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Analyzing the Impact of 6LoWPAN by varying the IETF De-facto Parameters of Back – Off –Transmission for WSN

N.Rahul Pal[1](Research Scholar), Prof S.Pallam Shetty[2]
[1,2]Department of CSE, AU, Engineering College.

Abstract: Wireless Sensor Network has been an essential component in the field of IoT. Energy consumption plays a vital role as sensors are battery-operated, in the paper an attempt has been made to reduce energy consumption and minimize delay in different network sizes to extend the network lifetime of the 6LoWPAN Protocol. This can be achieved using simulator-cooja supported by Contiki operating system and finding the parameter that most affects the network. By varying the IETF De-facto static values of Back off Tx, Beaconing interval, and Buffer size it was revealed that the power has been cut-down to 5.87% and delay to 7.32%.

1.Introduction:

The advancement ofheterogeneous networks and integrity of sensors resulting in abundant growth of wireless sensors networks. However, the connectivity of internet protocol over the internet has made a tremendous growth for IPV6 and low power personal area networks combination the transmission of IPv6 packets over Low power Wireless Personal area networks (6LoWPAN) came into existence. 6LoWPAN consisting of a WSN nodesand have communication ability with other nodes through Internet Protocol and placing a adaptation layer on top of IEEE802.15.4 link layer for packet forwarding ,disintegration, compose tasks.

Obtaining the minimum cost, less power, low bit rate, and reducing end to end delay etc, is the challenging factors of 6LoWPAN nodes which are comply to principles of IEEE 802.15.4

A sensor in 6LoWPAN is termed as a reduced function device when the data needs to be transferred the RFD will transfer the data packet to a router or Coordinator which is a highly capable sensor node called a Full Functional Device (FFD) in the same network (PAN). The FFD then transfers the packet in a hop count mechanism and sends the packet to the 6LoWPAN gateway. Then the packet is attached to an IPv6 dominion and will transfer the packet to its respective destination address.

A 6LoWPAN protocol stack consists of different layers like Physical layer, Medium Access Control (MAC) layer, Adaptation layer, Network layer, Transport layer, and Application layer. It tells about how the 6LoWPAN devices will be communicating with each other over the network, the services provided by the PHY layer are data and management services these services are constrained to how to transmit the packets to the MAC layer over a tuned radio channel. The Data Link Layer is also known as the MAC sub-layer out-fits two services data and management services.

The basic mechanism provided is to transfer data which is achieved by the MAC data frame, and by synchronization and coordination, the MAC beacon frame is generated.MAC management utilizes the MAC Command Frame. Through Carriers Sense Multiple Accesses with Collision Avoidance (CSMA/CA) mechanism.

Factors like security, energy related issues, QoS metrics confining to different network topologies, different attacks are the major factors related to 6LoWPAN.

2. Literature Review:

Nurulet al. [1]Deled with importance of 6LoWPAN in constructingheterogeneous networks, and modifications in the existing protocols.

Keng et al.[2],In this paper, different header types,encapsulations, routing protocols in 6LoWPAN such as Hi-Low protocols are studied.

Nejikouka1 et al.[3].In this paper a study related to QoS is done based on the TF and WithoutTF parameter.

Yigitel et al.[4] in this paper the main focus is on challenges, metrics,parameters and requirements of QoS aware MAC protocols for wireless sensor network.

Tsigkas et al. [5] This paper focused on improving the efficiency of QoS while maximizing the effecting use of bandwidth.

Oliveira et al.[6]This paper aimed the several security for the LoWPAN networks and reviewed on open protocols like LSEND and RPL.

Charles1 et al.[7] .In this paper RPL QoS metrics has been done to improve the network life time.

Eloudrhiri et al.[8]In this paper the performance of RPL routing protocol on different metrics is done with a new objective function called IRH-OF.

Mohd et al.[9]In this paper HRPL is compared with RPL on the basis of overhead, traffic control with respect to different topologies.

