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Comparison of Health Care System Architectures

Mahboobeh Abdoos
Department of Electrical and Computer Engineering
Qom Islamic Azad University
Qom, Iran.

***Abstract*—Body area sensor network is an important technology which is suitable for monitoring the patient's health and real time diagnosing the diseases. The body area network includes the sensors which can be spread over the body or the wearable cloth and a coordinator node which can be a mobile or a tablet or a PDA, which receives the signal of a person's sensors. In the new architecture the coordinator node sends the information to the central data server via internet or GPRS or MANET. The central data server is responsible for saving and analyzing and representing the received data in the text and graphical mode and sending SMS to the patient's family or the nearest ambulance or physician, or the operator can call them. The received information is analyzed by the data mining tools. The necessary information will be sent to the physician's computer. Every patient has a GPS, and it is supposed that the encryption is used for transferring information. In this paper the new architecture is compared with the traditional one which includes the base station and relay nodes. It is shown that the new architecture has less delay than the traditional one.**

Keywords — Architecture; Health care; Sensor; MANET

I. Introduction

The body sensor network can help people by preparing health care services, like monitoring and communication via SMS or GPRS. The health monitoring system uses the wearing cloth which has sensors or the body implanted sensors. The health care system helps the patients and their families by monitoring their physiological signal without interrupting the patient's normal life and increasing the quality of patient's life. The health care system does not limit a patient to stay in the bed and in the current architecture, the patient's physiological signal is received by the patient's sensors and it is transferred to the coordinator node which is a mobile or tablet, then it is transferred to the far base station and then to a computer to save and analyze them. In the close environments, the signal length weakens. Increasing of Obstacles between nodes causes the increasing of the packets loss ratio. So it is needed to increase the relay nodes, in the closed environment, to cover the entire of environment. This architecture is dependent to the infrastructure and relay nodes and base stations and suffers the infrastructure cost.

The proposed architecture eliminates the infrastructure and the sensor nodes transfer their information to the coordinator node and the coordinator sends the information to the central data server via internet or GPRS. The proposed architecture has less cost and less delay than the old architecture. In this paper, section 2, surveys the ad hoc network and some of the routing protocols of it. Section 3 reviews the body area sensor network and health care system architectures. Section 4 represents the simulation result of two health care system architectures comparison. There is shown that the new architecture which uses the internet or GPRS or MANET to transfer the signal information of coordinator node (the coordinator is gathering the signal information of sensors) to the central data server, has less delay in comparison with the traditional architecture which uses the base station and relay nodes to transfer the information of signal to the central data server [1], [2], [3], [4].

II. Ad Hoc Network

An ad hoc network consists of some wireless mobile nodes which route the packets without any infrastructure. The ad hoc network is divided to static and dynamic ad hoc networks. In a static ad hoc network, the location of a node does not change. In the dynamic ad hoc networks the nodes are moving like the mobile and vehicle ad hoc networks. The topology of the mobile ad hoc network is changing. There are two kinds of routing, the first one is the topology based routing and the second one is the location based routing. The topology based routing uses the information of links of the network to transfer the packets. It is divided to the table-driven and demand based routing protocols. The table-driven routing protocols consist of the distance-vector protocols and the link-state protocols [5], [6], [7], [8].

III. Routing Protocols In Ad Hoc Networks

A. Ad hoc On-Demand Distance Vector Routing protocol (AODV)

AODV uses the combination of demand based routing (DSR) and hop by hop routing (DSDV). It uses the sequential number in the table of node. This number is

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produced by the destination node. This number is not in the route request packet and in the route reply packet and it is sent to the requested nodes. This number is so important because it avoids the loop and the other node uses this number to update its routing information. AODV is consistent with the routing tables. The route request packets and the route reply packets and errors are defined like DSR. The privilege of this approach is the proper throughput, but it can not find and support and update the long paths.

B. Destination Sequenced Distance Vector Routing protocol (DSDV)

DSDV is the changed Bellman Ford algorithm. Every node has the entries for the destination node, which consists of the next hop and the number of hops to the destination node. Every node propagates its routing table to its neighbors to update them. The privilege of DSR is saving the fix paths to all other nodes of network by a node, but it causes the wasting of band width and saving the useless paths that may never are used.

