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Energy Efficient Target Tracking Protocol In Wireless Sensor Network

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Abstract- Now a days Target Tracking is the main aim of Wireless Sensor network in most of the field. An efficient Energy Model is required to minimize the communication cost effectively. This would help improve the network lifetime and efficiency of sensor node. In this paper we will discuss different Energy Efficient Routing Protocols for Target Tracking in the WSN and present open research issues related to consumption of energy by sensor a node. These protocols are broadly classified on the basis of target tracking methods such as Static cluster and Dynamic cluster. Further these protocols are classified based on the type of sensing model used, technique used to determine neighbouring node information, energy consumption by Boundary node. Also we propose an energy efficient routing protocol for target tracking and it will move smoothly from one cluster region to other cluster region.

Key words: HCCT, Target Tracking, Energy Efficiency, Boundary Problem, Cluster.

I. INTRODUCTION

Real life events are transformed into data that can be processed, saved and used later for different purposes by sensor nodes in WSN.Target tracking is considered important in WSNs, as it is a base for many practical applications, such as battlefield surveillance, disaster response, vehicular activity on roads, emergency rescue, and patient monitoring [1]. Identification of exact position and path travelled by the moveable object in an area uses the stable cluster for the network scalability and energy consumption. When we use a predictive mechanism to communicate with CH about detecting the target to a node, and then coherent cluster node sends a message about the target to a number of suitable nodes right before the arrival of the moving target. Clustering algorithms [3] are considered energy efficient approach for wireless sensor networks. Clustering divides the nodes in independent clusters and selects a head for each cluster. Nodes send sensed data to respective cluster head; cluster head applies data fusion [4] to reduce the collected data to some meaningful information and sends aggregated data to base station. Communication between two nodes is the main energy consuming process that depends upon the distance between the two. Clustering avoids long distance communication of member nodes and only cluster heads are communicating to base station. Cluster head selection is decisive for the performance of clustering algorithms. Total intra-cluster communication distance and total distance of cluster heads to base station depends upon number of cluster heads. Static cluster-based method is more appropriate for moving target tracking in wireless sensor network. However, the static cluster nodes have boundary problem when the target moves across or along the boundaries of one cluster to another cluster. The boundary problem will result in the increase of tracking uncertainty. Therefore, a better protocol is require to solve the boundary problem, to decrease the use of node energy, minimize processing time of the node, increase network lifetime [7] and local sensor communication in cluster based sensor networks.

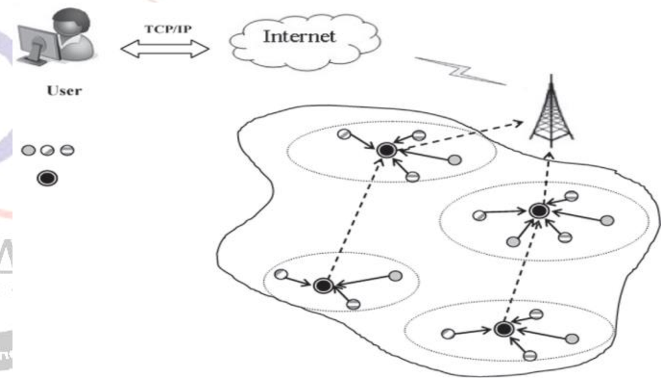

Figure 1: A typical clustered sensor network.

II. LITERATURE REVIEW

2.1 Low-Energy Adaptive Clustering Hierarchy (LEACH)

The clustering method LEACH has been proposed by Hein Zelman et al. [5] in which shared the energy load amongst the sensor nodes equally. LEACH consists of two working phases during network establishment. In the first set-up phase, sensor nodes select a local cluster head randomly among themselves, that the network may balance energy over consumption across the complete network. After the cluster head selection process, each cluster head broadcast their node id to all sensor nodes that these are the new cluster heads. Once the nodes receive the advertisement message from cluster head, each of them decides to which head it belongs to. In Second steady state phase, every sensor node sense and transmit data to the sink through their cluster head. After some period of time, the network again restarts the set-up phase. LEACH adopts multiple hops to communicate with

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node to base station, which makes it more practical than direct communication method.

