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LOWER LAYER EVALUATION IN WBAN USING CASTALIA

Lower Layer Parameters of WBAN in CASTALIA

Abhilash Hegde[1], Durga Prasad[2]

[1]Student, M.Tech(DEC), NMAMIT, Nitte, Udupi, INDIA
[2]Associate Professor, Dept. E&C, NMAMIT, Nitte, Udupi, INDIA

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Abstract— *Enhance in the wireless communication network and use of miniaturized equipments has made the researchers to develop Wireless Body Area Networks (WBANs). The network consists of several sensors attached on and off the body and some implanted within the tissues of a human body. This wireless scenery of a network and a vast diversity of sensors give various modern, practical and innovative applications to improve health care and the Quality of Life. These sensors are used in measurement of heart rate, temperature and humidity and also documentation a prolonged electrocardiogram in a human body. Wearable and implantable communication devices involved in a WBAN require having small form factor, low power consumption, and scalable data rates ranging from Kbps to Mbps. Low cost, simple hardware implementation, and low processing power are also key requirements for sensor nodes in a WBAN. So, the application is real time and evaluation of network parameter is necessary for the efficient working. Thus the proposed project gives the brief idea of the lower layer parameters in WBAN using certain simulations in Castalia.*

Keywords—*CASTALIA, IEEE 802.15.4, Wireless Body Area Networks (WBANs), Local Area Networks (WLAN), Wireless Personal Area Network (WPAN), Wireless Sensor Networks (WSNs), medium access control (MAC) layer and physical (PHY) layer.*

INTRODUCTION

Enhance in the wireless communication network and use of miniaturized equipments has made the researchers to develop WBANs. The network has quantity of many sensors attached on and off the body and some implanted within the tissues of a human body. This sensor device offers constant checking of health in real-time and this feedback is sent to the user or any other medical personnel. Furthermore, the measurements can be documented for over a very long phase of time, improving the superiority of the calculated data.

WBANs may also cooperates with the available Internet, further subsisting wireless technologies such as Bluetooth, cellular networks, video surveillance systems, other wireless networks and ZigBee.

The IEEE 802.15.4 aim is to describe the MAC and PHY layer to provide a certain level of quality for low power devices in communications surrounding the human being to support WBAN appliances for instance healthcare. As seen in Figure.1.(b) reference model for WBAN can be analyzed similar to standard reference model shown in Figure.1.(b).

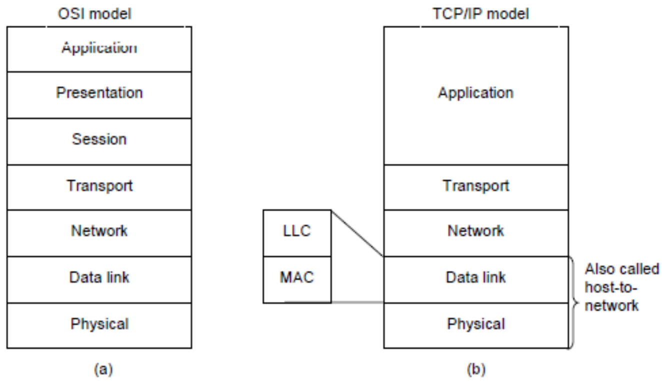

Figure.1: OSI Reference Model. (a)Standard OSI Model. (b)WBAN OSI Reference Model[1].

Implementation is done using Castalia, is a simulation tool for WSN, WBAN supporting the networks of embedded devices offering low-power requirement. Castalia is OMNet++ platform supported simulator for utilize of researchers, developers. The features of this simulation such as distributed algorithms feature and/or protocols showing authentic wireless mediums, radio representation feature with the authentic node function and behaviors especially that relates radio access.

Figure.2 shows example scenario for WBAN used in medical field.

