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RESEARCH ARTICLE

Simulative Investigation of Zigbee Network Coordinator Failure with Different QoS

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Abstract: ZigBee (IEEE 802.15.4-2006 standard) is a category in the IEEE 802 family, is responsible for ZigBee standard which uses the transported services of the 802.15.4 network specification therefore ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. In this paper, we perform extensive personal area network evaluation, to study the Effect of coordinators failures on ZigBee Star, Tree network, using OPNET Modeler. The performance is analyzed in terms of control traffic received and sent, throughput, data dropped, network load PAN1 and PAN2

Keywords: IEEE-802.15.4, ZigBee WSN, Topology, MAC Layer, Network Layer, Application Layer, OPNET Modeler, Traffic Received & Sent Throughput, Load, Delay, No. of Hop

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INTRODUCTION

ZIGBEE is a new wireless technology guided by the IEEE 802.15.4 Personal Area Networks standard. It is primarily designed for the wide ranging automation applications and to replace the existing non-standard technologies [1]. It currently operates in the 868MHz band at a data rate of 20Kbps in Europe, 914MHz band at 40Kbps in the USA, and the 2.4GHz ISM bands Worldwide at a maximum data-rate of 250Kbps.Zigbee is a low power spin off of WiFi. ZigBee is a specification for a suite of high-level communication protocols used to built from small, low-power digital radios. Though its low power consumption limits transmission distances to 10–100 meters line-of-sight, depending on power

output and environmental characteristics, ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) It is best suited for intermittent data transmissions from a sensor or input device.[2]

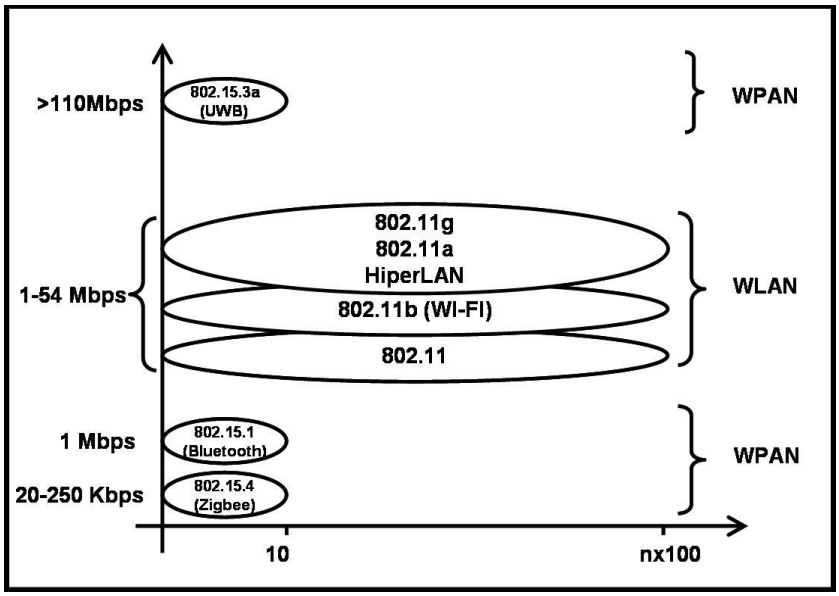


Figure 1 showing WPAN, WLAN, WPAN(Zigbee)

The ZigBee network layer natively supports both star and tree networks, and generic Mesh networking. Every network must have one coordinator device, tasked with its creation, the control of its parameters and basic maintenance. Within star networks, the coordinator must be the central node. Both trees and meshes allow the use of ZigBee routers to extend communication at the network level. ZigBee builds on the physical layer and media access control defined in IEEE standard 802.15.4 for low-rate WPANs. The specification includes four additional key components: network layer, application layer, ZigBee device objects (ZDOs). ZDOs are responsible for a number of tasks, including keeping track of device roles, managing requests to join a network, as well as device discovery and security. [3]

ZigBee devices are of three types:

- **ZigBee Coordinator (ZC):** The most capable device, the Coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee Coordinator in each network since it is the device that started the network originally (the ZigBee light link specification also allows operation without a ZigBee Coordinator, making it more usable for over-the-shelf home products). It stores information about the network, including acting as the Trust Center & repository for security keys.
- **ZigBee Router (ZR):** As well as running an application function, a Router can act as an intermediate router, passing on data from other devices.
- **ZigBee End Device (ZED):** Contains just enough functionality to talk to the parent node (either the Coordinator or a Router); it cannot relay data from other devices. This relationship allows the node to be asleep

a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.[4,5]

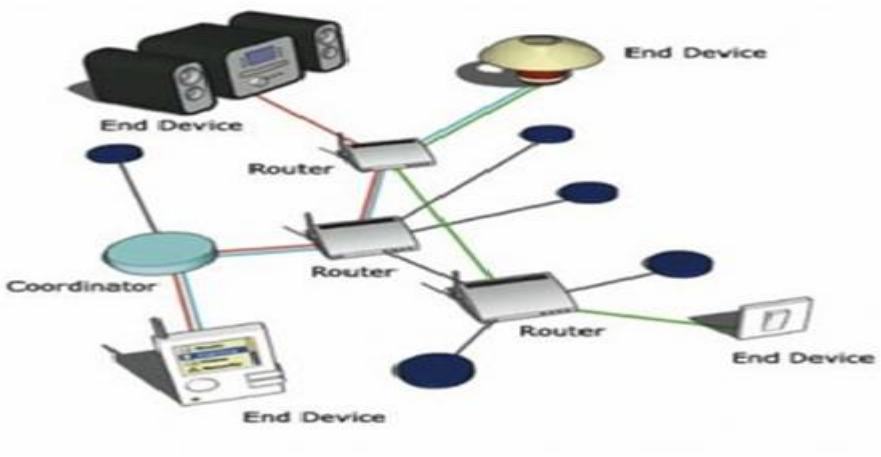


Figure 2 Generalized ZigBee Network[6]

OPNET SIMULATOR

OPNET simulator is a tool to simulate the behavior and performance of any type of network. The main difference with other simulators lies in its power and versatility. This simulator makes possible working with OSI model. OPNET 14.5 is designed for modeling communication devices, technologies, protocols and to simulate the performance of these technologies. User can create customized models and simulate various network scenarios. It is possible to simulate various wireless communication technologies such as MANET, 802.11, 3G/4G, Ultra Wide Band, WiMAX, Bluetooth, ZigBee using OPNET tool.[7]

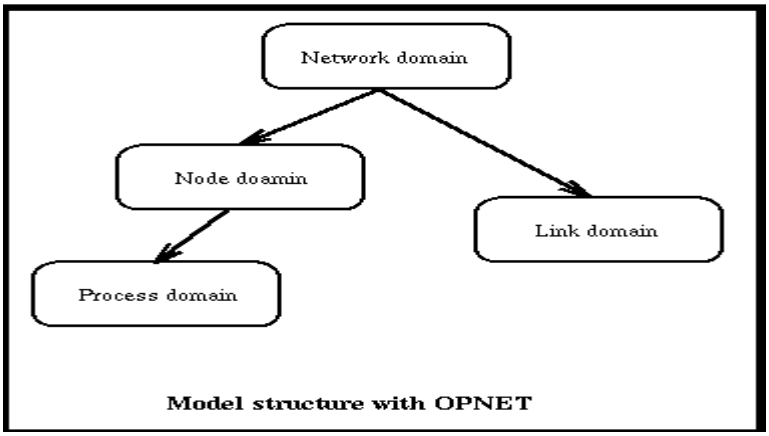
Opnet modeler is based on the Three-Tiered OPNET Hierarchy.

• Three domains: network, node, and process

• Node model specifies object in network domain

• Process model specifies object in node domain[8]

The OPNET modeler is object oriented and employs a hierarchical approach to model communication networks as shown in fig below.



