Energy Efficient Clustering Scheme for Prolonging the Lifetime of Wireless Sensor Network with Isolated Nodes

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ABSTRACT *An appropriate clustering algorithm for gathering sensor nodes can build the vitality productivity of WSNs. Be that as it may, clustering requires extra overhead, for example, group head choice furthermore, task, and group development. This paper proposes a new territorial vitality mind ful grouping strategy utilizing segregated nodes for WSNs, called Regional Energy Aware Clustering with Isolated Nodes (REAC-IN). In REAC-IN, CHs are chosen in view of weight. Weight is resolved by the leftover vitality of every sensor and the territorial normal vitality of all sensors in each group. Disgracefully planned appropriated grouping algorithms can make nodes end up plainly disengaged from CHs. Such confined nodes speak with the sink by devouring overabundance sum of vitality. To drag out system lifetime, the local normal vitality and the separation amongst sensors and the sink are utilized to decide if the secluded node sends its information to a CH node in the past round or to the sink. The recreation comes about of the present examination uncovered that REAC-IN beats other clustering algorithms.*

***Key Words**: Energy aware clustering, energy consumption, distributed clustering, isolated nodes.*

I. INTRODUCTION

IN a regular remote sensor organize (WSN), sensor nodes comprise of detecting, conveying, and information preparing parts [1]. Sensor nodes can be utilized as a part of various mechanical, military, and rural applications, for example, transportation activity checking, natural observing, brilliant workplaces, also, war zone observation. In these applications, sensors are sent in an impromptu way and work self-governing. In these unattended situations, these sensors can't be effortlessly supplanted or energized, and vitality utilization is the most basic issue that must be thought about [2], [3]. Various vitality proficient transferring plans have been outlined for WSNs, as [4]. Bunching is especially valuable for transfer based sensor Organizes that expect adaptability to Hundreds even a large number of nodes. A group contains at any rate a bunch head (CH) with group individuals. CHs are mindful for organizing the nodes inside their bunch and intermittently transmit totaled information to a remote onlooker (sink). Amid intermittent re-bunching, nodes with high remaining vitality can fill in as CHs. System lifetime is drawn out utilizing execution information total, which includes consolidating the information from source nodes into a little arrangement of significant data, what's more, make information transmission to be more vitality adequate. Be that as it may, these bunching calculations show disservices, for example, J.- S. Leu, M.- C. Yu, and K.- W. Su are with the Department of Electronic what's more, Computer Engineering, National Taiwan University of Science and Innovation, Taipei City 106, Taiwan (email: jsleu@mail.ntust.edu.tw). T.- H. Chiang is with ASUSTeK Computer Inc., Taipei City 11268, Taiwan. extra overhead amid CH choice and task, and amid the group development process. Analysts have proposed a few bunch based conventions as of late expect to amplify arrange lifetime. Low Vitality Adaptive Clustering Hierarchy (LEACH) [5] is a self organizing versatile convention that uses a dispersed bunching development calculation. In LEACH, CHs are chosen in light of a foreordained likelihood; different nodes pick a group to join by evaluating which of the chose CHs is nearest. Be that as it may, Filter does not ensure a uniform circulation of CHs in a system.

In LEACH, CHs can wind up noticeably over-burden, causing the degree of system stack adjust to decrease. Moreover, a node can be chosen to be a CH for more than one round of an operation, along these lines expending more vitality than different nodes. In [6], the creators proposed Hybrid Energy-Efficient Distributed bunching (HEED), which utilizes a consolidated methodology of vitality furthermore, correspondence cost to create CHs. Notice for the most part forestalls two nodes inside a similar transmission go from getting to be CHs in light of the fact that vitality is consistently appropriated over all nodes. Besides, the likelihood of CH choice is adaptable, Giving between CH availability inside a sensor's transmission extend. In HEED, each node must impart continually with its neighboring nodes for a foreordained number of cycles amid CH choice; in this way, additional correspondence costs are required. Along these lines, HEED is inadmissible for large scale WSNs. Dispersed Energy Efficient Clustering (DEEC) [7] is a bunching based calculation in which CHs are chosen in view of the likelihood of the proportion of the remaining vitality to the normal vitality of the system. DEEC includes assessing the perfect estimation of system lifetime, which is utilized to process the reference vitality that every node must consume amid a round. In this way, every node isn't required to have worldwide information of the system. The primary downside of DEEC is the overhead engaged with handling the normal vitality of the organize. In addition, the normal vitality of the system can't precisely speak to the condition of the local system. In this paper, another territorial vitality mindful bunching strategy with disconnected nodes for WSNs, called Regional Energy Mindful Clustering with Isolated Nodes (REAC-IN) is proposed.

