Performance Analysis of an IoT Wireless Transceiver Network for Smart City Applications

G. Sasi, G. Athisha, S. Surya prakash

Abstract: Smart City is the one which uses Information and Communication Technologies to make the critical infrastructure components and services of city administration, education, healthcare, public safety, real estate, transportation and utilities more aware, interactive and efficient. Majority of IoT network nodes employed indifferent applications involve various connectivity standards such as Near Field Communication (NFC), ZigBee, Bluetooth.To design an IoT device with Multistandard Microcontroller Unit and tointegrate the above IoT device with line transceiver to develop an IoT wireless transceiver node. After validating test the network with various wireless signals simulated for widely used wireless connectivity standards and application by evaluation of QoS parameters.

Keywords: Line transceiver,Received Signal Strength, Link quality Indiactor, Bandwidth, Transciver, Energia.

I. INTRODUCTION

A novel technique named “The Internet Of Things (IoT)” has been introduced based on communications methods.The design solutions for s ensible property may be a important technical challenge of the day. The smart connectivity will be established only if all communication devices get connected over an IoT network. Majority of IoT network nodes used in different applications involve numerous property standards like close to Field Communication (NFC), ZigBee, Bluetooth for mobile/retail payments, Wi-Fi, 3G, 4G and Sub – one GHz for smart Home and Industrial Application, smart Agriculture, smart Water and Transportation applications. In order to get the knowledge about IoT, First we need to understand the concept of RFID systems (used to identify and communication with other devices). IoT depends on Wireless Sensor Networks by collecting the information, processing and transmitting the collecting data’s. Some advanced technologies such as in order to initialize and solve the problemsand control the machine-to-machine interfacing[1EASE OF USE.

Review

IOT has been explained or defined in different perspectives. The main objective of the terms “Internet” and “Things”. Internet points towards a combination of multiple networks and things mainly include generic devices.

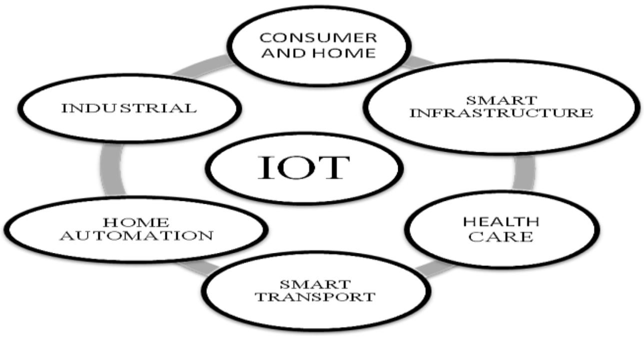

Fig.1 Different Aspects OfIot

While planning the IoT device, the wireless property technologies need to be properly chosen since communication plays the core role within the applications. The IoT wireless transceiver nodes should be designed taking into thought numerous factors like vary, output and low power. The nodes therefore designed will be accustomed construct AN IoT wireless transceiver network. The wireless take a look at signals are simulated and therefore the network is tested for best property by analysis of standard QoS parameters.

The Internet of Things connecting everyday devices like smart-phones, web TVs, sensors and actuators to the world Wide network wherever the smart devices are intelligently connected along enabled the new modes of communication between objects and receiver, and between the things itself [2].

II. ELEMENTS OF IOT

A. Sensing

The initial step in IOT is gathering the information at a “point of activity.” The information can get from an appliance, a wearable device and common devices.

B. Communication

Most of the IoT devices are not suitable for cloud environment. This requires either WiFi (wireless LAN based communications) or WAN (wide area network… i.e. cellular) communications.

C. Cloud Based Capture

The accumulated data is transmitted to a cloud predicated accommodation where the information coming in from the IOT contrivance is aggregated with other cloud predicated data to provide subsidiary information for the utilizer.

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III. TECHNOLOGY OVERVIEW

A. Sigfox

SigFox [7] incorporated with Ultra-Narrow Band (UNB) modulation with Differential Binary Phase-Shift Keying at 100 bps (DBPSK). In this methodology the equipment starts the transmission by sending three uplink data packs in sequence on three random uplink frequencies. The base station will successful receive the data stream, when any of the transmissions are lost due to e.g. distortions happen with other devices or interfere with other systems using the same carrier frequency.

B. LoRa

The LoRa solution consist of the LoRa physical layer specifications and the LoRaWAN network protocol,[10]. The LoRa physical layer uses chirp spread spectrum, with spreading factors from 6 to 12, and GFSK modulation to protect against in-band and out-band interference. LoRa can operate in the entire 868 MHz EU ISM band but has three mandatory channels; 868.10, 868.30, and 868.50 MHz.

