An approach to sense Carbon Monoxide by MQ-7 sensors and to increase lifetime of WSN using MMBS protocol

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***Abstract*: A portable base station approach has been implemented in this study to lessen the vitality utilization of bunch heads by encasing them with the Monitoring Mobile Base Station (MMBS), while on other hand a fluffy rationale is connected to deal with the movement of the base station. The proposed system is useful in sensing the Carbon Monoxide (CO) air pollutant using the MQ-7 Sensors. Each bunch head is appointed with a critical degree by the fluffy framework in view of info parameters, for example vitality, closeness to base station, and group size. At that point it advances the base station towards the bunch head with the high Critical Degree value, so it can substantially spare most of its strength.**

***Index Terms*: Monitoring Mobile Base Station (MMBS), Cluster Head, Fuzzy Logic, LEACH-C, Sensor Nodes, Energy.**

I. INTRODUCTION

The enormous utilizations of WSN create numerous difficulties as these minor sensor hubs are battery-oriented and sent arbitrarily and comparatively to dangerous spots where human checking is exceptionally hazardous. There are numerous average issues like power limitations, restricted figuring limit, open condition and remote availability makes the sensor hubs flawed ordinarily. Once the system is built up, hubs continue detecting the earth and the battery control goes off at the appointed time of time. At whatever point any occasions happen, the sensor hubs sense the earth and send the data to alternate hubs or the Mobile base station. At that point the Mobile base station totals the information and makes a more effective choice. So information duplication is a noteworthy issue in WSN. To evade this duplicate information and to make the system more vitality effective, information total and sensor combination have been accounted for in the writing [1]. Numeous conventions are directed with numerous inventive methods have been proposed in the writing to confirmation the system effectiveness [14]. Bunching is a productive strategy in which the sensor hubs are ordered into various gatherings and each gathering is termed as a Cluster. However, the decision of a pioneer hub – also known as group head - is a critical issue that contributes a considerable measure to limit the vitality utilization. Just group head is allowed to send the data to MMBS. Figure 1 demonstrates the general framework display for bunched based WSN.

Low Energy Adaptive Clustering Hierarchy (LEACH) [1, 2] is the main consistently bunching steering convention which is ended up being vitality productive over level directing convention. In LEACH, the clustering hierarchy is chosen on the basis of probability theory and endeavor for adjusting the heap at every sensor hub. The probabilistic incentive in LEACH chooses an insecure count of bunch heads per round. These heads might be chosen as per the system's limit or in excess of one number of CHs is chosen in each round that makes vitality appropriation inappropriate. Drain C is another incorporated steering convention [2] chooses the CH by gathering area data of every sensor hub through the MMBS. As it is a concentrated methodology, better number of groups is framed, and CHs are appropriated uniformly among the bunches. In this methodology, regardless of whether the system's lifespan extends, it builds the system overhead. This proposal demonstrates that we attempt to enhance the execution of LEACH in perspective of choosing a fitting CH by applying appropriate fuzzy Logic descriptors. Segment II talks about other research works related to this study area. Segment III displays the Radio Model of WSN. Area IV shows the Fuzzy Inference Modules and the proposed calculation. Area V introduces the outcomes and exchange taken after by additionally inquire about work and the indisputable comment

II. FOUNDATION DISCUSSION

In bunching based convention, each group head send the data carefully to the Mobile base station. In this area, a large portion of the well-known grouped based directing conventions are talked about. We have partitioned them in two classifications. In first class, couple of conventions where bunch heads are chosen in a probabilistic way are talked about and in the second classification, a portion of the fuzzy rationale (Type1) grouping based conventions are examined.