[9]

Figure 3 Model structure with Opnet

SIMULATION INFRASTRUCTURE AND SCENARIOS FOR FAILUR OF COORDINATER, ROUTER & END DEVICES

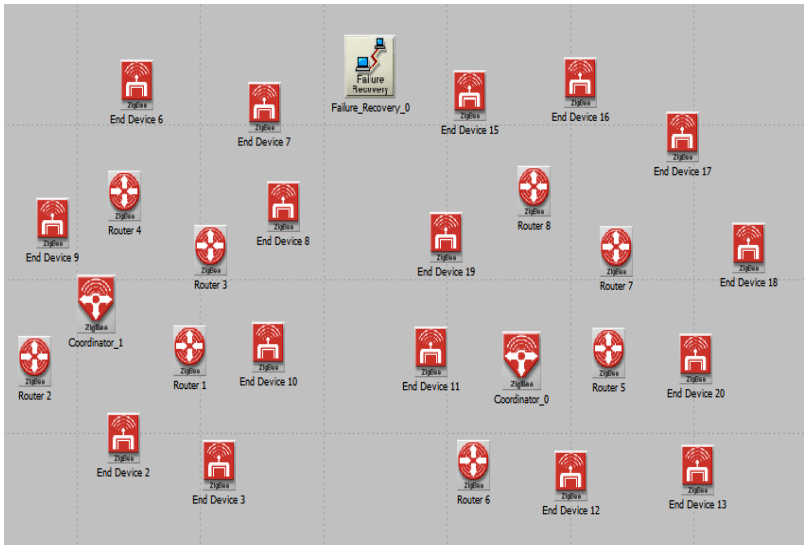


Figure 4 Network Model

Table 1

Network Model	No. of Coordinates	No. of Routers	No. of End Devices	Failure & Recovery Devices
Personal Area Network 1	1	4	9	1
Personal Area Network 2	1	4	10	

Simulation Parameter Setup

Table 2:

Parameters	MAC Layer	Network Layer	Application Layer
No. of Sensor Nodes	20	20	20
Transmit Power	0.05	0.05	0.05
Number of Retransmissions	5	5	5
Mesh Routing	Disabled	Enabled	Disabled
Transmission band (MHz)	2450	2450	2450
Transmit power (sensor nodes)	0.2	0.2	0.2
Packet size	1024	1024	1024
Packet inter arrival time	Constant (0.5)	Constant (0.5)	Constant (0.5)

Failure & Recovery Setup

Coordinator Failure & Recover Process

ZigBee coordinator – For every ZigBee network, there can be only one coordinator. This node is responsible for initializing the network, selecting the appropriate channel, and permitting other devices to connect to its network. It can also be responsible for routing traffic in a ZigBee network. In case of ZC failure, the routers and end devices take notice of the coordinator failure and decide to restart to join a new network. A device can recognize the ZC failure by sending "ACK message" to the coordinator in a pre-determined time. If the coordinator doesn't reply (coordinator failure or broken link), the device resets its MAC address and starts to find another network. Table show the result timing function of the failure and recover of coordinates. In first scenario we have two networks PAN1 & PAN2 and both networks consists coordinates_0 & coordinates_1 respectively. In 120 sec the coordinates_0 is fail & after 120 sec the coordinate_0 automatically is recover. Similarly at 480 sec coordinates_1 is fail and at 600 sec coordinates_1 is recover. Similarly in scenario 1,scenario 3,scenario 4 we have set the timing of recover the coordinates in both networks PAN1 &PAN2 .All the simulation results is compared with all four scenarios and their effect such Traffic Control Received & Sent, Delay, End-to-End Delay, Load, Throughput & Data Dropped.