C. HNB-IoT release 13

The NB-IoT is an incubation of the LTE system and operates with a carrier bandwidth of 180 kHz [2], [4], [16]. The NBIoT carrier can be deployed within an LTE carrier, in the LTE baby-sit band, or as standalone. The subcarrier bandwidth for NB-IoT is 15 kHz, and each device is scheduled on one or increasingly subcarriers in the uplink. Furthermore, uplink transmissions can be packed closer together by decreasing the subcarrier spacing to 3.75 kHz. For remoter information on NB-IoT performance refer to [10], [11].

D. GPRS

The GPRS systems accept been deployed for abounding years and serve as the advertence fr LPWA technology in abounding markets today. GPRS is the packet radio account congenital on top of GSM [3]. GPRS uses GMSK accentuation and is abundance analysis circuitous disconnected into frames of 4.6 ms that are added disconnected into 8 timeslots. GPRS requires a abundance reclaim arrangement of up to 12 accouterment a adequately inefficient ashen density. GPRS and NB-IoT accomplish in the accountant bands and are accordingly not belted by assignment aeon or accept afore allocution limitations. [9]

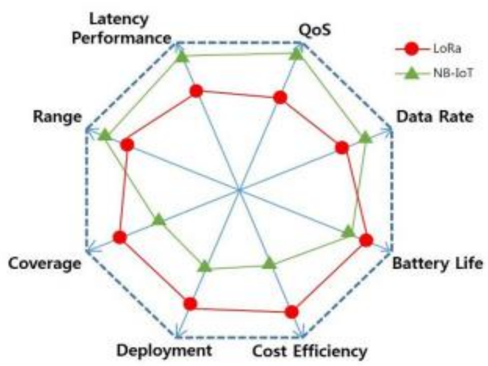

Fig.2 Comparisons In Various Factors

IV. ENERGIA TOOL

A.Software Description

Energia is an accessible antecedent & community-driven chip development atmosphere (IDE) & computer cipher framework. Supported the Wiring framework, Energia provides an automatic autograph atmosphere additionally as a able framework of easy-to-use applied Apis& libraries for programming a microcontroller. Energia supports several TI processors, primarily those on the market within the launch area development scheme. Energia is open supply & the ASCII text file is on the market.

B. Features

- Simple & easy-to-use cipher editor & compiler with built-in Serial Monitor/terminal
- Features a athletic framework of automatic applied Apis for ascendant microcontroller peripherals (i.e. digitalRead, digitalWrite, Serial.print, etc)
- Support for abundant TI anchored accessories
- Open supply & hosted in GitHub
- Higher level libraries are on the market (i.e. Wi-Fi, Ethernet, displays, sensors & more)
- Need additional options from your IDE? Seamlessly migrate your Energia project into Code musician Studio v6, permitting developers to require advantage of the launch area kit's on-board programme.
- Prototyping package to form Things straightforward

Energia eighteen is predicated on the newest and greatest Arduino IDE. This unharness options the new board (core) / library manager. Default the Energia installation comes with support for the MSP430. Alternative cores like TivaC, CC3200, MSP432 may be put in through the board manager selectively Tools->Board->Board Manager. For additional details on a way to install extra cores/boards see the board manager guide guide.

The cores enclosed within the board manager are: MSP430, MSP432 (MT, TI-RTOS primarily based multitasking), CC3200 and TivaC. The CC3200 (MT) TI-RTOS multitasking based core are created on the market within the close to future through the board manager. CC2650 has been faraway from Energia attributable to the shortage of BLE support that would not be enabled attributable to licensing problems with the BLE stack.Special due to the Arduino LLC team for the awful library / board manager integration into the IDE.

Energia is associate degree ASCII text file physical science prototyping platform started by parliamentarian

Wessels in January of 2012 with the goal to bring the Wiring and Arduino framework to the TX Instruments MSP430 primarily based launch area. The Energia IDE is cross platform and supported on mackintosh OS, Windows, and Linux. Energia uses the mspgcc compiler by Peter zealot and is predicated on the Wiring and Arduino framework. Energia includes associate degree integrated development atmosphere (IDE) that's supported process.Energia is additionally a transportable framework/abstraction layer that may be utilized in

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alternative in style day. Utilize an online browser primarily based atmosphere with CCS Cloud at dev.ti.com. Community maintained Energia plug-ins and integrations ar on the market for Xcode, Visual Studio, and Code musician Studio.

