Real Time Implementation and Comparison of ESP8266 vs. MSP430F2618 QoS Characteristics for Embedded and IoT Applications

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***Abstract*—This research article proposes a novel Smart Communication Platform (SCP) to improve the Quality of Service (QoS) parameters in real time by using MSP430F2618. A static network has been implemented with narrow band Internet of Things (IoT) architecture which contains 10 nodes. SCP performs tracking of environmental parameters like Temperature, Humidity, Pressure, Proximity and light. A prototype has been developed by using Open source Red hat Linux 14.4 version and programmed in Embedded C.MSP430F2618 has been configured as master and slave nodes, the output is observed in a serial monitor and Gateway as well. The QoS parameters of MSP430F2618 and ESP8266 are compared in terms of power. The power consumption improvements of QoS (Quality of Service) analysis results are around 1.01mW has been seen with the experimental setup. These empirical results are much useful for wireless sensor network and IoT applications.**

***Keywords*—Communication; ESP8266; gateway; Internet of Things (IoT); MSP430; power; sensor**

I. Introduction

The Embedded systems and Internet of Things (IoT) are the network of tiny, intelligent devices, actuators and other tools build together. These systems are mostly wireless and powered by batteries to ease the deployment. The popular version of the Embedded Systems development life cycle is designed from waterfall model. The basic feature of this model is managerial control and Modulate. This has distinct goals at every development step. Different scheduling mechanisms can be introduced at every stage of module and interface. This model is suitable for linear process models takes several steps. Those are 1) Requirement gathering 2) Pre-Design 3) Design review 4) Design implementation 5) Design final app Overview. These can also be put it another terms as Design, Coding, Testing, Maintenance. It is been seen that each phase is also connected back to earlier stage where it helps needed verification.

II. Literature Review

Recent advancements in IC technologies, Communication devices, Sensors places an immediate impact on embedded systems and IoT [1]. Hardware and Software co design technique like, design flow approach with prototyping principles are being used in [2] to build SCP implementation. Embedded system requires immense knowledge in the areas of Electronic devices like C-motes, CPU, GPU, and Gateway [3] to check the functionality of the proposed prototype. In the recent embedded system research domains, processor integrate new and relevant devices by adopting code motion techniques and independent APIs [4]. A prototype is designed to classify the systems, such as one to one node, one to multi node, multi to one node and multi to multi nodes via WINGS gateway and stores the data in cloud. Traditional data processing and measurement methods [5] are being slowly replaced by single wire and wireless communication technology where it is useful lot of starter embedded system application.

To reduce the duration of data transmission, and to improve the network lifetime in [6] like PRIMS algorithm, proposed a distance-based transmission rate selection and maximum emission rate (MER) determination. The web based remote dynamic data collection and Storage monitoring system has been proposed in [7] for data transfer and system characteristics are analyzed for centralized management. The power optimization techniques such as resource consolidation, virtu- alization, selective connectivity, and proportional computing are considered in [8] to improvise the proposed experimental set up. The Network Time Protocol (NTP) is used in [9] for time synchronization, allowing a more flexible network by avoiding the system placement needs. By using these devices one can get data in the form of (i) analog, (ii) digital values (iii) channels of various communication blocks, (iv) Software development tools and (v) Real Time Operating System (RTOS) parameters can be utilized [10]. Interfacing of an advanced micro controller like MSP430 with Wi-Fi makes the user to perform interactive operations. A practical approach [11] on MSP435 based TI CC3220SL results the pervasive computing aspects. Synchronized sampling control method [12] gives better ways to manage wireless node state information to improve flexibility and agility during load balancing, fail over, and life cycle operations, and designing VNFs to allow for their transparent migration across central and edge clouds. Inter-networking arrangement [13] gives the integration of individual modules into systems of architecture, often in network protocol which build the Green Network. Design of structures require environments and modelling methods [14] to understand the operational types and processes affecting the system. Popular patterns for VNFs are set up in future study directions. Future trend universal computing work explores to exploit utility computing and the Internet of Things in [15-17] to move ubicomp systems where computing is made to appear anytime and everywhere. Today’s research turned in various paths such as Power Optimizations [18-19], Wireless sensor networks [20], Embedded systems [21], and re conferrable antennas with IoT applications [22-25].

