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Impact of Sensor Motes on Web Server of IEEE 802.15.4 for Wireless Sensor Networks

Ashok K Yadav
Computer Science & Engineering,
BIET, Jhansi, Uttar Pradesh.

Sukhvinder S Bamber
Computer Science & Engineering.
Panjab University SSG Regional Centre, Punjab.

A K Solanki
Computer Science & Engineering,
BIET, Jhansi, Uttar Pradesh.

Abstract— Main aspire of this paper is to observe the outcome of diverse sensor motes namely BPART, MOTEIV, Z1 on web server of IEEE 802.15.4 in case of Wireless Sensor Networks (WSNs). The three motes are studied by keeping all the other factors same in all the three cases. The results are compared on the basis of collision status, packets marked noise, media access delay, throughput, end to end delay. These parameters are considered at physical, MAC and application layers and results were analyzed. Overall, it is concluded that if the performance of the web server is to be enhanced then there has to be trade-off for utilization of motes in the IEEE 802.15.4 (WSNs) connected to web server.

Keywords- *Wireless Personal Area Network (WPAN), BPART, MOTEIV Z1, Wireless Sensor Networks (WSNs).*

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I. Introduction

WSNs are gaining popularity with each passing day due to its potential use for a plethora of real world applications. The different applications have different expectations from WSNs and continuous research is being done to improve the performances of such networks in form of higher throughput, low energy consumption, low value for BER and delays etc. The major aim of wireless sensor network is to consume less power and send data in a reliable manner. Moreover, traditional IEEE 802.11 mechanism is made in order to provide minimum amount of power utilization. Hence, this is designed for less rate wireless applications. Further, IEEE 802.15.4 MAC contains the capability to give quite less duty cycles (almost from 100 % - 0.1%), that is mainly exciting for WSN areas (Casilari et al. 2010). In this, GTS system gives a bare least check promise for the consequent nodes & let the forecast of the nastiest-case efficiency for each node's function.

Various researchers have worked on the configuration and settings of different motes for WSNs and analyzing the performance of the same. Casilari et al. (2010) have presented an observed classification of battery utilization in commercial 802.15.4/ZigBee motes. This classification is dependent on the extent of the present that is exhausted from the power supply under various 802.15.4 communication works. Lee (2006[b]) made a comparison on non-beacon & beacon communication method in a practical scenario with two IEEE 802.15.4 advancement boards via various performance attributes. Performance of these sensor motes have been compared referring the standard datasheets available for these motes (memsic, 2010; moteware, 2010; xbow, 2010 &zolertia, 2010).

Here, we have compared and characterized the performance of web server based upon the present utilization in IEEE 802.15.4 WSN using different motes (BPART, MOTEIV and Z1) under the same set of conditions and attribute settings. The final objective is to confirm that definite sensor motes are more suited to IEEE 802.15.4 WSN than others for improving the performance of the web server.

A System Description

Simulative structure of IEEE 802.15.4/open-zb runs PHY & MAC layer described in IEEE 802.15.4 pre-defined set & APL layer described by open-zb. Opnet Modeler 14.5 is utilized for building 3 versions of 802.15.4 i.e. BPART, MOTEIV and Z1. Each variant (scenario) contains one web server, one router, 1 PAN Coordinator, 1 analyzer and twelve GTS enabled destination devices. All three scenarios are similar for each & every respect excluding the battery attributes such as current draw in various modes.

B Scenario

Figure 1 shows the identical scenario for all three motes which contains one web server, one router, one PAN Coordinator, one analyzer and twelve GTS enabled end devices. PAN Coordinator is a Fully Functional Device (FFD) which will be able to help 3 functional modes, serving as:

- A *Web Server*, the main manager of the PAN. Web Server device looks for its personal network, toward which further devices might be linked, performs routing, disassociation etc.
- A *Personal Area Network (PAN) Coordinator*, gives management services via communication of beacons. This kind of a coordinator should be linked with a PAN coordinator & cannot build its parsonal network.

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- A simple *Device* do not run the earlier operations but simply senses the information from the surroundings and convert them into electrical signals and transmits to the PAN coordinator.

Destination device is a RFD operating with reduced execution of IEEE 802.15.4 protocol. End devices do not perform routing & link to a solitary FFD at a time. They are known as end devices because they cannot perform routing and are at the end of the network.