3. Cooja –Simulator Used:

Cooja with Contiki operation system is a java based graphical user interface. Simulator it is a network simulator specially designed for wireless sensors networks. It has functionalities like network, simulation control, selection of modes like T-mote, Sky-mote, Micaza mote etc ,and with different topologies and Transmission ranges. Cooja simulator is more suitable for IOT.

Block diagram of Cooja:

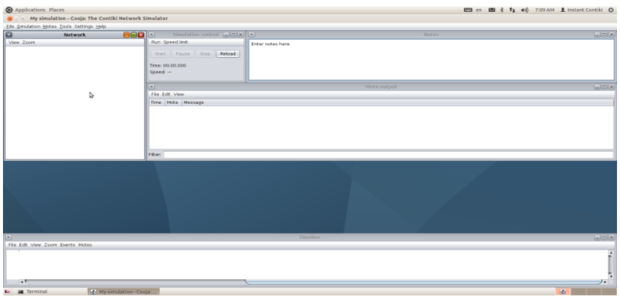

Fig1: Simulator for Cooja

4. Performance Metrics:

In this simulator, we are investigating the factors that minimize the energy consumption and QoS metrics of the 6LoWPAN protocol by varying the parameters.

Power: The aggregation of energy consumed by the node(sink)in a network which is represented as milliWatts(mW).

Delay: It is termed as an end-to-end delay between the sink node and the coordinator node (Router) in this simulator we are measuring the parameters like CPU, LPM, Listen time, and Transmit Time ignoring Q -delay.

5. Parameters for Simulation:

Here we are considering random topology for small, medium and large networks. And selecting mode as SKY and constructing a wireless network under UGDM environment with random seed. And changing the parameters of Beacon interval, Back off Tx and Buffer size. With respect to Tx and RX range as 100%.

Table1: Parameters for Experimentation

Specifications	Value
Model Type	UGDM
SEED	Random
Network Size	100*100
Mote	Sky Mote
Simulation Time	300 Sec
Topology	Random
Objective Function	OFO
Tx Ratio,Rx Ratio	100%,100%
Tx Range,Int Range	100%,50%
Buffer size	40000 to 80000
Becon interval	1000,500
Back-off Tx	2,3,5,6

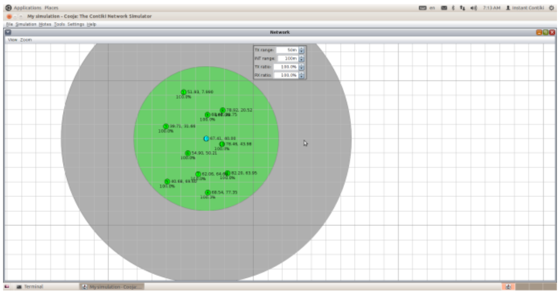

Fig 2: Sample Random Topology of 10 nodes

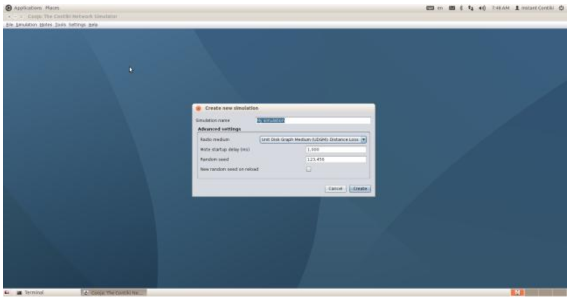

Fig3: Selection of Radio Medium (UDGM)

6. Discussion and Results:

Here we will modify the de –facto parameters of Beacon interval from 1000 to 500 and Buffer size from 40000 to 80000 and Back off Tx ranging from 2 to 6 and finding out the best optimal parameter for minimizing the energy and delay for small medium and large networks of 6LoWPAN protocol in random topology.

