Improve the QoS of Networks Using Advanced Hybrid Routing in WSN

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ABSTRACT: This project is enhancement of many to one transmission with power aware routing protocol. This work focuses on single sink based WSNs, in which a WSN is composed of a number of sensor nodes associated with a single sink node. The primary role of sensor nodes is to gather data of importance from its surroundings. In this work, we consider a WSN design that is practical, and low cost. We propose Advanced Hybrid Multi-hop routing (AHYMN) to mitigate the impact of sink node isolation. To our best knowledge, this is the first design that considers a hybrid multi-hop routing architecture1 given below.

      Although flat multi-hop routing algorithms enable routing of data in a fashion that minimizes the power consumption of the WSN, they fail to exploit the data aggregation opportunities by virtue of data collected from the WSN. In many WSN applications with the relatively high node density, the data collected by individual nodes are highly redundant, thus making data aggregation a very attractive scheme in WSNs. Hierarchical multi-hop routing algorithms aim to capitalize on the highly correlated nature of WSN's collected data. We describe the operation of the most notable example of hierarchical multi-hop routing algorithms, from that we can improve the routing efficiency and channel allocation in cluster networks. The cluster head selection is obtained based on energy level and routing efficiency of the network. We compare the various parameters like Cluster head size, energy, time, packet loss etc., with conventional methods (existing methods)

I. INTRODUCTION

      In recent years, with the rapid development of wireless communication technology, and the miniaturization and low cost of sensing devices, it has become feasible to employ Wireless Sensor Networks (WSNs). WSN is a group of sensors equipped with transmission capable devices that are deployed in great numbers to monitor areas of interest. The general structure of a WSN is composed of a set of sensor nodes and a sink node. The role of sensor nodes is to gather data from their surroundings and send them to the sink node. In addition, the sensor nodes also assume the role of relaying data by virtue of infrastructure less nature of the network. On the other hand, the general role of the sink node, which can be mobile or immobile, is to act as a data assembly point in which data is extracted from the network. A significant limitation of current sensor nodes is low battery capacity; as a direct consequence, efficient use of the sensor node's energy reserve is essential. The sensor node utilizes its built-in battery for communications and sensing; in the occasion of battery's exhaustion, the sensor's functionality stops. In such an occasion, part of the networks functionality is lost; also note that changing batteries of a large number of sensor nodes over wide areas in unsafe terrain is practically infeasible. Consequently, much research has been focused on maximizing the lifetime of the sensor network; however, most of the previous works do not take into account the isolation of the sink node, caused by the death of its surrounding nodes. In the case where the sink is mobile, the load can be balanced over all nodes in the network, and the problem can be avoided by changing the migration route of the sink node to gather data from most of the living nodes as in KAT [1]; this problem cannot be avoided if the sink node is immobile. However, it is possible to mitigate this problem by controlling the routes of data transfer that largely affect the variance of individual power consumption of each sensor node, especially inside the

high load areas. The objective of our research in this paper is to extend the network lifetime of WSNs via a better routing algorithm. In this paper, we propose a routing algorithm that assumes that the sink is immobile and demonstrate its effectiveness through mathematical analysis and computer simulations. The rest of this paper is organized as follows. Section II reviews existing multi-hop routing algorithms for WSNs, and describes the sink isolation problem.

II.MULTI-HOP ROUTING ALGORITHMS FOR WIRELESS SENSOR NETWORKS

In general, in order to maximize the WSN's lifetime, the total power consumption of the network should be minimized while ensuring fair power consumption among nodes. Much effort has been focused on WSN multi-hop routing algorithms, and many algorithms have been proposed. These may be widely categorized as flat multi-hop routing algorithms and hierarchical multi-hop routing algorithms.
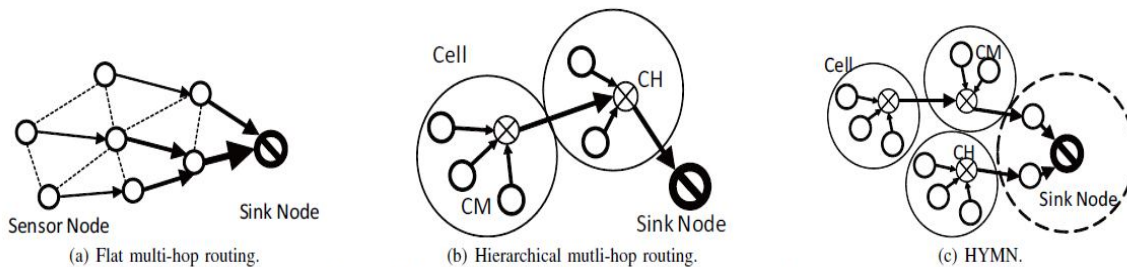

Fig. 1. Different categories of WSN multi-hop routing algorithms.

