Mesh Networking Using Bluetooth Smart for Many to Many Device Communications for Long Range and High Data Rate Applications

Abstract: ***Present days Embedded Systems making the world smaller, where physical things in the industries, offices, cities and wearable's etc., are sharing the information (status, control) in real time, providing more and more services. These services will change the traditional industries to smart industries, homes to smart homes and many such more applications. Many wireless communications like ZigBee, Z-wave, Wi-Fi are available for providing these smart solutions. One of the recent technology that available is Bluetooth Smart or Bluetooth Low Energy (BLE) appears quite attractive due to its low power, medium to high data rates, small distances, and small size characteristics. In this project, I will be developing the embedded system (hardware) and implementing the mesh topology (firmware) using Bluetooth smart to meet high data rate for long distances in the context of smart industries, devices and smart homes. The other challenges are to develop a framework for seamless integration of multiple resolution data in a distributed sensor network, which is generated by various nodes ranging from fixed nodes and portable nodes.***

Keywords: CC2640R2F, CC2540 USB, Mesh Network, Bluetooth Smart.

1. Introduction

Present days embedded systems making the world smaller, where physical things in the industries, offices, cities and wearable's etc., are sharing the information (status, control) in real time, providing more and more services. These services will change the traditional industries to smart industries, homes to smart homes and many such more applications. As shown figures some of the applications.

Figure (a)

. **Figure (b)**

Figure 1.1 Mesh Network (a) Smart Home & (b) Smart Industries

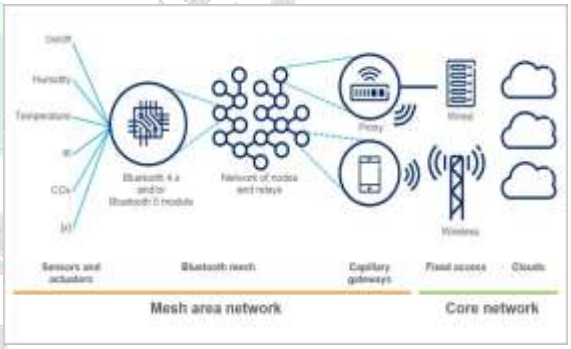
Technology advances (IoT, Cloud Services) are allowing these services to be more robust, economical and reliable and operate on very low power. Many wireless communications like ZIGBEE, Z-wave, Wi-Fi etc.., are available for providing these smart solutions. These solutions offer with some trade off like power, distance, authentication, and high data rate etc., ZIGBEE provides long distances but consumes more power, Wi-Fi based solutions require authentication, and this will increase the complexity of embedded solution. One of the recent technologies that available is "**Bluetooth Smart**" or " **Bluetooth Low Energy**" (BLE) appears quite attractive due to its low power, medium to high data rates, small distances, and small size characteristics. The challenge is to develop a framework for seamless integration of multiple resolution data in a distributed sensor network, which is generated by various nodes ranging from fixed nodes and portable nodes

2. LITERATURE SURVEY

1. Bluetooth mesh networking

In July 2017 Bluetooth mesh was officially launched, it is a highly accrued to the Internet of Things connectivity space. Bluetooth is a generally used as for short-range technology which is found in smart phones, tablets and consumer electronics. Bluetooth Special Interest Group has a strong reputation for delivering specifications and tools that are guarantee overall, multi-vendor interoperability.

It also presents a large-scale building automation and it can use in the case of configuration and deployment strategies on the mesh network.



2. CSR mesh

Cambridge Silicon Radio (CSR) developed CSR mesh, a proprietary protocol that operates with Bluetooth 4.0 which allows messages to be forwarded across BLE devices in a mesh network.

CSR mesh uses flooding over advertising channels for end-to-end communication. A basic model is used, where all devices have the same hierarchical level. Flooding is controlled by using a Time to live mechanism and by preventing rebroadcast of the same packet more than once. A CSR mesh network can in theory comprise up to 64,000 devices. Messages can have individual or group recipients. CSR offers CSR101× modules, which support CSR mesh and the CSR mesh Development Kit, which provides a set of tools and software development for CSR mesh.

