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An Effective Data Communication Using IEEE 802.15.4 For Wireless Sensor Network

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Abstract: Wireless Sensor Network are commonly used in all sector for data processing. The design of low rate Wireless Personal Area Network (LR-WPAN) by IEEE 802.15.4 standard has been developed to support lower data rates and low power consuming application. Where in industry the wired communication is more expensive or impossible due to physical conditions. A shortcoming of the existing wireless industrial communication standards is the existence of overcomplicated routing protocols and design topology. Zigbee wireless sensor network works on the network application layer in IEEE 802.15.4. Zigbee networks are configured in star, tree or mesh topology whose performance varies from topology to topology. Performances parameters are network lifetime, energy consumption, throughput, data delivery delay and sensor field coverage area vary depend on the network topology. The applications of Industrial Wireless Sensor Networks for Process Automation are time-critical, subject to requirements in terms of end-to-end delay and reliability of data delivery. In this Paper, designing of hybrid topology by using three possible combinations such as star-tree, star-mesh and star-tree-mesh for Wireless Sensor Network. The designed hybrid star-tree-mesh topology uses Zigbee communication protocol with two different routing protocol AODV and DSR for safe and economic data communication in industrial fields. Star-Tree-Mesh proposed hybrid zigbee sensor network performs better than other two topology Star-Tree and Star-Mesh.

Keywords: AODV-Ad hoc On-Demand Distance Vector Routing, DSR- Dynamic Source Routing protocol routing protocol, WSN

I. INTRODUCTION

IEEE 802.15.4 is a standard which was originally designed for wireless personal area networks (LR-WPAN) that supports lower data rate in kilo bit per second (kbps) for short range communication .Zigbee wireless sensor network is developed on the network and application layer in IEEE 802.15.4 standard. The characteristics of the physical and Medium Access Control (MAC)layers for low power and low rate wireless personal are networks (LR-WPAN) is defined by IEEE 802.15.4 protocol and the characteristics of network and application layers is defined by zigbee wireless sensor network. Zigbee are specially for high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4 stands for Wireless Personal Area Networks. Zigbee is targeted at RF applications that require a low data rate, and long battery life, secure networking. These networks are aimed at automation, remote control, and Wireless Sensor Network (WSN) applications. There are different standards like Bluetooth and Wi-Fi for mid to high data rates applications for voice, PC LAN, video etc. However there are so many applications in Industries and Automation, which uses Sensors and control devices that do not need high bandwidth but they do need very low energy consumption for long battery life, low latency for large device array support Zigbee alliance are providing standardized base set of solutions for automation. It has wide application such as home networking, industrial networking. The physical layer support three frequency bands 2.4 GHz, 915 MHz,868 MHz in which 2.4 GHz is an Industrial, Scientific band.

A. Average jitter

Average Jitter measures the variation time in the arrival of packets even if they are sent at the same time. The jitter value measured at receiver side. These delays may be due to the network congestion, route discovery, queuing, and propagation and transmit time. Jitter should be low for better performance of the network.

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B. Average end to end delay

The average time taken by a data packet to arrive in the destination. It also includes the delay caused by route discovery process and the queue in data packet transmission. Only the data packets that successfully delivered to destinations are counted. The lower value of end to end delay means the better performance of the network.

Average end to end delay= $\frac{\sum(\text{arrive time} - \text{send time})}{\sum(\text{Number of connections})}$

C. Throughput

Throughput or network throughput is the rate of successful message delivery over a communication channel. Throughput is usually measured in bits per second (bit/s or bps), and sometimes in data packets per second (p/s or pps) or data packets per time slot. The higher value of throughput means the better performance of the network.

II. STAR-TREE AND STAR - MESH ZIGBEE SENSOR NETWORK

Designing of hybrid topology based sensor network using two possible combination of Zigbee routing schemes are considered in different scenarios to certify the reliability of the communication network. The parameters: throughput, delay, packet delivery ratio, network load are measured during these scenarios.

A. Star-tree network topology

Star-tree hybrid topology consists of two PAN coordinator.

- One for establishing star network and other for establishing tree network,
- Six FFD and eight RFDs with CBR applications.