2.1A. Progressive Routing Protocols considering bunching

A. LEACH

LEACH [1,2] is a well-known various level directing convention where CH is chosen on revolution premise in view of a probabilistic model and every sensor hub persuades square with chance to be a CH. Filter convention works in two stages: set up stage and consistent state stage. Bunches are shaped in the set-up stage where the real information is transmitted. Every hub picks an irregular number

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somewhere in the range of 0 and 1 to be the CH. On the off chance that the number is not as much as the edge esteem T (n), the hub finds the opportunity to be the bunch set out toward the current round. The limit esteem T (n) is characterized in condition (1).

$$T(n) = \begin{cases} \dfrac{p}{1 - p * \left(r \bmod \frac{1}{p}\right)}, & if\ n \in G \\ 0, & otherwise \end{cases} \quad (1)$$

where r is the round which officially finished, p is the likelihood of the hubs to be the CH, G is an arrangement of hubs which have never been group head in the last 1/p rounds. Even though in LEACH, stack is similarly dispersed on each bunch head, still there are a few downsides which are talked about here. As LEACH utilizes probabilistic model, quite possibly two bunch heads are chosen with nearness which tends to debilitate over all vitality in the system. More CPU cycles are devoured because of the choice of arbitrary number in each round. If they chose hub is shut to the limit of the system, different hubs could disseminate the message to CH in a more vital manner.

B. LEACH – C

LEACH C [2] utilizes a brought together calculation to choose the CH. This brought together calculation is utilized by the MMBS to study the area data and vitality of individual hub. Better bunches are shaped by MMBS by aggravating Cluster Head hubs all through the system. The principle downside of LEACH-C is that the situation of the considerable number of hubs must be known to MMBS. In [3-8], many bunching conventions have been talked about.

2.2 B. Fuzzy Logic (Type-1) based Clustering Protocol

Fuzzy Logic Model handles vulnerabilities and ongoing issues bitterly contrasted with probabilistic model. Numerous scientists have put the exertion how Fuzzy Logic (FL) can be used to choose the proficient CH with the goal that considerable life time can be accomplished. Here, a portion of the outstanding FL Type-1 based bunching calculations have been talked about.

A. CHEF

In CHEF [4] CH is chosen by utilizing two parameters, for example, closeness separation and vitality. This methodology chooses CH hub with high vitality and locally ideal hub. Re-enactment result demonstrates that the CHEF performs 22.7% superior to LEACH. In [3], the creator has proposed three fuzzy parameters, namely vitality, fixation, and significanceof computing the opportunitiesto be the CH as well as enhance the system lifespan. Yet, the principle disadvantages with this convention are that every one of the hubs are not furnished with GPS beneficiaries and the hubs without GPS can't give area data. In F-MCHEL [7], CH is chosen by using fuzzy standards considering vitality and closeness of separation. The hub which is having greatest lingering vitality among the group heads is chosen as a Master Cluster Head (MCH) and sends the amassed information to the Mobile base station. F-MCHEL is a change of CHEF. It is steadier contrasted with LEACH and CHEF. In [9-12] numerous conventions have been examined in view of fuzzy strategies. In [15], a convention wasrecommended by taking three fuzzy parameters into account, for example, remaining battery power, portability, and separation to Mobile base station to choose a SCH. in any case, the real disadvantage of such a convention is that the lifespan of a system remains steady with independent variety of versatility.

III. VITALITY MODEL ANALYSIS

The radio model alluded from [6] is appeared in Figure 2. Amid transmission and gathering, the measure of vitality utilization from the transmitter to the collector for l bits to a separation d is given in condition 2.

$$E_{Tx}(l,d) = E_{Tx-elec}(l) + E_{Tx-amp}(l,d) = \begin{cases} l * E_{elec} + l * \varepsilon_{fs} * d^2 & if\ d < d_0; \\ l * E_{elec} + l * \varepsilon_{mp} * d^4 & if\ d \geq d_0; \end{cases} \quad (2)$$

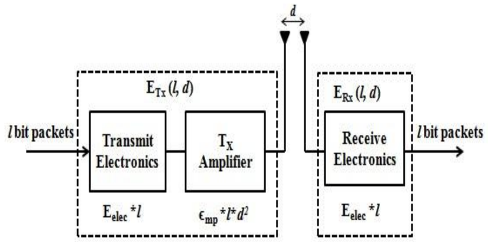

Fig 1. Radio Model

E_{elec} speaks aboutthe vitality scattered per bit for smooth functioning of the transmitter or the beneficiary circuit. The measure of vitality utilization relies upon a few parameters, for example, computerized coding, adjustment, separating and spreading of the flag.

ε_{fs} & ε_{mp} are the qualities of the transmitter intensifier where is utilized with the expectation of complimentary space and for multipath?

