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Design of Improved iLEACH using ACO for WSN

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ABSTRACT: - Wireless sensor networks are becoming popular in real life applications. Because of the features of the resource-constrained and battery-aware sensors; in WSNs energy utilization has found to become a major interesting subject of research. WSNs compose battery-powered nodes which are associated with the bottom station to for certain action or task. As sensor nodes are battery-powered i.e. can become dead following the consumption of the battery that is also called duration of WSNs. Ant Colony Optimization ACO is being widely found in optimizing the network routing protocols. Ant Based Routing can play an important role in the enhancement of network life time. The general goal is to locate the effectiveness of the iLEACH when ACO inter-cluster data aggregation is applied on it.

***KEYWORDS:*-WSN, LEACH, iLEACH, ACO**

I. INTRODUCTION

Energy is extremely serious issue in WSN [1,4], as a result of limited energy in sensor nodes, so to conserve energy clustering technique was introduced; by which out of thousands of nodes few nodes become cluster head and they manage the entire network. Cluster head is a node which is accountable for maintain cluster, collect data from nodes in the cluster and communicating with sink. By utilizing clustering method it has been observed that there is massive amount energy that's been saved. In static clustering method some rules were followed to elect a cluster head, once a cluster is formed and cluster head is elected, the cluster was statically operated before the head node dead. Because cluster head node have significantly more responsibility so rapid decrease in energy in the Cluster head node. The death time was head node was too early in static clustering technique.

II. TECHNIQUES

A. ileach

LEACH stands for Low-Energy Adaptive Clustering Hierarchy. The LEACH [8] protocol for sensor networks minimize energy dissipation in sensor networks. It partitions the nodes into clusters, and in each cluster, a separate node with extra privileges is called a bunch head (CH) is responsible for creating and manipulating a time division multiple access (TDMA)schedule and sending aggregated data from the nodes to the beds base station (BS) where these data are required using code division multiple access (CDMA). The residual nodes are cluster members. CHs change randomly over time for you to balance the power dissipation of nodes. The node chooses a random number between 0 and 1. The node becomes a CH for the existing round if the number is less than the following threshold:

$$T_n = \begin{cases} \frac{P}{1-P\times\left(r \bmod \frac{1}{P}\right)}, & n \in G \\ 0, & Otherwise \end{cases}$$

Where n may be the given number of nodes, p may be the likelihood of a node being elected as a cluster-head, r is really a random number between 0 and 1 that is selected by a sensor node, mod denotes modulo operator, G may be the pair of nodes that were not accepted as cluster head in the last “1/p”events. This protocol is divided in to rounds, where each round contains setup phase and steady state phase. The improved LEACH (iLEACH)[4,15] protocol is based on the initial energy and number of neighbors of the nodes. This protocol is more applicable than any type that assumes a protocol by which each node knows the sum total energy of the network and then adapts its election likelihood of becoming a group head based on its remaining energy. In the iLEACH protocol, assign a weighting probability to each node. This weighting probability should be corresponding to the first energy of every node divided by the first energy of the normal node. Where is the present sensor node power; is the typical energy of the network in the present round; is the amount of neighbors for *n*; is the typical number of neigh boring nodes in the network; $dtobs_{avg}$ is the average distance of the network sensor nodes to the BS;$dtobs_n$ is the distance of sensor nodes from the BS. The more is the distance of the sensor node not even close to the BS, the more is the quantity of energy used on sending data to the BS

$$T_{n=} \begin{cases} \frac{p}{1-p\left(r \bmod \left(\frac{1}{p}\right)\right)} \times \frac{E_{cur}}{E_{avg}} \times \frac{Nbr_n}{Nbr_{avg}} \times \frac{dtobs_{avg}}{dtobs_n} S \in G \ldots\ldots\ldots Eq[2] \end{cases}$$

B. ANT COLONY OPTIMIZATION

This section will explain a fresh general-purpose heuristic algorithm[16] which is often used to resolve different scombinatorial optimization problems. The brand new heuristic has the next desirable characteristics:

1. It is **versatile**, because it could be placed on similar versions of the exact same problem; for instance, there's a straightforward extension from the traveling salesman problem (TSP) to the asymmetric traveling salesman problem (ATSP).