For Small network consisting of 10 nodes:

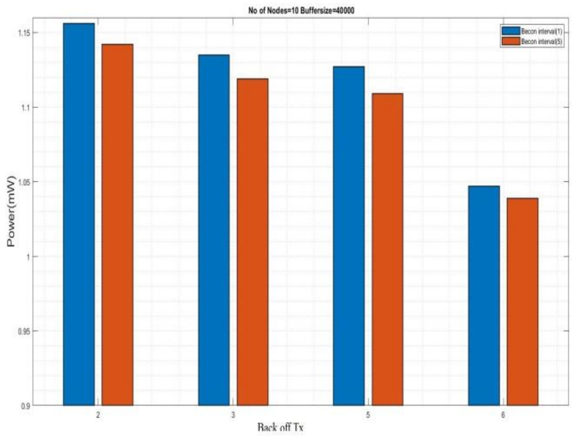

Fig 6(a) :No of nodes =10 Buffer size=40000

From the Figure 6(a) Power is observed (mW) on Y- axis, No of nodes considered are 10, Back Off Transmission taken as 2,3,5,6 on X-axis and Beacon interval is varied for 1000 and 500,with De facto Buffer size as 40000.

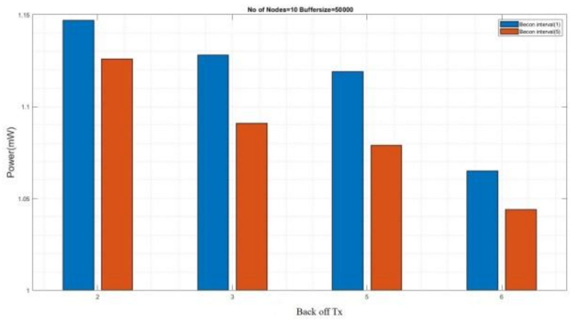

Fig 6(b): No of Nodes=10 Buffer size=50000

From the Figure 6(b) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 50000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

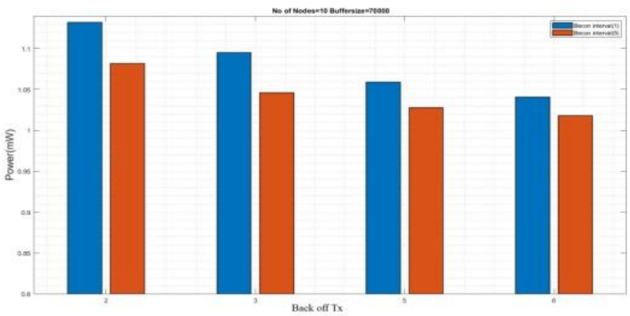

Fig 6(c): No of Nodes=10 Buffersize =60000

From the Figure 6(c) Power is observed (Y-axis) by considering No of nodes as 10 .Buffer size as 60000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

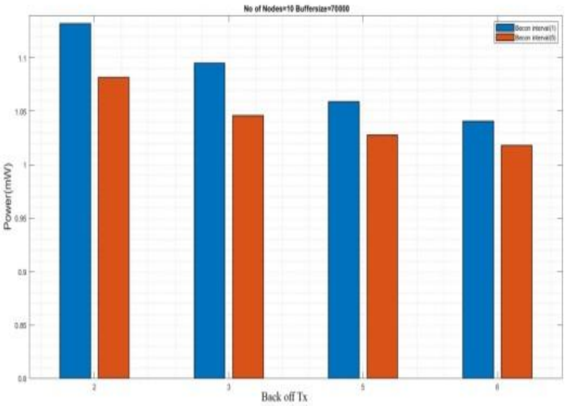

Fig 6(d): No of Nodes=10 Buffer size =80000

From the Figure 6(d) Power is observed (Y-axis) by considering No of nodes as 10 .Buffer size as 80000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

Medium Network consisting of 30 Nodes:

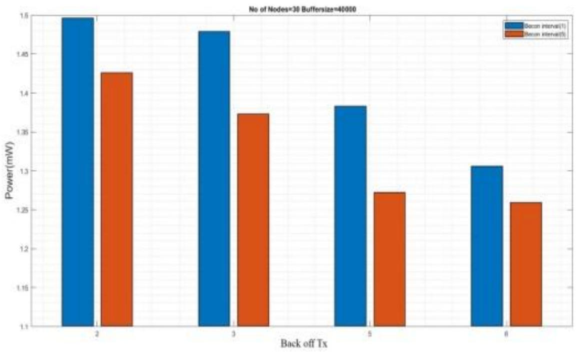

Fig 6(e):No of nodes =30 Buffer size=40000

From the Figure 6(e) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 40000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

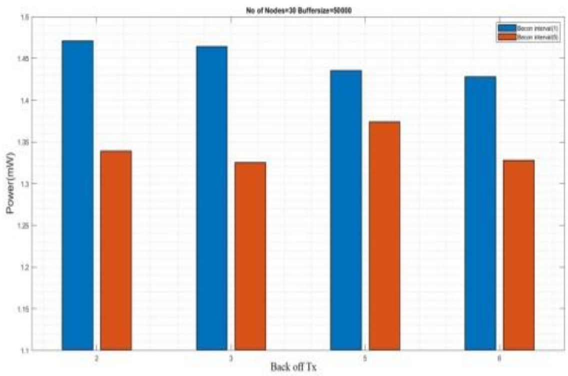

Fig 6(f):No of nodes =30 Buffer size=50000

From the Figure6(f) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 50000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

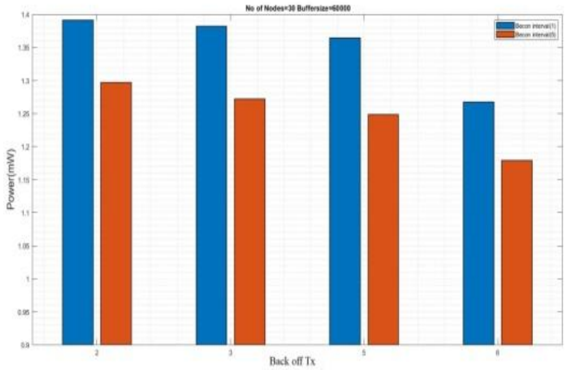

Fig 6(g):No of nodes =30 Buffer size=60000

From the Figure 6(g) Power is observed on Y-axis by considering no of nodes as 10 .Buffer size as 60000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

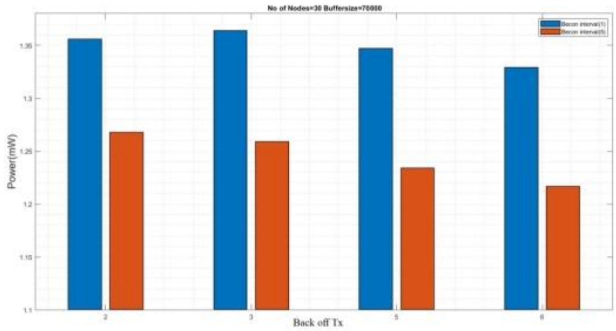

Fig 6(h):No of nodes =30 Buffer size=70000

From the Figure 6(h) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 70000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

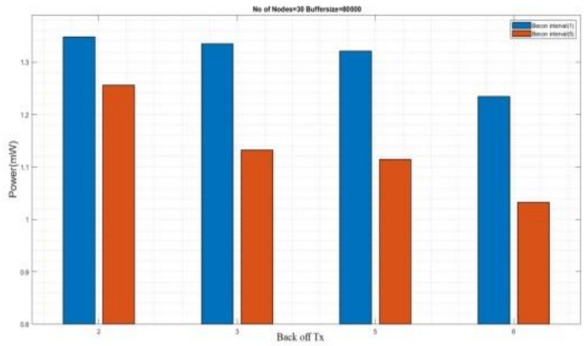

Fig 6(i):No of nodes =30 Buffer size=80000

From the Figure 6(i) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 70000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