As the separation among transmitter and collector is not as much as the edge esteem d0, the free space show (d2 control misfortune) is utilized. Something else, the multipath blurring channel display (d4 control misfortune) is utilized. Power control can be utilized to rearrange this misfortune by properly modifying the influence speaker. The condition 3 demonstrates the measure of vitality utilization to get l bit of information while condition 4 speaks to the limit esteem which is the proportion of & .

$$E_{Rx}(l) = Elec * l$$

$$d_0 = \sqrt{\varepsilon_{fs} / \varepsilon_{mp}} \quad (3)$$

IV. PROPOSED ALGORITHM METHODOLOGY

For the simulation purpose we consider an area of 100 * 100 sensor network with 100 air pollution sensor nodes deployed in the specified area with each MQ-7 sensor nodes have the initial energy of 1 joule in it.

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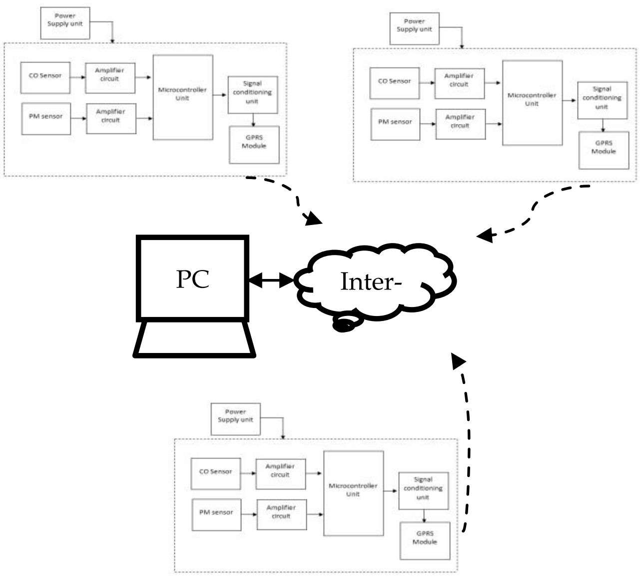

Fig 2: Block Diagram of proposed model

Gas Sampling. A user deploysonly one or more sensor nodes to monitor the air quality inside an area of interest. These nodes further calculate the concentration the damaging pollutants in air, e.g., *CO (Carbon monoxide), PM (particulate matter)*, and *NO2 (Nitrogen dioxide)*. The computations are performed occasionally.

Data Transfer. The obtained data are sequenced in a packet and transferred toserver using a wireless technology (e.g., Wi-Fi or GPRS) after the concentrations of the pollutants are measured.

*Air Quality Index Calculation.*After the server received the gas concentrations from a sensor node, it computes the *Air Quality Index (AQI)* for the area corresponding to the node. The server basically derives a number, which indicates how good/bad the quality of air isto correspond the increasing values as per the rise in the pollution levels.

Data sharing and view. Data collected from the sensor nodes are stored in a database that is later made accessible to the usersin adherence to a collaborative paradigm. Each user can thus view the AQI and gas levels with regardto her/his nodes.

Table 1:
Network Parameters

Parameters	Values
Location Area	100
Number of nodes	100

Table 2:
Simulation Parameters

Parameters	Value	Units
Init_Energy	1	%Joulez
Data packet	4000	% Bits
Control packet	32	% Bits
E_{elec}	50e-9	%joule
Efs	10e-12	% joule
dco	87	% meter
Eda	5e-9	% J/bit/signal
step_size	15	% meter
Efs	10e-7	

The location area is divided into 9 equal parts and in each division cluster nodes are formed by using a GMM-Gaussian Mixture Model for clustering and K-Means algorithm for formation of cluster heads (CH) in a sensor network. Each CH's are composed of several sensor nodes in it.

Algorithmic steps for k-means clustering

Let X = {x1,x2,x3,……..,xn} be the data set of points and V = {v1,v2,…….,vc} be the set of centers.

1) 'c' cluster centers are randomly selected.

2) Distance between each data point and cluster center is calculated.

3) A data point is assigned to the cluster center having minimum distance from the cluster center.

4) The new cluster center is computed by using:

$$v_i = (1/c_i) \sum_{j=1}^{c_i} x_i$$

where, 'ci' represents the number of data points in ith cluster.

