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Lifetime and Performance Enhancement in WSN by Energy-Buffer Residual Status of Nodes and the Multiple Mobile Sink

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Abstract:
Wireless sensor networks (WSNs) are consisting of spatially scattered independent nodes with sensors to sense and keep the ecological states. In WSNs, the nodes are outfitted with constrained sources of energy and buffer, hence, energy efficiency is an important challenge. Therefore, efficient techniques in routing based on energy and buffer are essentially required in WSNs to provide the network lifetime (NL) enhancement with less energy utilization. To enhance the NL and network performance in WSNs energy-efficient direction-finding practice is tremendously needed with multiple sink. Hence, by using clustering and energy balancing process with the help of multiple sink it can be achieved effortlessly in WSN. Furthermore, for those networks having constrained energy and storage capacities, well-organized power consumption is a significant issue to sustain, expand and enhance the network lifetime (NL). For that purpose, we are using data aggregation technique in an efficient energy approach to collect and aggregate data, so that network lifetime will enhanced**.** These all terms can be dominated with energy-efficiency routing techniques. Since, it is one of the basic sources for organizing the total energy of the wireless network. Hence, cluster-based routing in with energy-balancing is proposed for achieving the network performance, lifetime as well as energy-efficiency in WSN. Furthermore, by making multiple movable sink the network performance and network lifetime can be further enhanced for the outsized WSNs. Hence, we proposed a routing protocol "Energy-Buffer Residual Status (EBRS) with Multiple Mobile Sink" to enhance the lifetime and performance of the network in WSN. The outcomes show that our protocol outperforms to improve the networks performance and prevent the creation of intermediate bottleneck node in comparison with the existing routing protocols.

Keywords:*Wireless Sensor Networks, Network Lifetime, Network Performance, Sensor Node, Bottleneck Node, Node Energy, Node Buffer, Node Lifetime, Energy Efficiency, Cluster Head, Routing, Mobile sink, Residual Status.*

I. INTRODUCTION

In WSNs the sensed data transmitted to the external world all the way through the sink node [1]. In wireless networks the sink acts as an intermediary node between basic nodes and the external world. Furthermore, the communication process in WSN is done either by single- or multi-hop technique based on the distance between the sink and the sensor nodes [2]. Furthermore, the location of the sink node is an important aspect to evaluate and enhance the network performance and lifetime [3]. The sensor nodes might expire due to the exhaust of energy during the mission, as they are equipped with limited irreplaceable batteries [4]. The situation directly impact on the performance of the WSN and network lifetime[5]. Thus the suitable energy efficient mechanism is required to utilize the available node energy in an efficient way [6].

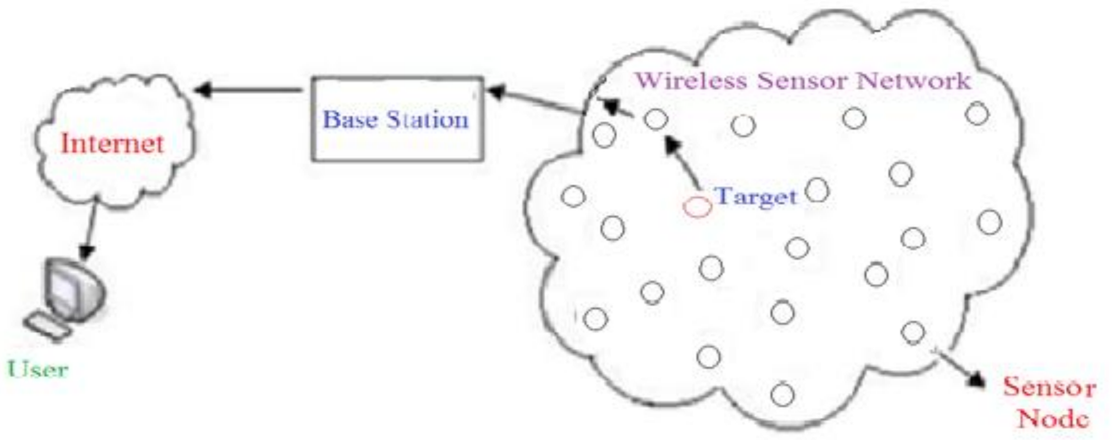

Fig. 1.Basic structure of WSN

The placement of a neighbor node to sink in WSN is also animportant parameterand can enhance the network lifetime in WSN.Mainly, theneighbornode to the sink faces an extra load and drops the data due to insufficient buffer. Moreover, the neighbor of sink node exhaust soon due to the depletion of energy. Thus the placing the sink node in a suitable position in WSN is a quite essential design issue and it will influence the performance as well as the network lifetime of the WSN.Thus the paper aims to compute the residual status of the sensor nodes in WSN in terms of the battery and buffer. Further, dynamic deployment of the sink node position is based on the computed residual status of the sensor nodes with respect to buffer and energy (EBRS) [7].

