



Zigbee-Analysis the Combined Effect of Variation in Mobility Andload of Zigbee End Devices on Hybrid Topology under Different Traffic Types

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Abstract: Zigbee is a wireless technology which is formalized by IEEE 802.15.4 standard. In this paper the performance of Hybrid topology is analyzed with the variation of Zigbee End Devices and their mobility. This performance is analysis under different traffic types. For analyzing we use OPNET modeler 14.5. The performance is analyzed in terms of delay, data traffic sent and data traffic received. The results shows that , overall performance is the best of 90 nodes at speed 10 m/s with data traffic type fast normal with smt. Hybrid topology with smt gives the best performance.

Keyword: ZigBee, OPNET modeler 14.5, Mobility, Hybrid topology, PAN

I. INTRODUCTION

ZigBee technology is a new wireless communication standard. Zigbee is a wireless technology which is based on standard IEEE 802.15.4. Zigbee is a LP-WPAN, LP-WPAN which can be defined as Low Power-Wireless Personal Area Network. This is a wireless network which has short range and less power consumption. It's range in the area of few 100 meters. Zigbee has low power and less processing capability wireless nodes. In this small power is required which is very small for e.g. 1mW. ZigBee devices can transmit data over long distances when by passing data through a mesh network of intermediate devices to reach long distance. It is used in low data rate applications that require long battery life and secure networking. During a few milliseconds in emission, a transmitting receiving ZigBee module will occupy the medium, then it will await for possibly answer , before the next emission then it will be in stand by for a long period, which will take place at one predetermined moment. It will introduce interesting problems of research on the level of the data link layer and network layer. ZigBee has two types of entities network: the FFD is the Full Function Device that implement the totality of the specification and the RFD is the Reduced Function Device which are the entities reduced in an objective of less power consumption and less memory used for the microcontroller. RFD is the final nodes of the network because they do not implement a routing mechanism. Typically, an embarked sensor will be RFD and supplied with batteries, whereas a central processing unit of treatment, supplied with a source not forced by an energy contained (hand powered), is FFD with the function of routing.

IEEE 802.15.4, ZigBee can work on three different frequency bands:

- 1) 868MHz in Europe
- 2) 915MHz in North America
- 3) 2,4GHz in World

The standard has two different physical layers (PHY), for the 868/915MHz (PHY868/915) and a second for 2,4GHz (PHY2450) implementing a spread spectrum modulation. The ZigBee protocol was designed for provide static, dynamic, or mesh network topologies which are supporting up to 65,000 nodes for the large areas for the industrial use. Many effects are produced i.e. environmental effects, to remove these effects, the ZigBee protocol provides a self-healing ability for the network to detect and recover from network or communication link faults without human intervention.

Zigbee devices are of three types:

- 1) **ZigBee coordinator (ZC):** In this there is one ZigBee coordinator in which sets all the network parameter i.e. packet size, type of topology used i.e. bus, tree etc. and it will store the information of the all network. Each network has one ZigBee coordinator.

Coordinator



Fig.1: coordinator

- 2) **ZigBee Router (ZR):** A router is a device which provides the routes to transfer the data from source to destination. Basically it acts as an intermediate device which passes the data as shown below;



Fig. 2 Router

3) *ZigBee End Device (ZED)*: It is used to talk to the parent node either the coordinator or a router and it cannot relay data from other devices. ZigBee end device is less expensive than ZR or ZC.



Fig.3 End device

II. ZIGBEE SPECIFICATION

	ZigBee 802.15.4
Transmission Range (meters)	1 – 100
Battery Life (days)	100 – 1,000
Network Size (# of nodes)	> 64,000
Throughput (kb/s)	20 - 250

Fig.4 Specifications

III. ZIGBEE TOPOLOGIES

802.15.4 Standard has tree, star, mesh and cluster tree topologies; But ZigBee supports only star, tree, and mesh topologies as below;

Star topology: In this topology there is a coordinator which is placed in the centre and end devices (nodes) are connected to central coordinator as shown in the figure. In this topology, the end devices can only directly communicate with the coordinator and but not with other end devices. There are exchanges of packets between end devices can only through the coordinator.

