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A Novel Buffer Packet Delivery Strategy for High Throughput and Better Health (HTBH) Method in Wireless Sensor Networks

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ABSTRACT- There is massive call for the Packet Sender Device Network (PSDN) primarily based on tracking of areas, figuring out the consequences of climate, detection of enemy vehicles. The PSDN could have useful Packet Sender Devices (PSD's) which can study the vicinity and then send the data from initial to receiver PSD. There are numerous constraints which have restrictions on the feature like battery, memory, and range. There is hierarchical community wherein the PSDs are spread on more than one area with every vicinity having their very own PSD's whilst communique has to manifest among PSDs of various areas then it requires chief PSD in every vicinity which have to be elected primarily based on higher battery degree, distance to base station in addition to mobility of the PSD over a duration of time. LEACH suffers from side-to-side propagation among base station and PSDs. LEACH elects the pinnacle PSD primarily based on random possibility which has consequences of Good-Bad Ratio due to the fact there are possibilities that the PSD with low battery degree be selected as a head PSD. The proposed (HTBH) method will select the head PSD based on battery level, distance between base station and PSD, the mobility of PSD. In order to deliver the data to the processing lab PSDs of the area along with head PSD are used. The packets are classified into high and low priority so that preferences can be used during the data delivery process. Along with sending the current data packets even the data packets reside within the PSD which have to send towards the processing centre. Two policies namely single threshold and dual threshold are used to evict the packets within the PSD and then moving them towards processing centre. This study proposes a higher choice of head PSD with the aid of using considering computation of element which takes into consideration battery, distance, and mobility. The communique among the detection vicinity to receiver vicinity takes place with the assist of PSD's and head PSD there with the aid of using decreasing range of hops. HTBH method is compared to LEACH and E-LEACH with respect various performance parameters.

Keywords: Packet Sender Device Network (PSDN), LEACH, E-LEACH, Packet Delivery, Throughput.

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1. INTRODUCTION

This section contains the definition of various entities used in the work, types of networks, ways in which the PSD head can be elected, parameters used to measure the performance.

1.1 Packet Sender Device (PSD)

All material on each page should fit within a rectangle of 18 x PSD can be treated as a device which is responsible for detecting the changes in the territory environment, movement of vehicles, monitoring of territory. It has various attributes like battery, memory, and a sensor in it. It is a basic building block for PSD.

1.2 Single Territory PSD

In a single Territory PSD, all the PSDs are spread in a random fashion within a bounded area limit. One PSD cannot have the same location as that of other PSD. The communication between two far away PSD can happen by making use of algorithms which are of multi hop nature.

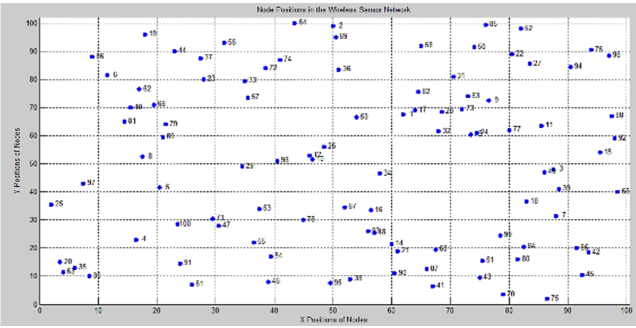

Figure 1: Single territory PSD

Figure 1 shows the single territory PSD in which all the 25 PSD are spread in a territory with bounded limits (1,50) and (1,50). All the 25 PSD have their own unique location.

1.3 Multi Territory FSN

In a multi territory PSD, a Territory of PSD have their own territory. The communication is such use cases can be of two kinds. In a territory specific communication, the communication happens between two PSD's which are within the same territory. It does not require any kind of involvement of territory head PSD for communication.

1.4 Inter Territory Communication

In a Inter Territory Communication, the communication happens between two PSD's which are in different territory. This communication requires a base station and territory head PSD to be elected. The communication link is usually established with the help of territory head PSD of multi territory for the data transmission.

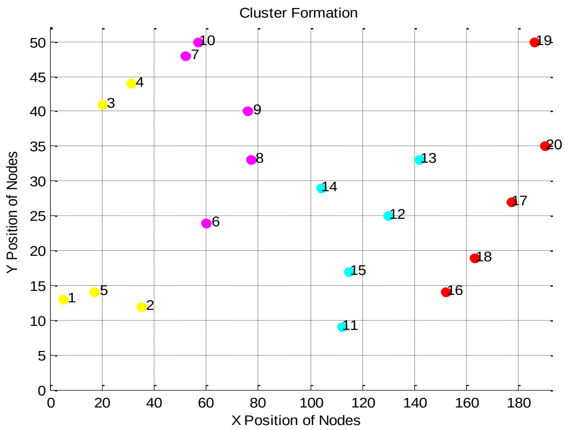

Figure 2: Multi Territory PSDN

Figure 2 shows 4 territory PSDN. First territory has the 5 PSDs in the range of (1, 50) and (1,50), For the second territory also there are 5 PSDs in the range of (51,100) and (1,50). For the third territory there are 5 PSDs in the range of (101,150) and (1,50), In the fourth territory there are 5 PSDs in the range of (151,200) and (1,50).