This platform gives 1) Design and development of hardware setup with soft real time values and test results. 2) Supports experimental digital/analog interfacing with wireless commu- nication. 3) Design of new device set ups for data transmission and reception techniques useful for Edge triggering applications. 4) Experimental results for QoS Analysis.

This article has been divided into various sections. Section II briefed about Literature survey. Section III deals with motivations of current Heterogeneous systems. Section IV discusses about proposed algorithm and implementation steps of MSPF2618. Section V presents results and discussions for QoS comparison analysis. The paper is ended with conclusion and future scope in Section VI.

III. Motivation Towards Heterogeneous Embedded Systems

Central Processing Unit (CPU) and Graphical Processing Unit (GPU) has employed in various applications like mon- itoring, data analytics etc. Master simulator design useful to help developers of slave devices or other devices how to test and simulate. Slave simulator as shown in Fig. 1(a) send the data from the foreign procedure calls. Assign the slave ID, address, size can read and write the registers. There are several data formats available with word order swapping, such as float, double, and long to program. These Processing units (PUs) shows unique features and strengths to conquer high performance computing [2]. Various techniques have applied to develop heterogeneous computing with peta scale range fused with design of CPU-GPU chips as shown in Fig. 2. Parti- tioning enables PUs performance and energy efficiency for heterogeneous computing techniques (HCTs) [4]. Computing has explained in below sections.

A. Design Strengths of PUs

Multi core GPU keeps Instruction set arises in CPU and few tens of PUs integrated on single chip though it in built with several different architectures. Single thread, large size caches with minimum latency, at high frequency rates leads the high through puts. CPU are clearly used for critical latency applications while GPU used for large throughput- critical applications. Thus, heterogeneous system used in number of applications with high performance context.

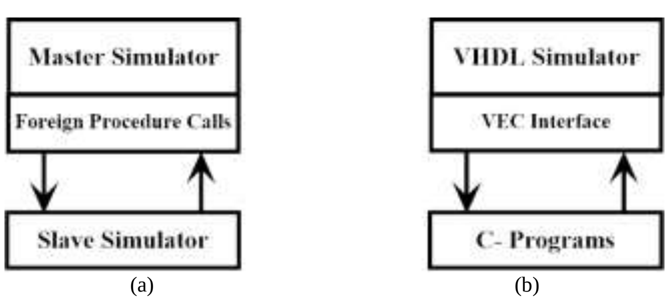

Fig. 1. Master Slave Co-Simulation (a) Hardware Architecture (b) Software Architecture in Embedded System and IoT Platform.

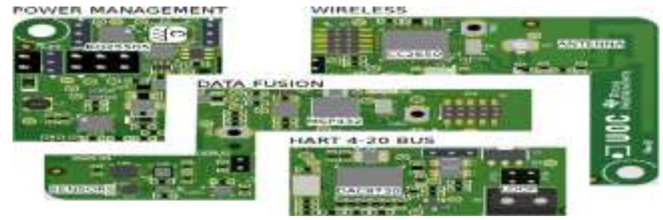

Fig. 2. Schematic of Embedded Chip Fabrication.

B. Embedded Algorithmic Features of PUs

For many applications of data transfers relishes execution time or case GPU cores does not allow uninterrupted ex- ecution and branch mitigations etc. In compared to GPUs CPUs own better performance in single applications at different stages which leaches the time factors of delivery of application.

C. Resource use Improvements

To conclude the resource utilization’s to both CPU and GPU are over featured though the use sends as low. Sometimes CPU stays idle if it sends the control to GPU and in reverse GPU bandwidth memory decreased.

D. Heuristic Algorithms

By the design of Wolf [2], this kind of algorithm have a pool of heterogeneous elements of tasks and provides commu- nication among it. Communication links, PEs and Task graphs acts as input to the algorithm. There are major aims and minor goals like to meet specified rate for execution, minimize the total cost.