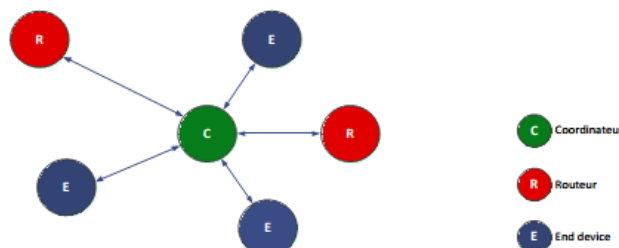


Fig.5 Star Topology

Mesh Topology: In a mesh topology, the coordinator is related to his routers and end devices. In this communication are more flexible because the routers can communicate directly between them. In mesh topology there is the alternate way for the propagation of packets when route break down or the congestions.

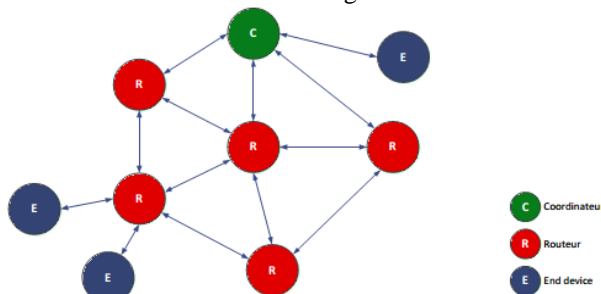


Fig.6 Mesh Topology

Tree Topology: In this tree topology, all the nodes are connected in form just like tree. In this, the end nodes are connected directly to the coordinator and the routers as further nodes. The routers and the coordinator have further divided. Each end device can communicate with its main nodes i.e. with the coordinator and router. But an end device cannot divide. An end device can communicate with another end device only through its main node and there is no direct link between these end devices. The main limitations of tree topology are that if one of the main nodes has some problem, then the further divided nodes will not work because there is the problem in the main node so these nodes cannot communicate with other devices in the network.

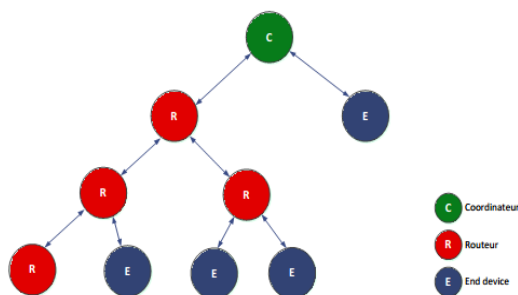


Fig.7 Tree Topology

Hybrid Topology: In this topology, there is the combination of two or more topologies like star-tree, star-mesh and mesh-tree etc. In this there is used the combination of star-mesh and star-mesh-tree topology.



Fig.8 Hybrid Topology

IV. EXPERIMENT SETUP

In this research paper the effect of Mobility and variation of Zigbee end devices (ZED) on hybrid topology under different traffic type is analyzed. Hybrid topology which is the combination star-mesh(sm) and star-mesh-tree(smt) is analyzed. In this to show the performance of hybrid topology use the OPNET modeler 14.5. OPNET modeler gives better simulation results, data analysis and collection. To analyze the effect different scenarios are made firstly by using 90 nodes by applying Poisson then with Fast normal traffic patterns for hybrid topology and then repeated for sm hybrid topology as shown in fig 9, Secondly 75 nodes with Poisson then with Fast normal with sm hybrid topology and then repeated for sm hybrid topologies as shown in fig 10, thirdly 65 nodes with Poisson then with Fast normal with sm hybrid topology and then repeated for sm hybrid topologies as shown in fig 11. These scenarios are made firstly at speed of 8m/s and then at 10 m/s. In each scenario 4 routers, 2 coordinators are used for sm hybrid topology and for smt scenarios 4 routers, 3 coordinators. All the nodes are moves randomly under the random way point model. To simulate this experiment different parameters are used as shown in table 1.