1.5 Selection Strategies of Territory Head PSD

In each of the territory there needs to selection of head PSD. The selection is done by making use of different techniques. For each of the territory a head PSD is chosen in each territory based on computation of probability for each PSD in territory. The PSD which corresponds to maximum value is chosen as the head PSD [1]. The criterion of selection is computed using battery level summed up with inverse of distance for each PSD and then PSD head is chosen based on maximum value [2]. The PSD are classified into LOW, MEDIUM, or HIGH with respect to distance and then LOW, MEDIUM, and HIGH with respect to remaining battery level. The PSD which has a good chance low distance and high battery is chosen as the head PSD [3]. In the proposed method the head PSD is chosen by using three different factors namely battery level, distance, and mobility over a period of time. The battery power of the PSD will come down when the PSD share in the path conformation and data packet delivery rates. LEACH is a classical system used for transmission of packets to the control center in a PSDN network. The selection of head PSD by LEACH will be by making use of the arbitrary selection of PSD in each territory using arbitrary probability selection medium. During the data deliver the scanning process will be from the generator PSD to head PSD and from there the link is established with the base station (BS), the BS will also overlook each territory until the destination PSD is reached. The selection of head PSD by LEACH causes further holes in the PSDN because there are chances that the non-performer PSD can come a head PSD. Secondly for the transmission of packets there's lot of back-and-forth propagation between the BS and the normal PSDs which reduces the battery level of the PSD by a large amount. In order to overcome the problem in LEACH the selection of PSD was bettered by making use of Fuzzy- LEACH system which selects the head PSD grounded on distance with respect to base station and energy position of the PSD. From the energy consumption measure defined in the former section bone can see that the energy spend depends upon the distance, change in position of PSD also pays an important part for the selection of head FP which causes in correct head to be named and thereby creating non-performer PSDs in the PSDN. Also, Fuzzy- LEACH follows the same data delivery medium by only varying the selection process of PSD. In order to extemporize the selection medium of head FP, reduce the hops during the data deliver, ameliorate the continuance packet data rate of PSDN the work done in the proposed method makes use of factor calculation for selection of head PSD which depends upon battery position, distance with respect to base station and time bound position changes thereby reducing the rate at which non-performer PSD do in the PSDN. There can be packets which are residing in the buffer of the PSD's and these packets can be very sensitive which have to be transmitted to the processing center. This will help in improving the Good-Bad Ratio of the PSDN.

2. BACKGROUND

In the PSDN network data delivery towards the processing centre is very important [4]. The performance of the PSDN network can be improved by optimizing the PSDs in the network along with packet delivery process [5]. The PSDs can be deployed on a terrain to monitor the workers, send the information about the strains towards the control center for a condition where the strain level is higher than threshold [6]. There are multiple ways for communication which can be either line of sight (LOS) or Non line of sight (NLOS) in the PSDN network. For the desert territory it can be LOS and for a farmland or a forest it can be NLOS [7]. The packet delivery process in the above methods will make use of base station and other PSDs to send agriculture data to processing center. Navdeep Singh and his colleagues [8] introduced an innovative approach aimed at enhancing energy efficiency through an intelligent routing protocol algorithm. The significance of conserving energy in PSDN networks cannot be overstated, given that these networks are comprised of low-power sensor nodes. This protocol is rooted in a reinforcement learning technique and introduces a novel clustering methodology within the network, established through a connected graph framework.

These aspects provide invaluable insights to designers, enabling the optimization of energy usage across PSDs. Gaining a comprehensive understanding of the energy consumption sources inherent to PSDN stands as an initial stride toward energy reduction. Consequently, the development of a precise energy model becomes imperative for the purpose of assessing communication protocols. Mohammed Farrag [9] and team present an intricate energy model tailored for PSDN. Notably, the investigation uncovers the existence of optimal transmission power levels for each modulation scheme, at which energy consumption is minimized. A model must be created for calculation of energy as well as consumption which will help in achieving an optimized PSDN. During the data transmission there's an impact on energy spend depending upon kind of noise donation which can either be White Gaussian or Non-White Gaussian noise. When the PSDs are used in the multiple paths the energy spend will increase in a drastic fashion. When these modulation ways are combined with measure of mean energy position, packet drop count along with detection we gain better PSDN capability [10]. Nishakumari and team performs a study on the enhancement of multi-hop mobility management within a PSDN ad hoc network through the application of the DVS algorithm to minimize energy consumption. The architecture comprises two pivotal phases: multi-hop task mapping and multi-hop scheduling. Through the utilization of Dynamic Voltage Scaling, these phases aim to achieve optimal energy efficiency within a PSDN ad hoc network [11]. Within this context, the central aims encompass the formulation of models and strategies to curtail energy consumption, both of which stand as pivotal goals in the design of PSDN. Mohammed Abo-Zahhad and team contributes to this field by introducing an innovative energy consumption model tailored to PSDN, rooted in the manipulation of physical layer parameters. This model is established through the meticulous calculation of aggregate energy necessary to achieve the successful reception of a single bit across Rayleigh fading channels [12]. The quantum of fading an electromagnetic wave undergoes will impact transmission of data and is responsible for determining the energy spend rate. While designing the PSDN it's important to consider the fading effect so that transmission power of a PSD can be optimized [13]. The collection of PSDs can be used to provide information on the objects, compose information on the objects and sent the information towards the Sink. But the limitations of PSD are energy, storehouse calculation and processing capability. The proper functioning of PSDN depends upon the time till which the PSD is performer. The enhancement in the performance of PSDN can be achieved with the help of forming the territory, determining better head PSD. When the packets are sent it'll go from normal PSD to head PSDs and also from head PSD's data is transmitted to the BS [14]. The energy spend has multiple way. As part of the first step there's profiling in which the same path will be used multiple times until all runs are performed energy spend will be attained as series list. Once the profiling completes the mean formula is executed to gain the average energy. For the alternate step p- value along with different identified values are used to find parameters which can be used to initiate the communication in PSDN [15]. The quantum of data being transferred towards the destination can be optimized to have lower energy spend. To achieve this quantum of spare data should be reduced [16]. Continuance rate Formulation The continuance rate will be responsible for having better PSDN. When the PSD will be used for data transfer the battery position of the PSD will be reduced. The energy spend will depend upon quantum of transmission energy, generation energy and distance between PSD. Consider a window time "T " and during this time the PSD has been used numerous times and battery position of PSD will come down due to which PSD can turn into non-performer PSD. The time duration during which there are non-performer PSD is called as 'Good-Bad Ratio' [17]-[20]. The Good-Bad Ratio definitions as per the survey can be summarized as below

Table1. Good-Bad Ratio

Good-Bad Ratio Indicator	Description
LR-1	The time difference between the end time to the start time during which Quality of Service is above a certain defined threshold [21]
LR-2	In the territory among N PSD's there will be one PSD at least of minimum count which can manage the entire PSDN [22].
LR-3	The time point at which the battery level of PSD will become zero [23]
LR-4	The duration of time during the data packet delivery ratio can be beyond a set percentage [24]