In light of the idea of LEACH, REAC-IN empowers every node to devour vitality consistently by turning the CH part among all nodes. REAC-IN chooses the CHs in light of the edge including the leftover vitality of every sensor and the territorial normal vitality of all sensors in each bunch so as to attempt to uniformly appropriate CHs, though LEACH chooses the CHs in view of the limit thinking about a foreordained likelihood.

as it were. REAC-IN involves adjusting the pivoting age of each node to its vitality and demonstrates the issue of node disengagement.

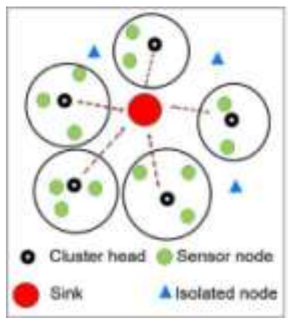
Disgracefully outlined conveyed bunching calculations can make nodes end up plainly disengaged from CHs. Such disengaged nodes speak with the sink by expending an abundance sum of vitality. Besides, the territorial normal vitality and the separate amongst sensors and the sink are utilized to decide regardless of whether the disconnected node sent its information to a CH node in the past round or to the sink.

The rest of the paper is composed as takes after. Area II presents preparatory data, including the issue definition. Segment III depicts the proposed conspire. Area IV gives reenactments comes about by contrasting REAC-IN and existing plans, and a concise conclusion in Section V.

II. ISSUE DEFINITION

A. Separated Nodes

Every sensor node in a WSN expends vitality to detect the condition and pass on or hand-off its detected information to a sink node. In a WSN shaped by shamefully planned disseminated grouping calculations, nodes may end up noticeably detached due to haphazardly chose CHs, as showed in Fig. 1. The vitality utilization issue of a confined node imparting with the sink would turn out to be more evident when the separation between them is genuinely far. Far more detestable, it is powerless against deplete its vitality, bringing about a fragmented detecting scope. To draw out system lifetime, territorial normal vitality and the separation amongst sensors and the sink were examined to decide if the detached node ought to send its information to a CH node in the past round or to the sink.



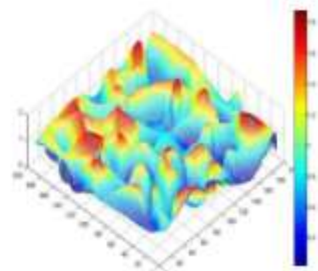


Figure 2.1. Isolated nodes Figure 2.2. Residual energy distribution of randomly deployed sensor nodes

B. Worldwide Average Energy and Local Average Energy

Fig. 2 demonstrates the remaining vitality appropriation of 200 haphazardly sent sensor nodes. The figure uncovered the remaining vitality circulation of all nodes is exceptionally uneven. Thus, for extensive scale organizes, the worldwide normal vitality of the system can't precisely speak to the condition of the whole system. The first plan in [7] did not think about local normal vitality (or neighborhood vitality). A node ought to think about the vitality level of nearby nodes while choosing a CH with a specific end goal to spare more vitality [5]. Along these lines, this investigation proposes the REAC-IN plan to expand the lifetime of WSNs by considering the territorial normal vitality of the WSN nodes.

III. PROPOSED SCHEME

This area presents points of interest on the REAC-IN convention. In this convention, the remaining vitality and local normal vitality of all sensors in each group are utilized to choose CHs. To anticipate the issue of node confinement, the local normal vitality and the separations amongst sensors and the sink are figured to decide if the confined node ought to send its information to a CH node in the past round or to the sink. The subtle elements of proposed conspire are as per the following:

A. Cluster Head Selection Algorithm Based on Residual Energy and Regional Average

Traditionally in LEACH, the cluster-head determination algorithm is partitioned into a few rounds. At each round, each node chooses in the event that it would turn into a group head in light of the limit which is figured by the recommended level of group sets out toward the entire system. In each round, every node picks an irregular number in the vicinity of 0 and 1. On the off chance that the number is not as much as an edge, the node turns into a bunch set out toward the current round. The limit $T(n_i)$ for the node ni is characterized as (1).