Table 1: Simulator Parameters

SR. No.	Attribute	Value
1.	Topology	Hybrid
2.	No. of nodes	65,75,90
3.	Speed	8,10
4.	Packet Size	2048
5.	Packet Interarrival time	Constant(1)
6.	Start time	Constant(0)
7.	Stop time	Infinite
8.	No. of Routers	4
9.	No. of Coordinators	2,3
10.	Mobility	Random way point
11.	Traffic type	Poisson and Fast normal

Scenarios

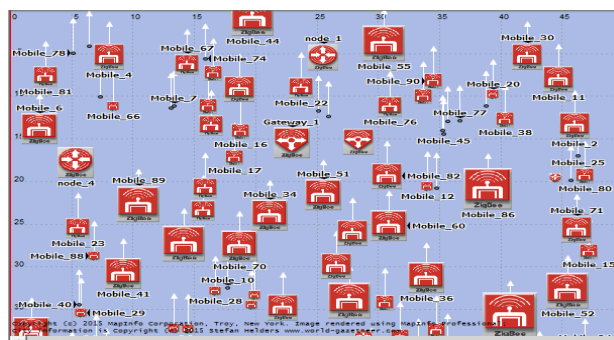


Fig. 9 Scenario 1 of 90 nodes

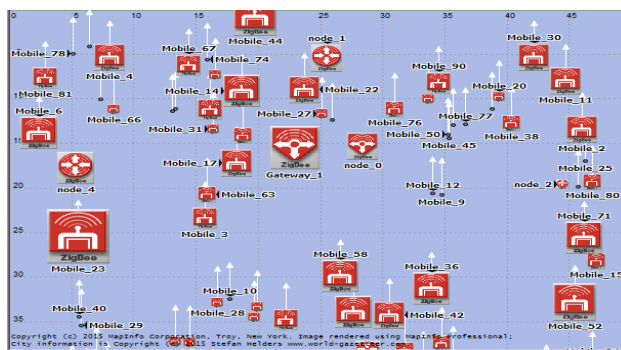


Fig. 10 Scenario 2 of 75 nodes

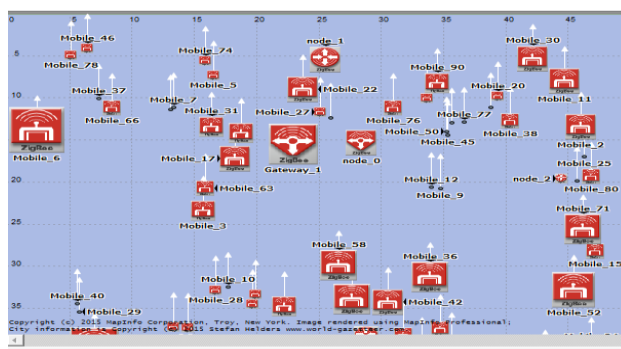


Fig. 11 Scenario 3 of 65 nodes

V. RESULTS

The simulations are analyzed for the performance of Hybrid topology with the variation of the nodes and by changing the mobility of Zigbee End Devices. This performance is analysis under different traffic types which are Poisson and fast normal. The performance is analyzed in terms of data traffic sent, data traffic received and delay. The different nodes are 90,75,65 and speed is 8 m/s,10 m/s and traffic type are fast normal and poisson. The results are as shown below;

Data Traffic Sent

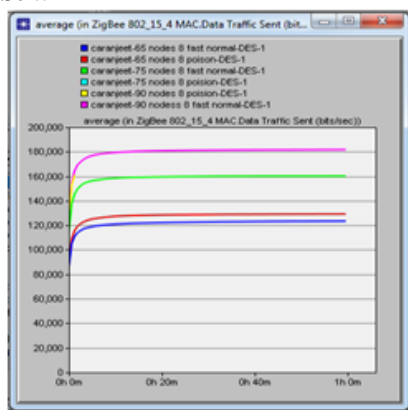


Fig.12 Data traffic sent in different nodes with 8m/s speed at different traffic with sm

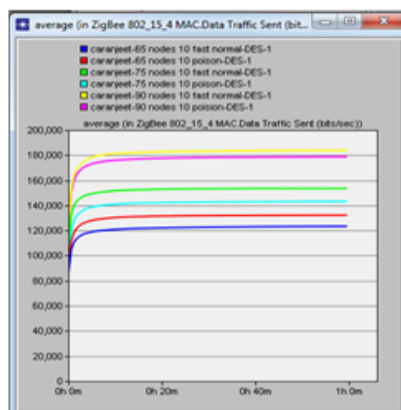


Fig.13 Data traffic sent in different nodes with 10m/s speed at different traffic with sm

