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Improvement of low energy adaptive cluster hierarchy protocol using information processing for WSN

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Abstract-Wireless Sensor networks (WSNs) are special type of adhoc networks which makes use of sensors (also known as motes) for gathering information. The data collected by each sensor is communicated through the network to a single processing center that uses all reported data to determine characteristics of the environment or detect an event. Routing is a process of sending the data from source to destination with the help of the nodes. Routing in sensor networks requires special attention because nodes in this network have limited energy supply. There are three types of routing in the WSNs. In flat networks, each node typically plays the same role and sensor nodes collaborate to perform the sensing task . Hierarchical Routing on the other hand has higher-energy nodes that can be used to process and send the information, while low-energy nodes can be used to perform the sensing in the proximity of the target, Location Based Routing: In this kind of routing, sensor nodes are addressed by means of their locations. This paper discusses the problem in one of the existing routing protocol and suggests an improvement to deal with the problem. The Low Energy Adaptive Clustering Hierarchical (LEACH) protocol performs information gathering & processing with the help of cluster heads. In the current approach, a cluster which has once acted as a cluster participates in the election again & again, which is not feasible in the given spectrum of limited energy. The work proposes a solution to the problem by adding the concept of information processing to it by eliminating the redundant data, old data and repeated data. Also there is not any solution when only one node left in the cluster and elected as CH result in the wasting of energy.

Keywords-WSN, sensor nodes, cluster, routing, energy efficiency etc.

I. INTRODUCTION

WSNs usually contain thousands or millions of sensors, which are randomly and widely deployed. Sensors are powered by battery, which is impossible to get recharged after deployment. But sensor networks are designed to last. Thus, energy efficiency is an important issue in sensor networks[1][2]. Hierarchical or cluster based routing methods, originally proposed in wire line networks, are well-known techniques with special advantages related to scalability and efficient communication. E.g :LEACH. It is named as Low Energy Adaptive Clustering Hierarchy as in every routing energy awareness is essential issue so LEACH protocol save the energy .LEACH is a clustering-based protocol proposed by Wendi shown in figure.1 LEACH utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station. First of all LEACH [5][6] protocol uses the CDMA/TDMA MAC to reduce the inter /intra collision and data collection is centralized and performed periodically.There is cluster head in the hierarchal routing, LEACH protocol randomly select the few nodes as cluster head and evenly rotate them to other nodes to save the energy, then the CH compress data that are arriving from the nodes and belongs to a respective cluster and

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CH send data to cluster in aggregated packet in order to reduce the unnecessary data that must be transmitted to BS. It is best use where energy dissipation and constant monitoring of data is required.

1.Advantages of LEACH are:LEACH protocol increases the network lifetime.

2.Disadvantages of LEACH are: Information is not processed in the LEACH. There is no solution when there is only one node left in the Cluster. Data is not negotiated. The Dynamic nature of the routing techniques also create overhead in the LEACH protocol.
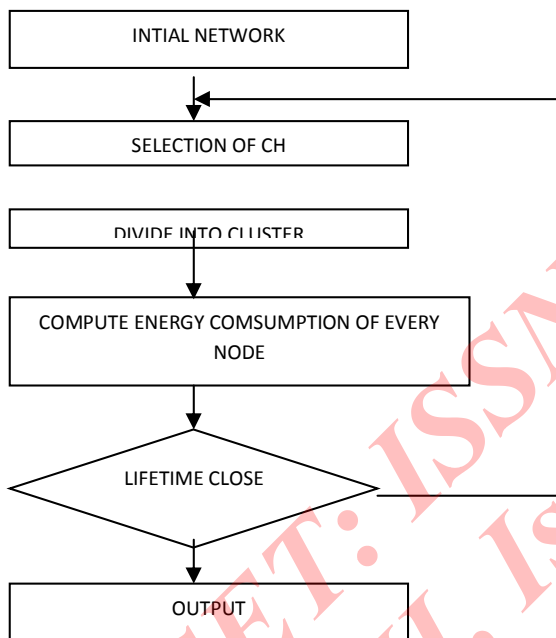

Figure.1 The LEACH protocol

II. WORKING OF EXISTING LEACH PROTOCOL

The operation of LEACH is broken up into rounds, where each round begins with a set-up phase, when the clusters are organized, followed by a steady state phase, when data transfers to the base station occur. In order to minimize overhead, the steady-state phase is long compared to the set-up phase. The operation of LEACH protocol is separated into two phases.

