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Coexistence of zigbee with 802. 11n

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***Abstract* - Wireless technologies are essential and important part of today's world. Zigbee technology is one of them and getting more popularity due to its advantages like low power and low-cost reliability. It is operated on 2.4 GHz industrial scientific and medical band. On the same band, there is another standard which is 802.11n wifi standard is also operated. When both the technologies coexist together then there is interference occurs. As data rate of zigbee is very less compared to the wifi impact of interference is more on zigbee technology. In this work new features of channel bonding, frame aggregation and multiple input multiple output (MIMO) is applied to the 802.11n and effect of 802.11n on zigbee technology is measured using different performance metrics packet delivery ratio(PDR), bit error rate (BER), control overhead and throughput.**

Index Terms— Zigbee, 802.11n, coexistence, 2.4GHz

I.INTRODUCTION

Deployment of wireless sensor networks in our surrounding environment becomes easy due to automation of different tasks and technology getting more popularity to perform these tasks is zigbee technology. Zigbee having applications such as game remote controllers, health care monitoring, industrial automation and Smart home due to its low-power, cost-effective, flexible, reliable, and robust wireless products [1], [2] and [3]. There are medical applications which depends on low delivery delay and high throughput performance like in health care monitoring, to report cardiac rhythm data by wireless tags attached on patient's body. In the game remote controls, or industrial automation, command delivering delay should satisfy user experience or typical demands. From [2] Smart grid is very effective and intelligent power system having electricity generation, consumption, transmission technologies. Smart grid can interact with different home appliances by using Zigbee technology. ZigBee is operated on 2.4 GHz unlicensed band. WiFi technology 802.11n is operated on 2.4 GHz and 5 GHz. When 802.11n using 2.4 GHz band coexist with Zigbee then they suffer from interference issue [4]. Zigbee is affected more severely by Wi-Fi networks as its 14 channels out of 16 channels are completely overlapping with WiFi. Moreover, WiFi having high transmission power as compared to Zigbee which is having low data rate. Many cases WiFi was not able to detect the existence of Zigbee [5]. With the growing popularity of Wi-Fi, the situation will be even worse. Thus, under the existence of Wi-Fi interference, how to improve communication performance of IEEE 802.15.4 is becoming a crucial issue. Bluetooth technology is also operating on the same band of 2.4 GHz [6]. Bluetooth technology differs in using frequency hopping spread spectrum due to which the packet loss rate decreases whereas Zigbee uses the carrier sense multiple access mechanism.

From [7] 802.11n, supports a maximum 600 mbps data rate due to several enhancements including MIMO (Multiple Input and Multiple Output), FA (Frame Aggregation) and channel bonding (CB) [4]. Its coexistence with other ISM band technologies such as ZigBee is crucial issue to the wide deployment of 802.11n applications. Wifi having interesting, important applications i.e. videoconferencing, video streaming, security fields, transfer of file, photos. Channel bonding means to two channels are bonded together to achieve the high bandwidth which results into less transmission time required, low delay in the network. In MIMO, multiple antennas are used for transmission and reception so that high throughput is achieved. MIMO supports spatial diversity in which single stream is transmitted through the single antenna. In frame aggregation feature, multiple frames are combined in a single transmission which results into low back off time and avoids channel contention.

In proposed work, zigbee and wifi coexistence is the main topic and wifi standard 802.11n uses its new features of frame aggregation, channel bonding and MIMO. Using all the features of 802.11n technology we will evaluate the performance of zigbee technology in coexistence scenario. In proposed work all the details is discussed.

II. RELATED WORK

From [8] coexistence depends on three factors frequency, space, and time. Frequency denotes frequency separation distance between nodes. Space indicates that sufficient distance between nodes and time is referred as channel occupancy time. Here, performance of coexistence of ZigBee with two different WiFi standards i.e.802.11b and 802.11n is evaluated. Author considered non-line of sight scenario for ZigBee transmitter and receiver devices. Packet error rate is calculated for both wifi standards with zigbee coexistence. It is observed that packet error rate for 802.11g is greater as compared to the 802.11n wifi standard. So, 802.11n performs better with ZigBee as compared to 802.11g WiFi standard. In [9] WLAN and zigbee comparison for agent based rate adaption is given. In agent adaptive scheme, the transmission rate of nodes is dynamically switched. Therefore, transmission rate of every node is greater than actual transmission rate. Results of delay and throughput metrics are given. It is observed that if delay and throughput both are considered then wifi performance is good but it comes to amount of traffic sent and received then zigbee performs well as compared to the wifi network.