Fig 12,13 shows the result for different nodes with different traffic types at different speeds with sm. In fig 12 as shows 90 nodes at speed 8m/s and traffic type is fast normal then the data traffic is obtained i.e. 180000 bits/sec, When 75 nodes at 8m/s at fast normal it gives data traffic sent i.e. 160000 bits/sec, at 65 nodes at 8m/s at fast normal 125000 bits/sec. At 90 nodes at 8 m/s at poisson gives 140000 bits/s. At 65 nodes 8 m/s at poisson gives the 130000 bits/sec. and 75 nodes at 8m/s at poisson gives minimum 115000 bits/sec data traffic sent. The maximum data traffic sent at 90 nodes at speed 8m/s and traffic type fast normal i.e. 180000 bits/sec

In fig 13 as shows 90 nodes at speed 10 m/s at traffic type is fast normal then the traffic type is 182000bits/sec, At 75 nodes 10 m/s at traffic type fast normal sends 155000 bits/sec, 65 nodes at 10m/s at fast normal gives minimum 122000 bits/sec data traffic sent. At 90 nodes at speed 10 m/s at traffic type is poisson sends 179000 bits/sec, At 75 nodes at speed 10 m/s at traffic type is poisson sends 142000 bits/sec, At 65 nodes 10 m/s at traffic type poisson sends 130000 bits/sec. The maximum data traffic sent at 90 nodes at speed 10m/s and traffic type fast normal i.e. 182000 bits/sec.

From the above results the data traffic sent at 90 nodes at speed 10m/s and traffic type fast normal with sm i.e. 182000 bits/sec is best.

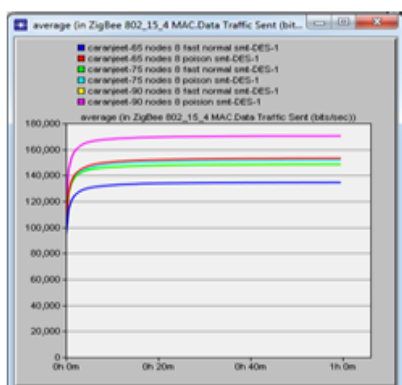


Fig.14 Data traffic sent in different nodes with 8m/s speed at different traffic with smt

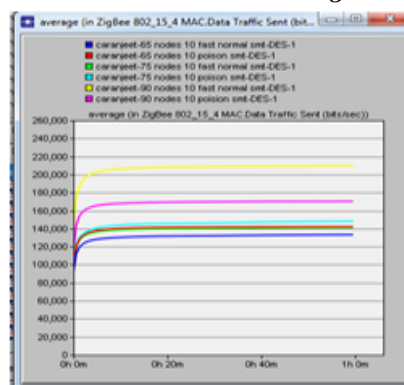


Fig.15 Data traffic sent in different nodes with 10m/s speed at different traffic with smt

Fig 14, 15 there are different nodes with different traffic types at different speeds with smt.

Fig 14 as shows At 90 nodes at 8m/s at traffic type fast normal then data traffic sent i.e. 140000 bits/sec, At 75 nodes 8 m/s at fast normal gives the 150000 bits/sec and 65 nodes at 8m/s at fast normal gives minimum 132000 bits/sec data traffic sent. 90 nodes at speed 8m/s and traffic type poisson then data traffic sent i.e. 170000 bits/sec. When 65 nodes at 8m/s at poisson gives data traffic sent i.e. 155000 bits/sec. At 75 nodes at 8 m/s at poisson gives 152000 bits/s. The maximum data traffic sent at 90 nodes at speed 8m/s and traffic type poisson i.e. 170000 bits/sec.

Fig 15 as shows 90 nodes at speed 10 m/s at traffic type is fast normal then data traffic sent i.e. 210000 bits/sec, At 75 nodes 10 m/s at traffic type fast normal sends 140000 bits/sec and 65 nodes at 10m/s at fast normal gives minimum 130000 bits/sec data traffic sent, at 90 nodes at speed 10 m/s at traffic type is poisson sends 170000 bits/sec, At 75 nodes 10 m/s at traffic type poisson sends 145000 bits/sec, At 65 nodes at speed 10 m/s at traffic type is poisson sends 142000 bits/sec. The maximum data traffic sent at 90 nodes at speed 10 m/s at traffic type is fast normal i.e. 210000 bits/sec. From the above results the data traffic sent at 90 nodes at speed 10m/s and traffic type fast normal with smt i.e. 210000 bits/sec is best.