The remnants of the paper is prearranged as, the part II will give the literature review, IIIrd will show the proposed work in fourth part performance comparison with the existing work is done and finally the conclusion is made in the fifth part.

II. Literature Survey

The wireless sensor network (WSN) is one of the greatest technology which gains high attention towards the researcher from the last few decades. WSN is composed of the number of wireless sensors nodes spread over the communication region for sensing and detecting the surrounding environment. These are self-directed nodes used to collect the environmental states such as humidity, gravity, temperature, etc [8]. WSNs are an access, between the nodes and a user, to provide wireless connectivity among the wireless distributed nodes and wired surroundings (figure 1). These networks are broadly used for data exchange between two or more sensor nodes (SNs). These SNs with multi-functionality are wireless devices with constrain energy. Hence, for achieving the given application a cluster of sensor nodes are formed to gather the information from the atmosphere surrounds. Additionally, it is used in numerous applications to monitor different objective or disorder in the environment mainly like, temperature, pressure, and sounds [9].

Additionally, all the nodes are associated with one or numerous sensor nodes. These wireless nodes have different parts: like an energy source, an electronic circuit for interfacing, a microcontroller, a radio transceiver, and usually a battery, in embedded form. However, these resources such as battery power, memory capacity, highly sensitive, processing capability and sensing range are constrained. Hence, the available energy of the network must be utilized in such a way that the given task should be fulfilled smoothly [10]. The main issue in WSNs are power consumed by each sensor node is directly proportional to the whole networks lifetime so that for maximizing the network's lifetime the node should consume less power. Furthermore, in WSN, delivery of data packets over any channels, like noisy, error-prone, should be reliable. WSNs are widely used to transfer the information data cooperatively to the sink through the network. It makes use of radio signals for exchanging the data between two or more SNs. The communication between the SNs takes place in wireless manner [11].Quite a lot of challenges are there in working, usage and the exploitation of the sensor nodes. The figure below shows various SNs which collects the information from the nearby atmosphere and transfer the collected information to the target node (sink) through gateway. It integrates a gateway between the nodes and a user to provide wireless connectivity to both wireless distributed nodes and wired environment [12].

A good wireless network includes the limitation in consumption of energy for nodes with battery as a source (Energy Efficiency), scalability to a large scale of distribution, node failure handling capacity (responsiveness), simple in usage, designed in cross-layered, should have the capability to ensure severe surrounding conditions, reliability and mobility. A WSN with these characteristics can prove to be very beneficial and if not can result in a network that suffers from overhead. Energy efficiency is the most important factor when developing WSN routing protocols, which has a direct impact on the network lifetime. In literature lot of work has done to achieve energy efficiency in WSNs. Furthermore, several surveys are there to develop energy-efficient routing protocols. Some of those literatures on routing protocols are presented with the discussion of comparison of existing protocols and our work [13]. A survey done on routing protocols on WSNs is discussed in which classifies the routing protocols. Thus, the survey describes the limited supply of energy, computing power and bandwidth of the wireless sensor nodes along with the advantages and disadvantages of each routing protocol. In this work, we compare energy-efficient routing protocols comprehensively focusing on energy efficiency issues to help the researchers on their work [14].

III. Proposed work

To enhance the performance and network lifetime in WSN through the mobility based mechanisms by changing the location of the sink i.e., making the sink movable. In this ideology the mobile sink will stayat some location which is efficient to collect and gather the data in the network. These locations are the set of different selected spots in the network for the movable sink node based on the EBRS value to receive the sensed data from the base nodes. This selection of the locationswill maximizethe network lifetime (NL), energy efficiency, and scalability of the network. Thus the placing of the sink at a suitable location in the network is a reasonablyessential design issue which influences the network lifetime as well as the performance. In this work wedesignaproficientsystem for deploying the multiple sink nodes to a position which is suitable for collection and gathering of data.