Packet Delivery rate can be increased by using different styles of transmission on occasions and scheduling of data transmission, energy garner, radiation conformation, extent and connected medium, path conformation and home conformation, data collection along with assignment of heads. The new operations make use of combination of IOT along with PSDN to break the world issues like health monitoring of cases, adversary vehicles movement. By making use of energy generation process along with energy patterns are used for conforming the communication data rate [25]. The homes can be made intelligent system by making use of energy garner medium which can be used for transferring the gobbets to destination PSD in an effective manner [26]. The parameters like duty cycle changes, adaptation of transmission power, the quantum of data being transmitted can be controlled to have better Packet Delivery rate and can be increased by making use of energy garner grounded on solar bias [27]. When the PSDN has the PSD, whose energy has depleted also it'll be no longer usable to deliver the data gobbets, the PSD can be replaced or can recharged using a energy source which can solar or grounded on automatic energy creator [28]. The energy of PSD can be increased by making use of energy garner styles which can be one of thermal, solar, wind and kinetic grounded systems. The selection of the PSD's depends upon energy position of the PSD and similar named PSD's can be increased by using energy mindfulness medium [29]. The PSD can be spread across the home and can be used for husbandry kind of use cases. For similar kind operations more content can be used. The Packet Delivery rate can be bettered by perfecting the range of transmission along with distributed; pad can help in adding the time of communication with the base station [30][31]. The bracket of PSD can be either active or non-active PSD and can be used for furnishing content in an optimized manner for the entire home. Multiple links are used to communicate the

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gobbets of detected information towards the destination PSD which will also shoot to hard control station [32]. The switch grounded system can be used for performing the ON as well as OFF functionality in order to cover the specific territory in order to ameliorate Packet Delivery rate [33].

3. HIGH THROUGHPUT BETTER HEALTH (HTBH)

This section describes the steps involved in the proposed method starting with PSDN formation, selection of head PSD, Path formation of PSD, Delivery of Packets send towards the destination using single threshold or multiple threshold approach.

3.1 Single Territory PSDN

The Single territory PSDN will place the PSDs in the random fashion in a specific territory. The territory is bounded by the limits $\{xs, xe, ys, ye\}$. *xs* is the starting dimension of the territory with respect to '*x*' dimension, *xe* is the ending dimension in the territory with respect to '*y*' dimension, *ys* is the starting dimension of the territory with respect to '*y*' dimension and ye is the ending dimension of the territory with respect to '*y*' dimension. All the PSD will have the dual set $\{xfsp, yfsp\}$ which will not match with that of other PSD in the territory.

3.2 Multi Territory PSDN

The Multi territory PSDN will place the PSDs across multiple territory in the PSDN network. Multi territory PSDN will define multi sets of $\{xs, xe, ys, ye\}$ and run on each set single territory PSDN to have PSD's independently in each territory. Each PSD will have territoryid along with $\{xfsp, yfsp\}$ as a unique identifier which will not be same as other PSD.

Multiple PSD's can have same territory id but cannot have the same$\{xfsp, yfsp\}$.

3.3 Territory PSDN Head

The system will compute the remaining energy of each PSDs in the territory, computes the distance between each PSD to the base station, takes the mobility calculation over a period of time of the PSD and use this information to cipher the selection factor for each PSD in the territory. The PSD which has the better selection factor will be chosen as a head PSD. The energy consumption measure can be set up by adding energy which is spend on each of the links within the route. It can be defined using a totality term as below:

$$\mathrm{ECM_c} = \sum_{k=1}^{Nc} \mathrm{ECl_k}$$

$$\text{Where, Nc} = \text{Numberofconnections}$$

$$\mathrm{ECl_k} = \text{Energyconsumedforthek}^{\text{th}}\text{connection} \quad (1)$$

The Energy Spend on each connection is energy needed for transmission, energy for generation and attenuation factor

$$\mathrm{ES} = 2\mathrm{E_{txPSD}} + \mathrm{E_{genPSD}} \mathrm{d(FPSD, SPSD)}^{\mathrm{EFa}}$$

$$\text{Where, } \mathrm{E_{txPSD}} = \text{energyrequiredfortransmission byPSD}$$
$$\mathrm{E_{genPSD}} = \text{energyrequiredforgeneration byPSD}$$
$$\mathrm{d(FPSD, SPSD)} = \text{distancebetweenthePSD}$$

$$\mathrm{EFa} = \text{environmentfactor} 0.1 \le \mathrm{EFa} \le 1 \quad (2)$$

The battery level for PSD can be summarized as below

$$BL(\mathrm{UPSD}) = \mathrm{CBL(CPSD)} - \mathrm{ES}$$
$$\text{Where, } \mathrm{CBL(CPSD)} = \text{currentbatterylevel}$$
$$\mathrm{ES} = \text{enegyspent}$$

$$\mathrm{BL(CPSD)} = \text{updatedbatterylevel} \quad (3)$$

3.4 Path Formation

Once the head PSD is set up in each of the territory. The generator FPN will deliver the data to the head PSD of generator territory, the head PSD will the deliver Route Request to all the head PSDs in other territory, one of them will deliver the Positive Acknowledgement and from there data is delivered to destination PSD. The path formation is summarized in *figure 3*.

3.5 Buffer Strategy Approach

The buffer strategy is defined as the ability to identify the stored packets and then send them towards the destination. In order to execute the policies. The buffer size is defined as the number of packets which are remaining in memory of Packet Sending Device (PSD). For the buffer strategy to work the design needs the count of number of packets to be picked along with certain limits known as minimum limit and maximum limit.

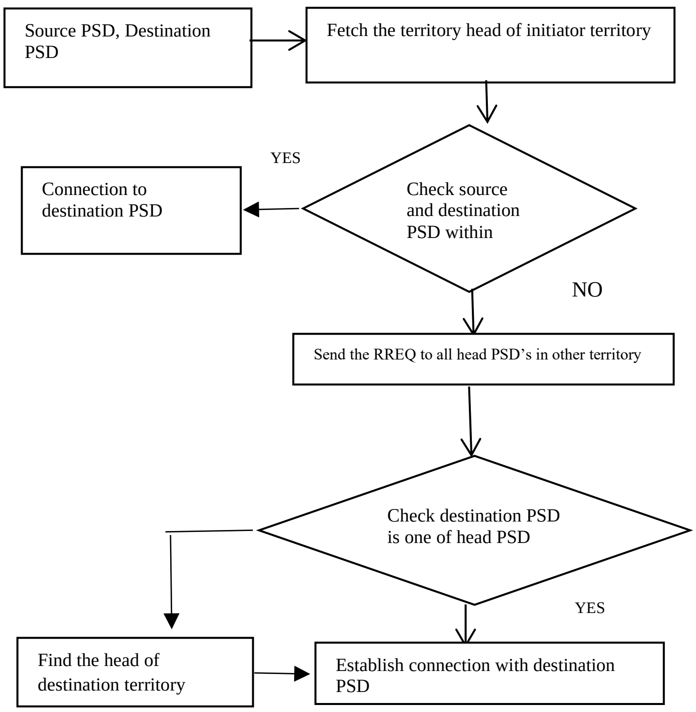

Figure 3: Path formation of PSD's

The minimum limit can be defined as below-
Find the minimum of the buffer size of all the PSDs within the given deployment.

