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Data Dissemination Model for IP cloud through Wireless Sensor Network

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Abstract—Different techniques are used to make data available from WSN through Internet, like Embedded Gateway, 6LowPAN technique etc. for the utilization. The user at any location can access the information using such techniques of WSN and IP connectivity. The sensor device is small and has low computation power and memory thus perceived as not suitable to be loaded with the high resource IP capabilities directly, which presents a significant challenge to establish such interconnection. In this paper the data dissemination model is proposed, which is having capability to provide a data from WSN in IP network compatible format. The proposed model utilizes MSP430 Microcontroller along with ZigBee module to represent the wireless sensing nodes. Embedded Gateway used will be regular computer but termed to be the embedded due to its minimum expected specific functionality requirement. Collected data is required to be preserved and made continuously available to satisfy the need of user at any time, it will be stored along with the time stamps on the developed Web page.

Keywords: Wireless Sensor Networks, LoWPAN, MSP430, ZigBee Module, Embedded Gateway.

I. INTRODUCTION

A Wireless Sensor Network (WSN) comprised of Sensing (measuring), computing and communication elements that gives an administrator the ability to instrument, observe and react to events and phenomena in a specified environment. The sensors are logically linked by self organizing means. Transmission standard used is the ZigBee (IEEE 802.15.4) providing less complexity, longer battery life with less data rate (250 kbps). The communication between wireless modules is achieved with RTS/CTS exchange among them for accessing shared communication medium. Considering the possible area of applications of WSN, extension of these along with IP connectivity will be the expansion of IP and Non-IP networks. Different approaches are available for WSN and IP connectivity, the suggested model having basic concept for implementation as shown in Figure 1. [1]

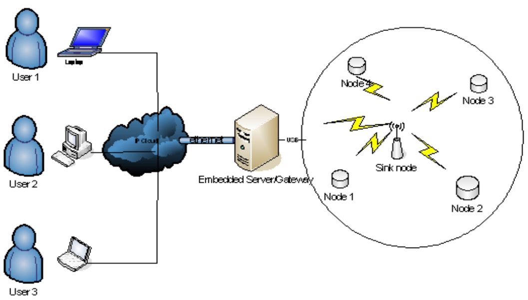

Figure 1: Concept of WSN & IP connectivity Model

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In the model each sensing node will transmit the data towards the sink node attached with an embedded Gateway having multi-one flows of Data. The sink node will collect information save it in the created database and made it available on the web on the request from user. To access the information from each sensing node directly on the web page short node ID's are mentioned to each node which is virtually acting as an IP assigned to it. These short node ID are invisible to the user and utilized internally only for the purpose of mapping. The benefit of this method is that each user is able to check the data generated by each node individually as well aggregated result at the sink.

II. RELATED WORK

The different approaches are put forwarded to achieve this IP and WSN connectivity; some of them are discussed here.

Aishwarya.V and Felix Enigo V.S suggest the method by which data storage and processing is moved from the resource constraint sensor nodes to a high capacity PC in [2]. Apart from this, it further enables the remote users to access the sensor data using simple http based URL via any internet enabled devices. To facilitate this method, sensor nodes are used with 6LoWPAN technology that eliminates the need for translators between WSN and IP networks.

Dejan Raskovic, Venkatramana Revuri and David Giessel suggest the use of MSP processor along with ZigBee module to represent the hardware model as a WSN instead of deploying actual sensing nodes in [3]. The concept of Embedded Web Server to work at a Gateway level so as to perform the required mapping of data as well as addresses is the core concept. Ping Pong, Chang Chen, Kejie Li and Li Sui in [4] proposes the structure of WSN using PXA270 along with the Ethernet controller card which in combination gives rise to the concept of the Gateway which will communicate between WSN and IP cloud.

III. PROPOSED WORK

Hardware Design:

For the deployment of sensing nodes the MSP430 microcontrollers are used along with ZigBee modules as a transceiver. The interfacing along with the basic signals is shown in Figure 2.

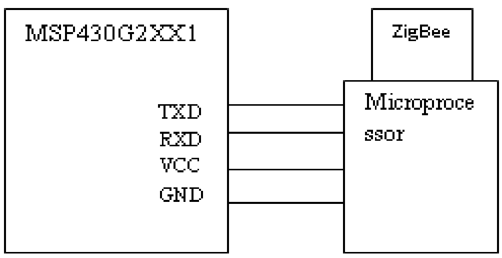

Figure 2: Hardware interfacing of Sensing node

The ZigBee is working with 9600 baud rate on channel 1at 2.4 GHz frequency and set up the communication with RTS/CTS mechanism. The range covered by each ZigBee module is of 30 Meters which can be extended with the selection of upgraded version of ZigBee. The selection of MSP403 is done due to its key features like ultrafast wake up from standby mode within less than 1 µs , 10 bit inbuilt ADC ,low supply voltage range ,ultra low power consumption and five power saving modes of it. [5].