Advantages: LEACH incorporates randomized rotation of the high-energy cluster-head position such that it rotates among the sensors in order to avoid draining the battery of any one sensor in the network [3]. LEACH Protocol is the first protocol of hierarchical Routings which proposed data fusion [3] [6].

Limitations with LEACH: In LEACH, Head selection criteria depend on the no of rounds and at a time only two nodes will be active others are sleep. But this is time consuming because it will take long time to broadcast data so the packet delivery ratio to the destination node will be low. This is disadvantage for large scale network.

2.2 Hybrid, Energy-Efficient Distributed Clustering (HEED)

HEED is clustering algorithms that use the rest energy of the node to select the Cluster Heads (CHs). It is an improvement of LEACH routing protocol that considers residual energy and communication range as a selection criteria of the cluster head. The result of the HEED routing protocol is generated with better energy efficiency even as compared to LEACH, also increasing the network lifetime of WSN node. Its primary parameter is residual energy of the node. In this, all nodes are considered to be homogeneous having same initial energy. As the lifetime of the sensor network is finite, there is requirement of re-energizing the sensor network by adding some sensor nodes. These nodes will be furnished with more energy than the nodes that are already in use, which creates heterogeneity in terms of node energy [6] [8].

Advantages [6] [8]*:*

(1) It is highly used clustering technique that advantages from the utilization of the two important constituents for CH determination, for example, node energy and correspondence range.

(2) Low power levels of cluster promote a development in spatial reuse while high power levels of cluster are important to use for middle cluster correspondence. This CH gives equalizations in the heap.

(3) Communications in a multi-hop trend between CHs and the BS warns more energy promotion and enhancement in difference with the single-hop trend, i.e., long-range communications directly from CHs to the sink, in the LEACH protocol.

Limitations with HEED:

(1) The bigger number of CHs are produced than the normal number this represents disequilibrium low energy drift in the system.

(2) Similar to LEACH, the work of cluster in every round forces critical measure of energy utilization in decreasing the network life time.

(3) HEED experiences a subsequent overhead since it needs a few reiterations to generate clusters. At every reiteration, considerable measures of parcels are broadcast.

(4) Some CHs, particularly close to the sink, may kick the bucket prior on the grounds that these CHs have most extreme work load.

2.3. Threshold sensitive Energy Efficient sensor Network protocol (TEEN)

TEEN [9] is a various levelled protocol whose primary aim is to adapt to sudden changes in the detected properties, for example, spot of the objective. The convention consolidates the various levelled technique in accordance with an information driven viewpoint. The nodes sense their surroundings reliably, yet the energy utilization in this calculation can likely be substantially less than that in the proactive network, in light of the fact that information transmission is done less over and over.

TEEN uses a 2-level clustering topology is having two threshold values, hard threshold and delicate threshold. The prior threshold is starting limit esteem for the detected attribute. It is the ideal worth, past which the node detecting this quality must switch on its transmitter to transmit detected credits and report to its CH. In TEEN, a CH transmits its introductory qualities a hard limit and delicate edge to the nodes. Therefore the hard threshold tries to straightforwardness information correspondences by permit the node to transmit just when the detected worth is in the middle of hard and delicate limit esteem. The delicate threshold diminishes information interchanges when there is little or no adjustment in the detected worth. At the expense of expanded energy use, a littler estimation of the delicate threshold removes more correct data of the system. Consequently clients can deal with trade-off between energy proficiency and information.

Advantages:

(1) Based on the two threshold values, information transmission can be controlled in better way, i.e., just the sensitive information can be send to BS, so it lessens the energy needed for transmission and enhances the viability and ease of use of the receiving information.

(2) It supplements for huge changes in the sensed properties, which is suitable for time discriminating applications.

Limitations with TEEN:

(1) It is not suitable for repeatable time discriminating applications since the client may not get any information at all if the estimations of the characteristics may not achieve the limit.

(2) TEEN has squandered time-slots and a plausibility that the BS will be unable to separate terminated nodes from live nodes.

(3) If CHs are not in the scope of one another the information may be lost, so the fact that data television is accomplished just by the CHs.

2.4 Hybrid cluster-based target tracking (HCTT)

The static bunch enrolment averts sensors in various clusters from working together and imparting information to each other, which causes a supposed boundary issue when the

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object moves over the boundaries of clusters .So the new protocol was developed to solve the boundary problem and realized the trade-off between energy consumption and local sensor collaboration for cluster-based sensor networks.