From the above results, maximum data traffic sent at 90 nodes at speed 10m/s and traffic type fast normal with smt i.e. 210000 bits/sec is best.

Data Traffic Received

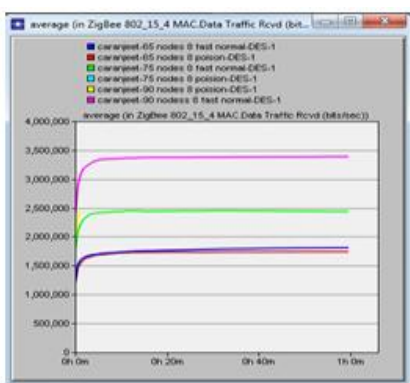


Fig.16 Data traffic received in different nodes 8 m/s with speed at different traffic with sm

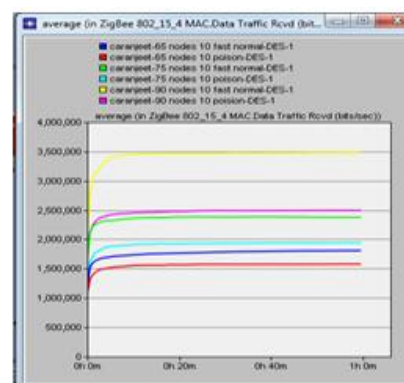


Fig.17 Data traffic received in different nodes with 10m/s speed at different traffic with sm

As shown in fig 16, 17 there are different nodes with different traffic types at different speeds with sm.

Fig 16 as shows 90 nodes at speed 8m/s and traffic type fast normal then the data traffic received i.e. 3350000 bits/sec. At 75 nodes at 8 m/s at fast normal gives 2400000 bits/s. At 65 nodes 8 m/s at fast normal gives the 1700000 bits/sec. When 90 nodes at 8m/s at poisson it gives data traffic received i.e. 2500000 bits/sec. At 75 nodes at 8m/s at poisson 1650000 bits/sec and 65 nodes at 8m/s at poisson gives minimum 1600000 bits/sec data traffic received. The maximum data traffic sent at 90 nodes at speed 8 m/s at traffic type is fast normal i.e. 3350000 bits/sec.

In fig 17 as shows 90 nodes at speed 10 m/s at traffic type is fast normal then data traffic received i.e. 3500000 bits/sec, At 75 nodes 10 m/s at traffic type fast normal sends 2400000 bits/sec, At 65 nodes 10 m/s at traffic type fast normal sends 1700000 bits/sec, At 90 nodes at speed 10 m/s at traffic type is poisson sends 2500000 bits/sec, At 75 nodes at speed 10 m/s at traffic type is poisson receives 1900000 bits/sec, and 65 nodes at 10m/s at poisson gives minimum 1600000 bits/sec data traffic received. The maximum data traffic received at 90 nodes at speed 10 m/s at traffic type is fast normal i.e. 3500000 bits/sec.

From the above results, maximum data traffic received at 90 nodes at speed 10m/s and traffic type fast normal with sm i.e. 3500000 bits/sec it is the best.

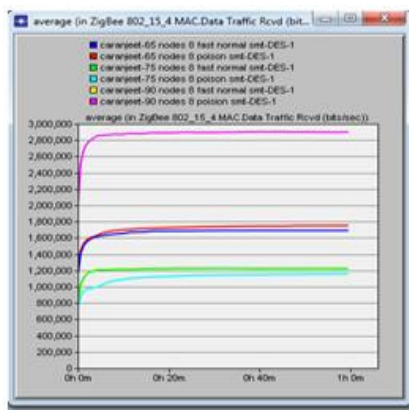


Fig.18 Data traffic received in different nodes with 8m/s speed at different traffic with smt

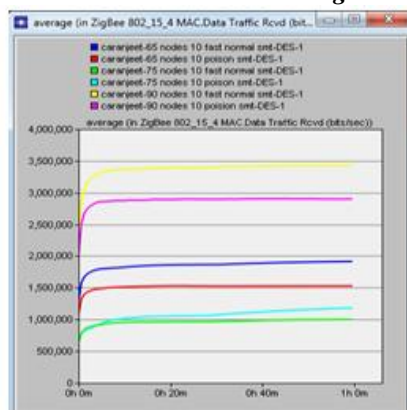


Fig.19 Data traffic received in different nodes with 10m/s speed at different traffic with smt

As shown in fig 18, 19 there are different nodes with different traffic types at different speeds with smt.

