

# IEEE 802 Standard Network's Comparison under Grid and Random Node Arrangement in 2.4 GHz ISM Band for Single and Multiple CBR Traffic

**J.Jaslin deva gift**

Department of ECE, Dr. Mahalingam College of Engineering & Technology, Udumalai Road, Pollachi -642003  
Email: jaslindevaece@gmail.com

**Dr.K.Sumathi**

Department of ECE, Dr. Mahalingam College of Engineering & Technology, Udumalai Road, Pollachi -642003  
Email: sumathimin@gmail.com

---

## ABSTRACT

---

The IEEE 802 standard well-known as 802.11 called as Wi-Fi network, 802.15.4 called as ZigBee or sensor network and 802.15.1 called as Bluetooth network. The network such as ZigBee, Bluetooth and Wi-Fi works in 2.4 GHz ISM band. All the above networks works in same ISM band of 2.4 GHz, but the performance of the network varies. The performance of simulation depends upon the coverage area, data rates, and power consumption in each network. The heterogeneous network performances is evaluated with static and mobility model in random and grid node placement by varying the traffic loads of one CBR and with five CBR for each network. The simulation result is compared in terms of jitter, average end to end delay and throughput to analyze the network performance in the 2.4 GHz frequency band. IEEE 802.11 network shows the low jitter and delay value with high throughput compared with sensor network.

Keywords - CBR traffic loads, IEEE 802.15.4, IEEE 802.11, Qualnet 5.0.2 simulator, Wireless Sensor Networks (WSNs).

---

Date of Submission: Jan 18, 2017

Date of Acceptance: Jan 31, 2017

---

## I. INTRODUCTION

The unlicensed ISM band is abbreviated as Industrial, Scientific and Medical is widely used among popular wireless network standards such as IEEE 802.15.4 called as Low-Rate Wireless Personal Area Network (LRWPAN) such as ZigBee or sensor network IEEE 802.15.1, called as Bluetooth network and IEEE 802.11b called as Wireless Local Area Network (WLAN) such as Wi-Fi or ad-hoc manet network. As the demand for the usage of ISM band is increasing rapidly, there are many scenarios where we need communication access such as wireless local area networks (WLANS) based on IEEE 802.11b specifications and wireless personal area networks (WPANs) on IEEE 802.15.4 based and Bluetooth specifications. Wireless Sensor Network (WSN) is a promising and ever growing sensor technology for implementing variety of applications like monitoring of environment, security aspects and applications that save our lives and assets. In WSN, more number of sensor nodes are adapted to sensing and gathering information and forwarding to the base station such as PAN coordinator with the help of routing protocol [1]. A WSN is the spatially distributed autonomous network for monitoring and collecting information about environmental conditions like, sound, temperature, pressure etc., WSNs are subdivided into two classes namely static WSNs and mobile WSNs [2]. Random based placement of sensor nodes and grid based placement of sensor nodes working depends on location [3]. WSNs are the integration of many technologies, such as communication in wireless medium, sensors network,

embedded computing and distributed information processing. It is widely used for military purposes, environmental conditions, medical field, transport and other fields [4]. Different traffic applications are constant bit rate (CBR), variable bit rate (VBR), and file transfer protocol (FTP) are used to analyze the performance of each network [5]. Mobile ad-hoc network is wireless network of mobile nodes without any centralized administration. The network topology changes periodically in mobile ad-hoc network [6]. IEEE 802.11 is the standard family of wireless networking. It is the first wireless LAN (WLAN) standard proposed in the year 1997. The medium access mechanism function, called the Distributed Coordination Function (DCF) is a Carrier Sense Multiple Access with Collision Avoidance mechanism (CSMA/CA) [7]. It uses microwaves frequency in the range of 2.4 GHz and 5GHz. Ad hoc network mobile nodes do not have any definite form of infrastructure. They are self-organized structure and communication done by wireless links [8]. The standard 802.11 provides two variations in radio frequency (RF) physical (PHY) layer. These include two modulation techniques such as direct sequence spread spectrum (DSSS) and frequency-hopping spread spectrum (FHSS) [9]. In the current era the interacting technologies are Wi-Fi and WLAN technologies. Many researches are being done in different networking field such as peer to peer or point to point network, cellular wireless, file server, World Wide Web and grid computing system. The mobility in distributed network provides the best quality of services to the clients and the mobility is important to accommodate