Many optimization problems [1] get the solutions from approximations of Heuristic algorithms. The best possible solutions are in maximum or minimum solutions to objective function. The solution is a function used to evaluate the objective function. Optimization problems are nothing but talk about several real-world issues. In all search algorithms solutions can be defined as search space and optimization algorithms, etc.

Dynamic programming branch and bound techniques effectively present in Heuristic practices, gives us time com- plexity and not completed tasks. Premature convergence is a significant drawback in Hill-Climbing algorithm because of it always fetches the nearest local optima of low quality. This can be targeted by, SIMULATED ANNEALING ALGO- RITHM: It resembles the same to Hill climbing but sometimes accepts results worse than the present scenarios where the fault tolerance will be acceptable and decreasing with time slices. TABU SEARCH: Continued the idea where neglect the local optimization by introducing several memory data structures. The “jump” instruction repeated in its loop acts as bottleneck, this is prohibited in Tabu Search. SWARM INTELLIGENCE: Introduced in 1989 by Gerardo Beni and Jing Wang. This is developed among self-organized, decentral- ized systems collective behavior cellular Robotic systems. The popular approaches are Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO). In ACO the design done on future ants to build improved solutions by showing the variations in the graph and changing its way. PSO it is entirely different that solutions produce point or surface in an ndimensional space. The main possible advantage is that local optima [7] can be resolved from impressively resistant algorithms in multi-application design aspects.

IV. Proposed Algorithm and Implementation Steps of MSP430F2618 for QOS Comparison Analysis

The rapid advancement in the areas of wireless networks, information technologies, sensor design and semiconductor has been put to the proliferation of Wireless Sensor Network (WSN). WSN is growing as a backbone technology for various applications such as agriculture, traffic control, natural disaster relief, health monitoring and control, home automation, environment and habitat monitoring ,consumer and industrial applications, product quality monitoring, seismic sensing etc. A WSN features are Low power consumption, self-organization, fault tolerance, low cost, and longer standalone life.

To implement the C-Mote set up in [3] used Red hat Linux 14.4 with SMA Antenna, Ubisense sensor, USB power jacks, data acquisition card through serial window, with I/O expansions and processor controls. Coming to C-Mote its specifications it has USB interface to PC, 256kB RAM+1MB XIP FLASH provides application level security, External USB peripherals, 2 to 20 pin connectors, 4 wire JTAG pins, On board antenna and GNU debugger support as well.

UbiSense is the sensor board developed for testing and integrating various sensors with C-Mote, UbimoteHR. UbiSense has applications where the users can make use of sensor data by plugging in the module directly to the Mote. The Sensors on UbiSense are I2C compatible and user can avail the advantage in interfacing. C-Mote has Female SMA Antenna connector. Antennas configured for 2.4GHz 50Ohms.

SMA compatible should be connected to the SMA connector. IEEE 802.11 is a wireless local area network (WLAN) for implementing computer communication in the 900 MHz and 2.4, 3.6, 5, and 60 GHz frequency bands. Most of the applications like Smart phones, laptops, Office Networks, Homes, etc. were widely used by this Wireless Networks.

A. Working Prototype

In Tele communication, Internet, and Data Communication the application interfacing happens through wireless via several protocols for remote locations. Communication happens from small to large from one point to another point. Depending on the height of the antennas and other devices, the frequency and power level used, and the surrounding environment, communications signals can travel up to tens of miles to its designated location.

The proposed algorithm, shown in Fig. 3 starts with sensors, here Ubisense sensor used. This Ubisensor board gives the experimental set up environmental values like Temperature, Humidity, Proximity, Light Intensity and Barometric pressure, etc. C-Motes are connected as Master and Slave node assigned with node ids. It is easily understandable from the flow diagram, as shown in Fig. 3. The sensor outputs are taken from the minimum values. If not, the setup again initializes from the start. The values are checked in the Wings gateway as well as it is seen in every slave node. QoS analysis improvised [9] by the values predicted from C-Mote Master and Slave nodes. Validation with respect to Power are considered and observations were notified else algorithm repeated.