In WSN, due to insufficient space, the neighbor sensor nodes to the sink drop the packets form its constrained buffer and additionallydie early due todrain of the energy in multi-hop type of setting. Because, the nodes neighbor to the mobile sink node gets extra loaded, and through them only the data packets aretransmitted to the sink node. If the thesefellow to the sink nodes gets more data than its processingcapacity, then automatically this

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node will drop the data packets due to its limited buffer. Besides, it is a fact that to process data received from the supplementary nodes takesadditional energy which causes the drain of their sources earlier than other nodes. This early die of the nodes will directly effect on the performance in respect with the network coverage, energy efficiency, and Lifetime of the network. Thus, our work is proposed aenergeticposition of the numerousmobile sink based on the sensor nodes EBRS value. This computation of EBRS for the nodes as well as the placement mechanism of the movable sinks is explained in the following sub sections [15].

Data gathering is a fundamental task of WSN. Study says that the neighbor node to the sink deplete its energy faster than those far apart nodes. It happens due to the heavy overhead of forwarding messages. Due to this the nodes consumes energy non-uniformly which causes reduced network lifetime. The main aim behind making the sink movable is to balance the consumption of node energy. It can efficiently enhance network lifetime without bringing bottleneck issue which affects as a negative impact on the WSN. In this manner sink moves towards the nodes which are surrounded to it with heavy data load. Hence, sink will move towards that nodes resulting in energy consumption balancing and interns will give enhanced network lifetime. This topology i.e., sink node with heavy surrounded nodes makes a “hotspot”in the network [16].

For small applications of WSNs a single sink node is sufficient to gather the data transmitted from the sensor nodes. But, in large applications one movable sink node is not sufficient to gather the data transmitted because there are large numbers of sensor nodes which transmit the data towards the mobile sink. Hence, co-operative processing of data has been done for the transmitted data from base nodes to the sink of the network. In this process the source nodes spent more energy to transmit the data of other source nodes and itself also. Because, the cooperativedata processing by the nodes reduces the consumption of energy of the individual node. An ideology is made for the large networks between the source nodes and sink a multiple mobile sinks are used to advance the minimization of energy consumption and enhance the network lifetime. In large networks clustering plays vital role for making the wireless system energy efficient. We can distinguish the sink mobility in three different ways as predictable, random, and controllable [17].

3.1 Energy residual status (ERS) of the node

The sensor nodes deployed in the network equipped with limited batteries which can’t be replaced within the operation. To improve the network lifetime and performance, the data packets sending nodes must communicate in such a manner that leastamount of power is consumed as well as the remaining energy state of the node should be considered. Thus, it is essentially needed that to compute the residual capacity of the node to process the number of packets in its available energy. In WSN, exhausting power of the node occurs at nodes that are neighbor to the sink, as they contract more traffic due to their location in the network [18]. Thus this paper computes the residual status of the node in its available energy as follows:

Considering a multi-hop WSN with number of nodes equipped with E joules of energy and it can handle the n packets. The energy require to process the packet P_i is determined by the following equation:

$$E(P_i) = e_r + e_t + e_p \dots\dots\dots..(1)$$

Furthermore, the remaining energy after processing of packet is computed as follows

$$E_{res} = E - E(P_i) \dots\dots\dots\dots(2)$$

The remaining packet processing capacity of the sensor node is computed by the following equation

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$$CRP = \frac{E_{res}}{E(P_i)} \; \forall \; E_{res} \geq E(P_i) \ldots \ldots \ldots (3)$$

Threshold packet processing capacity of the sensor node is computed as follows

$$CRP_{Th} = \frac{(75\%)*E}{E(P_i)} \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The location of the movable sink must be changed if the neighbor node of the sink packet processing capacity is lessthan the threshold packet processing capacity.

