ENERGY EFFICIENCY ENHANCEMENT IN INTERNET OF THINGS USING DATA AGGREGATION TECHNIQUE

Dissertation submitted in fulfilment of the requirements for the Degree of

MASTER OF TECHNOLOGY

in

COMPUTER SCIENCE AND ENGINEERING

By

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June 2017

PAC FORM

TOPIC APPROVAL PERFORMA

School of Computer Science and Engineering

Program : 1202D::B.Tech -M.Tech (Dual Degree) - CSE

COURSE CODE : CSE545 **REGULAR/BACKLOG :** Regular **GROUP NUMBER :** CSERGD0279

Supervisor Name : Ravishanker **UID :** 12412 **Designation :** Assistant Professor

Qualification : _____ **Research Experience :** _____

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SPECIALIZATION AREA : Networking and Security **Supervisor Signature:** _____

PROPOSED TOPIC : Energy efficiency enhancement in IoT using data aggregation technique.

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Final Topic Approved by PAC: **Energy efficiency enhancement in IoT using data aggregation technique.**

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ABSTRACT

The internet of things is the technology in which the sensor nodes sense the information and pass the information to base station. The size of the sensor nodes is very small due which energy consumption is the major issue of the network. To aggregate the data from sensor nodes to the base station, technique of clustering have been adopted which uses less energy consumption of the network. In the existing approach, technique of static clustering has been applied, due to which chances of fault get raised in the network. In this work, technique of neural networks has been applied which leads to the reduction of chances of fault in the network. The simulation of proposed model is performed in matlab and it has been tested that energy consumption of the network is reduced and network throughput is increased at steady rate.

DECLARATION STATEMENT

I hereby declare that the research work reported in the dissertation II entitled "ENERGY EFFICIENCY ENHANCEMENT IN INTERNET OF THINGS USING DATA AGGREGATION TECHNIQUE" in partial fulfilment of the requirement for the award of Degree for Master of Technology in Computer Science and Engineering at Lovely Professional University, Phagwara, Punjab is an authentic work carried out under supervision of my research supervisor Mr. RAVISHANKER. I have not submitted this work elsewhere for any degree or diploma.

I understand that the work presented herewith is in direct compliance with Lovely Professional University's Policy on plagiarism, intellectual property rights, and highest standards of moral and ethical conduct. Therefore, to the best of my knowledge, the content of this dissertation represents authentic and honest research effort conducted, in its entirety, by me. I am fully responsible for the contents of my dissertation work.

PAYAL GUPTA

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SUPERVISOR'S CERTIFICATE

This is to certify that the work reported in the M.Tech Dissertation entitled "**ENERGY EFFICIENCY ENHANCEMENT IN INTERNET OF THINGS USING DATA AGGREGATION TECHNIQUE"**, submitted by **PAYAL GUPTA** at **Lovely Professional University, Phagwara, India** is a bonafide record of his / her original work carried out under my supervision. This work has not been submitted elsewhere for any other degree.

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ACKNOWLEDGEMENT

I Payal Gupta, Student of B.Tech-M.Tech (CSE) has successfully doing my dissertation II entitled "ENERGY EFFICIENCY ENHANCEMENTIN INTERNET OF THINGS USING DATA AGGREGATION TECHNIQUE" under the proper guidance of Mr. Ravishanker. I thank all the teachers, people and my classmates who helped a lot while doing my dissertation works.

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Title of Dissertation: Energy Efficiency Enhancement in Internet of Things Using Data Aggregation Technique

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CHAPTER 1
INTRODUCTION

1.1 Internet of Things (IOT)

The Internet is a worldwide arrangement of interconnected PC organizes that use the standard Internet Protocol Suite (TCP/IP) to serve billions of clients around the world. It is a system of a huge number of private, open, scholastic, business, and government systems, from neighbourhood to worldwide in degree. Originating from the Advanced Research Projects Agency Network (ARPANET) around 1970, it was available in the 1980s and got to be famous around 1990. Beginning from the Advanced Research Projects Agency Network (ARPANET) around 1970, it was accessible in the 1980s and got the chance to be popular around 1990. Today, the Internet of Things has transformed into a main way to the shrewd universe of omnipresent figuring and systems administration. It is delineated as a self-configuring remote system of sensors whose expectation is to interconnect all things. A thing, object, or an element is any possible thing in this present reality that joins the correspondence chain. Thusly, the hidden essential goal of the Internet of Things was to consolidate correspondence abilities depicted by information transmission. The guideline question in the IoT was RFID. Therefore, the Internet of Things can be considered as the working of a worldwide foundation for RFID labels: a remote layer on top of the Internet. A system of interconnected PCs talks with a system of interconnected questions consistently following and representing a great many things, from extremely sharp steels to banknotes to auto tires. These articles now and again have their own specific Internet Protocol (IP) areas, are installed in complex frameworks, and use sensors to get data from their condition, e.g., nourishment items that record the temperature along the store network or conceivably use actuators to communicate with it, e.g., cooling valves that react to the proximity of individuals [1]. The accessibility of the Internet and advances in programming and media transmission administrations with the ability to associate each question and also thing, with any protest or conceivably thing, at whatever point and in any media have quickened the overall entrance of the IoT worldview. Specifically, the fundamental thought that each question or conceivably thing can in like manner be a piece of a little PC and also microchip that is associated with the Internet has outperformed any conjecture. The enabled technologies of the IoT are:

• RFID

• Sensors and actuators

• Miniaturization

• Nanotechnology

• Smart entities

Likewise, the expanding preparing power accessible in the littlest of bundles or gadgets in arranged registering is the substructure for the IoT worldview. RFID and sensors, among various advancements, have been progressively conveyed and allow this present reality condition to be inserted into the IoT organized administrations. Substance to-element situated IoT applications are observed continuously, contingent upon their real status, while the IoT consequently responds. This has finally brought about savvy articles or things which can act more brilliant than items or things which have not been labelled with a one of a kind visual or undetectable recognizable proof code or outfitted with sensors or actuators.

1.1.1 Characteristics of IoT [2]

- **Connectivity:** Producing and handling information movement on the IoT. Interfacing substances can be remote, as with RFID or wired, as with powerline correspondence. The IoT moreover allows the association of heterogeneous elements.

- **Connections:** Increasing and making totally new element systems of systems and IoT. The IoT is neither sci-fi nor industry development however depends on strong mechanical advances and dreams of system universality that are energetically being figured it out.

- **Embedding:** Short-go adaptable handsets in a wide exhibit of extra devices and general things, for instance, cell phones, empowering new correspondence shapes among individuals and things and in addition substances and among things and elements themselves.

1.1.2 Service Search

Service searching in internet of things is performed in a way that the protest which needs an administration will initially seek through its companions and if the coveted administration is not accessible with its companions then it looks with its companions of companions, subsequently making an appropriated seeking process. Service searching or benefit seeking is one of the noteworthy research regions in the field of IOT. The scanning of administrations is finished for playing out an operation and in addition for recovering information that stays at some other gadget. The necessities for the search are ordered into two; to be particular, point-based requirements and proximity based necessities. The point-based prerequisite is for gadgets which purposefully look for specific gadgets. In proximity-based requirement, the search is adaptable and it is finished in a way that it can have varieties or variations.

1.2 Properties of Things in IoT

The things are different from each other in size and types. In the mean time, they likewise have different features and access capabilities. Hence, one can summarize the properties of things in IoT from resource granularity, functional characteristics and access capabilities as follows:

A. Resource Granularity: The things in IoT can be divided into coarse and fine resources as indicated by the size of resources. The granularity of the resources ought to be based on the complexity of the structure and function. The fine grain resources more often than not have basic structure and single function, which can be further divided into sensors, controllers and RFID equipment as indicated by the resource type. By contrast, coarse grain resources more often than not have complex structure and multiple functions, and consist of the fine grained resources and different resources. For instance, a coarse-grain car contains a considerable measure of fine-grain sensors, and a coarse-grain household appliance contains different functional fine-grain switches. The coarse grain resources can be further divided into M2M devices, sensor networks and different devices as per the resource type [5].

B. Functional Characteristics: According to the functions it can give, a thing in IoT can be divided into single function and complex functions device. The single-function devices just have one sort of the basic functions of IoT. For instance, a wide range of sensors (temperature sensors, humidity sensors, pressure sensors, surveillance cameras, electric meter equipment and so forth.) possess the environment perception function; various controller devices (remote controls, motor

controllers, temperature controllers) can control types of equipment in industrial and home environment; and the devices with embedded processors for computing and data processing could be used as data processing nodes and server nodes. In contrast, the complex function equipment primarily alludes to the devices and equipment with multiple functions depicted previously. For instance, typical smart electrical switches have both switch status perception function and switch control function.

C. Access Capabilities: At present, things in IoT are chiefly composed of equipment and resources which can access the IoT and can process a wide range of information. For instance, a smart telephone or a computer can depend all alone hardware and software resources to access the IoT, and some industrial equipment that supports M2M technology can likewise access the IoT with the assistance of communication resources. In any case, notwithstanding the above things, there are additionally an expansive number of heterogeneous devices without access capabilities in the real world, which are called access restricted devices. For instance, a wide range of sensors and sensor networks can't access the IoT directly because of their exceptionally restricted resources. As the potential IoT access resources, they have to cooperate with the specific equipment and networks to access the IoT in the indirect way [6].

1.3 Access Requirements of Things in IoT

In this segment, the focus is on examining access requirements for the access restricted devices in IoT because they exist in real world with an extensive scale and contain a lot of useful information. With more access restricted devices accessing to the IoT, the IoT will enormously expand its application fields and turn out to be all the more powerful and intelligent. The access requirements for the access restricted devices for the most part include functional and non-functional requirements.

A. Functional Requirements

First, any access devices in the IoT should be correctly identified and certified for the follow-up operations. For example, when a computer accesses the internet, it can use its unique MAC or IP deliver to identify itself. Also, in order to execute their own particular specific perception, control or computing functions, the access restricted devices in IoT require the external hardware and software resources. For instance, an industrial controller needs external communication modules to receive the control direction from the upper platform for intelligent control. Based on

the above analysis, the access functional requirements of the access restricted devices are analyzed and summarized.

1. Identification & authentication: Things in IoT should be uniquely identified and authorized through particular identification. With this identification, things can be further operated and oversaw independently in the system. The identification ought to be unique, traceable and controllable. This process involves the registration mechanism, authentication mechanism, and information transmission security and other related technologies [7].

2. Environment perception: There are a few "things" directly or indirectly perceiving the surrounding environment information and processing the comparing information which are accommodated the specific applications of the IoT. The access restricted devices for Environment perception need to set up the communication interface and special channels between the perceptive terminal and the service platform. This process involves a number of key technologies, for example, the resources description, the resource addressing et cetera.

3. Interactive control: Under the IoT, there are a few "things" with the capability of operating some specific equipment for automatic control and management. The access restricted devices need to establish the control channels between the control terminal and the service platform for interative control. This process involves the business functions description, service publication and other key technologies.

4. Computing & processing: In addition to environment perception and interactive control capabilities, some of "things" in IoT likewise have the computing and processing capacities. This sort of access restricted devices in order to realize the computing and processing functions under the IoT, need to setup specific software and system resources which can support the data processing function and different business service function in IoT [8].

B. Non-founctional Requirements

In the non-functional requirements, the access restricted devices mostly expand their software and hardware resources for the performance requirements. Some access restricted devices are restricted by their hardware resources. For instance, some sensor networks are limited in calculation and storage performance, and some industrial controllers are absence of communication capability. Since their hardware performance can't support the normal

implementation of their functions and can't guarantee the quality of IoT services, the access restricted devices need to coordinate with the specific software and hardware resources to improve their hardware performance and guarantee the quality of service they give [9].

Based on the above analysis, the access non-functional requirements of the access restricted devices are analyzed and summarized:

1. Unified access: When the access restricted devices access the IoT, they ought to shield their heterogeneity and be as per unified interfaces and protocols for IoT, in order to unify the data format and operation processes, and eventually gives the universal application development platform. The unified access involves the general interface design, the general adapter design and the multi-protocol implementation.

2. Platform expansion: The access restricted devices can take care of the problem of the limited resources through the external equipments and resources .Through along these lines, we can improve the hardware platform performance and software platform performance, and ensure the implementation of the function and guarantee the quality of service, which alludes to the improvement of computing capabilities, storage capabilities and communication capabilities. Plus, we have to reduce the resource consumption while ensuring the basic and important functions [10].