The foundation of Energia and Arduino is that the Wiring framework that's developed by Hernando Barragan. The framework is thoughtfully created with designers and artists in mind to encourage a community wherever each beginners and specialists from round the world share ideas, information and their collective expertise. The Energia team adopts the philosophy of learning by doing and strives to form it straightforward to figure directly with the hardware. Skilled engineers, entrepreneurs, makers, and students will all take pleasure in the convenience of use Energia brings to the microcontroller.

Energia launched to bring the Wiring and Arduino framework to the TX Instruments MSP430 launch area. TX Instruments offers a MSP430, MSP432, TM4C, C2000, and CC3200 launch area. The launch area may be a affordable microcontroller board that's created by TX Instruments. The newest unharness of Energia supports the bulk of the launch area product offerings. Extra community kits from RedBearLab are supported.

V. THE OPEN IOT PLATFORM-THINGSPEAK

Thing Speak™ is an IoT analytics platform service that allows you to aggregate, visualize, and analyze live data streams in the cloud. You can send data to Thing Speak from your devices, create instant visualizations of live data, and send alerts using web services like Twitter. With MATLAB® analytics inside Thing Speak, we can write and execute MATLAB code to perform preprocessing, visualizations, and analyses. Thing Speak enables engineers and scientists to prototype and build IoT systems without setting up servers or developing web software.

The Internet of Things(IoT) is a system of ‘connected things’. The things generally comprise of an embedded operating system and an ability to communicate with the internet or with the neighboring things. One of the key elements of a generic IoT system that bridges the various ‘things’ is an IoT service. An interesting implication from the ‘things’ comprising the IoT systems is that the things by themselves cannot do anything. At a bare minimum, they should have an ability to connect to other ‘things’.

Key capabilities of ThingSpeak

- Configure devices to send data to ThingSpeak using a REST API or MQTT.
- Aggregate data on-demand from devices and third-party sources.
- Get instant visualizations of live or historical sensor data.

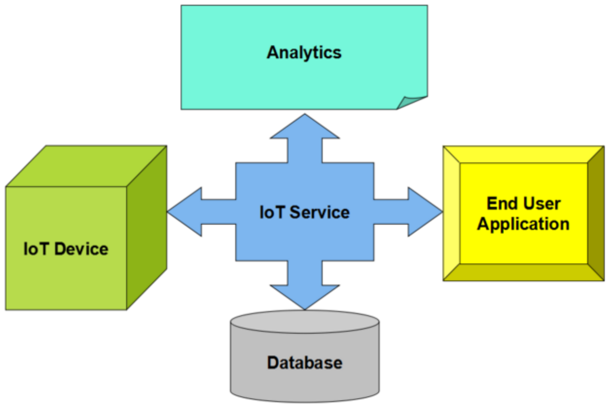

Fig.3 Iot Service Fits In AnIot Ecosystem

A. Expected Outcome

The impact of the project is that an IoT wireless transceiver network for any Smart City Application is developed. This work focuses on the development of IoT wireless transceiver node initially which works for any wireless connectivity standard. Different applications involve different connectivity standards such as Wi-Fi, ZigBee, Sub – 1GHz and 6LoWPAN etc., After establishing an experimental testbed with IoT wireless transceiver nodes, the appropriateness of the wireless connectivity standards for various applications is studied by simulating the signals and verifying the QoS parameters of the IoT network.

B. Technical field of the proposal

“Internet of Things” (IoT) is a network of physical objects, devices that contain embedded technology which can communicate, sense or interact with internal or external systems.IoT is identified as the emerging technologies in IT as noted in Gartner’s IT Hype Cycle. There will be 50 billion connected devices by 2020. The lowered cost of components such as sensors and processors along with increasing wireless connectivity has made many objects “smart” and able to communicate with each other.

The requirements of these smart IoT devices are low processing power, long wireless connectivity ranges and higher processing power. As the major objective of the IoT devices is to communicate with other devices, it is imperative that the wireless communication technologies must be suitably selected while designing the IoT device for an application. Majority of IoT devices rely on wireless technology which may range from Near Field Communication (NFC) for mobile payments, Bluetooth, Wireless LAN (WLAN).,ZigBee and so on.

The network has to come up with unique IoT devices with different connectivity requirements. Analyzing the performance of the wireless connectivity technologies has to be done by testing and validation of transmission and reception of wireless test signals. We would be able to select the suitable technology only after thorough simulation, testing and evaluation of the test signals with the designed IoT devices.