A novel distributed mobility management protocol [10], called hybrid cluster-based target tracking (HCTT), for efficient target tracking in a large-scale cluster-based WSN. HCTT incorporates on-request unique grouping into an adaptable cluster based WSN with the assistance of boundary nodes, which encourages sensors' joint effort among clusters to take care of the boundary problem. When the target is inside a static cluster, the cluster is responsible for target tracking; as the target moves close to the boundaries of clusters, an on-demand dynamic clustering process will be triggered to manage the tracking task so as to overcome the boundary problem. The on-demand dynamic cluster will destroy soon after the target moves away from the boundaries. When the target moves, static clusters and on-request dynamic clusters consecutively manage the tracking task. This mechanism guarantees smoothly target tracking and realizes well trade-off between energy consumption and local sensor collaboration.

Advantage:

With reference to above HCTT has benefit over the LEACH, HEED, TEEN and AFTEEN protocol, it avoids boundary problem, transfer target smoothly from one static cluster to another cluster.

Limitations with HCTT:

As per above discussion it has limitation about energy consumption. HCTT requires more energy in boundary region nodes for on demand cluster generation process.

2.5. Routing protocols for wireless sensor networks

Review chronology

A shown in Fig. 2 the chronology-based percentage calculation for routing in wireless sensor networks. In 2015, 42% of works are done in the field of routing, which is comparatively higher than the works that are done in the consecutive year. About 8% works are done in2014 and 2016. The predicted data represent the recent research and developments in the field of routing in wireless sensor networks. The routing protocols have been developed to face the problems, which are caused due to the features such as energy consumption, delay and error.

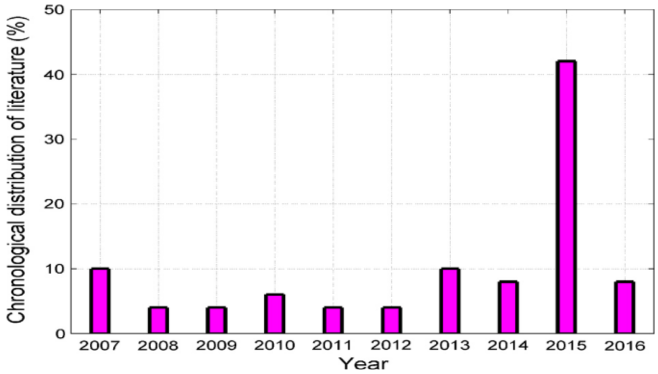

Fig.2: Development of routing protocols for WSN over the time period.

The protocol that imparts energy efficiency has been developed more in number than the other featured protocols and it has peaked 38.46% in 2015.

III. PROPOSED WORK

3.1 Energy Efficient Target Tracking Protocol (EETTP)

Each node can run in three states. In active state, it can send packets, receive packets, and sense the target. In Sensing state, it can only perform sensing operations. And in sleep state, it sleeps for most of the time and wakes up when it can sense the target and listen to messages from another node. Since energy consumption rate is high during communication. In this paper, I propose a novel distributed mobility management protocol called cluster-based target tracking protocol for energy-efficient target tracking in a large-scale WSN. CTT integrates clustering into a scalable cluster-based WSN with the help of boundary nodes, which facilitates sensors collaboration among clusters to solve the boundary problem. In energy efficient routing protocol whenever node detects the target at that time node stores that value as threshold value. This value consist some attributes such as target id, node id, cluster head id and time. When node monitors target continuously, simultaneously in back end monitoring node compare his historical threshold value with the new value if node obtains different node id, with new time slot then broadcast that new values to the neighbour nodes and cluster head that value is new threshold value. Otherwise that node will not make any communication with neighbour and cluster head. In this way with the help of energy efficient routing protocol we reduce communication cost.

The vital commitments of this paper are as per the following:

• We address the boundary problem for object tracking in a cluster-based Wireless Sensor Network.

• With the assistance of proposed routing protocol increase the system lifetime of the each node and diminish correspondence overhead between two nodes.

• The proposed algorithm is scalable to multi-hop static clusters and solves the problem of tracking uncertainty.

