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OPTIMIZING CLUSTERING ALGORITHM IN MOBILE AD-HOC NETWORKS USING PARTICLE SWARM OPTIMIZATION

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ABSTRACT

Mobile ad-hoc networks (MANETs) have been proposed to support dynamic scenarios where no infrastructure exists. Each node in the network acts as a host as well as a router and, forwards traffic to other nodes. MANETs can be set up quickly and at low cost in contrast to infrastructure networks which may be wired or wireless. Repeatedly simulated annealing with a 1/log k schedule is very slow, especially if the cost function is expensive to compute. Be that as it may, by and large don't realize what the vitality scene is for a specific issue. In this paper, we propose a Particle Swarm Optimization (PSO) to one clustering algorithm, PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In iterations, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far. (The fitness value is also stored.) This value is called Pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. This best value is a global best and called Gbest. When a particle takes part of the population as its topological neighbors, the best value is a local best and is called Lbest. After finding the two best values, the particle updates its velocity and positions with mathematical equations. The proposed technique is such that each cluster head handles the maximum possible number of mobile nodes in its cluster in order to facilitate the optimal operation of the MAC protocol. Consequently, it results in the minimum number of clusters and hence cluster heads. Simulation results exhibit improved performance of the optimized PSO algorithm than the original simulated annealing algorithm. The individuals (Particles) were divided into groups running in four neighborhood nodes simultaneously, extending the algorithm in a distributed computing manner. Simulation study showed that our approach is efficient and effective, especially when the distribution of mobile nodes is dense.

Keywords: *PSO, Simulated Annealing, Clustering Algorithm, MANET, NS-2.*

I. INTRODUCTION

Ad-Hoc is a Latin word, which means for this", meaning for this special purpose only", by expansion it is a special network for a particular application. A mobile ad-hoc network is a collection of mobile nodes, which have communicate over radio range. These networks have an important advantage; they do not require any pre existing infrastructure or central administration. Therefore, mobile ad-hoc networks are suitable for temporary communication links. This flexibility, however, comes at a price: communication is difficult to organize due to frequent topology changes [1-5].

MANET's are characterized by self-organized, dynamic changes of network topology, limited bandwidth, and instability of link capacity, etc, the reliability of data transmission in the network cannot be guaranteed. In some special application conditions with harsh requirements on PDR and link quality, higher criteria for routing protocol will have been laid out. Routing is the act of moving information from a source to a destination in an internetwork. During this process, at least one intermediate node within the internetwork is encountered. This concept is not new to computer science since routing was used in the networks in early 1970's. But this concept has achieved popularity from the mid-1980. Routing is the process of finding a path from a source to destination among randomly distributed routers the broadcasting is inevitable and a common operation in ad-hoc network. It consists of diffusing a message from a source node to all the nodes in the network. Broadcast can be used to diffuse information to the whole network. It is also used for route discovery protocols in ad-hoc networks [6-10].

Particle Swarm Optimization (PSO), which is a population-based global search method, is known to suffer from premature convergence prior to discovering the true global minimizes. In this thesis, a novel memory-based method is proposed which aims to guide the particles through the information deduced from the external memory contents rather than to re-inject them into the population.

This is done by calculate a coefficient, based on the distance of the current particle to the closest best and closest worst particles in the external memory at each iteration. Later, when updating the velocity component, this coefficient is added to the current velocity of the particle with a certain probability. Also, randomized upper bound and lower bound values have been defined for the inertia component. The algorithm starts with the upper bound value of the inertia. At each particle evaluation the inertia is decreased non-linearly with a small value and when its value reaches the lower bound, the inertia value is reset to its upper bound [11-15].

The resulting PSO finds the global optima much faster than the original PSO and it have been shown that it also performs better compared with a recent improvement of PSO, CLSPO namely. A state-of-the-art algorithm, CMA-ES (Covariance Matrix Adaptation Evolutionary Strategy), has also been chosen for comparison purposes. It has been shown by experiments that although the CMA-ES shows a better performance than that of our algorithm, in some cases where the overall topology pointing to the global optimum is missing and the attractor volume of global optimum is small, our algorithm performs better and finds the desired optimum value of the function in lesser evaluation counts. The tests have been conducted on standard benchmark functions as well as a simulation of the Aldebaran NAO robot for developing a kick action [16-20].