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VI. INTEGRATION OF IOT WITH CLOUD SERVICES

The integration of IoT with cloud is not a simple issue; the IoT does not allow all the things to integrate and all the resources to avail from the cloud. There are some issues which have to be addressed before the integration. The communication between the IoT and cloud are considered as the major constraint for the integration. QoS Provisioning: In IoT, the data size produced by the sensor nodes is more, it leads to the unpredictability and quality of service becomes major issue. The sensor nodes produce data at any time and some time it might be an important data. Therefore, cloud should provide prioritization to the data [11]. Quality of service is measured in terms of packet loss ratio, bandwidth, jitter and delay [12].

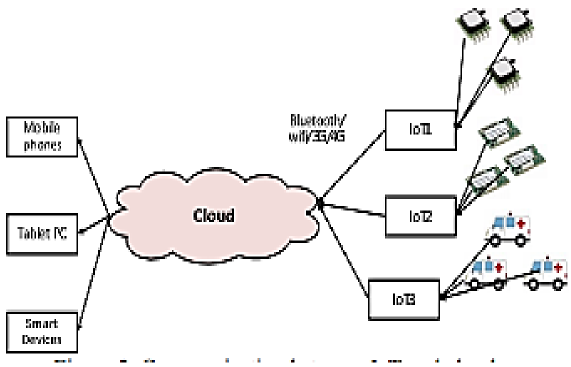

Fig.4 Communication BetweenIot And Cloud

VII. PROPOSED SYSTEM

An IoT transceiver node is constructed by integrating a microcontroller unit(CC3200 Simple Link WiFi) and a line transceiver (CC110L Wi-Fi Booster Pact). This would serve as a single communication link for a simple Wi – Fi link. In a similar way, IoT transceiver nodes for various Smart City applications are constructed with CC2650 Launch Pad and Sensor Tags, CC1310 Ultra – Low Power Sub – 1GHz Wireless MCU.A network of such nodes is constructed with n number of transceiver nodes thus designed. The Signal Studio software is used to create the wireless signals for different standards. The signals thus generated are transmitted and received at the other nodes. The QoS parameters of the network are studied. The wireless communication standard which provides the necessary QoS values is selected as the appropriate standard for a particular application.

VIII. RESULT AND DISCUSSION

The proposed clustering technique is implemented using Energia tool. For measuring performance analysis purpose, we have carried out a thorough experimental analysis understand the impact of the proposed clustering mechanism on IoT.

RSSI(db)	LQI	BANDWIDTH(kbps)
-43	44	-81
-43	42	-80
-43	44	-81
-43	42	-80
-42	45	1199
-42	44	1200
-42	43	1197
-42	44	1201
-49	40	1199
-48	37	1201
-48	43	1200
-48	40	1200
-46	43	1199
-49	44	1201
-48	41	1201

Table 1 Comparisons Of Various Factors

A. Bandwidth

Bandwidth is the bit-rate of available or consumed information capacity expressed typically in metric multiples of bits per second. The proposed IoT Transceiver system is compared with the conventional techniques as Sigfox and

LoRa using the following performance evaluation parameters.Table 1 shows the initial network parameters for performance evaluation

Network Parameter	Proposed model	Sigfox	LoRa
Bandwidth	Licensed LTE bands Guard band, standalone	Unlicensed ~900MHz	Unlicensed ~900MHz

Table.2 Bandwidth Comparisons

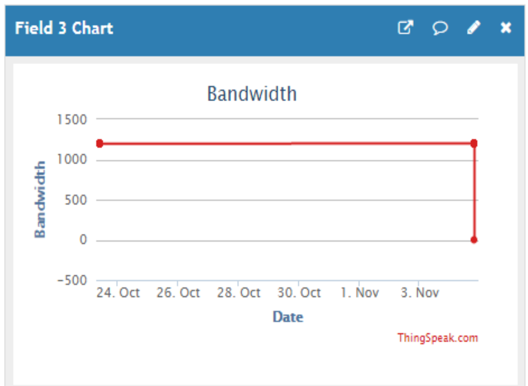

Fig5(A)Bandwidth(Vs)Time

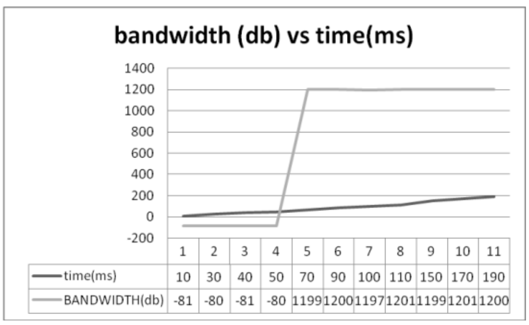

Fig 5.(b) Bandwidth (vs) Time

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A. RSSI (Received Signal Strength Indicator)