the demand in wireless network. The routing protocols plays major role in all kinds of network either static or dynamic model. The Ad hoc On-Demand Distance Vector (AODV) routing protocol is an on-demand approach to identify the most recent path by employing destination sequence numbers. Here, the next-hop information stored in the source node and the intermediate nodes corresponding to each flow for data packet transmission. In an on-demand routing protocol, the source node floods the Route Request packet in the network when a route is not available for the desired destination. It may also obtain multiple routes to different destinations from a single Route request [11]. AODV provides better throughput and high packet delivery ratio compared to other protocols under grid and random placement [12].The efficiency of AODV gives better throughput and performance of AODV plays better role in all case of topologies [13].

The rest of the paper is organized as follows. Chapter II addresses the ISM band and different network technologies. Simulation parameters and results are discussed in Chapter III. Conclusions are given in Chapter IV.

## II. ISM BAND

The ISM band is the parts of the radio spectrum or refers to a group of radio bands that are internationally reserved for the use of radio frequency (RF). ISM bands are generally open frequency bands, which vary according to different regions and permits. It uses the unlicensed ISM ranges are 902-928 MHz, 2400-2483.5 MHz and 5725-5850.

### 1.1 IEEE 802.11 (WI-FI)

The IEEE 802.11 standard is the WLAN wireless communication network and also called as Mobile Ad-hoc Network (MANET). It is intended for device to device or computer to computer wireless communication, as a replacement for cabled connection or wired networks. It gives internet access at broadband speeds through the connection access point. Wi-Fi gives a data rate in higher, whereas Bluetooth and ZigBee network gives lower data rates. Wi-Fi operates with either a 2.4, 5 GHz or 5.8GHz frequency band. It supports large number of nodes in a network when compared to other networks. The range is from 10-100m. The data rate is 2 - 54 M bits/sec and has medium power consumption. It uses star topology

### 1.2 IEEE 802.15.1(Bluetooth)

The IEEE 802.15.1 standard is the WPAN wireless communication network or Bluetooth network. It is intended to enable the communication in short-range that supports peripherals devices such as computer mice, keyboards, printer etc., This range is known as wireless personal area network. It also operates with a 2.4 GHz frequency band. The range is 10-30m with data rate of 1M bits/sec. Due to low data rate, the complexity and power

consumption is low. The frequency hopping modulation technique is used and uses star topology.

### 1.3 IEEE 802.15.4(ZigBee)

The IEEE 802.15.4 standard is the WPAN wireless communication network .For example ZigBee network. It is a standard that defines the set of communication protocols for low-data-rate, short-range wireless communication networking. ZigBee based wireless devices operate in 868 MHz, 915 MHz and 2.4 GHz frequency band. The 868 MHz band used in Europe, the 915 MHz frequency band in North America, whereas 2.4 GHz frequency band is used in world wide. The maximum data rate is 250 K bits/sec. The range supported is 10-30m. Due to low data rate, the complexity and power consumption is less than Bluetooth. It uses direct sequence spread spectrum and frequency hopping spread spectrum modulation technique. It uses star, tree and mesh topologies.

## III. SIMULATION AND RESULTS

The simulation is performed with the following parameters mentioned in Table I.

**TABLE I**  
**Simulation parameters**

Parameters	Values
Area	1000m*1000m
Simulation Time	300sec
Item to send	100
Packet size	50 bytes
Packet rate (packet per sec)	0.1,0.2,1,2
MAC layer	802.15.4, 802.11
Energy Model	Mica motes
Battery Model	Linear model
Protocol	AODV
Node placement	Random, Grid
No of nodes	10
Traffic	CBR

The nodes are placed both randomly and in the form of grid for both network as shown in Fig 1 and 2 for static model.The random mobility model shown in Fig 3. The simulation is carried out by varying the data rate per packet interval in both static and dynamic model.