For Large Networks consisting of 40 nodes

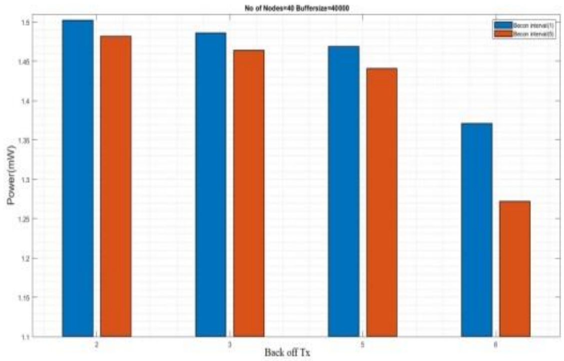

Fig 6(j): No of nodes =40 Buffer size=40000

From the Figure 6(j) Power is observed on Y-axis by considering No of nodes as 40 .Buffer size as 40000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

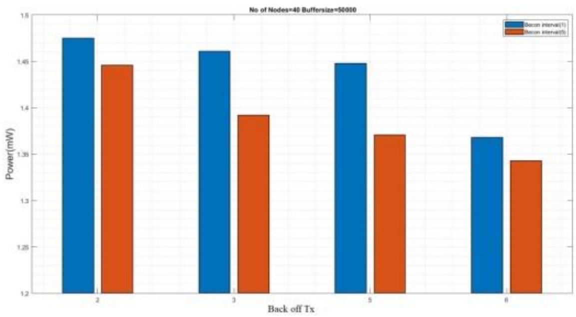

Fig 6(k):No of nodes =40 Buffer size=50000

From the Figure 6(k) Power is observed on Y-axis by considering No of nodes as 10 .Buffer size as 50000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

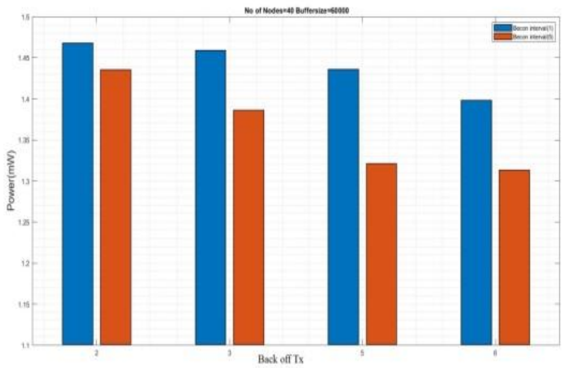

Fig 6(l):No of nodes =40 Buffer size=60000

From the Figure 6(l) Power is observed on Y-axis byconsidering No of nodes as 40 .Buffer size as 60000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

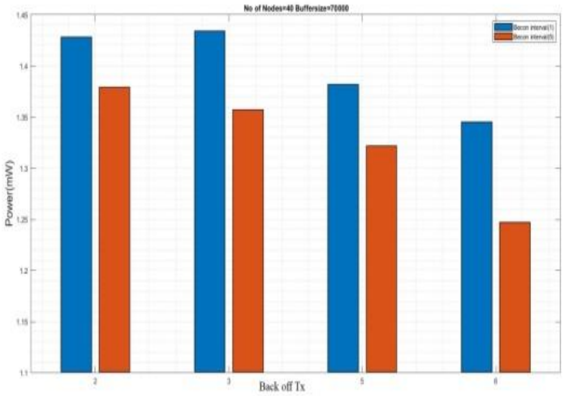

Fig 6(m):No of nodes =40 Buffer size=70000

From the figure 6(m) Power is observed on Y-axis by considering No of nodes as 40 .Buffer size as 70000, Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

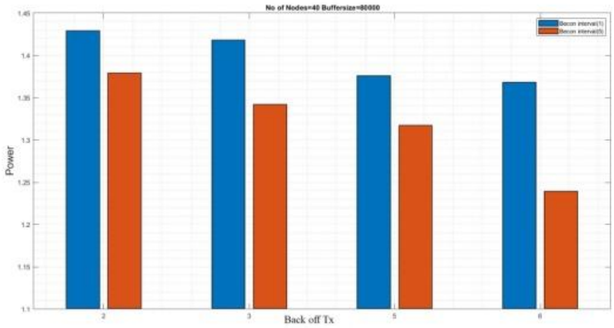

Fig 6(n):No of nodes =40 Buffer size=80000

From the Figure6(n) Power is observed on Y-axis by considering No of nodes as 40 .Buffer size as 80000,Beacon interval for 1000 and 500 and Back off Tx varied as 2,3,5,6 on X-axis.