The particle swarm algorithm is a computational method to optimize a problem iteratively. As the neighborhood determines the sufficiency and frequency of information flow, the static and dynamic neighborhoods are discussed. With velocity each particle moves with in the search space and dynamically adjusts its velocity, according to its previous behaviors. Therefore, particles tend to move towards better points within the search space. Since the method is easy to implement and has various application areas, neighborhood topologies used in the particle swarm optimization, parameter adjustment of particle swarm optimization algorithms, hybrid particle swarm optimization algorithms, stability analysis of the particle swarm optimization, and applications of particle swarm optimization method [21, 22].

II. LITRATURE REVIEW

The particle swarm algorithm is a computational method to optimize a problem iteratively. As the neighborhood determines the sufficiency and frequency of information flow, the static and dynamic neighborhoods are discussed. With velocity each particle moves with in the search space and dynamically adjusts its velocity, according to its previous behaviors. Therefore, particles tend to move towards better points within the search space. Since the method is easy to implement and has various application areas, neighborhood topologies used in the particle swarm optimization, parameter adjustment of particle swarm optimization algorithms, hybrid particle swarm optimization algorithms, stability analysis of the particle swarm optimization, and applications of particle swarm optimization method.

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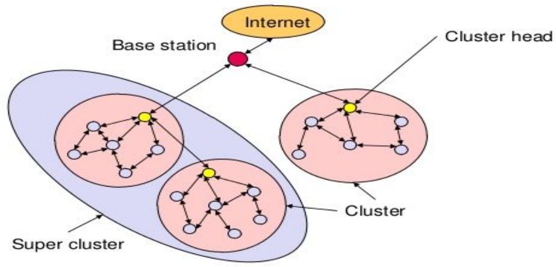

Figure 1: advert hoc network clustering

III. CLUSTRING TECHNIQUES

In this piece several ad hoc network clustering approaches are debated in detail with their appropriate domain of taxonomy

Connectivity based clustering
This form of clustering methods the connectivity amid nodes are the essential property for CH arrangement. The appropriate methods of such technique are discussed in this part.

K-hop connectivity ID clustering algorithm (K-CONID):
It merges 2 clustering algorithms that are highest-measure and Lowest- identification heuristics. At the beginning, node being a flooding procedure in which a clustering demands is transferred to every node. If using merely a lower ID clusters generated afterwards more clusters than necessity is generated. Therefore result is a set of cluster-heads increases. Conversely using only node connectivity causes numerous of evaluation between nodes. Consequently, by combining both can limit on number of clusters. The node having absolute best connectivity is chosen as the cluster-head, when quantity of hops k=1, connectivity is equal to node degree. K-CONID generalizes connectivity for a k-hop near-hood and if degree of connectivity of the two nodes is similar then priority node is elected with lowest id.

Adaptive cluster load balance method:
In HCC clustering design, one cluster head can be consumed and exhausted whenever it serves too many mobile hosts and CH becomes a bottleneck. So a fresh method is given in according to which f a source node is a CH, it will usual the number of its dominated member nodes as "Option" value n hello message format, there is an "Option" is obtainable in hello message format. When the sender node is not a cluster head or it is ambivalent, "Option" will be reset to 0. When Hello message of a CH displays which it's dominated nodes' number increase a threshold, no latest node will participate in this cluster. Therefore, resource consumption and information transmission is distributed to all clusters rather than few clusters.

Mobility –aware clustring
Mobility Based Metric for Clustering (MOBIC):
It recommends the partition of an ad hoc network in d-hop clusters depend at mobility metric. The clusters are formed in such a method mobility nodes with little speed relative to their near become CH. The aggregate mobility metric is calculated over a little time by calculating the difference of relative mobility amongst a node and all its neighbors. The only distinction between Lowest-ID and MOBIC is that it utilizes mobility metric for cluster formation rather than for ID information. Firstly, the pair wise relative mobility metrics is calculated and then aggregate relative mobility metric is computed before transmits the next packet

Combined weight basd clustring
Weighted clustering algorithm (WCA): The WCA is grounded on utilizes of a merged weight metric. For election of cluster-head the metrics used are the number of neighbors, distance with every neighbors, mobility plus cumulative time for which the node operates as the CH. The downside of WCA is, if a node moves in an area which

is not supervised by any cluster-head then the cluster set-up procedure is evoked again which triggers re-affiliations. A Hello message involves its position and ID. Every node builds its nearest list that is depending on the Hello messages accepted. Each node figures its weight value by algorithm stated below