3.2 Buffer residual status of the node

The nodes deployed in the network outfitted with constrained buffer space. The buffer space is alsoimportant parameters to enable the communication in the multi-hop infrastructure-less networks. The efficient way of utilizing buffer space for communication leads to enhance the packet delivery, energy efficiency and reduces the delay and prevents the wastage of other network resources. On the other hand, buffer overflow due to traffic load during the communication leads to negative impact on the packet delivery and energy efficiency and network life time. In WSN, buffer overflow due to high traffic load occur at the sensor nodes that are neighbor to the sink node. Thus, an early congestion finding algorithm is required to detect the congestion at the nodes buffer that are neighbor to the sink node [19]. Thus the traffic load of the sensor nodes need to be computed at network layer and according to that the mobile sink position must be determined. The number of packets queued at the node buffer is determined by the help of Random Early Detection (RED) gateway as follows:

$$\text{Averagenewqueue}(Q_{avrg}) = (\text{Weighted constant}) * \text{Instant Queue} + (1 - \text{Weighted constant}) * \text{Averageoldqueue} \ldots.. (5)$$

Subjective constant value is determined by the time constant value of low-pass filter.

Threshold queue rate of buffer space is kept in this approach as

$$\text{Threshold buffer}(Q_{Th}) = 75\% \text{ of Buffersize} \ldots\ldots\ldots\ldots\ldots (6)$$

The mobile sink locationshould be altered if the neighbor node's size of buffer space is less than the threshold value of the buffer.

3.3 Location finding of the mobile sink

The wireless network consists of mobile sink with satisfactorypower and processing capacities. The sink primarily deployed in the network randomly with the identified location. In this paper we assumes that the network consist of the position finding system to determine location of the sensor and sink nodes. During the communication phase all the sensor nodes in the WSN computes the residual buffer status and packet processing capacities respectively. This computed data is transmitted to the mobile sink. Afterword, sink authenticate its neighbor nodes remaining buffer status and packet processing capacity and evaluate the values with the threshold values [20], which are computed by equations(6). If the value is more than threshold value then the position of the sink node does not change. If not, the sink location is changed to the nearer node which satisfies the threshold status of buffer and packet processing capacity. The distance between movable sink and the sensor node is computed by the following equation(7).

$$D = \sum_{n=1}^{N} \sqrt{(A_i - A_s)^2 + (B_i - B_s)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Where,

$D = \text{Distance between the mobile sink and } i^{th} \text{ node}$

$N = \text{Total number of nodes n the network}$

$(A_i, B_i) = i^{th} \text{ node location}$

$(A_s, B_s) = \text{ sink node location}$

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Algorithm 1:- Dynamic replacement of the mobile sink node in WSN home network

1. Process for dynamic replacement of the sink $\left(N, CRP, CRP_{Th}, Q_{avrg}, Q_{Thre}, D\right)$
2. Obtain the positions of the N nodes along with theirCRP and Q_{avrg} values
3. Make sure the condition of the neighbor node of the sink by

   if ($CRP \geq CRP_{Th}$)&&($Q_{avrg} \geq Q_{Thre}$)
   {
   Sink locationdo not modify
   }
   Else
   {

1. Verify the number of nodes which satisfies the threshold status about the buffer and processing capability and also calculate the distance between sink and the sensor nodes.
2. Find out the nearbyposition node, which fulfill the threshold status of the buffer and the capability to process the packet.
3. Relocate the sink to presentlocation to the neighbor position to the node as per the threshold values of the buffer and packet processing capacity

   }

IV. Outcome performances

The performance assessment of the work(proposed and existing) is carried out in the same network surroundings with different calculation metrics which are described as follows. We used the Network Simulator of version NS2.34/2.35. We are considering uneven number of nodes with RWP mobility model and the pause time period as 10 m/s. All the nodes in the network are prepared with a 10 joules of energy battery initially and 300m as a fixed range of transmission. The MAC card having data rates of 2 Mbps is used which is an IEEE 802.11 MAC card. The transmitting and receiving power is set with a limit of 400mW and 200mW respectively. Simulation period is set as 1000s.

All the threshold values could be set at network initialization time only. Hence, these values can be changed depending on the network sensitivity and its application.

Table 1
Network Simulation Parameters

Parameter	Standards
Simulation Instance	1000 s
Total Nodes used	100
Used Layer	Logical Link
MAC protocol	802.11
Mobility method	Random waypoint
Network layer	SKA, ACK, Proposed
Communication	Two-Ray Ground
Method for making Queue	Drop-Tail priority
Source	10j
Traffic form	CBR
WSN Area	100m x100m

The output performances of different approaches are shown below. We are making comparisons with different metrics in relate with the network lifetime enhancement, energy and performance efficiency of proposed and existing routing protocols. It is depicted that the

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performances of the proposed work in all the metrics are outperforming in contrast with the existing work.

