A Strategy to Enhance Energy Efficiency for EC-MRPL in Internet of Mobile Things

[1]Latta Dodiya, [2]Bela Shrimali, [3]Hiren patel
[1]Research scholar, [2]Assistant Professor, [3]Professor
[1]LDRP Institute Of Technology And Research, Gandhinagar

***Abstract* - Decentralized type of network is used in internet of things environment, in which nodes communicate with each other and data is transferred to the internet via base station. The communication routing is applied using RPL (IPV6 Routing Protocol for Low Power and Lossy Network) in IoT. It is systematic routing protocol for LLNs (Low Power and Lossy Network). To ensure the mobility in RPL, MRPL (mRPL: Boosting mobility in the Internet of Things) is introduced. Energy consumption is one of the important criteria for mobile nodes because they are battery-powered. So, EC-MRPL (EC-MRPL: An energy-efficient and mobility support routing protocol for the Internet of Mobile Things), an enhancement of MRPL is introduced to improve the energy efficiency in MRPL. In this paper we proposed novel strategy to enhance the energy efficiency and network performance in EC-MRPL and MRPL. A cluster based approach is proposed to handle the traffic and energy consumption efficiently. Our proposed approach is implemented in ns-2 (Network Simulator Version 2) and our experimental results depict that the proposed approach is more energy efficient and has better performance in terms of delay and throughput with compared to MRPL protocol.**

***keywords* - MRPL, Energy efficient, Internet of Mobile Things, Network Performance.**

I. INTRODUCTION

A wireless sensor network is rising technology collection of the Internet of Things devices. Whereas IoT is a self configuring and decentralized type of network. It is used in many applications like home-automation, environmental monitoring, security purpose with a numerous number of benefits that builds up with sensor nodes. These nodes are battery powered hence it is much important that it runs very efficiently with respect to both communication and computational energy. In this chapter, detail introduction related to the Internet of Things is presented along with the various types of protocols and methods [1].Depending upon the link amongst objects, the objects function autonomously. Analysis of collected data to make decisions, providing lightweight data and extracting the data by accessing and authorizing the cloud-based resources are some of the actions performed by IoT nodes. The users, services, sensors as well as objects are linked to each other very closely through IoT. The applications ranging from smart grid healthcare applications to intelligent transport systems deploy IoTs within them. The number of smart devices and intelligent services provided through IoT networks has been outgrowing due to the huge business opportunities provided in the IoT scenarios [2]. The cloud-based IoT networks have been developed due to the relativity of IoT devices on the cloud infrastructure.Such that the data can be transmitted across applications. So data aggregation is a very important application of IoT. The procedure utilized for integrating and summarizing information obtained from sensor nodes is known as data aggregation. This procedure enhances the system lifespan by eradicating superfluous broadcasting of information. The approach of data aggregation is required for the enhancement of system lifespan and also for the reduction of power expenditure [3] .However, every nodule contains the capability of information retrieval from the neighbouring nodes or information generation by itself. These nodes in a certain period of time amassed the data and propel it obtains the combined results. With the help of this process, overabundance is detached from unprocessed information and this result in the lessening of interaction charge [4]. As we discussed above the sensor nodes deployed in the IoT network are basically resource-constrained and battery controlled data must be aggregated to keep resources and energy longer time. For the continuation of assets and power, information must be amassed. Thus, information aggregation is simply described as a process in which several sensor nodes congregate the composed outcomes from supplementary nodules [5]. The composed information should be managed by the nodule for the reduction of communication. The transmission process is mainly initiated from the base station or often from an external consumer who can have authority for the communication through the arrangement [6]. The amassed information is conveyed to the sink by selecting the efficient path. WSNs are considered an essential constituent of loT. This network provides help for the data compilation from the environment. Because of the positioning of the tremendously huge amount of devices, a large number of pertinent, associated and superfluous data is required to be transferred via sensor nodes to the base station. Information obtained from adjoining nodules is regularly interrelated and extremely unneeded [7].

