The network is traversed by the agent on a random path with the related event information. They visited nodes form a gradient to the event. Rumor only maintains a routing path between the source and destination. The main advantage of routing rumor is, it works very well when the number of events is lower than in a number of events, the cost of maintenance and event table's agents becomes impossible.

Hierarchical routing protocols based Cluster B. The main idea of hierarchical routing protocols (also known as the routing protocol on the basis of the cluster) is the sensor nodes of the group based on some appropriate criteria. cluster-based protocols normally chosen as node (s) with higher residual energy as the leader (s) of the cluster which facilitates the efficient distribution of energy. Protocols based cluster mentionable include Low Energy Adaptive Clustering Hierarchy (Leach) Life saving energy in Sensor Information Systems (PEGASIS) Threshold sensitive Energy Efficient sensor network protocol (TEEN).

B.1. Low Energy Adaptive Clustering Hierarchy (Leach)

LEACH is one of the first self-organization of hierarchical clustering protocols that apply randomization to spread the load of energy between the sensor nodes in the network concerned. LEACH protocol assumes that all nodes are homogeneous and they can transmit with enough power to reach the base station and each node also has enough computing power. It is also assumed that the base station is fixed and the observation nodes correlates. The main idea of LEACH is the formation of sensor nodes cluster based on the strength of the incoming signal, and leaders of local groups are used as routers to the sink. The power saving phenomenon is carried out using these transmissions by clusters, rather than only the sensor nodes. It is also estimated that 5% of the nodes will be the optimal amount for ammunition nodes [5]. One of the interesting features of LEACH has the flexibility to randomly change the cluster leaders. Balance the energy dissipation from the nodes with respect to time through this system also allows LEACH an important approach. The sensor nodes themselves elect to be cluster heads at one time with a certain probability. At each interval the decision whether a node rises to cluster head is made dynamically and only by each independent node of the other nodes to minimize overhead in establishing the cluster head.

B.2. TEEN (Network Threshold sensitive Energy efficient sensors)

TEEN cluster is a routing protocol based on the basis of which it improves LEACH simultaneously transferring data less frequently. The network is considered as mere nodes collection munitions heads first-level and second-level cluster leaders. LEACH strategy used in this protocol for the formation of clusters. After the formation of clusters, cluster head broadcasts thresholds both hard and soft thresholds knowledge to all nodes; which are the key element of adolescence. Hard threshold is the minimum threshold used to trigger a sensor node to activate its transmitter and thus transmitted to the cluster head. Thus, the hard threshold will ask the sensor node to perform the transmission if the attribute is detected within the required range and reduces the number of significantly transmissions. When a node detects a value to or beyond the hard threshold, data is transmitted only when the attribute changes from greater than or equal amount to the soft threshold. This is to limit the number of reduced soft frequent transmissions even after the disk threshold is crossed if there is no change or little change in the value of the attribute detected with a low threshold. A brief comparison on the basis of various schemes above performance parameters was presented in Table 1 [1], [2], [5], [18].

Table 1: Comparison of Routing Protocols for Wireless Sensor Networks

Protocols Feature	*SPIN*	*Directed Diffusion*	*ACQUIRE*	*Rumour Routing*	*LEACH*	*TEEN*
Type	Flat	Flat	Flat	Flat	Hierarchical	Hierarchical
Scalability	Low	Low	Low	Good	Good	Good
Data Delivery	Event driven	Demand driven	Demand driven	Demand driven	Demand driven	Threshold
Data Delivery Confirmation	No	Yes	No	Yes	No	No
Efficient Power Usage	Low	Low	Low	Low	Good	Good
Network Lifetime	Good	Good	Good	Very good	Very good	Very good
Overhead	Low	Low	Low	Low	High	High
Mobility Support	Good	Limited	Limited	Limited	Limited	Limited
Optimal Route	No	Yes	No	No	No	No
Hop Communication	Single-Hop	Multi-Hop	Multi-Hop	Multi-Hop	Single-Hop	Single-Hop

IV. CONCLUSION

In this paper, we presented an overview of existing research on the data communication network sensor-based approaches i.e. routing. We use cluster coordinators to reduce the overhead imposed on the cluster head. Since the cluster coordinators performs any calculation and intra-cluster munitions management while heads perform inter-cluster computing, management and transmission, it provides balanced energy consumption and improves the lifetime of the network. Future work can be devoted to the implementation of this scheme for sensor networks with mobile infrastructure. Specific measures may also be taken to optimize the inter-cluster communication paradigms.

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