2. It is **robust**. It can be applied with only minimal changes to other combinatorial optimization problems including the quadratic assignment problem (QAP) and the job-shop scheduling problem (JSP).

3. Its **population based** approach. In ACO [17, 18] it allows the exploitation of positive feedback as a search mechanism, as explained later in the paper. In addition, it

makes the machine amenable to parallel implementations. These desirable properties are counterbalanced by the fact that, for many applications, the Ant System could be outperformed by more specialized algorithms.

Consider for example the experimental setting shown in Fig. 1.6. There's a path along which ants are walking (for example from food source A to the nest E, and vice versa, see Fig. 1.6a). Suddenly an obstacle appears and the trail is cut off. So at position B the ants walking from A to E (or at position D those walking in the contrary direction) have to decide whether to turn right or left (Fig. 1.6 b). The decision is influenced by the intensity of the pheromone trails left by preceding ants. A greater level of pheromone on the right path gives an ant a stronger stimulus and thus a higher probability to turn right. The first ant reaching point B (or D) has exactly the same probability to show right or left (as there is no previous pheromone on the 2 alternative paths). Because path BCD is shorter than BHD, the very first ant following it will reach D before the very first ant following path BHD. The end result is that the ant returning from E to D will find a stronger trail on path DCB, due to the half of all ants that by chance made a decision to approach the obstacle via DCBA and by the already arrived ones coming via BCD: they will therefore prefer (in probability) path DCB to path DHB. As a consequence, how many ants following path BCD per unit of time will undoubtedly be greater than how many ants following BHD. This causes the total amount of pheromone on the shorter path to grow faster than on the longer one, and therefore the probability with which any single ant chooses the path to follow is quickly biased towards the shorter one. The last result is that quickly all ants will select the shorter path. The algorithms that individuals are likely to define in the next sections are models derived from the analysis of real ant colonies. Therefore we call our bodies Ant System (AS) and the algorithms we introduce ant algorithms. As we're not interested in simulation of ant colonies, in the utilization of artificial ant colonies as an optimization tool, our bodies could have some major differences with a real (natural) :Artificial ants will have some memory,

- They'll not be completely blind
- They will reside in an environment where time is discrete.

III. LITERAUTRE SURVEY

Halfwit and Maliki (2014) [1] has proposed a brand new technique by which notion of Vice Cluster head has been taken out. Vice Cluster head has been selected as alternate head that has worked when the cluster head has fallen down. Criteria for the choice of vice cluster head have set through to the foundation of three factors i.e. Minimum distance, maximum residual energy, and minimum energy. Enhancement in the network life has been obtained because of the cluster head has not dead ever. As a group have head has been died it has been replaced by it's vice Cluster head. Babaie et al. (2010)[2] have proposed a novel method to select a group Head. LEACH protocol has set threshold value to 0 for next 1/p rounds each time a node has been selected as a group head. This technique optimized LEACH method, by adjusting threshold considering some factors. Proposed algorithm has settled the threshold of each node correspondingly to the number of live and dead nodes in each round, therefore the probability for more nodes has been established to become cluster head. Energy factor has taken into consideration in this technique, During Cluster Head selection phase and no-cluster-head selecting node as its cluster head, while data transmitting procedure is just like LEACH[10]. This algorithm considered the number of live and dead nodes in each round to calculation the threshold value. Likelihood of select the cluster-head has been growing after rounds. Consideration of number of live and dead nodes in each round has visited calculate the Threshold. It concluded that the proposed method can reduce the low vitality sensor nodes to be selected as cluster heads, and create the power Balance of network load. Moreover, Results have now been achieved better network lifetime in WSN. Therefore, the method to modify the threshold might be an effective solution to resolve the problem of network energy consumption as this technique explained. Bakr and Lilien (2010)[3] have made focus mainly on extending the WSN lifetime. Lifetime has been extended by making WSNs redundant with the addition of spare nodes. The passive (switched off) spares has been made available to become active (be switched on) whenever any active WSN [5] node energy exhausted. A new proposed LEACH-SM (LEACH Spare Management) has modified the prominent LEACH protocol by enhancing it with an efficient management of spares. Addition of the spare selection phase has been done in LEACH; this functionality has been named as spare management features in LEACH-SM. During Spare Selection phase, each node has been decided in parallel if it would be become an energetic primary node, or a passive spare node. The nodes decided spares go asleep, as the WSN[5] as the complete has been maintained the necessary above-threshold target coverage. (The spares have awakened once the probability that any primary node exhausted its energy reaches a predefined value.) Identification of spares alone has increased energy efficiency for WSNs as proved, Decentralized Energy-efficient Spare Selection Technique has been found in spare selection phase by spare manger. Lowering of the duration of the active interval for cluster heads has been observed, considered as a part effect. Reduction energy consumption by cluster heads has been observed mainly. Beiranavand et al. (2013) [4] have proposed an enhancement in LEACH named it i-LEACH[4], Improvement has been done by taking under consideration basically three factors;