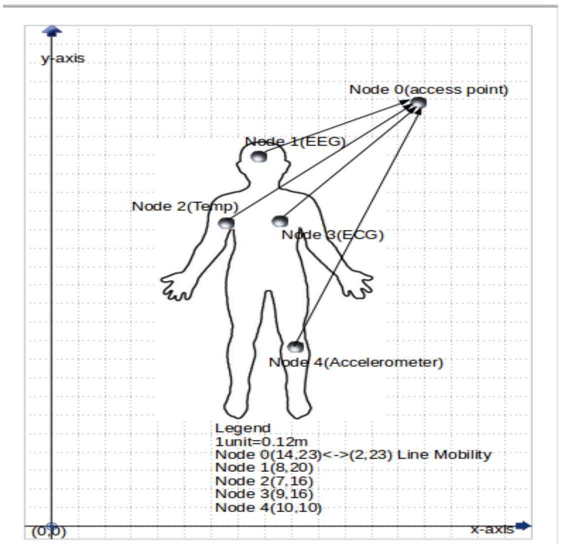

Figure.2: Scenario model WBAN for medical applications[2].

LITERATURE SURVEY

IEEE 802.15.4 Description

The two PHY layer variants seen in 802.15.4 is 868/915MHz and also 2.4 GHz. 868 MHz rate group has single channel having data rate 20 kbps, where as 915 MHz rate group has single 40 kbps channel, while 2.4 GHz rate group has been partitioned into 16 channels of each having the data rates of 250 kbps. For ease, let's reflect only on 2.4 GHz rate group [1] [2].

When coming to MAC description, categories which are maintained by 802.15.4 is peer-to-peer and star, here star network is considered. Star network are used here for a main advantage purpose in appliances for instance medical sensors so the external controller thus is used with admittance to a revitalized supply of power. Methods of communication in star topology are non-beacon and mode beacon [3] [4] [5].

In mode beacon, network coordinator controls communication, by continuously transmitting standard beacons meant for synchronization between devices and control of network association. Initiate and finish of superframe is defined by network coordinator by periodic beacon transmission. The user is capable of define the length of a beacon phase and thus defines the task phase of the structure between the certain limits as defined by the standards. The benefit in this mode of communication is that one can observe coordinator communicates at its determination between different nodes in the network. The drawback is rouse of nodes is must to acquire the beacon.

In mode non-beacon, if required using CSMA/CA, a node network at determination is capable to throw information to the coordinator. On the supplementary give, to obtain information from the controller the node should wake up and power up and poll the controller. The frequency of polling should be determined with the intention of accomplish the necessitated node life span done by power stores and supposed information measure. The benefit of mode non-beacon is that obtain the beacon then regularly power-up of nodes receiver is not required. The drawback is that the controller should hang around to be identified ahead by the node to converse and thus not possible to communicate at determination with the node [3] [4] [5].

In mode beacon, mutually active, inactive periods are present in the superframe. The portion of active contains 16 slots equivalently spaced, and is made up of 3 parts: beacon, contention access period (CAP), contention free period (CFP). Exclusive of utilize of CSMA the beacon is transmitted at the initiation of slot 0 and the CAP originates instantly following the beacon. The controller merely acts together with nodes for the length of the period in active and may also sleep for the length of the period in inactive. To permit lesser latency function there requires a guaranteed timeslot (GTS) preference in 802.15.4 [3] [4] [5] as given in Figure.3.

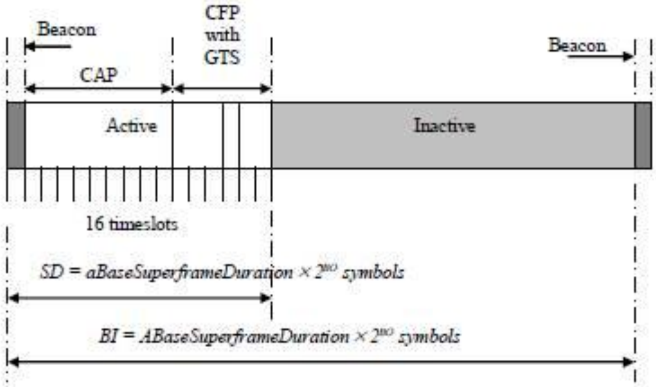

Figure.3: The Standard SuperFrame Structure for IEEE 802.15.4a [5].

