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Switching the Antenna Source Dynamically Based On RSSI in Iot Applications for Optimum Power Consumption

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ABSTRACT— In most of the embedded systems products or innovations the primary challenge is to deal with optimum power usage. The paper provided the concepts of switching between two types of antenna can optimize the power consumption. The concepts utilize PCB antenna and Whip antenna for exhibiting the optimization of power switching between receiving antenna provide advantage with respect to distance of receiving signal.
INDEX TERMS—*RSSI (Received Signal Strength Indicator) value between PCB (internal) Antenna and WHIP or CHIP (external) Antenna*

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I. Introduction

Wireless sensor networks (WSNs) are multi-hop self-organizing networks which include a huge number of nodes integrating environmental measuring, data processing and wireless communications in order to apprehend, collect and process information to achieve defined tasks. A diverse set of applications for WSNs encompassing different fields have already emerged including environmental applications, inventory monitoring, military applications, intrusion detection, health applications, motion tracking, machine malfunction detection and etc. Among these application areas the use of WSNs can adapted to Space and Planetary mission. In the last few years, space-based WSNs had gained increasing attention from both the research communities and

Companies involved in IOT application research. This paper outlines the use of miniaturized instrumentation in WSN which can be a potential tool for IOT application associated with wireless sensors in network.

II. Objectives

The Objective of this project is to propose a solution which reduces power consumption utilized by an active RF antenna by switching dynamically based on RSSI (Received Signal Strength Indicator) value between PCB(internal) antenna and whip or chip (external) antenna along with

Miniaturized instrument, so as to monitor the various environment parameters. The Proposed equipment is capable to with stand for high temperatures, low power consumption, small in size.

III. Challenges

The proposed hardware is designed using RF specifications. The Wireless sensor nodes transmit data in the network which is reliable and scalable mode. Power consumption of any given node always less in order to increase the battery lifetime and there by its operation. Another challenge for the sensor node is design of antenna. Thereare many variables to consider, including size, RF efficiency and detuning issues. The two popular methods for antenna technologies are internal antenna or external antenna.

IV. Typical Deployment Scenario

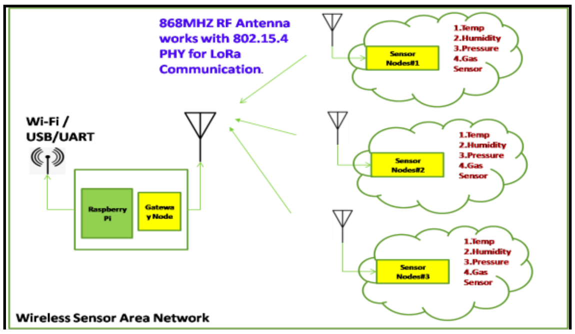

Fig-1

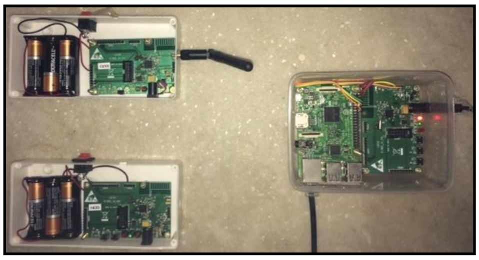

Fig-2

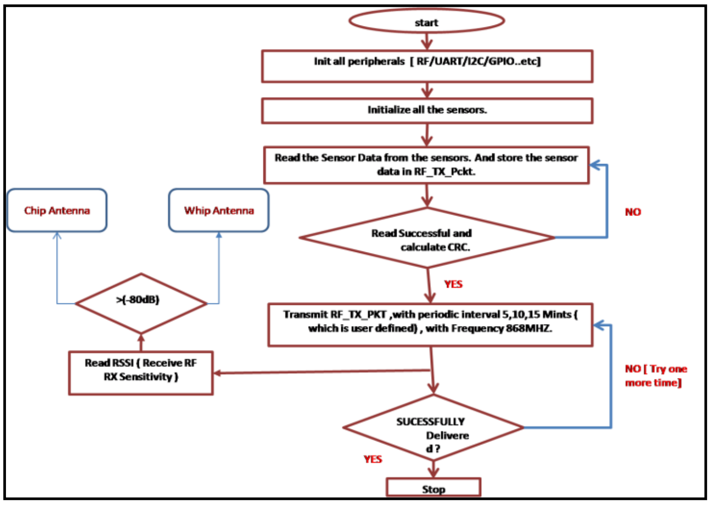

Fig-3

V. Typical WSN Architecture Description

The above functional diagram Fig-1, describes the full application of the sensor node network. Sensor nodes are equipped with Environmental sensors like RTD Temperature Sensor, Humidity, pressure, Air quality and wind flow sensors. The Nodes are placed in different locations in order to collect the data from different distances. The collected data is send to central sensor node using RF Transmitter. These sensor nodes are incorporated within built 802.15.4g PHY, in order to transmit the data over 868MHZ or 433MHZ

