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AN ANALYSIS OF BODY AREA NETWORK USING QUALITY OF SERVICE METRICS

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Abstract:-

To investigate the topological characteristics of a WSN we simulated and analyzed the detailed IEEE 802.15.4/Zigbee association procedure. This kind of analysis is missing in the literature while it is the starting point to better understand how to implement the ZigBee network formation where some topological parameters shall be imposed. Wireless Body Area Networks (WBANs), comprised of tiny intelligent physiological sensors, represent a promising addition to wearable systems for health monitoring. Following current trends in advances in size, low power, and dense integration.

Keywords: - [Wireless Body Area Networks, WBANS, ZigBee network, Topological.

1. INTRODUCTION

A Body Area Network is formally defined by IEEE 802.15 as, "a communication standard optimized for low power devices and operation on, in or around the human body (but not limited to humans) to serve a variety of applications including medical, consumer electronics / personal entertainment and other" [1]. In more common terms, a Body Area Network is a system of devices in close proximity to a person's body that cooperate for the benefit of the user. A Wireless Body Area Network consists of small, intelligent devices attached on or implanted in the body which are capable of establishing a wireless communication link. In general a Body Area Network has sensors and actuators, sensors are used to measure certain parameters of the human body, either externally or internally. Examples include measuring the heartbeat, body temperature or recording a prolonged electrocardiogram (ECG). The actuators (or actors) on the other hand take some specific actions according to the data they receive from the sensors or through interaction with the user. E.g., an actuator equipped with a built-in reservoir and pump administers the correct dose of insulin to give to diabetics based on the glucose level measurements. Interaction with the user or other persons is usually handled by a personal device, e.g. a PDA or a smart phone which acts as a sink for data of the wireless devices. BAN work through a process of data being transmitted from an implanted device to an external device. The sensor that is implanted inside the patient's body wirelessly interacts with other sensors and actuators. An actuator is the mechanism by which an agent acts upon an environment.

COMPONENTS AND SYSTEM OVERVIEW

As shown in Figure 2.1 the BAN concept enables wireless communication between several miniaturized, intelligent Body Sensor Units (BSU) and a single Body Central Unit (BCU) worn at the human body. The BAN data can be accessed online through a separate wireless transmission link from the BCU to a network access point, using different technology, (e.g. WLAN, GPRS etc). This way a patient wearing a BAN can be monitored externally at all times. Measurement data can regularly be stored in a medical server, a physician can check up on a patient whenever needed, and in case of an emergency an immediate response unit will be alerted. Alerts can be triggered by the patient himself or by highly irregular measurement data. A caregiver can also be contacted in less dramatic circumstances. A patient can also receive information from a physician or even receive the weather forecast for the day. The core functionality of a BAN provides wireless interconnection between several BSU units and a single BCU via an air interface which is unlicensed (see Figure 2.2). The air interface between the BSU and the BCU is characterized by the 2m maximum distance typical for human body dimensions. A BCU concentrates the data streams from multiple attached BSUs and performs the communication to the outside world. This is conducted by standard wireless communication technology like DECT, WLAN, Bluetooth, etc .

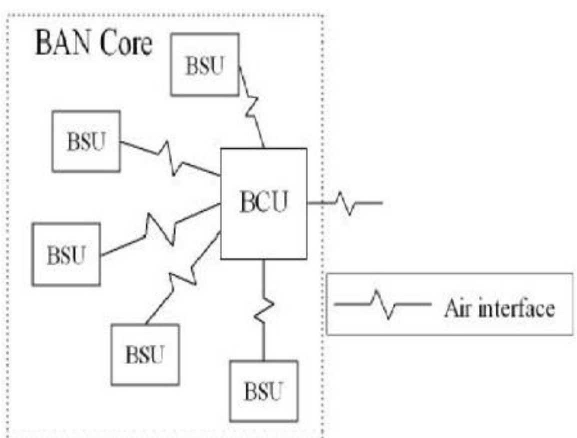

Figure 1. The core of a wireless body area network.