Table 3 :

Parameters	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Status**
Transmit Power	0.5	0.10	0.15	0.20	
Channel Sensing Duration(sec)	0.1	0.1	0.1	0.2	Active
Coordinates_0(Sec)	120	100	300	420	Fail
Coordinates_0(Sec)	240	200	500	640	Recover
Coordinates_1(Sec)	480	400	700	880	Fail
Coordinates_1(Sec)	600	500	900	1160	Recover

SIMULATION RESULTS

Here, We are analyzing the two Personal Area Network(PAN1) & Personal Area Network(PAN2), their failure & recovery process. We focus on performance measures Traffic Received & Sent, Load, Delay, Data dropped, Throughput and End-to-End Delay and retransmission attempts.

Control Traffic Received

Traffic received is the average number of packets per second forwarded to the MAC layer in the network . Below figure using IEEE 802.15.4 standard show the results of traffic received in difference scenario and we can clearly see the result as the transmit power and channel sensing duration is increase from 0.05 w to 0.20 w , 0.1 sec to 0.2 sec respectively, the control traffic is also increase.

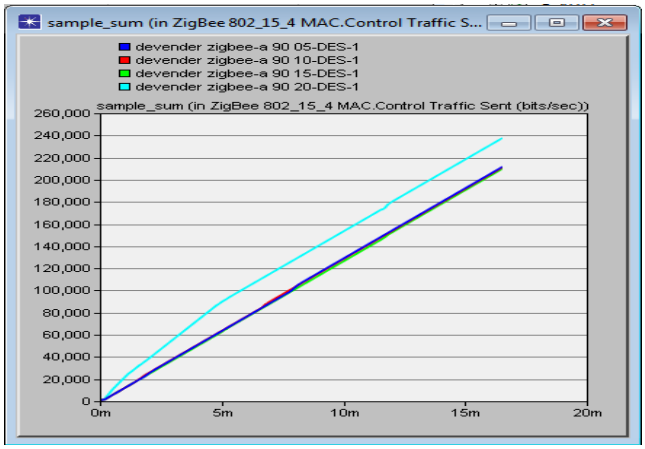


Figure 5 Control Traffic Received in MAC Layer(bits/sec)

Control Traffic Sent

Traffic sent is the average number of packets per second submitted to the MAC layer in the network and Below figure show the results of traffic received in difference scenario and we can clearly see the result as the transmit power and channel sensing duration is increase from 0.05 w to 0.20 w , 0.1 sec to 0.2 sec respectively, the control traffic is also increase.

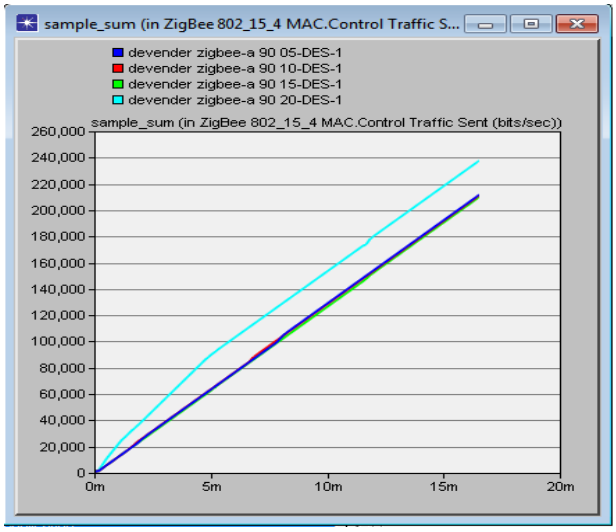


Figure 6 Control Traffic Sent in MAC Layer(bits/sec)

Data Dropped (bits/sec):
It measures the average of data packets that dropped due to their propagation through network model layers (i.e. overflow of buffers) and due to their fails to reach to their receiver entities (failure of all retransmissions until retry limit). It calculated as the total size of higher layer data packets (in bits/sec) dropped by all the WLAN. Below figure show the result of simulation of 1020 sec, data dropped at different transmit power i.e 0.05w, 0.10w,0.15w, 0.20w and channel sensing duration 0.1sec,0.20 sec using IEEE 802.15.4 standard.