VI. Hardware Design Of Sensor Node Module

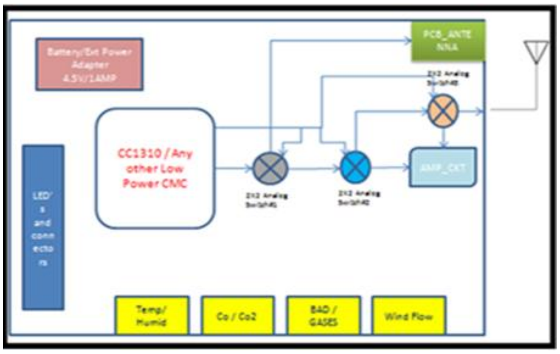

Fig-4a

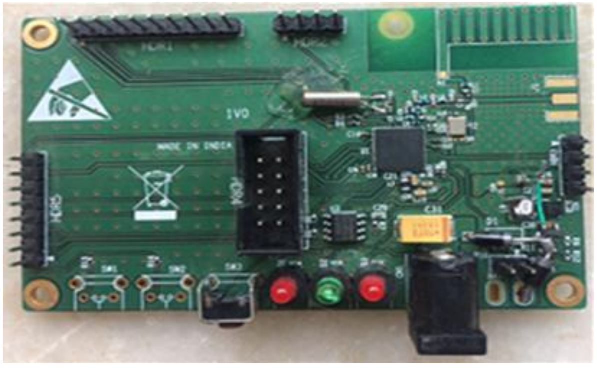

Fig-4b

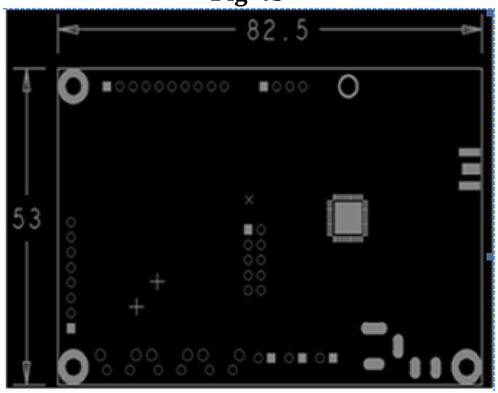

Fig-4c

Wireless Sensor Module is designed such way that, the power consumption should below. The selected hardware is having inbuilt 802.15.4g Phy, with Excellent Receiver Sensitivity –124 dBmusing Long-Range Mode, –110 dBm at 50 kbps (Sub-1 GHz).It is recommended to choose a best sensor module having interfaces to different sensors, like Temperature and Humidity, Gases sensors (CO,CO2, NH.) and wind flow etc. Sensor Board works with low power, such as either 3XAA or Coin Cell, preferably coin cell battery. As shown in the above Fig-2 the sensor node board is designed with size of 82mmX53mm in 2-layer stack.

The sensor moduleselected is a Sub-1 GHz family which is cost-effective, ultra-low-power wireless which consists of very low active RF and microcontroller (MCU). The Node has designed with PCB antenna as a default option and also have an option for chip antenna in order to trade of RF power, distance and achieve the best performance followed by a good battery life,

VII. PCB ANTENNA HARDWARE DESIGN

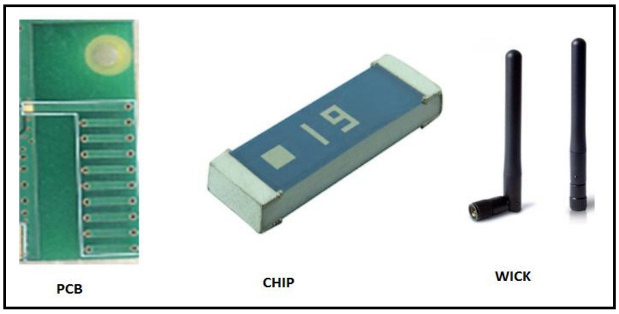

Fig-5

In order to improve the performance of gain and noise levels of the RF power of a PCBantenna, we consideredPCBstack layers which increased from 2 to multilayer. The selections of components are RF tuned parameters and also considered components from through hole to SMD. The Chip control has in built RF control in order to reduce the size in PCB and dense in components.