This superfluous information utilizes system possessions gratuitously. In order to solve this issue, a type of reckless information communication in such kind of reserve restriction network is needed. For this, a method for joining the whole surplus and associated information with applicable high-class data is desired at the transitional nodules[8]. With the help of this procedure, the total amount of data packets broadcast to the base station can be decreased. In this condition, data aggregation or information aggregation idea is an appropriate elucidation[9] .

These communications and collaboration between IoT entities use network layer standard routing protocol called RPL. The architectural design of RPL is a collection of numerous Destination-Oriented Directed Acyclic Graph (DODAG) systems. In this scheme, every DODAG considers several wireless sensor equipment which are connected via a DODAG path. For the

differentiation of all the DODAGs present in the system, RPL instance ID; DODAG ID; DODAG version number; and rank values are utilized/used. For the establishment and maintenance of DODAG and also for the direction _nding, novel ICMPv6 control messages like DIO (DODAG Information Object), DAO (Destination Advertisement Object), and DIS (DODAG Information Solicitation) are used by RPL[10].

In the present scenario, a number of data aggregation procedures are accessible and reminder of this paper is as follows the next Section 2 covers the detailed information about the MRPL protocol. Section 3 covers the related work in rpl protocol under the mobility scenario for energy saving. Section4 the more detailed information about our proposed work and implementation of proposed work. Section 5covers the experimental evaluation with experimental test bed and simulation result. In last section 6 conclude the paper.

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II. MRPL PROTOCOL

In different promising IoT applications comprising health-care scrutinizing, manufacturing computerization and elegant network, mobility support has become a fundamental obligation. Numerous researches have measured the collaboration among movable and predetermined sensor nodules. In medical observation, patients have entrenched wireless sensing equipment [11]. These types of equipment provide details in the authentic time slot. In oil processing plants, the fundamental cryptograms of employees are composed constantly for monitoring their health condition in hazardous surroundings. In addition, alots of applications entail appropriateness and consistency assurance for the broadcasting of dangerous messages from the transmitter to the receiver. It is also identified that the attainment of Quality of Service (QoS) in low-energy and movable networks is a very difficult task. For this purpose, mainly two methods are utilized in RPL and 6LoWPAN. These methods moderately deal with mobility. In the first method, the interrupted diffusion of control packages is planned with the help of the Trickle algorithm. This algorithm is very efficient in the detection of environmental alterations. During this process, RPL recommences a speedy comprehensive steering update and this leads to the adaptation of elevated transparency [12]. In the second methodology, usually known as Neighbor Discovery system, the attainment ability to adjoin node is access on a standard basis. During every commencement, the ND protocol overflows the whole arrangement with router commercials. This results in the attainment of elevated transparency.

A comparatively small commencement time slot which also decreases the network transparency becomes a cause of small sensitivity to the arrangement. Nevertheless, in the modified ND mechanism of LoWPAN, router billboard data packages are broadcasted after getting router solicitation information. Therefore mobility facilitated RPL relied on smart-HOP is presented. This is a hard hand-off system which was premeditated and tested in a general arrangement structural design in a protocol-agnostic approach [13]. The integration of smart-HOP inside RPL is carried out in such a way that this becomes very straightforward, efficient and reverse companionable with the typical protocol. In this mock-up, the typical RPL protocol remains unaffected while providing mobility support. This means that typical and smart-HOP facilitated nodes may coexist and inter-operate in an identical arrangement. The universal process of beacon and information interactions in smart-HOP included in RPL (MRPL) is alike to the authentic smart-HOP architecture; apart from utilizing RPL control messages (DIS and DIO) as beacons and adding several timers for the improvement of consistency and effectiveness. The timeline of this approach is portrayed. In this approach, the MN receives a reply package instantly after broadcasting a preset amount of information packages [14]. The DIO reply information absolutely strains the disproportional associations. After the recognition of high-quality connection, the MN endures the information broadcasting segment. After monitoring the ARSSI dilapidation, MN establishes the detection segment. MN recommences the messaging with the allocate AP till it does not find an enhanced AP. After a triumphant hand-off, the reverse procedure of the RPL algorithm is implemented. For the evaluation of probable parents, the MN transmits a rupture of DIS control information. After this, MN is replied by the whole APs in a non-contradiction basis [15]. The standard RSSI echelon is entrenched in the unicast DIO respond. After the retrieval of every DIO reply, the RSSI value is compared with Th level by the MN. In a case when obtained value is found unsatisfactory, MN persists transmitting DIS bursts sporadically. After the detection of an elevated connection, discovery segment discontinues and MN recommence normal information. Two modified versions of MRPL are EC-MRPL and EKF-MRPL.