CASTALIA

A simulation tool for WSN, WBAN supporting the networks of embedded devices offering low-power requirement. Castalia is OMNet++ platform supported simulator for utilize of researchers, developers. The features of this simulation such as distributed algorithms feature and/or protocols illustrating practical wireless straits and radio sculpt feature with the realistic node function and behaviors especially that relates radio admission.

- Castalia features:

1. Supported on experimentally calculated information advanced model for channel was developed:

- Not only simply links among different nodes, path loss map is defined.
- For chronological distinction of pathLoss a complex model is defined.
- Nodes mobility is supported.
- Not a parted feature but interference knobbed by power of a obtained signal.

2. Supported on real radios for low-power communication Advanced radio model was developed:

- Supported on packet dimension, SINR, modulation category probability of accepting is described. Phase Shift Keying, Frequency Shift Keying are supported, by significant SNR-BER curve custom modulation is allowed.
- Different power levels for transmitter with entity node distinctions are allowed.
- Different power consumption and switching delays between states.
- Carrier sensing is flexible (based on polling and based on interrupt).

3. Modeling for extended sensing provisions:

- Material method representation is elevated and elastic.
- Bias, utilization of power, device clamor sensing.
- CPU consumption of power, Node clock drift.

4. Routing and MAC protocols are available.

5. Especially for expansion and adaptation design.

Castalia simulation tool has been designed as of the scratch such that the different researchers can very effortlessly apply/introduce their own developed protocols and/or algorithms into this Castalia when making utilize of these characteristics as this simulator is providing to different users. Properly modularized and configurable, automation build procedures also helps towards this finish. The modularity feature, reliability of this tool, and tempo of this tool are to a definite degree facilitated by OMNeT++, an excellent framework to build event-driven simulators [OMNeT++ link].

SIMULATION WITH RESULTS AND DISCUSSION

The simulation scenario is from a BAN using 802.15.4 MAC. Let's check performance under different MAC functionalities and wireless channel circumstances. Also check the packet deliverance proportion under different MACs.

Now for the simulations let's go to Castalia software folder and open Simulations and then open file BANtest and then open omnetpp.ini, now that a .ini file is observed with outsized arrangement file i.e. utilized to summon up a multiplicity of circumstances to estimate MACs in BAN. In section General one be able to witness that tool is compose utilize of a convention pathLoss map. This map is described in a file named pathLossMap.txt. Also compose utilize of a file to describe the sequential distinction of the non-wire medium also resulting from the quantity operations. All circumstances bring into play the throughputTest function. Everyplace the entire nodes throw packets in the direction of a sink/hub node by the area of a invariable (configurable) tempo. The hub defined is always node 0 in this simulation.

In this sector let's give attention to ZigbeeMAC (precisely IEEE 802.15.4 MAC). Now let's execute this testing how ZigbeeMAC act upon when its Guaranteed Time Slot (GTS) utility is rolled on or off, also when having a non-wired strait that demonstrates chronological pathLoss distinction vs. solitary with the intention of it does not. For these 4 states of affairs let's fluctuates the packet tempo of the propelling nodes. Also run each demonstration with 5 dissimilar starting points situates. The result obtained can be viewed in Figure.4.

```
BANtest$ Castalia -c
ZigBeeMAC,allNodesVaryRate,[GTSon,GTSoff][noTemporal,General] -r 5
Running configuration 1/4
Running configuration 2/4
Running configuration 3/4
Running configuration 4/4
BANtest$ CastaliaResults -i 101221-191001.txt
+------------------+--------------------------------------------+------------+
|           Module |                                     Output | Dimensions |
+------------------+--------------------------------------------+------------+
|      Application |       Application level latency, in ms | 1x1(31)    |
|                  |                Packets received per node | 1x5        |
| Communication.MAC | Fraction of time without PAN connection | 5x1        |
|                  |               Number of beacons received | 5x1        |
|                  |                   Number of beacons sent | 1x1        |
|                  |                         Packet breakdown | 5x1(5)     |
|Communication.Radio |                       RX pkt breakdown | 6x1(5)     |
|                  |                                TXed pkts | 6x1        |
|  ResourceManager |                          Consumed Energy | 6x1        |
|   wirelessChannel |                  Fade depth distribution | 1x1(14)    |
+------------------+--------------------------------------------+------------+
```