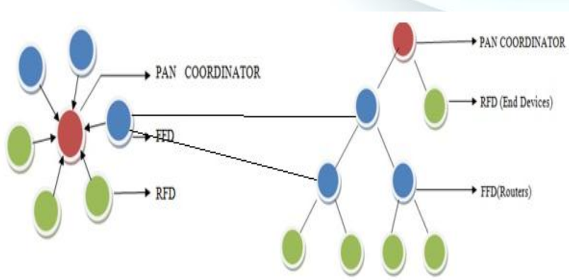

Fig.1 Block diagram of Star-Tree

B. Star-Mesh network topology

Star-mesh network, it consists of two PAN coordinator(1,10) one for establishing star network and other for establishing tree network, four FFD(7,8,11,12)s and six RFDs with 17 CBR applications.

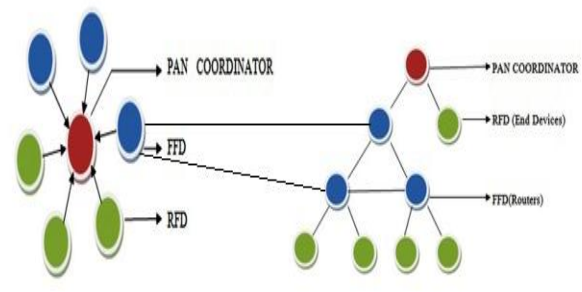

Fig.2 Block diagram of Star-Mesh

The result concludes that the combination of mesh and star topologies is better to make an effective hybrid topology, then the other two combinations. These scenarios are performed taking into account the specific features and recommendations of the IEEE 802.15.4/Zigbee standard using Qualnet 5.0. Simulation results quantify the impact of Zigbee network hybrid topologies on the performance factors.

The measurement and analysis of the combination of two topologies to make a hybrid topology for WSN. There will be two possible combination star-tree, star-mesh and tree-mesh routing schemes of Zigbee sensor Network. The results indicate that throughput is valuable in case of star-tree hybrid topology. Networking load is also maximum in case of star-tree hybrid topology. Delay is increases in all cases as the number nodes increases in the network. As seen in the case of throughput Star-Tree hybrid topology is effective.

III. PROPOSED SYSTEM PAPER

A. Star-Tree-Mesh

Consider star-tree-mesh scenarios consists of 50 nodes. In star-tree-mesh network scenario, it consists of three PAN coordinator(1,5,23) one for establishing star network and other for establishing tree network, and other for establishing mesh network , four FFD(7,8,11,12,)s and six RFDs with 24 CBR applications.

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In these hybrid topology was stimulated with two different protocol AODV and DSR. The parameters are measured and compared.

- Throughput
- Average end to end delay.
- Average Jitter.

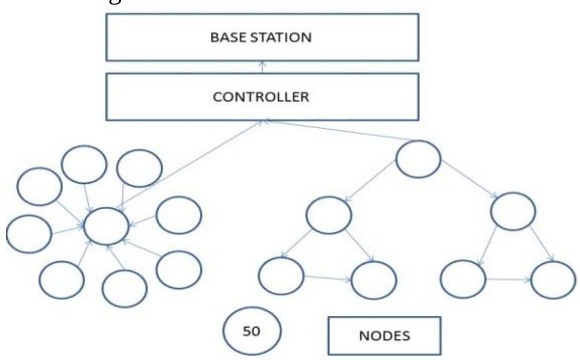

Fig.3 Block diagram of Star-tree-mesh network

IV. Simulation Results

A. Hybrid topology

The Two possible combination of Zigbee routing schemes considered in different scenarios. It has two fixed Zigbee pan coordinators and equal number of FFD and RFD devices in each scenario. The parameters: throughput, delay and jitter are measured.

Consider star-tree and star-mesh scenarios. Each scenario consists of 12 nodes. In star-tree network scenario, it consists of two PAN coordinator(1,10) one for establishing star network and other for establishing tree network, four FFD(7,8,11,12)s and six RFDs with 11 CBR applications. Similarly, in other scenario of star-mesh network ,it consists of two PAN coordinator(1,10) one for establishing star network and other for establishing tree network, four FFD(7,8,11,12)s and six RFDs with 12 CBR applications.