Fig. 1(a) shows an example of how flat multi-hop routing is used to send data. In the figure, an arrow's thickness is proportional to the amount of data being sent over the corresponding link. Each sensor node has the ability to communicate over a bounded area with other sensor nodes. Link utilization differs
greatly among different algorithms. For example, algorithms proposed in [2], [3] have been designed to minimize the total power consumption of the network as the objective; in this kind of algorithms, the cost of using a communication channel is defined by the following equations.

$$linkcost(i, j) = es(i) + er(j)$$

Here, $linkcost(i, j)$ is defined as the amount of energy consumed for sending a unit of data from node i to j. $es(i)$ is the energy consumed by node i while sending a unit of data to node j; this value is proportional to the square of $d_{i,j}$, which is the distance between nodes i and j. $er(j)$ is the energy consumed by node j in receiving a unit of data. By using the route where the sum of all link costs is minimized, the WSN's total power consumption can be minimized. From a different perspective, these algorithms pose an inherent problem, i.e., certain nodes are over-burdened, and thus consume their energy in a rapid manner. An effective algorithm [4], which uniformly distributes power consumption over each node, aims to address this problem. The following equation is used to define the link cost.

$$linkcost(i, j)uniform = linkcost(i, j) / Eni.$$

By using the residual power of the sending node, Ei, as the denominator of the link cost, the possibility of it being selected as a relay node decreases as its remaining energy decreases. Toh [2], set n to be 2. It is possible to uniformly distribute power consumption over individual nodes and at the same time to minimize overall power consumption. Besides the previously mentioned algorithm, others such as *zPmin* [3] and max–min T [4]–[5] have also been proposed.

B. Hierarchical multi-hop routing algorithms

In hierarchical multi-hop routing algorithms, sensor nodes assume different roles. Here, we briefly review the most notable example of hierarchical multi-hop routing algorithms, dubbed Low-Energy Adaptive Clustering Hierarchy (LEACH) [6], as an example for explanation. LEACH is a two-layered hierarchical multi-hop routing algorithm. Each node can take on the role of a Cluster Head (CH) or Cluster Member (CM). In addition, each node's role can be renewed in a time interval, referred to as a round. In each round, each node can declare itself as a CH with a certain probability; otherwise, the node behaves as a CM. A network is divided into a number of clusters, called cells. CMs communicate with the CH that controls the cell to which they belong. Each CH aggregates and compresses the data received from CMs within the cell that it controls, and sends it to the sink node. In LEACH, since CHs initiate communication directly to the sink node, the transmission distance between the sink node and each CH tends to be large, thus draining the battery quickly; Multi-hop LEACH (M-LEACH) [7] has been proposed to mitigate this problem, as shown in Fig. 1(b). In M-LEACH, minimizing the power consumption of the CHs by means of multi-hop communications, can obviously delay their power exhaustion. While CHs are determined randomly in LEACH, changing the principle that governs how CHs are selected can decrease power consumption, as in HEED [8] and PEACH [9]. In hierarchical multi-hop routing algorithms, since the number of relay nodes used to convey data to the sink node is relatively smaller than that in flat multi-hop routing algorithms, the length of the communication distance of each hop becomes greater, and thus requiring higher power to transmit a unit of data. Nevertheless, hierarchical multi-hop routing algorithms are a promising approach in terms of their capability to use data compression to reduce the power consumption of the network by reducing the data flow.

C. Sink node isolation problem in WSNs

In multi-hop routing algorithms, nodes that are within the maximum transmission range of the sink node form the subset of nodes that enable the sink node to gain connectivity to the network. We refer to the area, which contains these nodes, as the Sink Connectivity Area (SCA). As illustrated in Fig. 1(a), since the amount of data relayed per node increases as nodes become closer to the sink node, leading to quicker power exhaustion of these nodes than others. When all of the nodes located in SCA die, the sink node can no longer gather data from other alive nodes due to the lack of available routes between the sink node and the rest of the network; this is equivalent to the breakdown of the network deployed to gather sensed data. In other words, to evaluate the network lifetime exactly, it is essential to take into account the influence of the sink node isolation problem, while most of previous works have only investigated the surviving rate of nodes in the network. Therefore, we propose an algorithm designed with the consideration of the impact of the sink node isolation problem in order to improve the longevity of the network.

III. HYBRID MULTI-HOP ROUTING ALGORITHM

In general, since the number of sensor nodes in the SCA is much smaller than that outside the SCA, the amount of data generated by the nodes in the SCA can be negligible as compared to the volume of data flowing into the SCA from outside. This implies that most of the power consumption in the SCA is due to transferring the data that comes from outside the SCA to the sink node. In other words, in order to limit the power consumption in the SCA, the amount of data flowing into the SCA needs to be reduced, and/or the power consumption to relay the data from outside the SCA to the sink node needs to be minimized. In fact, the proposed scheme, referred to as HYbrid Multi-hop routiNg (HYMN), illustrated in Fig. 1(c), aims to achieve the effect of both solutions by employing a hierarchical multi-hop routing algorithm outside the SCA and using a flat multi-hop routing algorithm inside the SCA.