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$$Q_{min} = min([B_1 B_2 \ldots B_{maxPSD}])$$
Where,
$Qmin = \text{min value of buffer}$
$B_k = \text{kth PSD buffer}$
$maxPSD = \text{total PSD count}$

The maximum value of buffer size is computed across all PSD's and is summarized as below-

$$Q_{max} = max([B_1 B_2 \ldots B_{maxPSD}]) - Qmin$$
Where,
$Qmax = \text{max value of buffer}$
$Qmin = \text{min value of buffer}$
$B_k = \text{kth PSD buffer}$
$maxPSD = \text{total PSD count}$

The packets which reside in memory of PSD's can be divided into low precedence and high precedence packets. The count of low precedence packets which has to be send towards destination PSD can be computed as below-

$$C_{LPR} = \sum_{i=1}^{N_{PSDs}} N_{LP}(i)/N_{PSDs}$$
Where,
$N_{LP}(i) = i^{th}$ low precedence packet count
$N_{PSDs} = \text{total PSD's count}$
$C_{LPR} = $ count of low precedance packets to be removed

The count of high precedence packets which can be send towards destination PSD can be computed as below-

$$C_{HPR} = \sum_{i=1}^{N_{PSDs}} N_{HP}(i)/N_{PSDs}$$
Where,
$N_{HP}(i) = i^{th}$ high precedence packet count
$N_{PSDs} = \text{total PSD's count}$
$C_{HPR} = $ count of high precedance packets to be removed

In order to clean up the PSDN and deliver packets towards destination PSD at a faster rate the adjustment count is defined as

$$AC = C_{LPR} + C_{HPR}$$
Where,
$AC = $ adjustment count
$C_{LPR} = $ count of low precedence packets to be removed
$C_{HPR} = $ count of high precedence packets to be removed

The packets which reside inside the PSD's are to be removed if packet delivery rate. Good-Bad Ratio and throughput to be improved. Life time ratio can be obtained by taking the ratio between good and non-good count. The Life Time Ratio can be defined as below-

$$LTR = \frac{PSD_{good}}{PSD_{bad}}$$
Where,
$PSD_{good} = $ count of PSD's in good battery state
$PSD_{bad} = $ count of PSD's in bad battery state

The good PSD can be defined as the PSD's satisfy the strategy

$$PSD_{good} = countofPSDwhoseCBL >= PSD_{BL}/4$$
Where,
$CBL = currentbatterylevel$
$PSD_{BL} = firsttimebatterylevel$
$PSD_{good} = goodPSDcount$

The bad PSD is opposite to that of good PSD. The single buffer precedence can be summarized as below;

Process: **Single Buffer Threshold Strategy**
Input: Path between source PSD and Destination PSD, Buffer Sizes for all PSD's
Output: Packets delivered to Control Center based on single buffer threshold criteria
Steps:
1. Find the path using Path Formation technique
2. Compute $C_{LPR}, C_{HPR}, Q_{min} \& AC$
3. Measure the count of path
4. Start from the 1st PSD to till the end PSD in the path
5. Find the i^{th} PSD low & high precedence packet count
6. Find the i^{th} PSD buffer size $BS(i)$
7. If $BS(i) < Q_{min}$ then

$$U_{HP}(i) = C_{HP}(i) - (C_{HPR} + AC)$$
$$U_{LP}(i) = C_{LP}(i) - (C_{LPR} + AC)$$
where,
$U_{HP}(i) = countofHPpacketsfori^{th}PSD$
$U_{LP}(i) = countofLPpacketsfori^{th}PSD$

8. if $BS(i) >= Q_{min}$

$$U_{HP}(i) = C_{HP}(i) - (C_{HPR} + AC)$$
$$U_{LP}(i) = C_{LP}(i) - (C_{LPR} + AC)$$
where,
$U_{HP}(i) = countofHPpacketsfori^{th}PSD$
$U_{LP}(i) = countofLPpacketsfori^{th}PSD$

9. The new buffer size for the i^{th} PSD

$$NBS(i) = U_{HP}(i) + U_{LP}(i)$$

The multiple threshold approach can also be used to send packets towards the destination PSD. The multiple threshold packet delivery can be summarized below;

Process: **Multi Threshold Buffer Strategy**
Input: Path between source and Destination PSD, Buffer Sizes for all PSD's
Output: Packets delivered to Control Center based on single buffer threshold criteria
Steps:
1. Find the path using Path Formation technique
2. Compute $C_{LPR}, C_{HPR}, Q_{min}, Q_{max} \& AC$
3. Measure the count of path
4. Start from the 1st PSD in the path till the end PSD in the path

a) Find the i^{th} PSD low precedence packet count
b) Find the i^{th} PSD high precedence packet count
c) Find the i^{th} PSD buffer size $BS(i)$
d) If $BS(i) < Q_{min}$ then

$$U_{HP}(i) = C_{HP}(i) - (C_{HPR} + AC)$$
$$U_{LP}(i) = C_{LP}(i) - (C_{LPR} + AC)$$

$$\text{Where, } U_{HP}(i) = \text{count of HP packets for } i^{th} \text{ PSD}$$
$$U_{LP}(i) = \text{count of LP packets for } i^{th} \text{ PSD}$$

e) if $BS(i) >= Q_{max}$
$$U_{HP}(i) = C_{HP}(i) - (C_{HPR} + AC)$$

$$\text{Where, } U_{HP}(i) = \text{count of HP packets for } i^{th} \text{ PSD}$$

Only HP packets are delivered towards destination PSD

f) If $BS(i) >= Q_{min} \&\& BS(i) >= Q_{max}$

$$U_{HP}(i) = C_{HP}(i) - (C_{HPR} + AC)$$
$$U_{LP}(i) = C_{LP}(i) - (C_{LPR} + AC)$$

g) The new buffer size for the i^{th} PSD
$$NBS(i) = U_{HP}(i) + U_{LP}(i)$$

4. COMPARISON PARAMETER

The measure of the performance parameters is done for HTBT.

