A Novel approach of cluster node selection by Flower Pollination Optimization in Adhoc Network

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Abstract— Mobile ad-hoc networks (MANETs) are a specific kind of wireless networks that can be quickly deployed without pre-existing infrastructures. They are used in different contexts such as collaborative, medical, military or embedded applications. However, MANETs raise new challenges when they are used in large scale network that contain a large number of nodes. Subsequently, many clustering algorithms have emerged. In fact, these clustering algorithms allow the structuring of the network into groups of entities called clusters creating a hierarchical structure. Each cluster contains a particular node called cluster head elected as cluster head according to a specific metric or a combination of metrics such as identity, degree, mobility, weight, density, etc. Cluster Head selection process plays a vital role in improving resource management and network performance (routing delay, bandwidth consumption and throughput). In this paper, we present a study and analyse of some existing clustering approaches for MANETs that recently appeared in literature, and then use Flower Pollination Algorithm for cluster head selection process. Performance analysis is based on the parameters End to End Delay, Throughput and packet delivery ratio

Keywords- *Cluster Head, Throughput, End to End Delay.*

I. INTRODUCTION

Mobile ad-hoc networks (MANETs) are a specific kind of wireless networks that can be quickly deployed without pre-existing infrastructures. They are used in different contexts such as collaborative, medical, military or embedded applications. However, MANETs raise new challenges when they are used in large scale network that contain a large number of nodes. Subsequently, many clustering algorithms have emerged. In fact, these clustering algorithms allow the structuring of the network into groups of entities called clusters creating a hierarchical structure. Each cluster contains a particular node called cluster head elected as cluster head according to a specific metric or a combination of metrics such as identity, degree, mobility, weight, density, etc. This results in a network with hierarchical structure. Different routing schemes are used between clusters (inter-cluster) and within clusters (intra- cluster). Hierarchical routing is a solution for handling scalability in a network where only selected nodes take the responsibility of data routing. However, hierarchical approaches undergo continual topology changes. Several algorithms based on clustering techniques have been proposed in the literature.

This paper is a comparative study of the cluster head selection process in which we proposed Flower Pollination Algorithm for cluster head selection and then compare parameters such as Throughput, End to End delay and packet delivery fraction with previous approaches. The most popular simulation tool NS2 is used for this study.

Fig.1: MANET Example

The rest of the paper is organized as follow: we start by introducing different clustering approaches. Then, we present MANET properties in section II, Performance Matrices in section III, Flower Pollination Optimization Algorithm in section IV, Literature Review in section V, Methodology and result analysis.

II. MANET PROPERTIES

The following properties make MANETs different from other networks [1]:

A. Highly Dynamic Topology

The nodes in a MANET can leave or join at any point of time. Moreover the nodes are free to move thus causing breakage of links and formation of new links.

B. Lack of infrastructure

MANET is a self-organizing network. It lacks centralized infrastructure or administration. Each node itself behaves as router and forwards the traffic ahead.

C. Power constraint:

MANET mainly consists of miniature devices with limiting battery power. There is no source of power backup in this type of ad-hoc network.

D. Bandwidth constraint:

MANET nodes work on limited bandwidth. They mainly communicate only to their neighbours to conserve bandwidth.

E. Device diversity:

A Mobile ad-hoc network can include various types of miniature devices which differ in their hardware, operating system, interface etc. MANET nodes can use different protocols such as Bluetooth, IrDA, ZigBee, 802.11.

F. Limited Computing power:

MANET nodes can perform limited computation such as data caching, sensing, aggregation etc.

III. LITERATURE REVIEW

Edwin Prem Kumar Gilbert [2004]:ad-hoc wireless Networks (WSN) are used in diversity of fields which involves military, healthcare, environmental, biological, home and other commercial uses. With the massive progression in the field of set computer and sensor technology, adhoc wireless Networks (WSN), which is consist of various thousands of sensor nodes which are efficient of sensing, activating, and transmitting the collected information, have made extraordinary influence everywhere. This paper presents a summary of the several research problems in WSN based applications [1].