EC-MRPL has the ability to improve routing procedure in the framework of sensor nodes mobility by forecasting nodules progress relied on the Received Signal Strength Indicator (RSSI) in association with a cross-layer methodology [16]. With the help of this protocol, the life span of mobile equipment van can be increased. This approach also makes the relatedness extra vigorous by commencing a proactive procedure which is capable to foresee and forecast nodes' progress.

EKF-MRPL is considered proactive mobility sustaining routing protocol which makes the RPL mobile amenable and also eliminates the issues related to sensor node movability. A progress forecast of movable nodes is introduced for the mitigation of the pessimistic impact of mobility on the performance of the system. The novel approach is based on the Extended Kalman Filter (EKF) for the recognition of a non-linear route faction during the consideration of path change [17]. This method enhances the assessment of the mobile node position executes with the help of trilateral method relied on RSSI values.

So, in this research our main aim is to introduce and discussed a novel technique to enhance the energy efficiency which is one of the most important parameter in RPL under the mobile scenario.

III. LITERATURE REVIEW

In this section we have discussed a different research schemes for mobility in RPL routing protocol. The numerous research work have been studied and analyzed to understand rpl under the mobile scenario in our previous work [18]. We have covered the detailed information about previous researches in RPL under the mobile scenario which reflects our proposed work scenario. Maha Bouaziz, et.al [19] presented a new approach for providing assistance to EC-MRPL routing protocol. The main objective of EC-MRPL was the adaptation of unremitting connectivity for keeping MNs accessible apart from their location. The projected approach was based on a proactive protocol for the forecasting of a novel connection of mobile nodes prior to their detachment.

This procedure was implemented on the cross-layer data and the icmpv6 posts of RPL typical and relied on several preset flags. For the accomplishment of necessities and for providing desirable presentations, the firm restrictions of the system were considered by MRPL. The major aim behind the assistance of movability was the reduction of mobile node involvement for mandating power and sharing of resources dissipation. They claimed that various experimental results indicated the proposed approach performed well in comparison with the standard RPL protocol.

Hossein Fotouhi, et.al [20] proposed two novel approaches for handling the alterations in system topological conditions. The previously used approaches were capable to handle the behavior of sensor nodes movement and also behaved in a reactive manner. For solving the issues related to real-time and consistent mobile data compilation, a practical hand-off method inside RPL was developed. This method was very simple, efficient and well-matched with the typical protocol. The proposed approach was very compatible in terms of extended message latency, elevated packet hammering, and elevated transparency.

Maha Bouaziz et.al [17] presented a novel approach commonly known as EKF-MRPL (proactive mobility support protocol). The proposed approach relied on the modified version of the Kalman filter and the RPL establishment. The main aim of the proposed approach was the adaptation of faultless communication amid movable sensor nodules by decreasing the amount of exchange among connected ends. This process was initialized for the reduction of signaling overhead and power utilization. In order to predict the novel end of a connection, a movable sensor nodule with its non-linear trajectory relied on Kalman filter was proposed. With the help of an investigative mock-up, various experiments were performed. The tested outcomes clearly depicted that the proposed approach performed well in comparison with predetermined approaches by means of package release proportion relinquish impediment, signaling expenditure and power utilization.

