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Investigating the Most Essential Factor in Enhancing the Performance of 6LoWPAN using Taguchi Approach.

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Abstract:

Evaluation of IPV6 over LoWPAN which made the network critical, led to the development of the 6LoWPAN network, to minimize energy, and improve the network lifetime of the 6LoWPAN network to become a challenging factor. In this approach, we investigate the essential factor that improves the efficiency of 6LoWPAN in terms of Delay and minimization of energy consumption using the Taguchi methodology. To achieve this de-facto parameter of the beacon interval, Back off Transmission, buffer size values has been modified in different size of networks and find out which parameters effects the most in minimizing the energy and minimizing delay. The experimental reveals that Back-off-Transmission is the most compelling factor for 6LoWPAN in minimizing the energy consumption and delay in the WPAN.

Keywords: 6LoWPAN,Taguchi,Back off Transmission, Most Essential Factors.

I. Introduction:

The advancement in communication between the sensors is bringing a technological change in the field of wireless sensor networks this is bringing a remarkable change in the sectors like health, military, industrial, automation, etc as sensors are applied to collect data from real-world environments. In order to communicate between the sensor nodes presently Internet protocol Version 6 is been used as the network size is being increased this view ipv6 is replaced by ipv4 where it has a large number in addressing when compared to ipv4 (2128 addressing) in order to communicate between the sensor IP address need to transmit data packets over IEEE 802.15.4 Mac and Phy layers this been a complicated task, this mechanism has made the existence of 6LoWPAN this transmission of data packets of IPv6 over a LoWPAN sensor network is defined as 6LoWPAN where achieving QoS metrics, Energy reduction, the overhead reduction has been a challenging task.

II.6LoWPAN Network:

6LoWPAN consists of sensor nodes with Internet Protocol communication capability. This interconnectivity is applied to small and light devices, which is an infrastructure-less network. The evolution of heterogeneous networks and IoT has been developed with the occurrence of 6LoWPAN.with the development of 6LoWPAN the born of 4LoWPAN has vanished.

The insertion of the adaptation layer between the data link layer and network layer has made the difference between TCP/IP and 6LoWPAN protocol stack. Similar to TCP/IP 6LoWPAN contains different layers for communication the physical layer IEEE 802.15.4 PHY is responsible for the transmission of bits in the form of signals. this is forwarded to IEEE 803.25.4 MAC layer which is responsible for correcting errors and frames, this layer uses CSMA/CD or CSMA/CA mechanism to detect errors in the signals, and the frames are moved to the adaptation layer (IPV6 over LoWPAN) which has a small transmission range, low bandwidth low memory, and low energy dealing with these parameters is a crucial task in the WPN Network.

In this 6LoWPAN network the sensors which collect the data from the real environment are known as Reduced Function devices \these devices will forward the collected information to the full functional device (FFD) which acts as a router and the router will send the data to its respective 6LoWPAN gateway of the network will then connects to the IPV6 domain will send the data packets to receivers domain.

III. Literature Survey:

1. Ismail, et al.,[1] This paper detailed about importance of 6LoWPAN and its challenges in the Wireless Sensor Network. Explained about MAC, IEEE802.15.4 frame formats and integration of 6LoWPAN with network; layer and application layer.

2. Xiyuan, et al.,[2].Performance analysis of RPL in multi-hop network in large scale ,and deled with parameters like Mean end to end delay, Packet delivery ratio, Percentage of nodes in different objective functions and discussed about future works like transmission mode, energy issue, cross –layer issue etc.

3. Gabriel et al., [3] The study is related to performance of Telso-mote on 6LoWPAN protocol for monitoring the flood system on 1-hop tests and 2-hop scenarios. Resulted in the use of 1024ms and 1133B LPL configuration.

4. Wang et al.,[4] In this paper the work has done based on increasing Network Life Time by restricting the topologies to the planar networks on a small scale, including triangle and regular quadrangle topologies.

5. Rawat et al.,[5].In this paper the work has been focused on identifying the loss factor of routing protocols in (MANETS). On different services like routing ,movement aware, energy information and considered parameters like node type, antenna size ,type of antenna, no of nodes ,random seed , and finalized the performance of network.
6. Manikanta et al.,[6] Taguchi design of experiments approach to find the most significant factor of Dymo routing protocol in mobile ad hoc networks.