Peter Corke et al [2010]: This paper is apprehensive with the use of adhoc wireless network (WSN) technology to long-duration and large-scale environmental monitoring. The holygrail is a structure that can be employed and functioned by domain specialists not engineers, but this residue some distance into the future. They present our views as to why this field has advanced less quickly than many anticipate it would more than ten years ago. They use real examples taken from our own work in this field to suggest the technological complexities and limitations that are require in meeting end-user needs for information collect systems. Security and capacity are main concerns and impact the design choices for structure hardware and software. They concluded with a consideration of long-term limitation for WSN technology in environmental observing and framework their view point of the future [2].

RanjanaThalore et al [2005]: Energy competent protocol design for ad-hoc wireless Networks (WSNs) is a very demanding task for the reason that of inadequate battery ability of nodes. This need for energy efficient procedure of a WSN has provoked the expansion of new protocols in all layers of the communication stack. Layer wise deployment of densely deployed nodes to efficiently lengthen the overall network life is presented in this paper. Simulation is done in QualNet 6.1 network simulator. Successful number of layers as well as effective node density over a ground is also investigated to attain energy proficient design. Layering helps the network to work for a long time as only one layer in the network is in action at a time, rest layers are completely sleeping. Also, sensor nodes in ML-MAC (Multi-Layer MAC) have a very short listening time that minimizes the energy utilization throughout communication. The outcome is used to create a parameter estimator through MATLAB [4].

Mohammad Daneshzand et al [2001]: Most uses dealing with adhoc wireless networks require an approach to minimize energy use. Single node in adhoc wireless network has a definite amount of battery, in which in some applications is important for a scheme to have stable nodes with the capability of working properly. One of the current algorithm to have an energy well-organized topology is to use human‘s cells regeneration procedure as an inspiration of a adhoc wireless network models. Here we proposed a new energy efficient topology based on how human’s brain cells (neurons) will participate in doing a task while a group of these cells might be deactivated. There are approximately 10 billion neurons that can be measured as nodes of a very huge adhoc wireless network. How these neurons or nodes work jointly to carry out a task although they know brain uses a small quantity of energy, is an appealing motivation used in their anticipated energy competent adhoc wireless network.]: adhoc wireless networks (WSN) are existing receiving important attention because of their immense prospective. Hence, it is still very early in the lifetime of such systems and many research limitations exist. In this brief paper concentrate on six key research limitations for adhoc wireless networks. [5].

SukhchandanRandhawa [2009]: Adhoc wireless network (WSN) has significant uses alike remote environmental supervising and target tracking. This has been authorized by the possibility, specifically in current years, of sensors that are smaller, cheaper, and intelligent. These sensors are supplied with wireless interfaces with which they can communicate with one another to form a network. The design of a WSN relied more importantly on the application, and it must recommend factors alike the environment, the application’s design goals, cost, hardware, and system challenges. The main motive of survey is to present inclusive review of the current literature in adhoc wireless network. This paper reviews the major advancement and new research limitation in this research area [3].

EikoYoneki, Jean Bacon [2007]: Author report current trends in adhoc wireless network study involving a summary of the several classifications of WSN, a research of WSN technologies and a discussion of current research prototypes and industry uses. They focal point is on middleware technology, and explains brief of some recent research prototypes, then address limitations and future approaches on the middleware. This research highlights that middleware requires delivering a common interface for several operational elements of WSN: identification and data collection, signal processing, data aggregation, and notification [6].

Mohammad Rakibul Islam [2006]: Energy organized data transfer is one of the main factor for energy competent adhoc wireless network (WSN). In this paper, an energy well-organized supportive method is proposed for a WSN where preferred numbers of sensors at the transmit end are used to form a MIMO formation wirelessly related with selected number of sensors at the receiving end. The selection of nodes in the transmitting end is based on a selection work which is a grouping of channel condition, exceptional energy; inter sensor distance in a cluster and geographical location while the selection in receiving side is performed on the basis of channel condition. Energy models are evaluated for associated circumstances [7].