1.4 Energy Harvesting in IoT: IoT is a system containing different interconnected hubs, for example, vehicles, advanced mobile phones, PCs and other electronic contraptions. The IoT network comprises of sensors, actuators and remote gadgets whose capacity is to recognize, sense, control and computerize the articles. The RF gadgets that come in bring down cost and are by and large of short range are extensively utilized among every one of the gadgets. On including some extra measure of energy to these short range RF gadgets will upgrade greater usefulness for instance, mechanized control frameworks, work systems and detecting. IoT is not constrained to the PC frameworks, tablets and cell phones that are associated into each other through the web, additionally, to the billions of gadgets for instance, AC, water kettle and so forth or neighbourhood that are associated together through the web to increment effective usage of assets. The expanding number of IoT gadgets in the system prompted the expanding requirement for batteries for these gadgets and furthermore need to consider their cost, upkeep

and transfer. To address this issue, harvesting of energy presents a straightforward and simple arrangement through which these remote gadgets are controlled by using required vitality. The remote hubs in the IoT are inserted with the sensors that record the physical activities introduce in the earth and change the information into electrical signs or actuators that get the electrical flags and change it into physical activities. [1]The real prerequisite of the IoT network is to gather information by finding the sensor nodes into various areas. Thus, the issue that emerges is to introduce the power giving out wires or if there should arise an occurrence of batteries utilized, the battery life of the gadget or the era required to supplant the batteries. This is really not the issue if the quantity of gadgets is around 10-20 yet on the off chance that if the number increments to 10,000, a lac or a million then one needs to worry about the obtaining cost, upkeep cost and other required costs.

This is one reason that the spread of remote sensor nodes has transformed into a concern. Energy harvesting gives an answer for this challenging issue. Energy harvesting advancements utilize power generating segments, for instance, sunlight based cells, piezoelectric segments, and thermoelectric components to change over light, vibration, and heat energy into power and after that utilize that power proficiently. Regardless, the measure of harvested energy is at present constrained and energy storage is little. Therefore, energy harvesting advances require an answer for effectively dealing with the harvested energy [11].

1.5 Features of Sensor Networks

a) Lifetime: In sensor network, sensor nodes have compelled battery control, so the life time of sensor nodes is less. Lifetime is more crucial in some more fundamental applications. Regardless of the way that it is often acknowledged that the transmit control associated with packet transmission speaks to the detecting, signal handling and even equipment operation in standby mode devour a steady measure of energy too. In a couple of uses, extra power is required for huge scale activation.[16] At the physical layer directing and channel access conventions could be favorable position to exchange the data. Bring down radio commitment cycles and element scaling may be useful at physical layer for the consumption of energy. The deprivation of the sensors because of the consumption of battery must be avoided simply by one can use energy-proficient routing.

b) Flexibility: The sensor systems are alterable in behavior they can adjust the modifications in nodes thickness and topology. Sensor systems should be adaptable. In perception applications, most nodes may remain serene as long as nothing interesting happens. Regardless, they ought to have the ability to react to extraordinary events that the system hopes to consider with some level of granularity.[5] In a self-recovering minefield, different detecting mines may rest the length of none of their buddies impacts, however need to quickly get the opportunity to be operational because of an enemy assault. In control application, react time is especially fundamental (sensor/actuator systems) where the system gives a deferral guaranteed benefit.[17] In sensor networks, nodes are self-configured and nodes can without quite a bit of an extend receive the particular conditions. In sensor networks, in case of the collapsing of individual node, the sensor system is energetic to alter in its topology. Network and scope in these sensor nodes are reliably to be assured. Availability is expert if every center point is associated with sink node immediate or roundabout. To keep a check on the scope of the system, to gage the way of administrations is given by system particularly zone. Finish scope is particularly basic for perception applications.

c) Maintenance: The support in a sensor system is basic. The sensor system is overhauled completed or mostly over the remote channel. All sensor nodes should be overhauled, and the limitations on the size of the new code should be the same as because of wired programming. packet mishap must be spoken to and should not deter right reprogramming.[5] The code which is persistently running in the nodes, should maintained to reconstructing like a little impression, and updating frameworks should just point a concise intrusion of the standard operation of the node.[5] The failure can happen as a result of various reasons like battery consumption to unusual outside events, may either be self-sufficient or spatially related. Adjustment to inward failure is particularly crucial as progressing support is now and again a choice in sensor organize applications.[18] Self configuring nodes should allow to deployment process run effectively without human communication, the nodes are placed in given specific land region. The nodes should have the ability to review the way of the system sending and demonstrate any issues that may develop, and furthermore conform to changing ecological conditions by means of programmed re-configuration.[5] Time synchronous is must to taking part among nodes, for instance, data combination, channel access, coordination of rest mode, or security-related association.

d) Data Collection: Data collection is identified with system network and scope. A fascinating arrangement is the usage of inescapable portable specialists that haphazardly move around to gather information traverse sensor nodes and access points, it is frequently the case that all information are transferred to a base station, yet this sort of unified information collection may curtail organize lifetime.[15] Transferring information to an information sink causes non-uniform power utilization outlines that may overburden sending nodes. This is particularly savage on nodes giving end connections to base stations, which may wind up transferring movement starting from each and every other node, in this way forming a basic bottleneck for system throughput. In sensor network, we can use clustering technique to transmit data. The grouped nodes relay the information to the cluster head. Cluster head aggregates the information to the sink. The cluster nodes assemble up the group, in which one is the cluster head and rest are the person from the cluster. Fewer packets are transmitted and a uniform energy utilization illustration may be proficient by intermittent re-clustering. Information repetition is limited, as the collection strategy merges emphatically corresponded estimations. [19] In various applications a few inquiries are required that are transmitted to sensing nodes. Let's take an example, our objective is social event, a particular information or data with respect to a specific territory, where various sensor nodes have been passed on. This is the method of reasoning behind looking sensor network as a database. In a sensor network, sensor nodes are prepared to shield its information and nodes itself from outside nodes, however the extreme impediments of lower-end sensor nodes equipment make security an honest to goodness challenge.[20]

1.6 Applications of IOT

a) Military Applications: As because, most of the characteristic learning of sensor systems is basic on the application of defense towards the beginning, basically two basic tasks the DSN and the Sensor Information Technology (SenIT) structure the Defense Advanced Research Project Agency (DARPA), in military sensing, the sensor systems are associated successfully. Nowadays, IoT is more fundamental for military order, control, interchanges, enlisting, knowledge, perception, surveillance and concentrating on systems. IoT is furthermore a bit of the military applications.

In the battle of setting zone, quick arrangement, self-association, non-critical failure adaptation system's security should be required. The sensor nodes should give taking after services [22]:

- Monitoring the friendly forces, equipment and ammunition.
- Surveillance of battlefield.
- Reconnaissance of opposing forces.
- Targeting.
- Assessment of battle damage.
- Reconnaissance of Nuclear, biological and chemical attack.

b) Health applications: Before long Sensor frameworks are in addition utilized as a section in the region of therapeutic administrations. In expert's office sensor frameworks are utilized to screen quiet physiological data, to control the medicine association track and screen the patients and aces and inside a recovering office. In spring 2004 some master's office in Taiwan even utilize RFID significant of above named applications to get the situation at coordinate. [23]

Whole deal nursing home: this application is concentrate on nursing of old individuals. In the town cultivate cameras, weight sensors, presentation sensors and sensors for recognizable proof of muscle advancement assemble a multifaceted framework. They bolster fall area, conspicuousness acknowledgment, significant sign watching and dietary/work on checking. These applications diminish work constrain cost and energetic the reaction of rise situation. [24]

c) Environmental Applications: Today a sensor systems are also associated in ecological applications like regular surroundings checking, horticulture inquire about, flame discovery and movement control. By using sensor arrange as a piece of ecological zone, there is no intrusion to nature sensor systems, is not strict as in cutting edge.

Shrubbery Fire Response: Environmental monitor and failure reaction is negligible exertion flowed sensor network. An organized system of sensors solidifying on the sensors present on ground checking neighbourhood dampness levels, wetness, speed of the wind and heading, along with the satellite imagery and long haul meteorological estimating will engage the assurance of flame peril levels in centered districts and furthermore noteworthy data on likely fire course. Such a system will give noteworthy comprehension of hedge fire progression or more all help charging voices in sorting out a composed calamity reaction due to which property and lives will

be saved property by giving early advised to areas with high danger.[25] Information assembled by sensor systems could guide water system or gathering to improve quality, giving vineyard proprietors and administrators a prevalent profit for their venture.[26]

d) Home Application: Today with making business use of sensor framework, it is no so hard to picture that home application will wander into our commonplace life later on. [27] When you are returned home, entryway sensors identifies that you are at the entryway, the entryway will consequently open and as soon as you go inside the entryway will shut itself. All the switches of the room will consequently turned on like tube light, fan, aerate and cool. [28]

1.7 Challenges in IoT

There are many challenges faced by sensor networks due to number of factors:

- **Ad hoc deployment**: A substantial bit of infrastructure less sensor nodes are sent in areas. A run of the mill technique for arrangement in a wood would fling the sensor nodes from a plane. Here, it's the nodes which can distinguish its network and circulation.[31]

- **Unattended operation:** As the nodes are deployed without human connection in sensor networks this kind of sensor system can undoubtedly reconfigure itself and receive the adjustments in condition, if any progressions are happen.[32]

- **Untethered**: The nodes in a sensor system are not associated with any vitality source. There is just a limited energy wellspring to a sensor node, which must be ideally utilized for preparing and correspondence like battery power. A fascinating truth is that correspondence commands handling in energy utilization. [11]

- **Dynamic changes**: Sensor system is generally of dynamic nature. These nodes are self-configurable. These nodes are effectively embracing the adjustments in the sensor networks because of expansion of greater number of sensor nodes in the system and node failure.

- **Fault tolerance:** The adaptation to internal failure intends to keep up the foundation in a frame that in the event that one node passes on then it can't influence alternate nodes. The versatile conventions/protocols are created to keep up the other system unaffected.[33]

- **Security issues:** Most of the dangers and assaults against security in remote systems are skirting on like their wired accomplices while some are exacerbated with the incorporation of remote availability. Really, remote systems are regularly more prone to vulnerability against some security dangers as the wireless transmission medium is more helpless to security assaults than the wired transmission medium. The communicate way of the remote correspondence is a clear contender for spying because of its broadcast nature. In most of the cases diverse security issues and dangers identified with those we consider for remote specially appointed systems are also related for IoT. [34]

- **Synchronization and Localization:** In a few applications the information procured in all nodes bodes well all in all and consequently should be in sync. Synchronization of clock is a fundamental administration in the sensor systems. Synchronization of time hopes to give a typical timescale to close-by checks of nodes in the system. An overall check in a sensor structure will plan and separate the information accurately and foresee the lead of the future system. It's not as irrelevant as it appeared in light of the way that the delays are there in transmission and no communicating clock is there to sync nodes. It's an essential test in IOT. [35]

  The limitation of sensor nodes that are using just the relative places of the sensors is in like manner an imperative test in sensor systems. This is basic and examined territory in which various approaches have been made, for instance, manhandling got sign quality markers, time of entry, time contrast of landing, or point of entry. Disseminated calculations are accepting an extraordinary part in expanding accuracy. [36]

- **Short Range Transmission:** In IoT, we need to consider the short transmission goes so as to lessen network to be eavesdropped. As in long so as to lessen the chance of to be spied. We require high transmission in long range transmission because of the indicate point communication in between the nodes to achieve the objective which expands the shot to be eavesdropped by an attacker.[37]

- **Energy consumption:** Limited bandwidth of processor and little memory/capacity are two suspicious limitations in sensor systems, which may vanish through the progression of manufacture frameworks. Regardless, the requirement of energy is doubtful to be comprehended soon as a result of direct advance in making battery restrain. The untended way of sensor nodes and risky detecting situations block battery substitution as a feasible solution. Then again the observation way of various applications of sensor system requires a lifetime that is long enough; this is a basic issue of research to give a kind of energy gainful reconnaissance benefit for geographic zone.

1.8 Energy Consumption Issues in IOT

In the IoT the essential issue is obliged battery component. The sensor nodes are little in size so there are requirements like battery size, processors, stockpiling for information, these all are as little as the sensor nodes. So the key focus on redesigning energy utilization in IoT. [38] In IoT a significant measure of recognized information and directing data should be transmitted which consistently have the requirements of time so the data can be used before any occurrence happens, e.g. mechanical observing, equipment checking, et cetera. In IoT the energy control utilization is significantly higher in information correspondence than inside planning. So the energy conservation in IoT is ought to be addressed. [27]

Basically, sensor nodes depend on a battery with limited lifetime, and their substitution is unrealistic in light of physical limitations. Also the design and convention of sensor systems must have the ability of scalability. [40] As the lifetime of battery can be reached out in case we make sense of how to decrease the measure of correspondence. In the detecting subsystem by using low power segments, energy utilization can be diminished. In power supply subsystem it comprises of a battery whose lifetime can be expanded by diminishing the current certainly or despite turning it off.

