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Enhancing the Performance of 6LoWPAN for WSN Using Soft Computing Fuzzy Logic Technique

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Abstract:

In the research area of Wireless Networks, the Internet of Things is growing rapidly in today's technology. In this 6LoWPAN network, minimization of energy and end-to-end delay parameters has become a challenging task. In this paper, we consider parameters like buffer, back off transmission, and beacon interval, which minimize the energy consumption by fine-tuning of de facto parameters and applying soft computing techniques like fuzzy logic to enhance the optimal values, experimentation reveals that by applying soft computing techniques to Back –Off-Transmission energy has been minimized by 5.64% and delay by 3.23%.

1. Introduction:

The ability of connectivity between network devices has made the Internet of Things a field of research. Sensor nodes have become the evolution of connectivity between tiny, less-power, less expensive devices. These sensor objects are capable of sensing, Processing, and having certain trasnmission potential. The interconnectivity of these sensor devices is suitable for generating a potential wireless sensor network. The usage of internet protocol in these interconnectivity devices has been a rapid growth this leads to the development of new protocols like 6LoWPAN.The combination of IPv6 and IEEE802.15.4 lead to the development of the 6LoWPAN protocol. The protocol stack of 6LoWPAN contains a Physical Layer, Medium access control layer, Adaptation layer, Transport layer, and Application Layer, a part of these they 6LoWPAN has been incorporated in different routing protocols like Route-over, Mesh routing, and Hierarchal Routing. The 6LoWPAN Ad-Hoc On-Demand Distance for Mesh routing, 6LoWPAN Dymo, etc. on the other side obtaining less power, low memory, minimizing overhead achieving QoS metrics have become a challenging task in the field of Wireless Sensor Networks.

6LoWPAN consists of two different types of devices i) Reduced function Device (RFD) and ii) Full Functional Device. (FFD) initially, when the data packet has to be sent to other devices via IP firstly the Reduced Function Device comes in to picture this device first sense the environment collects the data, and once the data is collected it is forward to the Full Functional device which is having high capability than RFD. This FFD sends the collected data packet to the gateway of its PAN network in a Hop –to –hop mechanism. To transport data form one network to other network through gateway. In order to reach the destination the IPV6 domain will connect to 6LoWPAN is connected initially and later the data packet is sent.

Then the gateway will connect to the 6LoWPAN with the IPV6 domain then it will send the data packet to its desired destination via the internet.

6LoWPAN contains IEEE 802.15.4 PHY as a Physical layer, where this layer is responsible is how the devices should communicate with each other in a wireless channel. The next layer 2 is IEEE 802.15.4 MAC layer (Medium Access control) which instructs when to communicate with another device in a wireless medium. Beacon generation, Synchronizing, channel access via Carriers Sense Multiple Access with Collision Avoidance (CSMA/CA) mechanism, etc.

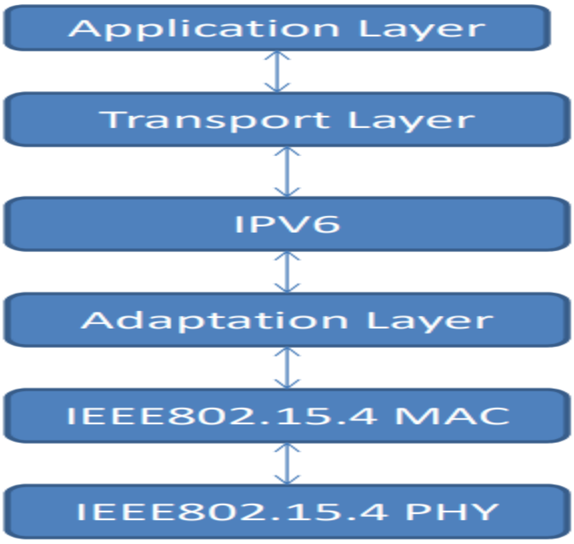

Fig1: Protocol Stack of 6LoWPAN.

2. Literature Review

Asmak et al.,[1] focused on different types of routing models (like mesh, Hierarchical) which are applied to the 6LoWPAN layer Protocol stack and interconnection between higher layers and lower layers of the 6LoWPAN protocol stack.

G.k.Ee et al.,[2] reviewed on different header types of 6LoWPAN, and encapsulation mechanisms to achieve full potential routing also studied 6LoWPAN existing routing protocols and compared them on the bases of metric, hop count is done.