3. Implementation:

The main aim of the project is to use the capabilities of "Bluetooth Smart" or "Bluetooth Low Energy" (BLE) for creating to implement the Mesh Network to meet high data rate for long distances in the context of smart industries, devices and smart homes. Presently, the latest advances technology is Bluetooth Low Energy (BLE) or Bluetooth smart is particularly used in commercially reliable Internet of Things (IoT) devices such that smart watches, fitness trackers, and smart applications. Computability to classic Bluetooth, Bluetooth Low Energy (BLE) or Bluetooth smart has been modified in many ways that includes its data exchange, connection establishment and encryption processes. Unfortunately, this significance comes at cost. First supported only for a star topology which is Bluetooth Low Energy(BLE) in the BLE stack and a peripheral (an IoT device) can communicate with only one gateway/peer like a Smartphone, or a BLE at any given set time.

4. Related Work:

The brief introduction of different modules used in this project is discussed below:

4.1 RTOS FRIMWARE AND STACK:

In this developed system RTOS Firmware is used to create profile service for peripheral or slave and creating network layer for central or Master by code composer studio (ccs) firmware

4.2 CC2640R2f:

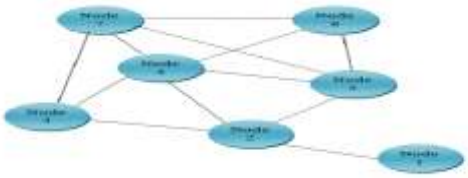
The CC2640R2F is a device wireless microcontroller communicating Bluetooth 4.2- and Bluetooth 5 low power applications. This device is a member of the Simple Link ultra-low-power CC26xx family of cost-effective, 2.4-GHz RF devices. Very low active RADIO FREQUNCY and Micro controller current and low-powered mode power consumption provides best battery lifetime and allows with operation on small coin cell batteries and in power gathering applications. The SimpleLink Bluetooth low power CC2640R2F device contains a 32-bit ARM Cortex -M3 core that runs at 48 MHz as a main processor and a high peripheral feature set that includes a specific ultra-low power sensor controller

4.3 CC2540 DONGLE:

Description

As shown above figure the CC2540 USB Evaluation Component Kit is define from texa instruments family which is one of the CC2540 Bluetooth low energy USB Dongle. The dongle can be used to implement the Bluetooth low energy in the systems . CC2540 can also be used as a packet sniffer for evaluate the Bluetooth Low Energy protocol to see the discovery of gatt characteristic values and for software and system level debugging The dongle comes to know about profile creation readable and writable preprogrammed as a packet sniffer.

4.4 MESH NETWORK:



Mesh network is described as local network in topologies in which the framework nodes such that like switches, bridges, and other framework devices etc…,in mesh network framework devices (nodes) dynamically, connects directly, and non-hierarchically to as many as nodes available as possible and cooperate with one another to accurately route data from/to clients. This reduction of addiction of one node allows for every node to participate in the one shortage process in the relay of information. Mesh networks means it describes dynamically self-organize and self-configure, it can reduce installation overhead. The ability of this to self-configure enables dynamic distribution of workloads, commercially in the events that a few nodes should fail. This in turn contributes to failing resistance and reduced maintenance costs.

4.5 Bluetooth Low Energy or Bluetooth Smart:

Bluetooth Low Energy (BLE), also referred to a Bluetooth Smart is the Bluetooth 4.0 core specification. It's attractive to present BLE as a smaller, highly enhance version of its considerable relation, classic Bluetooth, but in reality, Bluetooth Low Energy (BLE) has an entirely different origin and design goals. Originally designed by Nokia as Wibree and was later adopted by the Bluetooth Special Interest Group (SIG). It is an emerging wireless technology designed particularly for the purpose of short range communication, lowest possible power consumption focusing on applications and devices that require relatively low data transfer operate at low power rate, low cost and low cost

Mobile application:

The Android platform includes support for the Bluetooth network stack, which allows a device to wirelessly exchange data with other Bluetooth devices. These APIs let applications wirelessly connect to other Bluetooth devices, enabling point-to-point and multiple wireless features. Used multiple BLE app which is generated the application.