1. **Set up Phase:** In this phase, the cluster and cluster heads are organized.
2. **Steady Phase:** Here the actual data transfer to BS takes place and timing of this phase is always higher than the set up.

During the first phase randomly selected nodes p elect them as CH as follows: A sensor node selects a random number r between 0 and 1. If r < T (n), then it becomes the cluster head for that round. The threshold Value T (n) [1] is calculated as $T(n) = p / (1 – p(r \bmod(1/p))$ IF n belongs to G. Where G is the set of nodes that have not been selected and as CH in the last (1/p) rounds or set of nodes that are evolved in the cluster head election. Now when a node is elected as a CH, it will broadcast message to all the other nodes and the node which is participating in cluster head selection will also send message to CH that they are also the part of cluster. When message is sent to all nodes, CH creates a TDMA which assigns a timeslot to each node when it can transmit and the time when it can transmit is broadcast to all nodes in the cluster. This is shown in the figure.2 [8]. It shows that how the cluster heads are elected and how we apply the CDMA/TDMA. After the overall process i.e. CH selection and receiving data from nodes, the CHs send data to the BS station directly. This is shown in the figure.3

LEACH outperforms static clustering algorithms by requiring nodes to volunteer to be high-energy cluster-heads and adapting the corresponding clusters based on the nodes that choose to be cluster-heads at a given time. At different times, each node has the burden of acquiring data from the nodes in the cluster, fusing the data to obtain an aggregate signal, and transmitting this aggregate signal to the base station as shown in the figure.3LEACH is completely distributed, requiring no control information from the base station, and the nodes do not require knowledge of the global network in order for LEACH to operate.

The key features of LEACH are:

- Localized coordination and control for cluster setup and operation.
- Randomized rotation of the cluster "base stations" or "cluster-heads" and the corresponding clusters.
- Local compression to reduce global communication.

Drawback of LEACH is:

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- Cluster heads are selected randomly in LEACH, it is possible that nodes with less energy would be chosen, which could lead to these nodes die too fast.
- In addition, because in LEACH protocol cluster heads communicate with base stations in single-hop manner, it is energy consuming and its expandability is limited so that it could not adapt to large network.
- It did not give a definite method to determine the optimal number of cluster-heads, the ratio between the cluster-heads and whole sensor nodes will have great impact to the network performance.
- The idea of Dynamic cluster also put the extra overhead.
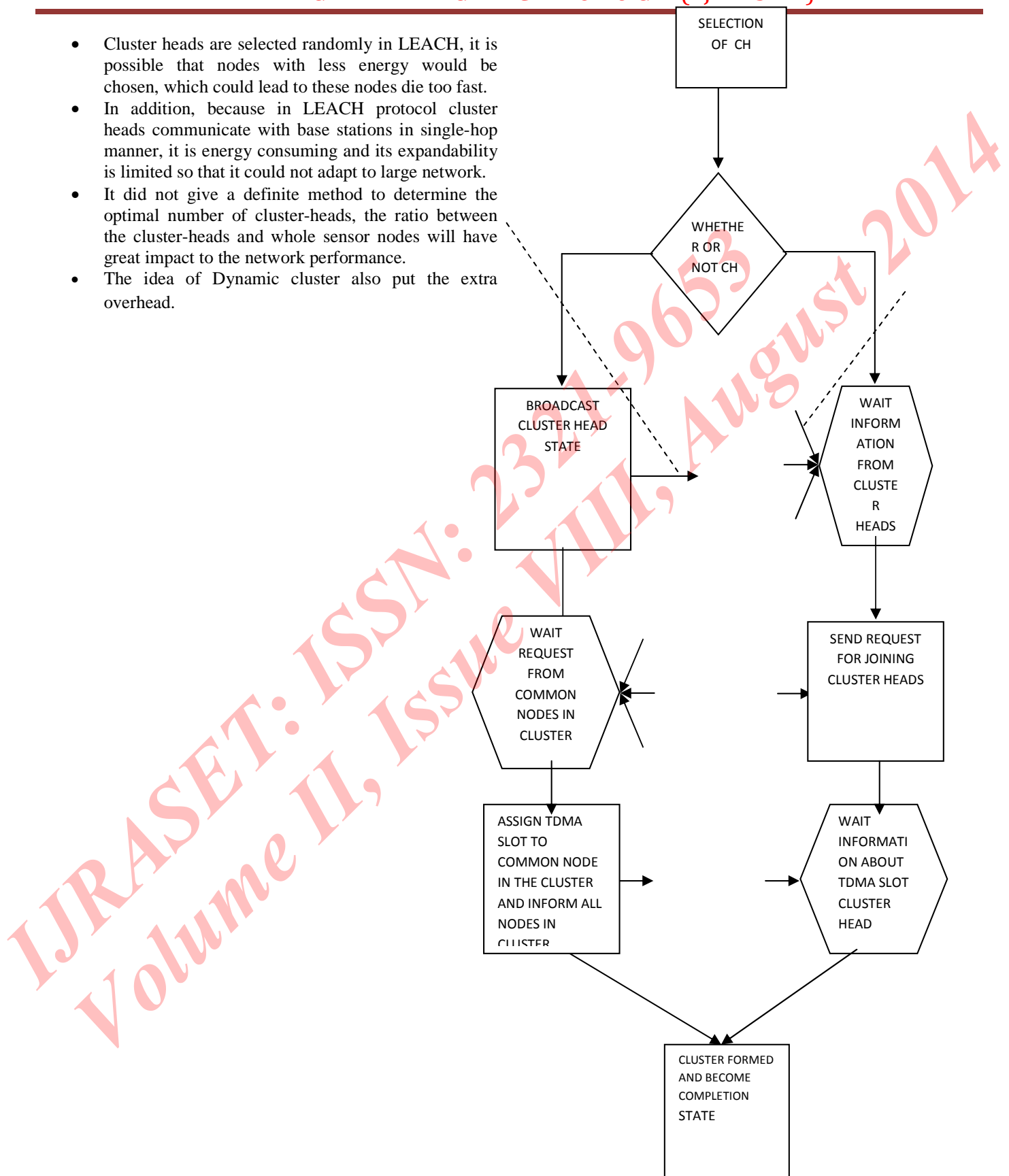
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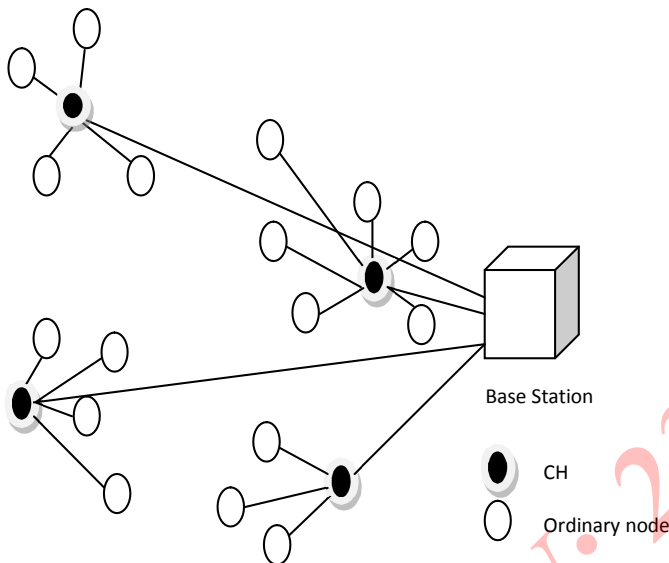
Figure.2 Selection of CH node