In [10] there is comparison between 802.11n devices and 802.15.4 devices for flying ad hoc network is given. OMNET software is used for simulation. It contains unmanned aerial vehicles and ground control stations. Applications of FANET are in defense, agriculture field and goods delivery. These networks are infrastructure less. Star and mesh topologies are considered here. In star topology UAV can directly connected to the ground station and in the mesh topology UAV require number of hops to go to the ground station. For both the technologies 802.11n and zigbee with both topologies star and mesh performance is evaluated. It is observed that wifi with mesh topology performance is better compared to zigbee. In future if zigbee will use due to its advantages like low power and low cost then mesh topology must be used.

In [11] actual performance of different wifi and zigbee nodes is estimated by considering network performances of 11 homes. Distance between 802.15.4 and 802.11n devices is varied. Two cases are considered i.e. zigbee with no interference of wifi and zigbee with interference of wifi. Here advance feature of 802.11n i.e. channel bonding is used so bandwidth of channel becomes 40MHz. Channel used in tis for zigbee are channel 11 and channel 15. In Without interference case packet successful rate is in between 90 to 100 percent and when with interference of wifi is estimated then performance decreases drastically from 90% to 10% as distance from zigbee and wifi is decreases. There are few solutions given to avoid these degradations of performance. Kept the wifi access point away from the meter which is incorporated into smart grid through home area network. Otherwise switch wifi operating band to the 5 GHz.

III. PROPOSED WORK

There is lots of work is done for coexistence scenario of other standards of wifi 802.11b, 802.11g etc. and zigbee technology and very few work related to 802.11n and zigbee coexistence. Here in this work, coexistence scenario is considered for wifi (802.11n) and zigbee (802.15.4) technologies to analyze the impact of 802.11n on zigbee.

As the data rate of wifi is much greater than zigbee technology, zigbee is greatly affected due to interference caused by 802.11n than vice-versa. As shown in the fig. 1, seven wifi nodes (1, 2, 10, 5, 13, 6 and 14), one base station (node 7) and seven zigbee nodes (0, 8, 9, 11, 3, 4, and 12) are considered for simulation. Tree topology is considered in proposed work. Network simulator version 2 is used for the simulation purpose. Different wired and wireless network simulation work is done in the Ns2 simulator. Ns2 is used for researches in the computer networks due its advantages like event driven and open source simulator. Here, various parameters and their values are shown in Table 1 for simulation of coexistence of 802.11n and zigbee technology. As both the technologies are working on same ISM band, 2.4 GHz channel frequency is considered. Protocol used for the simulation is AODV protocol i.e. ad hoc on demand distance vector protocol which is reactive routing protocol. As its name suggests whenever the communication is required then only it is used.

Wifi standard 802. 11n having three new features frame aggregation, channel bonding and MIMO is considered. These features are very important to increase the throughput

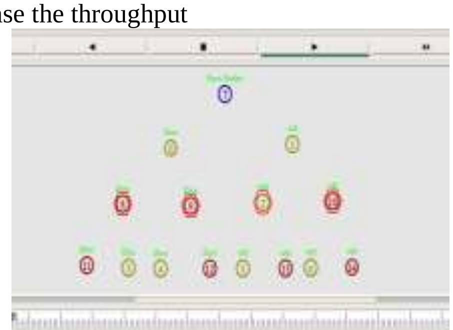

Fig 1: nam window of coexistence of Zigbee and 802.11n

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of wifi network in frame aggregation, value of maximum transmission unit is 2304 and frame size is 256 B therefore, total number of frame aggregated is given by ratio of maximum transmission unit to the packet size and it is (2304/256) 9 i.e. 9 frames are aggregated together to transfer the data between wifi nodes. Second is channel bonding two channels of 20MHz are combined to form 40MHz bandwidth which the maximum bandwidth for the 802.11n standard. Lastly, in MIMO feature two transmission antennas and two receiver antennas are used for optimization of signal and the data rate.
Now, traffic starts between wifi nodes and zigbee nodes in hierarchical way. Simulation time for the traffic is 20 seconds and CBR traffic is used for the simulation. Different performance metrics packet delivery ratio, bit error rate, throughput, control overhead, delay average and residual energy are used to estimate the performance which are discussed in detail below.

A. Packet delivery ratio (PDR):
It is the ratio of number of packets delivered to number of packet sent. For better performance PDR should be high.

B. Bit error rate (BER):
Bit error rate is number of bit error per unit time or it can be defined as ratio of total number of bit errors to the total number of transferred bits. It should be minimum to obtained good performance.

C. Control overhead:
Control overhead is defined as how many extra packets are required in given time. Control overhead should be minimum for the better performance.

D. Throughput:
Throughput is defined as total number of packet sent or bit transferred per unit time. For better performance throughput should be high

E. Delay
Delay is time interval between data sent and data received. Or It is amount of time takes to send data from sender node to receiver node.

F. Average residual energy:
Average residual energy simply means that average remaining energy of nodes after transmitting or receiving data.