Abdullah M. A Awad, et.al [21] proposed a novel metric relied on sensor nodules queue accumulations for the standard RPL routing protocol. The proposed approach showed superior network overhead recital and also maintained the impendent. The proposed approach had the capability to utilize a number of system functionalities. The proposed approach has relied on the package queue span of the sensor nodes. The projected approach also considered some other connections and nodule metrics such as power consumption. With the help of the projected approach, superior freight balancing was obtained. The simulations results indicated that the projected approach performed well in comparison with several other approaches. In the future, necessary architectural alterations will be studied in order to facilitate this metric in an effective manner.

P. Janani, et.al [22] performed a fresh investigation of RPL intentional utility. The presented investigation was carried out underneath the multi-hop wireless sensor atmosphere with the help of Cooja simulator. Various experiments were performed in passage stream prototype with the help of several established metrics like standard package production rate, package discontinuation, regular throughput, and package plunge and power expenditure. Various investigative and reproductive outcomes depicted that the connection superiority relied on RPL achieved a considerable enhancement in standard throughput from the lowest five flows to the highest twenty flows. In a similar manner, connection superiority relied on RPL methodology attained a noteworthy lessening in end-to-end packet discontinuation. In the future, the major area of consideration will be the development of RPL for both portable and stationary wireless atmosphere.

Buranin Khemapataphan, et.al [23] projected a new approach of Weight Ranking mechanism. The main objective of the proposed approach was the adaptation of a power complementary steering metric for the enhancement of the standard RPL routing protocol. The proposed approach provided supplementary significant power balancing and also improved the life span of the system in comparison with the traditional standard RPL approach. For this purpose mainly three ideas were considered like ETX, power utilization, and grade assessment. The simulations outcomes depicted that the proposed approach enhanced the network life span to a considerable amount in comparison with traditional approaches.

Problem Statement

1. Our proposed method is designed to support the massive tra_c pattern and better route discovery.
2. In MRPL Only a portion of nodes are required to participate in the route discovery for a source- destination node pair so location-based route discovery is implemented. Our proposed method results in a great reduction of routing overhead and reduced energy consumption.
3. We have simulated our proposed scenario with more number of mobile nodes so it is suitable for large mobile scenario under RPL.

IV. PROPOSED METHODOLOGY

Based on the insights described in the above section, we propose a novel strategy to achieve reliable data transmission in an energy- efficient manner. In this section, we have covered the system design of proposed method, and then experimental evaluation, performance metrics and simulation result with analysis chart.

System Design

The main focus of the proposed method is to reduce the energy consumption of MRPL protocol. The MRPL mobility sustaining routing protocol is the energy efficient protocol of IoT for the data aggregation. In the MRPL routing protocol, the whole network will be divided into the hierarchy and every level will aggregate the data to the next level until it reaches to the base station. The complete procedure of MRPL protocol is described in figure 1.

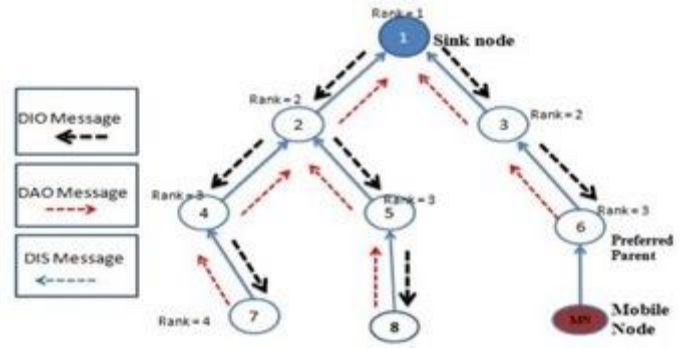

Figure 1. MRPL protocol procedure

In the MRPL protocol, the energy dissipation of the sensor nodes depends upon the distance between the source and receiver. When the distance is above the threshold value, then the energy dissipation is more as compared to distance when it is below the threshold value. In our proposed scenario, the MRPL protocol is improved using clustering approach with the gateway nodes. For the clustering cluster head is selected based on the maximum residual energy and minimum distance from the base station. The Gateway nodes are deployed between near the base station. After deployment of nodes the sensor nodes will send data to the gateway which forward data to base station. So the data is aggregated at cluster head and at the gateway nodes. The main advantage of data aggregation in our proposed work is we can eliminate the redundant data and data is passed from source to destination in energy efficient manner. That's why our proposed methodology will reduce the energy consumption of the network.