$T(n_i)= \sum p/1\text{-}p\text{-}|(r \bmod 1/p)|$ if $n_i \in G$ otherwise 0 (1)

Where p is the coveted level of bunch heads, r is the current round number, and G is the arrangement of nodes that have not been chosen as bunch heads in the past round. Amid the first round (r = 0), every node has a likelihood p of turning into a group head. The nodes that are bunch heads in cycle 0 can't be a bunch set out toward the ensuing rounds.

Note that every one of the nodes would not claim a similar lingering vitality as time passes by. In the event that all nodes utilize a similar p for each group head choice process, the lingering vitality of all nodes would not be all around disseminated and the nodes with bring down vitality would Breakdown more rapidly than the ones with higher vitality.

Our REAC-IN convention picks an alternate p in light of the leftover vitality and the territorial normal vitality of all sensors in each group to delay the lifetime of system.

Let Ec,i(r - 1) be the territorial normal vitality of node n_i in its bunch c at the round r ? 1, nc is the quantity of nodes in the group, and $E_i(r)$ is the lingering vitality of the node n_i. The local normal vitality $E_{c,i}(r - 1)$ is characterized as (2).

$$\overline{E_{c,i}}(r-1) = \frac{\sum_{i=1}^{n_c} E_i(r)}{n_c} \quad (2)$$

$$p_i = p\frac{E_i(r)}{\overline{E_{c,i}}(r-1)} \quad (3)$$

As shown in (3), pi is the probability that node n_i is selected as a CH in the round r, and p is the desired percentage of cluster-heads. If pi = p for each node ni, the network achieves a stable state where all nodes have the same residual energy.

We get the probability threshold in (4) that each node ni uses to determine if it would become a cluster-head in each round.

$$T(n_i) = \begin{cases} \frac{p_i}{1-p_i\times(r \bmod \frac{1}{p_i})} & \text{if } n_i \in G \\ 0 & \text{otherwise} \end{cases} \quad (4)$$

B. Isolated Node and Its Data Transmission Mode

First, isolated nodes occur in a WSN in the following situation. After the cluster head (CH) selection process is finished, all selected CHs broadcast a join-request message to the rest of nodes in the network. If a non-CH node receives many join-request messages, the node would decide to join the cluster which is the closest to it. Those non-CH nodes that do not receive a join-request message are considered as isolated nodes. Second, the data transmission method for isolated nodes can be determined according to the condition in the previous round and the current situation. In our work, we use the First Order Radio Model (FORM) [5] as the power consumption model for the data transmission between the transmitter and the receiver. The key parameters in this model are listed in Table I. The energy cost for transmitting a k-bit message is k(Eelec + "amp D2), where D is the distance between the transmitter and the receiver.

Table I
LIST OF PARAMETERS USED IN THE SCHEME

Parameter	Definition
μ	the cluster head node in the previous round
i	the current node
s	the sink node
$D_{i,\mu}$	the distance between i and μ
$D_{\mu,s}$	the distance between the μ and s
$D_{i,s}$	the distance between i and s
$E_i(r)$	the residual energy of i
$\overline{E_{c,i}}(r-1)$	the regional average energy of the cluster c where i belongs to at the round $r-1$
$C_{direct,i}$	the energy cost for directly transmitting a k-bit message from i to s
$C_{relay,i}$	the energy cost for relaying a k-bit message from i through μ to s
E_{elec}	the energy cost of transmitter electronics
ε_{amp}	the energy cost of transmit amplifier

Our proposed scheme determines how a node transmits its data not only by the distance between itself and the sink, but also its residual energy. The node i would send its sensed data directly to the sink s, if $E_i(r)$ is greater than or equal to Ec,i(r - 1)) and D2 I,s is less than the sum of D2 i,μ and D2 μ,s. Otherwise, the node i would send to the sink via the relay node μ, which is the CH node in the previous round. Thus, the transmission energy costs $C_{direct;,i}$ and $C_{relay;,i}$ can be formulated as (5) and (6) shown.

$$C_{direct,i} = k(E_{elec} + \varepsilon_{amp} * D^2_{i,s}) \qquad (5)$$

$$C_{relay,i} = k(2E_{elec} + \varepsilon_{amp} * (D^2_{i,\mu} + D^2_{\mu,s}) \qquad (6)$$