5) Distance between each data point and newly obtained cluster centers are measured.

6) The process is stoped if a data point is not reassigned, or else the process is repeated from step 3.

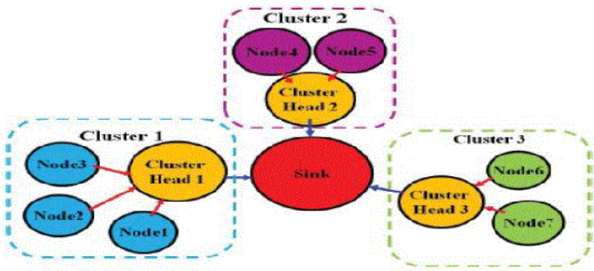

Fig 3: Clustering in WSN

These Clustering Hierarchies gather, compress and forward the data to the Dynamic Mobile base stations (DMMBS), which is also referred as Mobile base station protocol. The dynamic nature of MMBS is achieved in this system using a Fuzzy logic technique, and this station is moved to the CHin each iteration time and it further collects the data from CH. This is repeated with all the other CHs in same manner of a sensor network proposed in this work.

The main strategy in designing this algorithm is to manage the movements of MMBS to each CH and collects the sensed data from them and reduce the load over the CH's in energy consumption and to increase the lifetime of sensor network with maximum number of alive nodes in it.

These MQ-7 sensor nodes which are proposed in this paper have the feature to sense air pollutants example like Carbon monoxide etc. the communication between CH and

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MMMBS is determined by the distance and the "Status Packet". Packet consists if location, energy consumed and number if active members in that cluster.
It is the MMMBS decision to which CH it should approach in a network. The decision is based on Fuzzy Logic system with the following three input parameters:

i) Clustering Hierarchy's residual energy
ii) Closeness to MMBS (larger distance between CH & MMMBS)
iii) Total members in that cluster.

The working of the system is described in the following steps
Step 1: The MMBSdecides the most critical status of a CH and move towards to it.
Step 2: Once the information of status packet is gathered from that cluster, the MMBS determines new location of CH and move towards it.
Step 3: MMBS, situated in the same position, is broadcasted to the location across the network so that CHs would know it.
Step 4: CHs adjust the power as per their closeness to the MMBS and transmit the data.
Step 5: The above steps will repeat for each iteration until the energy dispersion of nodes reaches to zero.

V. RESULTS

The Mobile base station (MMBS) is dynamically move towards cluster heads (CHs) in a given 100 * 100 area based on the decision made by fuzzy system using CH's residual energy, distance between CH's and MMBS and number of sensors members in cluster. The three input parameters determine critical status of CH's. and then move the MMBS randomly select one of them and move towards CH.

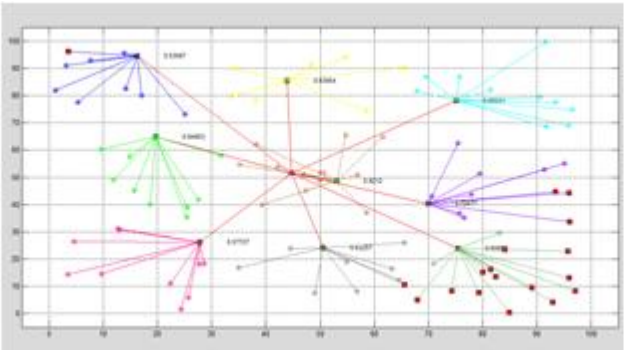

FIG 4: SIMULATION AREA OF 100*100 WITH CH'S &MMBS.

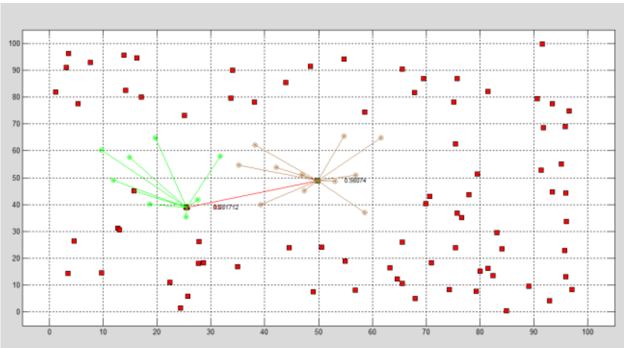

Fig 5: Red color squares represent number of dead nodes after data transfer to MMBS.

