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MOBILE SENSOR NODES IN A HIERARCHICAL MOBILE WIRELESS SENSOR NETWORK ARCHITECTURE

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Abstract- Users, sink nodes, and sensor nodes are all considered static in typical wireless sensor networks, and networks are arranged in the form of single-layer planar networks, which cannot adapt to the use of sensor nodes with mobility. This article begins with a discussion of network architecture, then moves on to a discussion of traditional wireless sensor network architecture, as well as the application scenario for mobile sensor nodes. Then we present a wireless sensor network design with mobile sensor nodes. A high-end node layer and a low-end node layer make up the architecture. The high-end nodes are in charge of data routing, while the low-end nodes are in charge of sensing and reporting data, allowing the mobile sensor nodes to be freed from the tedious calculation and execution of routing and effectively increase network performance The simulation findings show that a hierarchical mobile wireless sensor network may significantly minimize sensor node energy consumption and data transmission latency.

Keyword-flat mobile wireless sensor network; Hierarchical mobile wireless sensor network; wireless sensor network; mobile wireless sensor network; mobility; mobile sensor node..

I. INTRODUCTION

Wireless sensor networks have steadily become a research hotspot as wireless network technology matures and is fully supported by small, micro-mobile devices. A wireless sensor network (WSN) is made up of a number of sensor nodes (from a few tens to thousands) that can store, process, and relay data, as well as a Sink base station for additional processing It has a wide range of possible applications and usefulness in a variety of fields, including military and national defense, environmental monitoring, biomedical, smart homes, remote monitoring of dangerous places, and so on.

However, because sensor nodes in wireless sensor networks are energy-constrained, energy efficiency is one of the most important concerns in wireless sensor networks. In addition to conserving energy, wireless sensor networks must meet several performance requirements, such as network pocket latency, data transmission reliability, and network connectivity, according on the needs of various applications..

2. THE ARCHITECTURE FOR TRADITIONAL WIRELESS SENSOR NETWORK

Traditional wireless sensor network architecture is based on a flat layout (i.e. single-layer planar structure). This type of network is also known as a flat wireless sensor network [1]. A large number of sensor nodes with the same hardware structure and limited sensing, processing, and communicating capabilities are deployed in the monitoring area, and use multi-hop to transmit and forward information gathered by other sensor nodes to sink nodes with the help of other nodes within the wireless sensor network. Finally, a sink node connects the wireless sensor network to other types of networks, allowing the user to access, query, and operate the wireless sensor network remotely [2]. The majority of wireless sensor network research focuses on flat networks, such as single-hop wireless sensor networks [3], conventional wireless sensor networks with several hops, and so on. A typical architecture of traditional wireless sensor network is shown as Figure 1.

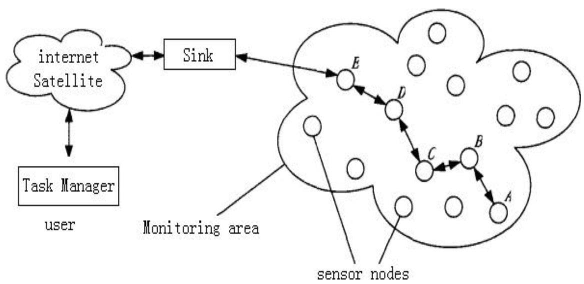

Fig 1 :The architecture of traditional wireless sensor network

The higher the network size in a flat wireless sensor network, the more data is lost in the communication path, and the lower the network performance. At the same time, the huge flat wireless sensor network causes higher energy consumption and energy heterogeneity problems by requiring intermediate nodes for data forwarding. As a result, a hierarchical wireless sensor network is more applicable in a variety of practical applications, such as IPv6 wireless sensor networks [4], hybrid wireless sensor networks [5-6], multiple sinks wireless sensor networks [7] and wireless sensor networks with mobile sinks [8] and so on. Hierarchical wireless

A sensor network is typically made up of a variety of heterogeneous devices that serve as sinks, collecting and forwarding data from underlying sensor nodes. Some of them are energy-dense or rechargeable, some have higher communication capabilities than sensor nodes, and some can even move at random. These features can not only increase network performance such as energy efficiency, throughput, reliability, and scalability, but they can also broaden the range of possible applications and simplify commercial deployment [9].