It is arranged C-Mote nodes as per the proposed setup shown in Fig. 4. The nodes are categorized as Master node which is shown as light grey color marked as M and Slave nodes which is shown as dark grey color marked as S. The Fig. 4(a) shows the point to point arrangement of C-Motes one as Master and another as Slave Node. Fig. 4(b) shows the point to multi point arrangement of C-Motes one as Master and two as Slave Node. Fig. 4(c) shows the point to multi point arrangement of C-Motes one as Master and nodes as Slave Node. In Fig. 4(c) Multi point communication made from Master node and Slave node and vice versa.

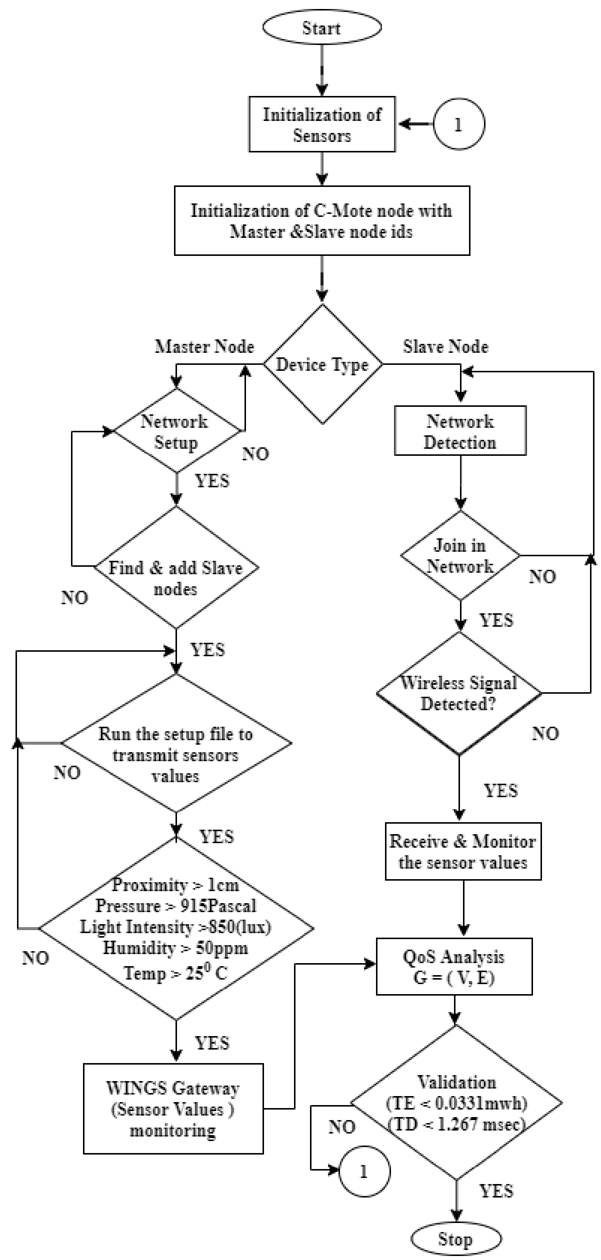

Fig. 3. Flowchart of MSP430F2618 QoS Analysis.

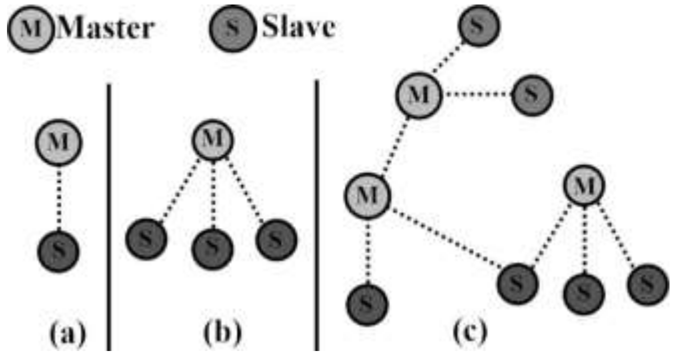

Fig. 4. Proposed Setting up of C-Mote Nodes in Various Combinations.