The above screen shot clearly implies the total number of dead nodes/members in red color small rectangular boxes and two CH's with their members still alive, with MMBS is still active in sensing information from alive nodes after the 1st simulation is completed successfully

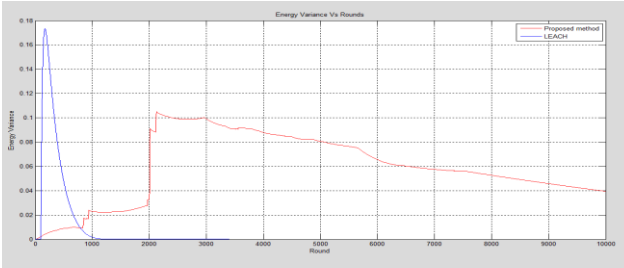

Fig 6: Comparision of Alive nodes in LEACH & Proposed model.

The simulated results of status packet collected from MMBS, from each sensor node of CH's using fuzzy system. A graph is plotted with number of alive nodes versus number of iterations performed.

Initially 100 sensor nodes are deployed in an area of 100 * 100 and CH's are decided based on K-means algorithm and simulation is performed and in parallel the LEACH protocol also executed and analyzed the comparison with proposed algorithm protocol.

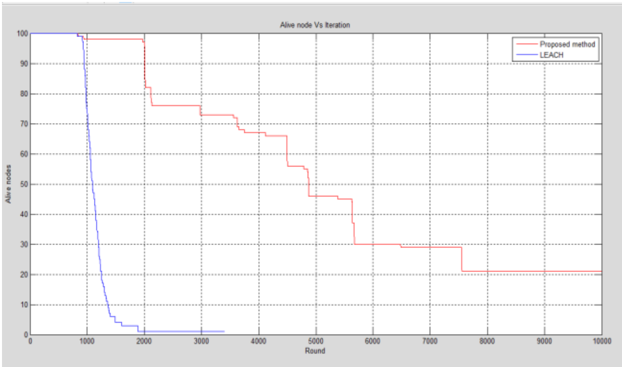

Fig 7: Energy Variance after simulation.

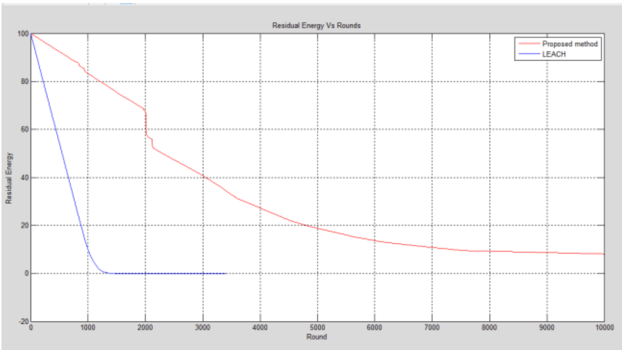

Fig 8: Comparision of Residual Energy of nodes after Simulation in LEACH &MMBS.

The energy consumption dispersion of sensors or a CH's depends on the relative position of a node and MMBS. It determines the network lifetime after the simulation is performed. The proposed algorithm provides a maximum network lifetime with less energy dispersion and it remains consistency and minimize the total energy consumption of the network, but LEACH-C protocol at the beginning of simulation a high dispersion of energy takes place and the network lifetime is almost reached to the '0' at the beginning. The LEACH based sensor network has utilized maximum amount of energy and leads to less network lifetime.