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Residual Energy in nodes, Distance from base station and number of neighbouring nodes. A node has been considered as head node if it's most favourable value for discussed three factors i.e. have significantly more residual energy when compared with average energy of network, more neighbours than average neighbours for a node are calculated in network and node having less distance from base station as comparison to node's average distance from BS in network. Reduced energy consumption and prolongation in network life time has been observed. Chen and Wang (2012) [5] have explained a greater model in WSN which has been predicated on heterogeneous energy of nodes for same initial energy and multiple hop data transmission among cluster heads is proposed. New threshold has been introduced on the basis of current energy and average energy of the node to cluster head election probability and provide reliability that higher residual energy have greater probability to become cluster heads than that with the low residual energy. Problem of number of cluster heads reduces with the increase of the amount of rounds. Confirmation has been supplied with the approach that nodes with higher residual energy have highest probability to become cluster heads than that with the low residual energy. Extension in the network lifetime and guarantees a well distributed energy consumption model been demonstrated. Elbhiri et al. (2013)[6] have explained the spectral clustering methods. Spectral Classification for Robust Clustering in Wireless Sensor Networks (SCRC-WSN)[17] named algorithm has been proposed. Spectral partitioning method has used the graph theory approaches for separation of network into a fixed optimal number of clusters. Optimal number of clusters and changing dynamically the cluster head election probability has proved to be very efficient in increasing the performance. A centralized approach has been used calculate the nodes residual energy. After-effect of node density on the robustness of the algorithm has been studied which has led to less energy consumption and escalation in lifetime. Heinzelman et al. (2000) [7] has proposed the initial LEACH protocol ever. Wireless distributed micro sensor systems offering the consistent observing the areas for military and civil applications have now been of clusters and changing dynamically the cluster head election probability has became very efficient in increasing the performance. A centralized approach has been used calculate the nodes residual energy. After-effect of node density on the robustness of the algorithm has been studied which includes resulted in less energy consumption and escalation in lifetime. Heinzelman et al. (2000) [7] has proposed the initial LEACH protocol ever. Wireless distributed micro sensor systems offering the consistent observing the areas for military and civil applications have now been explained. It in addition has explained that the communication protocols, which have done the effective improvement on the overall energy dissipation of WSN. Direct transmission, multihop routing, and static clustering have now been considered more effective in sensor networks, So LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol has been proposed that's developed non randomized scheme for cluster-heads. Localized coordination has exploited scalability and robustness in the networks, and data fusion has reduced the amount of data to the bottom station. A high level of Energy reduction has been achieved as weighed against conventional routing protocols. Katiyar et al. (2010)[8] have discussed concerning the unnecessary energy consumption because of the formation very small and big cluster at same. To overcome this dilemma a brand new protocol has been proposed named FZ-LEACH (Far Zone LEACH). Formations of Far Zones have now been done to overcome the problem of uneven cluster formation. Far-Zone has been explained as a group of sensor nodes which are positioned at locations where their energies are less when compared to a threshold. An improvement in the performance has been observed with regards to Energy dissipation rate and network lifetime. Liu et al. (2010) [9] this paper have explained at new methodology where reduction of energy load among all of the nodes has been presented an improved algorithm LEACH-D centered on LEACH. The combined ideas of adjusting the threshold function concerning the nodes, a fixed radius of the clustering and a multi-hop communication mechanism on the list of cluster heads to talk about system lifetime energy load among all of the nodes has been discussed. A noticable difference has been done mainly on following aspects, Connectivity density in the value of threshold that has taken the density of distribution of node into consideration, so that it escalates the likelihood of a node which may have a high connectivity density to become a head node. Second, in the clustering stage, the cluster head node decides its cluster radius according for their distance from the base station and the degree of connectivity. With this technique head node's energy consumption have reduced a lot. Non-Cluster Head nodes have to select to become listed on a bunch according to the energy of head node and the exact distance to the cluster head node. In the communication phase, cluster head node works on the multi-hop steady-state transmitting data to the base station. Reduction in the whole network energy consumption has been observed, and found suited to the tiny wireless sensor network effectively. Lu et al. (2013) [10] have been concentrated mainly on the nodes those are from base station and have been elected as cluster head, these node's energy have fallen very rapidly, so to overcome this a new model has been proposed where three factors have been discussed i.e. energy of every node at particular instance of time, quantity of time a node has been selected as cluster head and distance between the node and base station. By