Delay: For Small Network consisting of 10 nodes

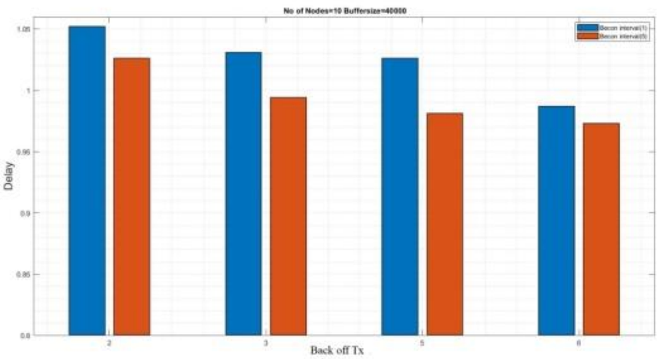

Fig 6(0) :No of nodes =10 Buffer size=40000

From the Figure6(o) Delay is observed on Y-axis for a network size of 10 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 40000 and on X-axis Back off Tx is varied from 2 3,5,6.

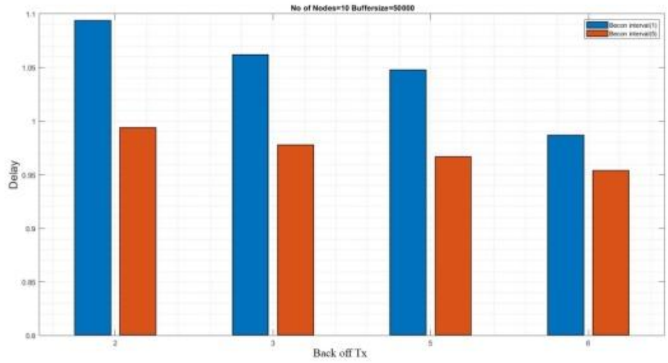

Fig 6(p):No of nodes =10 Buffer size=50000

From the Figure 6(p) Delay is observed on Y-axis for a network size of 10 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 50000 and on X-axis Back off Tx is varied from 2 3,5,6.

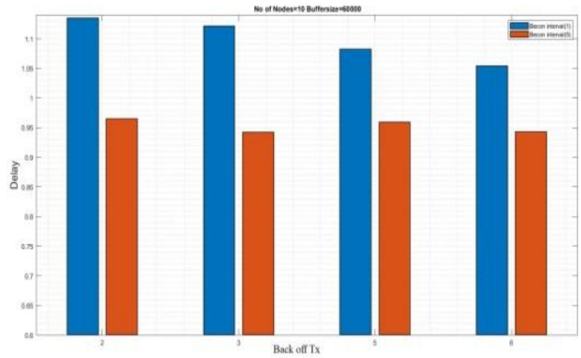

Fig 6(q):No of nodes =10 Buffer size=60000

From the figure 6(q) Delay is observed on Y-axis for a network size of 10 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 60000 and on X-axis Back off Tx is varied from 2 3,5,6.

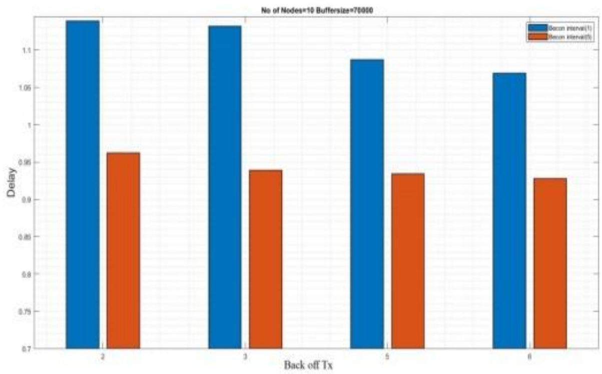

Fig 6(r):No of nodes =10 Buffer size=70000

From the Figure6(r)Delay is observed on (Y-axis) for a network size of 10 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 70000 and on X-axis Back off Tx is varied from 2 3,5,6.