The sink nodes and sensor nodes in typical wireless sensor networks are thought to be static. The influence of sensor node mobility on the network is frequently overlooked. Traditional network architecture is no longer applicable in several circumstances where sensor nodes must be mobile [10], such as medical care, infectious disease prevention in airport immigration, and so on. The tiny sensor nodes can be worn on the patient's body in these regions, and they move randomly with the movement of patients in the monitoring region. Because patients can enter and depart the care area at any time, the quantity and density of network nodes varies greatly at different network moments. At the same time, we must ensure network real-time and sensor node energy efficiency. These requirements are challenging to meet with a flat wireless sensor network. On the one hand, when sensor nodes move around randomly in the region, they may become disconnected from other sensor nodes and become isolated nodes, resulting in significant network delay; on the other hand, as the network grows in size, the hop number between the source sensor node and the sink node will increase significantly, causing intermediate sensor nodes to consume more energy and prolong data delay; finally, because the sensor nodes move around randomly in the region, they may become unconnected from other sensor nodes and become isolated nodes.

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3. III.HIERARCHICAL NETWORK ARCHITECTURE

It's a difficult task to construct low-power, low-delay wireless sensor networks using mobile sensor nodes. On the one hand, the architecture of such a wireless sensor network is extremely dynamic and movable; on the other hand, the mobile sensor nodes' sensing, processing, and sending capacities are extremely limited. Flat wireless mobile networks are finding it more challenging to enable dynamic extension of mobile sensor nodes and react to network architecture changes as network scale grows. At the same time, it is unable to meet the energy consumption and data latency requirements imposed by the network sensor nodes' dynamic expansion. As a result, for mobile wireless sensor networks, the flat network architecture is unsuitable [11]. Then, for a mobile wireless sensor network, creating a multiple layer network architecture that can fulfill the energy efficiency of sensor nodes as well as data transmission real-time is required.

A.Network Structure

We describe hierarchical mobile wireless sensor network architecture with a large number of mobile sensors in order to obtain an ideal condition in terms of energy consumption and pocket delay nodes. In flat mobile wireless sensor networks, we will increase the number of high-end routing nodes in the network design, and these high-end routing nodes will keep their connections and be responsible for collecting and forwarding sensing data from sensor nodes. Simultaneously, they have plenty of resources and maintain their position; however, in comparison to the high-end routing nodes, the sensor nodes, or low-end nodes, are only responsible for sensing data and reporting it to the high-end routing nodes, and they are unable to communicate with the other sensor nodes. The architecture of a hierarchical mobile wireless sensor network is divided into two layers, shown in Figure 2:

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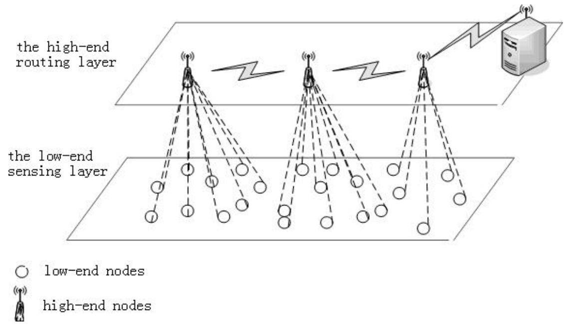
1)The low-end sensing layer: A large number of low-resource sensor nodes are randomly deployed in the specified region and can change location at any time; they are responsible for sensing interesting data in the monitoring region and sending the sensing data in single-hop form to the static high-end routing nodes after the sensor nodes obtain the interesting data. After collecting data from sensor nodes, the high-end routing nodes route the sensing data to sink via multi-hops in the high-end routing layer.

2)The high-end routing layer: This routing layer is made up of a small number of static high-end routing nodes that collect and forward the sensing data collected by sensor nodes. Their processing, communication, and storage capabilities are superior to those of mobile sensor nodes, and they can also receive continuous power. The data will be sent in multiple hops between the high-end routing nodes until it reaches the sink.