Fig 18 as shows 90 nodes at speed 8m/s at data traffic is fast normal then the data traffic received i.e. 1000000 bits/sec, At 75 nodes at speed 8 m/s at traffic type fast normal i.e.1200000 bits/sec. At 65 nodes at 8 m/s at fast normal gives 1700000 bits/s, At 90 nodes at speed 8m/s and traffic type poisson then the data traffic received i.e. 2900000 bits/sec. At 65 nodes at 8m/s at poisson then data traffic received i.e. 1750000 bits/sec. At 75 nodes at 8m/s at poisson 1100000 bits/sec and.The maximum data traffic received at90 nodes at speed 8 m/s at traffic type is poisson i.e. 2900000 bits/sec.

Fig 19 shows at 90 nodes at speed 10 m/s at traffic type is fast normal then data traffic received i.e. 3400000 bits/sec, At 75 nodes at 10m/s at fast normal gives minimum 1000000 bits/sec, At 65 nodes 10 m/s at traffic type fast normal sends 1900000 bits/sec,At 90 nodes at speed 10 m/s at traffic type is poisson sends 2800000 bits/sec, At 65 nodes at speed 10 m/s at traffic type is poisson receives 1500000 bits/sec, At 75 nodes 10 m/s at traffic type poissondata traffic received i.e. 1200000 bits/sec. The maximum data traffic received at90 nodes at speed 10 m/s at traffic type is fast normal i.e. 3400000 bits/sec.

From the above results, maximum data traffic received are at 90 nodes at speed 10m/s and traffic type fast normal with smt i.e.3400000 bits/sec andit is the best.

Delay

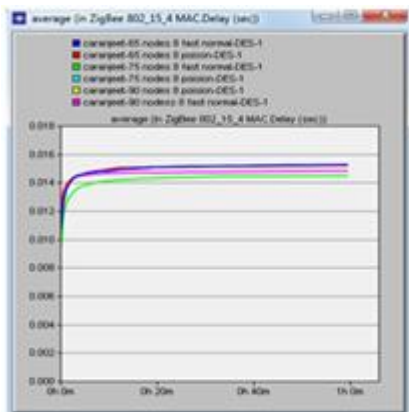


Fig 20 Delay in different nodes with 8m/s speed at different traffic with sm

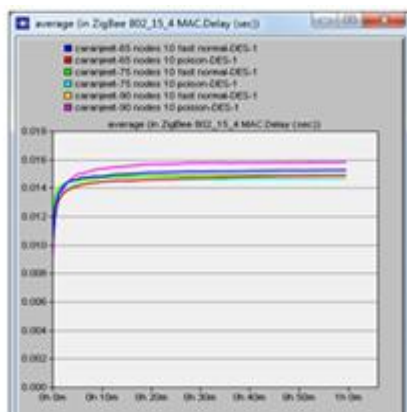


Fig.21 Delay in different nodes with 10m/s speed at different traffic with sm

As shown in fig 20, 21 there are different nodes with different traffic types at different speeds with sm.

Fig 20 shows at 90 nodes at speed 8m/s at fast normal gives delay i.e. 0.014 sec, At 75 nodes at 8 m/s at fast normal gives delay i.e. 0.015 sec, At 65 nodes at 8m/s at fast normal it gives delay i.e. 0.015 sec. At 90 nodes at speed 8m/s and traffic type poisson then it gives maximum delay i.e. 0.016 sec.. At 75 nodes 8 m/s at poisson gives delay0.015 sec. At 65 nodes at 8m/s at poisson0.015 sec and.The maximum delay at90 nodes at speed 8 m/s at traffic type is poisson i.e. 0.016 sec.

Fig 21 shows90 nodes at 10m/s at traffic type fast normal gives delay i.e. 0.014 sec, At 75 nodes 10 m/s at traffic type fast normal is 0.015sec ,At 65 nodes at speed 10 m/s at traffic type is fast normal delay is 0.015 sec, 90 nodes at speed 10 m/s at traffic type is poisson maximum delay i.e. 0.016 sec, At 65 nodes at speed 10 m/s at traffic type is poissondelay is 0.015 sec, At 75 nodes 10 m/s at traffic type poisson delay is0.015 sec and.The maximum delay at90 nodes at speed 10 m/s at traffic type is poisson i.e. 0.016 sec.