TABLE I. Simulation Parameters

S.no	1500m x 1500m		
	Parameters	***Star-tree***	***Star-mesh***
1	Simulation Time	300Sec	300Sec
2	Nodes placement	Star-Tree	Star-Mesh
3	Path loss Model	Two Ray	Two Ray
4	Traffic	CBR	CBR
5	Packet size	50 bytes	50 bytes
6	MAC layer	802.15.4	802.15.4
7	Energy Model	Mica motes	Mica motes
8	No of nodes	12	12
9	Routing Protocol	AODV	AODV
10	CBR	11	11

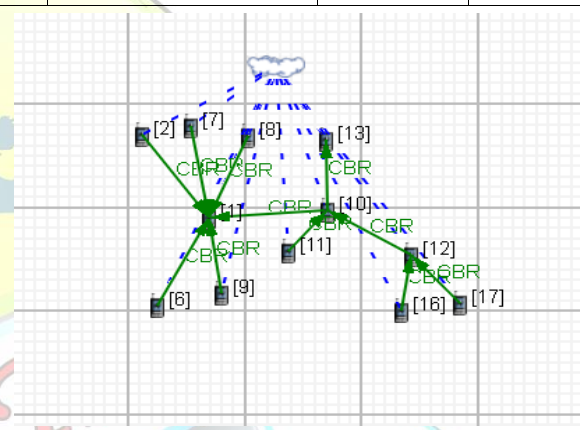

Fig. 4 Star-Tree network

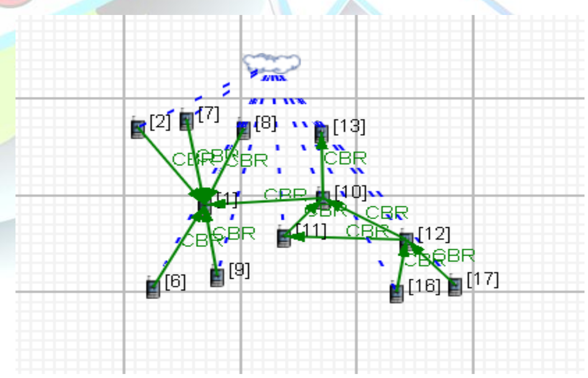

Fig. 5 Star-Mesh network

B. Average jitter

Average jitter is shown against varying data rates in Fig.6.The average jitter is randomly increasing and

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decreasing in both star-tree and star-mesh network. Jitter should be low for better performance of the network. It is low in star-tree network than star-mesh.

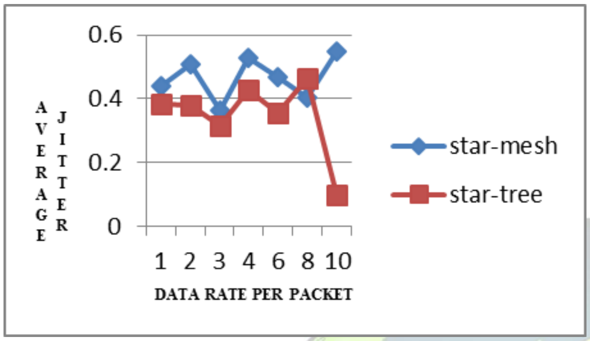

Fig. 6. Average jitter versus packet interval for 12 nodes

C. *Average end to end delay*

Average end to end delay is shown against varying data rates in Fig 7.The average end to end delay is low at low data rate and high at high data rate and in both star-tree and star-mesh network. Average end to end delay should be low for better performance of the network. It is low in star-tree network than star-mesh.

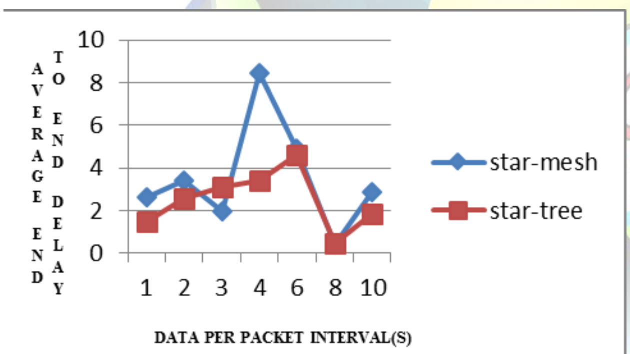

Fig. 7. Average end to end delay versus packet interval for 12 nodes

D. *Throughput*

Throughput is shown against varying data rates in Figure1.8. The throughput is low when the data rate is low and high when the data rate is also high. Throughput should be high for better performance of the network. The throughput is high in star-tree network than star-mesh network.