Shreyas et al.,[3] in this paper, with the help of fuzzy logic the work has done on congestion issues within IoT networks and solved, the problem of parent selection is done using the fuzzy weighted sum technique and calculated the grade for each parent adverse to expected transmission count, Rt Metric and buffer occupancy.

Balarengadurai et al.,[4] have focused on metrics like detection and prediction of different DDoS attacks in IEEE 802.15.4 LoWPAN and selected PDPT and SNR as inputs to the fuzzy system and achieved the level of output (LOA) as output.

Saidah et al.,[5] conducted a comparison study on different objective functions like OFO, MRHOF, and OFRRT-FUZZY for different QoS metrics like PDR, Overhead, average latency, and power consumption using a fuzzy logic system in RPL routing protocol and resulted that OFRRT- Fuzzy is best among the three objective functions.

Sennan et al.,[6] Using a fuzzy interface system, we produced a research based on RPL, MRHOF-RPL, and FL-RPL, FLEA-RPL. And it was indicated that FLEA-RPL had the best PDR performance and the might be increased by 2-5 percent.

Ababou et al.,[7] developed a novel intensive and logical routing protocol named EERPF-Ant for the Delay Transmission Networks, and to find the best path between nodes and enhance it by using the fuzzy logic system for decision making

Lyes et al.,[8] proposed a Fuzzy MARS approach to semi-stateless QoS for service delivery in wireless mobile ad-hoc. Fuzzy-MARS is a mechanism, especially for admission controller, mechanism, and real-time traffic regulation, the performance resulting in that delay can be optimal in the mobile ad-hoc network

3. Cooja-Simulator:

A Cooja Simulator is considered as one of the best simulators for Wireless Sensor Networks, the latest version 2.7 which is inbuilt with the Contiki Operating System and it is a java based Graphical simulator. Cooja simulator provides different Radio mediums like –Unit Disk Graph Medium (UDGM), Directed Graph Radio Medium (DGRM), etc, and various motes like Sky mote, ESB mote, Z1 mote, etc and can vary transmission range, TX Raito, Rx Ratio and contains collective view in a tabular form where the performance of each individual node can be observed effectively.

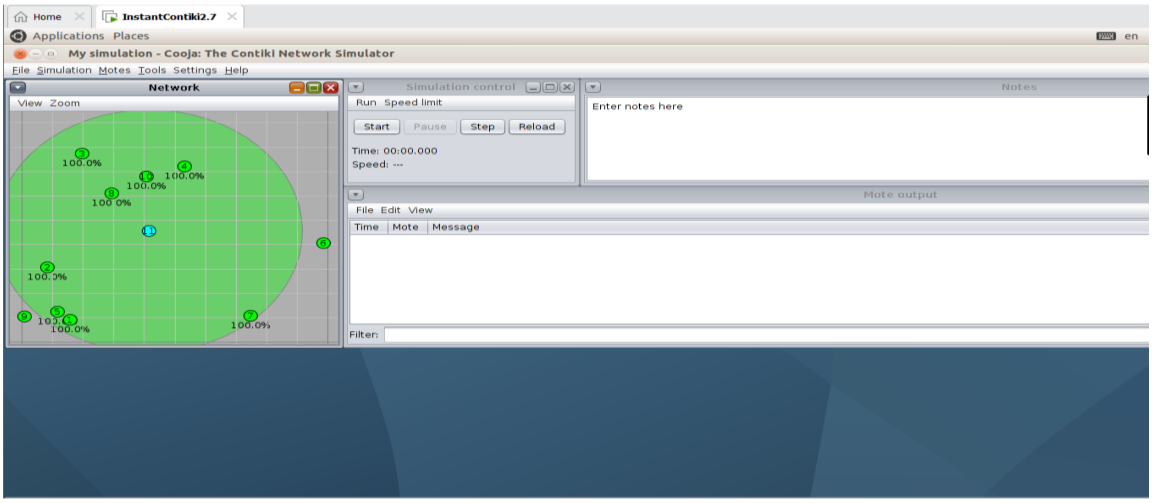

Fig 2: Simulator for Cooja.

4. Parameters used in Simulation:

In this Experimentation, we considered different parameters like Radio Medium as UGDM, with Random seed, and choosing network size, mote type and simulation time, different topologies Transmission Range, Objective function, etc are used for simulation. The tabulated parameters are shown below.