Table I: Different simulation parameters and their values

Parameters	Values
Simulator	Network simulator 2
Channel	Wireless channel
Propagation	Two-way ground
Topography	1300 x 1300
Routing protocol	AODV
Simulation time	20 seconds
Traffic	CBR
Packet size	256 B
Channel frequency	2.4 GHz
No. of nodes	15 (for wifi and zigbee 7 nodes each and 1 base station)
Topology	Tree
Data rate	Wifi = 60mbps Zigbee= 250 kbps

IV. SIMULATION RESULT

A. PDR: At the starting of the graph PDR is low due to nodes sending control packets and wherever decrease in the PDR there are interference issues. PDR for zigbee in coexistence with wifi is as shown below in fig. 2

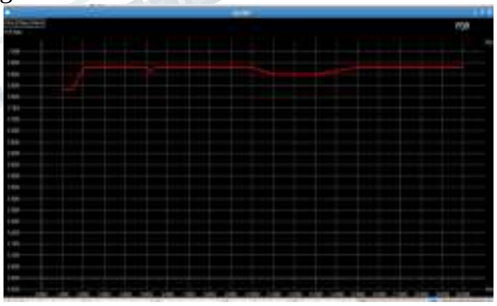

Fig. 2: Impact of 802.11n on Zigbee using PDR

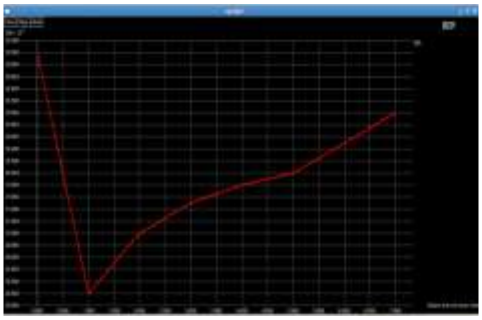

Fig. 3: Impact of 802.11n on Zigbee using Bit error rate

B. Bit error rate : It is decreases as the distance between wifi and zigbee nodes increases. BER decreases up to certain level which is 1m as shown in the fig. 3 After that due to some reasons like received signal strength decreases so BER increases.

C. Throughput: fig. 4 shows throughput graph. Significant decrease in the throughput of zigbee is observed in the presence of 802.11n. Between 0 to 1 throughput is very less and it increases at 5.5 seconds to 10kbps, after that it is variable at different time intervals.

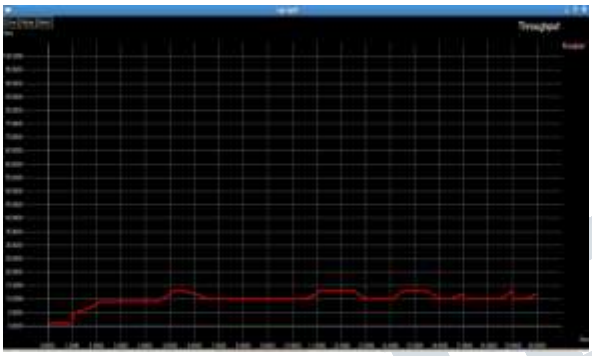

Fig. 4: Impact of 802.11n on Zigbee using throughput

D. Control overhead: Whenever node loses energy it results into loss of packets and control overhead is highest at points 10 and 14 seconds i.e. maximum no. of packets required at that peaks which are 500 as shown in the fig. 5

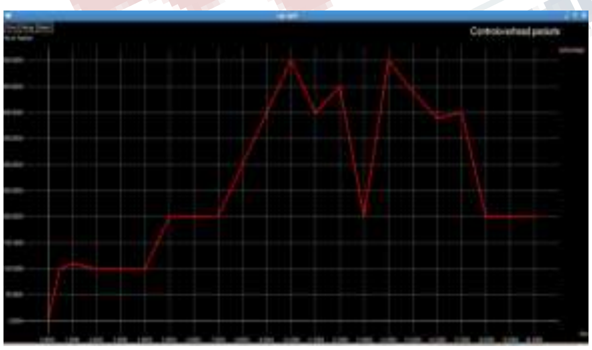

Fig. 5: Impact of 802.11n on Zigbee using Control overhead

E. Delay: It is obseverd that at the starting of the simulation delay is in increasing slope from approximatly 9.2 to 9.7micro seconds i.e. less time is required at the starting of the simulation. After that upto simulation time 9 seconds it slightely decreases then it is constant in remaimning simulation time shown in following fig. 6.