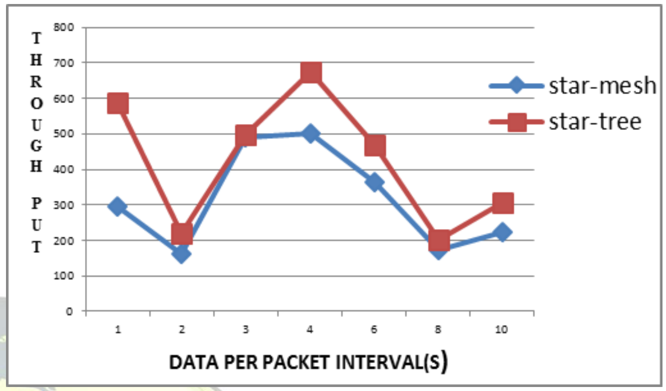

Fig. 8. Throughput versus packet interval for 12 nodes

E. *Star-Tree-Mesh*

The average end to end delay is low at low data rate and high Consider star-tree-mesh scenarios consists of 50 nodes. In star-tree-mesh network scenario, it consists of three PAN coordinator(1,5,23) one for establishing star network and other for establishing tree network and other for establishing mesh network, four FFD(7,8,11,12,)s and six RFDs with 24 CBR applications.

TABLE II. SIMULATION PARAMETERS

S.no	1500m x 1500m		
	Parameters	***Star-tree-Mesh***	***Star-Tree-Mesh***
1	Simulation Time	300Sec	300Sec
2	Nodes placement	Star-Tree-Mesh	Star-Tree-Mesh
3	Path loss Model	Two Ray	Two Ray
4	Traffic	CBR	CBR
5	Packet size	50 bytes	50 bytes
6	MAC layer	802.15.4	802.15.4
7	Energy Model	Mica motes	Mica motes
8	No of nodes	50	50
9	Routing Protocol	AODV	DSR
10	CBR	24	24

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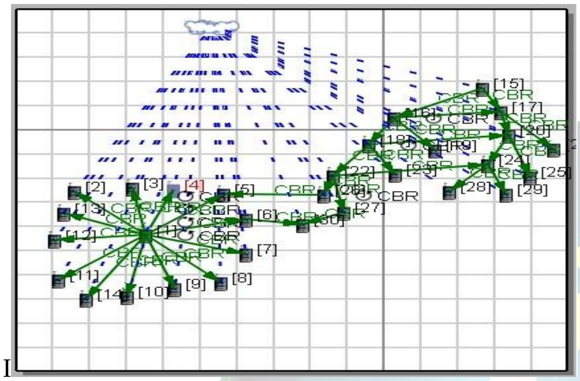
- Throughput
- Average end to end delay.
- Average jitter.



I

Fig. 9 Star-tree-mesh network for 50 nodes

F. Average end to end delay

Average End-to-end delay or One-way delay refers to the time taken for a packet to be transmitted across a network from source to destination .The average end to end delay is low at low data rate and high at high data rate in star-tree-mesh network.

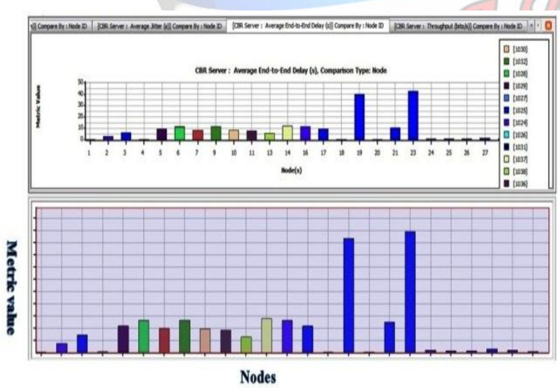


Fig. 10 Average end to end delay for 50 nodes in AODV

G. Throughput

Throughput is shown in Fig 11.The throughput is low when the data rate is low and high when the data rate is also high. Throughput should be high for better performance of the network.

Fig. 11. Throughput for 50 nodes in AODV

H. Average jitter

Average jitter is shown against varying data rates in Fig 12.The average jitter is randomly increasing and decreasing in both star-tree-mesh networks. Jitter should be low for better performance of the network.