Throughput:

Throughput will give the rate of transmitted data in a particular time period, at which messages are delivered productively, during the process of communication in the network. It is computed with changeable number of nodes with simulation time. The outcomes depicts that the throughput of existing work is very less as compare to the proposed one.

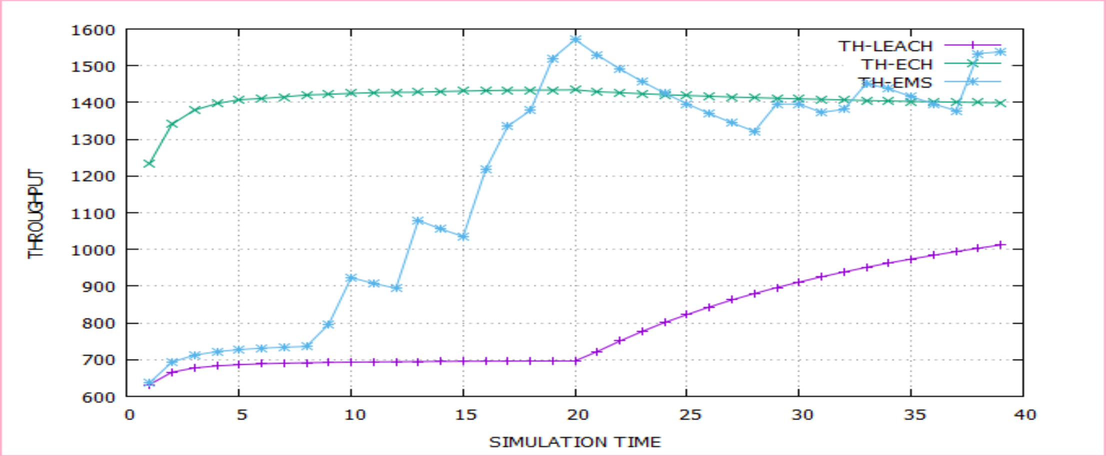

Fig.2. Throughput (Mbps) vs. simulation time (min) of different approaches

Figure 2, above gives the performance comparison of throughput of proposed and existing work with simulation time.

Packet Delivery:

Packet Delivery is defined as the number of packets forwarded through the supply to the target node. It is computed with variable number of nodes and simulation time. The figures below depicts that the PD performance of the existing protocol is less as compared to the presented one.

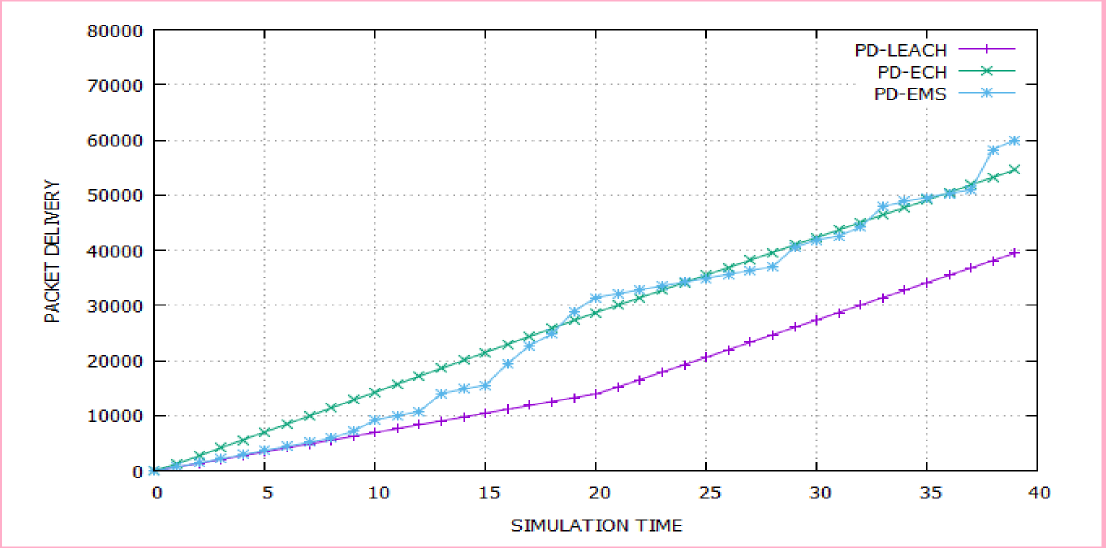

Fig.4. Output performance of Packet Delivery for different approaches

Figure 4, above give the performance of packet delivery comparison for the proposed and existing work withsimulation time.