7. Elshaikh ,et al[7] In this work has been done to identify Best effective factor for OLSR, DSDV routing protocols in mobile Ad-hoc networks.

8. Raj N, et al[8], To analyze the performance variation of routing protocols such as dynamic source routing (DSR), priority aware – DSR (PA-DSR), and adaptive multi-constrained quality of service (AMQoS) in consideration of various parameters numerous experiments are designed by incorporating Taguchi method.

9. Mohamed et al. [9]. In this paper six factors like(terrain region, no of nodes, speed, no of sources, transmission ,etc are considered so as to evaluate the performance of DSR routing protocol in MANETS using Taguchi approach.

IV: Research Methodology

4.1 Qualitative research:

There are many simulators to analyze the performance of networks like NS2, NS3, OPnet, Qualnet, omnet++, cooja, etc. as we are dealing with IoT the best suitable simulator is the Cooja simulator which is inbuilt in the Contiki operating system. This simulator facilitates the selection of different radio mediums, construction of different topologies, and selection of sink nodes, collective view of Qos metrics, bar graph representation of output, etc is done effectively. In this paper, we observe the differential between the parameters in different scenarios and observe the results and analyze which factor affects the most to enhance the performance of the network.

4.2 Quantitative Approach:

In this paper, we need to find the most indicative factor from the selected parameters to minimize the energy and reduce delay for the 6LoWPAN protocol. To achieve the desired output experiments are made based on the Taguchi approach. This method is used to validate which parameter has been shown as the most indicative factor among the selected parameters.

4.3 Cooja-Simulator:

Cooja simulator is the best suitable simulator for wireless Personal Areas which deals with low energy, low bandwidth, and low range, by using this simulator

1. Selection of radio channel can be done effectively Transmission range, InT range, TX ratio, and RX ratio can be modified.
2. Selection of Topology can be done effectively for any set of nodes.
3. Impletion of a new protocol and comparing it with existing protocols
4. The collective view of Qos metric and graphical representation of metrics.

4.4 Simulation Parameters need:

Cooja simulator is used for improving the performance of the 6LoWPAN protocol different parameters and their values have been considering for experimenting with different scenarios for obtained desired values:

Table1: Tabulated Parameters and Values

Parameters	**Values**
Protocol	6LoWPAN
Area	100*100
Mote Type	Sky mote
Radio channel	UDGM
TX Ratio, Rx Ratio	100%,100%
Nodes	10,30,40
Topology	Random
Traffic	CBR(Constant Bit Rate)
Buffer size	40000,5000,60000,70000,80000
Beacon Interval	1000,500
Back off Tx	2,3,5,6
Simulator time	300 sec

The Figure 1 shows the cooja simulator area where we can choose different types of motes like sky mote,Z1,ESB, MicaZ etc. and we can see simulation control, Mote output, Network area, and Timeline for movement of signal.

