ISSN: 2278 – 909X
International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE)
Volume 5, Issue 5, May 2016

# A Survey for Proposed System Model for Home Automation Using Zigbee

**Sagar Santaji [1], Snehal Kangralkar[2]**

4th Sem M.Tech, Electronics and Communication, KLS Gogte Institute of Technology, Belagavi, India [1]
Assistant Professor, Electrical and Electronics, KLS Gogte Institute of Technology, Belagavi, India [2]

## I. INTRODUCTION

***Abstract:*** **The aim of this Project is to propose a home automation system by making use of CC2538 ARM cortexM3 based micro controller unit used for high performance zigbee applications. This controller will remotely switch on or off any household appliance connected to it, and perform several applications listed below in the paper through a mobile application, a website and voice or mobile application as feedback. The objective of implementing this project is to implement a low cost, reliable and scalable home automation framework that can be utilized to remotely switch on or off any family unit machine, utilizing a miniaturized scale controller to accomplish equipment straightforwardness, mobile application for feedback and command from any application over the internet to toggle the switch state. It involves several variants and these variants play a very important role in deploying the model. Due to which this proposed system has very low power consumption reliable in use and very affordable model for a home appliance with low cost than other present techniques over home automation.**

***Index Terms*****: Home Automation, CC2538, ARM Cortex M3, Zigbee.**

## I. INTRODUCTION

Several methodologies have been proposed till now in the home automation using zigbee protocol. But the method which is been implemented in this proposed system controlling various controlling parameters by using theCC2538 Zigbee Protocol which makes use of low power and has capacity of covering the area of 200m and more than 100 appliances .There are total 3 variants involved each has several features such as, **Variant A** Which has features like the device should have the capability to speak to an Android driven Tablet placed somewhere in the house, the device should be able to communicate with the slave controllers which would instead control the individual appliances through Zigbee and through RS485 standard cable. The slave controllers should have diming circuit inside them to regulate the speed of the fans in response to the command from the master controller. The Master controller should have the capability to save the household circuit and as well as itself from any voltage surge. **Variant B** also has similar feature listed above along with a The Slave controller would be integrated with the temperature sensors to regulate fans. The Slave controller would be integrated with light sensors to control the lights. The slave controller would be sending out power consumption reports to the mobile application on-demand basis so that user can keep tab of the power consumption of the appliances in his/her house. **Variant C** has the following features the slave controller would be sending out power consumption reports to the mobile application on-demand basis so that user can keep tab of the power consumption of the appliances in his/her house. The slave controllers should be programmed to add feel to the room ambiance by controlling different sets of lights. The Device should be able to interface with Security Systems to give a holistic view of the security situation of the house. All these variants play a very important role in deploying the model which has very low power consumption, reliable in use and very affordable model for a home appliance with low cost

## II. LITERATURE SURVEY

Several Techniques are defined on power management system over zigbee for home automation [1], which have low memory space accumulation and the time for operation is also little high compared to our proposed system and design circuitry is also being the complex [2].In some cases the model has been used only over limited period of time and not being used most of the times during application which gives a low efficient techniques[3].Few of these techniques also have made use of transfer of messages in packet format , in which collision protection techniques have not been proposed properly[4].Looking all the above drawbacks in the home automation we propose a system which will overcome all these above mentioned issues and helps in giving a better quality of product when it comes to home automation using zigbee. Zigbee has several topologies such as Star, Mesh and ring [2].But Mesh topologies are been used in the most of the application which avoids many of the issues related to the zigbee protocols like Congestion, Flow control, Traffic management, Loss of packets, Routing strategies[1]. The project mainly concentrates on the controlling various Parameters at a home which are to be controlled by the CC2538 zigbee controller. We have Master and Slave Configuration involved in the module. Master will be receiving the messages from the Slave Zigbee; And Master will process the message and complete the required operation. This results are been displayed on the user Android mobile or website from where he can access the information related to the automation.These implementations have a lot of impact over the hardware requirement, Utilization of low power is been observed. And since its been implemented by making use of the IAR EWARM the coding which plays vital role in deploying this application easily. Smart RF 06EB is used for the various purposes which consists XDS110V3 debugger, Flash memory, UART, Accelerometer.