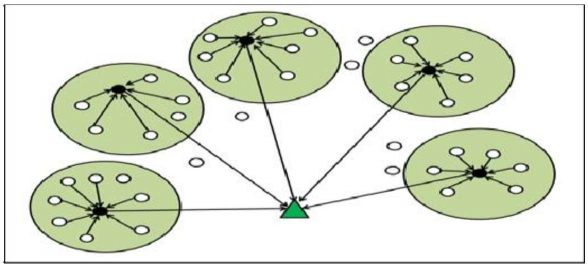

Fig 9: Proposed Model utilizing Fuzzy Logic Model

C. Fuzzy Logic Model

The Fuzzy rationale Type-1 display comprises of four modules: a fuzzifier, fuzzy derivation motor, fuzzy guidelines and a DE fuzzifier. The square outline of the Fuzzy Inference System is appeared in Figure.9. There are four stages required to finish the procedure. It is accepted that sensor hubs send the information in the wake of recognizing an intriguing occasion. CH gathers this information, totals it and send to the Mobile base station. Sort 1 Fuzzy rationale is utilized to deal with vulnerabilities to some degree, since type-1 fuzzy sets are sure. Sort 2 FLS when contrasted with Type-1 FLS, are extremely helpful in circumstances where a participation work can't be resolved precisely, and estimation vulnerabilities like the information influenced by clamor are likewise present in the framework [19]. The guidelines of FLS are portrayed by IF-THEN articulations, where their precursor or ensuing sets are of sort 2.

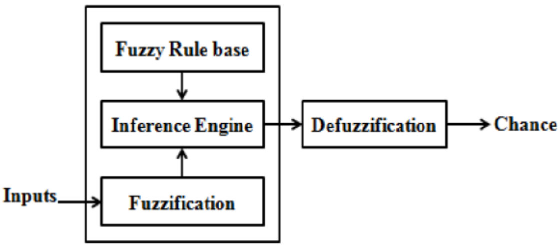

Fig 10: Square Diagram of Type-1 Fuzzy Inference framework

To spare some vitality, the thought is to choose the CH considering fuzzy descriptors, for example, Remaining Battery Power, separation to Mobile base station and Concentration. Commonly, a fuzzy set [20] is portrayed by two sort 1 fuzzy set enrollment works, a prevalent and a second-rate participation work. The impression of vulnerability (FOU) is characterized as the interim between these two Type-1 participations works and is utilized to portray a fuzzy set. Like a Type-1 fuzzy rationale framework, fuzzy rationale framework incorporates four sements:

1. Fuzzifier: Translates data sources or fresh qualities to fuzzy qualities.
2. Inference System: Combines standards and gives a yield of fuzzy sets from an information.
3. Type DE fuzzifier/Reducer: A Type-1 fuzzy set is produced by the Type reducer, which is then changed over by the DE fuzzifier to a numeric yield [21].
4. Knowledge Base: Contains an arrangement of fuzzy guidelines, and a participation work set known as the database.

Table 3
Fuzzy Rules and Value of Chance

Energy	Proximity to MMBS	Member	Critical Degree
Low	Close	Low	Medium large
low	close	Medium	Medium large
low	close	High	Rather arge
low	Medium	Low	Rather large
low	Medium	Medium	Rather large
low	Far	Low	Large
low	Far	Medium	Rather large
low	Far	High	Very large
Medium	Close	Low	Medium small
Medium	Close	Medium	Medium small
Medium	Close	High	Medium small
Medium	Medium	Low	Medium small
Medium	Medium	Medium	Medium
Medium	Medium	High	Medium large
Medium	Far	Low	Medium large
Medium	Far	Medium	Medium large
Medium	Far	High	Rather Large
High	Close	Low	Rather small
High	Close	Medium	Very small
High	Close	High	Smalll
High	Medium	Low	Small
High	Medium	Medium	Small
High	Medium	High	Rather small
High	Far	Low	Rather small
High	Far	Medium	Medium small
High	Far	High	Medium small

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VI. CONCLUSION

The outline of the paper presumes that a vitality proficient bunching calculation has been proposed for Wireless Sensor Network utilizing Type-1 Fuzzy Logic. The three fluffy descriptors (remaining battery control, separation to base station, and focus) have been chosen the Cluster Head (CH) and only CHs can convey the message to the base station. The primary thought is to utilize Fuzzy Logic Type 1 Model to choose the CH as it handles the vulnerability more precisely than Type 1 fluffy rationale show. Many research results are accessible in view of Type 1 Fuzzy Logic Model not with Type-2 Fuzzy Logic Model. The legitimacy of the proposed convention has been confirmed through MATLAB Fuzzy Inference System devices. The proposed system is useful in sensing the carbon Monoxide air pollutant using the MQ-7 Sensors.

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