Ameer Ahmed Abbasi et.al. In this paper, they show a scientific classification and general characterization of distributed clustering plans. They study diverse clustering calculations for WSNs; highlighting their targets, highlights, multifaceted nature, and so on. They additionally think about of these clustering calculations in view of measurements, for example, union rate, bunch stability, group overlapping, location awareness what's more, bolster for node mobility [8].

Seema Bandyopadhyay et.al. [9]In this paper, they proposed a dispersed, randomized clustering algorithm to arrange the sensors in a remote sensor arrange into bunches. They at that point stretch out this algorithm to create a chain of command of clusterheads and watch that the energy funds increment with the quantity of levels in the progressive system. Results in stochastic geometry are utilized to determine answers for the estimations of parameters of our algorithm that limit the aggregate energy spent in the system when all sensors report information through the clusterheads to the preparing focus.

Li Qing et.al. [10] They portray DEEC, an energy-aware adaptive clustering protocol utilized as a part of heterogeneous wireless sensor networks. In DEEC, each sensor hub autonomously chooses itself as a group head in view of its underlying energy and residual energy. To control the energy consumption of hubs by methods for adaptive approach, DEEC utilize the normal energy of the organized as the reference energy. In this way, DEEC does not require any worldwide learning of energy at each decision round. Dissimilar to SEP and LEACH, DEEC can perform well in multi-level heterogeneous wireless sensor networks.

IV. PERFORMNACE MATRICES

In this paper four performance matrices are considered to compare the results after applying FPA which are as follows:

A. THROUGHPUT

The throughput is the measure of how fast we can actually send data through the network. It is the measurement of number of packets that are transmitted through the network in a unit of time. It is desirable to have a network with high throughput

$$\text{Throughput} = \frac{\sum PR}{\sum tst - \sum tsp}$$

Where, PR – Received Packet Size,
tst-Start Time,
tsp- Stop Time.
Unit – Kbps (Kilobits per second)

B. PACKET DELIVERY RATIO (PDR)

It is the ratio of number of packets received at the destination to the number of packets generated at the source. A network should work to attain high PDR in order to have a better performance. PDR shows the amount of reliability offered by the network.

$$PDR = \frac{\sum NR}{\sum NG} \times 100$$

Where, NR – Number of Received Packets, NG – Number of Generated Packets
Unit – Percentage ratio (%).

C. AVERAGE END – TO – END DELAY

This is the average time delay consumed by data packets to propagate from source to destination. This delay includes the total time of transmission i.e. propagation time, queuing time, route establishment time etc. A network with minimum average end to end delay offers better speed of communication.

$$\text{AverageEnd-to-EndDelay} = \sum tPR - \sum tPS$$

Where, tPR – Packet Receive Time,
tPS – Packet Send Time
Unit – Milli Seconds (ms).

V. FLOWER POLLINATION OPTIMIZATION ALGORITHM (FPOA)

Flower pollination optimization algorithm (FPOA) is a recently invented optimization algorithm. It is inherited from the natural inspiration of pollination process. It mimics the process of flowering planets reproduction via pollination. As pollinators are mainly responsible for transferring pollens among flowers, pollination may occur in either local or global flow [4]. Pollination process can fall into two form categorizes; biotic and abiotic based on the pollens transferring mechanism. For biotic pollinations, flowers always depend on insects and/or animals as pollinators to transfer the flowering pollens. However for abiotic, flowers do not need any pollinators for the pollens transferring process [5, 6]. Naturally most of flowers considered to follow the biotic pollination form. This indicates that pollination or crosspollination process can take place by pollinators' movements or travelling long distances causing a global pollination. Travelling pollinators are usually follows the L'evy's flight behaviour. Their flying steps are also follows the L'evy's flight distribution [7]. For each kind of pollinators, there is a specific type of flowers that it is responsible for, this called flower consistency. Flower consistency helps to minimize the cost of investigation of each pollinator. Evolutionary wise, it increase the transferring time of pollens and hence optimize and maximize the reproduction process. With the limited available memory of pollinators, flower consistency eliminates the learning, investigation and switching [8]. Furthermore, it can be considered as an incremental step based on the similarity/difference of any two flowers. The biological objective of flower pollination is to optimally reproduce a new enormous generations of the flower kind with the fittest features that ensure the kind`s survival. In order to ideally formalize the flower pollination algorithm, characteristics of pollination process, flower constancy and pollinator behavior should be approximated based on the following essential rules:

i. Global pollination achieved by L'evy's flights` travelling pollinators for both biotic and cross-pollination.
ii. Local pollination achieved abiotic and self-pollination.
iii. The new generation reproduction probability depends on the flower consistency and proportional to flowers` similarities/differences.
iv. The switch probability p ∈ [0, 1] controls the shift between local and global pollination.

The simple flower pollination model assume that each plant has only one flower, and each flower only produce one pollen gamete. Thus, there is no need to distinguish a pollen gamete, a flower, a plant or solution to a problem [9]. According to the rules above, the flower pollination optimization algorithm (FPOA) can be represented mathematically as follows:

For global pollination, pollinators such as insects are intend to travel long distances to achieve the global optimization of reproduction based on flower consistency, this can mathematically achieve by:

$$x_i^{t+1} - x_i^t + L(x_i^t - g_*) \quad (2)$$

Where;
x_i^t: is the pollen i or solution vector xi at iteration t.
g_*: is the current best solution found among all solutions at the current generation/iteration.
L: is the strength of the pollination, which essentially is a step size.
In using L´evy`s flight model to mimic the characteristic of the flying insects efficiently [7, 11]. That is, L > 0 from a L´evy`s distribution.

$$L \sim \frac{\lambda\Gamma(\lambda)\sin(\Pi\lambda/2)}{\Pi} \frac{1}{S^{1+\lambda}} \quad (S>>S_0>O) \qquad (3)$$

Where;
$\lambda\Gamma(\lambda)$: is the standard gamma function. This distribution is valid for large steps s > 0.

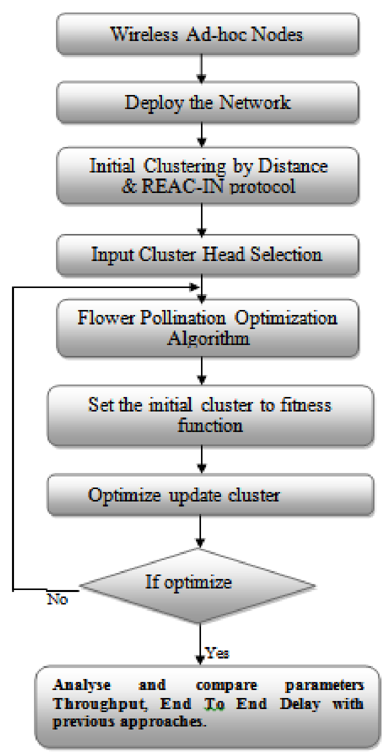
For the local pollination, that achieved by abiotic and self-pollination based on flower constancy, the mathematical representation is as follows:

$$x_i^{t+1} = x_i^t + c(x_i^t - x_k^t) \qquad (4)$$

Where;
x_i^t and x_k^t : are the pollens from the different flowers of the same plant species. x_i^t and x_k^t are the pollens from different flowers of the same plant species.
C: is local random walk drawn from the uniform [0,1]
For the fourth rule, the switch probability p ∈[0, 1] is used to control the exchange of the pollination process from local to global and vice versa. he following figure 1 presents the pseudo code for the flower optimization algorithm using L´evy`s flight model [10].

VI. METHODOLOGY

Step1: Wireless ad-hoc network is deployed.
Step2: Initialise the Clustering process by Distance & REAC-IN protocol.
Step3: In step 2 cluster head is formed which becomes input to Optimization Algorithm.
Step4: Apply the Flower Pollination Optimization Algorithm and set the initial cluster to fitness function.
Step5: When cluster is updated then optimized them.
Step6: In this a condition is applied, if cluster is optimized then proceed to parameter analysis with previous approaches otherwise process will be repeat again from step 4.