1) Wireless Point to Point Communication Setup (a) First C-Mote libraries are taken from Red Hat packages and is installed and configured from GCC, GNU and LIB, etc. With the help instruction set, built the needful configuration to make the nodes as master as well as slave. The setup powered with 5V, connected the UBISENSE sensor board to C-Mote and compiled the program. Master C-Mote node send the sensor data to Slave C-Mote node. Thus, set up point to point communication as shown in Fig. 5(a).

2) Wireless Point to Multi Point communication Setup (b) Here C-Motes, one is the transmitter as master Node and three are receivers as slave nodes setup is shown in Fig. 5(b). Ran the program to set up Point to Multi point communica- tion among Master and slave C-Mote nodes. Transmitter reads the physical parameter value from ubisense connected to the device and transmits. Receiver receives the data packet which includes the measured physical parameter transmitted by the transmitter. Receiver parses the packet and prints the data received on Hyper Terminal. This way Point-to-Multi point communication platform can be build [14] carried out via a distinct type of one-to-many connection.

3) Wireless Multi Point to Single/Multi Point node commu- nication Setup (c) The Multi point-to-Point network [3] communication has been configured to make communication between multiple remote user terminals and central hub which in turn makes and reduces the technical needs for remote locations. Data transmissions takes place from Master nodes to Slave nodes.

C-Mote is provided with a 10-pin connector which allows for the direct plug-in of UbiSense as shown in Fig. 5. It is a sensor board with temperature and relative humidity, light intensity, barometric pressure, proximity sensing and buzzer. The sensors communicate to the micro controller through I2C protocol. The USCI module B0 is incorporated for I2C functionality from micro controller viewpoint. The A1 module of USCI is used for UART with the required baud rate. Buzzer requires a PWM control signal used for alarm generation. This value is displayed on the Hyper Terminal as shown in Fig. 6. The outputs in the serial window checked and saw.

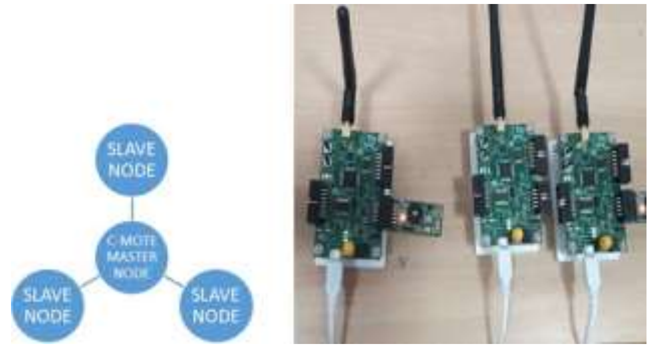

Fig. 5. C-Mote 1 Master Node and 2 Slave Nodes Setup.