Within the model MSP430 is not actually sensing any parameter instead information is provides in a hardcoded manner. The intension to provide the hardcoded data is to keep the option open for studying the different network design aspects like network density, change in reporting rate and different packet size vies performance of the WSN.

Along with all set up of ZigBee and MSP430 IC the simple microprocessor is included within interfacing for channel and baud arte selection. All nodes are powered through the USB. For the deployment of sink processor is interface with ZigBee as shown in Figure 3.

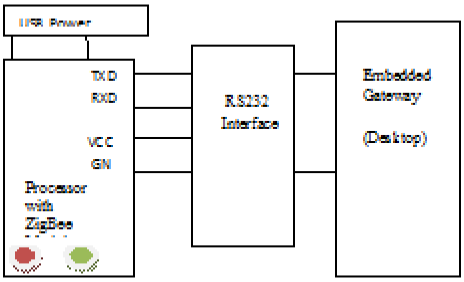

Figure 3: Hardware interfacing of Sink node

ZigBee is receiving information from all sensing node. The collected data at the sink is provided to an embedded server through the RS232 interface. The total hardware set up consists of seven sensing nodes and one sink node forming the WSN.

Software Design:

The different programming languages are used on IP and Non-IP area of the data dissemination model. Embedded C is used to program the MSP430 through the IAR Embedded Workbench. The basic frame format used to transmit the data within WSN is as shown in Figure 4.

Short Node ID	Flag 1 Byte								Data Field
1 Byte	X	X	X	H	S	P	C	D	1 Byte

Figure 4: Packet Frame Format

The size is kept fixed of 3 byte for taking the results of network density and change in retention ratio, while for different packet size it is increased up to 12 byte.

At the embedded gateway the Visual basic is used to receive data through comport and store in the database. The web page is developed using C# which provides the direct link for each node as well display the aggregated data along with date and time of reception. The algorithms of sink and sensing node functionality are:

Algorithm 1: Sink Node Functionality

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1. Set node ID = 1
2. Sense the channel
3. If Channel free = true then

    Call Set Frame ( )
    Call Transmit ( )
    ID = ID + 1

Else

    Call Receive Frame ( )
    Call Wait Count ( )
    Go to step 2

4. Process the input frame
5. Get the data payload along with source ID
6. Update the text file with proper format
7. Go to Step 2

Algorithm 2: Sensing Node Functionality

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1. Input the port for sensing ID
2. Set ID
3. Sense the channel
4. If Channel free = true then

    Receive Frame ( )
    If node ID = ID then
        Call Set Frame ( )
        Call Transmit ( )
        Exit ( )
    End If

Else

    Wait Count ( )
    Go to step 3

5. Go to step 3

IV. RESULT ANALYSIS

The results are taken for different network scenario, analysis and comparison is done based on NS2 simulator. The testing scenarios are selected considering the key features of WSN like different reporting rate, packet size and network density. Practically readings are taken with the span of 0 to 30 sec and averaged to calculate the reading for packet loss /delivery for each condition.

For the Reporting Rate (RR) parameter result, the network consists of seven nodes having packet size of 3 bytes. The RR is changed from 1 to 4 packets / sec. Figure 5 & 6 shows the result for PLR & PDR.

