Global Healthcare Information System

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Abstract: This paper presents a new concept of IP-based wireless sensor networks and also introduces a routing protocol that is based on clustering for global healthcare information system. Low-power wireless personal area networks (LoWPANs) conform the standard by IEEE 802.15.4-2003 to IPv6 that makes 6lowpan. It characterized by low bit rate, low power, and low cost as well as protocol for wireless connections. The 6lowpan node with biomedical sensor devices fixed on the patient body area network that should be connected to the gateway in personal area network. Each 6lowpan nodes have IP-addresses that would be directly connected to the internet. With the help of IP-address service provider can recognize or analysis patient biomedical data from anywhere on globe by internet service provider equipments such as cell phone, PDA, note book. The system has been evaluated by technical verification, clinical test, user survey and current status of patient. We used NS-2.33 simulator for our prototype and also simulate the routing protocols. The result shows the performance of biomedical data packets in multi-hope routing as well as represents the topology of the networks.
Keyword: Healthcare; Patient; PAN; 6lowpan; Routing; Monitoring.

I. Introduction

Nowadays, Ethernet yielded 10,100 and 1,000Mbps at low cost are broad commercialization. This making the benefits of operation above IP becomes more obvious as compare directly on the particular link. Besides that, computers, laptops, and PDAs used Wi-Fi (IEEE802.11) as their dominant wireless link. Wi-Fi is the most widely used in handheld client devices and embedded PCs, which are mains powered because of its high power consumption. IP-protocols cannot be fit to operate on micro controllers and low-power link such as IEEE802.15.4 radios because IEEE802.15.4 packets are quite small. Thus, IP-approach is close to wireless embedded networks. Low-power wireless personal area networks (lowpans) conform the standard by IEEE 802.15.4-2003. IEEE802.15.4 radios are characterized by low bit rate, low power, and low cost. IEEE802.15.4 uses in various protocols for wireless connections and indirectly gain its popularity due to its unique advantages. One of the versions of the IPv6 protocol is 6lowpan standard that was designed to operate on low-power device. 6lowpans support many features such as handling fragmentation, compression of the packet headers etc. The 6lowpans stack contains additional interface that support UDP packets. The most important issue about IP connectivity is low power and secure. When Utilization of IP-based interconnect is the most common concern of industrial instrumentation makers. IP option is introduce to utilizing neither TCP/IP nor UDP/IP over Ethernet. However, this making some fear because of IP's ease of integration and broad interoperability. Each communication link is corresponds to a specific low-level standards, which include a packet is coding scheme, and thus the physical device are able to communicate to each others. In 2004, IEEE standardized the latest wireless link, which is IEEE802.15.4. IEEE802.15.4 is developing in compact, low power, low cost embedded devices, which can run on batteries for a certain periods. IEEE802.15.4 radio is use in home and industrial automation proprietary. It carries information at 2.5 GHZ radio transceivers, at the power of 1mW, which is about 1% of the power Wi-Fi. Thus, it can say that it has low transmit power limits transmission range.

II. Routing Methods

Routing in homogeneous IP-based wireless sensor networks are used hierarchical routing methods for established connectivity patient to the gateway. In this system all 6lowpan nodes perform the same task. However, Each node has own IP-address for global connectivity. Its have two protocols DYMO-low, and LOAD (6lowpan Ad-hoc On-demand distance Vector) the IP-enable sensor nodes can the broadcast and then node send their energy to the gateway every cyclic of then . It works in ADV, REQ and DATA to communicate other nodes.

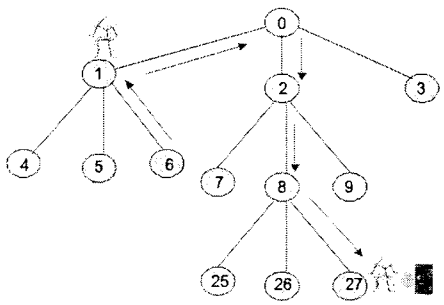

Figure-1 Hierarchical Routing Methods

Direct diffusion is a data centric process to save more energy. In hierarchical routing nodes works in multihop routing methods and sends data to base station. All the other nodes just sense data and send to the cluster heads. In this way the cluster head has more energy consumption, as they are involved in data transmission to the gateway. Selection of cluster head is based on some probability and threshold power level. Each nodes gets a chance to be selected a cluster head so in this way there is an even distribution of energy between the nodes in the network. 6lowpan root discovery methods have DYMO-low and LOAD protocols.