Table1: Parameters for Experimentation

Specifications	**Value**
Model Type	UDGM
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 ,50000,60000,70000,80000
Beacon interval	1000,500
Back-off- Tx	2,3,5,6

Cooja Simulator with network consisting of 10 nodes and with a sink node along with Tx range 50 % InT range 100%, Tx ratio 100% and Rx ratio 100%. is shown in Figure 3.

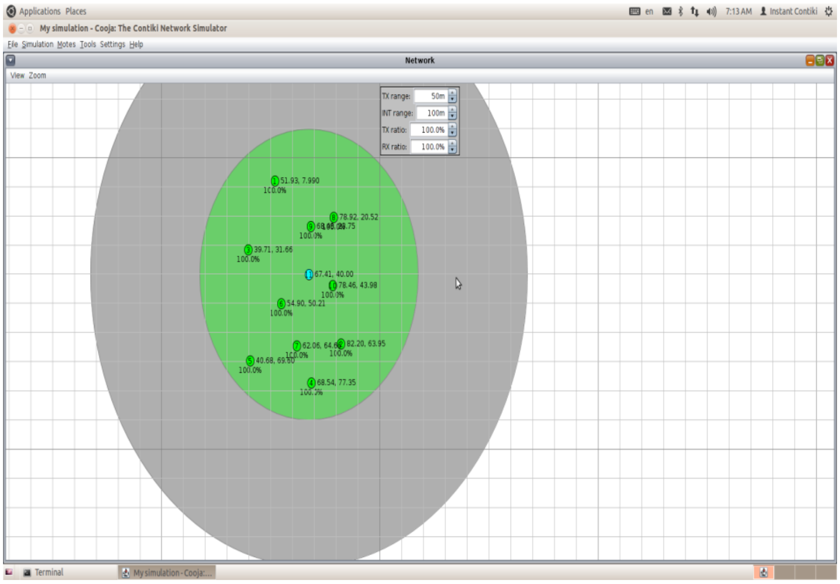

Fig 3: Random Topology with its Tx and Rx ratio.

5.6LoWPAN applying Fuzzy:

In this Fuzzy approach is applied to the 6LoWPAN for achieving the dynamic Back off TX. To achieve this we considered two inputs Beacon Interval, Buffer size, the static value of Buffer size is 40000, and beacon interval is 1000 in this fuzzy-based approach we vary values and observe the impact on Back off TX which is varying from 3 to 6.

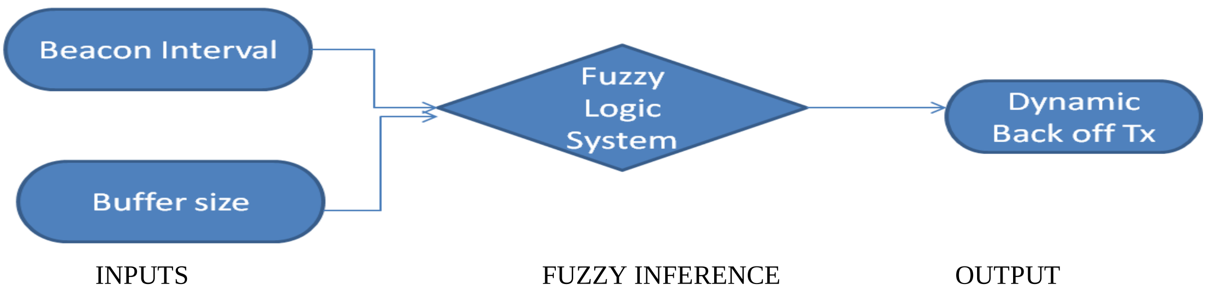

Fig 4: Fuzzy Interference System

Step by Step procedure for processing Dynamic Back off Transmission:

// selected input first: Beacon interval.

//Selected input second: Buffer size.

//Output: Dynamic Back Off Transmission.

1. *Initialize procedure ←Start*
2. *Set the Fuzzy interference System ← Sugeno.*
3. *Set the first input ←Beacon Interval.*
4. *Choose the Range for input1 ←[1 5]*
5. *Set the no of membership functions for Beacon Interval ←[3(Low, Medium, High)]*
6. *Set the type of membership function for input 1 ← Triangular.*
7. *Set the Second input ←Buffer size.*
8. *Set the range of Buffer size ←[40000 80000]*
9. *Set the no of membership functions for Buffer size ←[3(Low ,Medium, High)]*
10. *Set the type of membership function for input 2 ← Triangular.*
11. *Choose the output ←Back off Transmission.*
12. *Set membership functions for Back off Transmission ←[3(Low, Medium, High)]*
13. *Choose the Output type ← Constant*
14. *Set up the fuzzy rules ← if- then rules.*
15. *Set De-fuzzification method← wtever.*
16. *Set the ruler view for evaluation.*
17. *Record note for Back off Tx outputs for the given inputs←[input1 ,input2]*
18. *Set the 3D-Surface viewer.*
19. *End procedure←stop*

Fuzzy Layout:

The fuzzy model is designed for achieving the Dynamic Back off Transmission in Surgeon Model.