Fig.1.Random placement

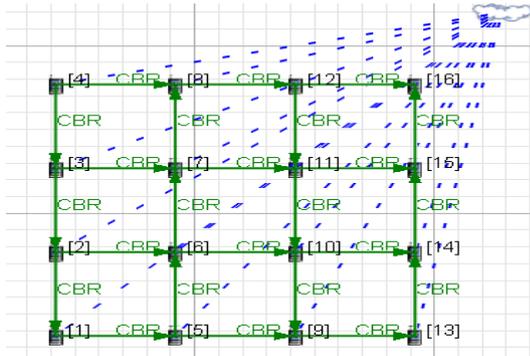


Fig.2. Grid placement

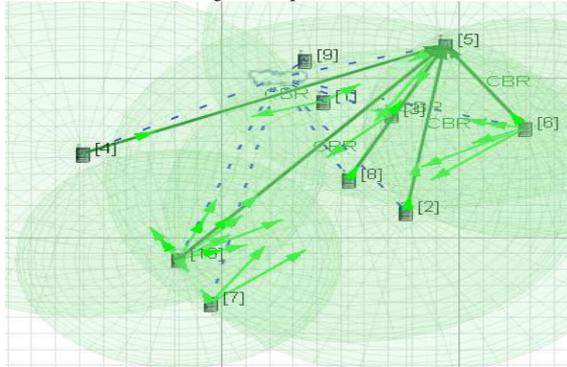


Fig.3. Mobility model

### 3.1 Average jitter

Average jitter versus packet interval in static model with one and five CBR is shown in Fig 3. Fig 4 shows the jitter comparison in static model with one CBR for 802.15.4 and 802.11. The network 802.11 shows lower jitter in static model. The jitter is low for 0.1 packet interval and increases with the increase in packet interval and high at 0.4 packet interval for both networks. The Fig 5 and Fig 6 shows the mobility model with one and five CBR for 802.15.4 and 802.11. In mobility model also, the network 802.11 has low jitter as compared with sensor network. The grid placed static and mobility model is shown in Fig 7 and Fig 8 shows lower jitter for 802.11 networks for all packet interval.