B.Network Features:

Hierarchical mobile wireless sensor network with mobile sensor nodes is a heterogeneous wireless sensor network



that uses hierarchical methods to arrange the network. It is a hybrid of the relative stability and absolute mobility models.

1)the relative stability model: A relatively stable high-layer sub-network is made up of static high-end routing nodes. This sub-network has a mesh structure and is generally steady in terms of position, inheriting the relatively static characteristics of standard wireless sensor networks. Furthermore, the high-layer sub-network only comprises a few high-end routing nodes, therefore that the average transmission hops of sensing data obtained by sensor nodes in the network will decrease, resulting in a reduction in network transmission delay. At the same time, high-end routing nodes can have a lot of resources to assure data transmission dependability.

2)The absolute mobility model: Many low-layer mobile sub-networks that belong to single-hop mobile wireless sensor networks are made up of a large number of sensor nodes, notably

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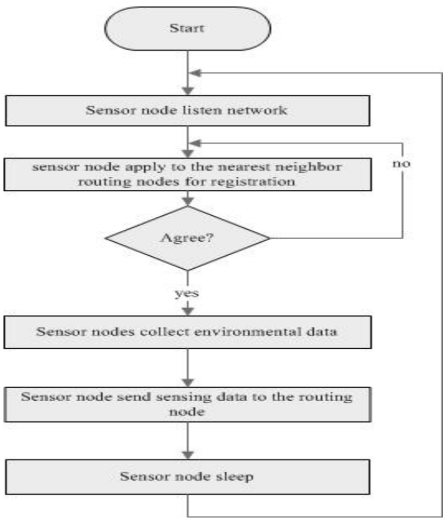
low-end sensing nodes and high-end routing nodes. Sensor nodes in a single-hop mobile wireless sensor network can move around in the monitoring area at random and do not communicate directly with one another. Multiple sensor nodes and a high-end routing node form a single-hop wireless sensor network with a star topology, and single-hop networks use media access time-division multiplexing technology to avoid large amounts of data collision



when sensor nodes compete for use of the wireless channel, reducing network pocket delay and mobile sensor node energy consumption. Furthermore, it can secure the network's expansion. Many single-hop mobile wireless sensor networks make up a hierarchical mobile wireless sensor network with mobile sensor nodes.

C.Node Work Process

The work process of sensor nodes: The sensor nodes in a hierarchical mobile wireless sensor network with mobile sensor nodes are free to move and change places. Because there are numerous high-end routing nodes in the network, there may be multiple routing nodes around the sensor nodes; therefore, the sensor node that wants to report sensing data should choose the routing node with the shortest distance and apply for registration to it. After successfully registering, the sensor node can gather environmental data and send it to the routing node. After that, the sensor node can go to sleep and wait for the next task. The work process of sensor nodes is shown as Figure 3.

Figure 3. The work process of sensor nodes

Fig 2 : The work process of routing nodes:

2)The collection is the responsibility of the high-end routing nodes in a hierarchical mobile wireless sensor network containing mobile sensor nodes and Forwarding of sensing data. When the high-end nodes are active, they constantly monitor the state of the wireless sensor network to see whether there are any registrations. If the routing nodes discover that there are some nodes to register, they get the required registration information and determine the type of nodes that have been registered. If they're sensor nodes, the routing nodes either add them to the sensor node set or to the neighbor node set. When routing nodes need to send data, they first figure out to whom the data will be sent: sensor nodes or neighbor routing nodes. If the routing nodes' destination is sensor nodes, the data is sent straight to them; otherwise, it is sent to neighboring routing nodes.

4. IV.THE SIMULATION

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Generates 4 trace file after 4 groups of Simulation, and we process the 4 trace file and display the consequence by gnu plot tool which is Linux native tool.