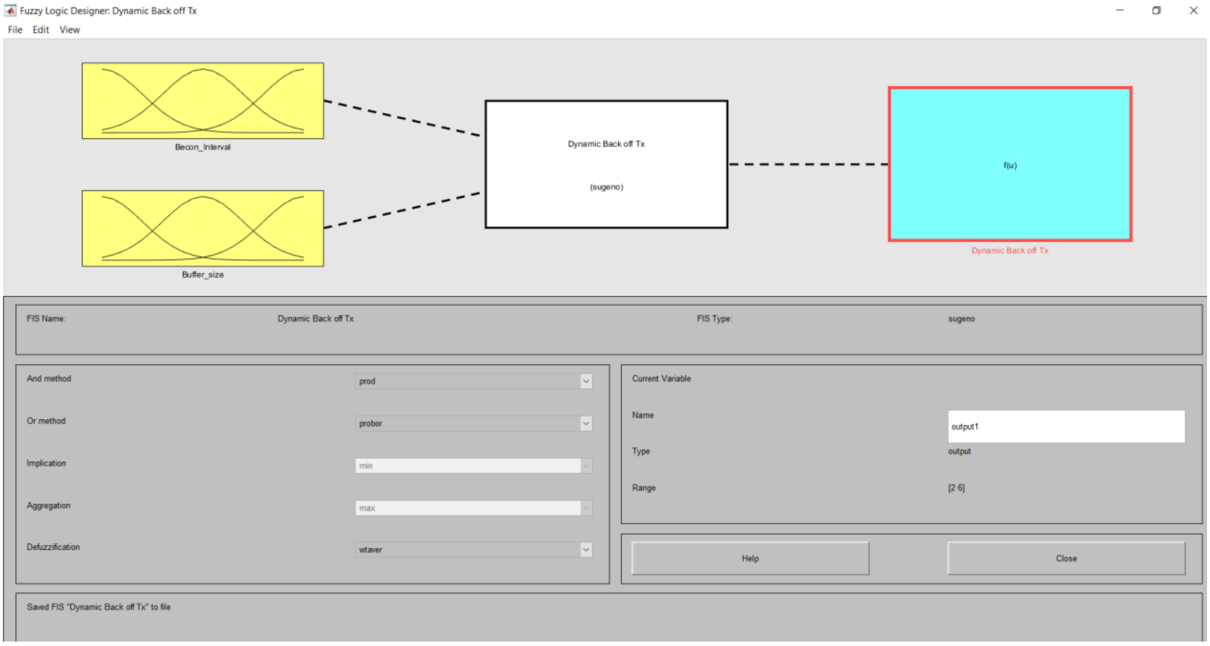

Fig5: Fuzzy Interference system for obtaining Dynamic Back off Tx.

From the Figure(5) it was observed that we are considering two membership functions as inputs and applying Sugeno model to achieve Dynamic Back off Transmission.

The first input is considered as Beacon interval. From the Fig (6) it was considering that the range between (1 to 3) is considered as Low range (2 to 4) as medium/mid and range 3 to 6 as High.