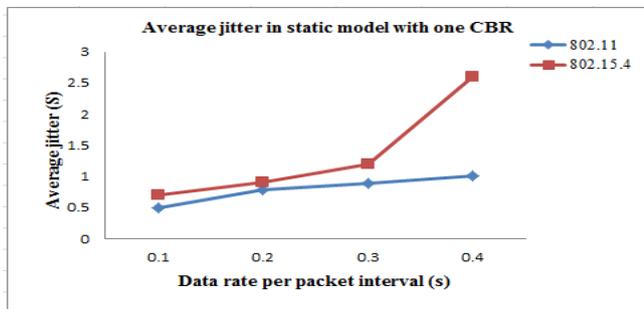


Fig.4. Average jitter in static model with one CBR

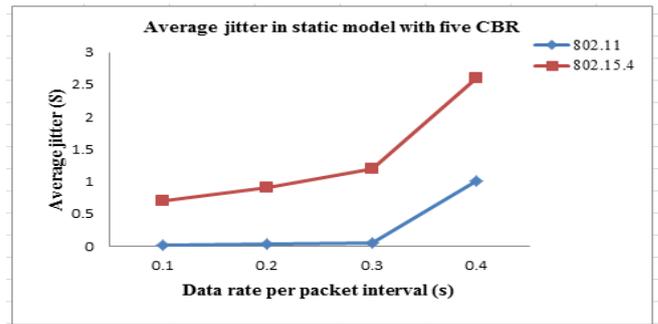


Fig.5. Average jitter in static model with five CBR

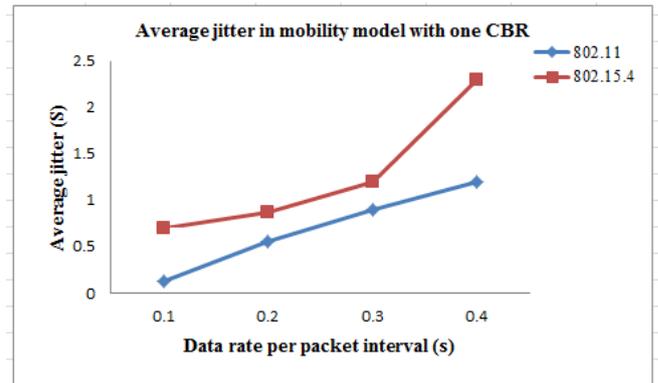


Fig.6. Average jitter in mobility model with one CBR

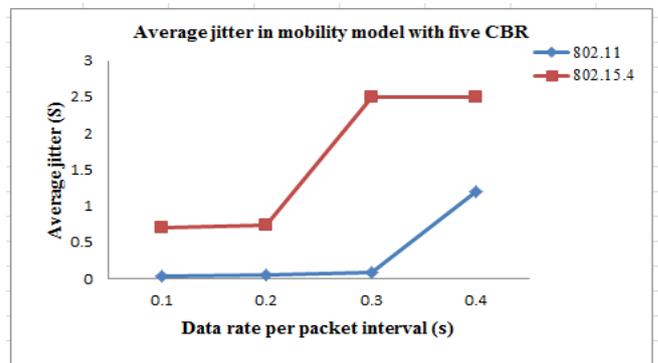


Fig.7. Average jitter in mobility model with five CBR

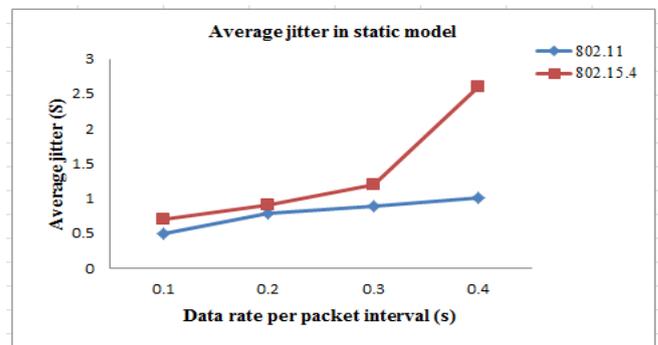


Fig.8. Grid placed average jitter in static model

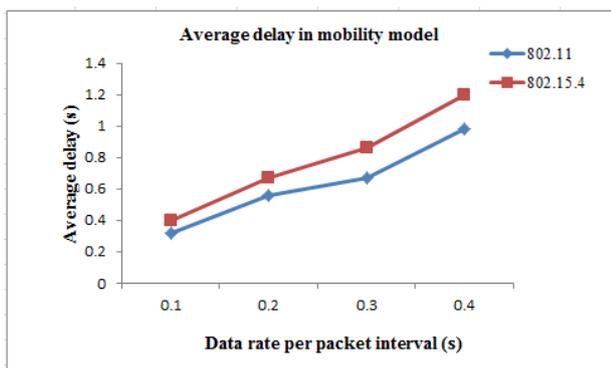


Fig.9 Grid placed average jitter in mobility model

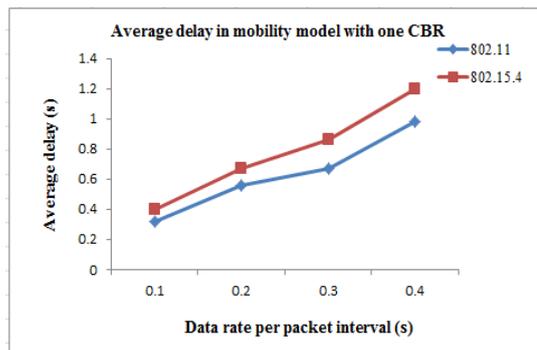


Fig.12. Average delay in mobility model with one CBR

### 3.2 Average end to end delay

Average end to end delay versus packet interval in static model with one and five CBR is shown in Fig 9 and in Fig 10 for 802.15.4 and 802.11. The network 802.11 shows low delay in static model. The delay is low at 0.1 packet intervals and increases when packet interval increases and high at 0.4 packet interval for both networks. The Fig 11 and Fig 12 shows the mobility model with one and five CBR for 802.15.4 and 802.11. In mobility model, network 802.11 has lower delay as well. The grid placed static and mobility model is shown in Fig 13 and Fig 14 shows lower delay for 802.11 networks for all packet interval.