4.1 Time Performance

The time performance is used to determine the time taken by the PSD to establish an end-to-end path and send a packet between two PSDs. It can be defined as follows

$$DP = Tackr - Tsend$$
$$\text{Where, Tackr} = \text{time at which acknowledgement has been recieved}$$
$$\text{Tsend} = \text{time at which packeth as been send}$$

$$DP = \text{delay} \quad (4)$$

4.2 Route Count Performance

When a path for communication between two PSD is established then the number of connections between two PSDs is defined as the Link count. Consider the following route between the PSD A and PSD X.

PSD-A ----> PSD-Y ---->PSD-Z--->PSD-V. For the above route there are 4 connections between the PSD-A which is the first PSD and PSD-V which is the last PSD.

$$LC = PathLength - 1$$

$$\text{Where, PathLength} = \text{number of FSPs usedinroute}$$

$$LC = \text{link count} \quad (5)$$

4.3 Energy Dissipation Measure

The energy dissipation measure can be found by adding energy which is spend on each of the links within the route.

$$ECM_c = \sum_{k=1}^{Nc} ECl_k$$

$$\text{Where, Nc} = \text{Number of connections}$$

$$ECl_k = \text{Energy consumed for the } k^{th} \text{connection} \quad (6)$$

The Energy Spend on each hop depends upon energy required for transmission, energy for generation and environment factor

$$ECl = 2E_{txFSP} + E_{genFSP} d(FFSP, SFSP)^{EF}$$

$$\text{Where, } E_{txFSP} = \text{energy required for transmission byFSP}$$
$$E_{genFSP} = \text{energy required for generation byFSP}$$
$$d(FFSP, SFSP) = \text{distance between the FSP}$$

$$EF = \text{environment factor } 0.1 \le EF \le 1 \quad (7)$$

4.4 GOOD PSD Count

The GOOD PSD Count will determine the count of PSD which can perform better in the network and have sufficient amount of battery level to operate in the PSDN

$$PFSPC = \text{countofFSPwhoseCBL} \ge \frac{FTBL}{4}$$
$$\text{Where, CBL} = \text{current battery level}$$
$$FTBL = \text{first time battery level}$$
$$PFSPC = \text{performer FSP count} \quad (8)$$

4.5 BAD PSD Count

The BAD PSD Count will determine the count of PSD which causes holes in the network and have lesser amount of battery level to operate in the PSDN

$$NPFSPC = \text{count of FSP whose CBL} < \frac{FTBL}{4}$$
$$\text{Where, CBL} = \text{current battery level}$$
$$FTBL = \text{first time battery level}$$

$$NPFSPC = \text{non performer FSP count} \quad (9)$$

4.6 Control Data Ratio (CDR)

The Control Data Ratio Measure is defined as the ratio of number of control chunks which were used to send a set of data chunks.

4.7 Good Bad Ratio

Good-Bad ratio can be obtained by taking the ratio between Good and Bad count. The Good-Bad Ratio can be defined as below

$$LTR = PCFSP/NPCFSP \quad (10)$$

4.8 Remaining Energy of PSDN

The remaining energy of PSDN is obtained by adding the sum of individual remaining energy of PSD in the PSDN. The remaining energy is defined as below

$$REFSPN_c = \sum_{k=1}^{Nfsp} CE(FSP)_k$$
$$\text{Where, Nfsp} = \text{Number of FSP in network}$$

$$CE(FSP)_k = \text{Current Energy of kth FSP} \quad (11)$$

5. RESULTS AND DISCUSSION

This section describes the existing methods which are used for comparison with proposed solution.

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5.1 LEACH Method

The selection of PSD in a LEACH method will happen in a random probabilistic fashion. This process is repeated for every territory in the Multi territory PSDN. The path formation for the LEACH based approach will take the initiator PSD, send the data to head PSD, from the head PSD the communication will happen to the Base Station, the Base Station will scan each of the territory's one by one until the destination PSD has been reached.

5.2 E-LEACH Method

The E-LEACH is also divided into multiple sections- Selection of Head PSD and chunk delivery using path formation which remains same as that of LEACH. The selection of Head PSD is done by making use of energy level and distance with respect to base station thereby improving the Good-Bad Ratio compared to LEACH but still suffers from throughput and link count as the chunk delivery is based on LEACH.

5.3 Experimental Setup

The experimental results of the HTBT, buffer strategy and its comparison with existing LEACH and E-LEACH method are summarized. To run the HTBT method first the PSDN network formation has to be done. *Figure 4* shows the PSDN formation with four independent areas in which 5 PSDs are deployed in each area. The first area has the PSD's namely PSD1, PSD2, PSD3, PSD4 and PSD5. The second area has the PSD's from PSD6 to PSD10, the third area has the PSD's from PSD11 to PSD15 and fourth area has the PSDs in the range of PSD16 to PSD20.

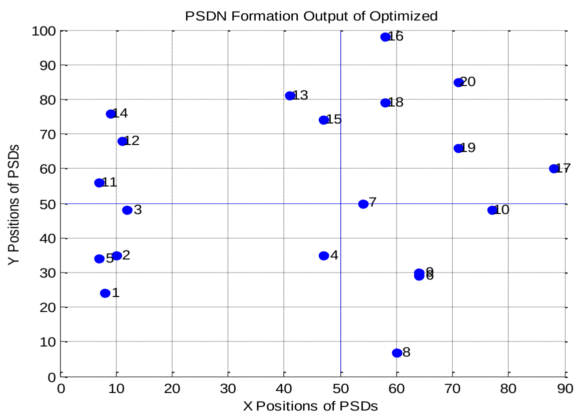

Figure 4: PSDN Formation

Table 2: Experimental Input

Name	Value
Number of Areas	4
End points for Area1	$X_s = 1, X_e = 50, Y_s = 1, Y_e = 50$
End points for Area2	$X_s = 51, X_e = 100, Y_s = 1, Y_e = 50$
End points for Area3	$X_s = 1, X_e = 50, Y_s = 51, Y_e = 100$
End points for Area4	$X_s = 51, X_e = 100, Y_s = 51, Y_e = 100$
Number of PSD's in Area1, Area2, Area3, Area4	5, 5, 5, 5
Transmission Energy	20 mJ
Generation Energy	10 mJ
Environment Variable	0.5
Packets Assigned in Buffer	Randomized Fashion