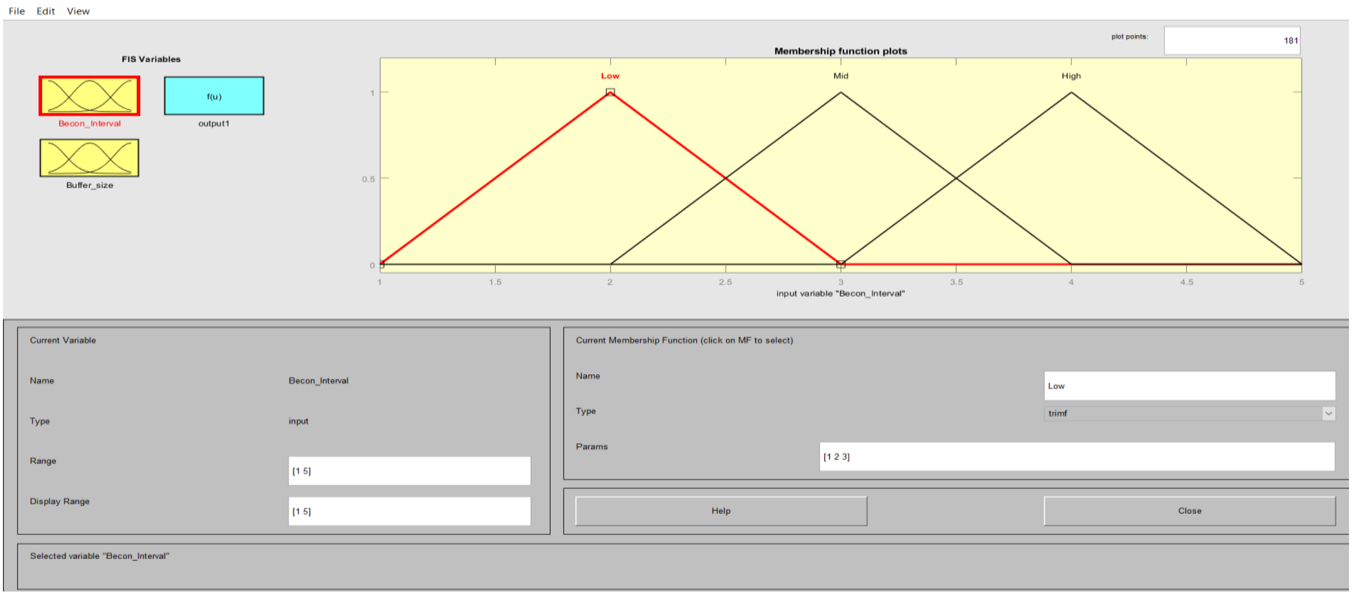

Fig 6: Beacon Interval as Input (1) Membership Function.

The second input member function is considered as Buffer size form the below figure the range from 4 to 5.5 as low ,the medium/mid range is from 5 to 6.5 and high range is varied from 6 to 8.

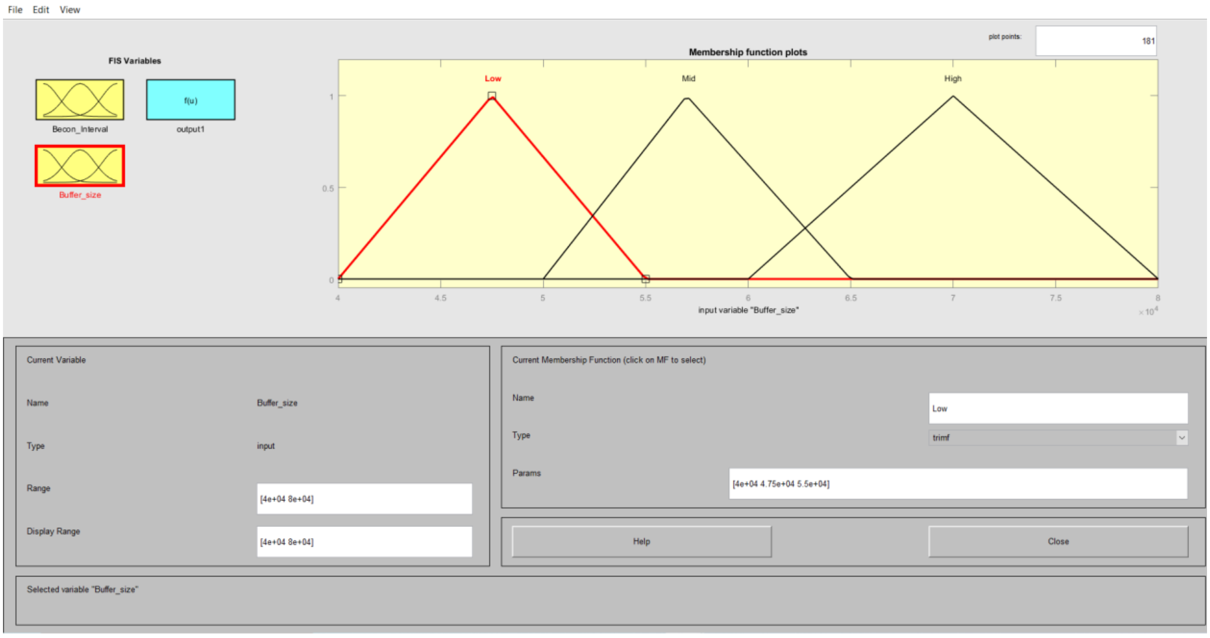

Fig 7 : Buffer size as Input (2) Member Function.