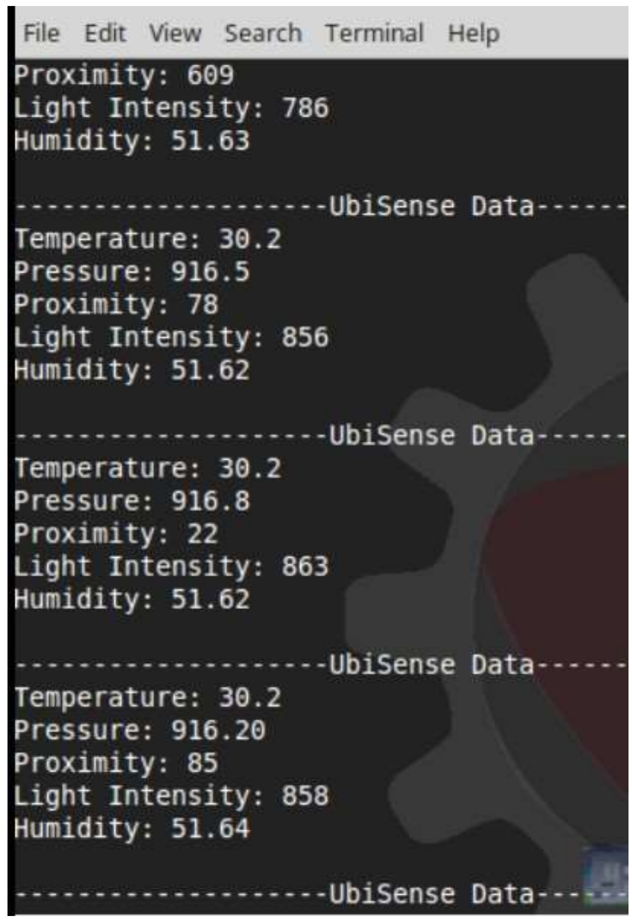

Fig. 6. Experimental Results in Serial Window.

System design supports multi point-to-multi point communication with efficiency and reliability. A protocol management mechanism for the multi-point-to-multi point communication protocol is [6] proved from the node configuration. A user joining the system network can change the topology of the multi-point-to-multi point communication network as per the need.

In the proposed SCP, the data is collected through mounts of sensor nodes distributed in the field of sensors and supported by multi-hop wireless communication to users towards application-specific, energy-constraint and uncertain topology. MIS (maximum independent sets) made up of cluster heads is achieved by clustering algorithms, based on which MCDS (minimally connected dominant sets) and MST (smallest spanning tree) are developed with improved Prims algorithm and created. In addition to that, the spanning tree maintenance and update algorithm is also provided. Simulation analysis eventually shows in Fig. 8 that the proposed algorithm is successful.

A gateway [5] output terminal shown in Fig. 7 is a node on a network that serves as an entrance to another network. In enterprises, the gateway is the computer that routes the traffic from a workstation to the outside network that is serving the Web pages. In homes, the gateway is the ISP that connects the user to the internet. The wings gateway tool has totally 10 channels meet so total communication between nodes would be predicted. The open source gate which is configured the 10 maxima of nodes.

The TX nodes and Rx nodes IDs were stored and mapped to the configured networks. Data rate is high and good in accuracy was seen. It keeps the monitoring the nodes data at the input and at the output. In the hyper terminal saw the parameters readings as shown in Fig. 8.

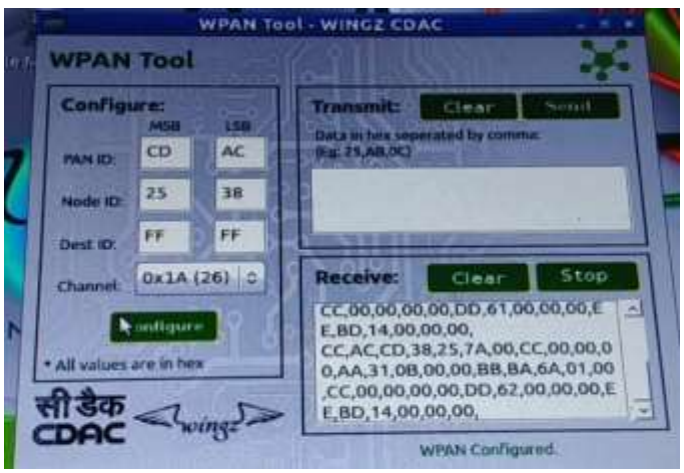

Fig. 7. Gateway Output C-Mote set up for 10No.Channels.

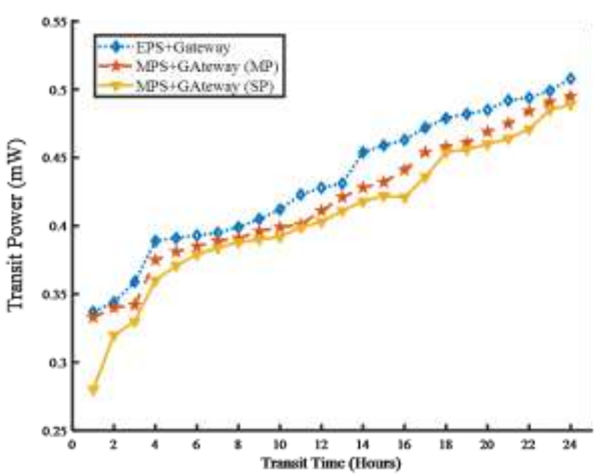

Fig. 8. Comparison Results for P-P P-M M-P M-M.

