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Analysis and Performance evaluation of Traditional and Hierarchal Sensor Network

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ABSTRACT: *The paper deals with the working of wireless sensor network. In which it compare the different working of wireless sensor network. Basically there are two types of wireless sensor network, Traditional sensor network and the Hierarchical sensor network. Traditional sensor network is the already available network which uses more battery. But hierarchical sensor network introduces two level of nodes i.e., low end and high end. This will increase the overall lifetime of network. After considerable research it is found out that performance of hierarchical network is more than traditional and it increases the lifetime of network.*

Keywords: *WSN, High-end, Low-end, energy –contraint, Hybrid.*

I. INTRODUCTION

As the technology of wireless networks become increasingly matured and supported by small, micro-mobile devices fully, wireless sensor network has gradually become a research hotspot. A wireless sensor network (WSN) consists of a number of sensor nodes (few tens to thousands) with the capability of storing, processing and relaying the sensed data, and often has a base station called Sink for further computation. It has very broad application prospects and great potential value in many areas, such as in the military and national defense, environmental monitoring, and biomedical, smart homes, remote monitoring dangerous areas, and so no.

However, in wireless sensor networks, because sensor nodes are energy-constrained, efficient use of energy is the key issues of wireless sensor networks. In addition to using energy efficiently, according to the requirements of different applications, wireless sensor networks need to meet the different performance, such as the delay of network pockets, the reliability of data transmission and the connectivity of Network.

II. THE ARCHITECTURE FOR TRADITIONAL WIRELESS SENSOR NETWORK

The architecture of traditional wireless sensor network generally adapts flat structure (i.e. single-layer planar structure). We also call this kind network flat wireless sensor network [1]. A large number of sensor nodes with the same hardware structure, and poor the sensing, processing, and communicating capabilities are deployed in the monitoring area, and transmit and forward information gathered by the other sensor nodes to sink node using the form of multi-hop under the help of other nodes within wireless sensor network. And then wireless sensor network is connected with other types of networks by sink node, finally the user can remotely access, queries and manage the wireless sensor network [2]. Most study of wireless sensor networks aim for flat wireless sensor network, such as single-hop wireless sensor networks [3], the traditional multi-hop wireless sensor networks, and so on. A typical architecture of traditional wireless sensor network is shown as Figure 1.

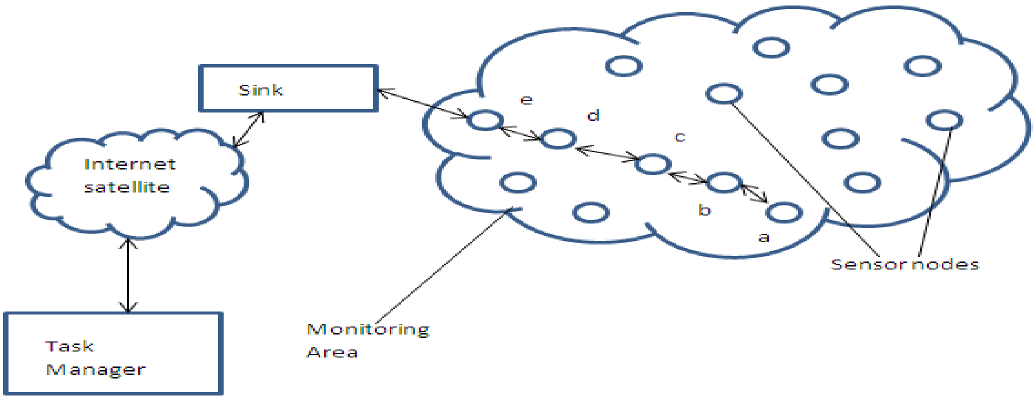

Fig 1: A typical architecture of traditional wireless sensor network

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In flat wireless sensor network, the larger network size is, the more data lost in communication path, and the worse the network performance is. At the same time, the large flat wireless sensor network also lead to intermediate nodes for forwarding data more energy consumption and energy heterogeneous problems arise. Therefore, there are a large number of practical applications where a hierarchical wireless sensor network is more appropriate, 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 sensor network is usually composed of some kinds of heterogeneous devices which mainly act as sinks that are responsible for gathering and forwarding data from underlying sensor nodes. Some of them are energy-rich or rechargeable, some have better capability of communication than that of sensor nodes, and some even are able to move randomly. These features can not only improve the network performance such as energy-efficiency, throughput, reliability and scalability, but also extend the potential applications and make commercial implementation easy [9].