Assume the angle between the edge from the node i to the relay node μ and the edge from the relay node μ and the sink s is θ, and according to the cosine theorem in (7),

$$D^2_{i,\mu} + D^2_{\mu,s} < D^2_{i,s} \text{ ,if } \cos(\theta) < 0 \qquad (7)$$

$C_{direct,i}$ would be greater than $C_{relay,i}$ if and only if cos(θ) < 0 and the equation (8) hold.

$$D^2_{i,s} - (D^2_{i,\mu} + D^2_{\mu,s}) > \frac{E_{elec}}{\varepsilon_{amp}} \qquad (8)$$

Thus, the gain g_i of the node i for each time when thedata are relayed to the sink with $C_{direct,i} > C_{relay,i}$ can be calculated with equation (9).

$$g_i = \varepsilon_{amp} * (D^2_{i,s} - (D^2_{i,\mu} + D^2_{\mu,s})) - E_{elec} \qquad (9)$$

Hence, the total gain for each round is depicted in (10) when there are n isolated nodes which use a relay-based transmission mode with a lower transmission cost, instead of a direct transmission mode with a higher transmission cost.

$$\Psi = \sum_{j=1}^{n} x_j, \text{where } x_j = \begin{cases} g_j & \text{if } C_{direct,j} > C_{relay,j} \\ 0 & \text{otherwise} \end{cases} \qquad (10)$$

IV. SIMULATION RESULTS

This section describes a performance evaluation of the REAC-IN protocol conducted using Network Simulator 2 (NS2). Main configurable parameters used in our simulations referred from the study in [5] are shown in Table II. Without losing generalization, the base station was assumed to be in the center of the network region.

Table II
ENVIRONMENT PARAMETERS FOR THE SIMULATION

Parameter	Value
Network size	200m x 200m
Node number	100
Node distribution	Random-uniformly distributed
Sink position	at (100m, 100m)
Initial energy/node	2 J

1) The variance of energy level: Fig. 4.1 shows the comparison between the variance of residual energy distribution produced by the DEEC protocol and our proposed REACIN protocol. The variance of the energy levels of all the nodes is the primary measure of the residual energy with local or global average energy in DEEC and REAC-IN. A high variance indicates the global average energy of the network cannot accurately represent the state of the entire network.

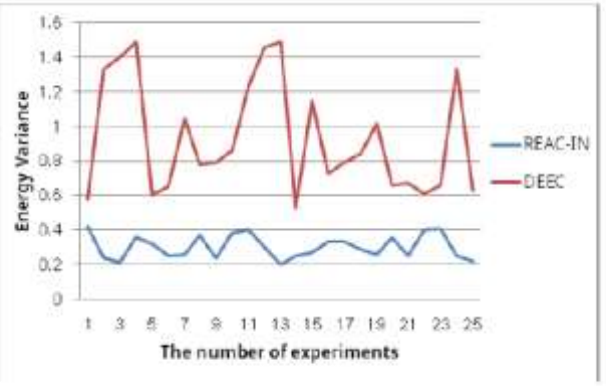


Figure 4.1. The variance of energy level

V. CONCLUSIONS

A WSN is a combination of wireless communication and Sensor nodes. The network must be energy efficient and stable, and have a long lifetime. The REAC-IN protocol presented in this paper improves the cluster head selection process and solves the problem of node isolation. The simulation results revealed that the performance of the algorithms used in REACIN to improve the lifetime and stability of a network is more favorable than that of the algorithms used in other protocols.

VI. FUTURE WORK

In this paper authors Jenq-Shiou Leu, Member, IEEE, Tung-Hung Chiang, Min-Chieh Yu, and Kuan-Wu Su are proposed algorithm and solves the problem of node isolation in different parameter. But our below mention proposed algorithm will give better result compare to author Jenq-Shiou Leu et al.

This convention utilizes a three-level system design and multi-bounce steering correspondence for information total and transmission from the sensor hub to base station. It has been watched that this sort of design upgrades the system adaptability for extensive scale natural applications. Multi-jump directing correspondence is utilized to lessen the debate of the channel range and give planned vitality investment funds by the assistance of long and multi-bounce correspondence from source to goal.

6.1. Vitality Show for Information Transmission

As of late, a ton of research has been done with respect to low-vitality spread radio models. This proposed directing convention utilizes a straightforward First Order Radio Model, where the transmitter and beneficiary disseminate E_{elec} 50 nj/bit and a transmit enhancer circuit at e_{amp} 100 pj/bit/m2 to accomplish a satisfactory Eb/No. The present best in class radio outline, First Order Radio Model's parameters are somewhat superior to alternate models.