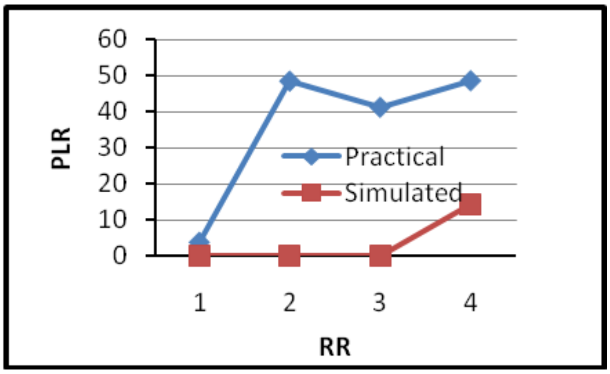

Figure 5: Packet Loss Ratio as a function of RR

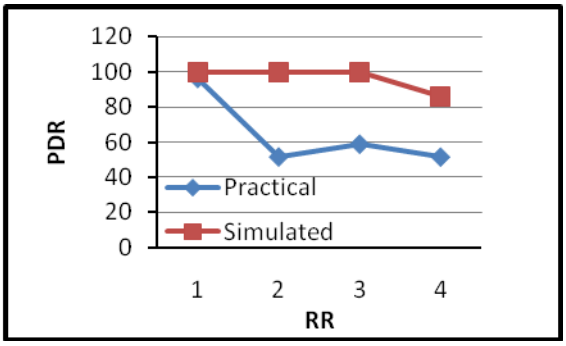

Figure 6: Packet Delivery Ratio as a function of RR

For the varying reporting rate the practical and simulated results shows the difference describing the actual burden on common channel sharing through CSMA/CA. With the increase in the packet number to be handles by the network in practical condition, the satisfactory performance is achievable with RR of 2 Packets / sec. Afterwards packet loss in much dominant due to heavy traffic generated in the common access channel. Depending on the parameters under consideration for sensing it is necessary to decide RR as factor as per required reliability and sustainable limit of data loss.

The second parameter considered for evaluating the network performance in the change in the packet size by keeping RR and network density of seven constant. Packet size is changed from 3 byte to 12 byte for each node the results obtained with change in packet size are shown in the Figure 7 & 8.

The packet size performance supported by the hardware is ideal up to 6 byte packet while, further increase in it degrades the performance of the network in terms of PDR. While with the simulation results are ideal.

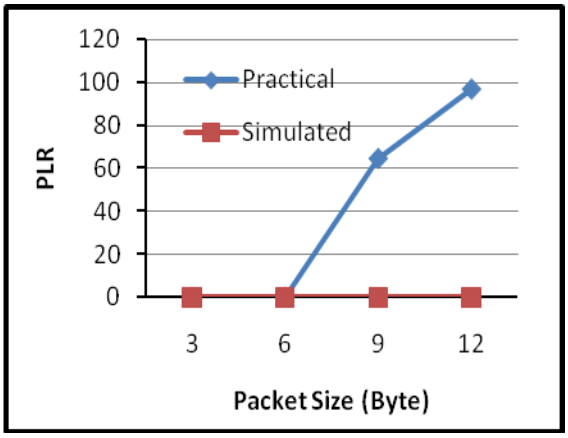

Figure 7: Packet Loss Ratio as a function of Packet Size

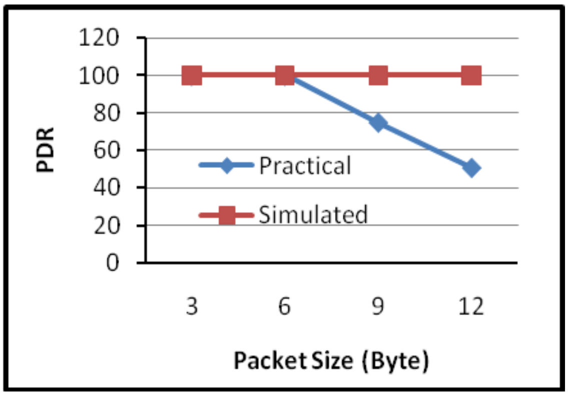

Figure 8: Packet Delivery Ratio as a function of Packet size

The difference in the result shows that the practically whenever any node acquires the channel , due to high size of packet channel remains engage by the same node and remaining nodes remain in starvation resulting in degradation of PDR.

The third parameter is the network density were, network check out its performance with 2 sensing nodes to 8 nodes working simultaneously. For checking the performance the RR and packet size of 3 bytes is kept constant.

The results obtained on simulated environment

And practically are exactly same showing ideal values of 0% for PLR and 100% for PDR. Thus, network density with 8 sensing nodes is able to handle channel properly on sharing basis. The confidence factor obtained for network density shows value of 0.956 and provides linearity equation (1).

$$y = 6.4x - 2.95 \qquad \ldots\ldots\ldots (1)$$

Where, x shows the density of nodes and y provides the value of received packets. Equation will be helpful to calculate the supported density in the network providing the satisfactory performance of the network.

From the above results it seems that in practical implementation the network follows the ideal condition similar to simulation result for network density up to eight nodes with the packet handling capacity of 6 Bytes with the reporting rate of 2 packets / second.

V. CONCLUSION AND FUTURE WORK

The further step will be checking of fairness and energy consumption of each node in the network. As well evaluating all mentioned parameters with increased number of nodes in the hardware set up so as to check out the performance based on linearity equation.

The data dissemination and IP connectivity have a great area under the application development but the prototype model deployed is particularly for application of smart home. Model described can be used to major the power consumption by each electric device in the home and generate the result periodically so as to calculate the consumption in terms of consumed power and payment for the same. The scope can be extended for adding any supporting feature for smart home concept.

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