## III. PROPOSED SYSTEM

The mandate of this project is to develop the Zigbee side firmware for both, Master and Slave. This consists of

1. Communication between Master controller and the Zigbee controller on the master side.
2. Communication between the Zigbee controller on the Master side and the Zigbee controller on the Slave side.
3. Control of Triacs to turn on or off the AC loads, Compute energy and manage Manual/Auto mode of function.

The architecture of the firmware is detailed in the following section. This assumes that the firmware for communication from the Master MCU with the Zigbee controller on the Master is developed by designer. We will program the Zigbee controller to communicate with the master MCU. The hardware designed uses a SPI-to-UART bridge with Master MCU communicating on SPI and Zigbee controller communicating on UART.

### A. Design

The design vis-à-vis the Zigbee section consists of Master Controllers that communicate with a host such as a Tablet, Smartphone or a Computer over the Wi-Fi interface and with Slave nodes over the Zigbee protocol. The simplified design of the Master is as shown in figure below.

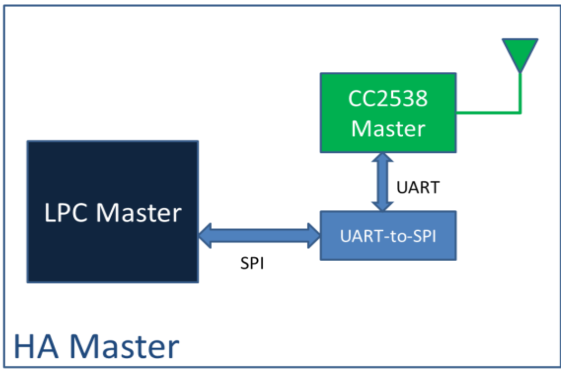


Figure 1. Home Automation Master Controller.

The Slave node consists of a Zigbee controller that communicates with the Master controller over Zigbee protocol to get commands or send status. The Slave node controls various AC electrical loads and performs other functions such as monitoring of temperature, light intensity, computer of electrical power/energy and allow manual mode of operation. The simplified architecture of the Slave is as shown in figure below.

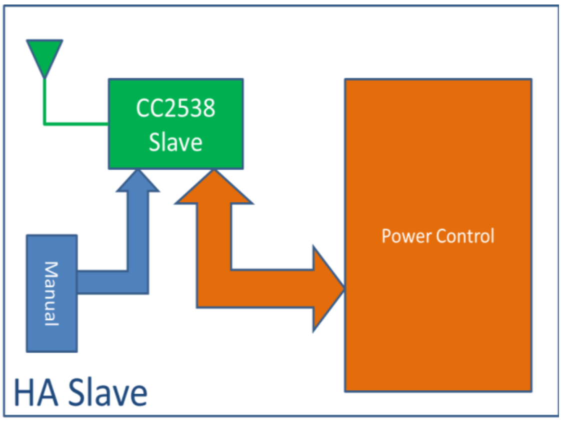


Figure 2. Home Automation Slave Node.

### B. Architecture

The firmware is designed with the objective of modularity and scalability. This also enhances the maintainability of the system. The firmware for Master and Slave sub-systems consists of common section and Master or Slave specific section. The common section of the code consists of the communication, computation, control and sensing. This essentially consists of the hardware drivers and the API. The drivers are simplified library functions that can be used with API by the application. The code is conditionally compiled using pre-processor directives in the C language system. This is shown in figure below.