Assume r2 is the vitality misfortune inside a channel transmission, when sending a k-bit message at a separation of d by the assistance of the radio model, the transmission end counts are in Eqs. (3) and (4):

$$E_{Tx}(k, d) = E_{Tx-elec}(k) + E_{Tx-amp}(k, d)$$

$$E_{Tx}(k, d) = E_{elec} * k + E_{amp} * k * d^2$$

(3)

And the receiving end calculations are:

$$E_{Rx}(k) = E_{Rx-elec}(k)$$

$$E_{Rx}(k) = E_{elec} * k$$

(4)

6.2. Bury and intra bunch correspondence

The conclusion to-end information transmission procedure of the proposed convention is isolated into many rounds with each round took after by a set-up stage and consistent stage for group development and information exchange, separately, from the sensor hubs to MDC and afterward at last towards the base station. The operation course of events of the LEACH convention is appeared in Fig. 7.

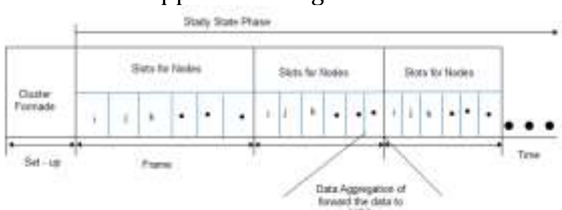


Figure 6.1. LEACH Operation Time Line.

Set-up Phase and Cluster Head Selection: In the time of bunch development, all hubs are self-sufficient, self-sorted out and orchestrated into groups through short messages utilizing the Carrier Sense Multiple Access (CSMA) convention. Each hub of the system needs to settle on a choice to end up plainly a bunch head or not with the likelihood of Pi and the leftover vitality of hub; Pi with the remaining vitality hub in the proposed recipe is ascertained by the LEACH calculation as appeared in Eq. (5).

$$P_i(t) = \begin{cases} (1 - (E_{con} / E_{Total})) * \frac{k}{N - k * (r \bmod \frac{N}{k})} \\ 0 \end{cases}$$

(5)

Toward the start of the set-up stage each hub utilizes this equation to compute the likelihood Pi check with the leftover vitality of hub. The initial segment of Eq. (5) registers the leftover vitality of every sensor hub; E_{con} and E_{total} are the consumed energy in each round and the total energy of the node respectively. The second part guarantees that the normal number of group sets out toward each round is k; this implies the entire system is isolated into k bunches and N is the aggregate number of hubs in the system. Each hub has been chosen once as a bunch head after N/k adjusts by and large and r demonstrates the round number. Those hubs chose as a bunch set out toward the current round are not qualified to be chosen as a group set out toward the following round.

clarifies the investigative examination comes about between the typical and proposed bunch head determination recipe, on the off chance that it is accepted that E_{total} = 2J, k = 10, N = 100 and r = 1, 2, 3 and 4. All group heads in the system communicate a declaration from every one of the hubs through the CSMA convention, this message has a few fields like bunch head hub position and message sort that show it is a short message. After time t1, hubs get numerous declaration messages from diverse group heads, at that point the part hub chooses the nearest bunch head on the premise of the flag quality of the parcel declaration and picks the nearest bunch head with the littlest separation.

Consistent Phase: Figure 6.2 clarifies the enduring stage stream transmission of proposed convention; this stage utilizes multi-jump steering by the assistance of Mobile Data Collector for information transmission towards the base station. After the group development, the bunch head sets up a Time Division Multiple Access (TDMA) plan for each hub to send information to the bunch head. This planning is to evade crashes and lessen the vitality utilization between the information messages in the group and empowers every individual from the radio hardware to be off when not being used.

To diminish bury bunch impedance each group utilizes a remarkable spreading code; when the hub is chosen as a group head it chooses that one of a kind code and advises all the part hubs inside the bunch to transmit their information utilizing this spreading code. In the information combination system towards the base station, the

Mobile Data Collector transmits a reference point message for all the bunch heads to refresh their present position as outlined in Fig. 6.2.