With these two inputs and considering Back off Tx as output we are generating fuzzy rules of total nine rules these rules are utilised to identify the dynamic Back off Tx.

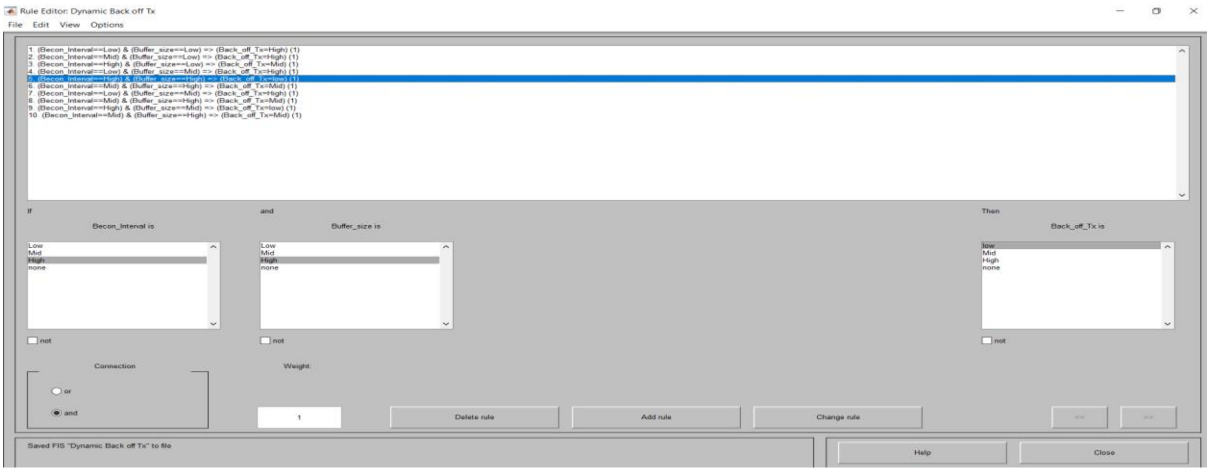

Fig 8 : Rules for achieving Dynamic Back Off Tx.

By varying inputs Beacon interval and Buffer size in the ruler view for generating Dynamic Back off Transmission.

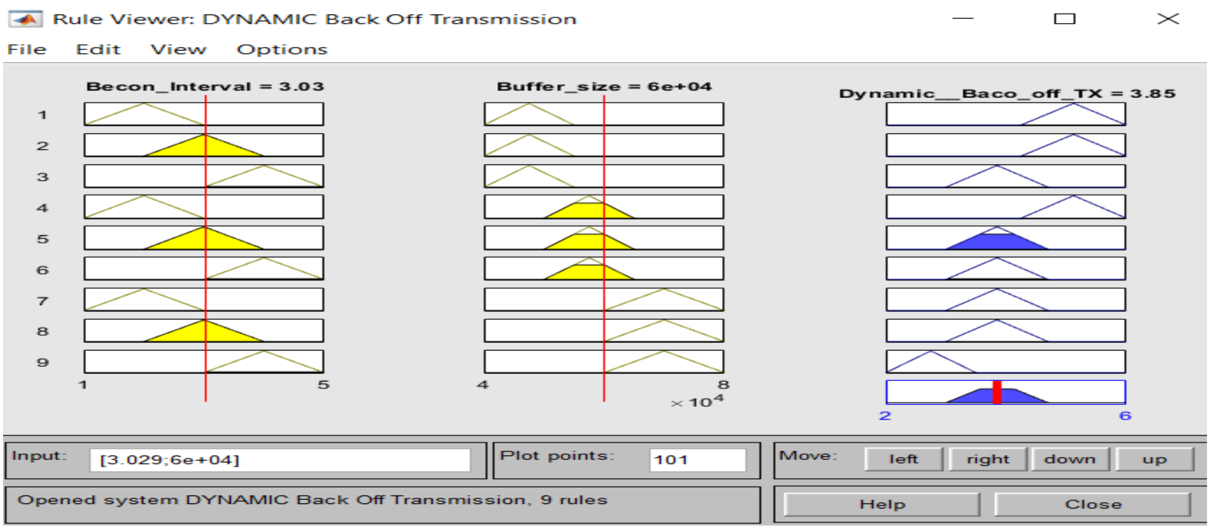

Fig9: Ruler view for Dynamic Back off Tx.