Figure.3 CH sending data to the BS

III.   PROBLEM STATEMENT

Hierarchical Routing is better than the Flat Routing because in the Hierarchical Routing there is not any collision overhead in it as compared to the flat routing. There are Clusters in the Hierarchical Routing which help is saving the energy and cover the large area and also data aggregation is provided by the Hierarchical Routing. In the Hierarchical Routing there are various protocols like LEACH, PEGASIS, TEEN, and MECN[4]. But among the all these protocols LEACH is best because it consumes less energy as well as it have high network cycle. Because in PEGASIS topology adjustment is needed and in TEEN, there may be possibility that node will never communicate if threshold do not meet etc. The extensive literature review done in the field of LEACH reveals that each versions of the LEACH have same advantages as well as limitation but still there is something to improve in the LEACH protocol.

IV.   THE PROPOSED WORK

Improvement in LEACH protocol using the Information Processing (LEACH-IP)

The proposed work thus introduces an efficient technique for routing in hierarchical wireless network. By using simulation, substantial improvement in energy can be achieved by the proposed algorithm. In the LEACH, from the earlier version two improvements has been done in the LEACH protocol[7][9]l. As LEACH protocol consists of two phases:1. Set Up State Phase**2.**Steady State Phase.

In the Set Up state phase when the Cluster head has been selected it don't include what will happen if there is a single node in the Cluster and that node is elected as CH. If there is only single node in the cluster and it is elected as CH then from where it will receive the data resulting in the wastage of energy, time as well as network lifetime. So in the research work in the Set up phase during the first round of CH selection apply a condition i.e. a node will be elected as CH only if when there are two or more than two nodes in the CH otherwise the node will be discarded .Second problem is in the Steady State phase. In the steady state phase when node is elected as CH, it will start receiving the data from the various nodes, then how can it be sure that data is complete and redundancy free. In the Steady State Phase, the research work suggests the concept of information processing i.e. when a CH receive the data from the various nodes, it will check the various things: First of all it will check that data is complete or not, if data is complete then it will apply next part of information process else CH will discard the data, Secondly it will check that data is repeated or not means CH already have same data or not, if it is then it will discard that data else CH will apply next part of information processing. Thirdly it will check for the old data in the terms of the time, if the CH receives the data that is not required at that time then CH will reject that data[3]. These all thing will be clear with the help of the flowchart as shown in the fig.4 and figure.5.

Working of the Proposed Protocol

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1 Algorithm for the Set up Phase: The algorithm for the set up phase of the propose protocol consists of nine steps. These steps are shown below:

Step 1 Start first round of the CH Selection.

Step 2 Take E_c of each node and Calculate E_a for all nodes.

Step 3 Select nodes for CH only which have $E_c >= E_a$.

Step 4 Check there are at least one node in the range of the cluster head.

Step 5 if yes then go to step 6

         Else discard node as CH and go to step 1.

Step 6 If node become the Cluster Head then

     a. Broadcast ADV message to all other nodes that it is CH.
     b. Receive Join Request from various nodes which want to join it.
     c. Assign TDMA slots for the transmission of DATA.

Step 7 Else

     a. Wait for the finalization of CH
     b. Receive join Request from the various CH.
     c. Send Join Request to the nearest Cluster

Step 8 Perform Steady Operation

Step 9 Perform Step 1 to 8 for the next rounds.

2. Algorithm For the improved Steady Phase

Step 1 If the node is CH, then

     a. Receive data from all nodes in the Cluster and check
         (i) If Data is incomplete then discard it and go to step a
         (ii) Else go to step b
     b. Check if Data is Repeated then discard it and go to step a
         (i) Else go to step c
     c. Check if data old then discard it and go to step a

         (i) Else go to step 2.

Step 2 Else

     (i) Send data to CH.
     (ii) Sleep the node until the next round

Step 3 Perform the Data Compression.

Step 4 Perform the Data Aggregation.

Step 5 Perform Multihop Routing.

Step 6 Send Data to the Base Station.

Step 7 Repeat Step 1 to Step 6 for the next rounds.