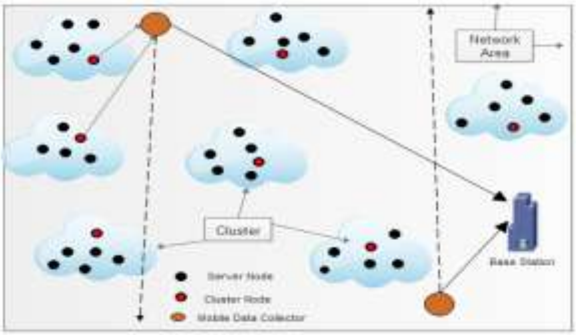
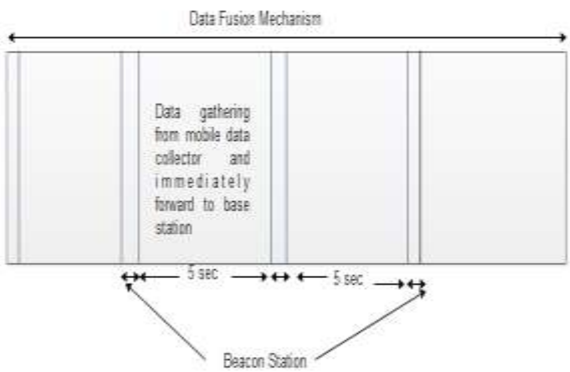


Figure 6.2. Steady Phase Flow Transmission.



As indicated by the backwards square law, the transmission vitality is conversely relative to the square of the separation, hence, sensor hub A figures minimal separation by the squared separation work S(M) to achieve the base station through MDC.

$S(M) = s^2$ A.M + s^2 M.BS (M denotes MDC)

At that point, minimal separation of them is taken in connection to the square of the separation from the head hub A to BS.

Min (S(M)) $< s^2$ A.BS

Pseudo Code of the Vitality Cluster Head Proposed Protocol:

BEGIN

1. Recognize the Probability *(pset),* number of hubs (s);
2. Einit(s) = E0, s = 1,2,3,… ..n;

SET-UP PHASE

1. do{/repeat for r rounds
2. r _ random (0,1);
3. **if** Eres > among all competitor CH and (Einit) > 0 and mod (1/popt) ≠ 0) then
4. process T (s);/given by (1)
5. **if** (r < T (s)) **then**
6. CH {s} = TRUE;//hub "s" be a CH
7. **Else**
8. CH {s} = FALSE;/hub "s" not be a CH
9. **End if**
10. **End if**
11. **if** (CH {s} = TRUE) **then**
12. BC (ADV) _ communicate a notice message;
13. Join (IDi) ;/non-group head hub I join into the nearest CH
14. Group (c);/frame a bunch c;
15. **End if**

STEADY PHASE (CH – MDC)

1. **if** (CH (s)= TRUE) **then**
2. Get (IDi, DataPCK)/get information from individuals;
3. Total (IDi, DataPCK)/total got information;
4. Trans To MDC (IDi, DataPCK);/transmit got information;
5. **Else**
6. **If** (My Time Slot = TRUE) **then**
7. Trans To CH (IDi, DataPCK);/transmit detected information;
8. **Else**
9. Rest Mode (I) = TRUE;/hub I at a rest state
10. **End if**
11. **End if**

STEADY PHASE (MDC – BS)

1. Get (area refresh);//get reference point message
2. **if** (CH (s)= TRUE) **then**
3. dis = cal_dist (CH , MDC);
4. after "t" Time
5. **if** (CH.dis > dis)
6. CH. dis = dis;
7. CH. MDCID = MDC.ID
8. **Else**
9. CH.dis = CH.dis
10. CH. MDCID = CH. MDCID
11. **End if**
12. **End if**
13. Trans to MDC (CH. ID, Data PCK);/transmit information from CH
14. **Else**
15. Refresh (X pos, Y pos)/directions of MDC
16. message (ACK);/message to MDC
17. **End Else**

At the point when a bunch head has gotten adequate information from its individuals, at that point it will change the spreading code for MDC and come back to get the detected information messages from its individuals after effective transmission. Amid the transmission from the bunch make a beeline for MDC, all the group heads communicate the messages inside the system through another appointed spreading code and CSMA/CA is utilized as a MAC layer convention to dodge conceivable crash between them. At the point when MDC has gotten the information from any of the bunch head, at that point it will specifically forward information towards the base station.

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Man is not made for defeat. A man can be destroyed, but not defeated.
~ Ernest Hemingway