Figure.4: CASTALIA result.

Let's come across at the packets obtained by means of the application. In Figure.5 the axis y defines the middling packets obtained per node. The axis x defines the propelling tempo for every node determined in packets per sec. Nodes are propelling packets for the time instant of 50 secs so to achieve reception to be perfect would have 1500 number of packets per node for 30packets/sec/node case. From the observation for stumpy passage the GTSon i.e. noTemporal bend reaches the utmost.

Generally the protocol executes superior when the GTS is rolled on. This is what is anticipated as TDMA systems which makes extra resourceful utilize of the non-wired standard and are minimizing interference. One can also observe that the presentation (packets received) is enhanced in crate of no temporal distinction channel.

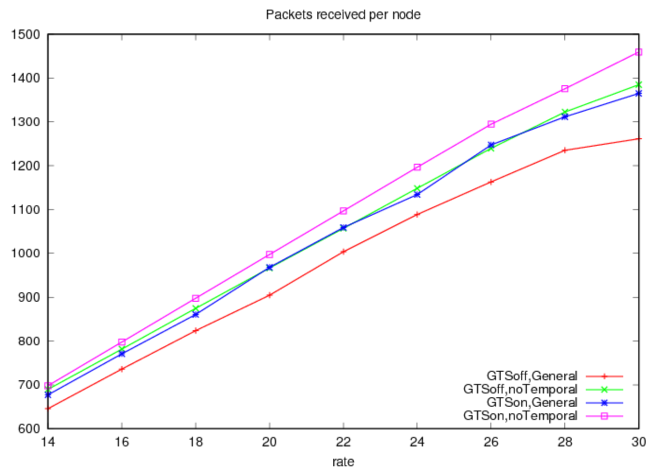

Figure.5: ZIGBEE-BAN-APP-4TYPES.

Come across at the Figure.8, 9, 10, 11 graph one be able to obtain an instantaneous be aware of on how enhanced the noTemporal crate is. Also can observe that the main difference is a segment of the packets who failed because of no Ack was received (a direct result of the deep fades in the channel and loss of connectivity). For high rates we also see more packets being overflown. This breakdown is for packets send at the side of the MAC level. Thus, can also come across at the breakdown of packets obtained at the Radio layer of node 0 (the hub).

As expected one can observe that there are no packets that fail because the channel is found busy (since we are not working with contention-based access). It is very interesting to see that there are considerably more packets over flown for the General case evaluated to the results when GTSoff. This also have the same opinions with our examinations on latency graphs as in Figure.6& 7