Most chip antennas make use of the PCB ground plane as part of the antenna setup, designers must think about RF performance and efficiency in relation to the overall size of their PCB.The node uses default PCB antenna andthe system also a provision of chip Antenna and whip antenna as shown in the above fig-5.The Chip Antenna and whip antenna required supported inductors and resister and few other active components, hence those active components consume more power than PCB antenna, so traditionally chip and whip antennas support more RF Power dBm than PCBantenna. Chip antennas are small, cheap and perform well. But bulky external “whip” type antennas must be accounted during initial circuit design stage Interference, proximity de-tuning & degradation concerns. Hence proposing switching of the antennas between PCB, whip and chip antennas dynamically (runtime) will reduce the electrical power, thereby increase the gain of the antenna, when the TX node and RX node are closer, so preferable use PCB antenna, when the same TX and RX are far, then need more power in dBm (gain) to communicate successfully, we need more power, so switch to whip or chip will give good distance coverage, but need to trade of with electrical power vs distance.

VIII. DIFFERENT ANTENNA TYPES AND ITS PROS AND CONS: -

Antenna types	Pros	Cons
PCB antenna	• Very low cost • Good performance at > 868 MHz • Small size at high frequencies • Standard design antennas widely available	• Difficult to design small and efficient PCB antennas at < 433 MHz • Potentially large size at low frequencies
Chip antenna	• Small size • Short TTM since purchasing antenna solution	• Medium performance • Medium cost
Whip antenna	• Good performance • Short TTM since purchasing antenna solution	• High cost • Difficult to fit in many applications

Table - A

The above Fig-3 explains the switching between antennas is achieved by software, there will be a separate thread running in a system other than main thread which periodically reads system vital parameters like RSSI (**Received Signal Strength Indication),** noise level, interference in dBm‘s , through software. Based on this data, the system will select appropriate antenna like PCB, whip or chip on the Fly (run time), if the RSS< -65dBm.

IX. RESULTS

Figures (6a, 6b) shows power consumption at various levels during the operations like transmit, receive and ideal states of the designed instrument, it consumes not more than 0.15 mA. By Switching between PCBand whip antenna, achieved significance distance cover of the 60mtrs.The above functional diagram describes the full application of the sensor node network. Sensor nodes are equipped with Environmental sensors like RTD Temperature Sensor, Humidity, pressure, Air

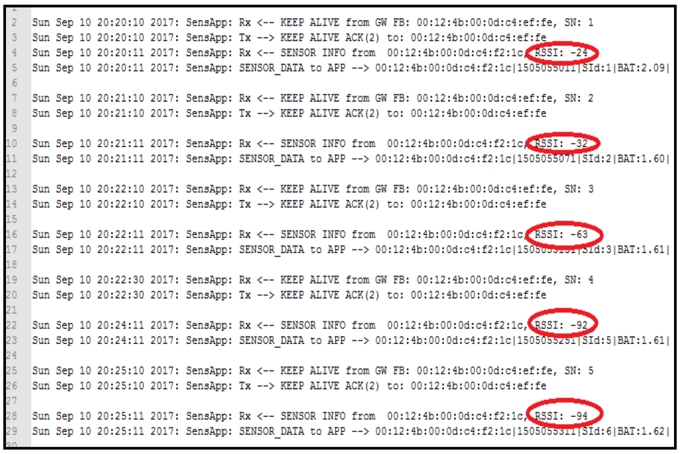

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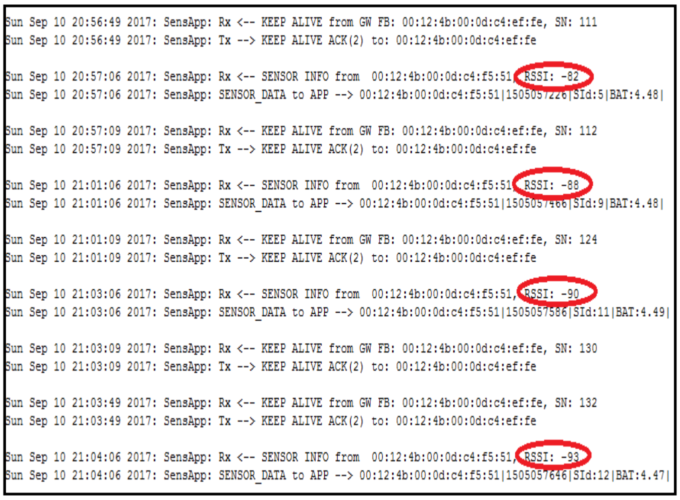
Fig-6a