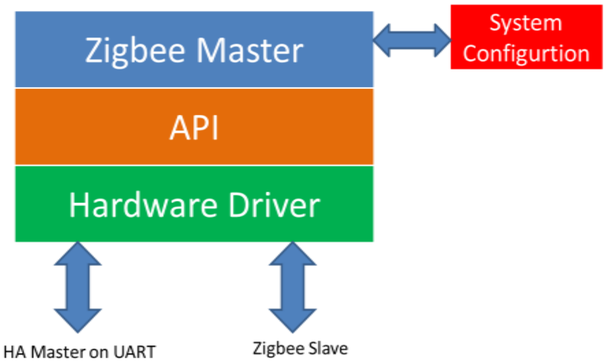


Figure 3.Zigbee Master Firmware Architecture.

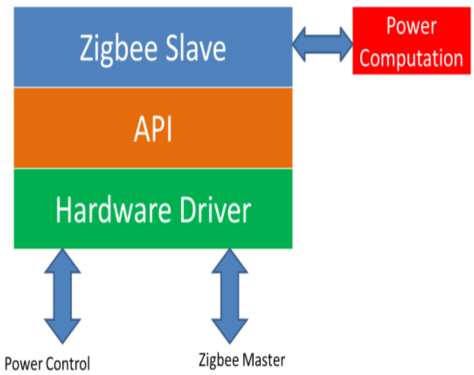


Figure 4.Zigbee Slave Firmware Architecture.

### C. Communication

The communication protocol used to communicate between the LPC ARM MCU on the Master (Master LPC) and the Zigbee MCU on the Master (Master Zigbee) as well as between Master Zigbee and the Zigbee MCU on the Slave (Slave Zigbee) uses a Packet Formats as described below.

i) Command Packet

| Field | Length (bytes) | Format | Value | Description |
|---|---|---|---|---|
| START | 1 | CHAR | 'C' | Indicates beginning of Command |
| SLAVE_ID | 2 | INT | 0 to 65535 | Address of slave to which the master wants to send the command. If the value is ZERO, this command is for the Master Zigbee on the Master Board |
| APPLIANCE_ID | 1 | BYTE | 0: NONE 1: SLAVE 2: SENSOR | |
| APPLIANCE_STATE | 1 | BYTE | 0 to 127* | Address of the unit that is to be configured |
| APPLIANCE_TYPE | 1 | BYTE | 0: NOTHING 1: OFF 2: ON | Condition of the Unit to be set |
| APPLIANCE_INTENSITY | 1 | BYTE | 0 to 255 | |
| ACK | 1 | BYTE | 0: NOTHING 1: ACK 2: NACK | |
| END | 1 | BYTE | 'F' | End of Current Packet |

Table 1.Command Packet Format.

ii) Configuration Packet

| Field | Length (bytes) | Format | Value | Description |
|---|---|---|---|---|
| START | 1 | CHAR | 'G' | Indicates beginning of Configuration |
| SLAVE_ID | 2 | INT | 0 to 65535 | Address of slave to which the master wants to send the command. If the value is ZERO, this command is for the Master Zigbee on the Master Board |
| CFG_UPDATE | 1 | BYTE | 0: NONE 1: SLAVE 2: SENSOR | |
| UNIT_ID | 1 | BYTE | 0 to 127* | Address of the unit that is to be configured |
| STATE | 1 | BYTE | 0: NOTHING 1: OFF 2: ON | Condition of the Unit to be set |
| ACK | 1 | BYTE | 0: NOTHING 1: ACK 2: NACK | |
| END | 1 | BYTE | 'F' | End of Current Packet |

Table 2.Configuration Packet Format

iii) Energy Packet Format

| Field | Length (bytes) | Format | Value | Description |
|---|---|---|---|---|
| START | 1 | CHAR | 'E' | Indicates beginning of Configuration |
| SLAVE_ID | 2 | INT | 0 to 65535 | Address of slave to which the master wants to send the command. If the value is ZERO, this command |

| | | | | |
|---|---|---|---|---|
| | | | | is for the Master Zigbee on the Master Board |
| CFG_UPDATE | 1 | BYTE | 0: NONE 1: SLAVE 2: SENSOR | |
| UNIT_ID | 1 | BYTE | 0 to 127* | Address of the unit that is to be configured |
| STATE | 1 | BYTE | 0: NOTHING 1: OFF 2: ON | Condition of the Unit to be set |
| ACK | 1 | BYTE | 0: NOTHING 1: ACK 2: NACK | |
| END | 1 | BYTE | 'F' | End of Current Packet |