DYMO-low

Proactive routing protocols, which is constantly update the route information is not suitable for use. This is because devices used in Wireless Sensor Network are low power and limited processing capabilities. Besides that, some devices are move around, added or removed, causing frequent changes in the network topology and require more devices that are capable. Thus, reactive protocols AODV (Ad-hoc On-Demand Distance Vector) method, which is allowing nodes to find a route only when needed, is introduced. DYMO (Dynamic MANET On-Demand) is introduced based on modification on AODV. DYMO provides simple and yet efficient to implement routing protocols. DYMO is based on UDP packets over IP and it work with IPv6 stack. With IPv6 stack is implemented in routing protocols, the IPv6 stack will give much heavier memory and processing requirement. In order to overcome this problem, DYMO-low routing protocol was introduced. DYMO-low routing protocol operate directly on the link layer, instead of using IP-layer. Thus, routing is performed on hardware address. In order to obtain the necessary hardware address for routing, latter will need to perform address resolution. Thus, it makes integration into 6lowpan stack even more difficult.

A small routing table is used in DYMO-low implementation to store known routes. DYMO-low main interface consists of a *nextHop* command. This command is used for the purpose of return to the next hop to the destination on the route. The command will return to its hardware address immediately if the hop is already known by node command. If the other way, the command will return to 0 and start all over again by initiate route discovery.

LOAD

LOAD is a reactive routing protocol that is based on AODV, which is similar to DYMO-low. It was designed to run on IEEE802.15.4 networks, with the purpose of reduce unnecessary of complex implementations and resources usage. Similar to DYMO-low, LOAD uses link layer to keep track of the state if connections between the nodes. It reduces the recourses usage because it does not need to send periodic messages. Besides that, similar to DYMO-low, the implementation of LOAD uses the *getNextHop*command. The purpose of this command is to find the next node to the given destination on the route. This command also returns the node if and only if the command is available in the routing table. One important point, which is contrast with the DYMO-low implementation, is route discovery mechanism is not started automatically if the command is not available in the accumulated routing table. Thus, this making the component slightly more complicated, however, it is similar to other routing protocols.

III. System Design

We design prototype for global healthcare information system, in this system we have 10 patient in a Personal Area Network. Each patient has fixed 6lowpan nodes with several biomedical sensor such as ECG, SPO2 etc. So Each patient has own IP-address, it can connect globally to others service providers. If the doctor wants current status of his patient so he can connect directly to the patient via internet service provider equipments. for example the doctor want patient no. one informations so he broadcast request query with IP-address to PAN via internet gateway.

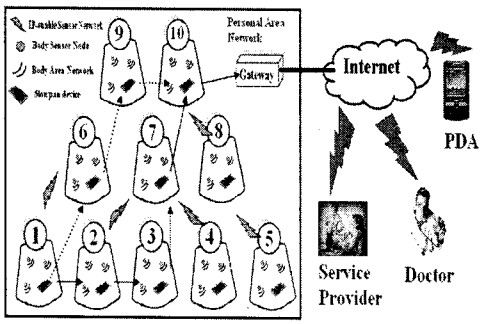

Figure-2 Global patient Information System.

So gateway broadcast IP-address in PAN via routing protocols LOAD and DYMO-low via set of instruction in routing protocols patient 1 transmitted his information to the doctor. The Doctor can analysis patient biomedical data form his home or global environment.

IV. Simulation Work

We assumed 10 6lowpan nodes their some of cluster head and one is pan coordinator or gateway. Each node connected to cluster head and has its own IP-address. Initially, the energy gateway is very much because it is connected to the fixed power supply and it is not resource constraint but for simulation purpose, we took this 100J Initial energy of CH is 1.5J and normal nodes 0.5J and it is fixed. CH knows their location to other CH from normal nodes we took a variable type that is 1 for CH, 0 for normal and 3 for gateway. The cluster head transmit its information to the gateway via multi-hop routing. for NS2.33 simulation we used table 1, parameters.