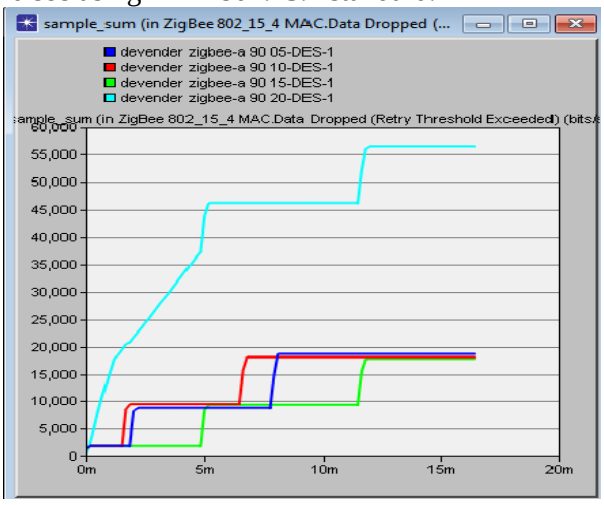


Figure 7 Data Dropped in MAC Layer

THROUGHPUT

Throughput is defined as; the ratio of the total data reaches a receiver from the sender (Latif and Rashid, 2004). The time it takes by the receiver to receive the last message is called as throughput. Throughput is expressed as bytes or bits per sec (byte/sec or bit/sec). Some factors affect the throughput as; if there are many topology changes in the network, unreliable communication between nodes, limited bandwidth available and limited energy. A high throughput is absolute choice in every network. After simulation of 1020 sec the average throughput approximately in the same order but as the transmit power increase and channel sensing duration time is also increase from 0.1sec to 0.2 sec than throughput also increase.

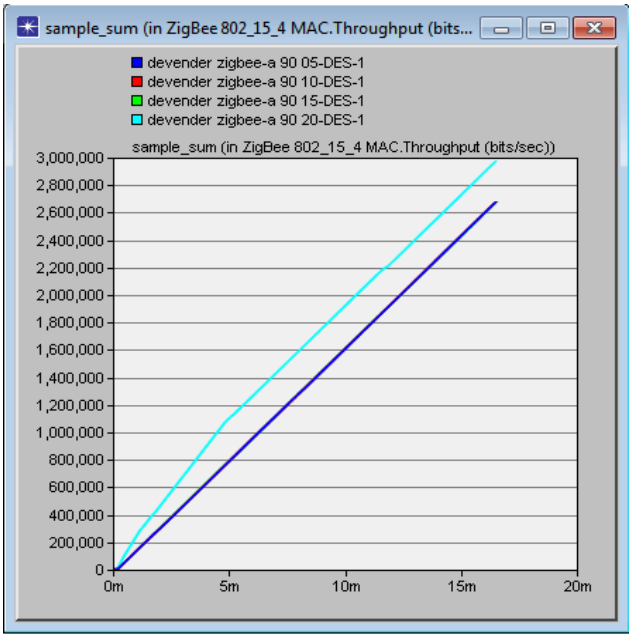


Figure 8 MAC Throughput

NETWORK LOAD

Network load represents the total load in bit/sec submitted to wireless LAN layers by all higher layers in all WLAN nodes of the network. When there is more traffic coming on the network, and it is difficult for the network to handle all this traffic so it is called the network load. After simulation 1020 sec of PAN1 (Personal Area Network) at different transmit power i.e. 0.05 w ,0.10 w,0.15 w,0.20 w the load measured is higher at 0.10 w using IEEE 802.15.4 standard show in figure.