An Efficient Weighted Distributed Clustering (CBMD): It take advantage of varied weight function which takes into consideration the parameters: residual battery energy (B), connectivity (C), usual mobility (M), and distance (D) of the nodes to choose locally top-quality CH. Benefits of these clustering algorithms are that load balancing between the clusters is achieved and less number of clusters formed by specifying the maximum and smallest number of nodes which a CH can ideally control. Additionally, all mobile node starts to measure its weight after n (small integer in order to minimize the memory requirement) consecutive HELLO messages, where the result spells out the precise value for the mobility and battery power. This algorithm is brought into play to choose optimal cluster-heads and divide optimal number of clusters without degrading the whole network performance, to meet with the load balancing between clusters, to maximize the cluster stability and to lessen the communication overhead and minimizing the overt control messages caused by cluster maintenance

A Distributed Weighted Clustering Algorithm:
It works similar to WCA apart from that power management and distributed cluster set up is done by localizing configuration and reconfiguration of clusters. The expended battery power is a better influence equated to the cumulative time during that the node works like a CH which is utilized in WCA as it reflects the concrete amount of power usage. Two situations can enable the cluster maintenance phase, first is when there is node movement outside of its cluster boundary and second is when there is excessive battery consumption at the CH. In the former case, it is necessary to search a fresh CH to affiliate with. If it searches a novel CH, it hands over to the novel one cluster. If doesn't, it declares itself as a CH. If the extent of consumed battery power becomes more than a threshold value then the cluster-head resigns and becomes an ordinary node. This algorithm offers superior performance than WCA in jargon of the number of re-affiliations, end-to-end throughput, overheads throughout the primary clustering Set up section, with the lifespan of nodes.

IV. EVOUTION OF THE PSO ALGORITHM

Original PSO Algorithm
The basic idea of particles searching individually while communicating with each other concerning the global best in order to produce a more capable collective search applies to all forms of PSO from the originally conceived algorithm through the more capable models available today. Particle swarm, as originally published [4], consisted of a swarm of particles each moving or flying through the search space according to velocity update equation

$$\vec{v}_i(k+1)=\vec{v}_i(k)+c_1\vec{r}_{1_i}(k)\cdot\left(\vec{p}_i(k)-\vec{x}_i(k)\right)+c_2\vec{r}_{2_i}(k)\cdot\left(\vec{g}(k)-\vec{x}_i(k)\right)$$

where

$\vec{v}_i(k)$ is the velocity vector of particle i at iteration k,

$\vec{x}_i(k)$ is the position vector of particle i at iteration k,

$\vec{p}_i(k)$ is the n-dimensional personal best of particle i found from initialization through iteration k,

$\vec{g}(k)$ is the n-dimensional global best of the swarm found from initialization through iteration k,

c is the cognitive acceleration coefficient so named for its term's use of the personal best, which can be thought of as a cognitive process whereby a particle remembers the best location it has encountered and tends to return to that state, 2 c is the social acceleration coefficient so named for its term's use of the global best which attracts all particles simulating social communication, r k and 2 ( ) i r k are vectors of pseudo-random numbers with components selected from uniform distribution U(0,1) at iteration k , and · is the Hadamard operator representing element-wise multiplication.

"Lbest" PSO

Though Eberhart and Kennedy published the Lbest version the same year as the Gbest version [13], it was Gbest PSO that gained prominence – apparently for its quick initial convergence [5]. The only difference between the two is that the velocity updates equation of Lbest PSO uses a neighborhood best rather than the global best as explained in the research motivation section. "Lbest" PSO often outperforms Gbest PSO as demonstrated in Table V-1 since hasty decisions often lead to a compromise in solution quality when taking more time would be practical, though for real-time implementations or cases of limited available data, the ability to make real-time decisions – even if imperfect – becomes valuable so that Gbest PSO may be better for such applications.

Inertia Static Inertia Weight & Constriction Coefficient: This recommends a value for the constriction coefficient based on preselected values of the acceleration coefficients, where smaller values of K lead to quick convergence and larger values allow more exploration. Equation is based on theoretical studies of particle trajectories, but since it was hoped that the constriction models would eliminate the need for velocity clamping [19], the calculations that led to did not account for the velocity clamping value, though it affects particles' trajectories. This is unfortunately somewhat of a weakness in the model since it appears from empirical testing that all PSO parameters are inter-related so that would be more useful if it accounted for the velocity clamping value, which has continued to be beneficial as discussed in the following section. The same process that led to beginning with velocity update equation leads to when beginning with velocity update equation with inertia weight.