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considering these parameters threshold have been changed to improve the network life time. NEWLEACH name protocol has been proposed that has introduced a new concept named optimum factor by considering the rest of the energy of nodes, times of a node to be chosen as a bunch head node and the distances between nodes and base station. Enhancement in Network lifetime and even distribution of dead nodes has been revealed that approach contained balanced energy model. Melese and Gao (2010) [11] have explained the vitality use of sensor nodes in Wireless sensor network. Main effort has been prepared for balancing the vitality consumption over the network to ensure that survival time of all nodes can increase. Optimization of the ability consumption has been focused by taking consumed energy as a significant factor for criteria cluster head selection. Energy consumption factor have contributed more effectively in increased network lifetime of WSN as opposed to residual energy. By considering energy consumption, new formula has been proposed to calculate threshold value. To be able to optimize energy consumption and increase network lifetime, it's necessary to balance energy among nodes has been summarized. Extension in the LEACH formula has been done on the basis of a factor that includes the consumed energy of every nodes of WSN. Major impact has been observed in the cases when long distances occurred between the beds base station and the nodes. Remarkable improvement has been concluded for cluster head selection. Peng et al. (2011) [12] have proposed a fresh technique by which adaptive clustering hierarchy algorithm has been proposed to meet QOS (Quality of Services) requirements. Modification has been done in basic LEACH and a better protocol has elaborated by which improvement has been occurred in the vitality efficiency and other QOS parameters by excluding the node with improper geographic location to be the cluster heads. The optimum measuring selection of head nodes has been designed to be a criterion of cluster head selection, and every cluster heads has been elected according to the node density threshold, that is defined by the node distribution situation process and communication among nodes. An Improvement has been shown in the network lifetime and the communication quality by selecting the Cluster head in the region of proper node density. Achieve good results if you have uneven distribution of nodes. Sun et al. (2009)[13] has proposed a technique in which some implementation did to basic LEACH[18], named as ILEACH[4].ILEACH has on the basis of the characteristic of limited energy of wireless sensor networks to prolong the time of the Whole networks. Consideration of Nodes for cluster head selection has been done on the cornerstone of residual energy. The constraint threshold of distance has used to optimize cluster scheme. Construction of the routing tree has been proposed on the cornerstone of Cluster heads 'weight. A tree based routing has been done in which a bunch head is elected as root node and the criteria for selecting root node is to be nearer to the bottom station and owing enough energy. A better performance in both network entire life and cluster head election has been drawing out as a conclusion.

IV. PROPOSED METHODOLOGY

This section shows the flowchart of the proposed methodology.