Overhead

Overhead of the network is computed in control packets with respect to the number of nodes. This metric computes that how many control packets are used by the algorithm in one complete communication session, apart from data packet.

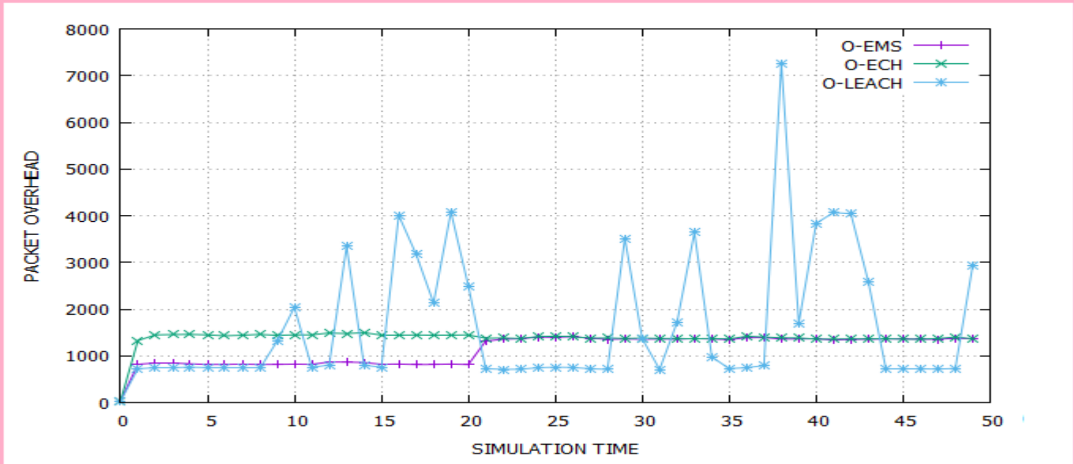

Fig.6.Overhead comparisons with changeable number of nodes between proposed and existing work

From figure 6 we can say theproposed works overhead isless as it sends the acknowledgment packets after a specified time interval.

Life Time:

This metric is an important metric in WSNs for increasing the lifetime of the network (NL). The NL is computed with respect to the number of nodes with their remaining energy. Itcomputes thathow many information packets can be processed by the node in its remainingpower in its complete communication session.

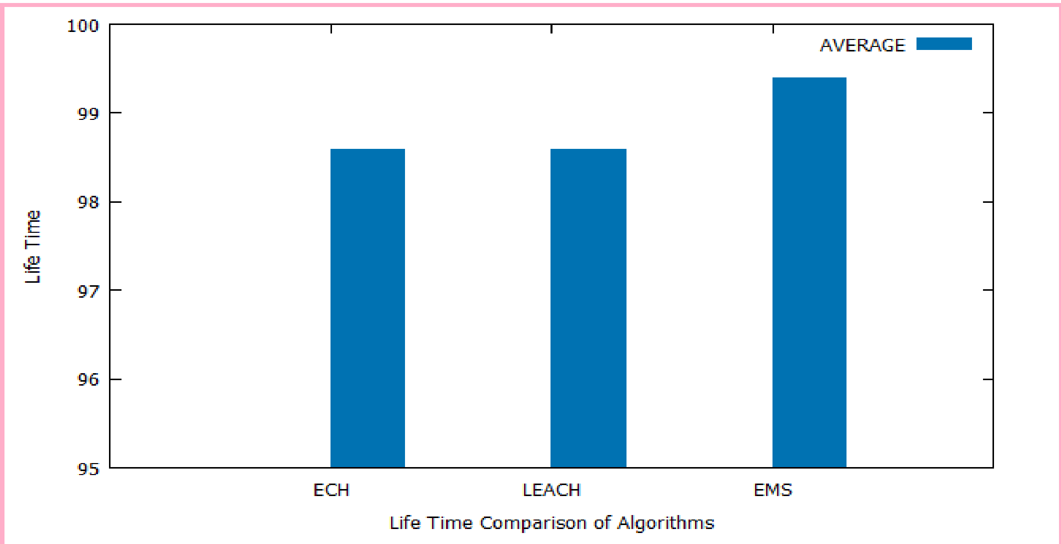

Fig. 8. NLcontrast between proposed and existing work

The Figure 8, gives the performance evaluation among the existing and proposed work to enhance the NL. The outcomes clearly depicts that the proposed formmaximize the NL in contrast with existing scheme.