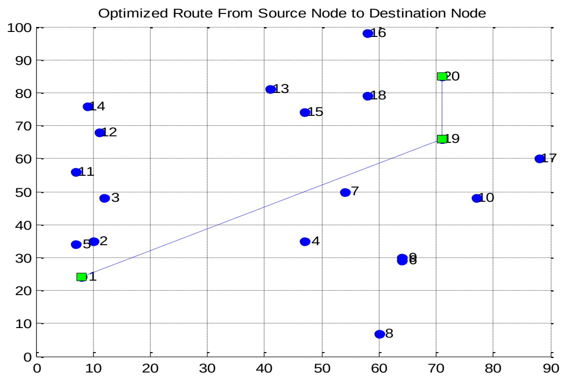

Figure 5: Path Formation End to End

Figure 5 shows the end-to-end path formation and then from the source PSD to destination PSD. PSD1 to PSD 20 path is formed. Since PSD1 is the head PSD it directly communicates to PSD19 from there the link is established with PSD20.

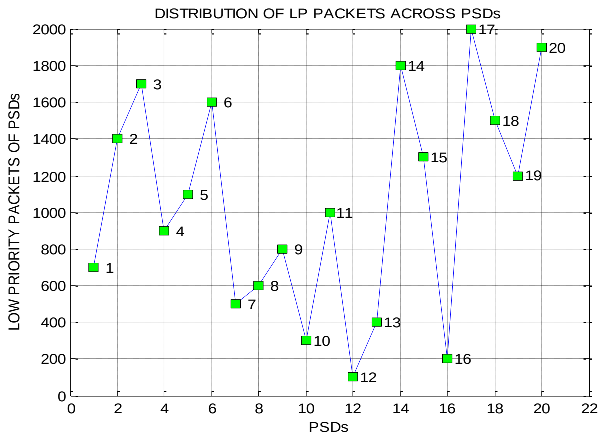

Figure 6: Low Precedence Packets PSD's

Figure 6 shows the Low Precedence packets across all the PSD's. PSD1 has 700 LP packets, PSD12 has 100 LP packets in a similar fashion all PSD's have their own count of packets.

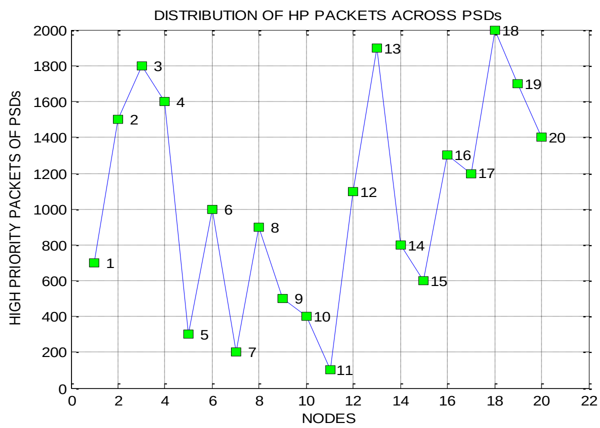

Figure 7: High Precedence Packets PSD's

Figure 7 shows the High Precedence packets across all the PSD's. PSD1 has 700 HP packets, PSD12 has 1100 HP packets in a similar fashion all PSD's have their own count of packets.

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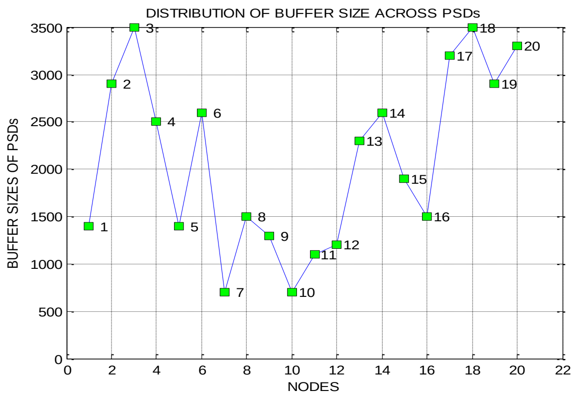

Figure 8: Buffer size PSD's

Figure 8 shows the buffer size across all the PSD's. Totally there are around 20 PSD's. PSD1 has the buffer size of 1400, PSD2 has the buffer size of 2900, PSD3 has the buffer size of 3500.

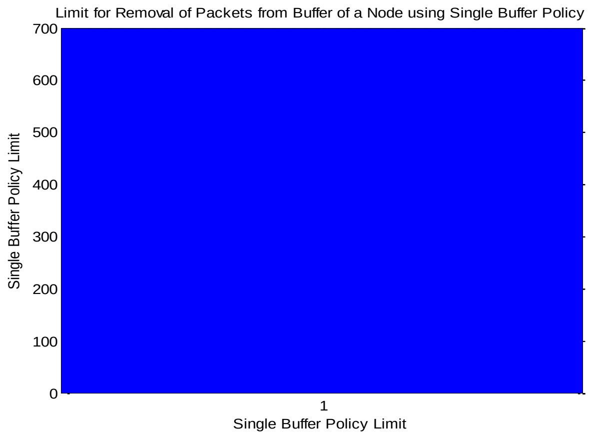

Figure 9: Lower Precedence Threshold Limit

Figure 9 shows the lower precedence threshold has a value of 700 for lower precedence threshold. The value is computed as the minimum buffer size in the PSD.