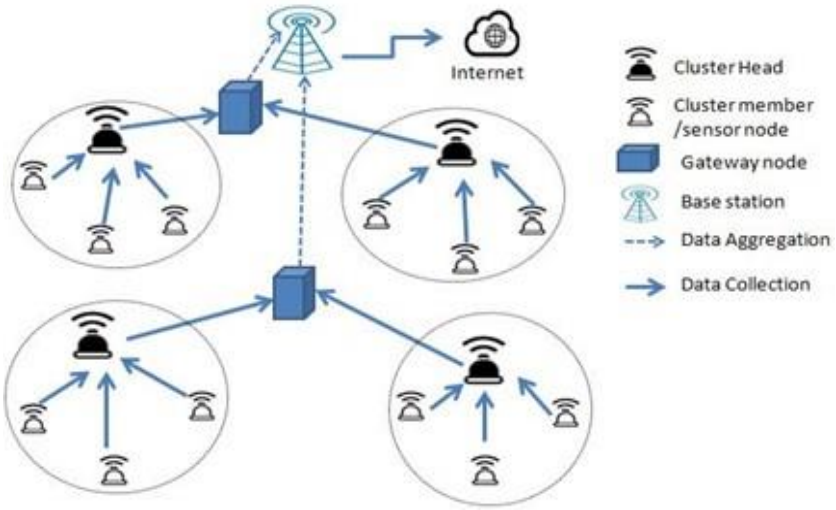

Figure 2. Proposed MRPL Protocol

As shown 1 in Figure 2, sensor node sends the collected data to the cluster head and meanwhile cluster head aggregate data from all the sensor node it eliminates the duplicate data at that level. The gateway nodes are deployed near the base station which collects the data from the cluster head and also forwards data to the base station.

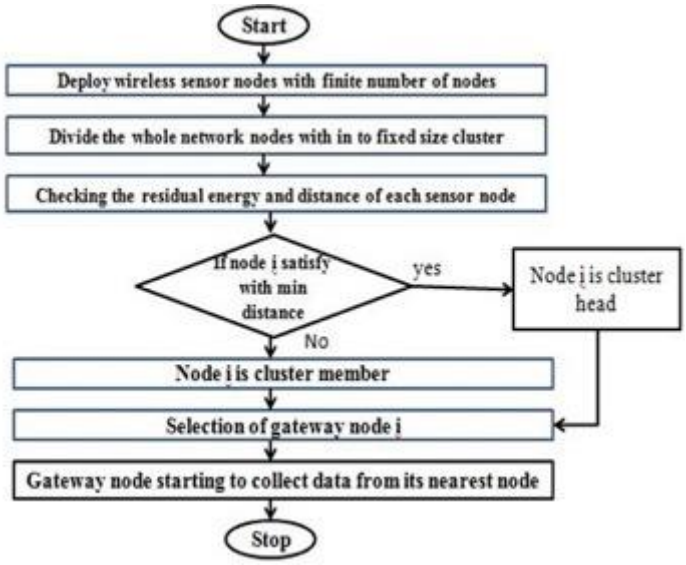

Figure 3. Flowchart of deployment of nodes

V. EXPERIMENTAL EVALUATION

Experimental Test-beds

This research method is implemented with NS-2 (network simulator version 2). NS-2 is an open-source and event based simulator. The proposed technique will reduce energy consumption in MRPL. We have set the parameters for the simulation analysis is described in table 1.A different topology is generated when we have runs the simulation and each data of the results is the average value from ten runs. We have simulated our proposed scenario in 800*800 m. The node moves in the simulation area based on the random waypoint mobility model.

Table 1. Simulation Parameters

Parameter	Value
Antenna type	Omi-directional
Queue type	Priority queue
Simulation time	14 second
Mobility Model	Random Way point model
Number of gateways	2
Traffic type	CBR
Data Rate	250 k-bit/ second
Number of nodes	31
Simulation area	800 * 800 meters

Performance Metrics

The subsequent metrics are domesticated to evaluate the desired network performance of the proposed method.