In traditional wireless sensor networks, the sink nodes and the sensor nodes are generally assumed to be static. We usually ignore the impact of the mobility coming from sensor nodes on the network. In some scenarios which need the sensor nodes are mobile, the traditional network architecture is no longer applicable [10], such as in the field of medical care, the prevention of infectious diseases in airport immigration, and so on. In these areas, the tiny sensor nodes can be worn on the patient's body, and randomly move with the movement of patients in the monitoring region, and patients can enter and leave the care area at any time, so the number and density of network nodes are quite different at different network moments. At the same time, we need to ensure the real-time of network and energy efficiency of sensor nodes. The flat wireless sensor network is difficult to meet these requirements. On the one hand, when the sensor nodes randomly move in the region, they may be unconnected with other sensor nodes and then become isolated nodes, which will result in significant network delay; on the other hand, with the growth of the network size, the hop number between the source sensor node and the sink node will increase significantly, which will cause intermediate sensor nodes to increase the energy consumption and prolong data delay; besides, because the sensor nodes are mobile, the collision probability of sensing data will rapidly increase in the process of transmission, which will also grow the network delay and energy loss of sensor nodes.

III. HIERARCHICAL NETWORK ARCHITECTURE

To design a low-power, low-delay wireless sensor networks with mobile sensor nodes is a very difficult task. On the one hand, the topology of such wireless sensor network has very high dynamics and mobility; on the other hand, the mobile sensor nodes have very poor sensing, processing, and transmitting capabilities. With the expansion of network scale, flat wireless mobile networks are difficult to achieve the dynamic extension of the mobile sensor nodes and to adapt to network topology changes. At the same time, it also cannot meet the requirements of energy consumption and data delay caused by the dynamic extension of the network sensor nodes. Therefore, the flat network architecture is not suitable for mobile wireless sensor networks [11]. And then, designing multiple layer network architecture for mobile wireless sensor network is necessary, which can meet the energy efficiency of sensor nodes and the real-time of data transmission.

A. Network Structure

In order to make energy consumption and pocket delay achieve an ideal state, we present hierarchical mobile wireless sensor network architecture which has a large of mobile sensor nodes. In the network architecture, we will increase a small number of high-end routing nodes in flat mobile wireless sensor networks and these high-end routing nodes keep connection each and are responsible for collecting and forwarding the sensing data from sensor nodes. Simultaneously, they have abundant resources, and their position remain unchanged; while relative to the high-end routing nodes, the sensor nodes, namely low-end nodes, are only responsible for sensing data and reporting of the data to the high-end routing nodes, and they cannot communicate with the other sensor nodes. The hierarchical mobile wireless sensor network architecture is divided into two layers, shown in Figure 2:

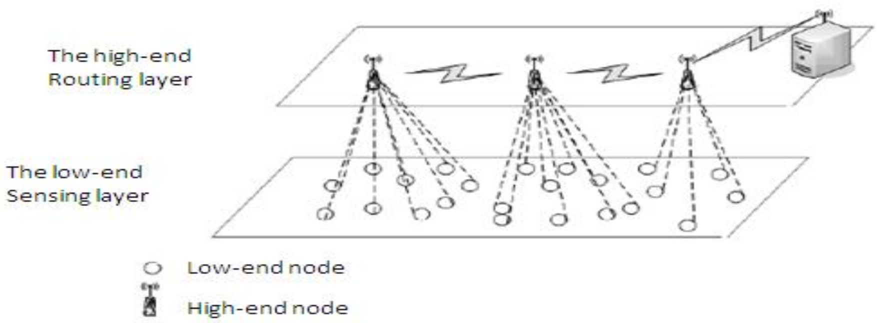

Fig 2: Architecture of hierarchical mobile wireless sensor network

a) The low-end sensing layer: A large number of sensor nodes with poor resource are randomly deployed in the specified region and can randomly change its location; they are responsible for sensing interesting data in the monitoring region, and send the sensing data to the static high-end routing nodes in single-hop form, after the sensor nodes obtain the interesting data. Then the high-end routing nodes route the sensing data to sink by muti-hops in the high-end routing layer after collecting data from sensor nodes.

b) The high-end routing layer: This routing layer consists of a small number of static high-end routing nodes, and plays the role of gathering and forwarding the sensing data obtained by sensor nodes, and their processing, communication, storage capabilities are stronger than the mobile sensor nodes, even they can get continuous power supply. The data will be transmitted in multi-hop form between the high-end routing nodes until it do not arrive sink