From the above figure (9) it was observed that by varying the input membership functions (Buffer size and Beacon interval) dynamic Back off transmission can be achieved.

The visualization of result in shown in graphical representation with the surface view and it represents graphs in a 3D view with input as Buffer size ,and Beacon interval and output as Dynamic Back off Transmission.

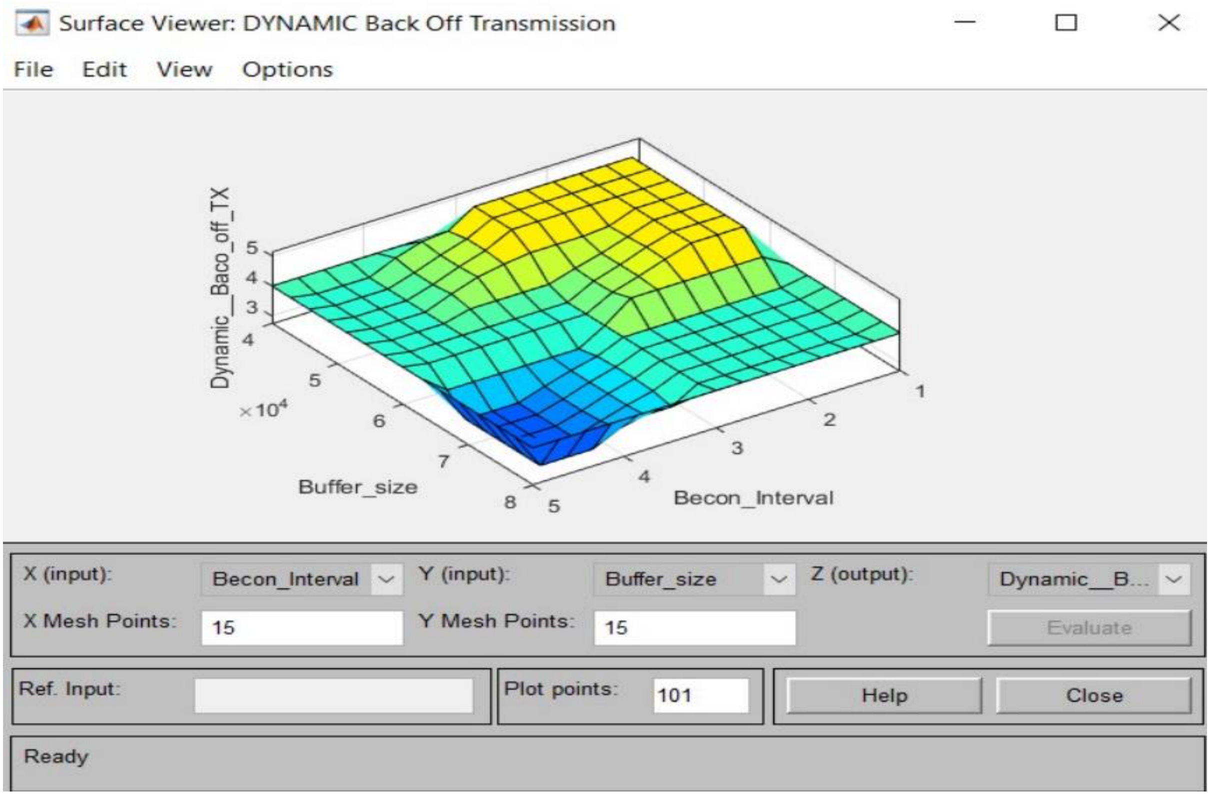

Fig 10 : Represents the Surface View for Dynamic Back off Tx.

6: Results:

Power: The power which is utilized by the nodes to transfer packets from source to destination in the network it is defined as summation of CPU.LPM.