1. Energy consumption: it refers to aggregated energy is consumed by the node to transfer the data from source node to destination node. The aggregated energy consumption of the whole network accommodates the energy depleted for all phases of the network throughout the simulation.
2. Delay: it refers to difference between time at which node generated a packet and the time at which packet reaches the destination.
3. Throughput: it refers to number of packets successfully received at destination node in unit time.

Simulation Result

It has been identified over proposed method is performed well compare to the existing one. The existing approach is compared based on energy consumption, delay and throughput. These are the criteria or parameter we used to measure network performance.

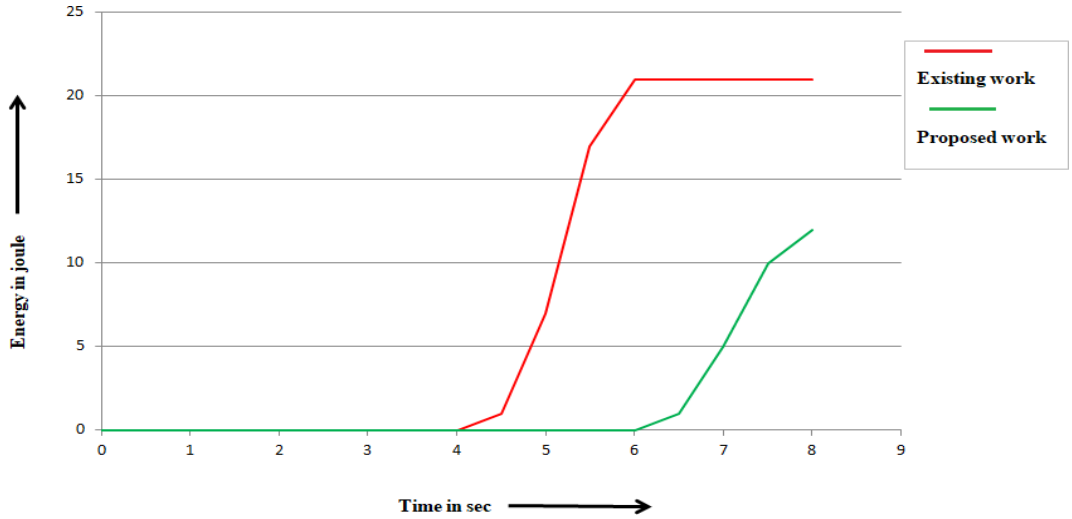

Figure 4 . Energy Consumption

As shown in Figure 4, the energy consumption of the proposed method and existing method are compared for the performance analysis. It is analyzed that the proposed technique has less energy consumption as compared to existing MRPL due to the use of gateway nodes.