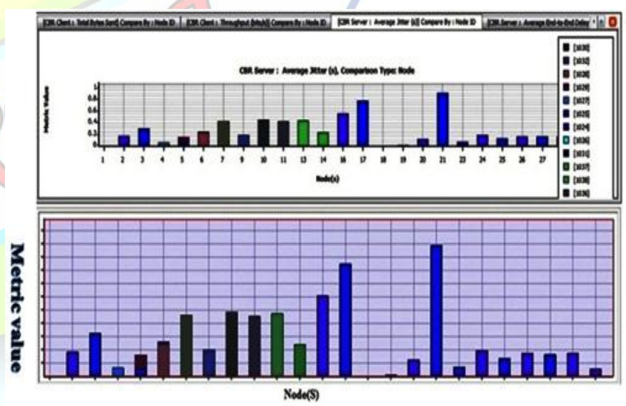


Fig. 12 Average jitter for 50 nodes in AODV

V. STIMULATION RESULTS- DSR ROUTING PROTOCOL

A. Average jitter

Jitter is shown against varying data rates in Fig. 13.The average jitter is randomly increasing and decreasing in both star-tree-mesh networks. Jitter should be low for better performance of the network.

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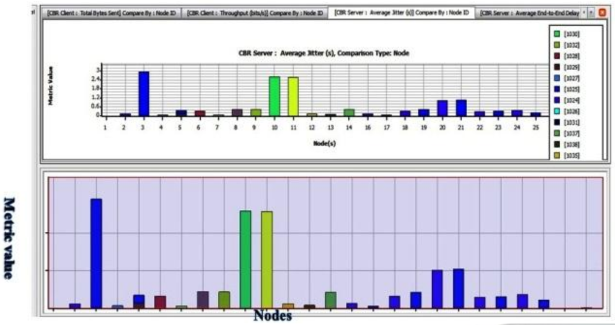

Fig. 13 Average jitter for 50 nodes in DSR

B. Average end to end delay

Average End-to-end delay or One-way delay refers to the time taken for a packet to be transmitted across a network from source to destination .The average end to end delay is low at low data rate and high at high data rate in star-tree-mesh network.

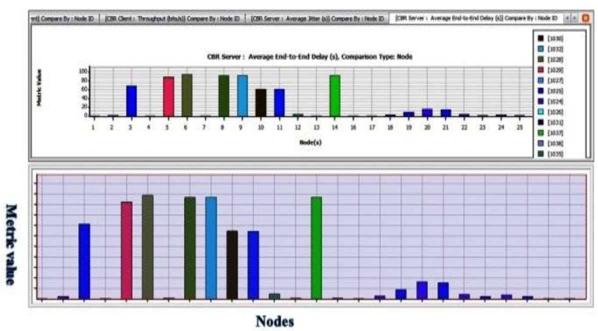

Fig. 14 Average end to end delay for 50 nodes in DSR

C. Throughput

Throughput should be high for better performance of the network. Throughput is shown in Figure 1.15 is high compared to star-tree and star-mesh.