1.9 Clustering of Sensor Nodes

In order to save the sensor nodes' energy, any of the clustering technique is used. Through gainful system association each one of the hubs in sensor system can be apportioned into little gatherings i.e., clusters. Every group has a cluster head and the remaining nodes are members from that cluster.[40] A two-level request is brought by the clustering in which group heads shape the more elevated amount while the lower level is outlined by part nodes. The clustering

incorporates the gathering nodes into groups and the cluster heads are picked occasionally so that people from a cluster can communicate with their cluster heads and these cluster heads send the gathered information from its members to base station. Since information is transmitted consistently over longer detachments by the group head, their energy consumption is more in contrast with part nodes. [23] The clustering technique is used to limit the energy utilization. By clustering, the packet collision and channel conflict is decreased. Clustering improve the lifetime of the system. Lifetime is the fundamental component to surveying the execution of sensor systems. [41] The clustering approaches can't particularly apply to IoT, these systems has unique operational qualities and arrangement. IoT are sent in specially appointed way they have more number of nodes. In ad hoc systems nodes are ignorant of their locations. [42] Hence, circulated clustering conventions that depend just on neighbourhood data are favoured for IoT (regardless, most reviews around there still expect that the system topology is known not concentrated controller). [43]

We understand that in the IoT the nodes work at battery control which has obliged energy. In light of the some astounding decay of the node, re-clustering is principal as the group needs like outstanding vitality and degree of node, this sort of clustering is called dynamic clustering. For information get ready static parameters are required like partition among nodes and expect that the reliability of the nodes. The clustering method is utilized so that the energy of battery will be saved. Right when using clustering as a part of the sensor system, the burden on cluster head is way greater than for non-cluster heads.

- **In heterogeneous sensor networks:** There are by and large two sorts of sensors, sensors with higher preparing capacities and complex equipment. This form is utilized to make some kind of spine inside IoT being present as the group head and furthermore fill in as information authorities and handling places for information accumulated by other sensor nodes.[43] Common sensors, having lower capacities, utilized to truly detect the coveted traits in the field. In the homogeneous systems, all hubs have same equipment, qualities and get ready limits i.e., it’s the normal circumstance when the sensors are passed on in forefronts. For this circumstance every sensor can transform into a bunch head. Moreover, the clusters head part can be periodically turned among the nodes all together accomplish better load balancing and more uniform energy consumption.[44]

- **In homogeneous sensor networks:** To procure adaptability and better performance meeting of the amount of nodes in IOT in homogeneous sensor systems had done by disseminated cluster head election and development technique of cluster is most fitting approach.[43] There are furthermore a couple approaches using centralized or creamer strategies, where at least one coordinator nodes or the BS is dependable to segment the entire system detached from the net and control the cluster cooperation. They are typically not suitable for helpful comprehensively valuable considerable scale IoT applications they may be sensible just for one of a kind reason confined scale applications where great availability and system partitioning is required.[43]

1.9.1 Clustering parameters

Before clustering formation, the clustering algorithms fulfill all conditions for clustering which are necessary for clustering in IOTs. There are some parameters which are important for whole clustering processor in IOTs, it give more detail about clustering formation. These clustering parameters are:

- **Number of clusters:** In most recent probabilistic and randomized clustering algorithms the cluster head election and formation process lead naturally to variable number of clusters.[45] In some techniques, cluster heads are predefined and number of the cluster are also preset. For efficiency of total routing protocol the number of cluster is very critical parameter.
- **Intra-cluster communication:** one-hop communication is used in initial clustering techniques where the cluster head and sensor nodes are communicating direct. For communication between the sensor nodes and cluster head multi-hop intra cluster communication is required in this large number of sensor nodes and communication range is limited. So here cluster heads is bounded.[46]
- **Nodes and cluster head mobility:** If we assume that sensor nodes and cluster head are stationary, there is a led to stable clusters with facilitated intra cluster and inter-cluster network management. If the cluster heads and the sensor nodes to be mobile, in this case the cluster head and other members of that cluster are moveable. They all change their positions dynamically. Dynamic changes will occur in the clusters, probably need to be continuously maintained of that clusters.[47]

- **Nodes types and roles:** In heterogeneous environment the cluster head has more capabilities than other nodes like more communication resources and computations. In homogeneous environment all the nodes have the same capabilities as cluster head.
- **Cluster formation methodology:** In most recent approaches, when cluster heads are just regular sensors nodes and time efficiency is a primary design criterion, clustering is being performed in a distributed manner without coordination [48]. In a centralized approach one or more sensor nodes are coordinator nodes which are used for to control the cluster members and to partition the whole network off-line.
- **Cluster-head selection:** In heterogeneous environments the leader nodes of the cluster is pre-assigned. Pre-assigned nodes become the cluster head. In homogeneous environments the CHs are picked from the deployed set of nodes either in a probabilistic or in a completely random way or based on other more specific criteria (residual energy, connectivity etc.)[49].
- **Algorithm complexity**. The primary design goal is the fast termination of the executed protocol in most recent algorithms. The time complexity or convergence rate of most cluster formation procedures proposed nowadays is constant or just dependent on the number of CHs or the number of hops.[3] In some earlier protocols, however, the complexity time has been allowed to depend on the total number of sensors in the network, focusing in a completely different criteria first.[50]
- **Multiple levels:** In several clustering approaches the concept of a multi-level cluster hierarchy is introduced to achieve even better energy distribution and total energy consumption instead of using only one cluster level.[51] Especially when there is an availability of very large networks and inter-CH communication efficiency is of high importance so improvements are offered by multi-level clusters are under study.
- **Overlapping:** The sensor nodes are overlapped with in different clusters due to some reasons, either for better routing efficiency and for faster cluster formation protocol execution it is also a high importance clustering parameter. Most of the known protocols, however, still try to have minimum overlap only or do not support overlapping at all.[52]

1.9.2 Classification of Clustering Techniques

Clustering algorithms for IoT can be additionally isolated into two standard arrangements in light of the group development criteria and parameters used for cluster head determination [53]:

- Probabilistic clustering algorithms: Energy-Efficient Hierarchical Clustering (EEHC), Low Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy-Efficient Distributed Clustering (HEED) etc.
- Non- probabilistic clustering algorithms: Node Proximity and Graph-Based Clustering Protocols, Weight-Based Clustering Protocols, Biologically Inspired Clustering Approaches.
- Clustering in IoT includes gathering nodes into groups and choosing a bunch head with the end goal that [23] :
    - The individuals from a cluster can speak with their group head (CH) straightforwardly.
    - A cluster head can forward the totaled information to the focal base station through different CHs.
- There are numerous strategies that are utilized as a part of bunching these are LEACH, and numerous more enhanced types of LEACH like E-LEACH, LEACH-SM, multi-jump LEACH, ENCM et cetera. LEACH convention contains two stages [14]:

Cluster set up phase: In this stage the every node portrays regardless of whether to wind up a cluster head node for the ongoing round. A random number between 0 or 1 is picked up for making a decision. A threshold worth is setup, if the quantity/weight of node is not as much as threshold quality, then that node turns into a head node for the ongoing round.

Steady phase: The system is going to enter the steady stage when the group head dole out time slots to its individuals for utilizing TDMA mode. The steady stage is isolated into frame, where hubs send their information to the group head at most once per outline in the midst of their distributed transmission opening. [14]

The decision of group head node in LEACH has a few inadequacies, for example,

- Some huge groups and little bunches may exist in the system in the meantime.
- Unreasonable group head choice while the hubs have diverse vitality.
- Cluster part nodes exhaust vitality after cluster head was dead.
- The calculation does not consider the area of nodes.
- Ignores leftover vitality, geographic area and other data, which may effectively prompt bunch head hub will quickly fail. [16]

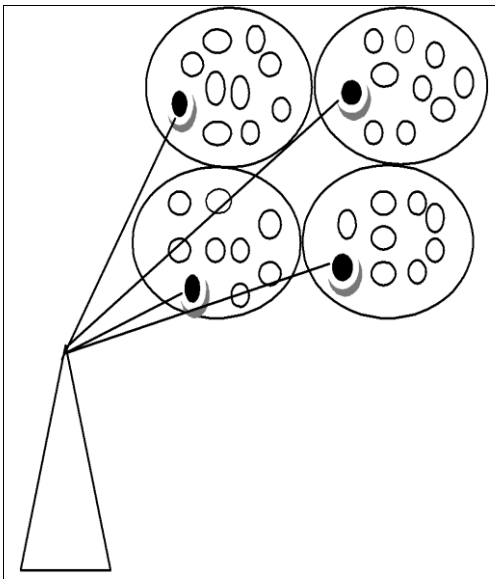


Figure 1.1: single hop with clustering

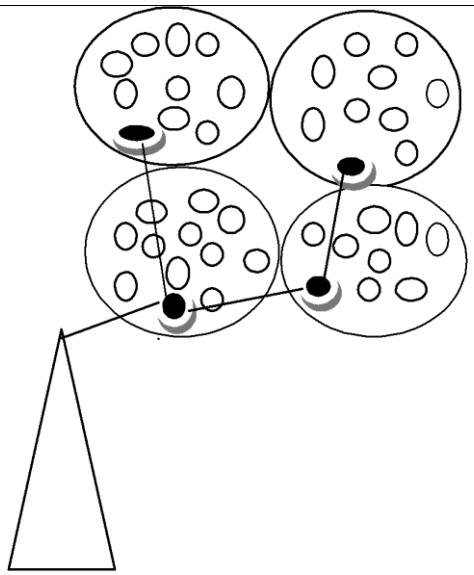


Figure 1.2: multi hop with clustering

The clustering is as appeared in above figure 1.1 and figure 1.2. Figure 1.1 demonstrates that single hop with grouping and figure 1.2 multi hop with clustering. In the above figure 1.1 and figure 1.2 the LEACH is partitioned into three groups. Dark node is the cluster head which communicate to the group. All the white nodes are the individuals from the group. In a group, the cluster head is changed arbitrarily by any clustering convention. To changing the group head between each cluster nodes is to disseminate the system stack. Along these lines the execution of the whole system is enhanced and can be accomplished lower energy utilization.

Disadvantages of the LEACH Protocol

LEACH protocol has a few issues rather than plane multi-hop and static routing, in light of the fact that it drags out the system lifetime. In this convention the cluster head is chosen haphazardly, so every one of the nodes can't be cluster head. The dissemination of cluster heads can't be guaranteed. In the group every one of the nodes has same need to wind up plainly a cluster head node with high as well as low energy. Thusly, the nodes with low outstanding energy might be picked as the cluster heads which will come about that these nodes may pass on first. [54] LEACH can't be utilized as a part of vast scale IoT for the farthest point successful

communication scope of the sensor nodes, on the grounds that the cluster heads communicate with the base station in single-hop mode. [54]

1.9.3 Need of clustering

- **Load balancing**: The cluster heads requires extensive energy consumption as they have to aggregate data first from member nodes and then to transmit the aggregated data to base station. This can be located far from the respective network. Therefore, the load can be divides equally between all the nodes in the network by rotating the role of cluster heads. [6]

- **Optimal number of bunch heads**: In a few procedures, the group head is resolved from the earlier. Accomplishing the ideal number of bunch heads guarantee the minimum vitality utilization in the framework/arrange and along these lines, diminish control utilization so as to delay organize lifetime. [6]

- **Maximum organize lifetime:** Sensors are asset limitation gadgets and reliant on their batteries as wellspring of vitality, accordingly, the lifetime ends up noticeably vital thought in sensor arrange topology design. [6]

1.10 RFID Protocol:

RFID (Radio Frequency Identification) is a contact less programmed identification expertise that depends on radio recurrence. There are commonly two sorts of RFID as indicated by the power source: dynamic RFID and latent RFID. Dynamic RFID is less advantageous than detached RFID regarding its label cost, size, and battery administration, yet more favourable circumstances in term of detecting nature, its tendency, detecting rate advertisement detecting separation. RFID is delivered so that the physical data can be put away and recognized for quite a while to improve nature of the structure moreover of crucial functions.