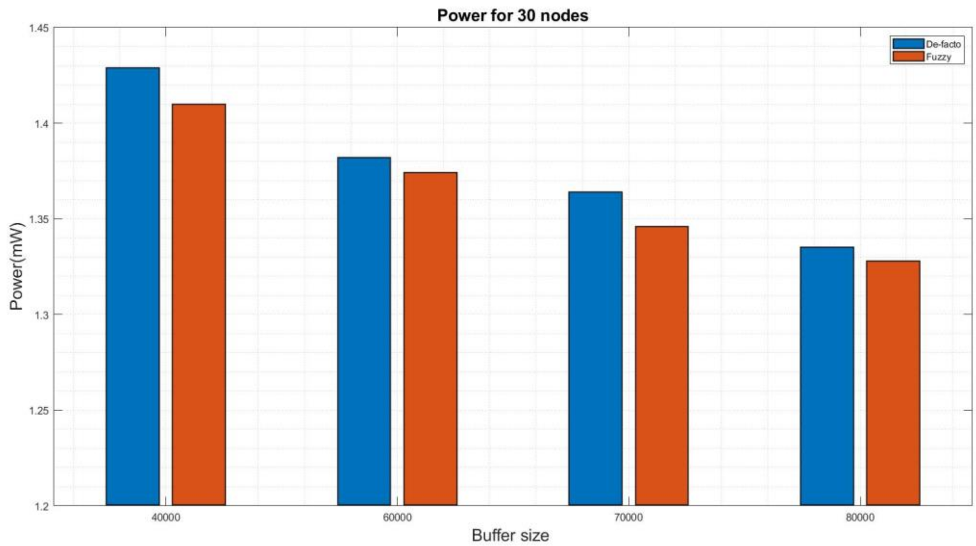

Fig11: Power consumed for 30 nodes

Form the above graph it was observed that the amount of power minimized form the de-facto to fuzzy is 6.72%by varying the inputs beacon interval and buffer size.

Delay: the delay is termed as movement of data packet from source node to its destination node in this experiment we omitted Q-delay and considered network delay, transmission delay, process delay.

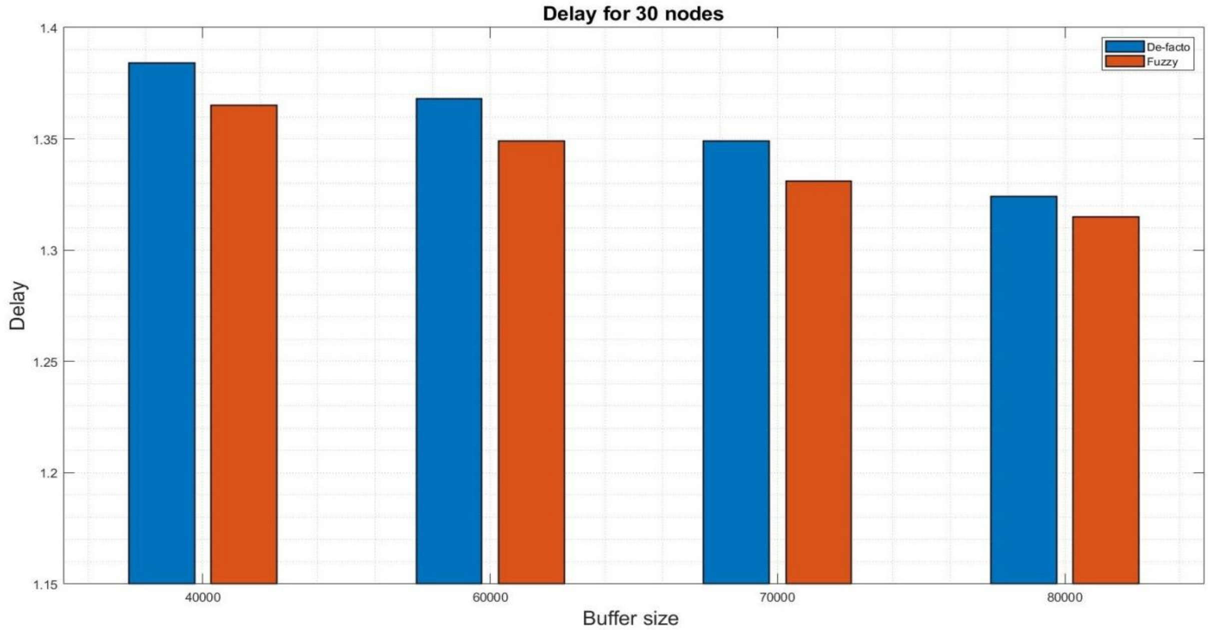

Fig12.Delay consumed for 30 nodes

From the above graph it was observed that by varying the Buffer size and Beacon interval the delay can be reduced to 3.23% when compared with de-facto.

7: Conclusion and Future Scope:

By applying soft computing techniques like fuzzy, the performance of Wireless Sensor Network can be improved for the 6LoWPAN protocol. Fuzzy interference system has minimized the power by 6.72% and delay by 3.23% when compared to static de-facto parameters.

Further by applying soft computing like ANFIS fine tuning of Back off Tx can be done so as to enhance the performance of WSN.

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