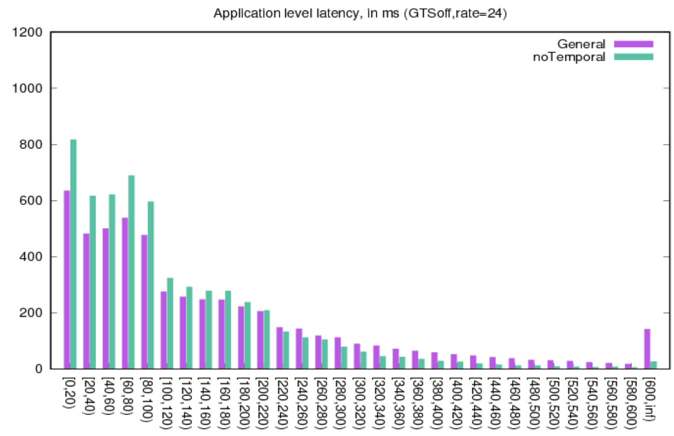

Figure.6: Application Latency GTSon

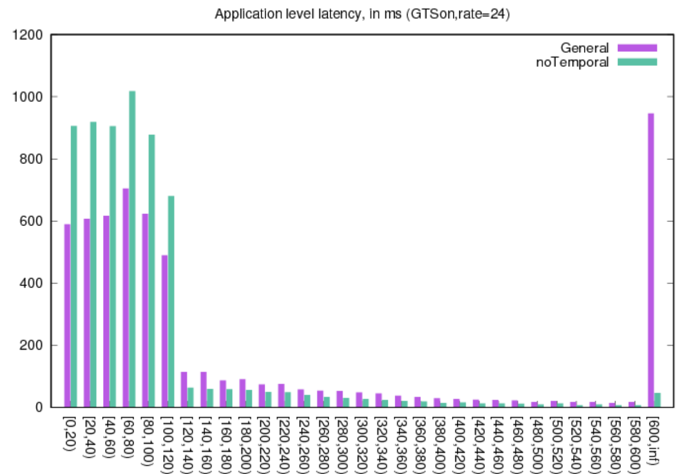

Figure.7: Application Latency GTSoff

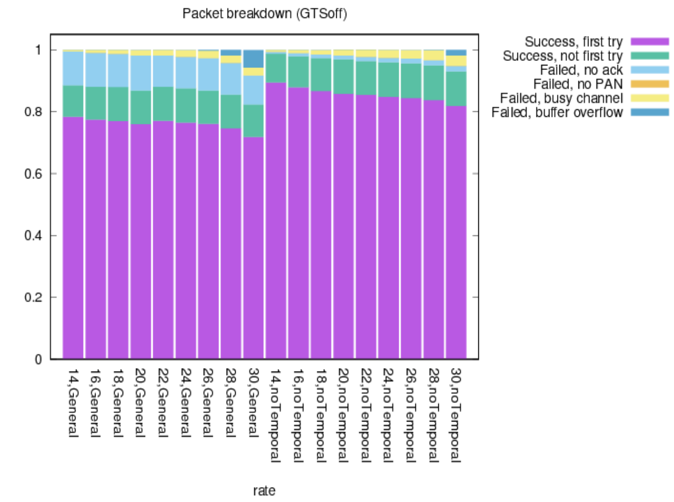

Figure.8: ZIGBEE-BAN-MAC-GTSOFF-PERCENTAGE.