RFID is self-sorted out innovation which is based upon the radio frequency. RFID is separated into two classifications:-

1) Active RFID

2) Passive RFID

Dynamic RFID/IOT will play out the availability of tag-to-label communication. Dynamic RFID is less preferred standpoint than latent due to its labels estimate, cost, battery administration yet less favourable position through detecting rate, dependability, and detecting separation. Dynamic RFID spare the energy of label work on the label ID period and information accumulation period. To convey the stored physical data to the user, the dynamic RFID tag uses the radio module. RFID gives the point to multipoint (P2MP) Communication framework where the user controls the labels. To lessen the energy utilization of tag, the user controls the vitality that the radio module eats up by making the label work in the dynamic and rest periods. The user transmits an accumulation charge to different labels, which deliver the ID to the user by methods for dispute. information accumulation period, the user assembles the information on the labels that are identified from the label ID gathering period utilizing their IDs, through the point to point(P2P) methodology.

The dynamic time frame is isolated into the label ID period and information gathering period. The id time frame is called conflict period. A user can transmit a charge to different label which in like manner convey id to user by methods for conflict. In the information accumulation period, the user assembles the information on the labels that are distinguished from the label ID gathering period utilizing their IDs, by methods for the point to point (P2P) procedure. At that point the sleep command kills the radio module of the tag from which the information has been assembled. This is known as the collection period (CP). The user repeats this system until every one of the labels inside its communication reach is assembled.

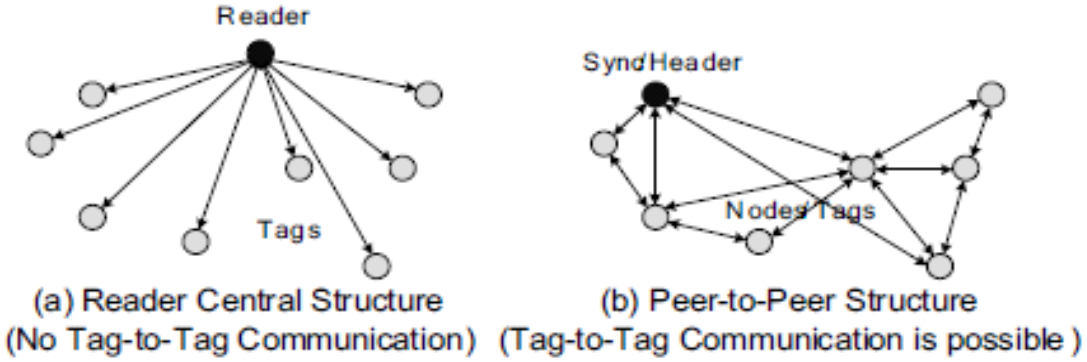


Figure 1.3 communication structure of (a) RFID (b) IOT [32]

These strategies are hard to apply, in any case, in light of the way that their correspondence structures differentiate from those of the dynamic RFID system. The MAC of the dynamic RFID has a per user focal correspondence structure, wherein the per user controls the correspondence of the considerable number of labels. The MAC of IOT has a distributed correspondence structure, wherein all hubs control their own particular correspondence shapes. If each one of the nodes need to control their own correspondence frames in IOT, the correspondence direct ought to reliably be in the carrier detecting and the medium must be involved through RTS/CTS. The control of the medium is just for the Tx and Rx hubs, and the rest can't pass on. In case the labels in the dynamic RFID system utilize conveyor detecting, every one of the labels must direct transporter detecting an indistinguishable number of times from the amount of labels to transmit their IDs. This makes label gathering delay, which is an extra wellspring of vitality utilization. This may prompt the loss of the crucial typical for the RFID structure that accumulates labels.

CHAPTER 2
REVIEW OF LITERATURE

Mahdi, O.A et al. [7], Data aggregation and clustering are the two generally utilized systems for diminishing vitality use and expanding the lifetime of remote sensor systems. In target following applications, expansive measure of redundant information is created routinely. In order to reduce the redundancy, data aggregation techniques are vital to use. This work expects to lead a similar study of different research approaches that utilize clustering methods for productively collecting information in target tracking applications as choice of a proper clustering algorithm may reflect desired outcomes in the process of data aggregation. In this paper, various existing clustering based aggregation techniques are discussed alongside a point by point discourse on their preferences and issues that may corrupt the execution. The four clustering approaches have been compared i.e., static, dynamic, adaptive and combined clustering, out of which adaptive has been proven as the most suitable due to its better performance among the rest.

Jan, M.A., Nanda, P et al. [13], Remote sensor systems involve asset starved sensor nodes, which are sent to detect environment, accumulate information, and transmit it to a base station (BS) for further handling. Cluster based various hierarchical routing conventions are utilized to productively use the constrained vitality of the nodes by sorting out them into clusters. Just cluster head (CH) nodes are qualified for information gathering in each group and transmitting it to a BS. The unbalanced clusters result in system clog, packet loss, delay, and corruption of Quality of Service (QoS) measurements. In this paper, a priority-based application-specific congestion control clustering (PASCCC) convention, which coordinates the versatility and heterogeneity of the nodes to distinguish congestion in a system. PASCCC diminishes the obligation cycle of every node by keeping up edge levels for different applications. On comparison with existing clustering protocols, (PASCCC) experimental results are better in terms of energy consumption, data transmission and network lifetime.

Chae-Seok Lee et al. [55], purposed Reservation Aloha for No Overhearing that is utilized to inform the tag of its viable communication for eliminate overhearing issue. Extensive of energy is reduced because of overhearing is ordinarily bigger than consumed powerful communication .to eliminate this issue creator reason calculation (RANO). A tag has data about the time and term of correspondence progress since it keep up dynamic mode for kept the rest mode as a

result of other transmission time span. RANO Protocol saves the 60 times vitality than another convention.

Amilcare Francesco Santamaria et al. [33], Proposed that the residential framework structure is an astounding approach to accomplish more noteworthy connection between savvy gadgets, individuals and the earth. The structure created can be utilized for vitality utilization, helping, warming and molding. The fundamental objective of this system is to make the family clients mindful about their day by day vitality utilization and vitality wastage. The IoT engineering includes four layers: the most minimal layer incorporate the gadgets like AC, evaporator, attachment. The second layer from the base contains the sensors associated with such gadgets i.e. s-attachment, s-AC, s-kettle and so forth. The third layer is benefit layer which gives administrations to the interconnected layers. The top most layer is application layer which specifically cooperates with the clients. Subsequent to learning time, clients expect without anyone else's input how to evade wastage of cash and spare vitality. The learning time and the incline of the patterns exhibit that clients can take focal points from valuable apparatuses that assistance them to settle on the correct choice raising target information that shows constant vitality utilizations and how little changes in their conduct can lessen wastages. The investigation appears if the clients mindful of their vitality utilizations and can have the likelihood to control a portion of the gadgets, after some measure of preparing, they can set aside to 20% on their vitality bills.

Degan Zhang et al. [35], proposed a method forward mindful part (FAF-EBRM),this procedure is used for the accompanying jump hub picked by the forward vitality thickness and connection weight .The FAF-EBRM contrasted and LEACH and EEUC. The proposed strategy modifies the vitality diminishment, work lifetime and give incredible nature of administration and lessens the probability of dynamic hub breakdown.

Nicolas Gouvy et al. [36], proposed PAMAL (PATH MERGING ALGORITHM) new geologies directing count for portable hub .the proposed first steering convention which is found and uses ways intersection to adjust the topology to decrease the system movement subsequently while still redesign vitality effectiveness. The convention makes the crossing point to move a long way from the goal, getting closer to the sources, permitting higher information accumulation and vitality sparing. It upgrades the system life time 37% than leaving.

Peyman Neamatollahi et al. [37], proposed a a half and half clustering approach a group head lessen of its vitality, it by implication advises each other hub and grouping is usual to start of the up and coming round. Grouping is performed on request. To expound the effectiveness of recommendation, the appropriated bunching convention HEED (Hybrid Energy Efficient Distributed) cream grouping count is used as pattern case. Through reproduction comes about, it shows that HCA is around 30% more capable as far as system lifetime than the other convention. The principle reason is that the grouping is executed on request.

B. Krishnamachari, et al. [28], In this paper data-centric routing mechanisms are modelled what's more, contrast its execution and traditional end-to-end routing mechanisms. The effect of source-destination position and correspondence density of the network on the vitality expenses and delay related with information accumulation. It is demonstrated that data-centric routing offers critical gains in performance over an extensive variety of operational situations.

Kuo, M.J., et al. [2], In numerous applications, it is a fundamental operation for the sink to intermittently gather reports from all sensors. Since the information gathering process more often than not continues for some rounds, it is critical to gather this information effectively, that is, to decrease the energy cost of information transmission. This paper addressed the issue of building an information accumulation tree that limits the aggregate energy cost of information transmission in a remote sensor organize. Likewise, this paper additionally address such an issue in the remote sensor network where exist relay nodes and consider the situations where the connection quality is not great. This paper demonstrated that these issues are NP-finished and propose O(1) - estimation calculations for each of them. Simulations demonstrate that the proposed calculations have great performance regarding energy cost.

Dahlila P. Dahnil, et al. [6], presents a similar investigation of clustering strategies and cluster nature of a single criterion cluster heads election and cluster formation in IoT. The HEED, LEACH and Energy-based LEACH protocols are reenacted and their performance are compared in terms of the quantity of cluster head generated, cluster size, cluster head distribution, adaptability and coverage. The results of these protocols are presented to show how the cluster formation prolongs the network lifetime. It came out that the versatility viewpoints in the presence of advanced nodes in the network and its impact on the network lifetime. This paper proposed to investigate A HEED and AE-LEACH protocols, a new

approach for cluster heads election that enhanced network lifetime in the presence of advanced nodes. The simulation demonstrates that having fraction of advanced nodes in presence of advanced nodes. The simulation demonstrates that having fraction of advanced nodes in the network gives critical change in network lifetime as compared with having more homogeneous nodes in the network.

Rabia Noor Enam, et al. [8], proposed that the IoT comprises of sensor organizes that are connected to objects and other specialized gadgets which give the information that can be inspected, investigated and used to start the activities. Presently, the structure of IoT has given another distinguishing proof to the Wireless Sensor Networks (WSN) with the end goal that the WSN can be taken as the information gathering module of the IoT. One of the major basic issues of the WSN is the proficient gathering of information with restricted data transmission, parcel sizes and power supply. Development of various groups alongside one bunch head in each bunch is one of the information accumulation strategies in a WSN. This paper utilizes a virtual framework based system to balance out the sizes of the bunches in the system and arbitrarily send the group based remote sensor systems. This is done as the pre-condition period of the following stage i.e. differential conglomeration system for the associated information on the bunch based system. The usage of results is finished utilizing reproduction where three calculations are analyzed i.e. proposed calculation, framework group and LEACH. It is watched that the dependability of the system in the proposed calculation is superior to the LEACH and the general system vitality utilization is lower than that of group matrix.

Matthias R. Brust, et al. [38], analyzed various leveled arrange is made by grouping strategies is called bunches. In a group all sensor hubs pick the bunch head. To pick the group head in IOT and in impromptu system is fundamental issue in view of their dynamic nature. This paper proposed topological criteria for powerful group head competitor determination, strong to sporadic hub portability and disappointment and furthermore for gainful data spread. In this strategy is to keep up a key separation from the periphery hubs to pick the bunch head since they can move to other group whenever and again re-grouping will happen and again pick another bunch head. This is absolutely wastage of time and more vitality expending. The investigations were led for static topologies and moreover for cases in the nearness.

Vinay Kumar, et al. [30], In this paper they talked about in IoT to augment the lifetime of the sensor network, for the data transfer the path is chosen in such a route in which the energy consumption is minimized in that path. To support high scalability and better data aggregation, sensor nodes are often grouped into clusters. Clusters create hierarchical IOT, the sensor nodes utilization their constrained resources in efficient way and in this manner extends network lifetime. The taxonomy has been presented which is of energy efficient clustering algorithms in IoT, and likewise presented timeline and description of LEACH and Its descendant in IoT.

Fan Xiangning and Song Yulin [9] presented review study on LEACH protocol, and advances energy-LEACH and multi-hop LEACH protocols. Energy-LEACH protocol enhances the decision strategy for the cluster head, makes a few nodes which have more residual energy as cluster heads in next round. Multihop-LEACH protocol enhances communication mode from single hop to multi-hop between cluster head and sink. Simulation results demonstrate that energy-LEACH and multihop-LEACH protocols have preferable performance over LEACH protocols Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is a clustering based protocol to gather data from wireless network.

Bilal Abhu et .al. proposed [4] the LEACH-SM protocol, which adjusts the prominent LEACH protocol by providing an ideal energy-saving of spare management having all the spare selection. Drain SM adds the spare selection stage to LEACH. This paper presented a quantitative comparison of energy consumption and IOT lifetime for both protocols.