2. FRAMEWORK SIMULATION

Simulation and modeling are important approaches to developing and evaluating the systems in terms of time and cost. A simulation shows the expected behavior of a system based on its simulation model under different conditions. To study system behavior and performance by means of real deployment or setting up a test-bed may require much effort, time and financial costs. However, the simulation results are not necessarily accurate or representative. Hence, the goal for any simulation model is to accurately model and predict the behavior of a real system. Recently, several analytical and simulation models of the IEEE 802.15.4 protocol have been proposed. Nevertheless, currently available simulation models for this protocol are both inaccurate and incomplete, and in particular in the area of IEEE 802.15.4/Zigbee standards. This paper presents an accurate IEEE 802.15.4/ZigBee simulation model developed in the Opnet Modeler simulator. Opnet Modeler was chosen due to its accuracy and to its sophisticated graphical user interface. The idea behind this simulation model was triggered by the need to build a very reliable model of the IEEE 802.15.4 and ZigBee protocols for Wireless Sensor Networks (WSNs). By using this simulation model, we present the impact of performance parameters like throughput, packet dropped, data traffic received and data traffic sent for three network topology scenarios.

3. THROUGHPUT

The purpose of this section is to evaluate and compare the data throughput for three different topologies as discussed above. Throughput is the average number of bits or packets successfully received or transmitted by the receiver or transmitter channel per second. Figure 5.1 shows the throughput for the cluster, mesh and star topologies respectively.

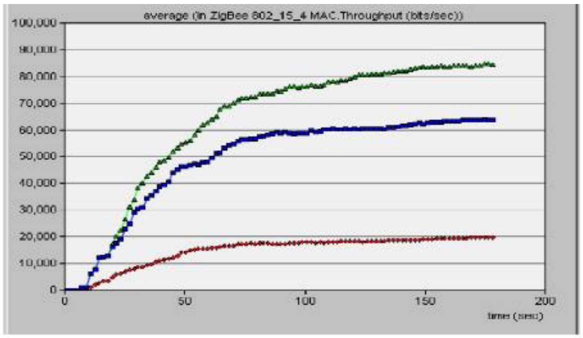

Figure 2. Throughput.

The above figure shows the statistics for throughput for each scenario and the maximum throughput values are recorded has 83.674, 65.736 and 19.989 Kbits/sec for cluster, mesh and star topologies respectively. By analyzing the graph above and the behavior for the cluster-tree topology has more throughput than star and mesh topology because each end device is communicate with the respective Fully Functional Devices like PAN coordinators and routers where the star topology communicates with the single PAN coordinator which in turn have more network load than cluster topology and each device in the mesh topology can communicate each other so the data transmission between the end devices to end devices are not efficient than the data transmission between the end devices and PAN coordinator or routers. In turn the mesh topology has fewer throughputs than cluster topology in WSN. Also observed that the throughput is minimum in case of star topology compare to mesh and cluster topology because of single PAN coordinator needs to communicate with all the end devices which increase the network load and lowering the throughput.

4. PACKET DROPPED

Packet dropped is key metric for evaluating the successfully transmission of data packets from source to destination. It is defined as the packets are unable to reach the destination from source and are lost on the way due to the factors like signal degradation over the network medium, oversaturated network links, corrupted packets, faulty network hardware, faulty network drivers etc. [2]. Figure 5.2 shows the packet dropped for Cluster, Mesh and Star topologies.

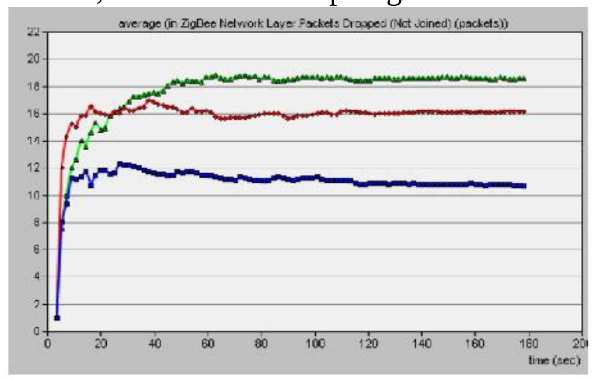

Figure 3. Packet dropped.

The above Figure 5.2 shows the number of packet dropped for the duration of 180 sec. The average packet dropped are recorded has 11.247, 16.148 and 18.783 for Cluster, Mesh and Star topologies respectively. It has been observed that the packet dropped for mesh and star are more compare to cluster because the network load in the system is shared with fully functional device which reduce the load and in turn it reduces the collision between packets in cluster topology. Also the packet dropped is more in case of star topology because of oversaturated network links, collision delays etc.