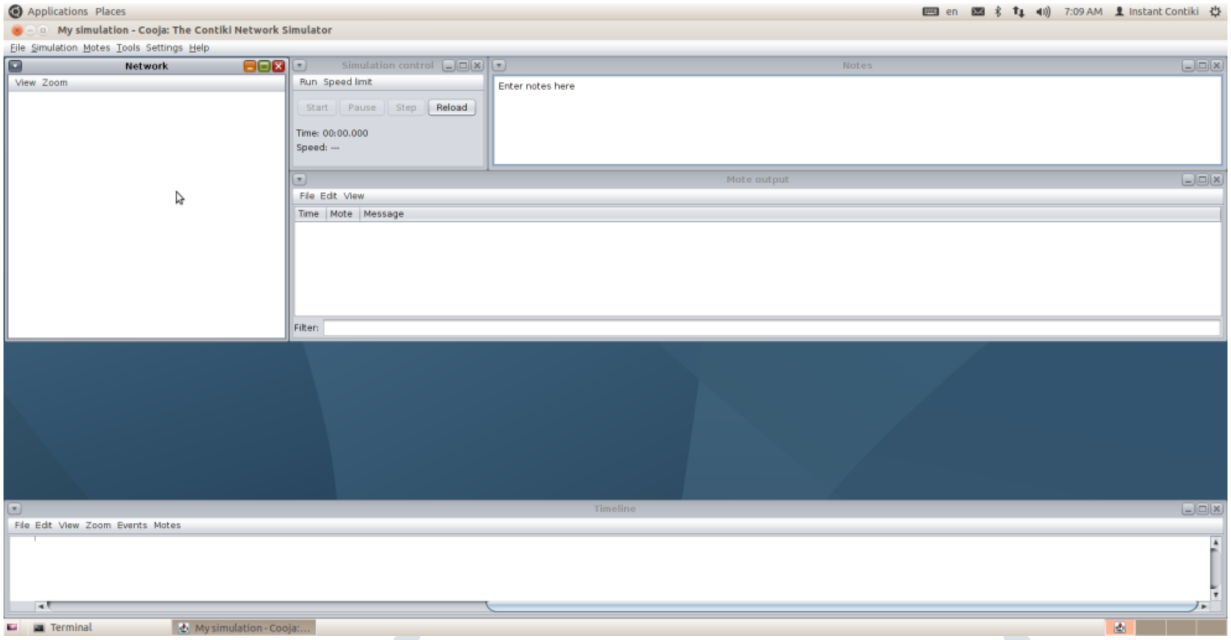


Fig1: Simulation Area.

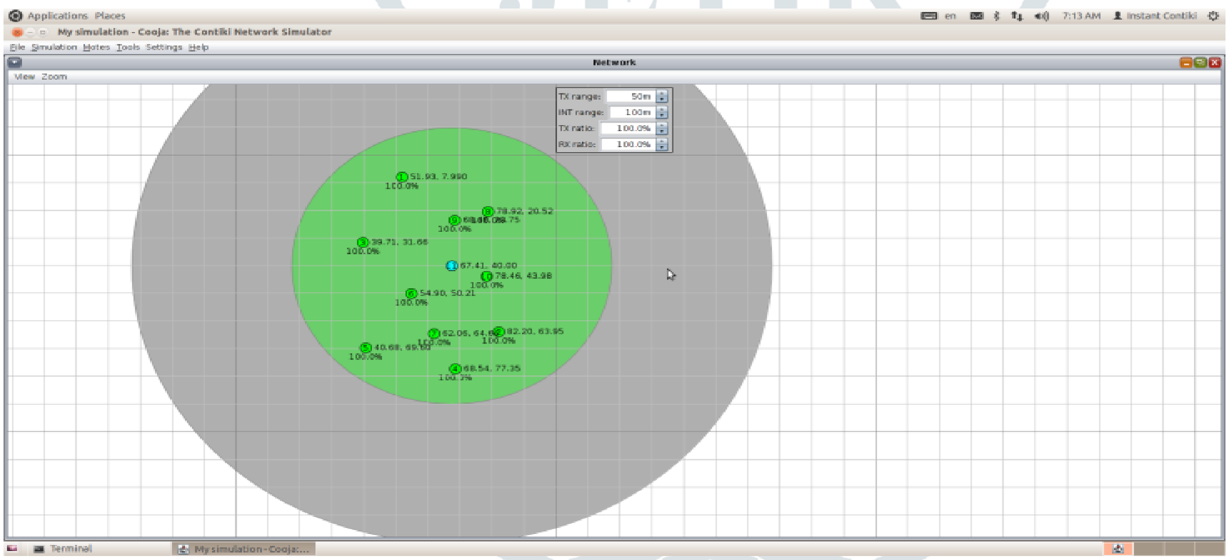


Fig2: Random Topology.

The Fig2 shows a random topology network consisting of 10 nodes and one sink node with respective to TX range, InT range, Tx ratio, Rx ratio.