.E_c, E_a :Calculate Current Energy and Average Energy

Eli L_e :Eliminate nodes with the lower energy

CHS, CF: Cluster Head Selection and Cluster Formation

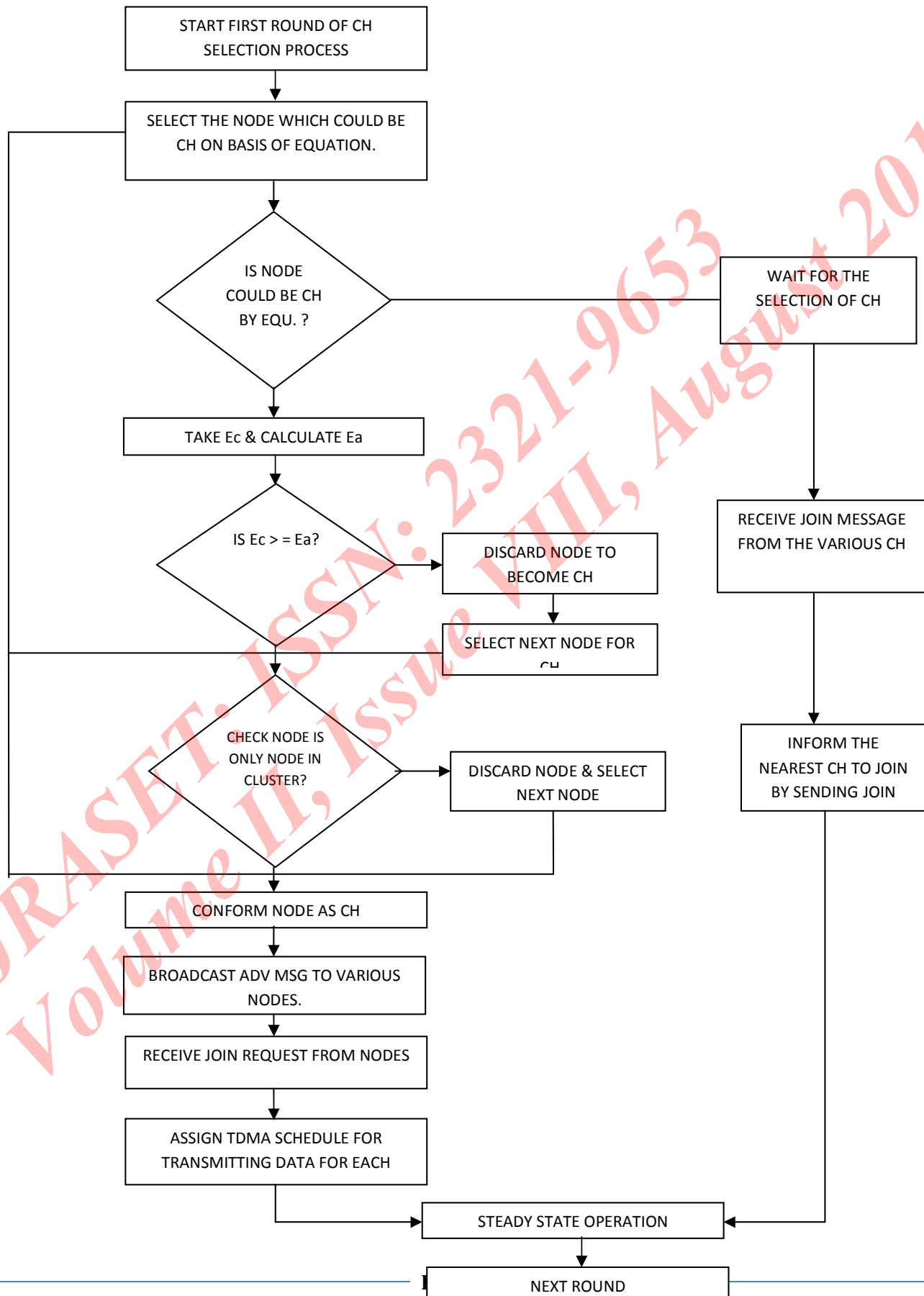TDMA :Assigning Time Division Multiple Accesses