Remaining Energy:

It gives the remaining energy of the node during the process of communication in the network. Further, it is measured with inconsistentnumber of nodes with their simulation timings. The figures outcomes depict that the residual energy is very less for existing work as compared to the proposed work.

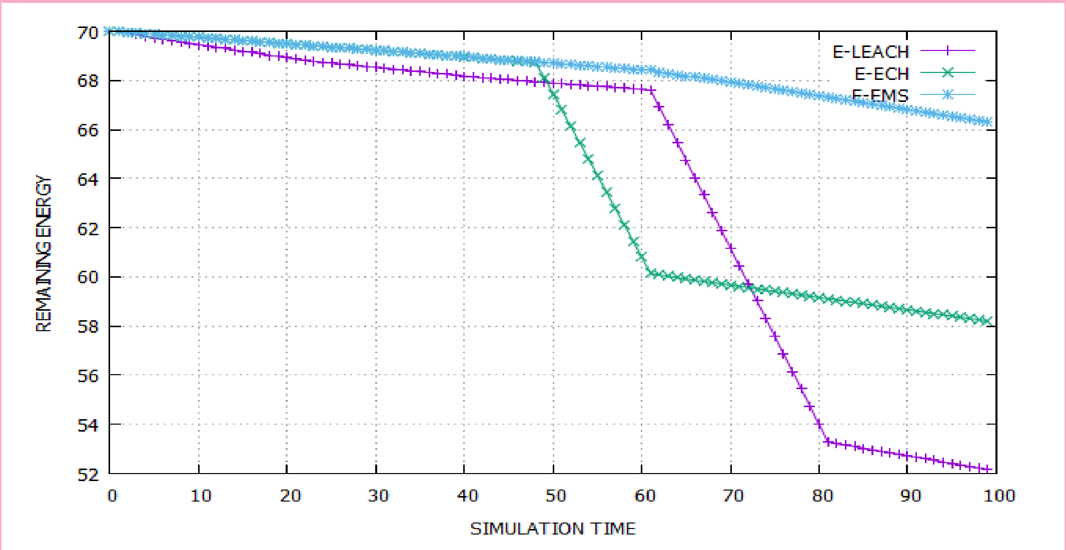

Fig. 9.Contrast of Remaining Energy Performance for existing and proposed work

Figure 9, gives the conclusion that the remaining energy performance of the proposed work is looks good as compared to the existing method with the simulation time.

Finally, we can say the projectedeffort outperforms than the existing one, because it prevents the packets drop due to the constrained resources.

V. Conclusion

In this work, an energy-efficient routing for WSNs are designed with the sink mobility considerations. Thedesigned protocol enhances the performance with the packet loss reduction. For that purpose it removes the overcrowded and constrained nodes from the path of routing. Moreover, it elaborates network's lifetime by making movable sink node on the basis of the load status of its neighbor node. Achieving efficient Power and extending the network's lifetime is an active research area in WSN. One of the resources for data communication is routing. Thus, WSN needs a routing protocol to address this packet dropping issue. It can be done by managing the data quantity and multi-hops routing path in the transmission region. But, the node nearer to the sink node will become the bottleneck and drops the data packets as well as it will exhaust very quickly due to the high load, as the nodes have limited energy and buffer in the network. To overcome these issues, one possible solution is to make the sink node mobile, to move from one place to another place according to neighbor node properties with respect to energy and load. Thus, the aim is to change the position of the sink node

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for getting energy-efficient and extended lifetime network or to provide mobility to the sink node. Aiming at this concern, we investigated the method that provides the sink node to mobile by removing the problem of the neighbor node of the sink to become bottleneck. The proposed method uses the cluster based approach for implementing the sink mobile routing protocol, where the node near to sink changes its location depends on the nodes status based on their residual status of buffer and power.

VI. REFERENCES:

[1]. Kamalinejad, Pouya, ChinmayaMahapatra, Zhengguo Sheng, ShahriarMirabbasi, Victor CM Leung, and Yong Liang Guan. "Wireless energy harvesting for the Internet of Things." IEEE Communications Magazine 53, no. 6 (2015): 102-108.

[2]. Amgoth, Tarachand, and Prasanta K. Jana. "Energy-aware routing algorithm for wireless sensor networks." Computers & Electrical Engineering 41 (2015): 357-367.