Maciej Nikodem and Bartosz Wojciechowski [14] explained on the theoretical parts of clustering in IoT, as an intend to enhance the network lifetime. Here investigated, whether clustering its can enhance network lifetime specifically application when compared to non-clustered networks. This paper utilizes integration programming to break down 1D and 2D networks, taking into record capacities of real-life nodes. The results demonstrate that clustering itself can't enhance network lifetime so additional systems and means are required to be utilized as a part of synergy with clustering.

F.J. Atero, J.J. et al [10] proposed a new architecture called HARP (Hierarchical Adaptive and Reliable Routing Protocol), a clustering algorithm which fabricates intercluster and intra-cluster hierarchical trees, which are advanced to spare power. This architecture is scalable and can be

utilized as a part of homogeneous as well as heterogeneous IoT. The recovery slot in the scheduling plan, HARP gives very much sorted out link fault tolerance and likewise supports node mobility management.

D.G.Anand et.al [18] has proposed a randomized calculation which is run locally at a sensor hub to manage its operation. In this paper, a current vitality productive associated scope issues proposed in writing, their plans and suppositions and furthermore arrangements proposed. Sensor scope, availability and vitality are the three basic parts for QoS in applications with IOT. The execution of the conventions utilizing NS2 test systems is analyzed and exhibited that the introduced brings about basic lessening of vitality, with unequivocally associated scope. Most recent takes a shot at the sensor associated scope issue are as yet obliged to hypothetical investigation.

Maryam Soltan et.al [19] displayed an area mindful tweak plot and demonstrated how the regulation determination can fix and alter the spatial appropriation of vitality dispersal over a scope zone in an IOT. It ought to be noticed that, when all is said in done, the proposed location-aware heterogeneous modulation plan might be executed in conjunction with other low power systems in different network layers keeping in mind the end goal to enhance the network lifetime.

CHAPTER 3
PRESENT WORK

3.1 Problem Formulation:

The degradation of network performance of an IOT is caused due to the energy depletion. This energy depletion causing in making energy holes in the network. Various energy models have been proposed by many researchers. These models provide different explanations but they also need to be improved. The stability period and lifetime of a network are the major key factors. These factors play an important role in routing protocols through clustering technique. The clustering technique prolongs these factors. The communication in the IOT through clustering technique is done from one cluster head to another. The reduction of battery consumption and increment of packet overhead is done through this technique. The load csn be divide equally in the network between the cluster heads. This can increase the efficient working of the network. Whenever there is a load imbalancing observed in the network, the battery consumption of the cluster heads is seen to be increasing. This results in reducing the lifetime of the network. The factors such as transmission distance, optimal routing conventions and the amount of the information to be transmitted are the key factors that affect the energy consumption of the network. The requirements in the IoT are met by the cluster heads. Same adjacent sensors are grouped into a cluster. A problem is observed in the network when the data is to be transferred from source to destination. Due to battery failure sometimes, the cluster nodes become dead. Due to this problems such as degradation of network occur which result in decreasing the network performance. So, various techniques such as clustering, re-griding etc. are used to minimize the energy consumption. This results in the reduction of energy consumption gradually. The principle idea of this work is to actualize revamping of lattice for IoT systems utilizing neural system approach. Some algorithms can be used in neural networks which can easily adjust the weights. Our work can consider this as an important key point. The difference here is that we adjust the nodes instead of weights according to the nodes capacity to send for communication. In a cluster, the node with higher sending capacity is set as the cluster head of the cluster. Only one node can act as a cluster head in a particular cluster. There are numerous cluster heads in a system. The re-clustering is process which is dynamic in nature can be adjusted according to the situation.

3.2 Objectives of the Study:

1. Simulation based implementation of cluster based energy balanced network of IoT devices.
2. To elect the most efficient node according to maximum energy and sensing capacity.
3. To select the cluster head dynamically by using Boltzmann learning.
4. To provide implementation to the proposed and existing techniques along with their comparisons in terms of energy, throughput and packet loss.

3.3. Research Methodology: Re-clustering the grids with the help of neural networks in the main concern of our proposed work. In the existing technique the grids clustering is static but in our proposed work, the grids clustering is dynamic in nature. The situations arising can change and adjust them accordingly. According to the situation and the calculations made on the basis of battery consumption the node data sent is easily adjustable. The major concern here is to avoid the battery wastage. The cluster head selection is also done on the basis of minimum battery consumption through election algorithm.

For instance, let us consider a network which has number of batteries placed in it each having the data send capacity in milliampere. Each battery available in the network forwards the data from source to destination with the help of AODV algorithm. There are clusters and so their respective cluster heads are also present. The maximum sensing capacity and minimum battery consumption factors help in selecting the cluster heads. So the battery with both the mentioned factors is chosen as cluster head. Instead of choosing the cluster head randomly to aggregate the data when the energy of all the nodes are same like in the initial round of data aggregation approach (LEACH), choose it dynamically using the error values using neural network technique i.e. Back-Propagation algorithm. Lesser the value of error for a particular node more will be its rating and hence more will be its chances to become cluster head which will give energy balanced topology.

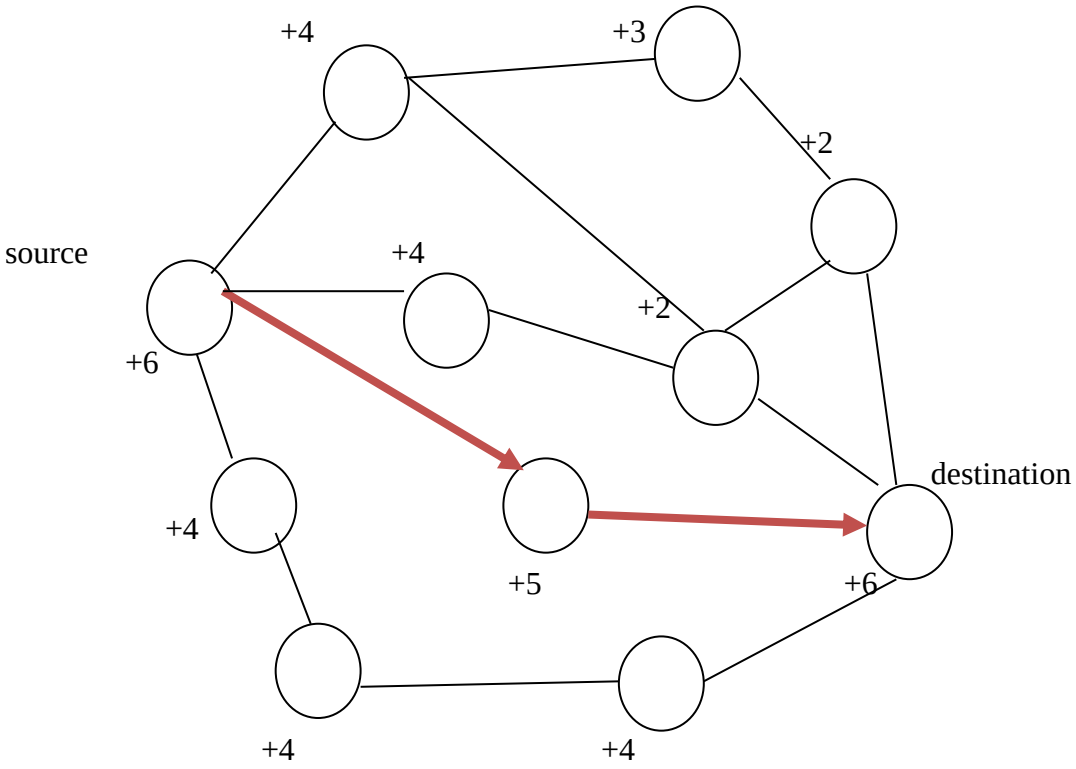


Fig.3.1 Nodes with higher battery participated for routing

Procedure:

1. Deploy the IOT network with the finite number of nodes.
2. Apply the neural network approach i.e., Back-propagation algorithm to calculate the error value

   Actual error= $\sum_{\substack{x=0 \\ w=0}}^{\substack{x=n \\ w=n}} x_n w_n$**+bias**

   Error=Desired error-Actual error
3. Calculate closest value from error

   Closest ∝ 1/error

   Use this value to rate nodes and choose effectively the cluster heads when the energy of the nodes is same (As in initial round of LEACH).
4. The aggregate energy is calculated using the below formula where Et is the energy transmitted r is the current round, rmax is the maximum number of rounds and n is the number of nodes.

Ea=Et*(1-r/rmax)

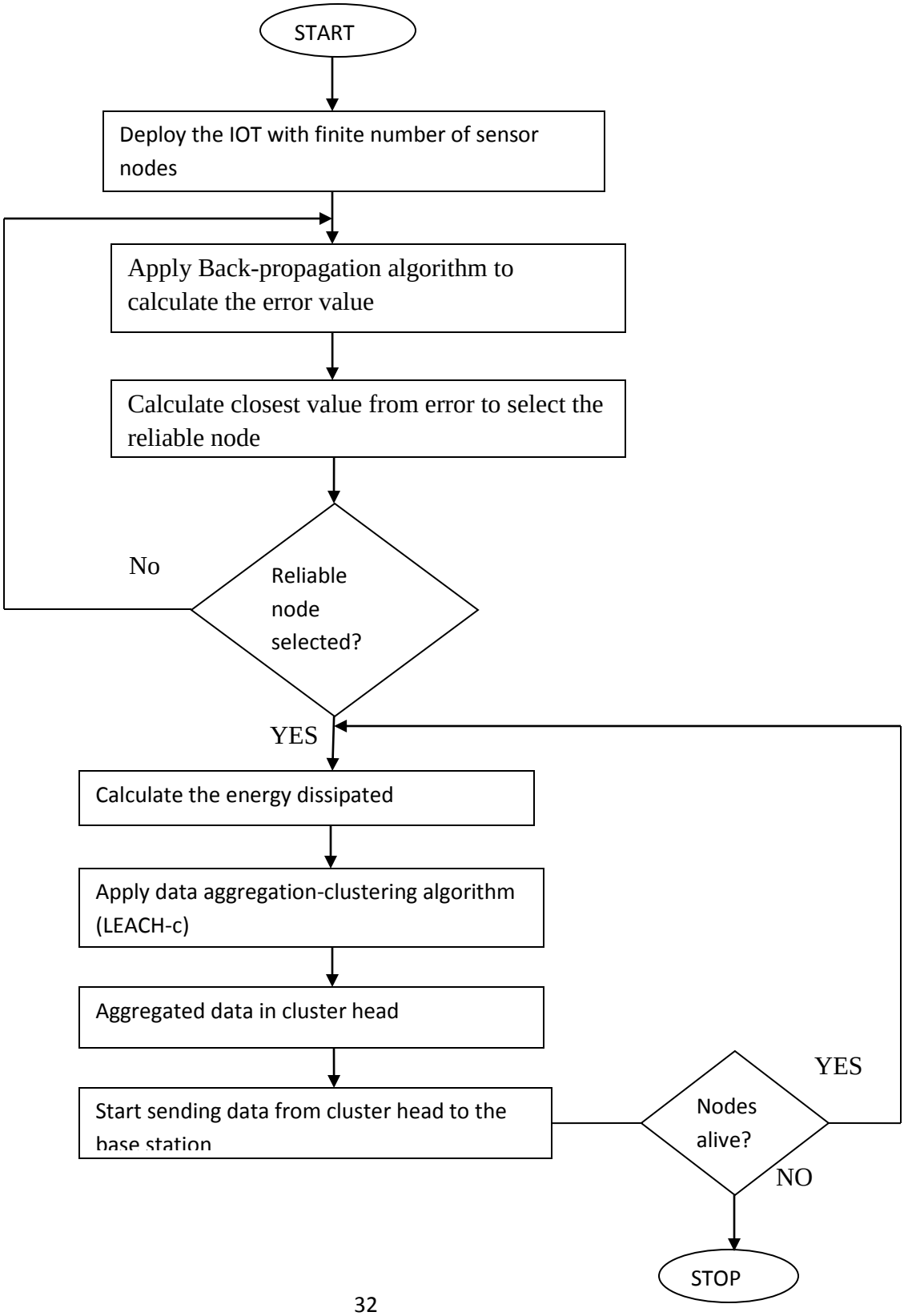
5. Apply data aggregation technique when energy of the nodes are not same (LEACH)

$$\frac{\boldsymbol{p}}{\mathbf{1}-(\boldsymbol{p}*\boldsymbol{mod}(\boldsymbol{r},\boldsymbol{round}(\frac{\mathbf{1}}{\boldsymbol{p}})))}$$

Here, p is the percent of cluster heads required in particular round and r is the current round.