Table-1. Simulation Parameters

Parameter	Value
Transmission Range	15m
Simulation Time	120 s
Topology Size	100m * 100m
Number of Mobile Nodes	10
Number of Sources	2
Number of PAN Coordinator	1
Traffic Type	Constant bit rate
Packet Type	15 packets/s
Packet Size	36 bytes
Power loss	0.28J
Maximum Speed	2 m/s

The simulation time is 120s for a transmission range of every node is 15m. The frame error and packet rate is controlled and directly related to the delivery rate. The traffic type is constant bit rate. The Repeat Request (RREQ) packet size is 36 bytes, which is the same size because these are control packets. Their frequency of transmission is depending on the traffic of the network.

V. Results

We used NS-2.33 simulator for AODV, LOAD, DYMO-low protocols for performance if the root discovery in a limited time interval. We can see the performance of the LOAD and AODV protocol. LOAD protocol packet delivery ration is less then AODV.

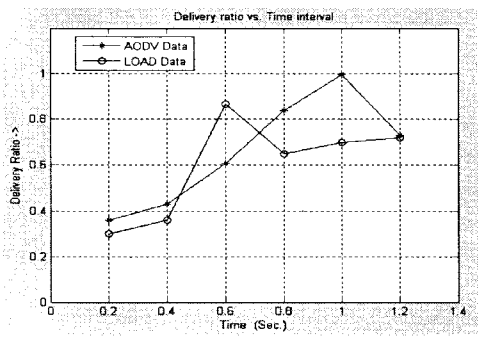

Figure-3 Packet delivery ration in time interval (AODV vs. LOAD)

Figure-4 shows the packet delivery is a constant inter val here blue colour is AODV green is DYMO-low. In DYMO-low, at the time interval 0.6 to 0.8, reduce the packet delivery ratio in compare AODV protocols.

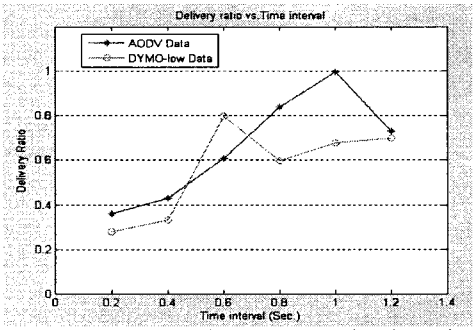

Figure-4 Packet delivery ration in time interval (AODV vs. DYMO-low)

In figure 5, AODV protocol is more constant performance compare ot otheres LOAD and DYMO-low. In AODV protocol the packet delivery reduce at the time interval of 1.o to 1.2. However, for LOAD and DYMO-low protocol, packet delivery reduce at time interval 0.6 to 0.8.

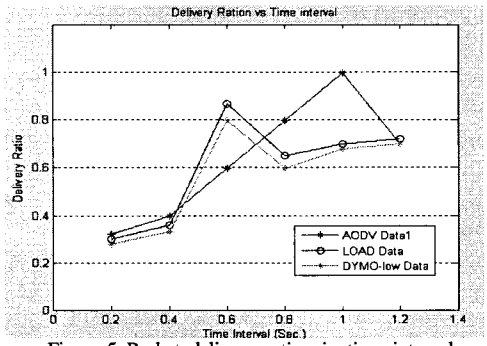

Figure-5 Packet delivery ration in time interval (AODV, LOAD, DYMO-low)

In conclude, both LOAD and DYMO-low protocols gives slightly same performance in compare to AODV. AODV protocol is not more reliable compare to LOAD and DYMO-low due to AODV constantly high delivery rate at the time interval 0.4 to 1.0 seconds. DYMO-low gives the highest packet delivery of 0.8 and LOAD gives 0.83 but AODV goes to highest at 1.0. For our global health information system we need more reliable data. Thus, LOAD and DYMO-low protocols is the better choice compare to AODV.

V. Conclusions

In this paper we have assumed all the node including CH head are uniformly distributed in the PAN. We set then parameters of healthcare monitoring requirements to received biomedical data from patient's body in a Personal Area network to the server via gateway. We designed IP-enable ubiquitous sensor network for global connectivity. Emerging global healthcare technology supports IP-based networks to assist status of the patient in hospital-based PAN. We used NS-2.33 simulator for our prototype. In this paper we simulate three protocols which are AODV, LOAD, and DYMO-low and show the performance of each protocol on 6lowpan nodes. The results shows that LOAD and DYMO-low gives better performance in term of more reliable data transmission. With the used of protocols, we can establish a global communication in PAN.

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