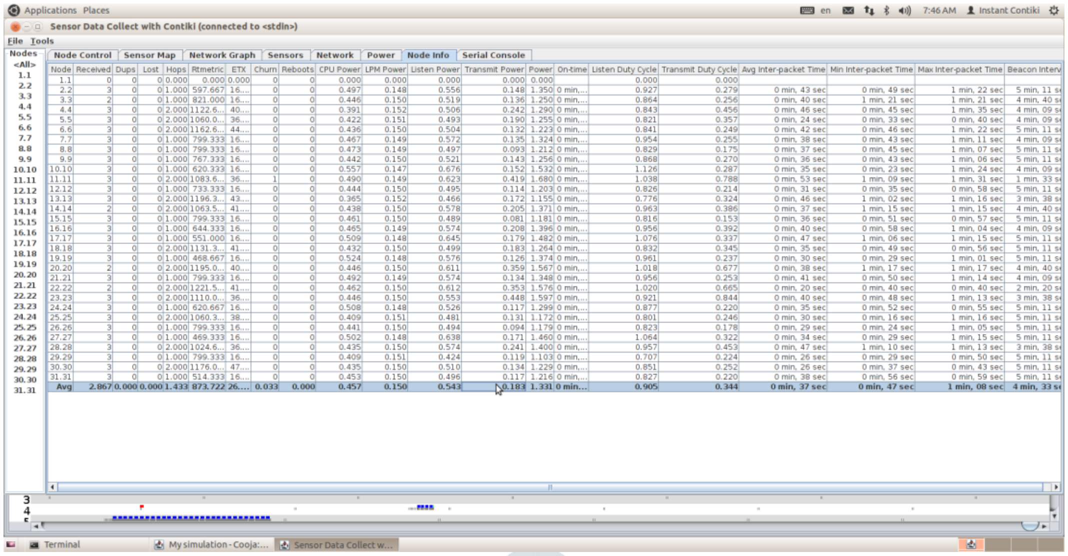
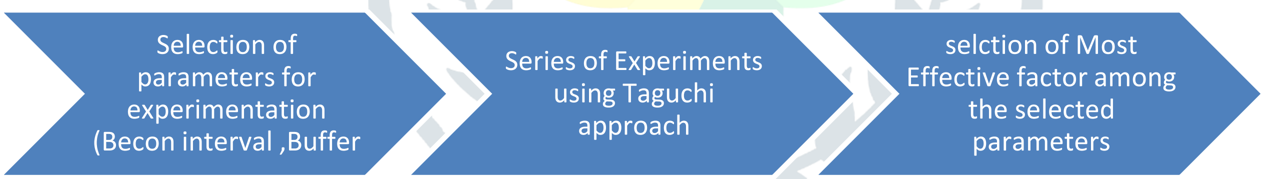


Fig3: Collective View of results.

The Figure 3 collective view gives the results in graphical and in numerical manner of each node values like ETX, CPU Power, LPM Power, Listen Power, Transmit Power, Duty Cycle, Beacon Interval etc.

V. ANALYSIS AND FINDINGS

Using the cooja simulator and experimenting the basing on different scenarios upon various for (6LoWPAN) protocol it is observed that among the parameters chosen (Beacon interval ,Back off Tx, buffers size) here we are finding which parameter gives optimal result in minimizing energy and delay in different series of experiments using Taguchi approach.



Taguchi Orthogonal Design:

A Taguchi model has been designed by using a L(32),mixed array of level 4,4,2 for the input parameters like (Beacon interval, Back off Tx, Buffer size) so as to find the optimal result.

Orthogonal array of (L32) design for the selected parameters:

Table2: Representation of Orthogonal array

Sno	Parameter	L1	L2	L3	L4
1	Buffer size	40000	50000	60000	80000
2	Beacon Interval	1000	500	*	*
3	Back off Tx	2	3	5	6

Steps for finding optimal value:

Step1: Select the objective function for the protocol requires in this case we chosen 6LoWPAN Protocol.

Step2: Selection of parameters like Beacon Interval ,Buffer-size, Back Off Tx .

Step 3: choose an orthogonal array (L32 mixed array) of level 4, 4, 2.

Step4: Analysis the results though ANOVA model.(Smaller is Better)

Design of Taguchi Orthogonal Array:

Design Summary:

Taguchi Array	L32(2^1 4^2)
Factors:	3
Runs:	32

Representation of Taguchi array.