C. Dynamic Source Routing Protocol (DSR)

DSR is a routing protocol which can manage the ad hoc network without needing to routing tables and updating them. To save the band width, it is done, when just it is needed. In DSR, the source node defines all of the routes from source node to the destination node and saves the path of intermediate nodes. It is a link state algorithm. Every node saves the best route to the destination node. If any change is occurred in the network, all nodes of the network are informed via broadcasting the changes. DSR does not need to update periodically. The control overhead is little, which causes saving the band width.

IV. New Architecture

This architecture includes four parts

A. Sensor Nodes

The sensor nodes monitor the main body parameters, which show the patient's health or sickness, like the body temperature, heartbeat, blood pressure, breathing ratio, blood oxygen. For example the sensors for monitoring heart beat are EGG, the sensors for sensing signal of the brain are EEG and the sensors for sensing signal of the muscles are EMG.

B. Coordinator Node

The coordinator node is a wireless node in the BANET, which is responsible for receiving signal of sensors and sending the information to the central data server. This node can be identified by a unique patient's ID. This node can be a mobile or tablet that uses the internet or GPRS or MANET to send the information to the central data server. (See figure 1) [9], [10], [11], [12]

C. Central Data Server

This server saves the received information to process later. The data mining is a useful tool for analyzing the huge amount of information. The graphical user interface in the central data server is responsible for saving and analyzing and representing the received data in the text and graphical mode and sending SMS to the patient's family or the nearest ambulance or physician or the operator can call them. The figure 2 shows the new architecture that the patients in the different locations can use this health care system.

The privilege of this architecture is that it removes the infrastructure cost of traditional architecture (removes the base station and relay nodes). The communication between the coordinator node and the central data server is via internet or GPRS or MANET and the routing protocols in MANET like DSDV, DSR, and AODV are used.

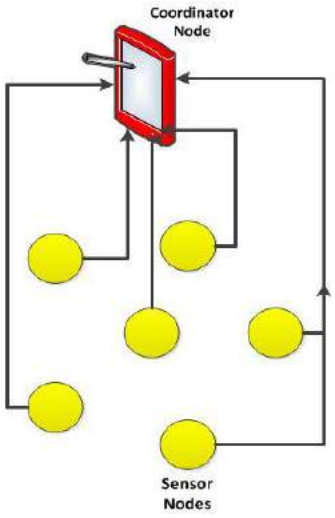

Figure 1. Sensor nodes in the body or wearable cloth and coordinator node which can be a mobile or a tablet.

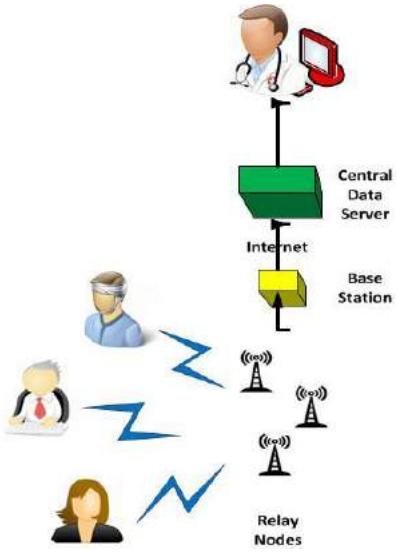

Figure 2. Traditional health care system architecture which uses the relay nodes to transfer information to the central data server.

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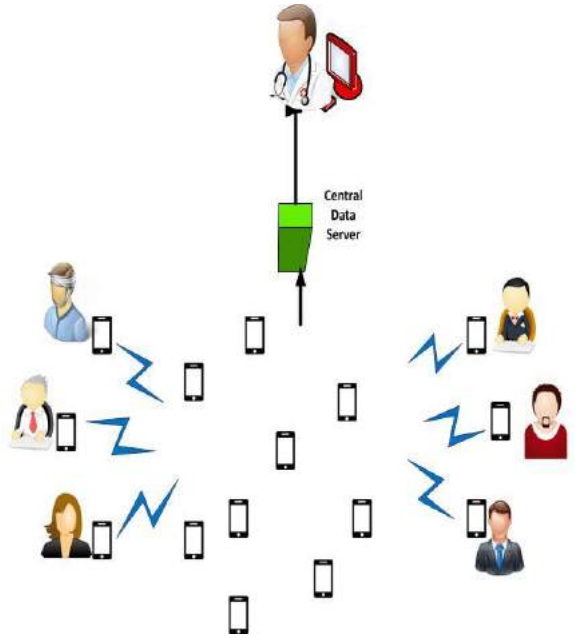