A.Energy Analysis

In this section, we'll use simulations to look at the network's energy use. Our method is to calculate the corresponding total remaining energy of each moment using trace files for both types of mobile wireless sensor networks with the same number of mobile sensor nodes—flat mobile wireless sensor networks and hierarchical mobile wireless sensor networks—and then compare total remaining energies of both types of mobile wireless sensor networks in the same moment. If one of two types of mobile wireless sensor networks has a significant total remaining energy at a given time, it must have low energy consumption. On the other hand, if one mobile wireless sensor network

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consumes more energy than another, the total remaining energy must be lower when the two mobile wireless sensor networks have the same total initial energy. The four experiments have been carried out in this work. There are two types of mobile wireless sensor networks: flat mobile wireless sensor networks with 15 and 30 mobile sensor nodes, and hierarchical mobile wireless sensor networks with 15 and 30 mobile sensor nodes. At different times, we compared the total remaining energy of two types of mobile wireless sensor networks with the same number of mobile sensor nodes. The results of four experiments are shown in Figure 5 and Figure5.

Figure 4 depicts the energy analysis of a mobile wireless sensor network with 15 mobile sensor nodes. The triangle line depicts the total remaining energy trend of a hierarchical mobile wireless sensor network with 15 nodes, whereas the circle line depicts the total remaining energy trend of a flat mobile wireless sensor network with 15 nodes. At different times, the values of the circle line are smaller than those of the triangle line, indicating that the hierarchical mobile wireless sensor network with 15 mobile sensor nodes consumes less energy than the flat mobile wireless sensor network with the same number of mobile sensor nodes.

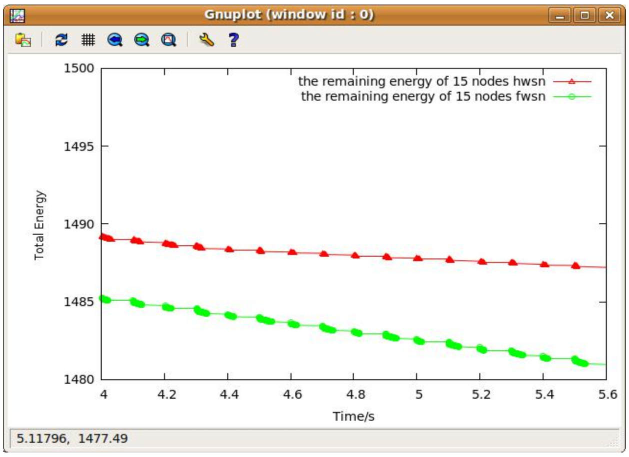

Figure 4. The total remaining energy trend of mobile wireless sensor network with 15 mobile sensor nodes

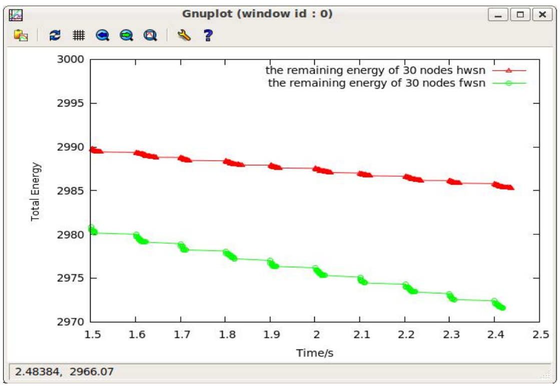

Figure 5: The total remaining energy trend of mobile wireless sensor network with 30 mobile sensor nodes

Similarly, the triangle line also reflects the total remaining energy trend of a hierarchical mobile wireless sensor network, while the circle line shows the total remaining energy trend of a flat mobile wireless sensor network;

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however both networks in Figure 6 have 30 mobile sensor nodes. At different times, the values of the circle line are also smaller than those of the triangle line, indicating that the hierarchical mobile wireless sensor network has higher energy efficiency. Finally, the aforementioned experiment results show that a hierarchical mobile wireless sensor network uses less energy than a flat mobile wireless sensor network.

B.Delay Analysis

This section examines the pocket delay of a mobile wireless sensor network. The abscissa reflects the packets' start time, whereas the vertical coordinate represents the packets' delay at the matching start time, shown as Figure 6 and Figure 7.