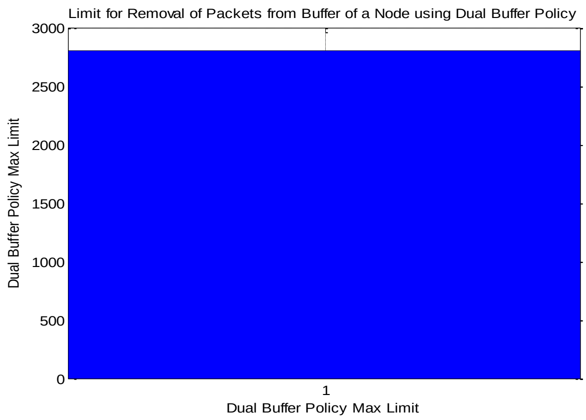

Figure 10: High Precedence Threshold Limit

Figure 10 shows the high precedence threshold has a value of 2800 for high precedence threshold. The value is computed using maximum buffer size and minimum buffer size and taking the difference between them.

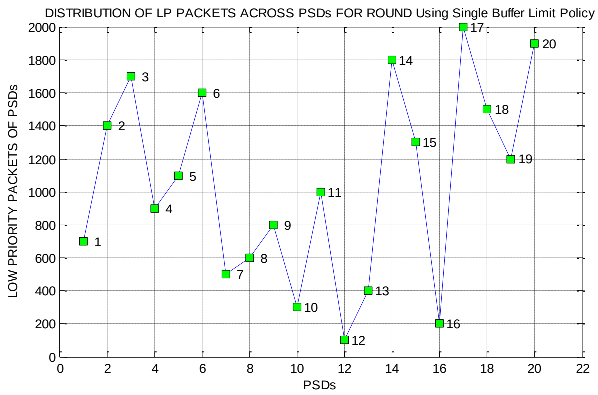

Figure 11: LP Packets Distribution

Figure 11 shows the Low Precedence (LP) packets remaining within the PSDs after the Single Buffer Threshold Strategy in executed. The counts of packets are the remaining LP packets within memory of PSD after the strategy has been executed. Before the single buffer strategy is executed the PSD1 has 700 LP packets while PSD 19 has 1200 LP packets, after the single buffer strategy has been executed then remaining packets for PSD1 and PSD19 are 700 &1700 LP packets respectively.

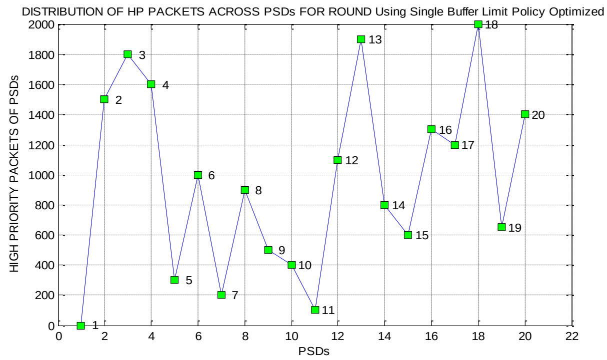

Figure 12: HP Packets Single Buffer Strategy

Figure 12 shows the High Precedence (HP) packets remaining within the PSDs after the Single Buffer Threshold Strategy in executed. The counts of packets are the remaining HP packets within memory of PSD after the strategy has been executed. Before the single buffer strategy is executed the PSD1 has 700 HP packets while PSD 19 has 1200 HP packets, after the single buffer strategy has been executed then remaining packets for PSD1 and PSD19 are 700 HP packets, 650 HP packets respectively.

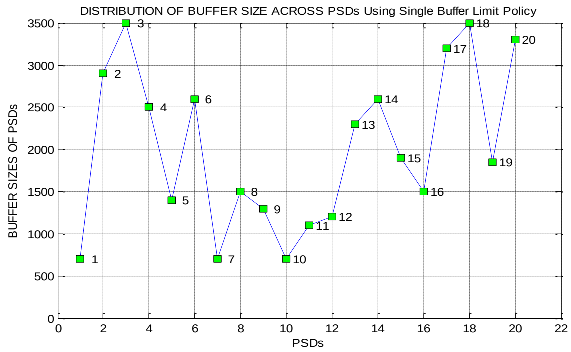

Figure 13: Buffer Size Single Buffer Strategy

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Figure 13 shows the remaining packets within the PSD's. Before Single Buffer Strategy was executed the PSD's used in the route namely PSD1 and PSD19 had 1400 packets, 2800 packets. After the Strategy was executed the remaining packets in PSD1 are 700 and then for PSD 19 the remaining packets are 1850.

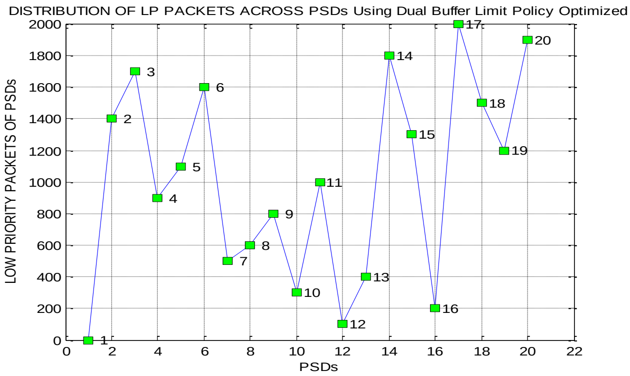

Figure 14: LP Packets for Multi Threshold Buffer Strategy

Figure 14 shows the LP Packets for Multi Threshold Dual Buffer which are packets remaining after dual buffer strategy has been executed. Before the execution of Multi Threshold Strategy the packets in PSD1 and PSD19 are 700 and 1200 packets. After the execution of Multi Threshold Strategy the packets which are remaining in PSD1, and PSD 19 are 0 and 1200 packets.

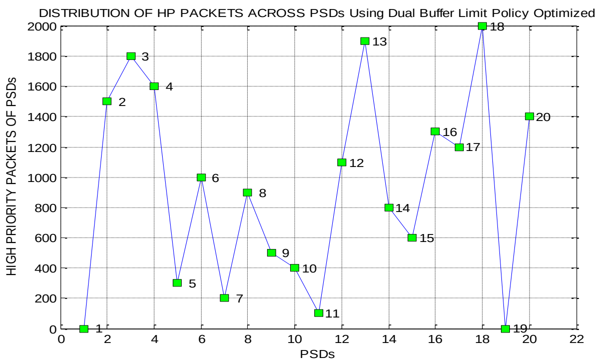

Figure 15: HP Packets for Multi Threshold Buffer Strategy

Figure 15 shows the HP Packets for Multi Threshold Dual Buffer which are packets remaining after dual buffer strategy has been executed. Before the execution of Multi Threshold Strategy the packets in PSD1 and PSD19 are 700 and 1200 packets. After the execution of Multi Threshold Strategy the packets which are remaining in PSD1, and PSD 19 are 0 and 0 packets.