From the above results, maximum delay at 90 nodes at speed 10m/s and traffic type is poisson with sm i.e. 0.016 second it is the best.

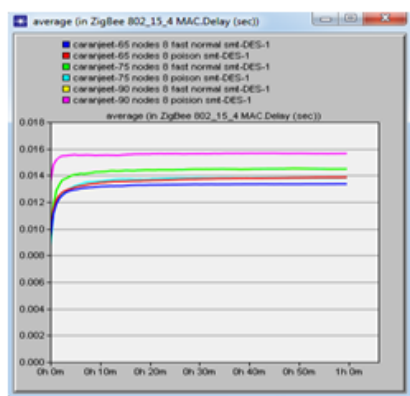


Fig.22 Delay in different nodes with 8m/s speed at different traffic with smt

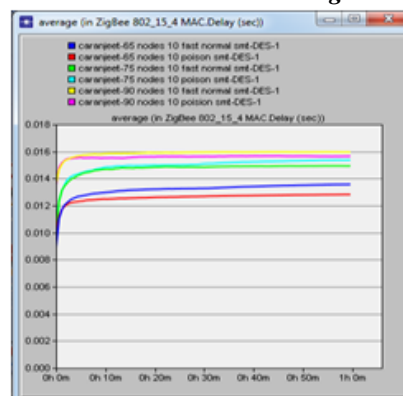


Fig.23 Delay in different nodes with 10m/s speed at different traffic with smt

As shown in fig 22, 23 there are different nodes with different traffic types at different speeds with smt.

Fig 22 as shows 90 nodes at speed 8m/s at traffic type is fast normal then delay i.e. 0.012 sec, At 75 nodes at 8m/s at fast normal it gives delay i.e. 0.015 sec, At 65 nodes at 8m/s at fast normal 0.013 sec, At 90 nodes at speed 8m/s and traffic type poisson then it gives delay i.e. 0.015 sec, At 75 nodes at speed 8 m/s at traffic type poisson gives delay 0.014 sec. At 65 nodes at speed 8 m/s at traffic type poisson gives delay 0.014 sec. The maximum delay at 90 nodes at speed 8 m/s at traffic type is poisson i.e. 0.015 sec.

Fig 23 as shows 90 nodes at speed 10 m/s at traffic type is fast normal maximum delay is 0.016 sec, At 75 nodes at speed 10 m/s at traffic type fast normal delay is 0.015 sec, At 65 nodes 10 m/s at traffic type fast normal delay is 0.013 sec, At 90 nodes at speed 10 m/s at traffic type is poisson, delay is 0.015 sec, At 75 nodes 10 m/s at traffic type poisson delay is 0.015 sec and 65 nodes at 10m/s at poisson gives minimum delay is 0.013 sec. The maximum delay at 90 nodes at speed 10 m/s at traffic type is fast normal then delay i.e. 0.016 sec.

From the above results, maximum delay at 90 nodes at speed 10m/s and traffic type is fast normal with smt i.e. 0.016 sec and it is the best.

VI. CONCLUSION

In this paper the effect of mobility and no. of Zigbee end devices (ZED) on hybrid topology under different traffic type is analyzed. The different nodes i.e. 90,75,65 are taken at different speed 8m/s and 10m/s at different data traffic type i.e. Fast normal and Poisson are considered. These results are simulated by OPNET modeler 14.5 in terms of data traffic sent, data traffic received and delay. The results shows that maximum data traffic sent at 90 nodes at the speed of 10 m/s with data traffic type fast normal with smt are obtained and it gives the best performance. The maximum data traffic received at 90 nodes at speed 10 m/s with data traffic type fast normal with sm are obtained and it gives the best performance. The maximum delay at 90 nodes at speed 10 m/s with data traffic type fast normal with smt are obtained and it gives the best performance. Then from all the results, overall performance is the best of 90 nodes at speed 10 m/s with data traffic type fast normal with smt. Hybrid topology with smt gives the best performance.

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