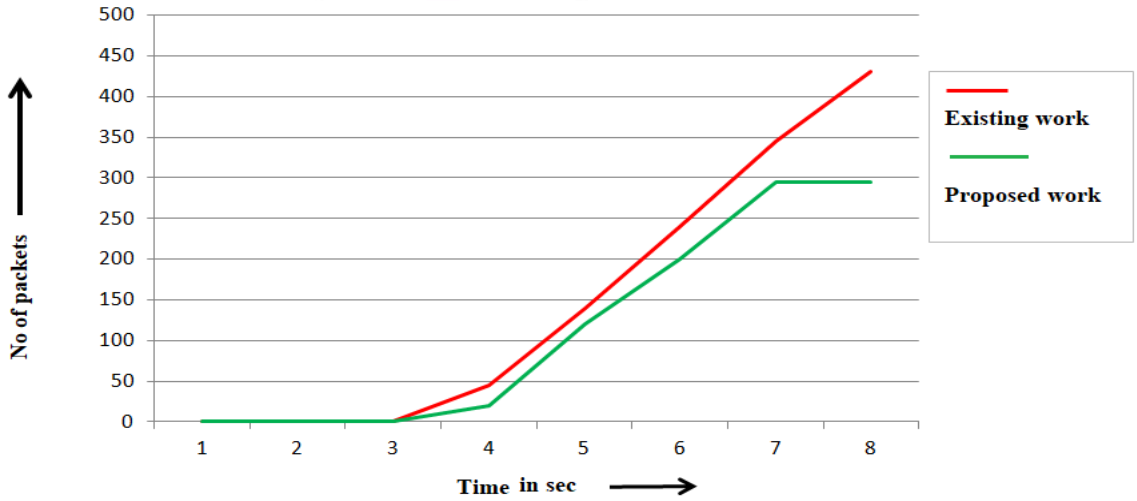

Figure 5. Delay Comparison

As shown in Figure 5, the delay of proposed MRPL protocol and existing MRPL protocol is compared for the performance analysis. It is analyzed that proposed MRPL protocol performs slightly better and has less delay as compared to existing MRPL protocol because of the better decision-making in route selection for transmitting the data. Although we use the same objective function, the proposed method is more compatible than MRPL leading to less delay from source to destination. As shown in Figure 6, we have compared the existing method throughput with the proposed method. It depicts that our proposed approach has high throughput as compared to existing method.

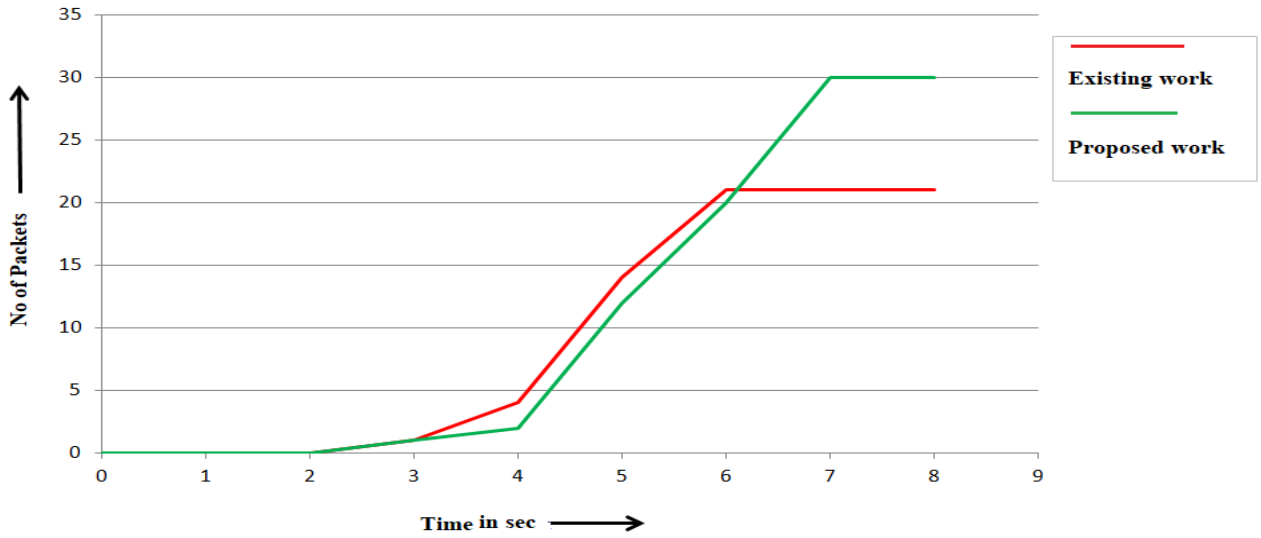

Figure 6. Throughput Comparision

VI. Conclusion

This paper has proposed a novel strategy to enhance the network performance and efficient energy conservation in MRPL protocol through the data aggregation approach by using the gateway nodes. The existing method and proposed method both have implemented and analyzed in ns2. From the analysis we have concluded that our proposed method is outperforms in terms of both the parameter energy consumption and delay after runs the simulation ten times also depict that the network performance increases by 72 % in our proposed work. As our work is focus only with single static sink our plan is to extend our work with multiple mobile sink.

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