1. Identical Network Scenario: BPART, MOTEIV & Z1 Motes

C Battery Process Model

Figure 2 depicts the development structure for the 802.15.4 battery & this battery contains 2 states of init and dissipation. *Init* state starts the node identification & the attributes such as Energy-supply, startup energy & current draw (receive method, communication method, idle form as well as inactive form). Further, the *dissipation* condition gathers the information linked to the distant interrupt, computes size of packet & consumed energy when sending or receiving a packet, calculate the time exhausted & energy frenzied by the node in inactive condition & lastly updates the present energy point in sending, receive, inactive and active time.

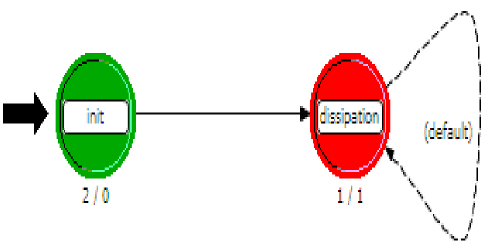

Figure 2 Battery Process Model.

D Attribute Settings

Attribute values for all three scenarios are same except for the battery parameters ;e.g. attribute values of the PAN Coordinator acknowledged traffic like: MSDU Interarrival time, MSDU size, start time, stop time etc. are same in all three scenarios and the battery attributes like: current draw in 'Idle mode' are different for each scenario.

II. Results and Performance Analysis

Here, the outcome obtained at the web server by changing the sensor motes in IEEE 802.15.4 three various schemes & placing all other required attribute values same as stated in table 1 have been presented and analyzed.. Reasons for the performance variations at the web server are in accordance with the implementation of battery process model (transmit, receive, idle and sleep modes) and the equations derived from its coding.

Physical Layer

Lowest protocol layer in the IEEE 802.15.4. This layer is neighboring layer to hardware& straightly maintains & communicates through radio transceiver. Further, PHY layer is liable for triggering the radio which sends or receives packets. It also chose the channel frequency & makes confident that the channel is not presently utilized by any other device(s). It deals with the following significant performance metrics that affect the efficiency of IEEE 802.15.4 WSNs:

A Collision Status (Radio Receiver)

Collisions that take place at the radio receiver when the frames or packets arrive at the destination is under collision status.

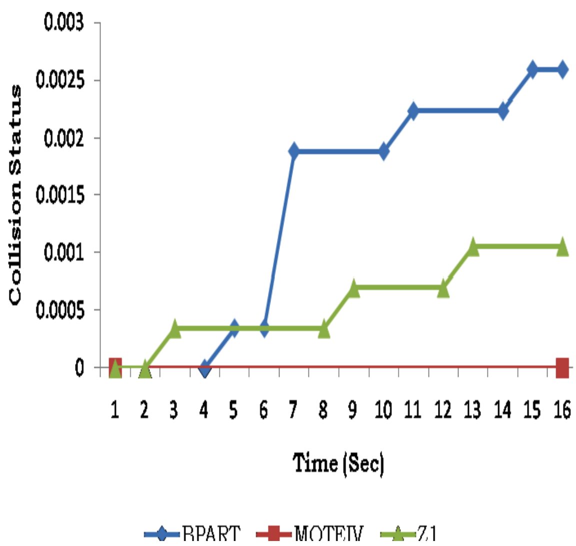

Figure3: Radio Receiver Collision Statusat Web Server

Figure 3 depicts that the status of collision at the radio recipient of the web server in case of BPART, MOTEIV and Z1 is: 0.002591, 0.0 and 0.001056 respectively. It is precieved that collisions are maximum for BPART mote. Also on observing it can be judged that the collisions are least for MOTEIV mote as this consumes the utmost existing in receive mode. From table 1, it is clearly seen that MOTEIV takes 23 mA of current in receive mode whereas BPART takes 8 mA and Z1 takes 18.8mA. Since BPART takes the least amount, the value for collision status is maximum for it. Therefore, it is concluded that if the minimum collisions are required at the radio receiver of the web server then MOTEIV should be implemented.

B Packets Marked Noise (Radio Receiver)

The ratio of the packets that are marked noise to the total number of packets arriving at a receiver of the web server.