Taguchi Analysis: Power- versus, Beacon interval, Buffer size, Back off Transmission.

Response Table for Signal to Noise Ratios

Smaller is better

Level	Becon interval	Buffer size	Back off Tx
1	-2.634	-3.138	-3.128
2	-3.070	-2.878	-3.037
3		-2.662	-2.838
4		-2.729	-2.404
Delta	0.436	0.476	0.724
Rank	**3**	**2**	**1**

Response Table for Means

Level	Becon interval	Buffer size	Back off Tx
1	1.356	1.437	1.434
2	1.425	1.394	1.420
3		1.360	1.387
4		1.371	1.321
Delta	0.069	0.077	0.113
Rank	**3**	**2**	**1**

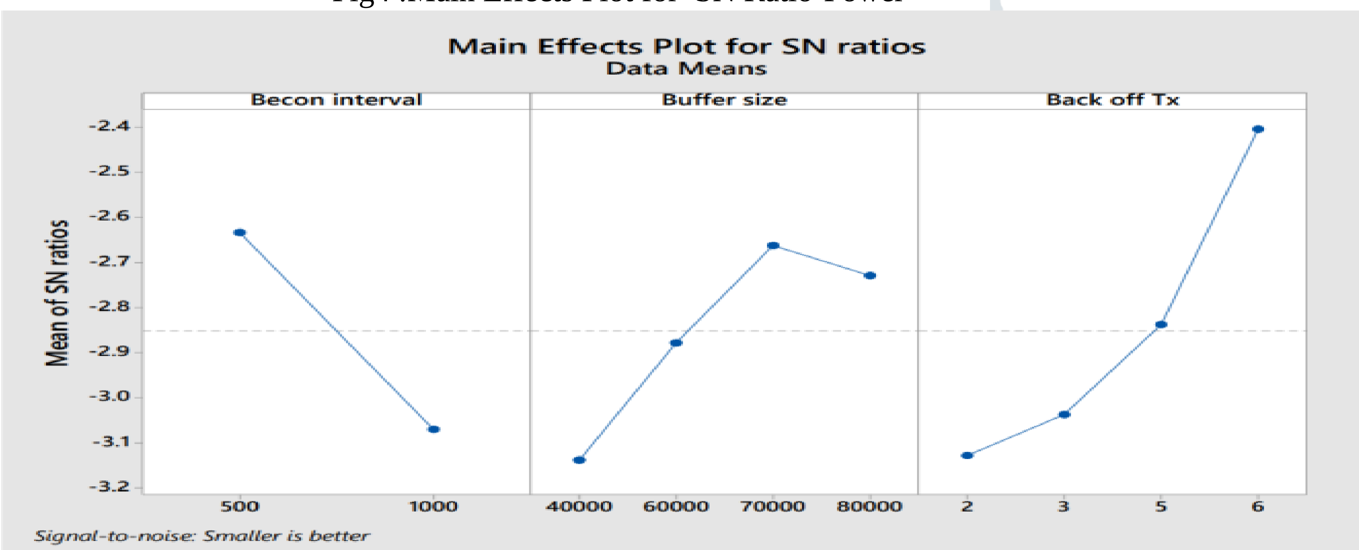
Response Table for Variance.

Nested ANOVA: SNRA1 versus Beacon interval, Buffer size, Back off Tx

Analysis of Variance for SNRA1

Source	DF	SS	MS	F	P
Beacon interval	1	1.5233	1.5233	7.154	0.037
Buffer size	6	1.2776	0.2129	1.341	0.278
Back off Tx	24	3.8095	0.1587		
Total	31	6.6105			

Fig4 :Main Effects Plot for SN Ratio-Power



The Figure4 shows the Beacon Interval varied from De-facto 1000 to 500 and Buffer size is varied from De-facto value 40000 to 80000 and Back off Transmission value from 2 to 6.

In SN ratio larger number (Scale) gives a better specification and results when compared with lower number values (which has lower performance).