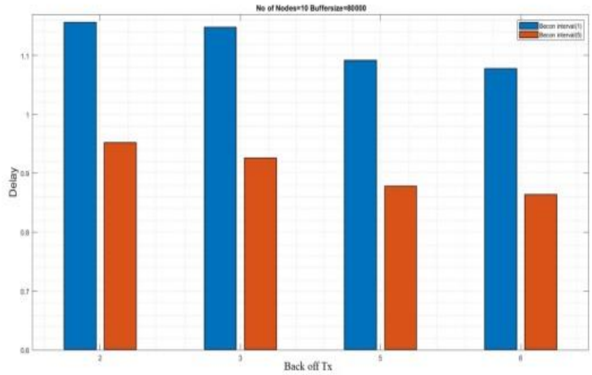

Fig 6(s):No of nodes =10 Buffer size=80000

From the Figure 6(s) Delay is observed on Y-axis for a networksizeof 10 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 80000 and on X-axis Back off Tx is varied from 2 3,5,6.

Medium Network consists of 30 nodes:

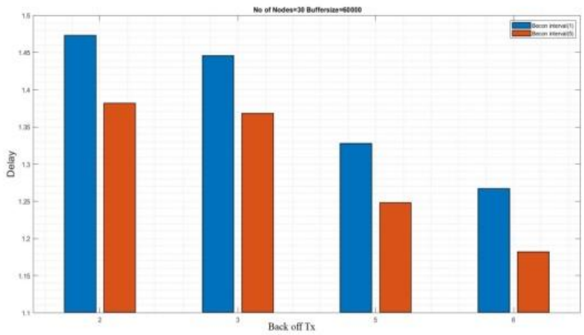

Fig 6(t):No of nodes =30 Buffer size=60000

From the Figure 6(t) Delay is observed on Y-axis for a network size of 30 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 60000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

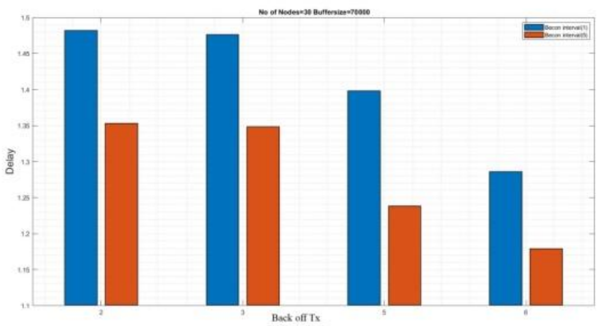

Fig 6(u): No of nodes =30 Buffer size=70000

From the Figure 6(u) Delay is observed on Y-axis for a network size of 30 nodes, Beacon interval varied for 1000 and 500 .Buffer size as 70000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

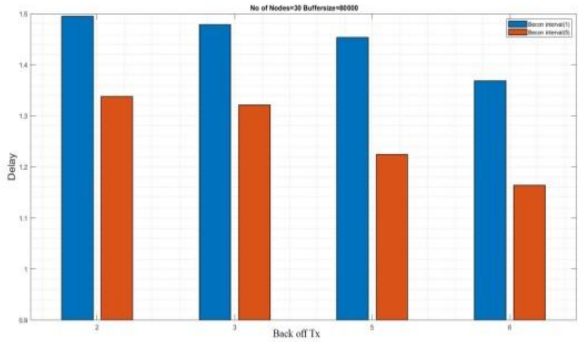

Fig 6(v):No of nodes =30 Buffer size=80000

From the Figure 6(v) Delay is observed on Y-axis for a network size of 30 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 80000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