Figure 3. New health care system architecture which does not use the relay nodes to transfer information to the central data server

V. The Simulation Environment

The simulation is done in NS2. The simulation scope is 1500×1500 meters in 200 seconds. In this simulation, it is used the IEEE 802.11 protocol in the MAC layer and the band width is 2 Mbps. The data packets size is 512 byte and the CBR traffic is used. The packets sending rate is 4 packets in a second. In simulation running, the random way point model is used for moving the nodes. The nodes maximum radio range is 200 meters. The nodes number in this simulation is 100 and the nodes speed are 10 m/s and 1 m/s for the first and second scenarios. As it is shown, in the figure 4, when the speed of nodes is increasing the probability of fast packets transferring to the neighbor nodes and the delay is increasing. By comparing the architectures, it is shown that the new architecture has less delay than the traditional architecture.

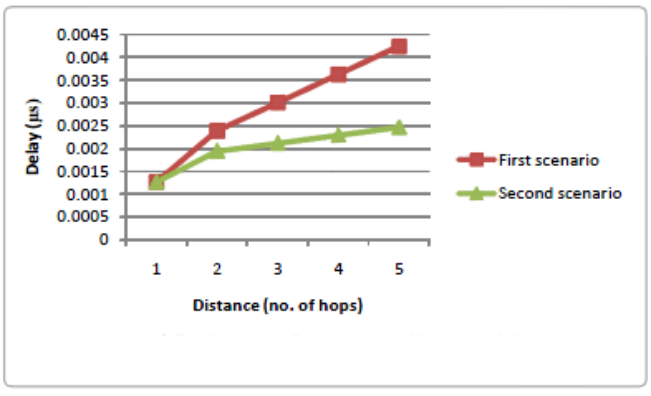

Figure 4. Scenarios delay comparison of new architecture.

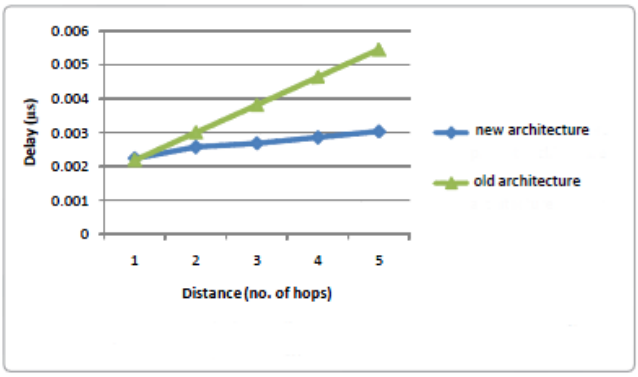

Figure 5. Delay comparison of two architectures

VI. Conclusion

Wireless sensor networks (WSNs) are finding applications in many areas, such as medical monitoring, emergency response, security, industrial automation, environment and agriculture, seismic detection, infrastructure protection and optimization, automotive and aeronautic applications, building automation, and military applications. The body area sensor network is an important technology that is suitable for monitoring the patient health and real time diagnosing the diseases. The body area network includes the sensors which can be spread over the body or the wearable cloth and a coordinator node that can be a mobile or a tablet or a PDA that receives the person sensors signal. In the new architecture the coordinator node sends the information to the central data server via internet or GPRS or MANET. The central data server is responsible for saving and analyzing and representing the received data in the text and graphical mode and sending SMS to the patient's family or the nearest ambulance or physician, or the operator can call them. The received information is analyzed by the data mining tools. The necessary information will be sent to the physician's computer. Every patient has a GPS, and it is supposed that the encryption is used for transferring information. In this paper the new architecture is compared with the traditional one which includes the base station and the relay nodes. It is shown that the new architecture has less delay than the traditional one.

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AUTHOR PROFILE

Mahboobeh Abdoos received the B.S and M.S degrees in computer engineering from Azad University, Ghazvin, Iran, in 2002 and 2007 respectively. She is now the Ph.D. research student of Islamic Azad university, Qom, Iran. She has taught at Islamic Azad and Payam Nour Universities from 2005 til now. She has been the referee of some conferences. Her current research interest includes position based routing protocols in mobile ad hoc networks, QOS and security based routing protocols in mobile ad hoc networks, cloud computing and data base.