RSSI stands for Received Signal Strength Indicator. It is a measure of power level that a RF client device is receiving from an access point or router

RSSI = −10n log10 (d) + A

Fig 6(a) RSSI vs TIME

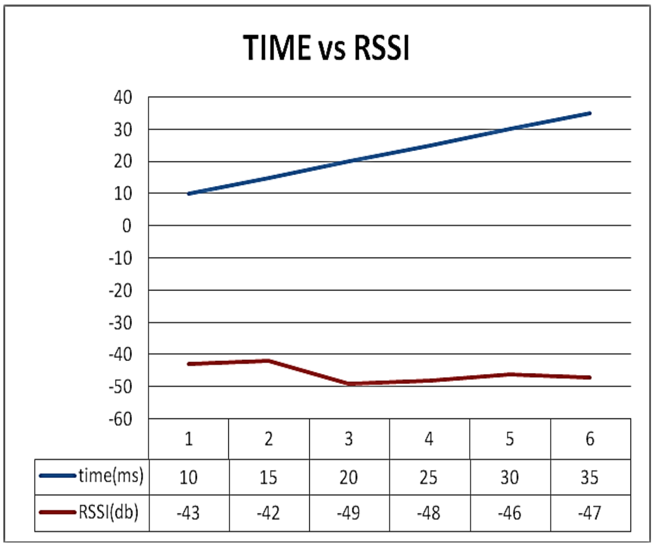

Fig.6(b) RSSI vs TIME

C. LQI (Link Quality Indicator)

LQI (Link Quality Indicator) is a parametric of the current quality of the received signal. LQI is best used as a relative measurement of the link quality (a low value indicates a better link than what a high value does), since the value is dependent on the modulation format.

Network Parameter	Proposed model	Sigfox	LoRa
Data Rate	170-250kbps	0.1kbps	0.3-50kbps

Table 3.Data Rate Comparisons

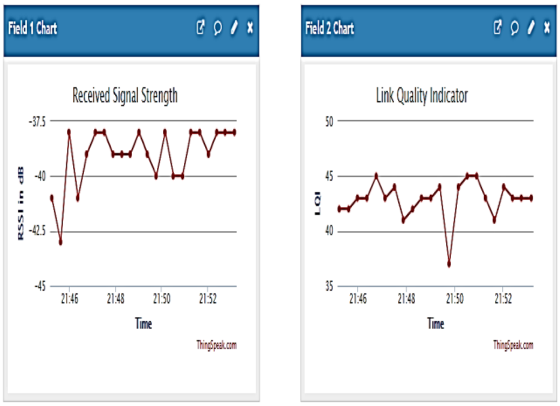

Fig 7(a) LQI vs TIME

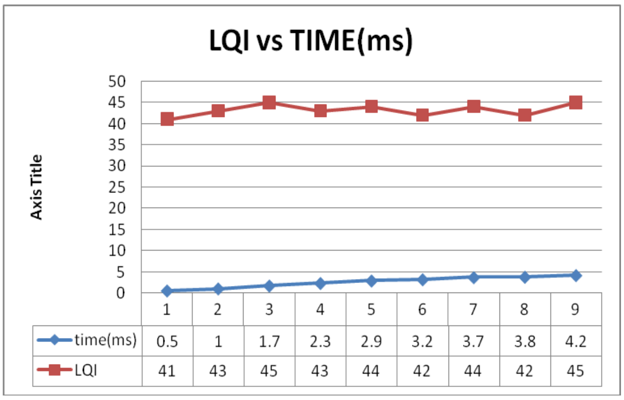

Fig 7(b) LQI vs TIME

IX. CONCLUSION

In this paper, we presented the technologies and its specification that can be used to make Internet of Things a reality. An IoT transceiver node is constructed by integrating a microcontroller unit(CC3200 Simple Link WiFi) and a line transceiver (CC110L Wi-Fi Booster Pact). This would serve as a single communication link for a simple Wi – Fi link. In a similar way, IoT transceiver nodes for various Smart City applications.integration of IoT with cloud services and the research issues which need to be addressed at the time of integration.

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