Large Networks consists of 40 nodes

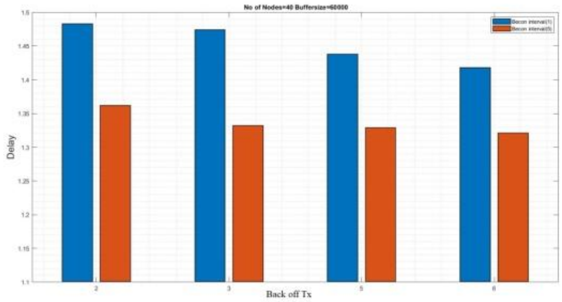

Fig 6(w): No of nodes =40 Buffer size=60000

From the Figure 6(w) Delay is observed on Y-axis for a network size of 40 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 60000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

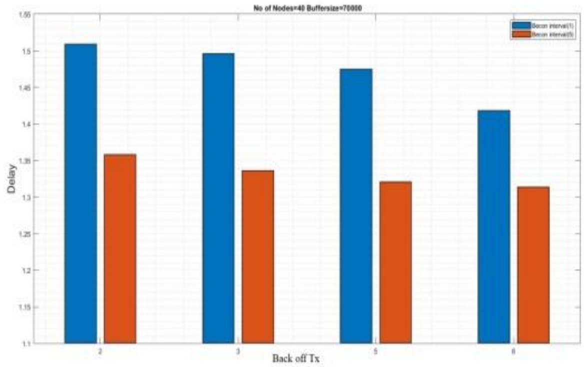

Fig 6(x):No of nodes =40 Buffer size=70000

From the Figure 6(x) Delay is observed on Y-axis for a network size of 40 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 70000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

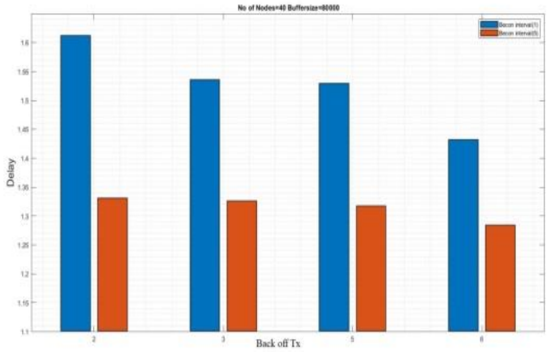

Fig6(y): No of nodes =40 Buffer size=80000

From the Figure 6(y) Delay is observed on Y-axis for a network size of 40 nodes, Beacon interval varied for 1000 and 500 . Buffer size as 80000 and on X-axis Back off Tx is varied from 2 3, 5, 6.

7. Observation:

From the graphs, it was observed that by using the de-facto parameters the energy and delay are increasing. In this experimentation initially increased the buffer size from static (40000) to 50000,60000,70000and 80000, from this it was observed that there is a decrease in energy when we increase the buffer size, however, the delay value is been increased, to reduce delay we change the beacon interval value from 1000 to 500 this leads to decrease in the delay in all the networks sizes further study by changing the Back off Tx from 2,3,5,6 it was observed that both the energy and delay are being minimized in all the network sizes in random topology. Thus power has been minimized to 5.875% and the delay is reduced to 7.32%.

8. Conclusion and Future Scope:

From the experiment, it was observed that there is a tremendous change. By considering the Beacon interval, Buffer size, and Back-off -Tx in the different sizes.The impact of Back-off-Tx is high in minimizing energy which is reduced to 5.875% and delay has been reduced to 7.32%.

To achieve better performance the static values have to be modified this can be done by applying soft computing techniques like fuzzy to enhance the better performance of the networks.

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About the Author:

N.Rahul Pal currently doing his Ph.D in CSE at Andhra University and has 5 years of experience in teaching.

S Pallam ShettyWorking as the Professor in CS&SE Department at Andhra University college, and has 30 years of teaching experience.