CR, COD :Check for redundant data and old data

PDA :Perform data aggregation and Data Compression

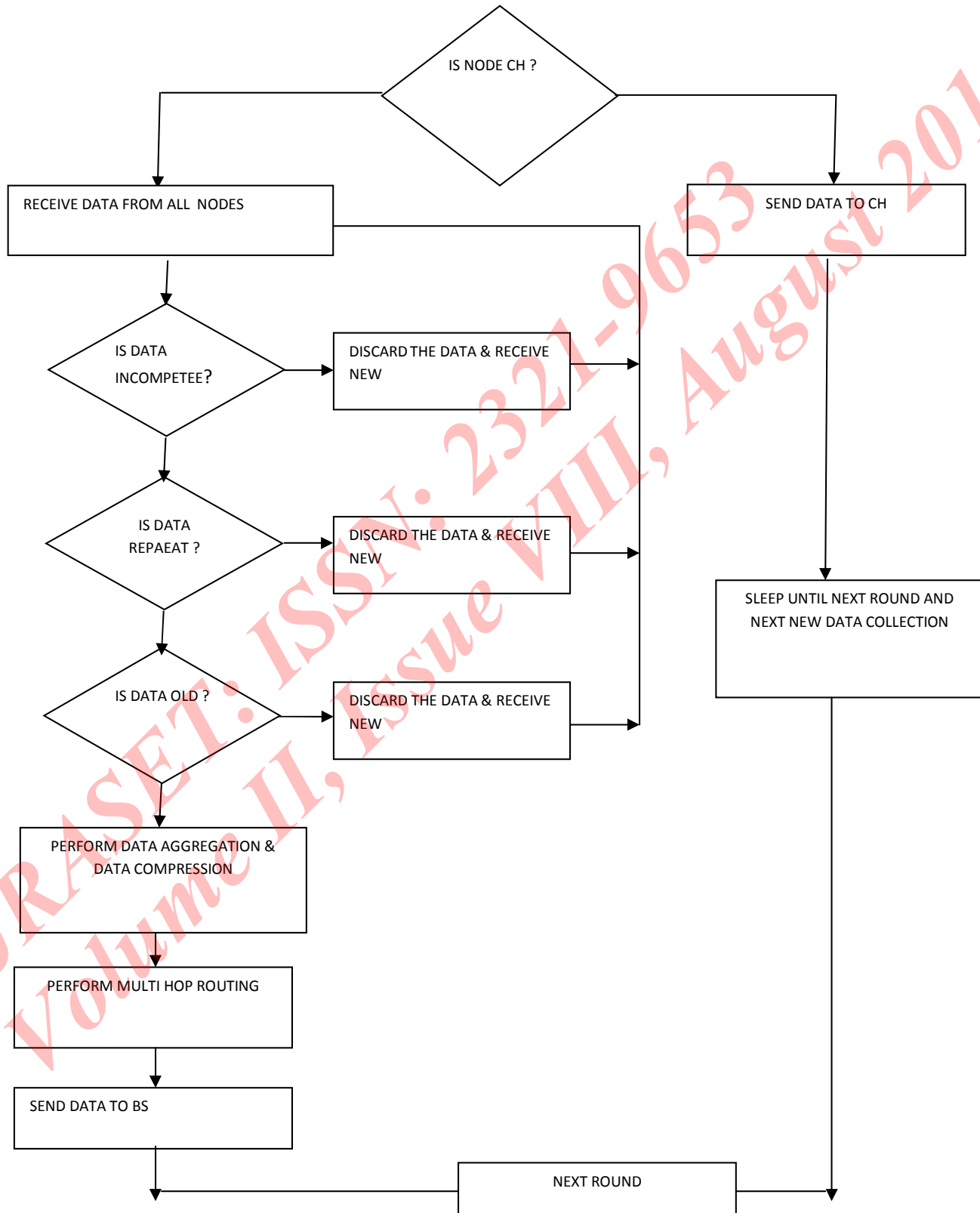PMHR :Perform Data Compression and Multihop Routing

Send to CH: Send the data to the cluster head

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Figure.4 Flowchart of improved setup phase.