3.2. Cluster Generation

The Cluster formation process is shown in following algorithm. Cluster formation uses the RN, NTE, and CD to group the sensor in the same cluster. Upon receiving the broadcasted message each node checks the value of RN, NTE. If its value is within RN, NTE it saves in its buffer and compares CD with each node's distance. If the distance between nodes is less than or equal to CD and sensed value is within given RN then those groups of nodes forms a cluster.

Algorithm 1. Cluster Formation

Input: NID, NL, TS, NTE, NV, RN, CD

Output: CHID, CHTID

Node: Total Received Request from Nodes in RN

ClusterFormation (NID, TS, TE, NL, CD, RN, NTE)

{

NodeBroadcast (NID, NL, TS, TE, NV, RN, NTE) //within given CD

Receive (NID, NL, NV, RN, NTE) //Receive with CD sensor Ids

Compare data range RN

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For (Sensor Vi=1 to Vi=n, i++)
{
//Compare each Si RN and CD to
If (RNi<=RNi+1 && NTEi<=NTEi+1)
{
Join Cluster (RNi+1)
}
Else
{
Join Cluster (RNi)
}}
Return (CHID, CHTID)
}

3.3. Boundary Node Formation

In static cluster when the target approaches the boundaries of multiple clusters. A challenging issue is how the system finds the scenario when the target is approaching the boundaries. As sensor nodes are randomly deployed, it is difficult to calculate the geometric boundaries of irregular clusters. In this paper, we use boundary nodes present at the boundary region of cluster to solve this issue in a fully distributed way.

In contrast, a node is defined as an internal node of its static cluster if it is not a boundary node. As each node is aware of its own location and its neighbour information, it checks its neighbour list in the buffer to determine whether there exists a node belonging to another cluster within its sensing range. If yes, it is a boundary node; else, it is an internal node of the cluster. The boundary node bunch of a cluster Ci, denoted by $B(Ci)$, is formed by all the boundary nodes in Ci.The internal node set of a cluster Ci, denoted by $I(Ci)$, is generated by all the internal nodes in Ci. The pseudo code of the boundary node formation process is described in Algorithm 2.

Algorithm 2: Boundary node formation.
Input: Graph G = {V, E}, cluster sets Ci*, i = 1, 2. . . m.*
Output: B (Ci*), i = 1, 2. . . m.*
(1) For each cluster Ci *do*
(2) B (Ci*)* $\leftarrow \phi$
(3) For each node $Vj \in Ci$ *do*
(4) While $\exists Vk \in N(Vj)$ *such that* $d(lk, lj) \leq rs$ *and*
$(Vj) \neq (Vk)$ *do*
(5) Vj. $state \leftarrow boundary$
(6) $B(Ci) \leftarrow (Ci) \cup \{Vj\}$

After boundary nodes are specified, each cluster can be divided into three parts: safety region, boundary region, and alert region.

Safety Region: The safety region of a cluster Ci, denoted by (Ci), is the region in cluster Ci that can be monitored by at least one internal node of Ci, but not by any boundary node of Ci. That is, (Ci) can be formulated as in equation 1:

$$Ri = \bigcup_{\forall Vi \in I(Ci)} Ri(Vi, Rs) - \bigcup_{\forall Vi \in B(Ci)} Ri(Vi, Rs) \qquad (1)$$

Boundary Region: The boundary region of a cluster Ci, denoted by RB (Ci), is the region that can be monitored by some boundary nodes of both Ci and any of its adjacent clusters at the same time. That is, (Ci) can be formulated as in equation 2.

$$Rb(Ci) = \bigcup_{\forall Vi \in B(Ci), \forall Vj \in B(Cj), \forall Ci \mp Cj} R(Vi, Rs) \cap R(Vj, Rs) \qquad (2)$$

Alert Region: The alert region of a cluster Ci, denoted by RA (Ci), is the region that can be monitored by at least one boundary node of Ci but not belongs to the boundary region of Ci. That is, R (Ci) can be formulated as in equation 3.

$$Ra(Ci) = \bigcup_{\forall Vi \in B(Ci)} R(Vi, Rs) \cap Rb(Vj, Rs) \qquad (3)$$

IV. ADVANTAGES OF CLUSTER BASED METHOD

When we use a cluster based target tracking protocol for moving target in a given region in wireless sensor network. This protocol grows the scalability of a sensor network. Throughout energy consumption of the nodes is reduced, leading to prolonged network lifetime. Sensor nodes organized into a cluster based network borrow it for perfect data aggregation, which results in better use of the bandwidth. Cluster-based routing take good assurance for many-to-one and one-to-many communication samples those are regnant in sensor networks. By using this protocol we trace out the exact position and path travelled by target at a given instant of time with no error.