A. Routing outside the SCA

Since the transmission power is proportional to the volume of data, it is important to reduce the volume of data that enters the SCA; this can be achieved by using a data compression mechanism. If there is any relationship among data, it can be aggregated and compressed; the compression ratio depends on the correlation of the data and can be derived from the maximum mutual information. In the case of environmental monitoring which collects information on temperature, humidity, and atmospheric pressure, it has been widely known that data collected from neighboring areas have a strong correlation that can lead to high compression ratio. From the above discussion, HYMN employs a hierarchical multi-hop routing which is an appropriate strategy to perform efficient data compression to reduce the amount of data flowing into the SCA.

B. Routing inside the SCA

In the SCA, the most important aspect in routing is to minimize the power consumption while transferring the data coming from outside the SCA to the sink node. Fortunately, this can be completely achieved by adopting a flat multi-hop routing scheme in the SCA.

C. Optimal location of hybrid boundary

Herein, we consider the optimal location of the hybrid boundary, where the employed routing algorithm is switched from flat to hierarchical and vice versa. To derive the mathematical formulation representing the effect of the hybrid boundary on the performance of power consumption in the SCA.

IV. ADVANCED HYBRID MULTI-HOP ROUTING PROTOCOL

This protocol is interconnecting the Flat multi-hop and hybrid multi-hop. Where in this approach the next cluster head is search and found in the same range of height in the plane. In the flat multi-hop the source to destination the distance is fixed and the time is more. In the hybrid multi-hop finding the cluster head in zic-zac manner and the distance is unknown and time is also unknown. So when we combine both approaches the time, distance are known and the searching is happening in a certain height and certain range, so we are saving the energy and power consumption. Hence we are saving the life time of the network

V.NETWORK MODEL

In this paper, we propose to use the hybrid architecture to achieve both adaptively to changing traffic and low channel switching overhead. Let G (V, E) be the network topology, where V is the set of mesh routers and E represents pairs of mesh routers that are within radio communication range. Assume each mesh router has multiple interfaces. In the hybrid architecture, we let one interface of each mesh router be able to switch channel frequently, and let the other interfaces work on fixed channels. In the rest of this paper, we call the former interface as dynamic interface, and the latter as static interface. Fig. 1 illustrates a hybrid multichannel multiradio wireless mesh network. Most mesh nodes including the =gateway have 3 interfaces, and a few boundary nodes (c, g, I, f) have 2 interfaces. For each mesh node, one interface works as dynamic interface, and the others work as static interfaces. The channel allocation of static interfaces aims at maximizing the throughput from end-users to gateways, which usually constitutes a major portion of the traffic in the network. Some heuristic algorithms, such as [10], could be used. In the algorithm, a load balanced tree is constructed for each gateway. The goal of the tree construction is to allocate bandwidth fairly to each user with regard to the user-gateway throughput. After the topology has been constructed, each link can then be assigned channels.
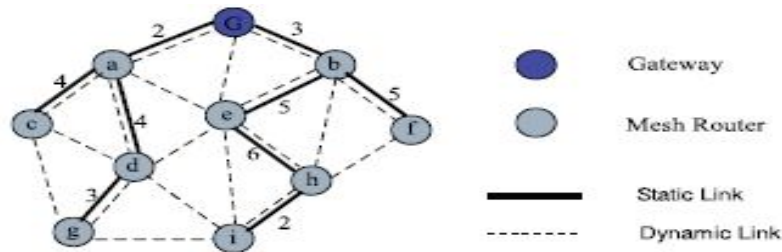
Fig. 1. The hybrid WMN architecture.

The links closer to the gateways are given higher priority to be allocated with less congested channels. In Fig. 1, the tree topology is shown in bold lines, and we call these links as static links. The channels assigned to static links are also shown in the figure. Dynamic interfaces work in an on-demand fashion. Two dynamic interfaces that are within radio transmission range of each other are able to negotiate a common channel and communicate when they have data to transmit. We call these links as dynamic links. Fig. 1 illustrates all possible dynamic links in dotted lines. As we are considering hybrid architecture, the dynamic channel allocation should be aware of the interference from the static interfaces, which requires some additional considerations in the protocol design.