6. Start communication
7. If(nodes are alive)
8. Repeat step 4
9. Else stop

Flowchart


START
Deploy the IOT with finite number of sensor nodes
Apply Back-propagation algorithm to calculate the error value
Calculate closest value from error to select the reliable node
Reliable node selected?
No
YES
Calculate the energy dissipated
Apply data aggregation-clustering algorithm (LEACH-c)
Aggregated data in cluster head
Start sending data from cluster head to the base station
Nodes alive?
YES
NO
STOP

CHAPTER 4
RESULTS AND DISSCUSSION

For 2000 rounds:

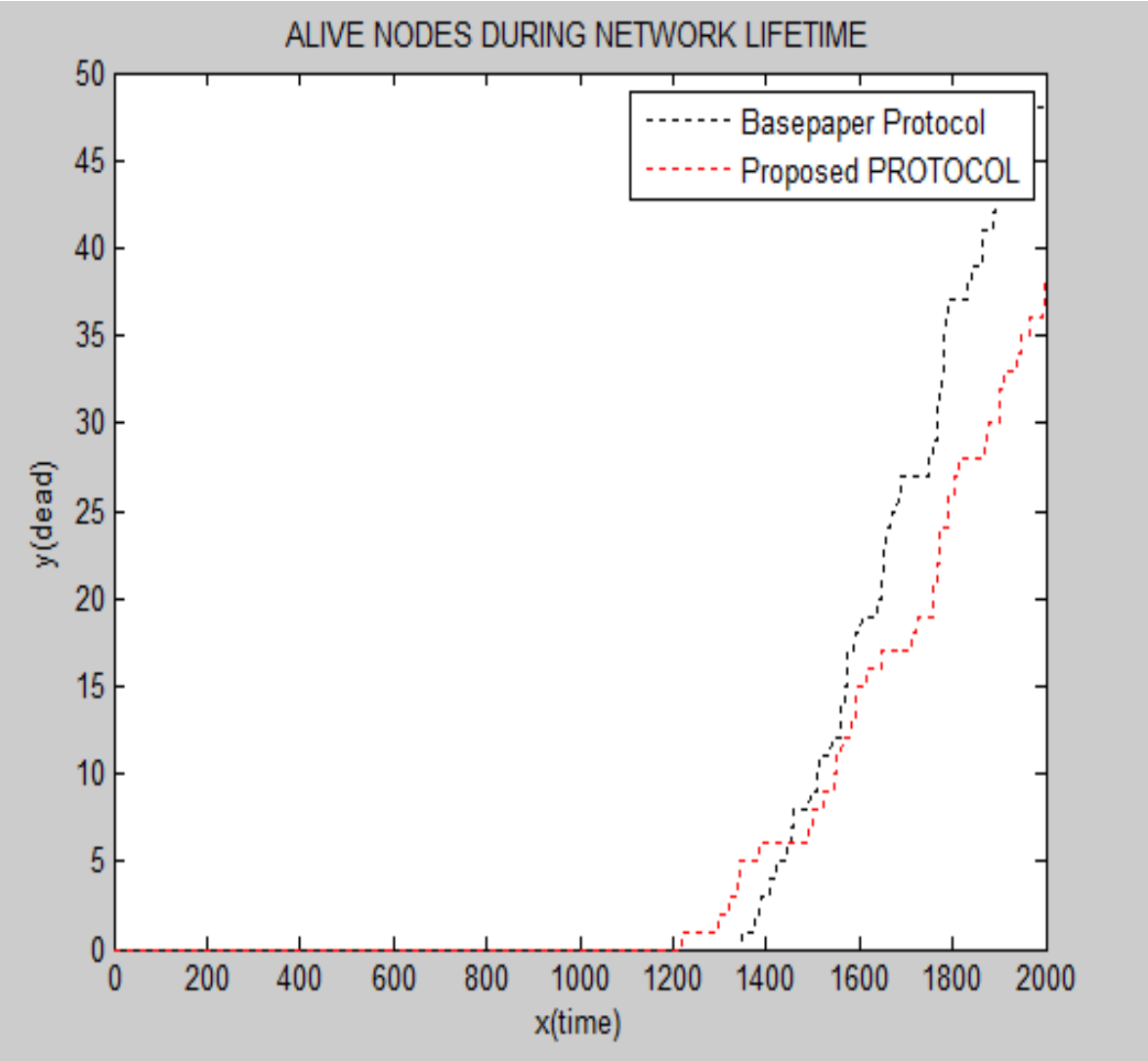


Fig 4.1: Lifetime of the nodes

As illustrated in figure 4.1, the lifetime of the nodes is compared in existing and proposed techniques and the proposed technique nodes are alive for more time than the existing technique ones and providing energy balanced topology.

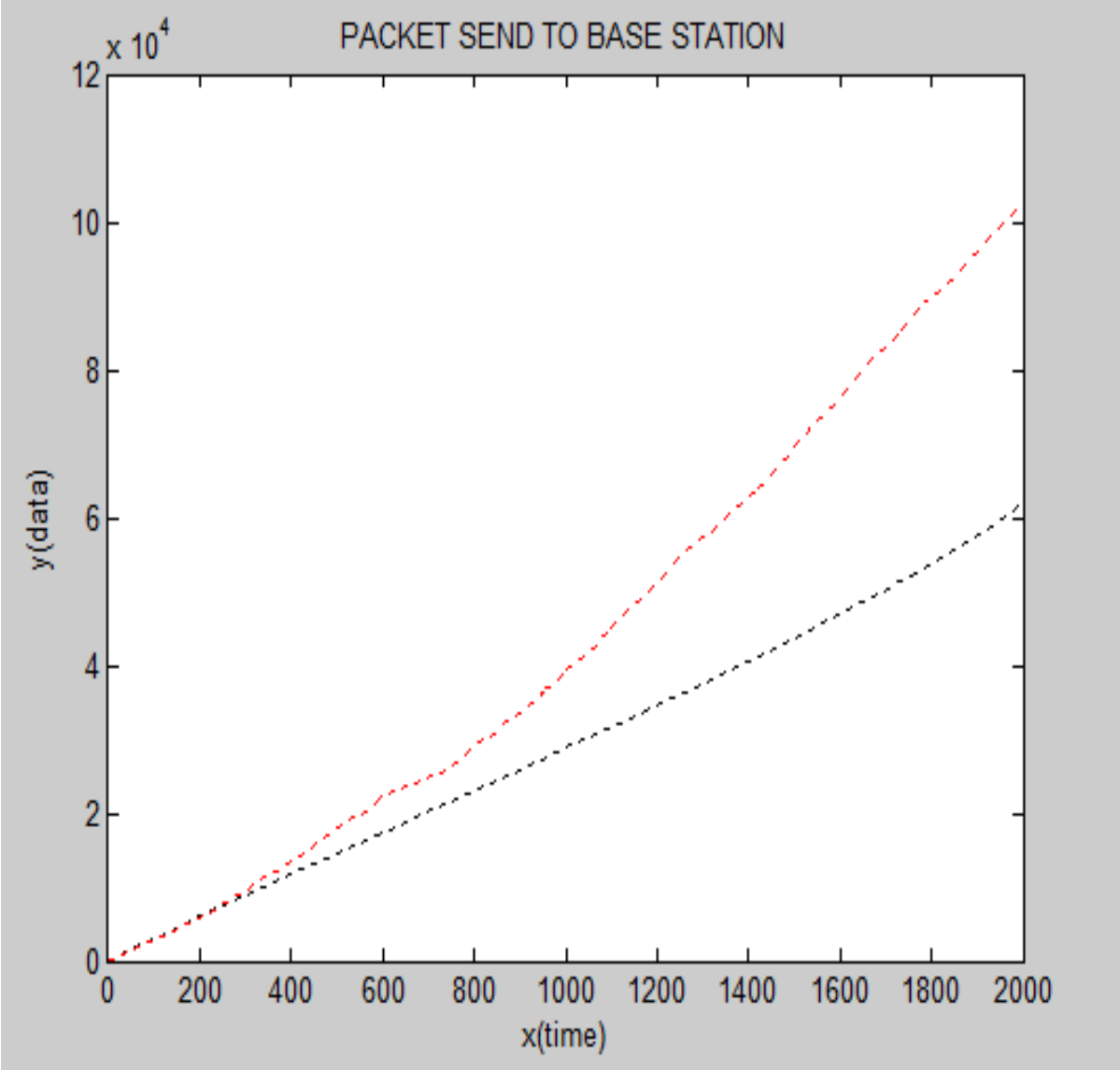


Fig 4.2: Packet sent to Base station

As shown in figure 4.2, the packet loss is compared in existing and proposed techniques and the proposed technique packets are sent at higher rates with less loss of data than the existing technique ones.

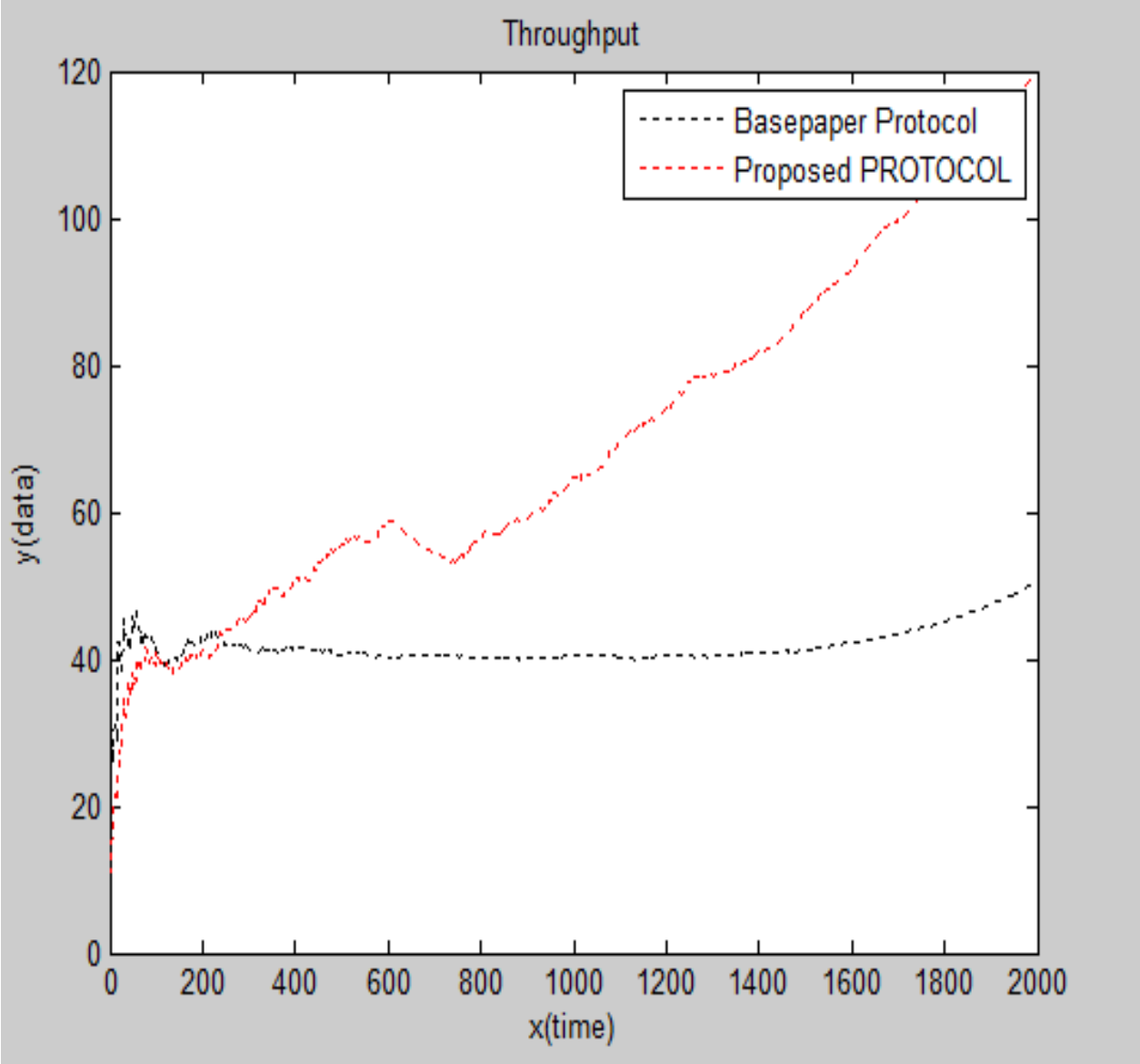


Fig 4.3: Throughput Graph

As illustrated in figure 4.3, the throughput of the nodes is compared in existing and proposed techniques and the throughput value in proposed technique is enhanced as compared to the existing technique.