Table 1: Comparative study of static and dynamic clustering

Parameters	Static Clustering	Dynamic Clustering
Localization error	Maximum	Minimum
Cluster head selection	Statically defined	Maximum residual energy
Cluster formation	Simple	Complex
Energy consumption	Low	High

V. ARCHITECTURAL DESIGN

After all nodes deployed over an area, sensor nodes are organized into static clusters. Each and every node works in two states active state, sleep state. In active state node is responsible to sense the target, send the message about target to the neighbour node, and cluster head. In sleep state node is only responsible to receive the message form neighbour. When the sleep state node receive message about target approaches in his neighbour node range that means it change its state from sleep to active state. When the target is in the network, static cluster nodes sense the target. Static cluster nodes will send target ID, node id, time, cluster head id to neighbour node and cluster head, Wakes up neighbour node to track the target. When neighbour node receive message from his neighbour node, that node firstly check his buffered neighbour information, change its state from sleep state to active state and it is ready to track the target. This whole process requires more communication cost and it consumes energy of the node because continues monitoring and broadcasting and receiving nature. For reducing communication cost we use prediction method such as like TEEN and AFTEEN protocol.

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In energy efficient routing protocol whenever node detects the target at that time node stores that value as limit value. This value consist attributes such as target id, node id, cluster head id and time (Ti d, Ni d, CHi d, Ts) respectively. When node monitors target continuously, simultaneously in back end monitoring node compare his historical limit value with the new value. If node obtains different node id, with new time slot then broadcast that new values to the neighbour nodes and cluster head and that value is considered as a new limit value. Otherwise that node will not make any communication with neighbour and cluster head. In this way with the help of energy efficient routing protocol we reduce communication cost. In second case, when target reach in boundary region. Boundary nodes in that region can detect the target and that node smoothly tracking the target because that node is responsible to communicate with boundary nodes of another cluster and with static nodes in his cluster. As the target moves across the boundaries, static clusters and boundary nodes are alternately manage the tracking task.

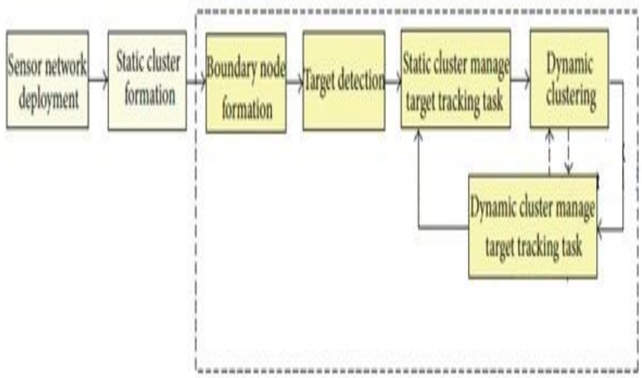


Figure 3: System Architecture

Data Design

5.1 Internal / Global data Structure

This information is used when we deploy and create clusters of the wireless sensor nodes. The table is used to store neighbour node information. Tuple contains $N_{i\ d}$, $CH_{i\ d}$. Node id field represents the node that is neighbour node, Cluster head id represents the leader node of the node belongs to that cluster region.

5.2 Temporary Data Structure

This information is used when we track moveable target over an area. The table is used to store neighbour node information. Tuple contains ($T_{i\ d}$, $N_{i\ d}$, $CH_{i\ d}$, and Ts). Node id field represents the target detecting node, Cluster head id represents the leader of the node belongs to that cluster region, $T_{i\ d}$ represents the moveable target id. T_s represents current time.

VI. SIMULATION PARAMETERS AND RESULT ANALYSIS

Following are some performance metrics considered for analysing the performance of cluster based target t using WSN. Based on these parameters we can analyse and compare the performance of our system with some existing protocols.