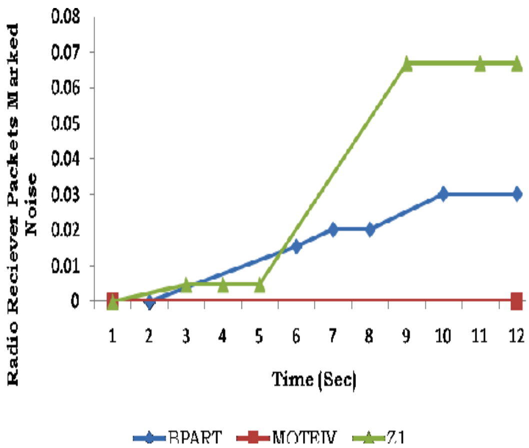

Figure4: Radio Receiver Packets Marked Noise at Web Server

Figure 4displays that the packets marked noise at the radio receiver of web server in case of BPART, MOTEIV and Z1 are: 0.030106984022, 0.0 and 0.066853366453 respectively. Further observation states that packets marked noise are maximum in case of Z1. Also it has been observed that packets marked noise are minimum in case of MOTEIV. It is attributed to the fact that in case of MOTEIV, 10kb RAM and 512 kb Program memory is used, whereas, Z1 uses RAM of 8kbs. For the intermediate performance of BPART, a RAM of 8Kbs and program memory of 256kb is held responsible. Therefore, it is concluded that if the packets marked noise are to be taken into consideration then MOTEIV should be implemented at the radio receiver of web server.

C Busy (Radio Transmitter)

It is degree to which the physical layer remains busy in transmitting the data between the source and the destination.

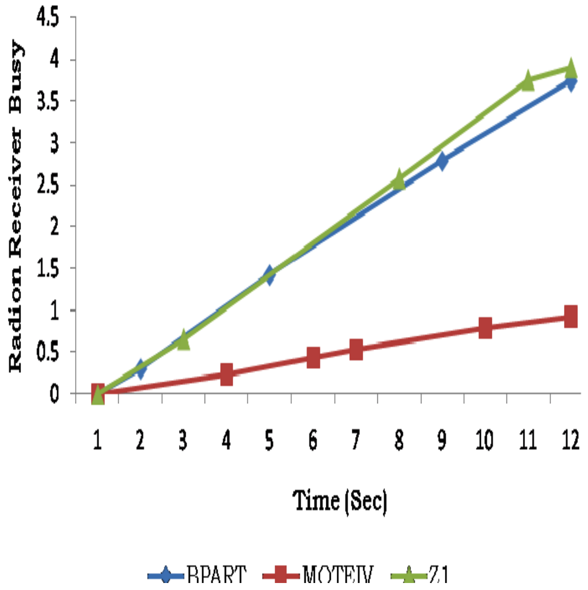

Figure5: Busy at Radio Transmitter of Web Server

Figure 5 shows that the radio transmitter of web server in case of BPART, MOTEIV and Z1 is: 3.738656000001, 0.920076 and 3.897760000001 busy respectively. It is observed that radio transmitter is maximum busy for Z1 mote. Moreover, it is to be perceived that the radio transmitter is lower busy in case of MOTEIV. The traits of MOTEIV to draw more current and a higher RAM also contributes to its least busy character out of the three motes. Therefore, it is concluded that if the busy attribute at the radio transmitter of the web server is to be focused upon then MOTEIV mote must be implemented as it is least busy so it can transmit the data immediately.

MAC Layer:

Layer on the peak of the physical layer is the MAC layer. It is accountable for accessing a medium for the transmitting the data from source to destination. Also, it is responsible for error detection and correction.

D Media Access Delay

MAC Media Access latency is the time taken while trying to get the access of the channel on which the data is to be transmitted either to the physical or the network layer from the MAC layer i.e. the extra time taken for getting the access to the channel in excess to the normal time.

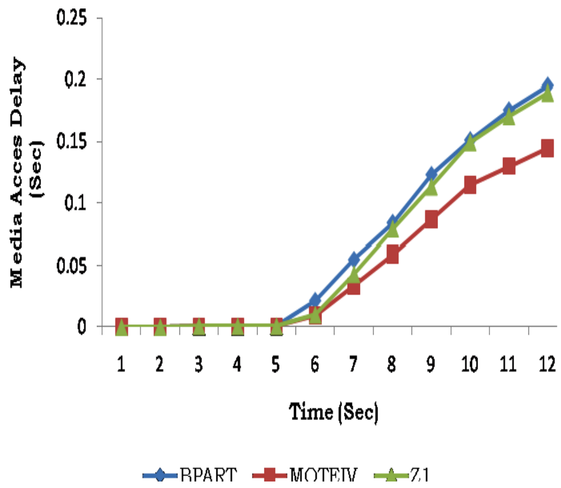

Figure6: Media Access Delay at MAC Layer of Web Server

Figure 6 shows that the media access delay at the MAC layer of web server in case of BPART, MOTEIV and Z1 is: 0.1948261005, 0.144922235669 and 0.189434628056 sec correspondingly. Further thing to notice is that the media access delay is most in case of BPART mote. Moreover observation are to be made that the delay is lower in case of MOTEIV mote. Since, MOTEIV and Z1 uses the RISC architecture along with higher RAM and program memory, they experience less delays. Whereas, the BPART mote uses 8051 or CISC architecture and faces slightly more dealy. Therefore, it is concluded that if the Media Access Delay at the MAC layer is to lower after that the MOTEIV mote mustbe worked on.