For 3000 rounds:

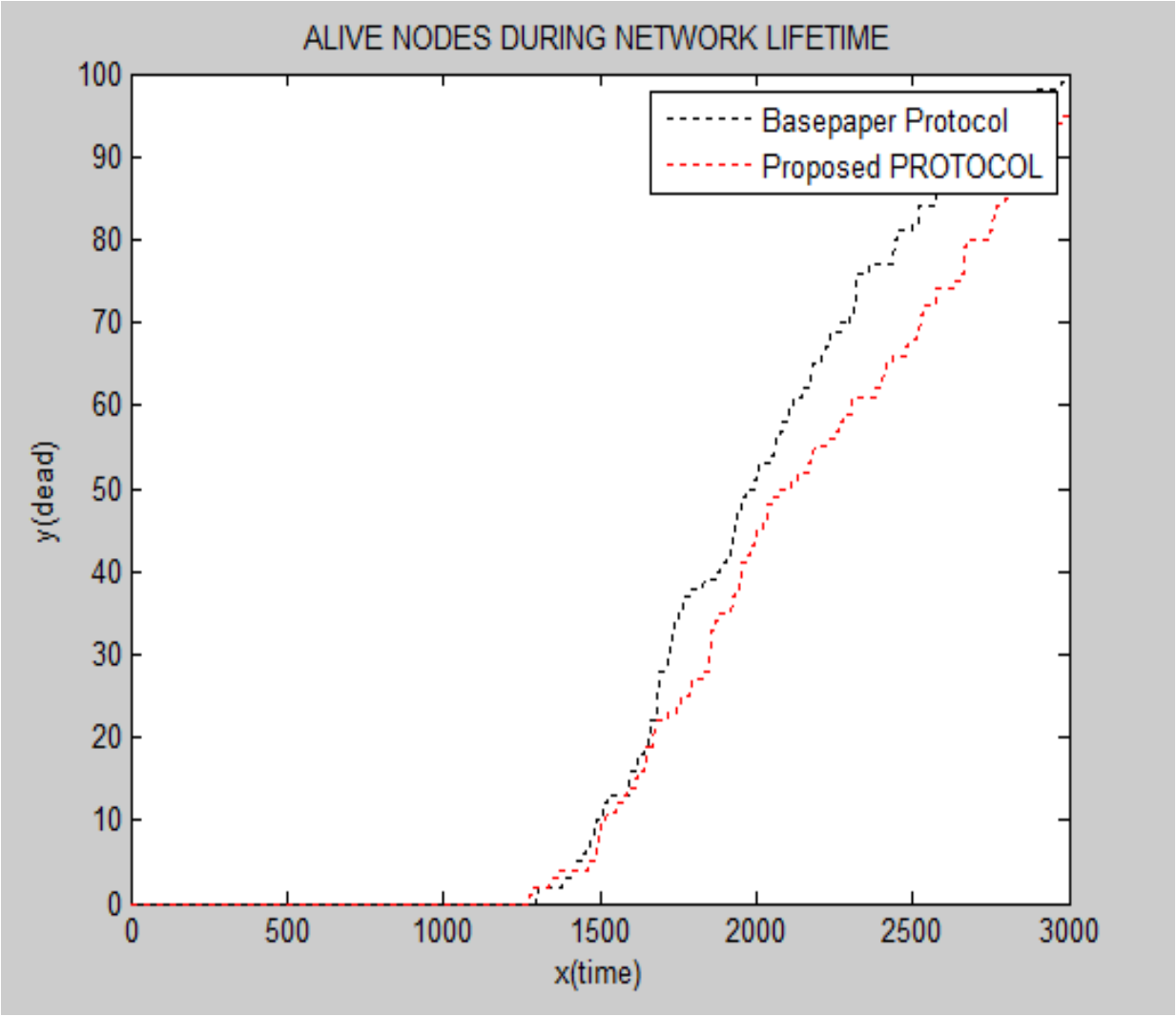


Fig 4.4: Lifetime of the nodes

As illustrated in figure 4.4, the lifetime of the nodes is compared in existing and proposed techniques and the proposed technique nodes are alive for more time than the existing technique ones and providing energy balanced topology.

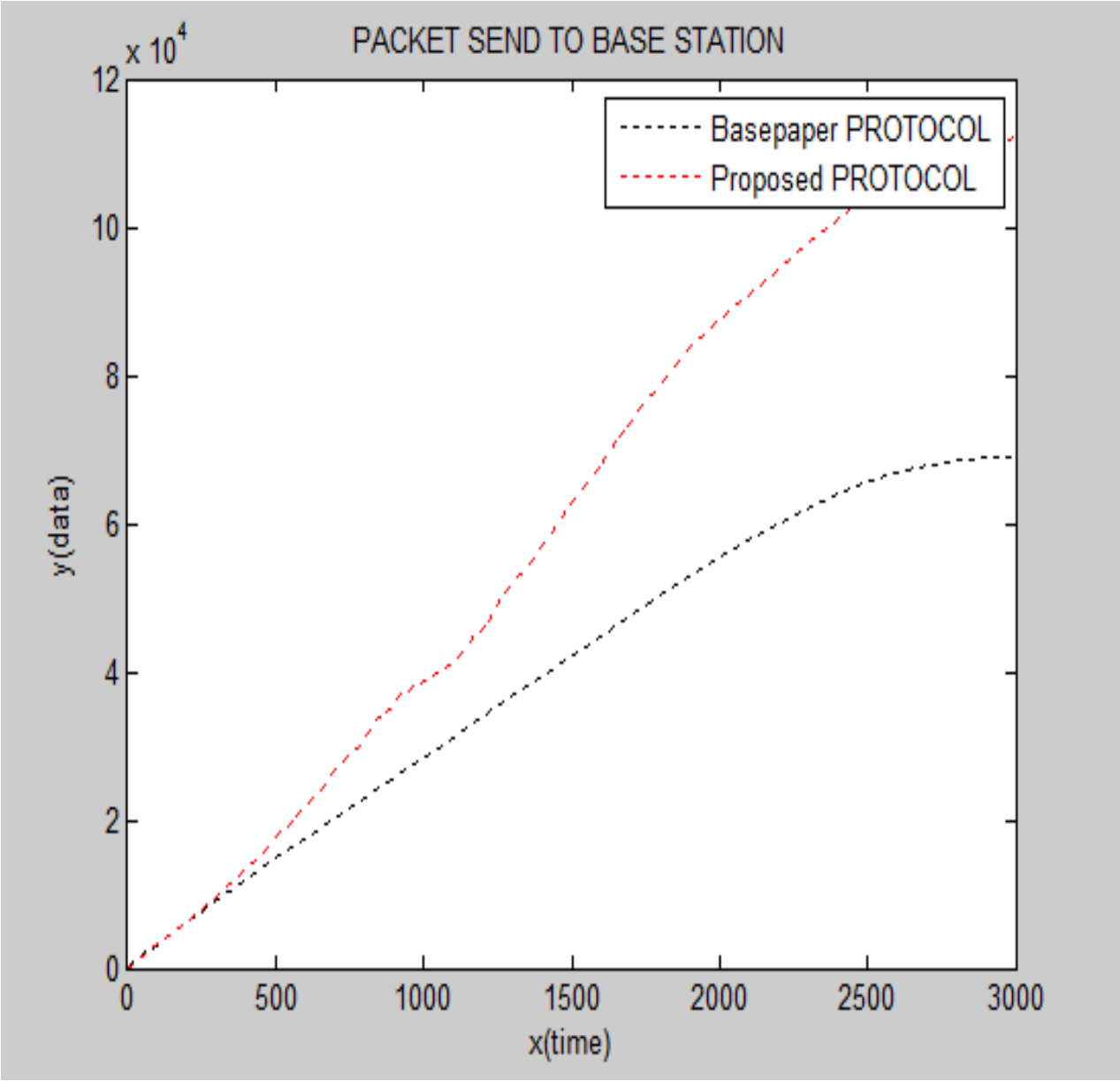


Fig 4.5: Packet sent to Base station

As shown in figure 4.5, the packet loss is compared in existing and proposed techniques and the proposed technique packets are sent at higher rates with less loss of data than the existing technique ones.

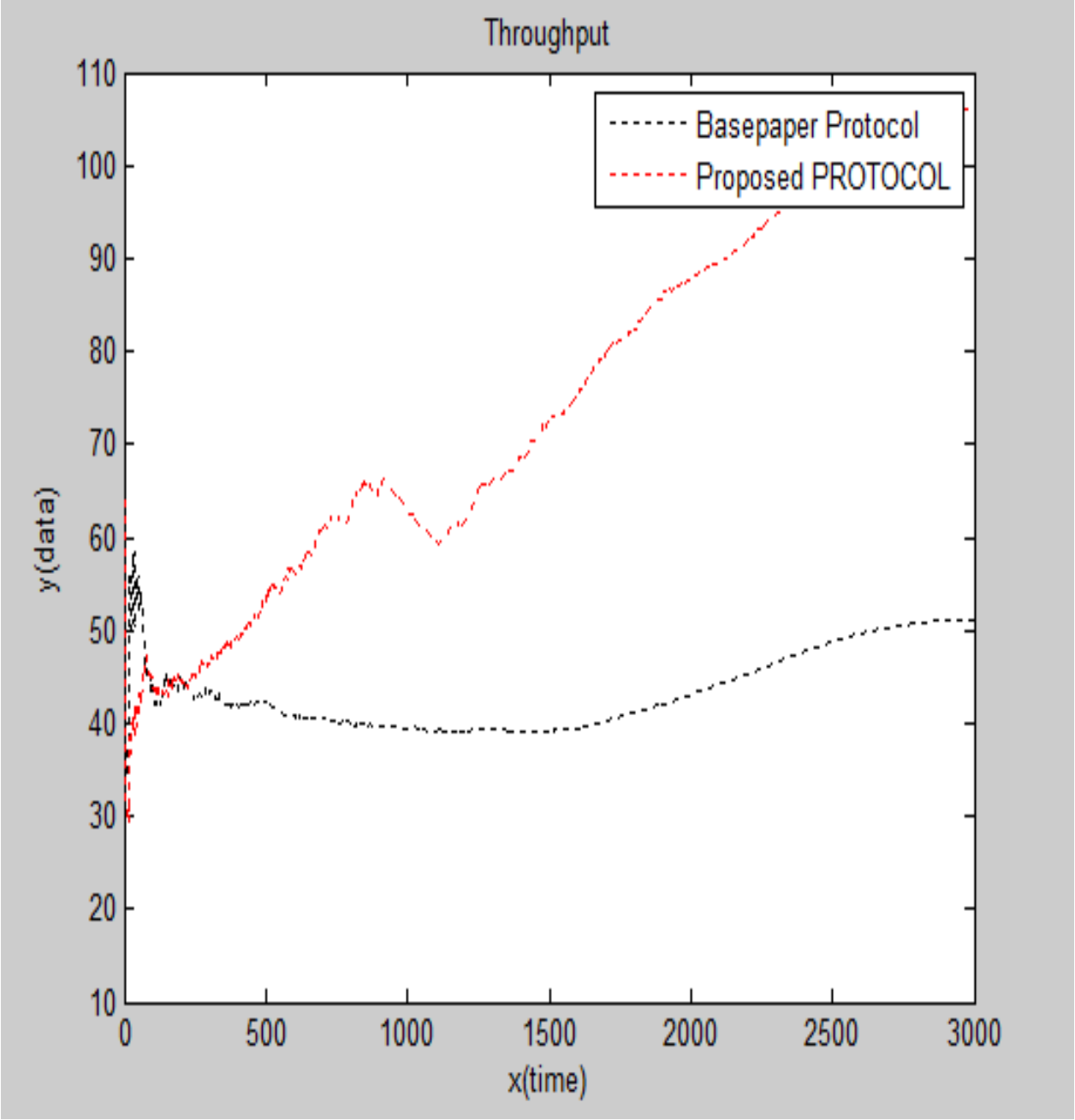


Fig 4.6: Throughput Graph

As illustrated in figure 4.6, the throughput of the nodes is compared in existing and proposed techniques and the throughput value in proposed technique is enhanced as compared to the existing technique.