Delay: The amount of time taken for a packet to reach to destination from source in this scenario we considered a packet moving form leaf node to sink node and vise versa. We considered all delays except Q-delay.

Response Table:

From the response table for the delay parameter we can see that Back off Tx, Parameter is resulting the better results when compared to Beacon Interval and Buffer Size:

Response Table for Signal to Noise Ratio:

Taguchi Analysis: Delay versus Beacon Interval, Buffer size, Back Off Tx.

Response Table for Signal to Noise Ratios

Smaller is better

Level	Becon Interval	Buffer size	Back Off Tx
1	-2.202	-2.490	-3.084
2	-2.874	-2.490	-2.946
3		-2.551	-2.280
4		-2.622	-1.842
Delta	0.672	0.132	1.242
Rank	**2**	**3**	**1**

Response Table for Means

Level	Becon Interval	Buffer size	Back Off Tx
1	1.291	1.335	1.428
2	1.395	1.335	1.405
3		1.345	1.303
4		1.357	1.238
Delta	0.104	0.022	0.190
Rank	**2**	**3**	**1**

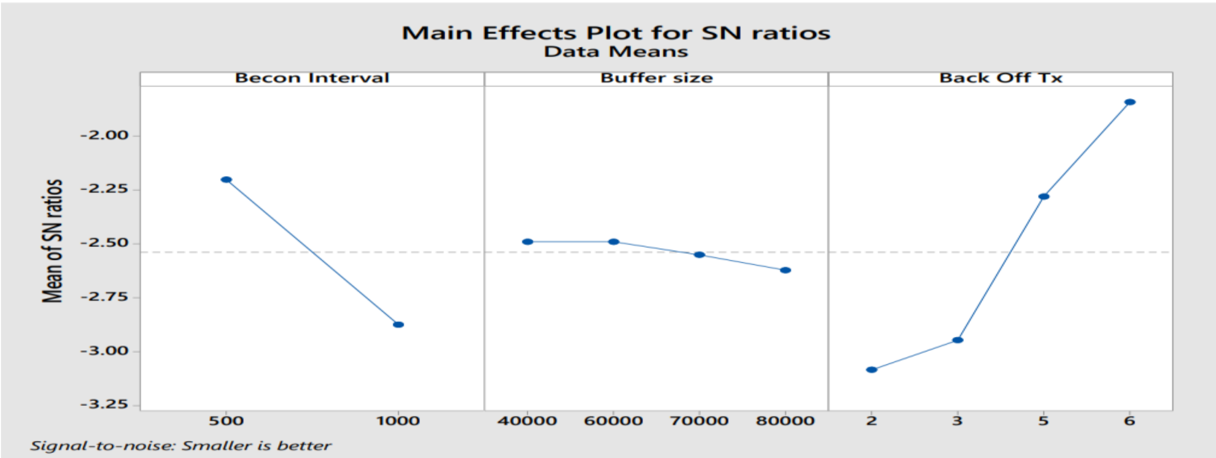
Analysis of Variance for Delay

Table for variance:

Nested ANOVA: Delay versus Beacon Interval, Buffer size, Back Off Tx

Source	DF	SS	MS	F	P
Becon Interval	1	3.6145	3.6145	14.027	0.010
Buffer size	6	1.5461	0.2577	0.722	0.636
Back Off Tx	24	8.5606	0.3567		
Total	31	13.7213			
Total		0.566		0.753	

Fig5: Main Effects Plot for SN Ratio-Delay.



From the above Figure 5 we can state that the higher value gives better performance when compared with small value which resulted lower performance. In the above figure the Back off Tx value 6 gives better results and considered as Most Essential factor than De-facto value 3.

VI. Conclusion and Future Scope:

A series of experiments have been done basing on the parameters like Beacon interval, Back off Tx, Buffer size, in Taguchi model it was observed that small ranking from the above experiments reveals that Back –Off-Transmission is resulted as most essential value for minimizing the energy and delay for 6LoWPAN protocol in various network sizes.

At value 6 for Back off Tx, the energy can be minimized and delay can be reduced. When compared to the static values of 6LoWPAN as per IETF draft. To further enhancement we use soft computing techniques like Fuzzy, ANFIS.

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