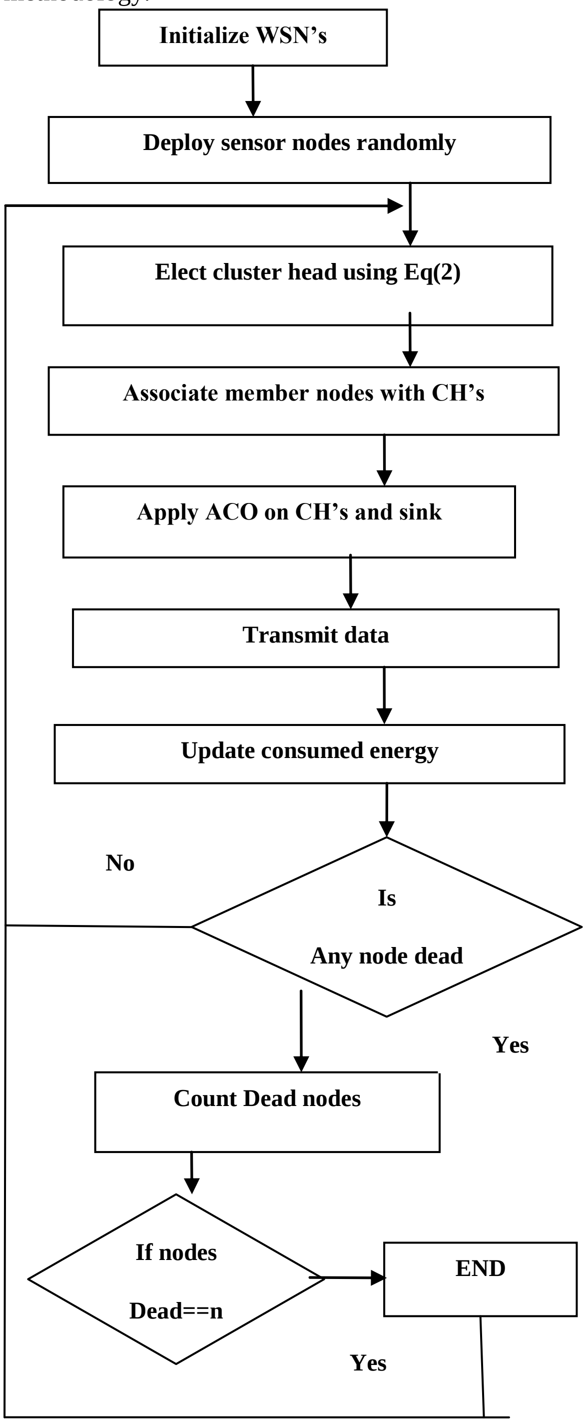

Fig 1: Flowchart of the proposed algorithm

V. DESIGNED ALGORITHM

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Volume 4, Issue 11, May 2015

Begin AcoiLeach (X,Y,BS.X,BS.Y,n,P,E_0)

STEP1 Deploy Sensor nodes
For i= 1:n
W(i).xd= rand* X;
W(i).yd = rand * Y;
W(i).G = 0;
W(i).E = E_0;
W(i).type = 'NCH';
End
STEP2 Place base station
W(n+1).xd=BS.X;
W(n+1).yd = BS.Y;
STEP3 While r $\leq$ MAXTIME

3a Check for epoch
If r % (1/P)== 0
For 1= 1:n
W(i).G = 0;
End
3.b check for dead nodes

$$\text{dead} = \begin{cases} 1 & \text{if } W(i).E \leq 0 \\ 0 & \text{otherwise} \end{cases}$$

dead= dead +1;
end

$$\text{FND} = \begin{cases} r & \text{if } dead == 1 \\ 0 & \text{if } dead == 0 \end{cases}$$

$$\text{HND} = \begin{cases} r & \text{if } dead == n/2 \\ 0 & \text{if } dead < n/2 \end{cases}$$

$$\text{LND} = \begin{cases} r & \text{if } dead == n \\ 0 & \text{otherwise} \end{cases}$$

3c Apply clustering

$$\text{CH}=\begin{cases} 1 & \text{if } rand \leq 1 - \frac{P}{P*(r\%p)} \text{ and } W(i).G \leq 0 \\ 0 & \text{otherwise} \end{cases}$$

CH = CH +1;
W(i) type= 'CH';
W(i).G = 1/p -1;
3d Relay node selection
If CH> 1
for i=i:CH
if W(CH).dis < min- d
min-d = W(CH).dis
reylay = W(CH).id
end
3e Update distance matrix
for ACO
for i= 1: CH
for j = 1: CH

$$G(i,j) = \sqrt{c(i).xd + c(i).y - c\,(j).yd}$$

if i= j
G(i , j) = inf ;