5. DATA TRAFFIC RECEIVED

Figure 5.3 shows data traffic received for the cluster, mesh and star topologies. It is defined as number of bits the data received per unit time.

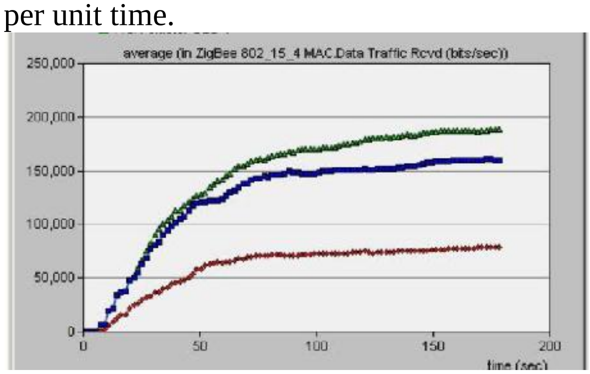

Figure 4. Data traffic received.

Figure 5.3 shows that the data received by the cluster, mesh and star topologies is 192.764, 158.435and 80.769 Kbit/Sec respectively. Its indicate that the traffic received is maximum in the case of cluster topology because all end devices are communicate through PAN coordinates or Routers (FFD) and these devices are responsible for traffic generation and routing. Also the lesser collision, lower packet loss leads to maximum data traffic in case of cluster topology.

Also it has been observed that received data traffic is minimum in case of star topology because the topology uses the end devices (RFD) need to communicate through the PAN coordinator which increases data traffic between devices and PAN coordinator and causes more collision and packet loss and reduces the received data traffic. It is also same in the case of mesh topology but only few end devices in directly communicate with the PAN coordinator.

6. DATA TRAFFIC SENT

Data traffic sent is defined as the total number of data bits sent by the source to destination per unit time irrespective of the condition whether all of the data bits reach the destination or not [2].

The below figure shows the data traffic sent for cluster, mesh and star topologies respectively. Figure 5.4 depict the data traffic sent for cluster, mesh and star topologies is 23.653, 19.989 and 12.874 Kbit/Sec respectively.

It indicates the maximum data traffic sent is more in case of cluster topology because cluster topology makes use of PAN coordinators (FFD) for communication; these Fully Functional Devices are responsible for traffic generation and maintaining routing tables in PAN coordinators only. Also the lesser collision, lower packet loss leads to the maximum data traffic in case of cluster topology.

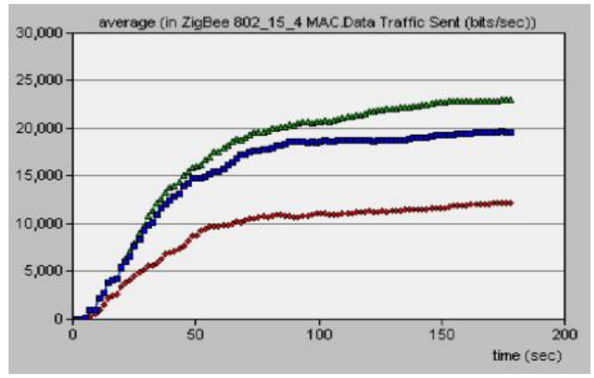

Figure 5. Data traffic sent.

Also it has been observed that data traffic is minimum in case of star topology because the communication suffers more collisions and time-outs, both of these factors leads to reduction of traffic sent. In addition the mesh topology uses some end devices communicate through the PAN coordinator directly instead of intermediate router which increases the data traffic between devices causes collision, time-outs and reduces the traffic sent.

CONCLUSION

Wireless Body Area Networks (WBANs), comprised of tiny intelligent physiological sensors, represent a promising addition to wearable systems for health monitoring. Following current trends in advances in size, low power, and dense integration (complete systems on a chip), it is expected that WBAN sensor nodes can be easily integrated into a user's clothing or worn as tiny patches on the skin. The absence of wires and small weight make them unobtrusive and allow ubiquitous, ambulatory health monitoring for extended periods. Integration of WBANs into a broader telemedicine system empowers patients and users with continuous ambulatory monitoring, a chance for remote rehabilitation at reduced cost while adding value, and the earliest possible detection of abnormal health indicators. This thesis presents a WBAN implementation which consists of multiple sensor nodes, a personal server, and a network coordinator.

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