VII. SIMULATION SCENARIO

Simulation is carried out using NS2 (Network simulator2) ver-2.35 which is considered as the best tool for simulating wired and wireless systems.NS2 consists of two key languages: C++ and object oriented Tool Command Language (OTCL).While the C++ defines the internal mechanism (i.e. a backend) of the simulation objects, The OTCL sets up simulation by assembling and configuring the objects as well as scheduling discrete events(i.e. a frontend).Various simulation parameters are given below in Table1:

Table 1: Simulation Parameters

Sr. No.	Simulation Parameters	Value
1	Routing Protocol	AODV
2	Network Topology	AREQ
3	Number Of nodes	100
4	Simulation Duration	1456sec
5	Initial Node Energy	1J
6	Packet Size	1234bit
7	Traffic Agent / Source	random
8	Queue Type	linear

VII. RESULTS AND ANALYSIS

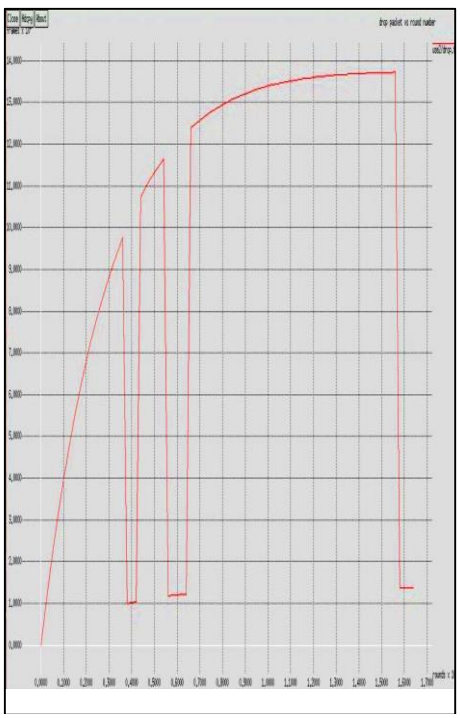


Fig.2: Drop Packet vs Round Number:

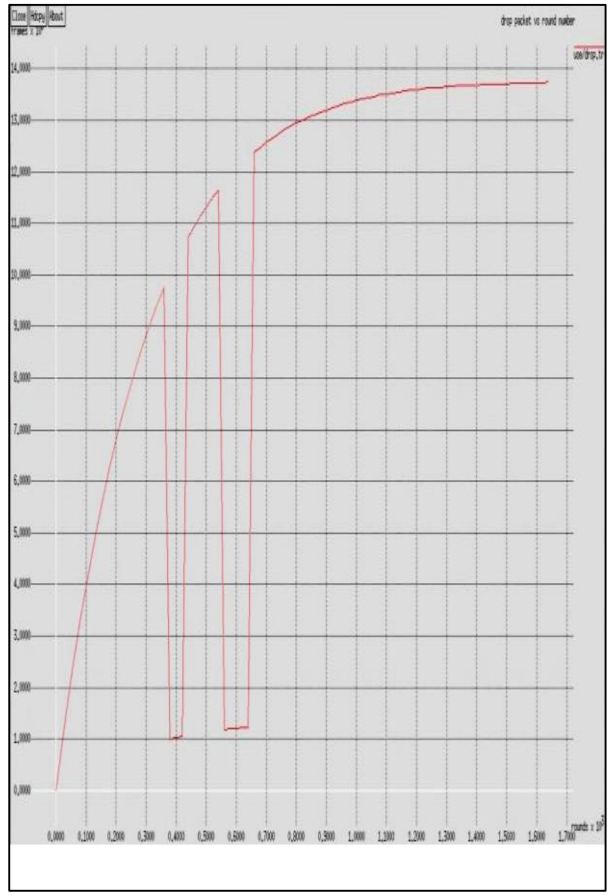


Fig.3: Drop Packet vs Round Number with FPA:

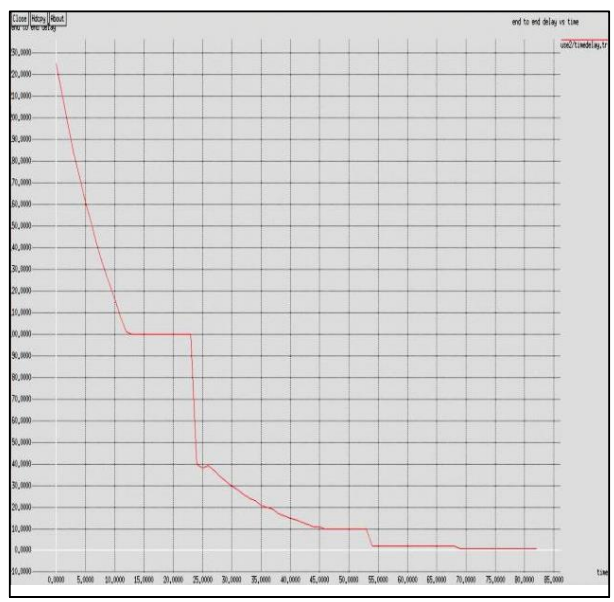


Fig.4: End to End delay vs Time:

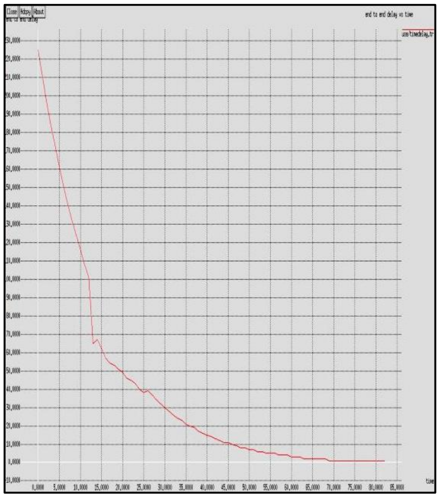


Fig.5: End to End delay vs Time with FPA:

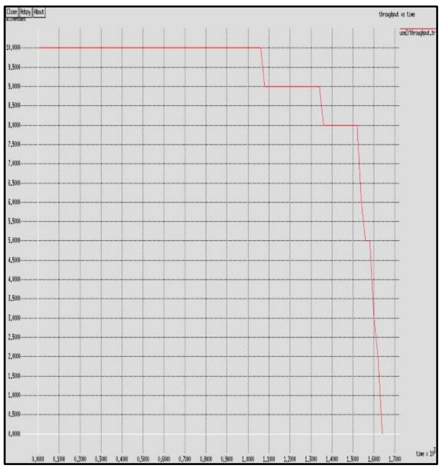


Fig.6: Throughput vs Time:

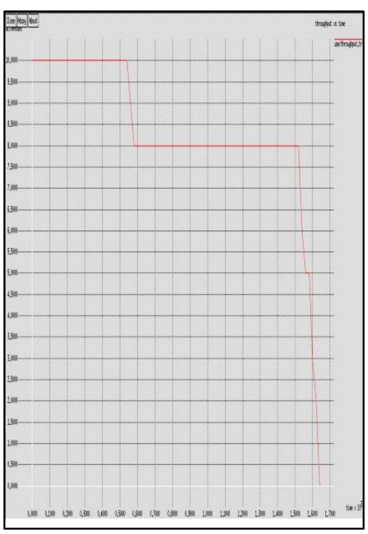


Fig.7: Throughput vs Time with FPA:

VIII CONCLUSION

In this paper show the optimization of clustering in adhoc network by dynamic optimization algorithm. Reduce the enrgy by cluter head selection , so reduce the dead node and reduce timedelay which increase throughput**.** clustering approaches for MANETs that recently appeared in literature, and then use Flower Pollination Algorithm for cluster head selection process. Performance analysis is based on the parameters End to End Delay, Throughput and packet delivery ratio

IX. REFERENCES

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