So long as the inertia weight has a magnitude less than one, Figure shows that past personal bests are expected to have less effect on a particle's velocity at iteration $k + 1$ than more recent personal bests due to the effect of multiplication at each iteration by the inertia weight, ω . This makes sense conceptually since recent bests – both global and personal – are expected to be of higher quality than past bests. However, past bests could still have more effect on a particle's overall velocity than recent bests for a while at the beginning of the search since (a) $-$(a) , at least, is generally more significant in early iterations when the swarm is more spread out.

Standard "Gbest" PSO

Where f is the objective function, or cost function, of an application problem. The decision vector consists of the n decision variables to be optimized, thus producing the most desirable function value. A decision vector is called the global minimiser if it produces the optimal function value called true global minimum. Even it is considered an unconstrained optimization problem, in practice only solutions belonging to a subset $\Omega \subset Rn$ are considered feasible. The search space is defined by a subset

V. PROPOSED WORK

Mobile ad-hoc network one of the interest fields of research where lots of work done in the field of routing algorithms and security now a day's researchers focus on structure or we can say the formation of the group of nodes. Here we start work on cluster formation technique in mobile ad-hoc network, in previous research which is based on SA (simulated annealing) gave the idea that how to weighted cluster or cluster head selection process done with help of SA, this approach had some issues to overcome issue we propose a particle swarm optimization based clustering algorithm for better outcomes.

Problem domain

Mobile ad-hoc network is one of growing field of research where lots of works have done; in our paper which is based on simulated annealing have following issues:

- Repeatedly annealing with a 1/log k schedule is very slow, especially if the cost function is expensive to compute.
- For problems where the energy landscape is smooth, or there are few local minima, SA is overkill --- simpler, faster methods (e.g., gradient descent) will work better. But generally don't know what the energy landscape is for a particular problem.
- Heuristic methods, which are problem-specific or take advantage of extra information about the system, will often be better than general methods, although SA is often comparable to heuristics.

- The method cannot tell whether it has found an optimal solution. Some other complimentary method (e.g. branch and bound) is required to do this.

Due to these above issues when we apply SA for cluster head formation process mobile node lose more energy, Optimizing Clustering Algorithm in Mobile Ad hoc Networks Using Simulated Annealing re-elect cluster head based on objective function which have work over number of neighbors due to moving behavior of nodes this objective function could not perform accurate result, second thing if any mobile node does not become a cluster head or cluster member than what the work of this node and how data flow happen among all cluster head, overcome this problem we apply particle swarm intelligence to get better results.

VI. METHDOLOGY

The proposed network clustering technique is works on the three main phases. The different phases are given in figure.

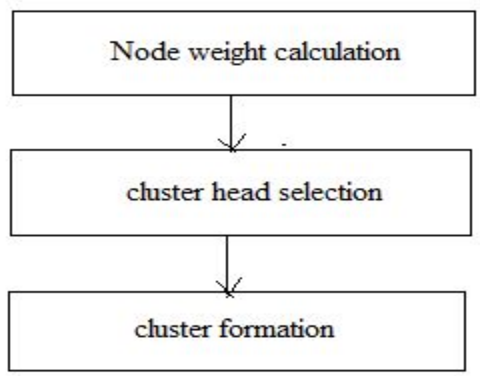

Figure 2: clustering phases

According to the given diagram the proposed clustering scheme is taken place in three main phases the detailed description of the proposed system is given section.

1. Node weight calculation

The mobile ad hoc network is a connected group of nodes which are connected with each other through the wireless links. Additionally as the network node perform functions the resources are consumed in similar manner. In order to manage the life time of network the efficient node selection and load normalization is primary aim of the clustering algorithm. By which the load on nodes are distributed in network and optimum resources are preserved. Thus in order to perform network clustering the following performance and resource parameters are considered.

SNR: Which associate the extent of a desired signal to the extent of history din? It's outlined just like the ratio of signal vigor to the din vigor, often expressed in decibels. The node sends a data packet to neighbor node and between both the signal strength the values are estimated using the given formula.

Connectivity: On this network, the nodes are stated to join which might be in radio range of a node. Thus Extreme numbers of nodes are in linked thru this node reasons the more serving ability.

Remain Energy: The network devices in MANET are made with fixed amount of energy But if a node loss their vigor almost always then the node isn't functioning as indispensable. As a consequence remain energy is an important parameter for clustering, so as to be computed utilizing the beneath given components formula.