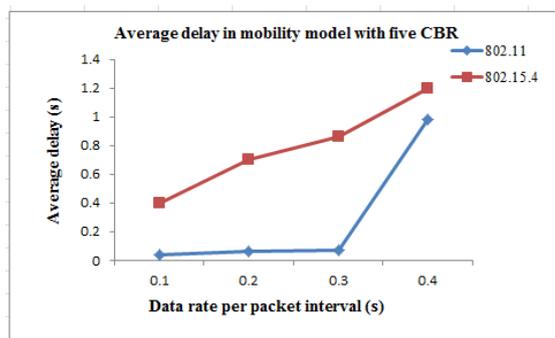


Fig.13. Average delay in mobility model with five CBR

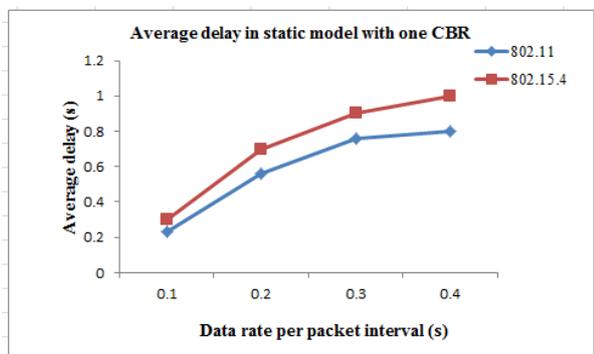


Fig.10. Average delay in static model with one CBR

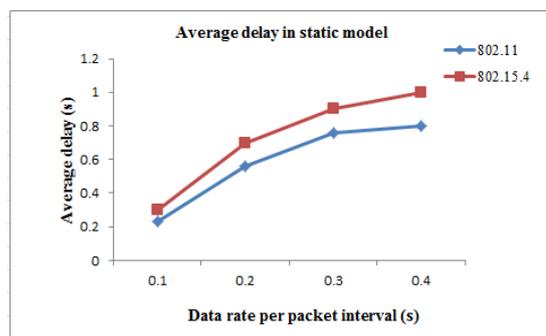


Fig.14. Grid placed average delay in static model

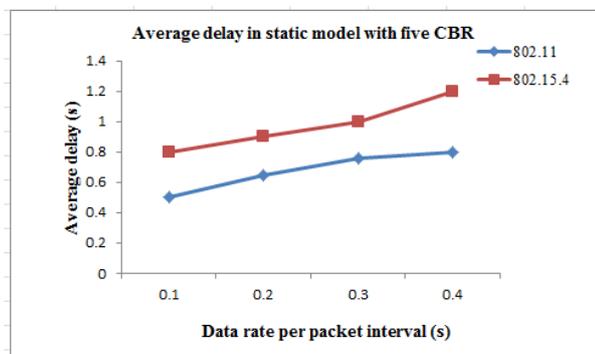


Fig .11. Average delay in static model with five CBR

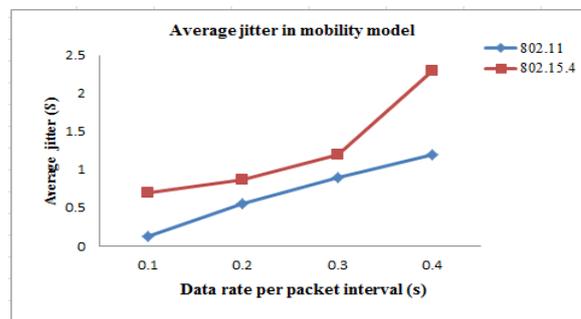


Fig.15. Grid placed average delay in mobility model

### 3.4 Throughput

Throughput versus packet interval in static model with one and five CBR is shown in Fig 15 and in Fig 16 for 802.15.4 and 802.11. The network 802.11 shows higher throughput in static model. The throughput is high at .1

packet intervals and decreases when packet interval increases and low at .4 packet interval for both networks