3f Apply ACO
Set d, B &
dist_array = G;
city list = C
trial = .5;
m=ch_tabu;
Eta=1./dist_array;
no_ants=ones(ch_tabu,ch_tabu);

```
ant_sol=zeros(m,ch_tabu);
NC=1;

Rbst=zeros(max_iterations,ch_tabu);
Lbst=inf.*ones(max_iterations,1);
Lavg=zeros(max_iterations,1);

figure(1);
while NC<=max_iterations %
  randloc=[];
  for i=1:(ceil(m/ch_tabu))
    randloc=[randloc,randperm(ch_tabu)];
  end
  antsl(:,1)=(randloc(1,1:m))';

  for j=2:ch_tabu
    for i=1:m
      visit_tour=ant_sol(i,1:(j-1)); %
      J=zeros(1,(ch_tabu-j+1));%
      P=J;
      Jc=1;
      for k=1:ch_tabu
        if length(find(visit_tour==k))==0
          J(Jc)=k;
          Jc=Jc+1;
        end
      end
      for k=1:length(J)
%pheromen as

P(k)=(no_ants(visit_tour(end),J(k))^Alpha)*(Eta(visit_to
ur(end),J(k))^Beta);
      end
      P=P/(sum(P));
      %
      Pcum=cumsum(P);
      Select=find(Pcum>=rand);
      to_visit=J(Select(1));
      antsl(i,j)=to_visit;
    end
  end
      %Updating ant Information

  if NC>=2
    antsl(1,:)=Rbst(NC-1,:);
  end
  %
```

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```
  L=zeros(m,1);
  for i=1:m
    R=antsl(i,:);
    L(i)=Deval(dist_array,R);
  end
  %Local best solution
  Lbst(NC)=min(L);
  pos=find(L==Length_bst(NC));
  Rbst(NC,:)=ant_sol(pos(1),:);
  Lavg(NC)=mean(L);
  NC=NC+1;
  Dants=zeros(ch_tabu,ch_tabu);
  for i=1:m

    for j=1:(ch_tabu-1)

Dltaants(ant_sol(i,j),ant_sol(i,j+1))=Delta_no_ants(ant_sol(i,j),ant_sol(i,j+1))+Q/L(i);
    end

Dltants(ant_sol(i,ch_tabu),ant_sol(i,1))=Delta_no_ants(ant_sol(i,ch_tabu),ant_sol(i,1))+Q/L(i);
  end

  nants=(1-Rho).*no_ants+Dltants;
  antsol=zeros(m,ch_tabu);

end

Pos=find(Length_bst==min(Length_bst));
brsol=Root_bst(Pos(1),:)
plen=Length_bst(Pos(1))

  for i=1:1:n
    if ( W(i).type=='N' && W(i).E>0)
      if(cluster-1>=1)
        min_dis=Inf;
        min_dis_cluster=0;
        for c=1:1:cluster-1
          d=min(min_dis,sqrt( (W(i).xd-C(c).xd)^2 + (W(i).yd-C(c).yd)^2 ) );
          if ( d<min_dis )
            min_dis=d;
            min_dis_cluster=c;
          end
        end

STEP 4 Update consumed energy
          min_dis;
        if (min_dis>=do)    W(i).E=W(i).E- ( tx_energy*(4000) + multipath*4000*( min_dis *min_dis * min_dis * min_dis));
 end
        if (min_dis<do)
W(i).E=W(i).E- ( tx_energy*(4000) + free_space*4000*( min_dis * min_dis));

End Return network lifetime(r);
```

VI. CONCLUSION AND FUTURE SCOPE

Utilizing the energy in well-organized way may bring about prolonging the duration of the WSNs. Sensor nodes possess a negative characteristic of limited energy which pulls back the network from exploiting its peak capabilities. Hence, it is necessary to gather and transfer the info within an optimized way which reduces the energy dissipation. In this paper, an Inter-cluster Ant Colony Optimization algorithm has been used that relies upon ACO algorithm[for routing of data packets in the network and an attempt has been designed to minimize the efforts wasted in transferring the redundant data sent by the sensors which lie in the close proximity of each other in a densely deployed network.

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