[3]. Abo-Zahhad, Mohammed, Sabah M. Ahmed, Nabil Sabor, and Shigenobu Sasaki. "Mobile sink-based adaptive immune energy-efficient clustering protocol for improving the lifetime and stability period of wireless sensor networks." IEEE Sensors Journal 15, no. 8 (2015): 4576-4586.

[4]. Morgan, David. Images at Work: The Material Culture of Enchantment. Oxford University Press, 2018.

[5]. Sert, SeyyitAlper, HakanBagci, and Adnan Yazici. "MOFCA: Multi-objective fuzzy clustering algorithm for wireless sensor networks." Applied Soft Computing 30 (2015): 151-165.

[6]. Ilyas, Mohammad, and ImadMahgoub. "A Practical Perspective on Wireless Sensor Networks." In *Smart Dust*, pp. 127-154. CRC Press, 2018.

[7]. Jan, Mian Ahmad, Syed RoohUllah Jan, Muhammad Alam, Adnan Akhunzada, and Izaz Ur Rahman. "A comprehensive analysis of congestion control protocols in wireless sensor networks." *Mobile networks and applications* 23, no. 3 (2018): 456-468.

[8]. Erdelj, Milan, MichałKról, and Enrico Natalizio. "Wireless sensor networks and multi-UAV systems for natural disaster management." *Computer Networks* 124 (2017): 72-86.

[9]. Ojha, Tamoghna, SudipMisra, and Narendra Singh Raghuwanshi. "Wireless sensor networks for agriculture: The state-of-the-art in practice and future challenges." *Computers and Electronics in Agriculture* 118 (2015): 66-84.

[10]. Pardo, Juan, Francisco Zamora-Martínez, and Paloma Botella-Rocamora. "Online learning algorithm for time series forecasting suitable for low cost wireless sensor networks nodes." *Sensors* 15, no. 4 (2015): 9277-9304.

[11]. Kumar, Arvind. "Energy Efficient Clustering Algorithm for Wireless Sensor Network." PhD diss., Lovely Professional University, 2017.

[12]. Rani, Shalli, and Syed Hassan Ahmed. *Multi-hop routing in wireless sensor networks: an overview, taxonomy, and research challenges*. Springer, 2015.

[13]. Amjad, Muhammad, Muhammad Sharif, Muhammad Khalil Afzal, and Sung Won Kim. "TinyOS-new trends, comparative views, and supported sensing applications: A review." *IEEE Sensors Journal* 16, no. 9 (2016): 2865-2889.

[14]. Hasan, Mohammed Zaki, Hussain Al-Rizzo, and Fadi Al-Turjman. "A survey on multipath routing protocols for QoS

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ISSN: 0193 - 4120 Page No. 3835 - 3845

assurances in real-time wireless multimedia sensor networks." *IEEE Communications Surveys & Tutorials* 19, no. 3 (2017): 1424-1456.

[15]. Rahmani, Amir M., Tuan Nguyen Gia, BehailuNegash, Arman Anzanpour, Iman Azimi, Mingzhe Jiang, and PasiLiljeberg. "Exploiting smart e-Health gateways at the edge of healthcare Internet-of-Things: A fog computing approach." *Future Generation Computer Systems* 78 (2018): 641-658.

[16]. Kumar, Arvind. "Energy Efficient Clustering Algorithm for Wireless Sensor Network." PhD diss., Lovely Professional University, 2017.

[17]. Chaudhary, Kriti, and Divya Sharma. "Body area networks: A survey." In *2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom)*, pp. 3319-3323. IEEE, 2016.

[18]. AlSkaif, Tarek, Manel Guerrero Zapata, and Boris Bellalta. "Game theory for energy efficiency in wireless sensor networks: Latest trends." *Journal of Network and Computer Applications* 54 (2015): 33-61.

[19]. Dillon, P. J. "Enabling Tetherless Care with Context-Awareness and Opportunistic Communication." PhD diss., University of Pittsburgh, 2015.

[20]. Han, Guangjie, Jinfang Jiang, Chenyu Zhang, Trung Q. Duong, Mohsen Guizani, and George K. Karagiannidis. "A survey on mobile anchor node assisted localization in wireless sensor networks." *IEEE Communications Surveys & Tutorials* 18, no. 3 (2016): 2220-2243.