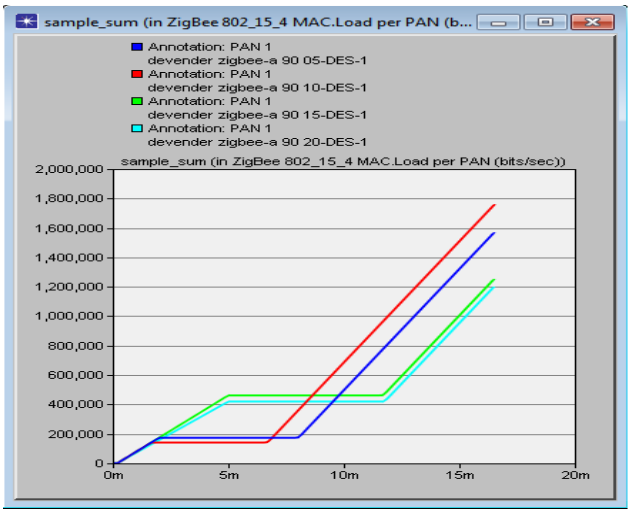


Figure 9 MAC Layer Load PAN1 (bits/sec)

MAC Layer Load PAN2

After simulation of 1020 sec PAN2 (Personal Area Network) at different transmit power i.e. 0.05 w ,0.10 w,0.15 w,0.20 w the load measured is higher at 0.20 w using IEEE 802.15.4 standard show in figure.

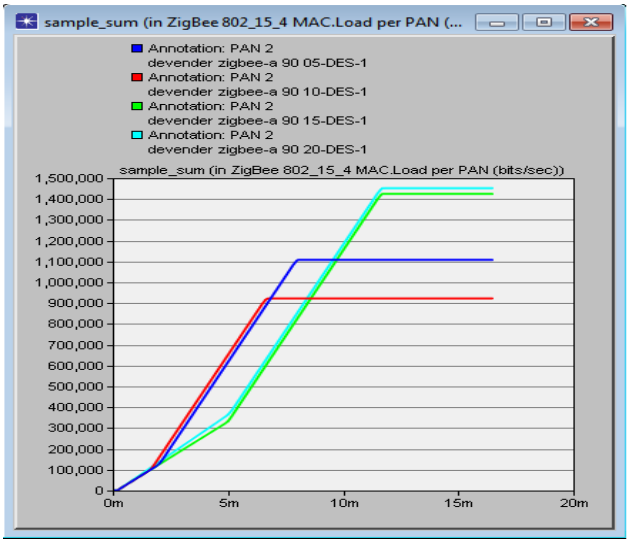


Figure 10 MAC Layer Load PAN2 (bits/sec)

Conclusion

This paper presented a simulation study to analyze the effect of failure and recovery of coordinates on the Control traffic received and sent, Data dropped, Throughput, Network Load of PAN1 and PAN2. At higher values of transmit power and CSD (Channel sensing duration) value of Control traffic received and sent, Data dropped, throughput, Network Load is increased. So the result shows that more the values of transmit power and CSD than more the better performance. In the future one can compare the performance of coordinate's failure and recovery by increasing the values of transmits power and CSD.

References

[1] www.wikipedia.com

[2] Lovish Jaiswal et al.," Performance analysis of back off exponent behaviour at MAC layer in ZigBee Sensor Networks", International Journal of Computer Applications, Vol. 57, No. 22, November 2012.

[3] Mumtaz M.Ali AL-Mukhtar Department of Internet Engineering Information Engineering College/AL-Nahrain University Baghdad-Iraq "Diagnosis of Failures in Zigbee Based Wireless Sensor Networks".

[4] Lovish Jaiswal et al. " Performance Analysis of Topological Variation in Personal Area Network using ZigBee Wireless Sensors" IJCST Vol. 3, Issue 4, Oct - Dec 2012

[5] http://www.creativeworld9.com/2011/04/zigbee-technology-abstract.html

[6] Singh et al., International Journal of Advanced Research in Computer Science and Software Engineering 3(12), December -2013, pp. 1121-1126

[7] OPNET Modeler [Online]. Available: http://www.opnet.com/products/modeler/home.html

[8] http://www.sce.carleton.ca/faculty/lambadaris/courses/5001/opnet_tutorial.pdf