Table 3.Energy Packet Format

iv) Heart Beat Packet Format.

| **Field** | **Length (bytes)** | **Format** | **Value** | **Description** |
|---|---|---|---|---|
| START | 1 | CHAR | 'H' | Indicates beginning of Configuration |
| SLAVE_ID | 2 | INT | 0 to 65535 | Address of slave to which the master wants to send the command. If the value is ZERO, this command is for the Master Zigbee on the Master Board |
| CFG_UPDATE | 1 | BYTE | 0: NONE 1: SLAVE 2: SENSOR | |
| UNIT_ID | 1 | BYTE | 0 to 127* | Address of the unit that is to be configured |
| STATE | 1 | BYTE | 0: NOTHING 1: OFF 2: ON | Condition of the Unit to be set |
| ACK | 1 | BYTE | 0: NOTHING 1: ACK 2: NACK | |
| END | 1 | BYTE | 'F' | End of Current Packet |

Table 4.Heart Beat Packet Format

D. Master LPC to Master Zigbee or Slave Zigbee Communication
1. Master LPC sends a command packet to Master Zigbee .
2. UART interrupts Master Zigbee.
3. MasterUartHandler is invoked to read the data from the UART Receive Buffer and place the data in MasterRxBuffer [MasterRxTail]. MasterRxCount is incremented. The function also checks if last byte in the packet is received. It, appropriately, sets a Boolean variable MasterMsgReceived to true or false.
4. In the main loop, Master Zigbee checks if MasterRxCount is non-zero and MasterMsgReceived is true.
    a. If the Unit/Slave ID is ZERO, MasterCmdParser is called else,
    b. Master Msg Send Slave is called.
5. If MasterCmdParser is completed, MasterCmdExecute is called
    a. If MasterCmdExecute is complete, MasterMsgSend is called to send status to Master LPC
6. If MasterMsgSendSlave is completed, MasterResponseTimeoutStart is called
    a. If Slave response is received before SlaveResponseTimeout, the timer is disabled else,
    b. SlaveResponseTimeoutError is handled and MasterMsgSend is called to send status to Master LPC.

E. Slave Zigbee to Master LPC Communication
1. Slave Zigbee sends a message to Master Zigbee by calling SlaveMsgSend.
2. MasterZigbeeHandler is invoked to read the data from Zigbee Receive Buffer and place the data in SlaveRxBuffer [SlaveRxTail]. SlaveRxCount is incremented. The function also checks if last byte in the packet is received. It, appropriately, sets the Boolean variableSlaveMsgReceived to true or false.
3. In the main loop, Master Zigbee checks if SlaveRxCount is non-zero and SlaveMsgReceived is true.
    a. MasterMsgSend is called

F. Master Zigbee to Master LPC Communication

1. Master Zigbee sends status and other messages to Master LPC using the MasterMsgSend function
2. The MasterMsgSend function writes the data to the MasterTxBuffer [MasterTxTail]. MasterTxCount is incremented.
3. MasterTimerHandler is invoked periodically. The period is set by TIMER_HANDLER_INTERVALmacro
4. MasterTimerHandler gets data from MasterTxBuffer[MasterTxHead] and writes to UART Transmit Buffer. MasterTxCount is decremeted. MasterMsgTransmitted is set true when all bytes in the message are transmitted