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Sun Sep 10 21:03:06 2017: SensApp: Rx <-- SENSOR INFO from  00:12:4b:00:0d:c4:f5:51, RSSI: -90
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Sun Sep 10 21:04:06 2017: SensApp: Rx <-- SENSOR INFO from  00:12:4b:00:0d:c4:f5:51, RSSI: -93
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Fig-6b

Above two figures describe the RSSI values, when PCBantenna connected and whip antenna connected. It is observed, that the range got improved up to 100mtrs by switching antenna method from PCBto whip. Figure 6a and 6b are the results, captured after increasing the no of layers, and changing the battery option to coin cell. Table B and C indicate the variation with parameters (Distance, Current, Power)

S.No	Distance [in mts]	Current (mA) PCB Antenna	Power (Watt)
1	0	0.008	0.0264
2	5	0.008	0.0264
3	10	0.008	0.0264
4	20	0.008	0.0264
5	30	0.008	0.0264
6	40	0.01	0.033
7	60	0.01	0.033
8	80	0.01	0.033
9	100	0.01	0.033
10	120	0.01	0.033

Table - B

S.No	Distance [in mtrs]	Current (mA) Whip Antenna	Power
1	0	0.01	0.033
2	5	0.01	0.033
3	10	0.01	0.033
4	20	0.01	0.033

S.No	Distance [in mtrs]	Current (mA) Whip Antenna	Power
5	30	0.01	0.033
6	40	0.01	0.033
7	60	0.01	0.033
8	80	0.01	0.033
9	100	0.01	0.033
10	120	0.02	0.066
11	140	0.02	0.066
12	155	0.03	0.099
13	160	0.03	0.099

Table - C

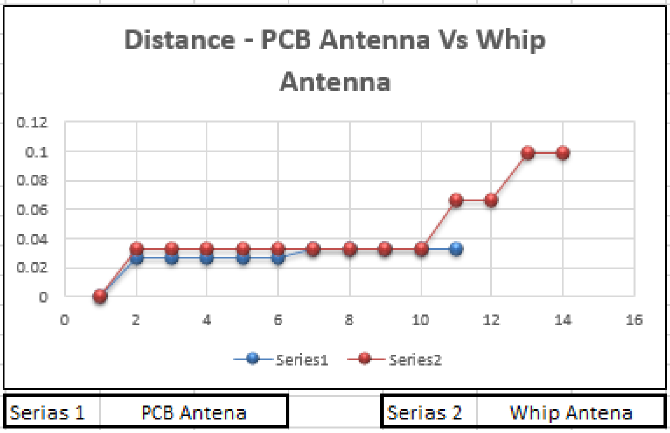

Fig-7: Distance Vs Power graphical representation

X. CONCLUSIONS & FUTURE WORK

Low-power sensor node with Sub-1G capability was successfully designed and tested with reducing PCBsize with low foot print size components. The average expected battery lifetime for this design with the active timer set to 30 minutes is >10 years. The future work including the range of the system using CHIP antenna cascading with an amplifier. Continuous Amplifier circuit operation will take sufficient power consumption. So in order to save the battery life, we would like to switch the antenna path(routing) from direct antenna to through amplifier antenna power by using MCU intervention. The switching of these two paths will be decided by using RSSI power.

REFERENCES

[1]. Wireless Sensor Networks - A potential tool to probe for water on Moon. Durga Prasad &Murty, Advances in Space Research, 2011.
[2]. A NOVEL APPROACH FOR PRECISE TEMPERATURE MEASUREMENT BY PLANETARY THERMAL PROBES Durga Prasad et. al., Planetary and Space Science, 2012
[3]. https://radiocrafts.com/uploads/WP008_Antenna%20Selection%20Guide_1_2.pdf.
[4]. http://www.ti.com/lit/an/slyt296/slyt296.pdf
[5]. https://www.surrey.ac.uk/ssc/research/environments/introduction/
[6]. https://www.plugintoiot.com/sub-1-ghz/#wpcf7-f962-p719-o2
[7]. http://www.ensembletech.in/lora-frequency-bands-india/
[8]. http://www.ti.com/lit/an/swra161b/swra161b.pdf
[9]. http://www.ensembletech.in/lora-frequency-bands-india/
[10]. http://www.radio-electronics.com/articles/wireless-technology/designing-for-the-iot-overcoming-the-

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