- All dynamic interfaces need to negotiate on a default channel in each control interval. As the control interval is very important for dynamic channel allocation, we should eliminate the interference from static interfaces in this phase. Thus, we exclude this default channel in the channel allocation of the static interfaces. Note that this will not harm the channel usage efficiency of the whole system, because dynamic interfaces can still use this default channel in the data interval.
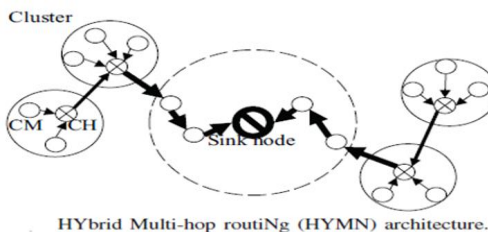
- The data channel is determined by choosing the "least congested channel" in the neighborhood of the communicating pair. As dynamic interfaces negotiate on the same default channel in each control interval, each interface can be aware of the channel usage of their neighboring dynamic interfaces by listening on the default channel for their communication demands. However, they cannot know the channel usage of nearby static interfaces in the same way. To solve this "hidden terminal problem" in the multichannel environment, we can take advantage of the static nature of wireless mesh networks. As wireless mesh networks usually have static topology, each mesh node can maintain a stable list of other mesh nodes within its interference range. (Note that the list of interfering neighbors may change due to the change in the radio environments. However, it is not varying frequently, so we can assume that it is stable in a period of time. The list can be updated by rediscovering the radio environment periodically.) We can let each mesh node measure the channel usage of its static interfaces periodically, and send this information to all the other mesh nodes within its interference range. Thus, the dynamic interface of each mesh node is able to know the channel usage of static interfaces within its interference range. There are several advantages of using this hybrid architecture.

- If purely static channel allocation strategies are used, the connectivity of the original network topology may be degraded; this can lead to suboptimal routing paths. By using one dynamic interface in each mesh node, the connectivity of the network topology can be well maintained, because each dynamic interface is able to communicate with any other interface within radio transmission range.

- Purely static channel allocation strategies cannot adapt to the frequently changing network traffic. For example, in the tree topology, if the users of the left subtree happen to generate a much larger amount of traffic than the users in the right subtree, then the links in the left subtree get more congested. The use of dynamic links is able to direct traffic around the congested areas and therefore achieve better load balance in the network.

VI. BLOCK DIAGRAM FOR HYMN

Although flat multi-hop routing algorithms enable routing of data in a fashion that minimizes the power consumption of the WSN, they fail to exploit the data aggregation opportunities by virtue of data collected from the WSN. In many WSN applications with the relatively high node density, the data collected by individual nodes are highly redundant, thus making data aggregation a very attractive scheme in WSNs. Hierarchical multi-hop routing algorithms aim to capitalize on the highly correlated nature of WSN's collected data. We describe the operation of the most notable example of hierarchical multi-hop routing algorithms, dubbed Low-Energy Adaptive Clustering Hierarchy (LEACH), for illustrative purposes. In LEACH, nodes are organized in a two-level hierarchy, where their roles differ according to which level they belong to. That is, a node can be a Cluster Head (CH) or a Cluster Member (CM), and these roles are changeable in a unit of time referred to as a round. To implement the Advanced HYMN routing approaches in Mesh Network to improve the life time and QOS of the network through routing. Clustering approaches are used to increase the number of nodes in network. CH (channel head) selection is based on dynamic (based on highest energy level in every node). To reduce the routing distance through the clustering approaches (packets transfer from CH to Sink node (receiver node)).

HYbrid Multi-hop routiNg (HYMN) architecture.

VII. PERFORMANCE EVALUATION

We performed simulations in NS2. The Hyacinth extension [11] was used to support multiple channels and multiple interfaces per node in the simulator. We made further extensions to support dynamic channel switching on each interface. In this section, we first evaluate ADCA by comparing it with MMAC. After that, we evaluate the hybrid wireless mesh network and compare it with purely static and dynamic architecture. Evaluation is based on impact of number of nodes and impact of number of channel also the impact of number of interfaces. To clarify the influence of the hybrid boundary location on the performance of HYMN, we conducted simulations by varying the distance, r, between the sink node and the hybrid boundary, and examined the changes in the power consumption in the SCA. To evaluate the performance of HYMN with respect to both flat and hierarchical multi-hop routing algorithms, the transmission distance of each node and the amount of traffic relayed by each node in each strategy is investigated.

VIII. CONCLUSION

In this paper, we have proposed a hybrid wireless mesh network architecture, where each mesh node has both static and dynamic interfaces. We consider a WSN design that is practical, and low cost. We propose Advanced Hybrid Multi-hop routing (AHYMN) to mitigate the impact of sink node isolation. To our best knowledge, this is the first design that considers a hybrid multi-hop routing .Although flat multi-hop routing algorithms enable routing of data in a fashion that minimizes the power consumption of the WSN, they fail to exploit the data aggregation opportunities by virtue of data collected from the WSN. We proposed HYMN to mitigate this problem by combining flat and hierarchical multi-hop routing algorithms. In many WSN applications with the relatively high node density, the data collected by individual nodes

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