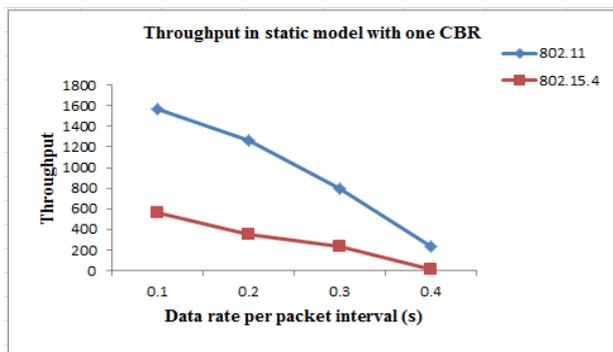


Fig.16.Throughput static model with one CBR

The Fig 17 and Fig 18 shows the mobility model with one and five CBR for 802.15.4 and 802.11.In mobility model, network 802.11 has higher throughput as well. The grid placed static and mobility model is shown in Fig 19 and Fig 20 shows higher throughput for 802.11 networks for all packet interval.

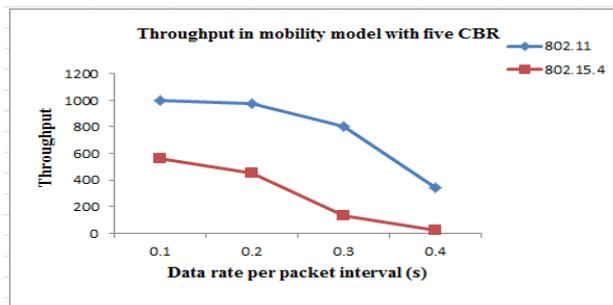


Fig.19. Throughput in mobility model with five CBR

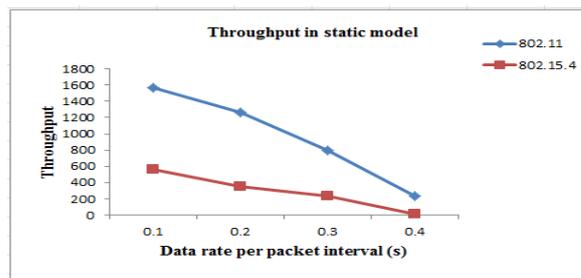


Fig.20 Grid placed throughput in static model

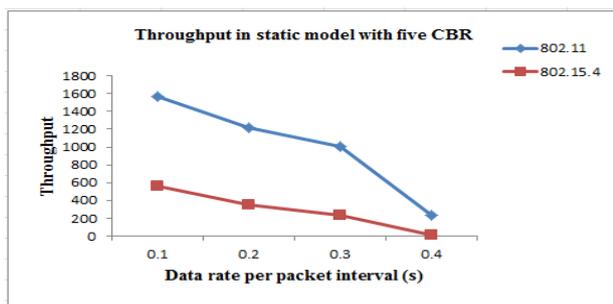


Fig .17. Throughput in static model with five CBR

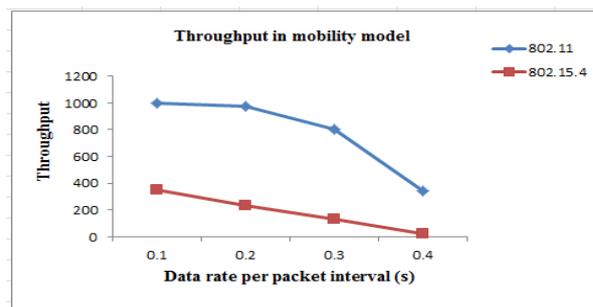


Fig.21.Grid placed throughput in mobility model

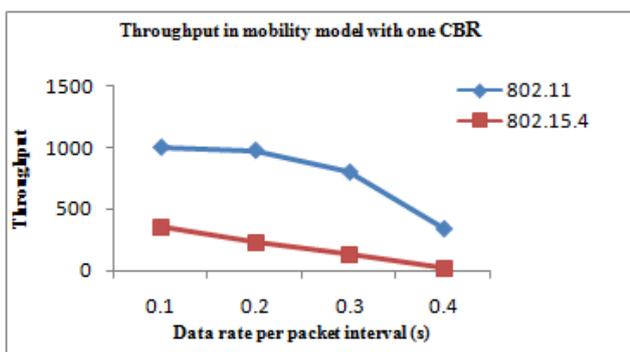


Fig .18. Throughput in mobility model with one CBR

#### IV. CONCLUSION

The performance evaluated using qualnet simulator.The two IEEE 802 standard works in 2.4Ghz ISM band.The result shows the performance of 802.11 and IEEE 802.15.4 in random placement and grid placement for static and mobility model with single and multiple CBR traffic loads. The simulation performance of the IEEE 802.11 network shows the low jitter and low delay value followed by high throughput when compared to the standard network of 802.15.4.The performance degradation of this network is due to the low coverage area and has low data rates though works in the same 2.4GHZ ISM frequency band. The future scope is to detect the collision of two network by placing in heterogeneous manner.

## REFERENCES

- [1] P.N.Renjith and E.Baburaj, "Analysis On Ad Hoc Routing Protocols In Wireless Sensor Networks", in *International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC)*, Vol.3, No.6, pp. 3480-3493.2012.
- [2] P. Samundiswary, K Dilip, "Performance Analysis of Energy Aware LAR Protocol in IEEE 802.15.4 based Mobile Wireless Sensor Networks", in *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, Vol 3, Issue-9, pp.1243-1255, 2014.
- [3] PratibhaKevre, LaxmiShrivastava., "Compare threereactive routing protocols in grid based cluster wireless sensor network using qualnet simulator", in *International journal of Applied Sciences and Engineering Research*, Vol. 3, No. 2, 2014