E Throughput

Average number of packets (bits) successfully transmitted / received from the MAC layer from the physical or network layer per unit time.

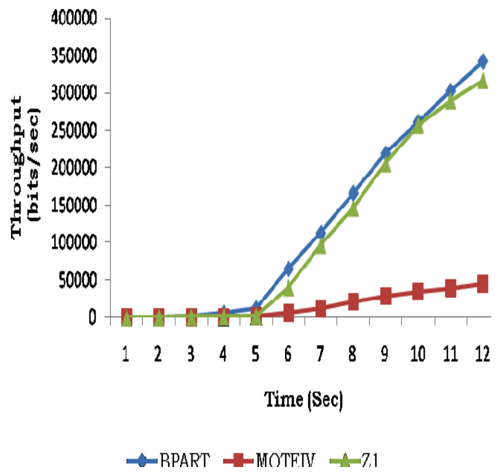

Figure7: Throughput at MAC Layer of Web Server

Figure 7 shows that the throughput at the MAC layer of web server in case of BPART, MOTEIV and Z1 is: 341568, 44274 and 316641 bits / sec respectively. Further most important thing to be noticed is that the throughput is maximum for BPART mote. Also it is to see that the throughput is minimum for MOTEIV mote. Since, the battery life and current usage is an important measure in WSNs, therefore the least current usage is desirable in the overall picture. There is a tradeoff between the delay, collision and overall MAC throughput. Therefore, it is concluded that if the throughput at the MAC layer of the web server is to be improved then BPART mote ought to be implemented.

Application Layer:

Top most layer of the protocol stack which interacts with the client directly. It is responsible for inputs / outputs to / from lower layers.

F End to End Delay

End-to-End delay is the extra time in use (in addition to a specified time) in reaching of the packet / frame from the original source to the final destination.

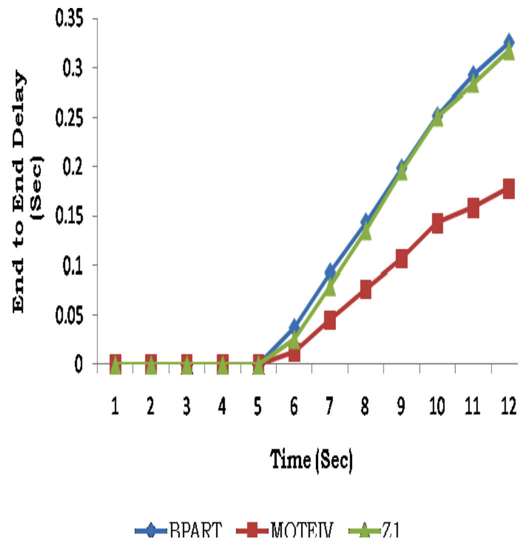

Figure8: End to End Delay at Application Layer of Web Server

Figure 8 depicts that the end-to-end latency at the application layer of web server in case of BPART, MOTEIV and Z1 mote is: 0.325685754907, 0.178514800804 and 0.317513246086 sec correspondingly. Further observation is made that the maximum end-to-end delay occurs for BPART mote. Also it is to be noticed that minimum end-to-end interruption occur for MOTEIV mote. For reasons outlined in 3.4, pertaining to architecture, RAM size and current drawn, the least value of end to end delay can be explained in MOTEIV. Hence, it is concluded that if the end to end delays at the application layer

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of the web server are to be reduced afterward MOTEIV mote should run.

Conclusion

It is concluded that if the performance atweb server of IEEE 802.15.4 WSNs is to be enhanced then there should be trade-off for the use of sensor motes i.e. the performance of web server based upon IEEE 802.15.4 WSNs is performance metric specific.If the minimum collisions are required at the radio receiver of the web server then MOTEIV should be implemented. If the packets marked noise are to be taken into consideration, then MOTEIV should be implemented at the radio receiver of web server.For the maximum utilization at the radio receiver of web server Z1 mote should be implemented.If the Media Access Delay at the MAC layer needs to be reduced, after that the MOTEIV mote must be done. If the throughput on the MAC layer of the web server is to be improved, then BPART mote should be implemented. If the end-to-end latency on the application layer of the web server is to be reduced, subsequently MOTEIV mote should be run.

Overall, it is concluded that if the performance of the web server is to be enhanced then there has to be trade-off for utilization of motes in the IEEE 802.15.4 WSNs connected to a web server.

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