For 5000 rounds:

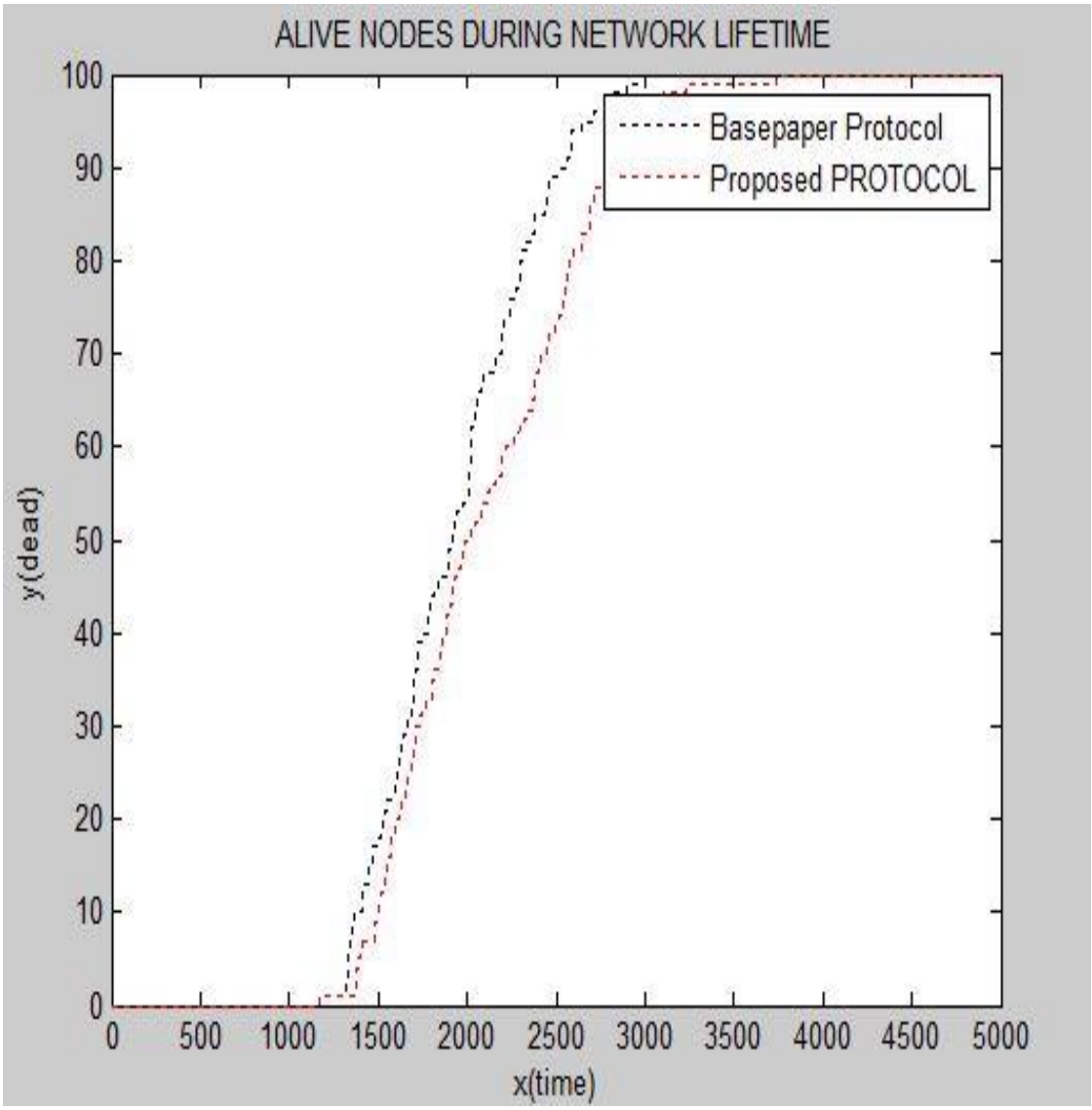


Fig 4.7: Lifetime of the nodes

As illustrated in figure 4.7, the lifetime of the nodes is compared in existing and proposed techniques and the proposed technique nodes are alive for more time than the existing technique ones and providing energy balanced topology.

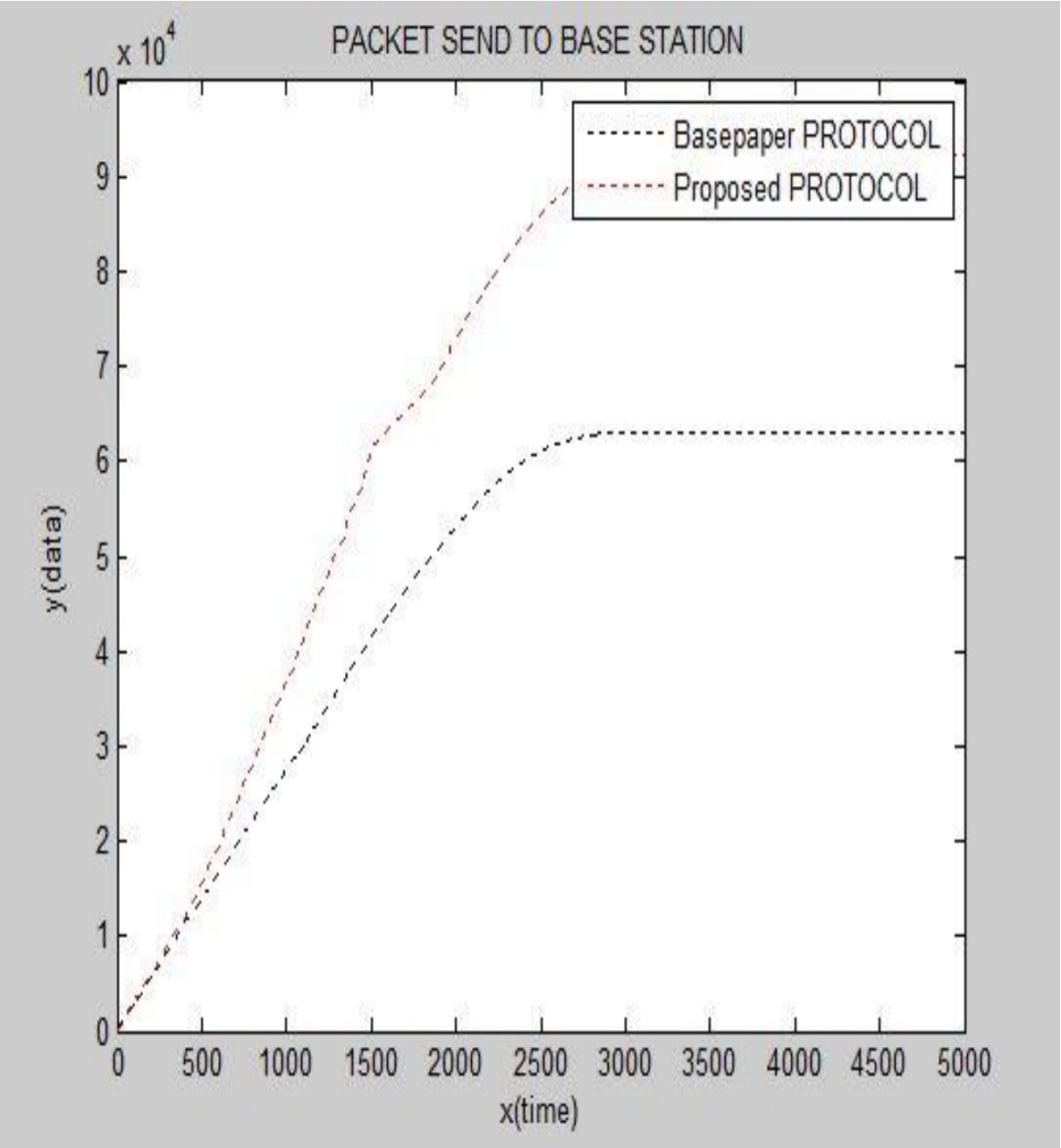


Fig 4.8: Packet sent to Base station

As shown in figure 4.8, the packet loss is compared in existing and proposed techniques and the proposed technique packets are sent at higher rates with less loss of data than the existing technique ones.

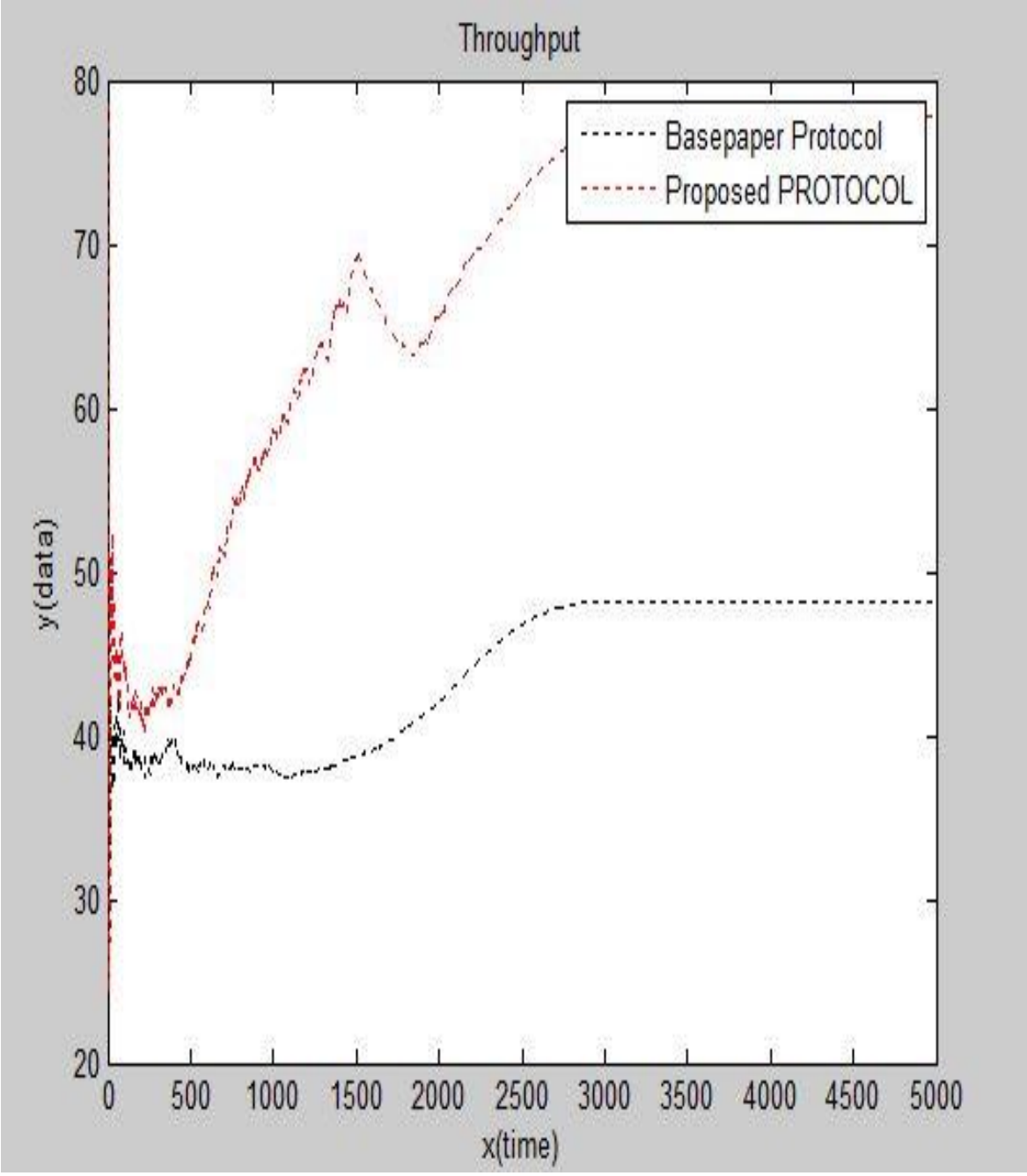


Fig 4.9: Throughput Graph

As illustrated in figure 4.9, the throughput of the nodes is compared in existing and proposed techniques and the throughput value in proposed technique is enhanced as compared to the existing technique.

CHAPTER 5
CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

In this paper, it has been concluded that the energy consumption is the major issue in the IOT networks. The technique of efficient data aggregation is applied which reduce energy consumption of the network. The clustering is the most efficient technique, due to static clustering selection which leads to fault in the network. The technique of Boltzman learning has been applied which selects the cluster head in the dynamic manner. The proposed algorithm is able to increase the network throughput up to 20 percent, energy consumption to 28 percent.

5.2 Future scope

The results can be improved further, by using any other sophisticated technique in terms of throughput, packet loss, and energy consumption. There is a chance of reducing the energy consumption further.

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