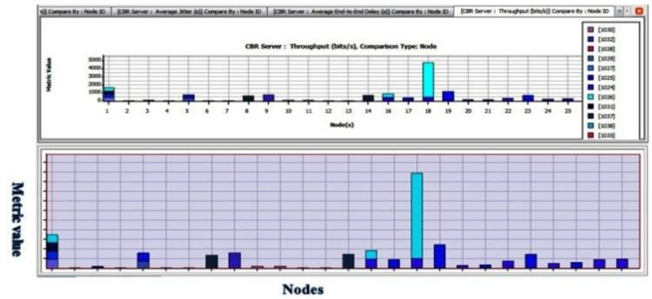

Fig.15 Throughput for 50 nodes in DSR

VI. Comparison of AODV-DSR in Hybrid Star-Mesh-Tree Topology

A. Average jitter

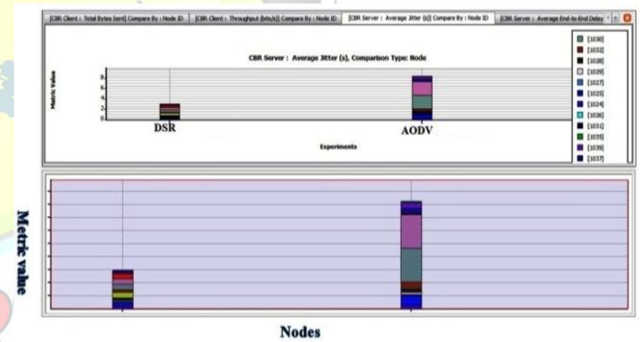

Fig. 16 Average jitter for 50 nodes

B. Average end to end delay

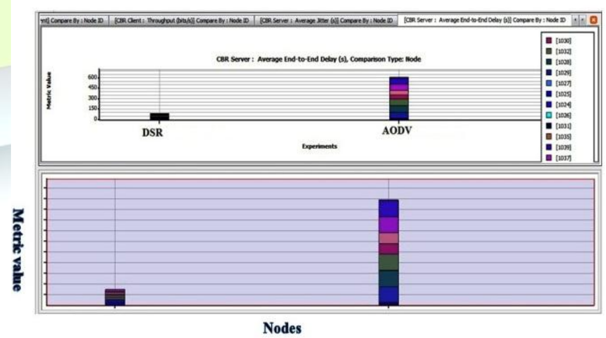

Fig. 17 Average end to end delay for 50 nodes

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C. Throughput

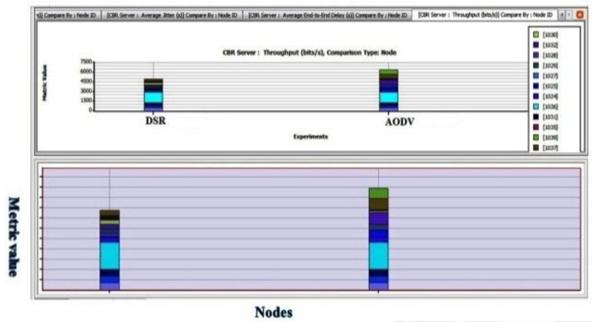

Fig. 18 Throughput for 50 nodes

VII. CONCLUSION

The designing of hybrid topology by using three possible combinations such as star-tree, star-mesh and star-tree-mesh is simulated and verified the communication reliability. The parameters such as throughput, average end to end delay and average jitter are calculated from proposed network .The result shows the performance of star-tree-mesh network is better by considering for 50 nodes in hybrid topology.

REFERENCES

[1]. Amritpal Kaur, JaswinderKaur & GurjeevanSingh, proposed an Efficient Hybrid Topology Construction in Zigbee Sensor Network 2014.

[2]. Burratti(2010),'Performance analysis of IEEE 802.15.4 beacon enabled mode', IEEE transactions on Vehicular Technology.

[3]. Chandane M.M, Bhirud S.G. and Bonde S.V(2012), 'Performance Analysis of IEEE 802.15.4,' IEEE international conf. on ICWCUCA

[4]. Elkissani Kaoutar, Pr.Moughit Mohammed&Pr.NasserdineBouchaib, proposed the Zigbee Routing Opnet Simulation for a Wireless Sensors Network 2014.

[5]. ItuSnigdh,SwarnSaurabh(2014)'Multi Tree based Approach for Performance Analysis in Hierarchical Wireless Sensor Networks', in International Journal of Digital Information and Wireless Communications (IJDIWC).

[6]. Manju, Ranjana Thalore, Jyoti,M.K.Jha proposed the performance evaluation of bellman-ford, aodv, dsr and dymo protocols using qualnet in 1000m×1000m terrain area 2013.

[7]. M. M. Chandane, S. G. Bhirud andS.V. Bonde,proposed performance analysis of IEEE 802.15.4 is performed using Qualnet 4.5 2012.

[8]. ItuSnigdh, SwarnSaurabh(2014), 'Multi Tree based Approach for Performance Analysis in Hierarchical Wireless Sensor Networks', in International Journal of Digital Information and Wireless Communications (IJDIWC),pp. 438-446.

[9]. Sarvesh Kumar Singh, Rajeev Paulus, A.K. Jaiswal, Mayur Kumar(2014) , 'Analysis of energy model and Performance of IEEE 802.15.4 WSNs under Different Duty Cycle', in IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) ,Vol 9, No. 2,pp. 48-54.

[10]. Honey Soni anf HimanshuSoni(2015), 'Hybrid Approach For Wireless Sensor Network', in International Journal Of Engineering And Computer Science,Vol.4,pp. 12132-12138.

[11]. ShubhanshiRathore, Rajeev Paulus A.K.and Jaiswa(2015), 'Analysis of QOS and Energy Consumption in IEEE 802.15.4/ZigBee Wireless Sensor Network', in International Journal of Computer Applications ,Vol 121, No.17, pp.1243-1255.

[12]. Mohit Kumar1, Mohnish Sharma1, Rishabh Narayan1, Sumit Joshi1, Sanjay Kumar proposed the zigbee based parameter monitoring and controlling system for induction machine 2013.

[13]. T. Tarun Krishna proposed the Estimation of Carrier Sense Range and its effect on Performance of IEEE 802.15.4 Sensor 2014.