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Figure.5 Flowchart of improved steady phase

V. COMPARITIVE STUDY OF EARLIER LEACH AND MODIFIED LEACH

There are a lot of differences between the earlier LEACH protocol and modified protocol on the basis of the proposed work. The modified LEACH protocol is advantageous than the earlier version due to a lot feature in the modified. So there some differences which makes the modified LEACH protocol better than the earlier and they are shown in the table.1

VI. ANALYSIS OF THE PRORPOSED WORK

The existing routing protocol (i.e. LEACH) has been enhanced by adding the concept of **information processing** to it. The extension proposed to LEACH protocol contributes to improve the performance of the protocol. By adding the feature of data negotiation substantial improvement in time & energy is estimated. The algorithms that have been proposed above are assumed to increase the lifetime of a network as well as save the energy because the same data will not be repeated every time.

1.The proposed enhanced protocol

In LEACH-C, energy is consumed in the following Four phases:

a. Prior to each round of cluster head selection, all nodes report its residual energy to the sink node. So energy is consumed in this phase of the LEACH-C protocol.

b. After a round of CH selection the sink node broadcasts messages to all nodes so energy is also consumed in this phase.

c. Stable Transmission also consumes energy

d. Energy is also consumed in reselection of the CH by considering all the nodes as a participant and energy is consumed when there is only node in the cluster and it is cluster head because no data is transmitting during this period.

e. So total energy consumed in the LEACH-C protocol is a + b + c + d.

In LEACH-IP (Low Energy Adaptive Control Hierarchical Protocol with information processing), energy is consumed in the following three phases:

a. Energy is consumed is deciding the nodes having energy greater than or equal to average in selection of CH. Energy is saved in the next round of CH selection because the nodes which have energy less than the average are not considered here thus negligible energy is consumed in deciding this.

b. Energy is consumed in sending and receiving ADV messages.

c. Energy is consumed in the information processing by removing old data as repeated data.

d. Stable transmission of data also consumed energy.

Total energy consumed in the LEACH-IP protocol is a + b + c + d which is same the earlier version of the LEACH protocol. But the feature of the Information processing has been added in the newer version which is very helpful in the various applications as well as it save the energy by elimination the node as CH when there is only node in the cluster. This save the energy as compare to the earlier version because it allow the node to be a CH when there is only node in the cluster and the CH will not be able to receive any data, so wastage of time as well as energy.So analysis shows that the current version of LEACH i.e. LEACH-IP consumes less energy as compare to the earlier version of LEACH as well as the various feature like information processing has been added to the earlier version.

2.Advantages: Energy Consumed is less as compared to earlier LEACH. It is used in the military application where always new data are required instead of repeated data.It can used be the greenhouse monitoring where the latest data are

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required from time to time as our improved protocol have the capacity to discard the old data.

Table.1 Comparative Study of Earlier LEACH and Modified LEACH

Difference	Earlier LEACH Protocols	Modified LEACH Protocol
Differentiation on the basic of single node in Cluster	In Earlier protocol, it did not include the effect of a single node in the cluster which consumes time and energy	In modified protocol, it takes the effect of single node in the cluster and apply condition that no node in a cluster would be CH if there is one node in a cluster
Incomplete Data	It does not take the effect of the incomplete data, earlier protocol accept all data whether it is complete or not	In the modified protocol, it apply the restriction that the node will accept data only when it is complete otherwise reject it
Repeated Data	In earlier protocol there is not any restrictions for repeated data, CH will take all the data even if it have the same data	In the Modified protocol the cluster head will select only the new data otherwise CH will reject that data
Old Data	In the earlier protocol, there is not any issue regarding the old data in term of time means when CH require a data at particular time but it will received the data after a long time than required so data becomes old and not usable	In the modified protocol, it applies the restriction for the old data in the terms of the time, it will reject the data if it is old
Information Processing	There is not any information processing in the old approach	There is information processing the new approach

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Multihop Routing	There is not any multihop routing in the various some protocol	In modified protocol, it includes the multihop routing along with the information processing

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