G. Master Zigbee to Slave Zigbee Communication

1. Master Zigbee sends status and other messages to Slave Zigbee using the MasterMsgSendSlave function
2. The MasterMsgSendSlave function writes the data to the SlaveTxBuffer[SlaveTxTail]. SlaveTxCount is incremented.
3. MasterTimerHandler is invoked periodically. The period is set by TIMER_HANDLER_INTERVAL macro
4. MasterTimerHandler gets data from SlaveTxBuffer[SlaveTxHead] and writes to Zigbee Transmit Buffer. SlaveTxCount is decremeted. SlaveMsgTransmitted is set true when all bytes in the message are transmitted

When the Master LPC sends message to the Master Zigbee, the Unit/Slave ID is used by the Master Zigbee to determine if the packet is to be forwarded to the Slave Zigbee or is intended for itself as a configuration command. This is decided by validating the Unit/Slave ID. If this ID is ZERO, the Master Zigbee uses the packet as a Configuration Command else the same is forwarded to the SlaveZigbee. This project is carried to provide a unique solution for the home automation services. Recently it's been observed the many home automations are carried out but the implementation method used in the proposed system is by making use of the CC2538 zigbee processors. In this proposed system there will be a master and Slave combination. Master which receives a data signal from it's slave and process it's information ,later identifies which process to carry out and performs the required operation.

H. Master Controller Features:

a) The Master Controller would be connected to the Android Tablet via Wi-Fi. The Android Tabletwould be sending commands via message over Wi-Fi over a port. The Message Format for thesame has already been devised.
b) The Master Controller (read LPC 2387) should understand from the Command Message as
to what is required of it to do and perform the relevant task.

I. Based on the functionalities there can be 4 types of tasks:
c) Command Mode: The LPC 2387 should extract the Slave Controller ID from the message
and pass the rest of the message to the Slave Controller via Zigbee (CC2538) or RS485 as
applicable. The CC2538 should send across the message to the relevant Slave Controller Which also has a CC2538. Also the acknowledgement should be sent back after execution
of task all the way back.
d) Config Change Mode: The LPC 2387 should be able to change the configuration settings of Slave and Sensors via this Mode.
e) Energy Report Mode: The LPC 2387 would request the energy consumption report from
each slave at regular interval of time and store it in its Flash. When this request comes
from the Android Tab, the LPC should be able to send back the response accordingly.
f) HeartBeat Mode: The LPC 2387 should send Heartbeat packets to all its Slaves to get their
g) Current Status and save that information in its Flash.
h) There should be acknowledgment from the device after execution of every command in every
i)Mode all the way back to the Android Tablet.
j) The device should have a reset button to reset itself if it's nonresponsive.
k) Display Energy Report, Current Status of Slave (Automated Mode or Manual Mode) and
Settings on the Graphic LCD Display.
l)The Keypad should be able to control LCD Display.

J. Smart RF 06 Evaluation Board.

This evaluation board is specially used for Low power Rf application which has many features involved in it. Like it consists of XDS 110V3 debugger which will help in debugging controllers like CC2538 and interfacing with other interfaces. It has provision for both C-JTAG and JTAG emulator, also it consists of the high speed USB , accelerometer, micro SD card slot, light sensors and current measurements provision.


Figure 5.Smart RF 06 EB

## IV. CONCLUSION

The above proposed system gives a better way of implementing the home automation technique for the home appliances which can be applied over a large scale and also power consumption , time limit, memory usages have been improved with advanced proposed system. This system can be implemented over large number of houses with lesser pricing that the existing available market pricing.

**REFERENCES**

[1] Gao Yongqing, Shang Dan "The Research of Home Intelligent PowerSystem Based on ZigBee".

[2] Chiung-Hsing Chen, Hung-Wei Lin and Yen-Sou Huang and Jwu Jenq Chen "Power Management System Based on ZigBee".

[3] Mohammed Abo-Zahhad, Sabah M. Ahmed, Mohammed Farrag, Mohammed F. A. Ahmed and Abdelhay Ali "Design and Implementation of Building Energy Monitoring and Management System based on Wireless Sensor Networks".

[4] Dae-Man Han and Jae-Hyun Lim "Smart Home Energy Management System using IEEE 802.15.4 and ZigBee".