- [4] Manju Khurana "Direction Determination in Wireless Sensor Networks Using Grid Topology", in *Journal Of Emerging Technologies In Web Intelligence*, Vol. 5, No. 2, 2013
- [5] Gurjit Kaur, Kunal Malik and Kiran Ahuja., "Impact on Power Consumption of ZigBee based Home Automation Network using Various Traffic", in *International Journal of Future Generation Communication and Networking* ,Vol.6, No.6 , pp.17-24,2013.
- [6] Dhanvanthri Gokulkrishna1, Rinki Sharma, Narasimha Murthy3, "Design And Implementation Of A Routing Protocol For Mobile Ad HocNetworks", In *Sastech* 29, Vol.10, Issue 2, 2011.
- [7] Manish Uzzwal1, Rajan Sharma2, "Energy Efficient MAC Protocol & Radio Energy Model for AODV & Bellman Ford Routing Protocol", in *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE)*.Vol 9, Issue 1, pp. 44-50 ,2014.
- [8] Prinu C. Philip<sup>À</sup>, Rajeev Paulus<sup>À</sup>, A.K. Jaiswal<sup>À</sup> and A. Ashok<sup>À</sup>, "Comparative Analysis of Adhoc Routing Protocols in Wi-Fi & Wi Max Networks using QualNet 6.1", in *International Journal of Current Engineering and Technology*, Vol.4, No.1 2014.
- [9] Prof. K.H. Wandra, Dr. Ketan Kotecha and Mitul R. Khandhedia, "Various effect of modulation schemes on Wi-Fi Network using Qualnet Simulator", in *International Conference on Education Technology and Computer (ICETC)*,2010.
- [10] Pulak Singh, Mayur Kumar and A.K.Jaiswal, "Characteristic Analysis of Mobility using Heterogeneous Network", in *International Journal of Computer Applications*, Vol. 119, No.9, 2015.
- [11] Dr. Sumathi.K, Kiruthika Gowri.D Sathiyapriya.T Sureshkumar.K, "Performance Analysis of various MANET Protocols based on Route Processing using different Antenna Models",
- [12] Dr. Sumathi, K. Suresh Kumar, T. Sathiyapriya, and D. Kiruthika Gowri , "An Investigation on the Impact of Weather Modelling on Various MANET Routing Protocols", in *Indian Journal of Science and Technology*, Vol 8(15), 59557, July 2015.
- [13] Jaslin Deva Gifty. J and Dr Sumathi K, "Simulation Of Wireless Sensor Network With Hybrid Topology "in *ICTACT Journal On Communication Technology*, March 2016, Volume: 07, Issue .01.