V. Results and Discussions

The results are seen from the serial window in the IDE. With the serial println functional libraries in Embedded board [10] for the environmental values are tracked for the built network. Initially it is shown for Temperature, Humidity, Light Intensity, Barometric pressure, etc. These values were chronically repeated till the node is active. The node data transfer happens from all the modes like point to point, point to multi point, multi-point to point, multi-point to multi point configurations.

All the series of sensor values are taken into the course of time (24 Hrs.) is displayed in Fig. 9 and predicted the values that affects the energy optimization methods. Improved QoS calculations QoS calculations results were shown in Fig. 9 with respect to ESP8266 and MSP430 boards.

Ubisensor prompts the values of Temperature, Humidity, Pressure, Light Intensity continuously measured over period. The nodes which are configured are static nodes [11]. If nodes are aligned dynamically causes various energy, vertices, and location change in values also. The sensor used for this prototype had a standby current resulting in power used up by both the sensor and MSP430 board during sleep mode. For the temperature sensor with the shutdown feature, the standby current parameters could be saved. As future predictions this would result in more power savings and replacing the sensor with a no-standby current would be a choice for the future to reduce power usage. The UBISENSE sensor would be high while taking the reading and then turned to low within the code before it goes into sleep mode. This leads the power optimization [12], and only the standby current would be used.

As the graph from Fig. 8 mentioned initially plotted with the point to point communication. It is seen that the energy values are almost similar except in the first 10min and 50 mins of time. There the value started from 0.3 mwh when compared to earlier result.

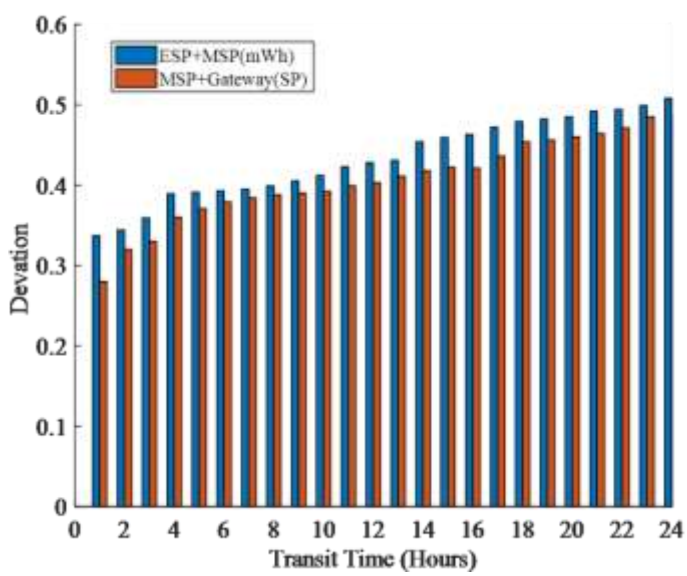

Fig. 9. Improved QoS Analysis.

The minimal spanning distance too calculated according to the theory of Prims algorithm which finds an edge of the least possible weight that connects any two trees in the forest. It is a greedy algorithm in graph theory as it finds a smallest spanning tree for a connected weighted graph adding increasing cost arcs at each step. The Greedy Choice is to pick the smallest weight edge that does not because a cycle in the MST constructed so far. own in Table I with the combination of MSP430+Gateway. This arrangement produces better results for communication applications.

In the Table II its represented with deviation of power in with respect to ESP8266 and MSP430. The comparison between both boards were compared and drawn the plots as shown in Fig. 9. The blue bar in the chart shows ESP+MSP board as the experimental set up for SCP. The red bar shows.