Figure 16 shows the Packets remaining for Multi Threshold Dual Buffer which are packets remaining after dual buffer strategy has been executed. Before the execution of Multi Threshold Strategy the packets in PSD1 and PSD19 are 1400 and 2900 packets. After the execution of Multi Threshold Strategy the packets which are remaining in PSD1, and PSD 19 are 0 and 1200 packets.

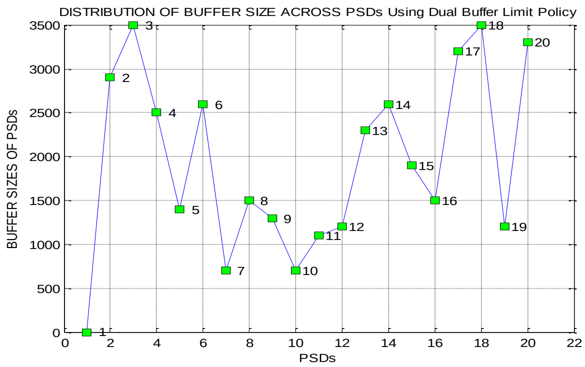

Figure 16: Buffer Size for Multi Threshold Buffer Strategy

From the *figure 17* the PSD's which participates in the routing process have cleaned up their buffers which will improve the network health. Before execution packets for PSD1 are 1500 and then after execution packets for PSD1 are 1400. For PSD19 before execution packets are 2900 and after execution 1700 packets.

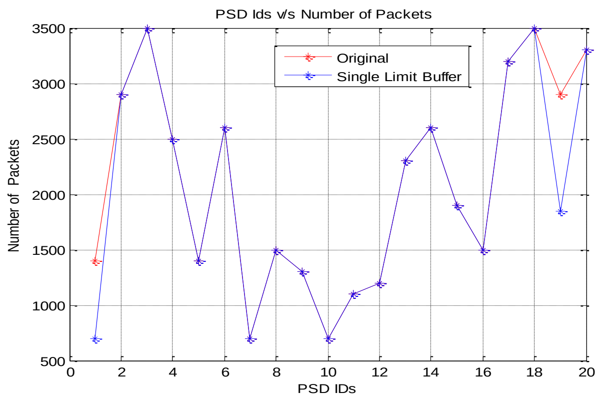

Figure 17: Packets Counts Comparison with Single Threshold Buffer Strategy

From the *figure 18* the PSD's which participates in the routing process have cleaned up their buffers which will improve the network health with respect to dual threshold buffer strategy. Before execution packets for PSD1 are 1400 and then after execution packets for PSD1 are 0. For PSD19 before execution packets are 2900 and after execution 1200 packets.

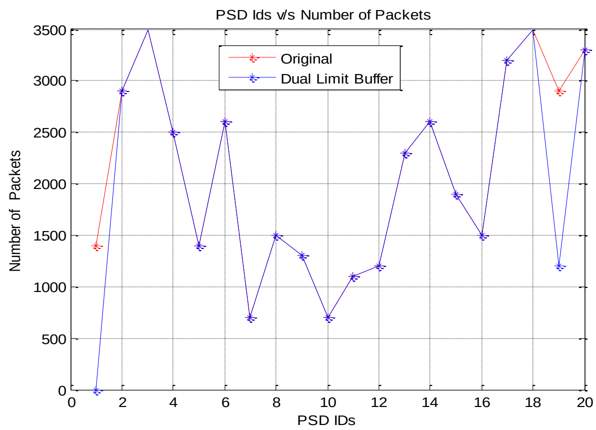

Figure 18: Packets Counts Comparison with Dual Threshold Buffer Strategy

Table 3 shows the improvement of HTBH compared to LEACH and E-LEACH. Total time has been improved by 28.65% when compared to LEACH and 52.24% compared to E-LEACH. In a similar fashion improvement have been made with respect to other factors.

Table 3: Improvement to Existing Methods

Parameter Name	LEACH	E-LEACH
Total Time in ms	28.65%	52.24%
Route Performance Count	58.28%	31.20%
Total Energy Consumed	62.15%	21.99%
GOOD Count	88.47%	85.98%
BAD Count	46.39%	44.65%
Good-Bad Ratio	98.40%	95.44%
Throughput	14.62%	14.65%
Control Data Ratio	58.28%	32.20%

6 CONCLUSION

The paper first describes the different kind of networks, followed by deployment strategy, approaches used to deliver the packets, head PSD selection methods. After that HTBH method deployment process, head selection in each group, path formation, single buffer threshold strategy and dual buffer threshold policy has been defined. This is followed by LEACH and E-LEACH methods description. After that experimental results are presented which conclude the performance of HTBH provided improvement of 8 parameters. LEACH selects the head PSD based on random probability, for the data delivery the initiator PSD will send the head PSD of source area, the data is then sent to base station, the base station scans all the areas until processing center is reached. The probability pf selecting the head PSD which is under performing is higher and also hops are higher during delivery of data. In order to improve the LEACH, E-LEACH selects the head based on higher battery level and multiple heads are chosen which are primary and secondary. The data is sent to the processing center by taking help from PSDs, primary and secondary PSD. The E-LEACH has better health or lifetime ratio compared to LEACH due to good criteria for head PSD but suffers from lower data delivery due to involvement of multiple head PSDs and only battery level criteria. The proposed HTBT method will compute battery level, distance with respect to base station, mobility of PSDs in order to pick head PSD which improves the performance in terms of network health, life time ratio. It makes of multi threshold policy in order to improve packet delivery. The comparison of HTBT is done with existing methods namely LEACH and E-LEACH with respect to energy, hops, time taken, network health and from the experiment HTBT performs the best. HTBT execution is done for a free space path loss model.

7. FUTURE SCOPE

HTBT performance can be future studied on other radio propagation models like Log Normal shadowing and Free outdoor model. The antenna or sensors used in the PSD are dipole in nature which can send sequential data or receive sequential data. The Packet delivery ratio can future be increased by sending parallel streams of data to the destination.

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