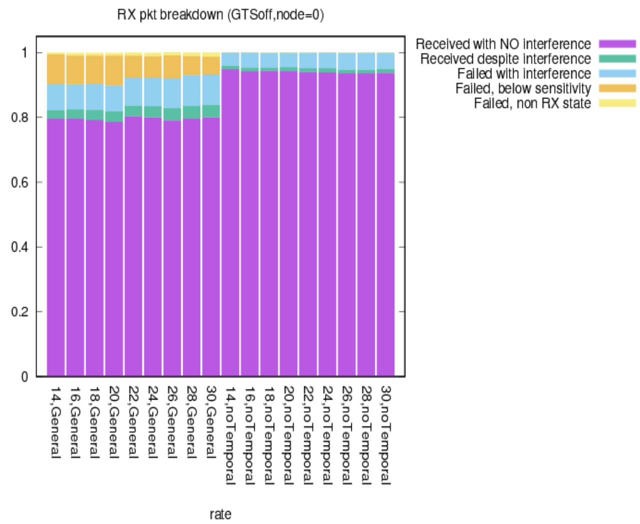

Figure.9: ZIGBEE-BAN-MAC-GTSOFF-PERCENTAGE.Node 0

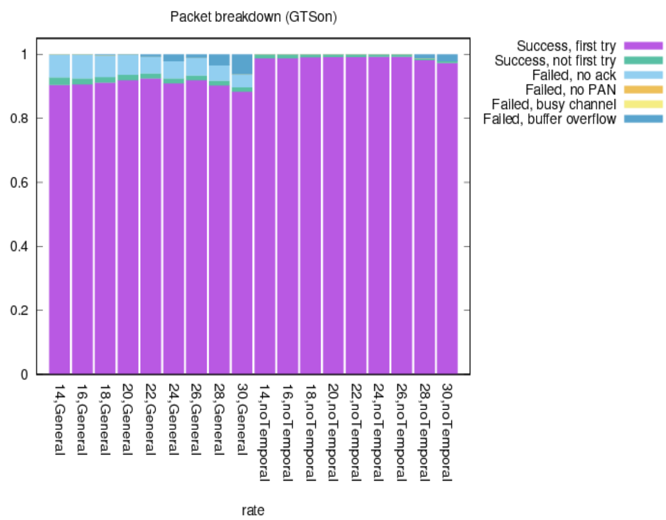

Figure.10: ZIGBEE-BAN-MAC-GTSON-PERCENTAGE.

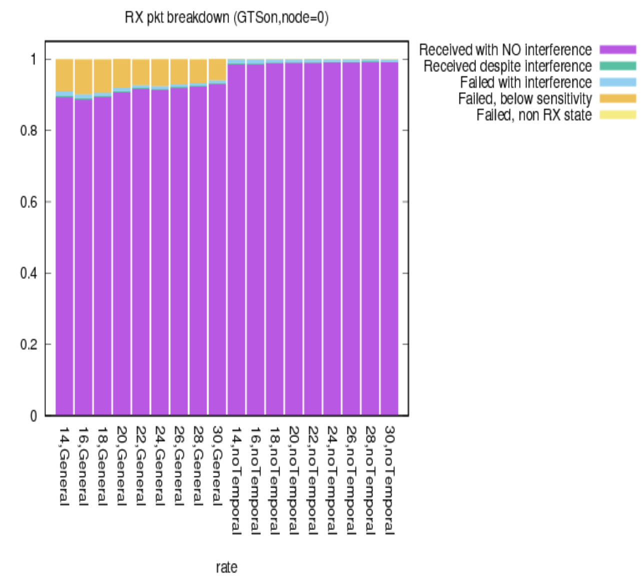

Figure.11: ZIGBEE-BAN-MAC-GTSon-PERCENTAGE.Node 0

In the Figure.6 & 7 graph (GTSoff, i.e. only contention-based access) we can see that most of the packets are received with under 100msecs latency, which means that they are transmitted in the first MAC frame after their creation (for this particular BAN simulation scenario we have chosen the MAC frame to be 120ms). We also see that no temporal is performing better as expected. The non-negligible portion of packets at the (600..inf) bucket is a sign of oncoming saturation for the temporal case (General). In the second Figure.7 graph (GTSon) we see even more pronounced effects. The majority of the packets are received within the first frame of creation and we also see a big portion of packets with large delay. This tells us that there is potential saturation in this case, with overflown buffers, possibly explaining some of the low performance points in the "packets received per node" graph [1].

CONCLUSION

A brief thought on this inferior layers of WBAN system are presented using Castalia simulation tool. The model outcomes obtained evaluates the need for WSNs over wired networks and also gives the needful results to bring away WBAN in medical applications with greater efficiency. Also requirement of quality of service (QoS) with limitation of power in sensor nodes of WBANs is achieved. Thus helps in deploying equipments in larger numbers with low cost and high efficiency.

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