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Mobility: Another asset of node in ad hoc network that is mobility. Nodes are on the whole moving from one location to other on this network randomly. The low mobility nodes are ready to sort more stable clusters. So node mobility can also be computed utilizing the subsequent formula.

2. Weight calculation:
The computed weights are aids to search the optimum node in network therefore a list of efficient nodes are make utilizing the calculated weights.

3. Cluster head selection:
In the previous phase all node compute the weights of their neighbor nodes using a neighbor table. Thus after comparison of evaluated weights the cluster heads are elected for a cluster of nodes.

Thus section provides the detailed understanding of the network parameter calculations, in the next section the steps are summarized using an algorithm.

APPLYING PSO
Mobile ad-hoc network is one of the most focusing area of research where lots of work done in this field cluster formation is one the technique by which researchers focus over the easiest communication now for cluster formation we apply particle swarm optimization

Step1: initialize network
Step2: communication start send RREQ packet
Step3: RREQ packet contain hop count information
Step3: generate population of nodes according to their hop count
Step4: set the parameter c1, c2, w1,w2 as constant
Step5: nodes (population) create their neighbor by using fitness function
Step6: if (nodes hop count between two)
Node become neighbor and form cluster
Update velocity and position of nodes by using above mention formula
If (velocity is high){
Node exclude from cluster
And these nodes are free nodes or work for path builder
Else
Node include cluster
Else
Node search best neighbor
Step7: data transfer happen within the cluster using cluster nodes
Step8: data send outside by using outer or boundary node
Step9: update cluster using their velocity
Step9: nodes change its velocity update its position and calculate fitness using hop count and repeat step 3 to 6
Step10: nodes move freely and form cluster whenever they found neighbors or want to send data
Step11: communication takes place
Step12: exit

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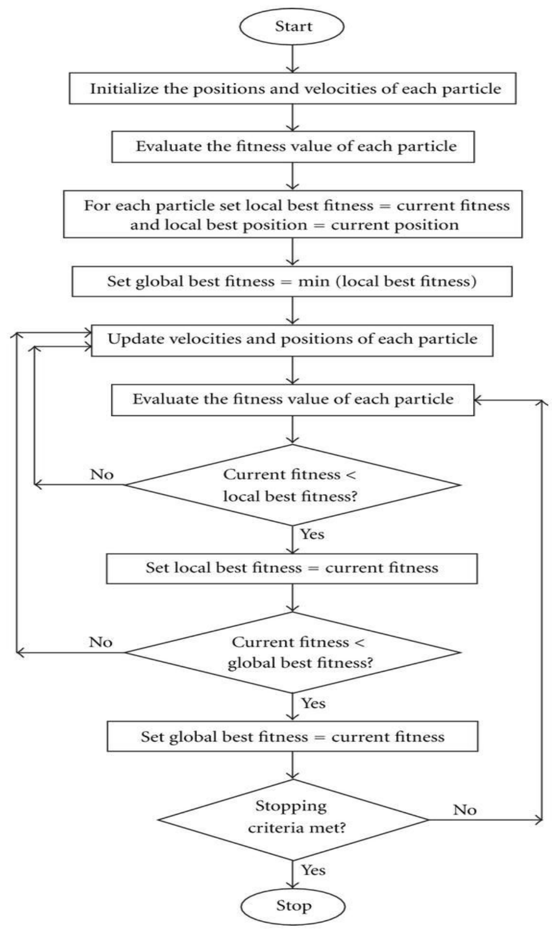

Figure 3: PSO flow chart

VII. RESULT ANALYSIS

Packet Delivery Ratio

The packet delivery ratio (PDR) of a network is defined as the ratio of total number of data packets actually received and total number of data packets transmitted by senders.

Pdr = ∑ Number of packet receive / ∑ Number of packet send

Normalized Path Discovery:

Normalized path discovery is defined as the number of RREQ packets generated per data packet.

End to end delay

The End-to-End delay is defined as the difference between two time instances: one when packets generated at the sender and the other, when packet I received by the receiving application.

End to End Delay =∑ (arrive time – send time) / ∑ Number of connections

***Comparison of Proposed work with base work*:**

a) End To End Delay:

In below graph shown that, end to end delay in earlier technique is greater delay on the other hand our proposed work end to end delay is less in attacked condition that is far less than earlier technique.