5. CONCLUSION:

By using Bluetooth low energy or Bluetooth smart for mesh networking solutions are implemented. One of the Flooding based schemes favor simplicity, compared to routing-based solutions are more elaborate. From these two solutions flooding categories use advertising channels and data channels, respectively, for data transmission. While using data channels requires Link Layer connection establishment between other devices, this approach allows BLE Physical Layer features , Link Layer features is bidirectional communication and reliability is used for implement mesh network

From this Bluetooth low energy developed first star network then it is implemented mesh network with the using of BLE stack for long range and to meet high data rate applications which is utilized as light intensity, temperature and humidity by using mobile application is checked.

6. ACKNOWLEDGEMENT

We would like to thank all the authors of different research papers referred during writing this paper. It was very knowledge gaining and helpful for the further research to be done in future.

7. RESULTS

Results are shown below which is described from one node to node process to implementing mesh network.

This shows the device communicating with one to one and other nodes which is star topology

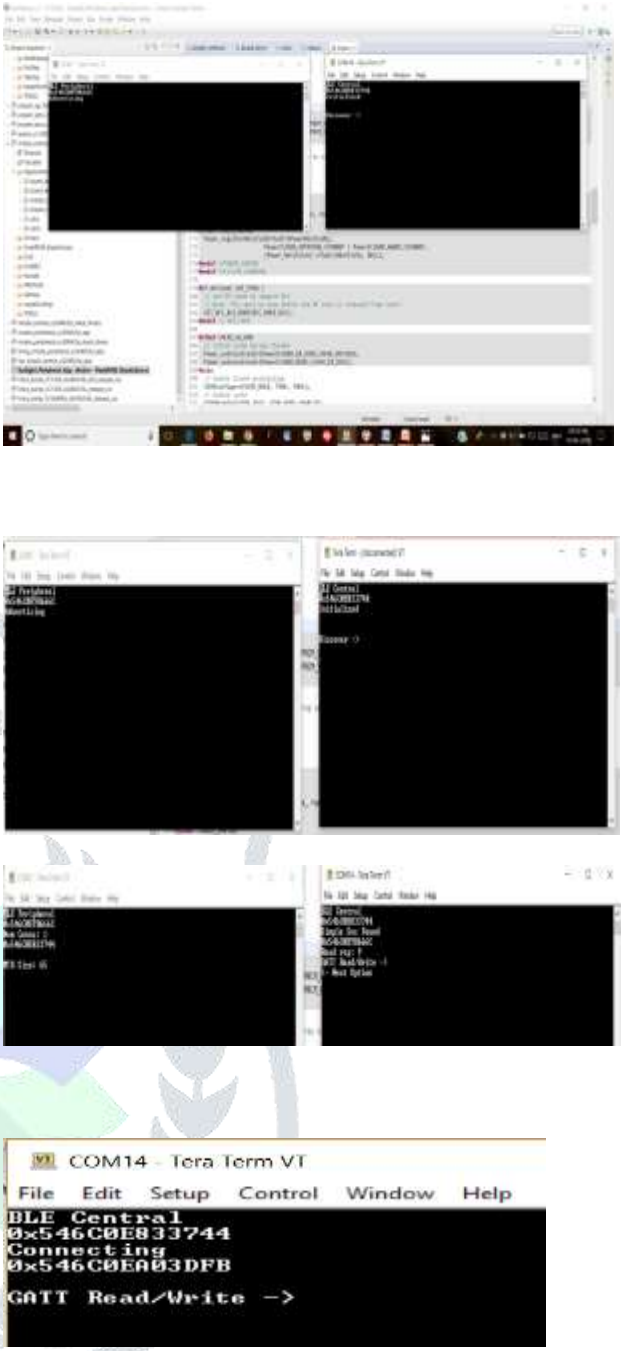


Figure 6.1 one to one device connecting results, star topology, many to many device communications

Finally the result is shown as mobile application with multiple devices communicating and also application as shown below

Figure 6.2 mobile applications with multiple devices

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