In the WINGZs gateway the values were seen from the Master and Slave nodes. Over 10 channels configured, 1 as master node and being still all as slave nodes and made the sensor data transmission. Nodes are assigned with static ids to build the green energy [13] network model. The values of the output sensor are measured for the software compatibility in Hexadecimal number system and converted into sensor values.

As the graph shown in Fig. 8 mentioned initially plotted with the point to point communication. It is seen that the energy values are predicted compared to earlier result [15]. By using Cooja simulator these nodes can be configured as a Zone based node, foreign nodes, local nodes, etc. The predictions or outputs are based on static allocation node positions.

From the observations of Multi point access Transit Power per node started from 0.333 mw to extend up to 0.5 mw as improvised algorithm experimental set up for SCP. In the Table II, it is shown that there is deviation.

TABLE I. SINGLE AND MULTI-POINT COMMUNICATION SETUP RESULTS

Transmission Time in Hrs.	ESP+Gateway Power in mW.	MSP+Gateway Power M-M in mW.	MSP+Gateway Power S-P in mW.
1	0.337	0.28	0.28
2	0.334	0.28	0.32
4	0.389	0.375	0.36
6	0.393	0.379	0.379
8	0.399	0.388	0.388
10	0.412	0.399	0.392
12	0.428	0.411	0.400
14	0.454	0.418	0.418
16	0.463	0.440	0.428
18	0.479	0.458	0.454
20	0.485	0.460	0.46
22	0.494	0.484	0.471
24	0.508	0.489	0.489

TABLE II. COMPARISON OUTPUTS OF ESP8266 AND MSP430F2618

Transmission Time in Hrs.	ESP8266 Power in mW.	ESP8266 Power in mW.	Difference Power in mW.
1	0.337	0.28	1.04
2	0.334	0.28	1.05
6	0.393	0.379	1.04
8	0.399	0.388	1.03
14	0.454	0.418	1.09
20	0.485	0.460	1.05
24	0.508	0.489	1.04

The scenario that we have considered is for unidirectional communications from [22] the sensor master node to slave node, which fits well with a sensor gathering readings or a smart button triggering an alert. Bidirectional communications [23] have significant implications on energy use because the reception circuitry must be left on in listening mode. For Gateway, bi-directional communication requires the device to be attached to the access point, which requires it to be active to receive beacon frames. MSP430 has a light sleep mode that has a timer to switch the central processing unit and radio circuitry off between beacons to save power, waking the chip up before the next beacon. However, while this offers significant reductions over keeping the chip active, the overall power usage stays in the 0.5–1-mA range, which is clearly far too high for long-term battery operation. Delays can be tolerated, for example, for updating configuration values, data can be sent to the sensor as part of the acknowledgment when the sensor sends data to the server, or the sensor can periodically poll the server even if there is no data to be sent.

VI. CONCLUSIONS

In the last few years wireless sensor networks and IoT have drawn the attention of the research community, driven by a wealth of theoretical and practical challenges. This progressive research in WSN and IoT explored various new applications enabled by larger scale networks of sensor nodes capable of sensing information from the environment, process the sensed data and transmits it to the remote location. WSN and IoT [24-25] are mostly used in, low bandwidth and delay tolerant, applications ranging from civil and military to environmental and healthcare monitoring. The output values can be processed and mapped for several Environmental measure applications. Based on the results from this article, when combined with a low-power processor such as the MSP430, is power efficient for use in an IoT device. The results illustrated using ESP-8266 efficient if it is to be used for a short period. When used for static defined networks, the MSP430 coupled with the gateway offers effective monitoring and data handling results. The power consumption results were then carried out using static IP to prove. The use of the processor MSP430 showed in Fig. 9. an increased power saving compared to the ESP8266. This configuration can be used for IoT devices Academic experiments, data analysis, Data mining sources setups. Hence concluding that suggesting this kind of set ups for Industrial, Environmental, Cold storage's, Health Monitoring applications and many more. As the future scope this concept can be extended for even more node set up pool and much more WSN network data transfer predictions via several spanning tree techniques for any one dedicated application platform.

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