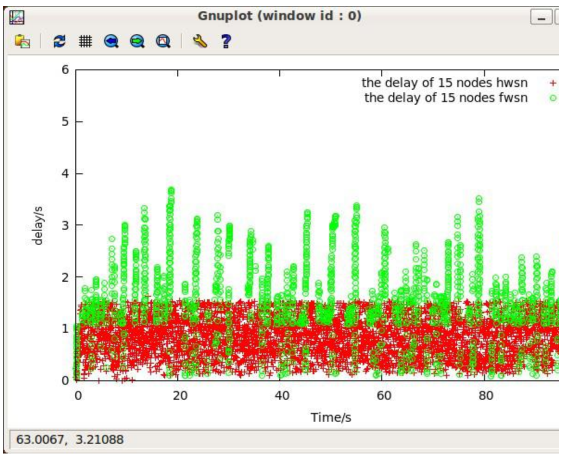

Figure 6:The pocket delay trend of mobile wireless sensor network with 15 mobile sensor nodes

The circle-points represent the pocket delay trend of a flat mobile wireless sensor network with 15 nodes, whereas the cross-points represent the pocket delay trend of a hierarchical mobile wireless sensor network with 15 nodes, shown as Figure 7. According to the distribution

of circle-points, Because there are several discontinuous time regions and a considerable delay, many packets were finally unable to be effectively received by sink at the same time. The cross-points, on the other hand, have a uniform distribution, with the majority of values being lower than the circle-points, as can be shown. The average pocket delay of a hierarchical mobile wireless sensor network with 15 mobile sensor nodes is smaller than that of a flat mobile wireless sensor network of the same size, but the hierarchical mobile wireless sensor network transmits data at a faster rate.

Similarly, The flat mobile wireless sensor network with 30 mobile sensor nodes has a longer pocket delay and a lower data transmission rate than the hierarchical mobile wireless sensor network with the same number of sensor nodes, as shown in Figure 8, but its most

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pocket delays are much larger than those of the flat mobile wireless sensor network with 15 mobile sensor nodes, while the most pocket delays of the hierarchical mobile wireless sensor network with 30 mobile sensor nodes is As a result, the higher the size of a flat mobile wireless sensor network, the longer the network's pocket delay would be when the sensor nodes successfully transmit a packet, but this is not the case with hierarchical mobile sensor networks with mobile sensor nodes.

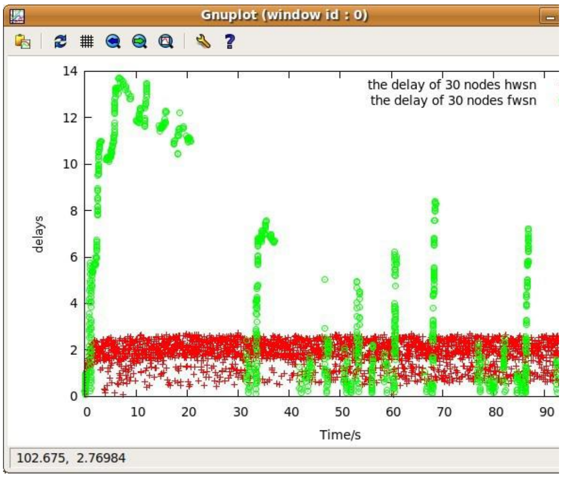

Figure 7. The pocket delay trend of mobile wireless sensor network with 30 mobile sensor nodes

Furthermore, when the size of the flat mobile wireless sensor network expands, we can see that the point density decreases. This station is similar to the hierarchical mobile wireless sensor network; however the point density has changed slightly. As a result, the loss rate of pockets sent from a hierarchical mobile wireless sensor network is lower than that of a flat mobile wireless sensor network of the same size.

5.CONCLUSION

We may deduce that the overall energy consumption and pocket latency of a flat mobile wireless sensor network increase as the network size grows, and the loss rate of data from mobile sensor nodes increases, resulting in network instability. Total energy usage and pocket delay can be effectively lowered by adapting the hierarchical network architecture. Data from sensors can be consistently transferred, and the network maintains communication throughout the state. A hierarchical wireless sensor network can be used efficiently in scenarios including mobile sensor nodes.

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