6.1 Data transfer across nodes

Data transfer is done through two steps; packet segmentation and encoding; data forwarding. The details are given below.

6.2 Impact of packets generation rate

In this experiment, we change the packets arrival rate at the target detecting node when the event is done at current time instant packets. We compare our protocol with the HCTT protocol.

6.3 Average energy consumption

Following Fig shows the results for the energy consumption. From the figure, we note that EETTP slightly outperforms HCCT; this is because of the communication overhead induced by the node computation. However, meeting the quality of service requirements (delay and throughput) introduces a certain over- head in terms of energy consumption. Thus a minimum trade-off with delay and throughput should be made to reduce the energy expenditure [21]. Average energy consumed by node during simulation time is calculated using following formula:

$E_{avg} = E_{tr} + E_s + E_i$

Where

E_{avg}: Energy consumed by a node

E_{tr}: Energy consumed by a node during packet transmission.

E_s: Energy consumed by a node during packet received by a node.

E_i: Ideal power.

Energy of a node during simulation according to hctt33.tr file.

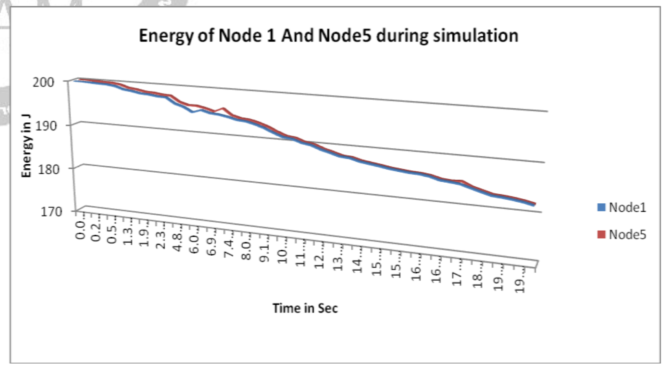
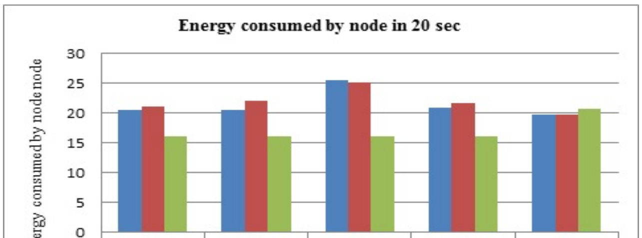


Fig.4: Energy of node1 and node5 during simulation of 20 sec.

Energy consumed by a node in 20 sec.



	1	2	3	4	5
NT	20.47	20.47	25.6	20.99	19.82
HCTT	21.07	22.14	25.19	21.73	19.82
EETTP	16.18	16.18	16.18	16.18	20.67

Figure 5: Energy consumption by a target tracking node in 20 sec.

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Energy Consumption by Node 1 and Node 5 in 20 seconds is as shown below.

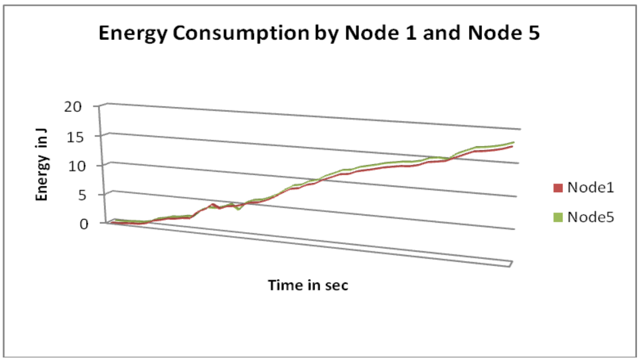

Figure 6: Energy consumption by a target tracking node in 20 sec.

VII. CONCLUSION

One of the best applications of WSN is tracking the moveable object. Tracking a moveable target in cluster-based wireless sensor network is facing the boundary problem in cluster. In this paper, we propose an energy efficient target tracking protocol for tracking a moveable object in WSN with high accuracy and smoothly. The protocol intact scalable cluster based wireless sensor network with the boundary nodes, which access sensors co-operation among clusters and their target tracking from one stable cluster to another. Also we presented a Clustering and initial threshold value for reducing energy consumption and communication cost that will extend the lifetime of WSNs effectively.

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