B. Network Features

Hierarchical mobile wireless sensor network with mobile sensor nodes belongs to heterogeneous wireless sensor network and adapts the hierarchical means to organize mobile wireless sensor network. It combines the relative stability model and the absolute mobility model.

a) Static relative stability model: Static high-end routing nodes constitute a relatively stable high-layer sub-network. This sub-network follows mesh structure and its location is relatively stable, which inherited the relatively static features of traditional wireless sensor network. In addition, the high-layer sub-network has a small number of high-end routing nodes so that the average transmission hops of the sensing data obtained by sensor nodes in the network will decrease, which effectively reduce the transmission delay of network. At the same time, in order to ensure the reliability of data transmission, the high-end routing nodes can have rich resources.

b) The absolute mobility model: A large number of sensor nodes, namely low-end sensing nodes, and high-end routing nodes constitute many low-layer mobile sub-networks which belong to single-hop mobile wireless sensor network. Sensor nodes within such single-hop mobile wireless sensor network can randomly move in monitoring region and do not directly communicate with each other. Multiple sensor nodes and a high-end routing node form a single-hop wireless sensor network which shows star topology, and single-hop network adapt media access time-division multiplexing technology to avoid large amounts of data collision when the sensor nodes compete to use wireless channel, which reduce pocket delay of network's and energy consumption of mobile sensor node's. Moreover, it can ensure the expansion of the network. A hierarchical mobile wireless sensor network with mobile sensor nodes is composed of many such single-hop mobile wireless sensor networks.

C. Node Work Process

a) The work process of sensor nodes: In the hierarchical mobile wireless sensor network with mobile sensor nodes, the sensor nodes can freely move and change their positions. Since there exist many high-end routing nodes in network, the routing nodes around the sensor nodes may be more than one, so the sensor node wanted to report sensing data should select one routing node which has smallest distance and apply to it for registration. The sensor node can collect the environmental data and send it to the routing node after successfully registers, then the sensor nodes into sleep and wait for the next task. The work process of sensor nodes is shown as Figure 3.

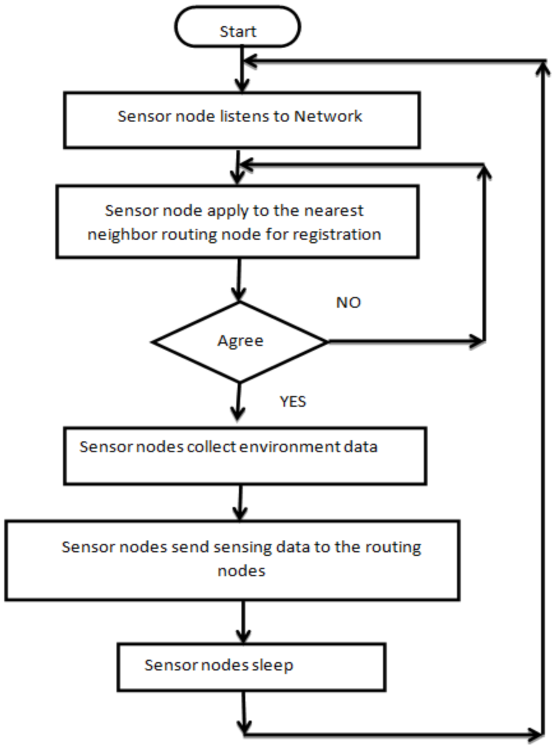

Fig 3: Flow Chart for the working of sensor nodes

b) The work process of routing nodes: In the hierarchical mobile wireless sensor network with mobile sensor nodes, the high-end routing nodes are responsible for the collection and forwarding of sensing data. When the high-end nodes work, they always listen to the state of wireless sensor network and determine whether there are registrations in the network. If the routing nodes find there are some nodes to register, then they obtain the relevant information of registrations and judge the type of registered nodes. If they are sensor nodes, the routing nodes add them to the set of sensor nodes, or add them to the set of neighbor nodes. When the routing nodes need to transmit data, they firstly determine the data will be transmitted to whom, sensor nodes or neighbor routing nodes. If target is sensor nodes, then the routing nodes directly send the data to sensor nodes, otherwise to neighbor routing nodes. The work process of routing nodes is shown as Figure 4.