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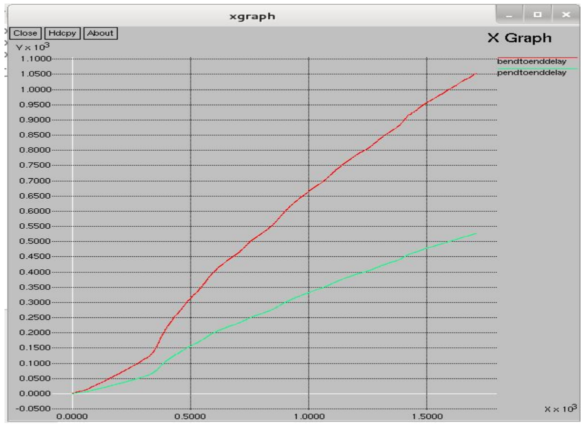

Figure 4: end to end delay comparison

In above graph green line shows proposed work and red line shows earlier technique so in our comparative graph propose algorithm end to end delay minimum value is 0.001 ms and highest is 0.046 ms if we compare this value with earlier technique work so minimum value for earlier technique end to end delay is 0.004ms and highest value is 0.146ms so on the basis of these values we conclude that our propose work is a novel solution for this problem.

b) Packet delivery ratio :

Below graph shows comparison graph of earlier technique and proposed work on the basis of graph we see that our propose work is far better than earlier technique.

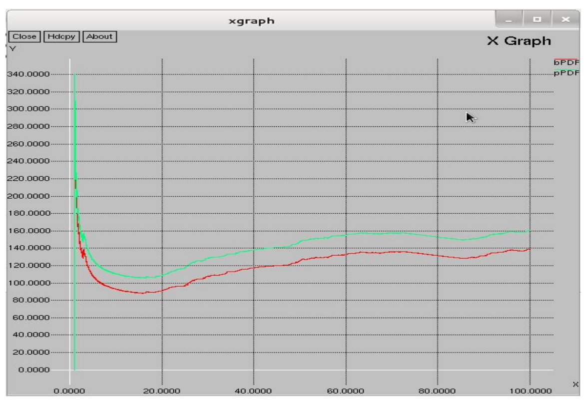

Figure 5: packet delivery comparison

In above graph green line shows proposed work and red line shows earlier technique so When the simulation start minimum packet delivery ratio of our proposed technique is 0.90 and highest is 0.98 and the other end earlier technique minimum packet delivery ratio is 0.00 and highest 0.97 so on the basis of these comparative results we easily say that our propose work is an novel approach.

c) Throughput:

Below graph shown the comparison between earlier technique and our proposed work so on the basis of comparison we easily say that our proposed technique is far better compare to earlier technique.

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Figure 6: throughput comparison

In above graph green line shows proposed work and red line shows earlier technique so, when simulation starts because of our proposed solution throughput increases gradually and reach highest point as compare to base solution, on the other hand when simulation start in our earlier technique paper throughput increases rapidly and decrease also with same manner it's not good in real time scenario.

VIII. CONCLUSION

MANET is a dynamic transportation of statement. In this network the mobility and dynamic network topology is an essential property of network. These properties are making it adoptable for different complex applications. The major areas of applications are also ad hoc in nature such as battle fields, disaster management and others. These applications are rapidly configured on ground and become operational in small units of time. On the other hand the performance and security is major area of concern in such network. Therefore various performance enhancement techniques and security techniques are developed in recent years.

In this presented work the ad hoc networks performance and scalability issues are investigated and cluster based solution is presented. In the proposed clustering technique the network node's performance parameters are used as the quality of the nodes and based on the optimum node quality the cluster Head choice is executed. The cluster head choice algorithm usage the weighted system for locating the top-rated node. Because the nodes quality estimation is performed on different scales of performance parameters thus weight calculation normalize all the different scale parameters and makes a single domain result.

Finally the weighted concept of the mobile ad hoc clustering technique is implemented using NS2 simulation environment and the performance of the network is computed. The performance summary according to the experimental evaluation of network is demonstrated using the table, according to the demonstrated outcomes of the proposed clustering algorithm provides optimum network clusters and able to scale the performance of network successfully.

Table 1: performance summary

S. No.	Parameters	Proposed scheme	Traditional scheme
1	Throughput	High	Low

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2	Packet delivery ratio	High	Low
3	End to End Delay	High	Low

Future work

The proposed cluster head selection algorithm is designed and implemented successfully and the performance of the proposed technique is compared with the traditional cluster head selection technique. Among them the performance of the proposed scheme is found optimum as compared to the traditional approach. But in the proposed technique the performance of the network is lacked in terms of throughput. Thus in near future the throughput optimization is performed.

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