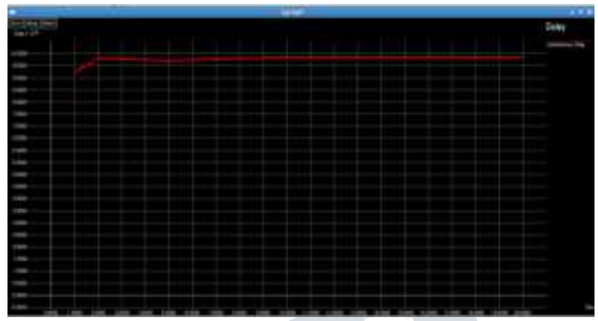

Fig. 6: Impact of 802.11n on Zigbee using Delay

F. Average residual energy: It is decreases at the starting of the simulation drastically and after that it decreases slowly shown in fig, 7.

Fig. 7: Average residual energy of Zigbee in the presence of 802.11n

In [4] channel bonding and MIMO are combined for 802.11n standard and this wifi and zigbee standards coexists together. In that case, performance of zigbee is calculated using packet delivery ratio. If we compare proposed scenario PDR with above mention system PDR then proposed system i.e. in which wifi 802.11n has combination of three features channel bonding, MIMO and frame aggregation which coexist with zigbee has better performance as compare to above existing scenario.

CONCLUSION

Wifi standard 802.11n and zigbee coexistence scenario is considered with tree topology. Channel bonding, MIMO and frame aggregation all combined features were applied to 802.11n. Effect of 802.11n wifi standard on zigbee is calculated by using different performance metrics PDR, control overhead, throughput, bit error rate, average residential energy and Delay. It is observed that proposed system has better performance than the existing.

REFERENCES

[1] Daniele Croce, Pierluigi Gallo, Domenico Garlisi, Fabrizio Giuliano, Stefano Mangione, Ilenia Tinnirello, "ErrorSense: Characterizing WiFi Error Patterns for Detecting ZigBee Interference", pp.447-452, IEEE 2014.

[2] Mohd Adib Sarijari, Anthony Lo, Mohd Sharil Abdullah, Sonia Heemstra de Groot,Ignas G.M.M. Niemegeers, Rozeha A.Rashid, "Coexistence of Heterogeneous and Homogeneous Wireless Technologies in Smart Grid-Home Area Network.", International Conference on Parallel and Distributed Systems, pp.576–581, IEEE 2013.

[3] Sajdl Ondrej, Bradac Zdenek, Fiedler Petr, Hyncica Ondrej, "ZigBee Technology and Device Design", International Conference on Systems and International Conference on Mobile Communications and Learning Technologies, , IEEE 2006.

[4] Zenghua Zhao, Xuanxuan Wu, Xin Zhang, Jing Zhao, Xiang-Yang, "ZigBee vs WiFi: Understanding Issues and Measuring Performances of their Coexistence", IEEE 2014

[5] Shehzad Amir, Young-June Choi, Mohd Sharil Abdullah, Sonia Heemstra de Groot, Ignas G.M.M. Niemegeers, Rozeha A.Rashid, "Interference Coordination Scheme between WiFi and Zigbee Networks.", 9th Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks, pp.91–93, IEEE 2012

[6] Charbel Nicolas and Michel Marot, "Dynamic Link Adaptation Based on Coexistence- Fingerprint Detection for WSN.", 11th annual Mediterranean ad hoc networking workshop, pp.90–96, IEEE 2012

[7] Byung Soo Kim, Ho Young Hwang, and Dan Keun Sung, "Effect of Frame Aggregation on the Throughput Performance of IEEE 802.11n", International Conference on Parallel and Distributed Systems, pp.1740–1744, IEEE 2008

[8] Nickolas J. LaSorte, Samer A. Rajab, Hazem H. Refai, "Experimental Assessment of Wireless Coexistence for 802.15.4 in the Presence of 802.11g/n", International Conference on Parallel and Distributed Systems, pp.473–479, IEEE 2012.

[9] Vasos Hadjioannou, Constantinos X. Mavromoustakis, George Mastorakis, Evangelos Pallis, Dimitrios Stratakis, Dimitra Valavani, "On the Performance Comparison of the Agent-based Rate Adaptivity Scheme for IEEE 802.11n and ZigBee.", International Conference on Telecommunications and Multimedia, IEEE 2016.

[10] Emerson A. Marconato, Daniel F. Pigatto, Kalinka R. L. J. Castelo Branco, Jean Aime Maxa, Nicolas Larrieu, Alex S. R. Pinto, "IEEE 802.11n vs. IEEE 802.15.4: a study on Communication QoS to provide Safe FANETs", 46th Annual IEEE/IFIP International Conference on Dependable Systems and Networks Workshops, pp.184–191, IEEE 2016.

[11] Daniel Ihlenfeldt, Afshin Amini, Clint Powell, "Investigating the Effects of 802.11n Interference on Home Area Networks", 1st IEEE Conference on Technologies for Sustainability, pp.218–222, IEEE 2013.