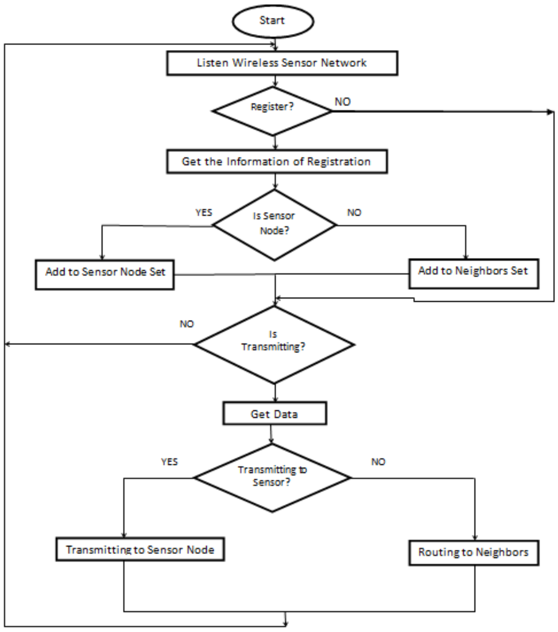

Fig 4: The work process of routing node

IV. SIMULATION

We evaluate two different performance metrics which are crucial to prolong the lifetime of wireless sensor network and improve the quality of delay. The data delivery delay is referred to the duration from data generation to data reception by sink. For evaluating the lifetime of the network, we observe the total remaining energy of mobile sensor nodes.

In this paper, we make simulation using ns2 in the Linux environment, the simulation region is set to 50 × 50 rectangle, and the scenarios of the movement and cbr traffic are generate by the corresponding tools of ns2. The moving speeds of sensor nodes are set from 1 to 5m per second, the communication range is set as 15m, and the size of packets is 1024 byte. Simulation time is set to 100s, the initial energy of sensor nodes are 100. The sending and receiving energy of node is set as 1, idle listening energy is 0.5, and dormant energy is 0.1. It generates 4 trace file after 4 groups of Simulation, and we process the 4 trace file and display the consequence by gnuplot tool which is Linux native tool.

Energy Analysis

In this section, we will analyze the energy consumption of the network by the simulations. Our approach is to calculate the corresponding total remaining energy of every moment using the trace files for both kinds of mobile wireless sensor network with the same number of mobile sensor nodes—one is flat mobile wireless sensor network, another is hierarchical mobile wireless sensor network, and then to compare total remaining energies of both kinds of mobile wireless sensor network in the same moment. In a certain moment, if one of two kind mobile wireless sensor networks has a large total remaining energy, it must have small energy consumption. On the contrary, we could also say that if one mobile wireless sensor network has larger energy consumption than another one, it must have smaller total remaining energy when the two mobile wireless sensor networks have the same total initial energy. In this paper, the four experiments have been made. The flat mobile wireless sensor network which have 30 mobile sensor nodes, and the hierarchical mobile wireless sensor network which have also 30 mobile sensor nodes. We have compared the total remaining energy of tow kind mobile wireless sensor networks which have the same number of mobile sensor nodes at different moment. The results of experiments are shown in Figure 5. Finally, we can conclude by the experiment results that the hierarchical mobile wireless senor network has better energy efficiency than flat mobile wireless sensor network.

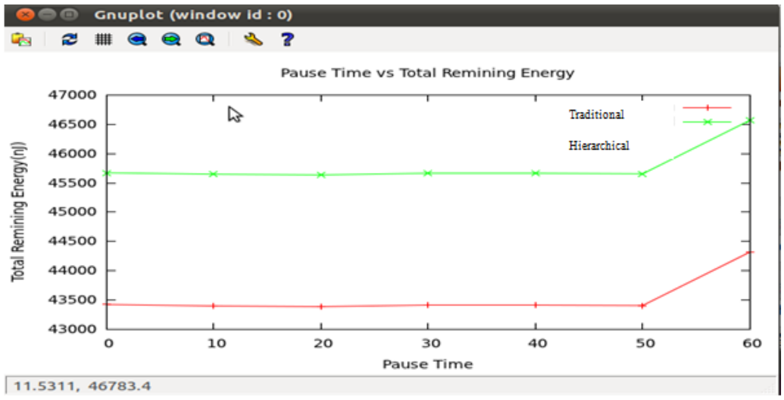

Fig 5: Remaining energy for traditional and hierarchical

V. CONCLUSION

We can conclude that the total energy consumption and pocket delay of flat mobile wireless sensor network are increasing with the growth of network size, and the loss rate of the mobile sensor nodes' data is higher, which makes the weak stability of network. When we adapt the hierarchical network architecture, the total energy consumption and pocket delay can be effectively reduced. Sensing data can be reliably transmitted, and network is connectivity at all moments in the state. Hierarchical wireless sensor network can be applied to the scenarios with mobile sensor nodes effectively.

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